JPL D-26678-C

SIRTF FOCAL PLANE SURVEY
A PRE-FLIGHT ERROR ANALYSIS

APPENDIX C: MIPS

David S. Bayard
Paul B. Brugarolas
Dhemetrios Boussalis
Bryan H. Kang

September 1, 2003

Jet Propulsion Laboratory
California Institute of Technology

Copyright © 2003 California Institute of Technology. Government sponsorship acknowledged.

SIRTF INSTRUMENT POINTING FRAME KALMAN FILTER EXECUTION SUMMARY

IPF RUN NUMBER: 991087
REPORT TYPE: COVARIANCE ANALYSIS

PRIME FRAME: MIPS_160um_center_large_FOV (87)
INFERRED FRAMES: (88) (89) (91) (92) (1) (1) (1) (1)

IPF TEAM

Autonomy and Control Section (345)
Jet Propulsion Laboratory
California Institute of Technology
4800 Oak Grove Drive
Pasadena, CA 91109

Contents

1 IPF EXECUTION SUMMARY **4**

2 FLUTE DATA SUMMARY **8**

2.1 FLUTE CONFIGURATION PARAMETERS 8

2.2 FLUTE GENERATED UNIT TEST DATA 11

3 IPF EXECUTION RESULTS **16**

3.1 IPF EXECUTION OUTPUT PLOTS 16

3.2 IPF OUTPUT DATA (IF MINI FILE) 30

3.3 IPF EXECUTION LOG 35

4 USER COMMENTS **38**

List of Figures

1.1 A-priori and a-posteriori IPF frames 4

1.2 A-priori and a-posteriori IPF frames (ZOOMED) 7

2.1 Focal plane survey scenario plot (See key in [3]) 12

2.2 Commanded-only source locations 13

2.3 True (+) and commanded (o) source locations 13

2.4 True (+) and commanded (o) source locations (ZOOMED) 14

2.5 True-sampled (o) and centroided (+) locations on S/I array (W,V) 14

2.6 True (o) and centroided (+) locations on S/I array (W,V) 15

2.7 True (o) and centroided (+) locations on S/I array (W,V) showing prime and inferred frames 15

3.1 TPF coords of measurements and a-priori predicts 17

3.2 Oriented Pixel Coords of measurements and a-priori predicts 17

3.3 A-priori prediction error 18

3.4 Oriented Pixel Coords of measurements and a-priori predicts (PCRS only) 18

3.5 IPF execution convergence, chart 1 19

3.6 IPF execution convergence, chart 2 19

3.7 Parameter uncertainty convergence 20

3.8 IPF parameter symbol table 20
3.9 KF parameter error sigma plots 21
3.10 LS parameter error sigma plot 21
3.11 KF and LS parameter error sigma plot 22
3.12 Oriented Pixel Coords of meas. and a-posteriori predicts 23
3.13 Oriented Pixel Coords of meas. and a-posteriori predicts (attitude corrected) 23
3.14 Array plot with (solid) and w/o (dashed) optical distortion corrections 24
3.15 KF innovations with (o) and w/o (+) attitude corrections 24
3.16 W-axis KF innovations and 1-sigma bound 25
3.17 V-axis KF innovations and 1-sigma bound 25
3.18 Estimated attitude corrections (Body frame) 26
3.19 Estimated attitude error sigma plot (Body frame) 26
3.20 Thermo-mechanical boresight drift (equiv. angle in (W,V) coords) 27
3.21 Thermo-mechanical boresight drift (equiv. angle in Body frame) 27
3.22 Gyro drift bias contribution (equiv. rate in (W,V) coords) 28
3.23 Gyro drift bias contribution (equiv. angle in (W,V) coords) 28
3.24 Gyro drift bias contribution (equiv. angle in Body frame) 29

List of Tables

1.1 IPF filter input files 5
1.2 IPF filter execution configuration 5
1.3 IPF filter execution mask vector assignment 5
1.4 IPF calibration error summary ([arcsec], 1-sigma, radial) 6
1.5 Measurement prediction error summary (1-sigma) 6
1.6 IPF Brown angle summary 7
2.1 FLUTE Parameter Table (1) 8
2.2 FLUTE Parameter Table (2) 9
2.3 FLUTE Parameter Table (3) 10
2.4 Table of figures (FLUTE) 11
3.1 Table of figures (IPF run) 16

1 IPF EXECUTION SUMMARY

This report summarizes the SIRTF Instrument Pointing Frame (IPF) Kalman Filter execution associated with run file: RN991087. In particular, this Focal Point Survey calibrates the instrument: MIPS_160um_center_large_FOV (87), as part of the Covariance Analysis. The main calibration results from the IPF filter execution have been documented in IF991087 typically stored in the mission archive DOM collection IPF_IF. This report only summarizes the main aspects of the run, and does not substitute for the full information contained in the IF file.

Section 1 summarizes the filter execution results. The filter configurations are tabulated in Table 1.2 and the mask vector assignments are tabulated in Table 1.3. A total of 27 state parameters are estimated in this run. The overall End-to-End pointing performances are tabulated in Table 1.4. The prediction residuals throughout the estimation processes are tabulated in Table 1.6. Section 2 documents the FLUTE generated input file data. Section 3 summarizes resulting plots, a mini summary of the IF IPF output file, and the execution log. Section 4 captures the user comments that are specific to this particular run.

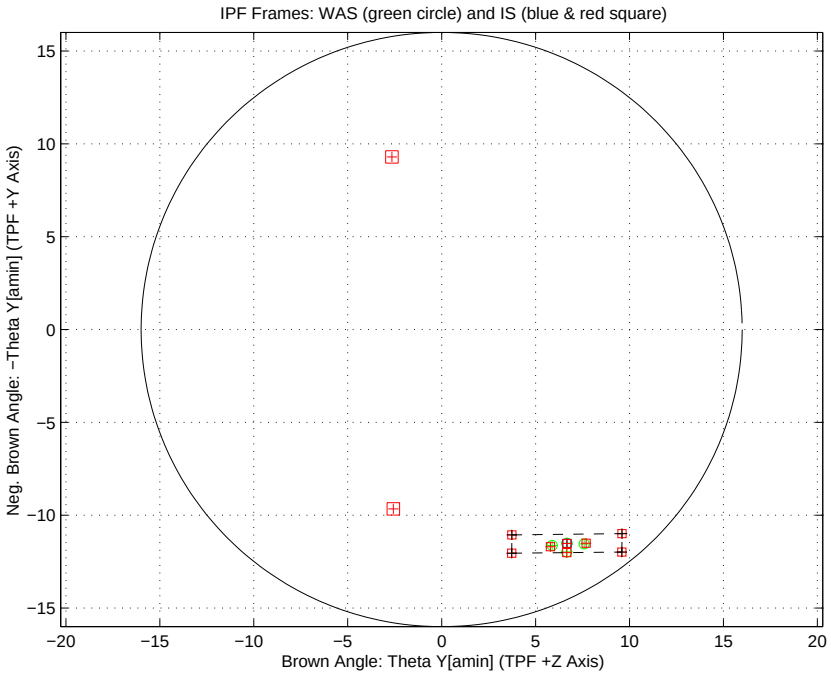

Figure 1.1: A-priori and a-posteriori IPF frames

RAW	FINAL (After Editing)
AA991087	AA991087
AS991087	AS991087
CA991087	CA991087
CB991087	CB991087
CS991087	CS991087

Table 1.1: IPF filter input files

EXECUTION CONFIGURATION ITEM	CURRENT STATUS
IPF Filter Version Used	IPF.V2.0.1Beta
Frame Table Version Used	FTVE2E1
Scan-Mirror Employed?	YES
IPF Filter Mode	NORMAL-MODE(0)
SLIT-MODE Operation	DISABLED
Kalman Filter Operation	ENABLED
Least-Squares Data Analysis	ENABLED
IBAD Screening	ENABLED
User-Specified Data Editing	DISABLED
Total Number of Iterations	20
LS Residual Sigma Scale	1.10536712E+000
Total Number of Maneuvers	30

Table 1.2: IPF filter execution configuration

Con. Plate Scale			Γ Dependent				Γ^2 Dependent				Linear Plate Scale						Mirror	
a_{00}	b_{00}	c_{00}	a_{10}	b_{10}	c_{10}	d_{10}	a_{20}	b_{20}	c_{20}	d_{20}	a_{01}	b_{01}	c_{01}	d_{01}	e_{01}	f_{01}	α	β
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	1	1
IPF (T)			Alignment R									Gyro Drift Bias						
θ_1	θ_2	θ_3	a_{rx}	a_{ry}	a_{rz}	b_{rx}	b_{ry}	b_{rz}	c_{rx}	c_{ry}	c_{rz}	b_{gx}	b_{gy}	b_{gz}	c_{gx}	c_{gy}	c_{gz}	
20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	

Table 1.3: IPF filter execution mask vector assignment

FOCAL PLANE SURVEY ANALYSIS: Covariance Analysis.
INSTRUMENT NAME: MIPS_160um_center_large_FOV NF: 87

```
PIX2RADW: 7.73998982E-005[rad/pixel] = 1.5965E+001[arcsec/pixel]
PIX2RADV: 7.73998982E-005[rad/pixel] = 1.5965E+001[arcsec/pixel]
```

FRAME	DESCRIPTION	IPF[1]	SF[2]	ARW[3]	TOTAL	REQ
087(P)	MIPS_160um_center_large_FOV	0.2224	0.0855	0.0384	0.2413	3.70
088(I)	MIPS_160um_plusY_edge	0.3130	0.0855	0.0384	0.3268	N/A
089(I)	MIPS_160um_large_only	0.2224	0.0855	0.0384	0.2413	N/A
091(I)	MIPS_160um_small_FOV1	0.2521	0.0855	0.0384	0.2690	N/A
092(I)	MIPS_160um_small_FOV2	0.2550	0.0855	0.0384	0.2717	N/A
TR (C)	CORNERS OF INSTRUMENT	0.4719	0.0855	0.0384	0.4811	N/A
BR (C)	CORNERS OF INSTRUMENT	0.4549	0.0855	0.0384	0.4644	N/A
TL (C)	CORNERS OF INSTRUMENT	0.4592	0.0855	0.0384	0.4686	N/A
BL (C)	CORNERS OF INSTRUMENT	0.4660	0.0855	0.0384	0.4753	N/A

Table 1.4: IPF calibration error summary ([arcsec], 1-sigma, radial)

RMS METRIC	A PRIORI[4]	A POSTERIORI[4]	ATT. CORRECTED[5]	UNITS
Radial	8.4111	2.9188	2.6882	arcsec
Radial	0.5268	0.1828	0.1684	pixels
W-Axis	0.4327	0.1172	0.1073	pixels
V-Axis	0.3006	0.1404	0.1298	pixels

Table 1.5: Measurement prediction error summary (1-sigma)

[1]IPF filter removes systematic pointing errors due to: thermomechanical alignment drift (Body to TPF), gyro bias and bias drift, centroiding error, attitude error, and optical distortion. IPF SIGMA presented here is "NOT Scaled" by the Least Squares Scale factor. The Least Squares Scale Factor was: 1.105367.

[2]Error due to gyro Scale Factor: assumes 95 ppm error over 0.250 degree maneuver.

[3]Error due to gyro Angle Random Walk: assumes ARW = 100 $\mu deg/\sqrt{hr}$, with 615 second Maneuver time (max), and 30 independent Maneuvers.

[4]This can be interpreted as estimate of "pixel to sky" pointing reconstruction error if no science data is used.

[5]This can be interpreted as estimate of achieved S/I centroiding error

IPF BROWN ANGLE SUMMARY						
	WAS			IS		
Frame Number	theta_Y (arcmin)	theta_Z (arcmin)	angle (deg)	theta_Y (arcmin)	theta_Z (arcmin)	angle (deg)
087	+6.669000	+11.517000	+0.000000	+6.668431	+11.520707	-0.051814
088	+6.664000	+11.974000	+0.000000	+6.663796	+12.014610	-0.051814
089	+6.669000	+11.517000	+0.000000	+6.668431	+11.520707	-0.051814
091	+7.589000	+11.546000	+0.000000	+7.694403	+11.509241	-0.051814
092	+5.879000	+11.626000	+0.000000	+5.787480	+11.695169	-0.051814
001	+0.000000	+0.000000	+0.000000	+9.604416	+10.994042	-0.051814
001	+0.000000	+0.000000	+0.000000	+9.595146	+11.981851	-0.051814
001	+0.000000	+0.000000	+0.000000	+3.741715	+11.059564	-0.051814
001	+0.000000	+0.000000	+0.000000	+3.732445	+12.047370	-0.051814

Table 1.6: IPF Brown angle summary

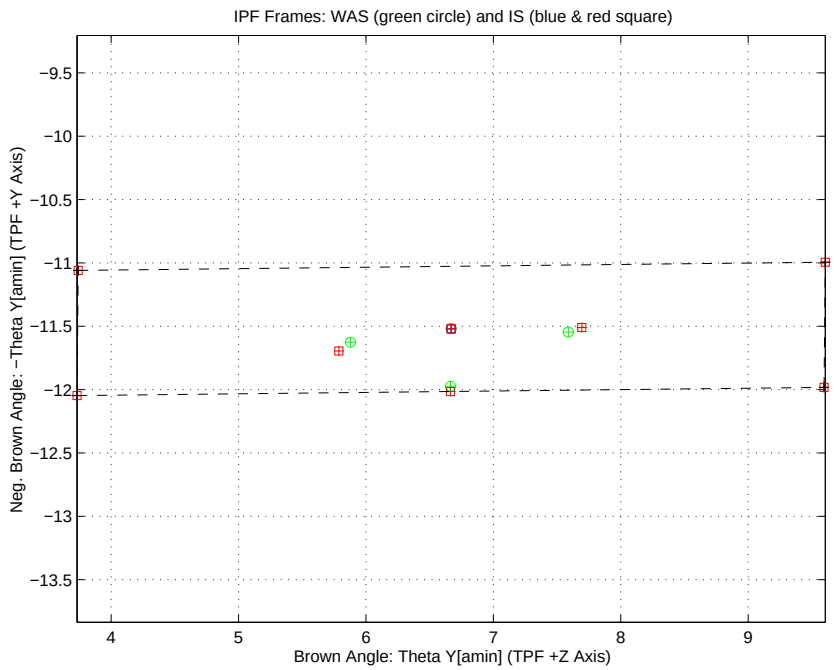

Figure 1.2: A-priori and a-posteriori IPF frames (ZOOMED)

2 FLUTE DATA SUMMARY

2.1 FLUTE CONFIGURATION PARAMETERS

The covariance analysis was performed using the FLUTE generated input data files. The internal configuration parameters, used to produce the data are tabulated in Table 2.1, Table 2.2 and Table 2.3.

NAME	DESCRIPTION	VALUE	UNIT
d2003	days into YEAR2003	+6.0000000000000000E+001	day
tstart	start time	+7.3051200000000000E+008	sec
tdel	data rate	+1.0000000000000001E-001	sec
tshelf	Inertial Hold duration pad	+5.0000000000000000E+000	sec
ipro	slew profile(1-linear, 2-S-curve)	1	int flag
sig_gcf [1]	gcf sigma(1)	+4.8481368110953601E-008	rad/sec
sig_gcf [2]	gcf sigma(2)	+9.6962736221907205E-009	rad/sec
sig_gcf [3]	gcf sigma(3)	+9.6962736221907205E-009	rad/sec
igcf	gcf bias correction flag	1	int flag
SigA [1][1]	Sigma A(1,1)	+9.4017722156391537E-009	rad^2
SigA [2][2]	Sigma A(2,2)	+2.3504430539097885E-011	rad^2
SigA [3][3]	Sigma A(3,3)	+2.3504430539097885E-011	rad^2
NFprime	Prime Frame NF	87	int
ftable [name]	Frame Table row number	87	int
ftable [q0]	Frametable quaternion q0	-1.6247706156225429E-006	N/A
ftable [q1]	Frametable quaternion q1	-9.6996521888884340E-004	N/A
ftable [q2]	Frametable quaternion q2	-1.6750781782660256E-003	N/A
ftable [q3]	Frametable quaternion q3	+9.9999812663721077E-001	N/A
ft_cmd [name]	Command row number	87	int
ft_cmd [q0]	Command quaternion q0	-1.6247706156225429E-006	N/A
ft_cmd [q1]	Command quaternion q1	-9.6996521888884340E-004	N/A
ft_cmd [q2]	Command quaternion q2	-1.6750781782660256E-003	N/A
ft_cmd [q3]	Command quaternion q3	+9.9999812663721077E-001	N/A
ft_true [name]	Truth row number	87	int
ft_true [q0]	Truth quaternion q0	-1.6247706156225429E-006	N/A
ft_true [q1]	Truth quaternion q1	-9.6996521888884340E-004	N/A
ft_true [q2]	Truth quaternion q2	-1.6750781782660256E-003	N/A
ft_true [q3]	Truth quaternion q3	+9.9999812663721077E-001	N/A
ft_prior [name]	Prior row number	87	int
ft_prior [q0]	FTprior quaternion q0	-1.6247706156225429E-006	N/A
ft_prior [q1]	FTprior quaternion q1	-9.6996521888884340E-004	N/A
ft_prior [q2]	FTprior quaternion q2	-1.6750781782660256E-003	N/A
ft_prior [q3]	FTprior quaternion q3	+9.9999812663721077E-001	N/A
ntable [NF]	ntable row number	87	int
ntable [iprime]	Prime frame indication flag	1	int
ntable [SIG_CX]	CX Sigma	+1.0000000000000001E-001	pixel
ntable [SIG_CY]	CY Sigma	+1.0000000000000001E-001	pixel
ntable [PIX2RADX]	Nom. angular pixelsize X-dir	+7.7399898172000000E-005	rad/pixel
ntable [PIX2RADY]	Nom. angular pixelsize Y-dir	+8.7086140999000005E-005	rad/pixel
ntable [CX0]	Center pixel along X-axis	+1.0500000000000000E+001	pixel
ntable [CY0]	Center pixel along Y-axis	+2.0000000000000000E+000	pixel
ntable [BETA0]	Nominal mirror scale factor	+2.8047410000000001E-006	rad/(e.u.)
ntable [GAMMA_E0]	Reference Mirror position	+2.0070000000000000E+003	(e.u.[6])

Table 2.1: FLUTE Parameter Table (1)

[6]encoder units

NAME	DESCRIPTION	VALUE	UNIT
ntable [D11]	x-to-w frame flip parameter	-1	int
ntable [D12]	y-to-w frame flip parameter	0	int
ntable [D21]	x-to-v frame flip parameter	0	int
ntable [D22]	y-to-v frame flip parameter	-1	int
ntable [DG]	Mirror flip parameter	1	int
ntable [sisizew]	Array size (w-direction)	+1.5417075059283244E-003	pixel
ntable [sisizev]	Array size (v-direction)	+2.3271056693257729E-004	pixel
ntable [p2i_w]	w-offset from prime	+0.0000000000000000E+000	pixel
ntable [p2i_v]	v-offset from prime	+0.0000000000000000E+000	pixel
p1true [a00]	True Constant Plate Scales	+1.0000000000000001E-001	N/A
p1true [b00]	True Constant Plate Scales	+1.0000000000000001E-001	N/A
p1true [c00]	True Constant Plate Scales	+1.0000000000000000E-002	N/A
p1true [a10]	True Γ Dependent Plate Scales	+1.0000000000000001E-001	1/rad
p1true [b10]	True Γ Dependent Plate Scales	+1.0000000000000001E-001	1/rad
p1true [c10]	True Γ Dependent Plate Scales	+1.0000000000000000E-002	1/rad
p1true [d10]	True Γ Dependent Plate Scales	+1.0000000000000000E-002	1/rad
p1true [a20]	True Γ^2 Dependent Plate Scales	+1.0000000000000001E-001	$1/\mathrm{rad}^2$
p1true [b20]	True Γ^2 Dependent Plate Scales	+1.0000000000000001E-001	$1/\mathrm{rad}^2$
p1true [c20]	True Γ^2 Dependent Plate Scales	+1.0000000000000000E-002	$1/\mathrm{rad}^2$
p1true [d20]	True Γ^2 Dependent Plate Scales	+1.0000000000000000E-002	$1/\mathrm{rad}^2$
p1true [a01]	True Linear Plate Scales	+2.0000000000000000E+000	N/A
p1true [b01]	True Linear Plate Scales	+2.0000000000000000E+000	N/A
p1true [c01]	True Linear Plate Scales	+2.0000000000000000E+000	N/A
p1true [d01]	True Linear Plate Scales	+2.0000000000000000E+000	N/A
p1true [e01]	True Linear Plate Scales	+2.0000000000000000E+000	N/A
p1true [f01]	True Linear Plate Scales	+2.0000000000000000E+000	N/A
p2true [am1]	True Scan mirror alignment Ux	+0.0000000000000000E+000	N/A
p2true [am2]	True Scan mirror alignment Uy	+2.0000000000000000E-002	N/A
p2true [am3]	True Scan mirror alignment Uz	+9.9979997999599901E-001	N/A
p2true [beta]	True Scan mirror scale factor	+1.1000000000000001E+000	N/A
p2true [qT1]	True IPF q1	-1.6247706156225429E-006	N/A
p2true [qT2]	True IPF q2	-9.6996521888884340E-004	N/A
p2true [qT3]	True IPF q3	-1.6750781782660256E-003	N/A
p2true [qT4]	True IPF q4	+9.9999812663721077E-001	N/A
p2true [qR01]	True Boresight Alignment q1	+2.4240684048319150E-005	N/A
p2true [qR02]	True Boresight Alignment q2	+1.2120342024159575E-006	N/A
p2true [qR03]	True Boresight Alignment q3	+1.2120342024159575E-006	N/A
p2true [qR04]	True Boresight Alignment q4	+9.9999999970472575E-001	N/A
p2true [brx]	True B. Alignment drift rate X	+5.6000000000000000E-011	rad/sec
p2true [bry]	True B. Alignment drift rate Y	+5.6000000000000000E-011	rad/sec
p2true [brz]	True B. Alignment drift rate Z	+5.6000000000000000E-011	rad/sec
p2true [crx]	True B. Alignment drift accel. X	+5.0000000000000002E-014	$\mathrm{rad/sec}^2$
p2true [cry]	True B. Alignment drift accel. Y	+5.0000000000000002E-014	$\mathrm{rad/sec}^2$
p2true [crz]	True B. Alignment drift accel. Z	+5.0000000000000002E-014	$\mathrm{rad/sec}^2$
p2true [bgx]	True Gyro bias correction X	+2.5000000000000002E-006	rad/sec
p2true [bgy]	True Gyro bias correction Y	+2.5000000000000002E-006	rad/sec
p2true [bgz]	True Gyro bias correction Z	+2.5000000000000002E-006	rad/sec
p2true [cgx]	True Gyro bias-rate correction X	+4.9999999999999999E-013	$\mathrm{rad/sec}^2$
p2true [cgy]	True Gyro bias-rate correction Y	+4.9999999999999999E-013	$\mathrm{rad/sec}^2$
p2true [cgz]	True Gyro bias-rate correction Z	+4.9999999999999999E-013	$\mathrm{rad/sec}^2$

Table 2.2: FLUTE Parameter Table (2)

NAME	DESCRIPTION	VALUE	UNIT
p2cmd [am1]	CMD Scan mirror alignment Ux	+0.0000000000000000E+000	N/A
p2cmd [am2]	CMD Scan mirror alignment Uy	+0.0000000000000000E+000	N/A
p2cmd [am3]	CMD Scan mirror alignment Uz	+1.0000000000000000E+000	N/A
p2cmd [beta]	CMD Scan mirror rotation SF	+1.0000000000000000E+000	N/A
p2cmd [qT1]	CMD IPF q1	-1.6247706156225429E-006	N/A
p2cmd [qT2]	CMD IPF q2	-9.6996521888884340E-004	N/A
p2cmd [qT3]	CMD IPF q3	-1.6750781782660256E-003	N/A
p2cmd [qT4]	CMD IPF q4	+9.9999812663721077E-001	N/A
p2cmd [qR01]	CMD Boresight Alignment q1	+0.0000000000000000E+000	N/A
p2cmd [qR02]	CMD Boresight Alignment q2	+0.0000000000000000E+000	N/A
p2cmd [qR03]	CMD Boresight Alignment q3	+0.0000000000000000E+000	N/A
p2cmd [qR04]	CMD Boresight Alignment q4	+1.0000000000000000E+000	N/A
p2cmd [brx]	CMD B. Alignment drift rate X	+0.0000000000000000E+000	rad/sec
p2cmd [bry]	CMD B. Alignment drift rate Y	+0.0000000000000000E+000	rad/sec
p2cmd [brz]	CMD B. Alignment drift rate Z	+0.0000000000000000E+000	rad/sec
p2cmd [crx]	CMD B. Alignment drift accel. X	+0.0000000000000000E+000	rad/sec^2
p2cmd [cry]	CMD B. Alignment drift accel. Y	+0.0000000000000000E+000	rad/sec^2
p2cmd [crz]	CMD B. Alignment drift accel. Z	+0.0000000000000000E+000	rad/sec^2
p2cmd [bgx]	CMD Gyro bias correction X	+0.0000000000000000E+000	rad/sec
p2cmd [bgy]	CMD Gyro bias correction Y	+0.0000000000000000E+000	rad/sec
p2cmd [bgz]	CMD Gyro bias correction Z	+0.0000000000000000E+000	rad/sec
p2cmd [cgx]	CMD Gyro bias-rate correction X	+0.0000000000000000E+000	rad/sec^2
p2cmd [cgy]	CMD Gyro bias-rate correction Y	+0.0000000000000000E+000	rad/sec^2
p2cmd [cgz]	CMD Gyro bias-rate correction Z	+0.0000000000000000E+000	rad/sec^2
a1	Semi-Major Axis of SIRTF (HCO [7])	+1.4960000000000000E+011	m
a2	Semi-Major Axis of Earth (HCO)	+1.4960000000000000E+011	m
e1	Eccentricity (SIRTF in HCO)	+1.6722000000000001E-002	N/A
e2	Eccentricity (Earth in HCO)	+1.6722000000000001E-002	N/A
inc1	inclination (SIRTF in HCO)	+4.0142572795869580E-001	rad
inc2	inclination (Earth in HCO)	+4.0142572795869580E-001	rad
Omega1	Ascending Node Long.(SIRTF in HCO)	+0.0000000000000000E+000	rad
Omega2	Ascending Node Long.(Earth in HCO)	+0.0000000000000000E+000	rad
omega1	Argument of Perigee(SIRTF in HCO)	+1.7627825445142729E+000	rad
omega2	Argument of Perigee(Earth in HCO)	+1.7627825445142729E+000	rad
nu0_1	True Anomaly of SIRTF(HCO)	+8.6071031605199810E-001	rad
nu0_2	True Anomaly of Earth(HCO)	+1.0328523792623976E+000	rad
inav	Velocity Report Flag	+0.0000000000000000E+000	rad
wsize	Array size W-dir	+1.5417075059283244E-003	rad
vsize	Array size V-dir	+2.3271056693257729E-004	rad

Table 2.3: FLUTE Parameter Table (3)

[7] Heliocentric Orbit

2.2 FLUTE GENERATED UNIT TEST DATA

This subsection plots the FLUTE generated IPF filter input files. Seven figures, as tabulated in Table 2.4, show the campaign maneuver senario, the true sampled locations on the array and the actual centroided data superimposed the array plane. All angles shown in FLUTE plots have units of radians.

FIGURE NO.	DESCRIPTION
Figure 2.1	Focal Plane Survey Scenario Plot
Figure 2.2	Commanded-only source locations in TPF
Figure 2.3	True and commanded source locations in TPF
Figure 2.4	True and commanded source locations (ZOOMED) in TPF
Figure 2.5	True-sampled and centroided locations in Focal Plane (W,V) including rectangular array boundary approximation
Figure 2.6	True and centroided locations on S/I Array (W,V) including rectangular array boundary approximation
Figure 2.7	True and centroided locations on S/I Array (W,V) showing Prime and Inferred Frames including rectangular array boundary approximation

Table 2.4: Table of figures (FLUTE)

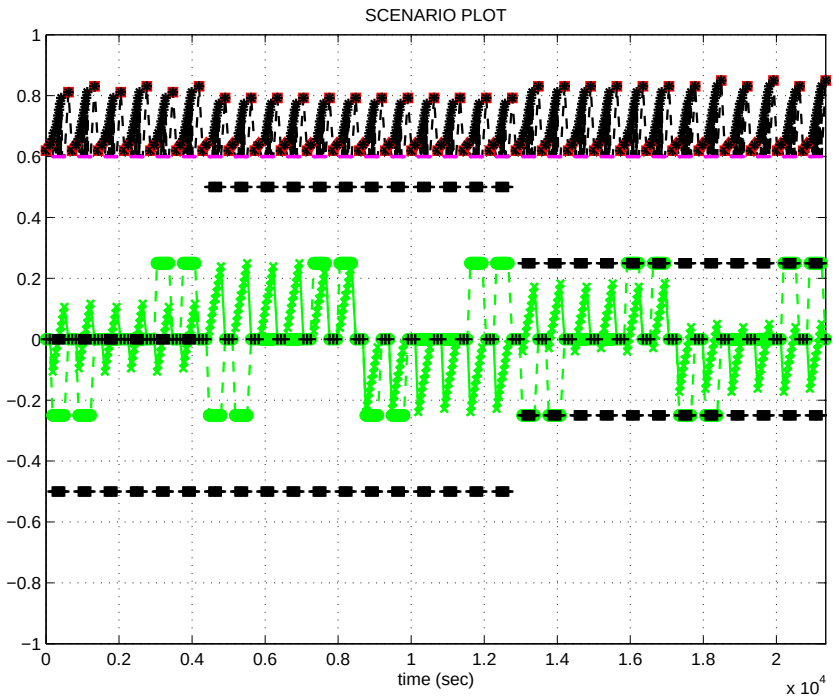

Figure 2.1: Focal plane survey scenario plot (See key in [3])

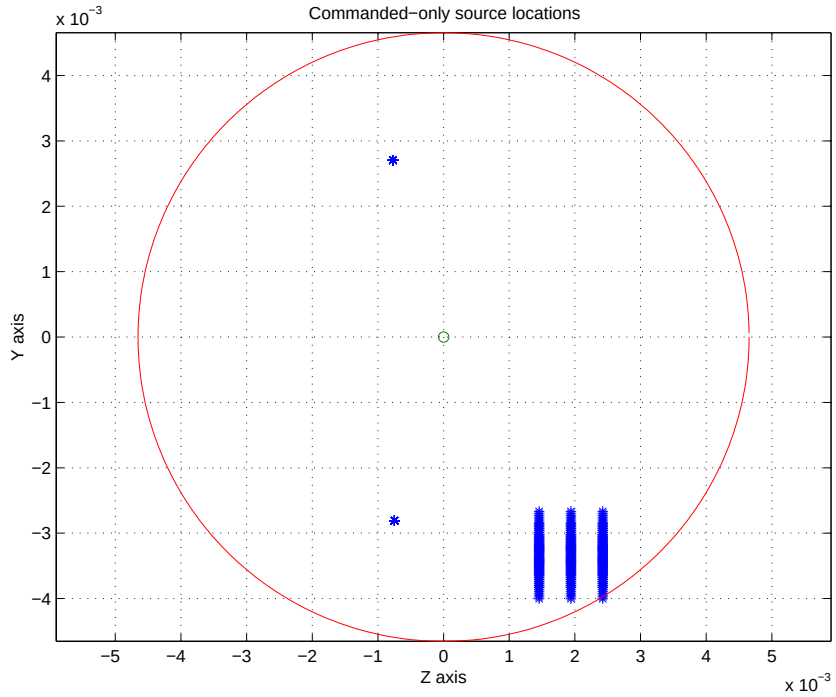

Figure 2.2: Commanded-only source locations

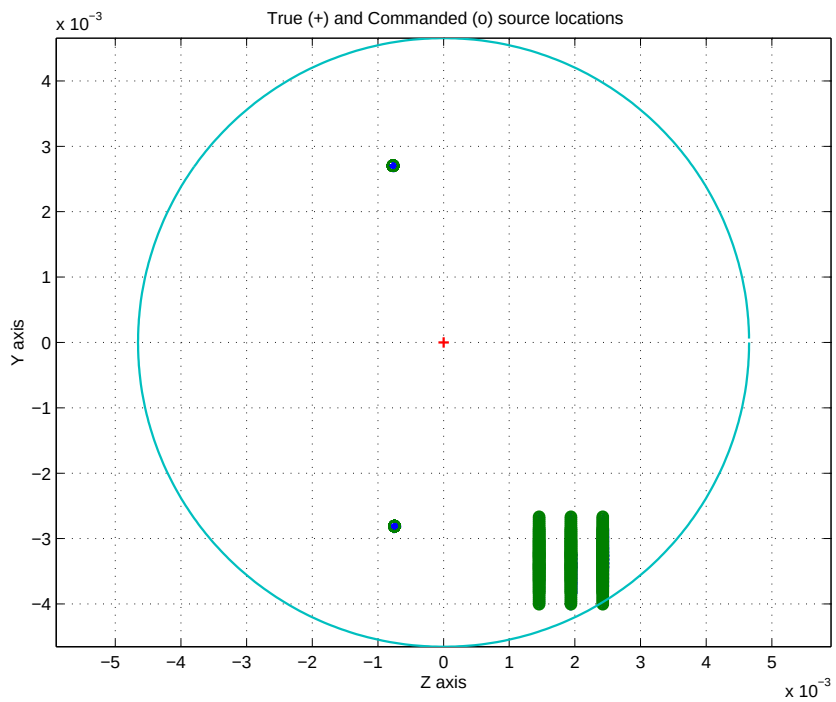

Figure 2.3: True (+) and commanded (o) source locations

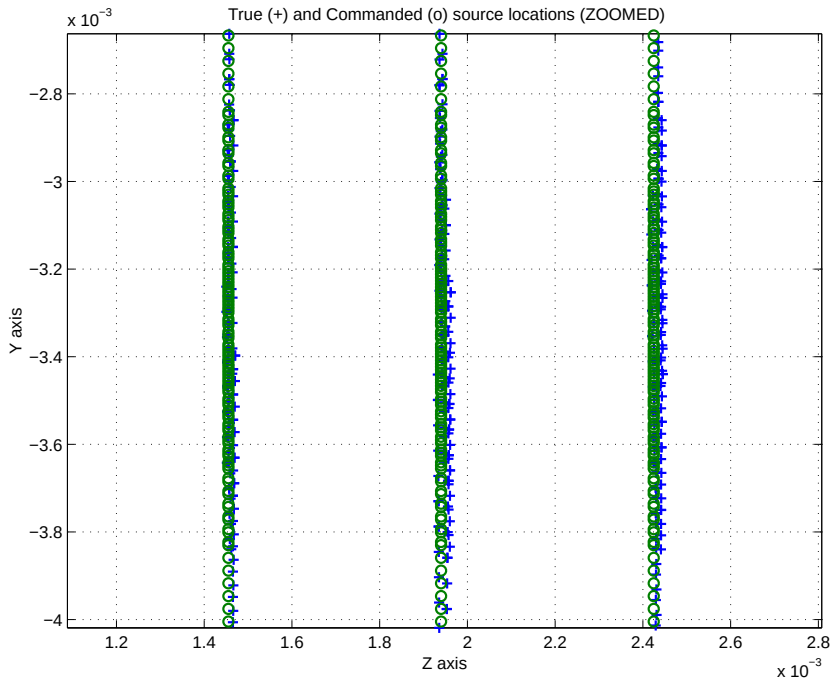

Figure 2.4: True (+) and commanded (o) source locations (ZOOMED)

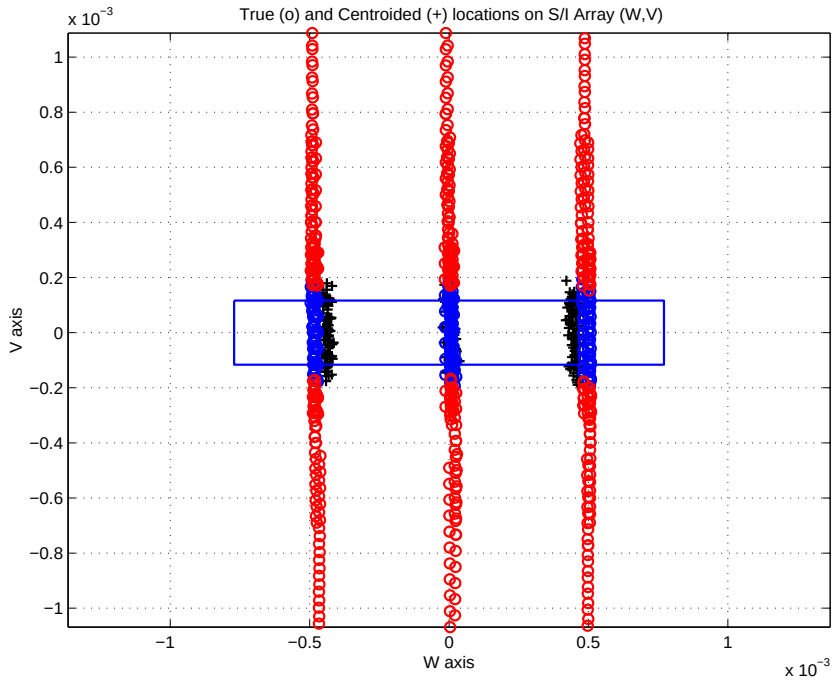

Figure 2.5: True-sampled (o) and centroided (+) locations on S/I array (W,V)

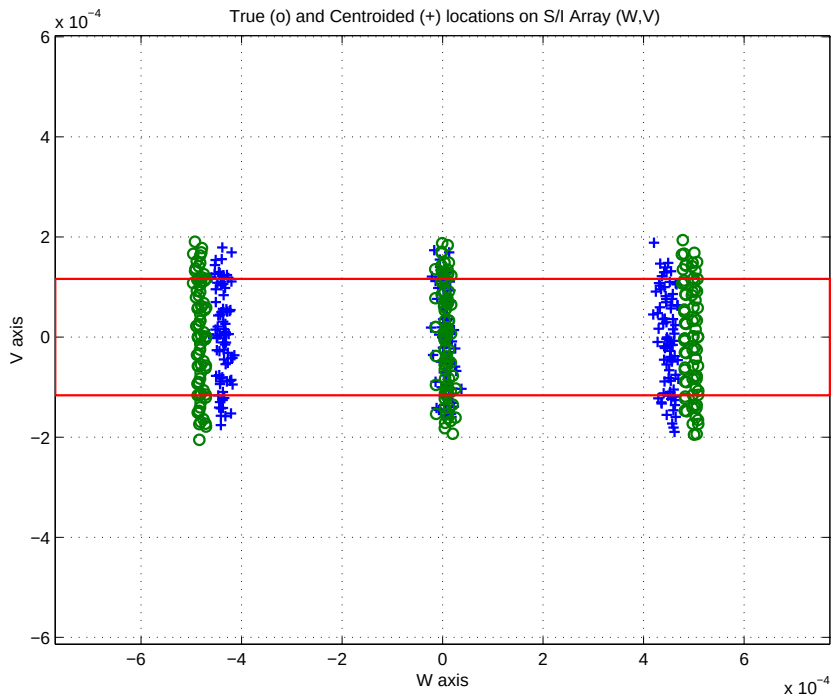

Figure 2.6: True (o) and centroided (+) locations on S/I array (W,V)

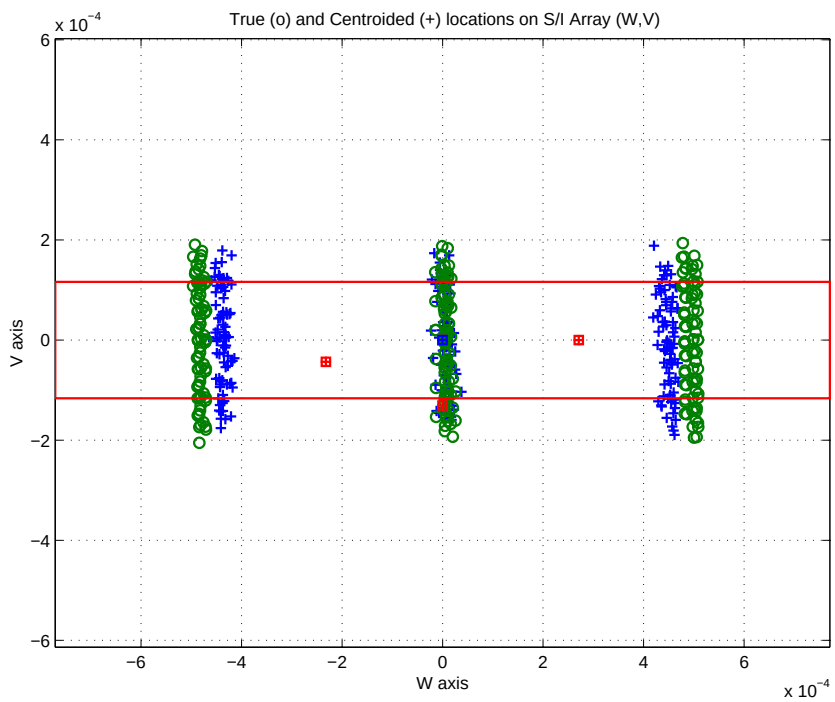

Figure 2.7: True (o) and centroided (+) locations on S/I array (W,V) showing prime and inferred frames

3 IPF EXECUTION RESULTS

3.1 IPF EXECUTION OUTPUT PLOTS

This subsection summarizes the IPF filter results. As shown in Table 3.1, the output plots are segmented to three groups: predicted performance, post-run results and IPF trending plots.

FIGURE NO.	DESCRIPTION
Predicted performance prior to IPF run	
Figure 3.1	Meas. and a-priori predicts in TPF coords
Figure 3.2	Meas. and a-priori predicts in Oriented Pixel Coords including rectangular array boundary approximation
Figure 3.3	A-priori prediction error
Figure 3.4	Oriented Pixel Coords of measurements and a-priori predicts (PCRS only)
IPF filter performance (post run results)	
Figure 3.5	IPF execution convergence, chart 1: (top) normalized residual error vs. iteration number and (bottom) norm of effective parameter corrections
Figure 3.6	IPF execution convergence, chart 2: parameter correction size vs. iteration number
Figure 3.7	Parameter uncertainty convergence: square-root of diagonal elements of covariance matrix vs. maneuver number
Figure 3.8	IPF parameter symbol table
Figure 3.9	KF parameter error sigma plot (a-priori-dashed, a-posteriori-solid). Includes true parameter errors (FLUTE runs only)
Figure 3.10	LS parameter error sigma plot. Includes true parameter errors (FLUTE runs only)
Figure 3.11	KF and LS parameter errors sigma plot (Figure 3.9 & Figure 3.10 combined)
Figure 3.12	Measurements and a-posteriori predicts in Oriented Pixel Coords including rectangular array boundaries (a-priori-dashed, a-posteriori-solid)
Figure 3.13	Attitude corrected meas. and a-posteriori predicts in Oriented Pixel Coords including rectangular array boundaries (a-priori-dashed, a-posteriori-solid)
Figure 3.14	Array plot with (solid) and w/o (dashed) optical distortion corrections
Figure 3.15	KF innovations with (o) and w/o (+) attitude corrections
Figure 3.16	W-axis KF innovations and 1-sigma bound
Figure 3.17	V-axis KF innovations and 1-sigma bound
IPF parameter trending plots	
Figure 3.18	Estimated attitude corrections (Body frame)
Figure 3.19	Estimated attitude error sigma plot (Body frame)
Figure 3.20	Systematic error attributed to thermo-mechanical boresight drift (equiv. angle in (W,V) coords)
Figure 3.21	Systematic error attributed to thermo-mechanical boresight drift (equiv. angle in Body frame)
Figure 3.22	Systematic error attributed to gyro drift bias (equiv. rate in (W,V) coords)
Figure 3.23	Systematic error attributed to gyro drift bias (equiv. angle in (W,V) coords)
Figure 3.24	Systematic error attributed to gyro drift bias (equiv. angle in Body frame)

Table 3.1: Table of figures (IPF run)

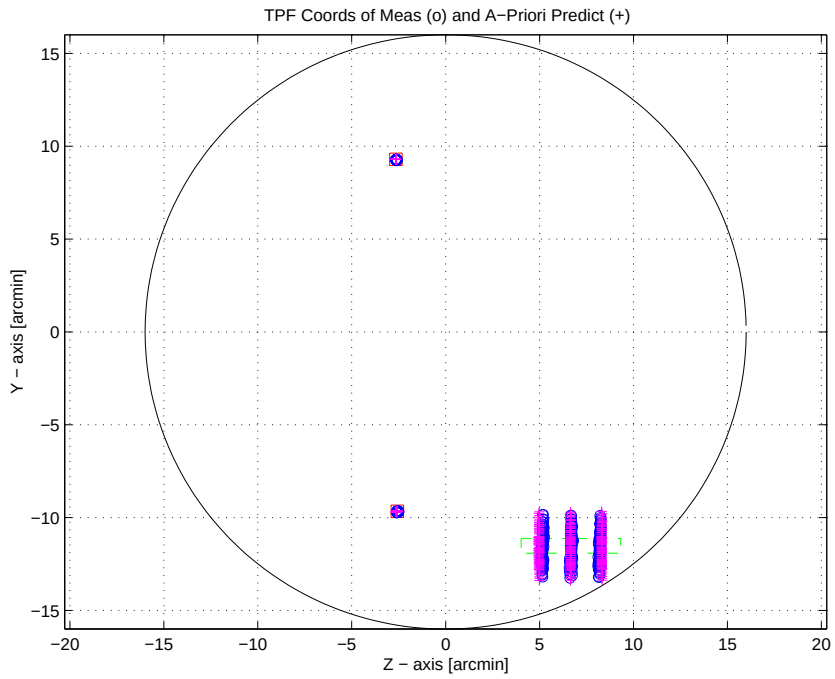

Figure 3.1: TPF coords of measurements and a-priori predicts

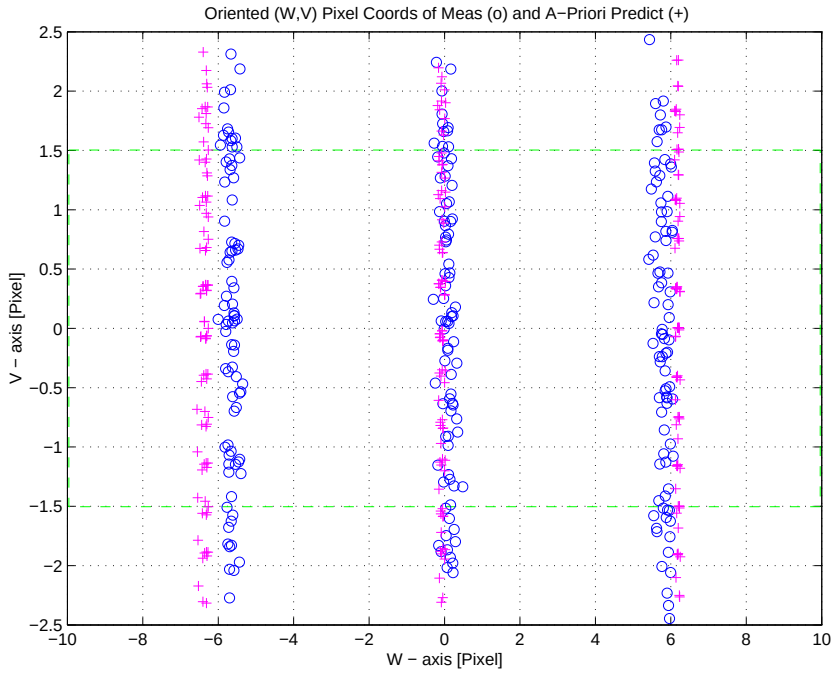

Figure 3.2: Oriented Pixel Coords of measurements and a-priori predicts

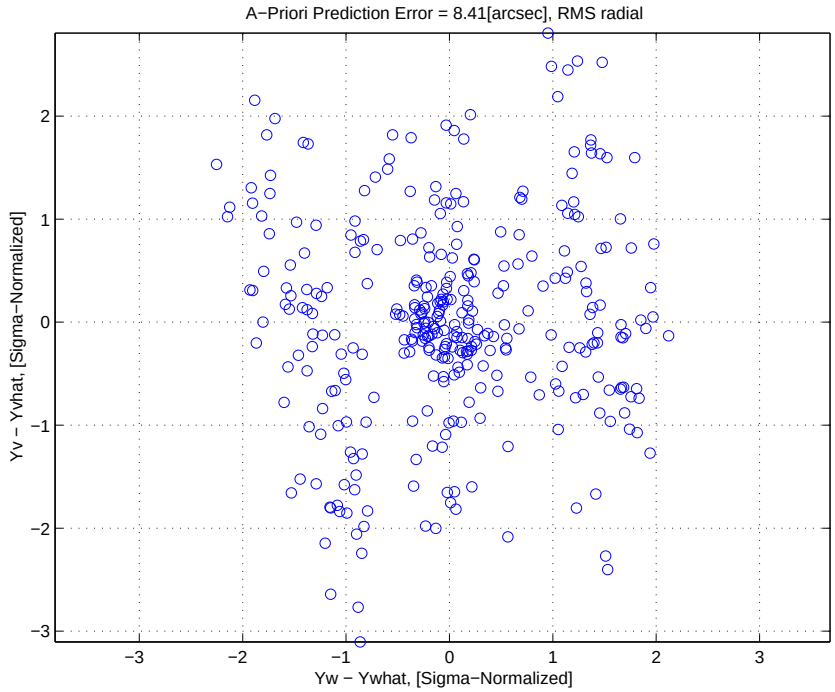

Figure 3.3: A-priori prediction error

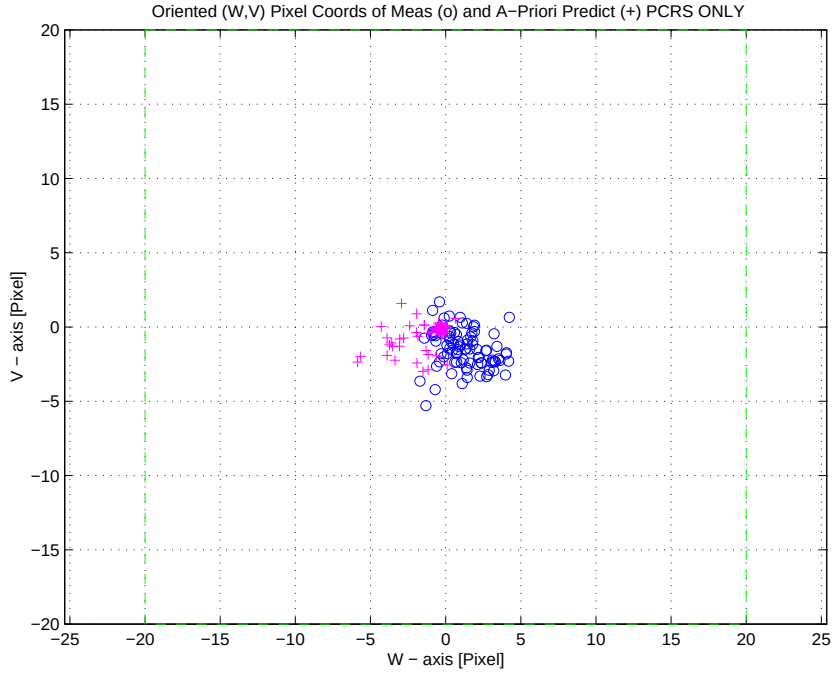

Figure 3.4: Oriented Pixel Coords of measurements and a-priori predicts (PCRS only)

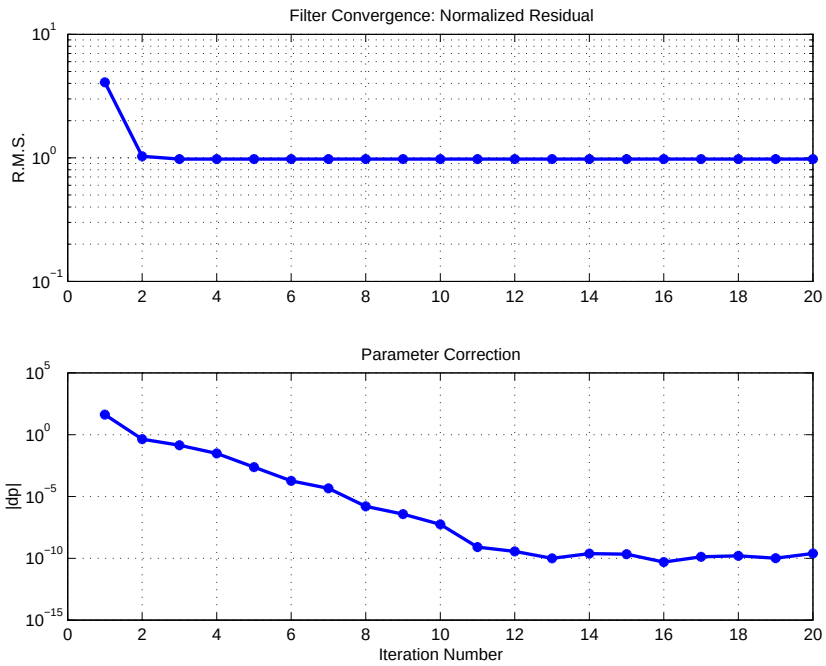

Figure 3.5: IPF execution convergence, chart 1

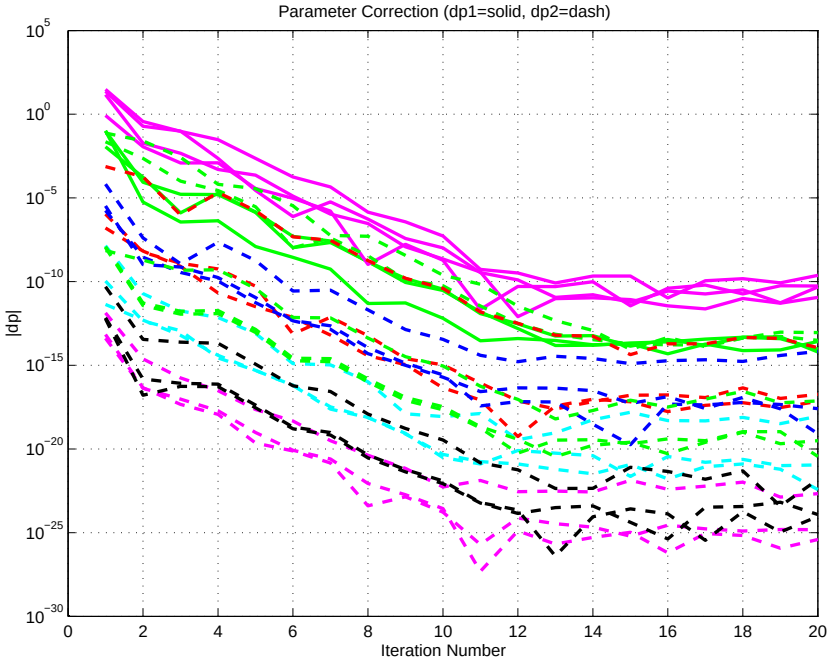

Figure 3.6: IPF execution convergence, chart 2

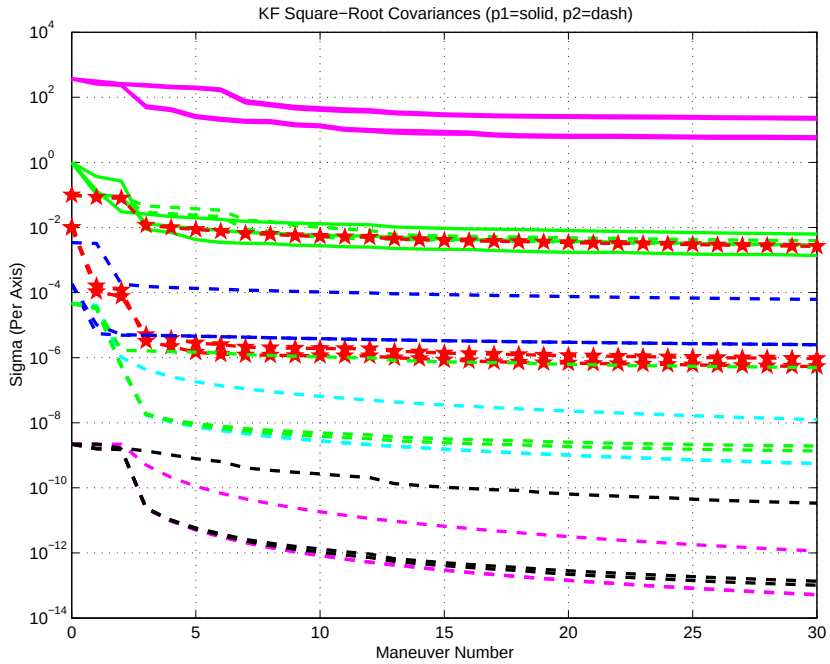

Figure 3.7: Parameter uncertainty convergence

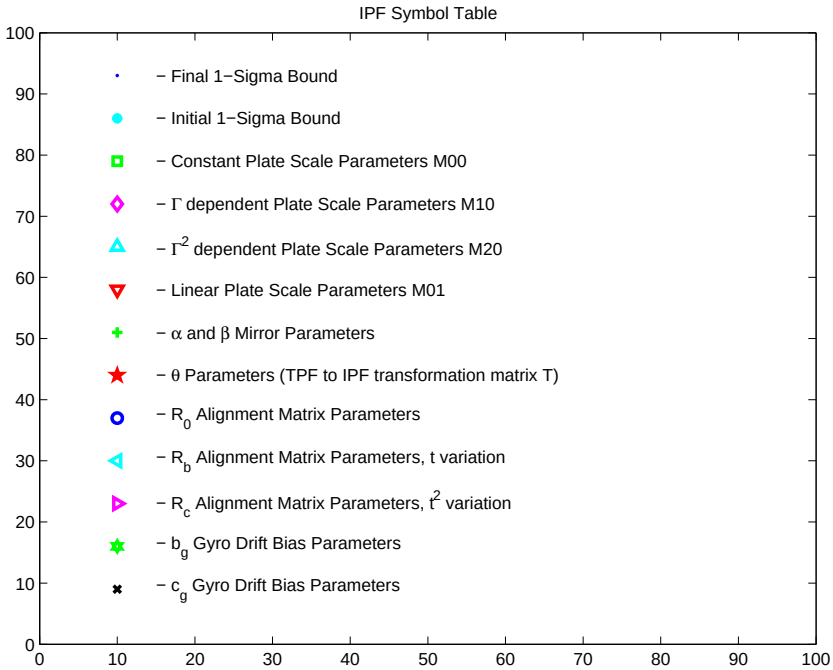

Figure 3.8: IPF parameter symbol table

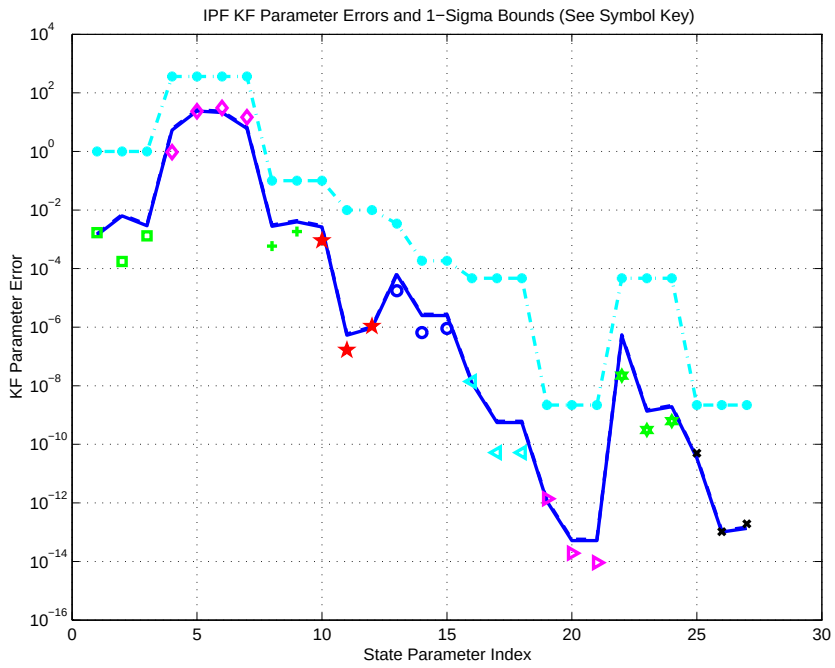

Figure 3.9: KF parameter error sigma plots

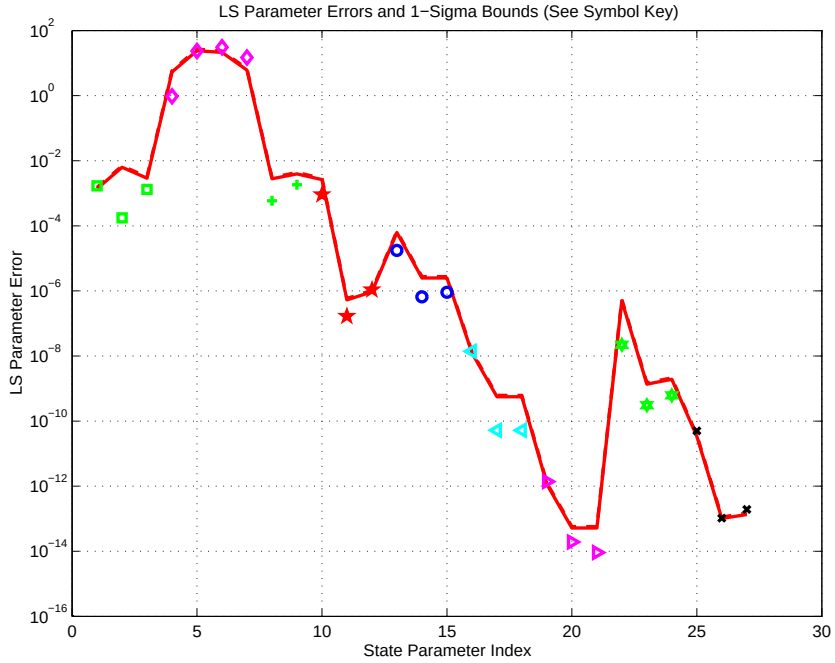

Figure 3.10: LS parameter error sigma plot

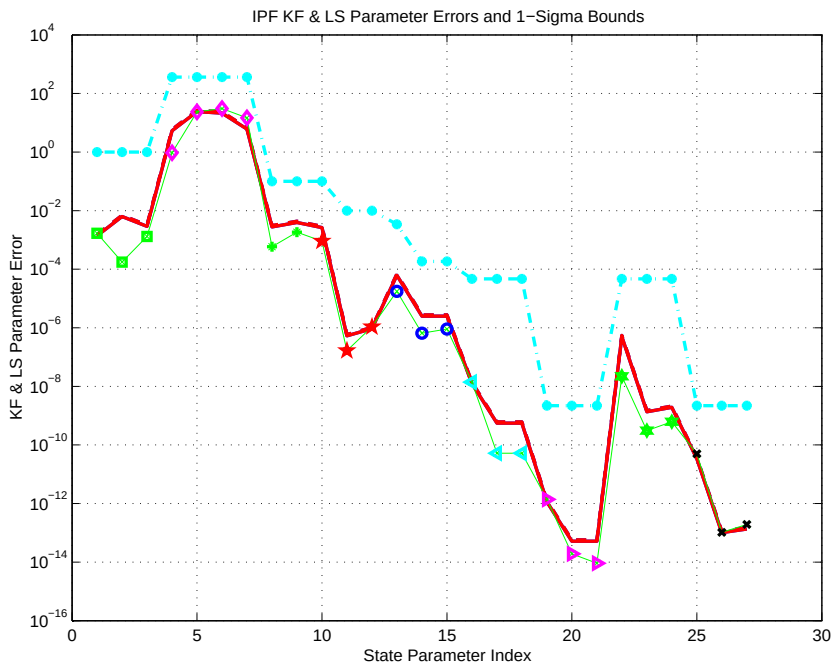

Figure 3.11: KF and LS parameter error sigma plot

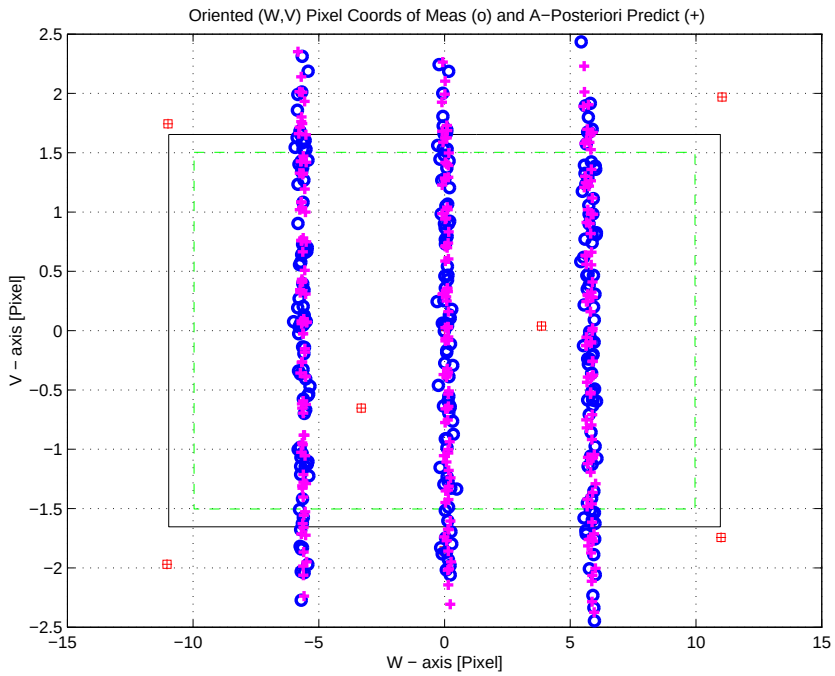

Figure 3.12: Oriented Pixel Coords of meas. and a-posteriori predicts

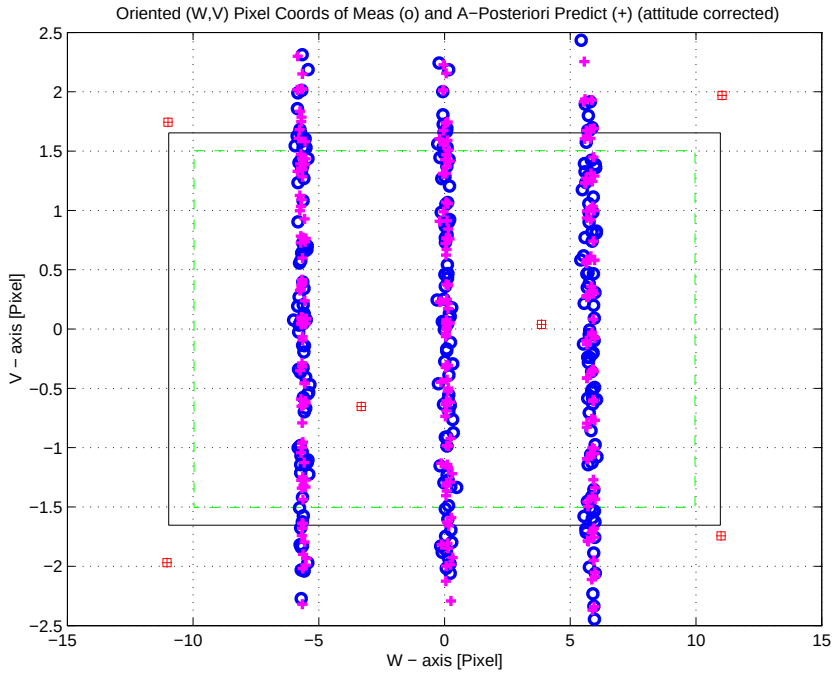

Figure 3.13: Oriented Pixel Coords of meas. and a-posteriori predicts (attitude corrected)

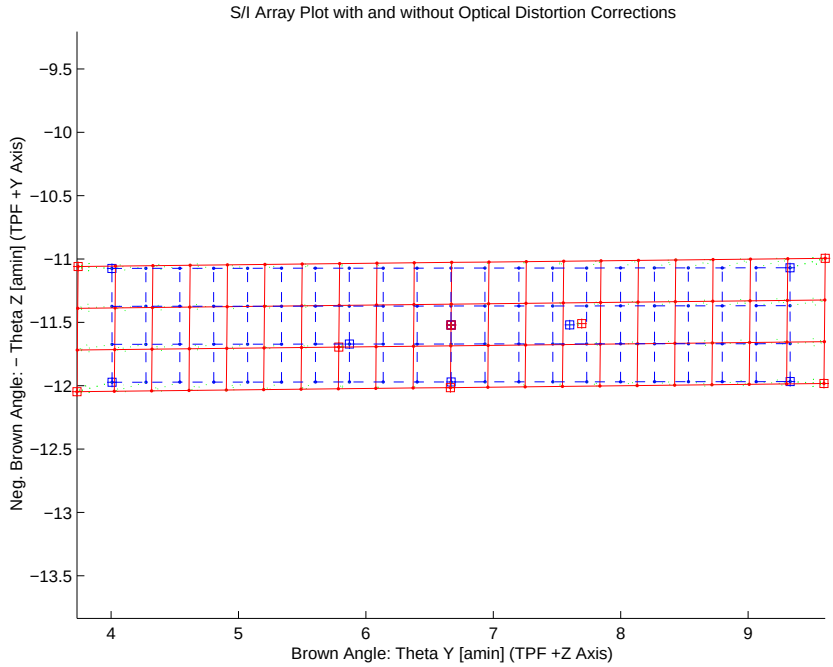

Figure 3.14: Array plot with (solid) and w/o (dashed) optical distortion corrections

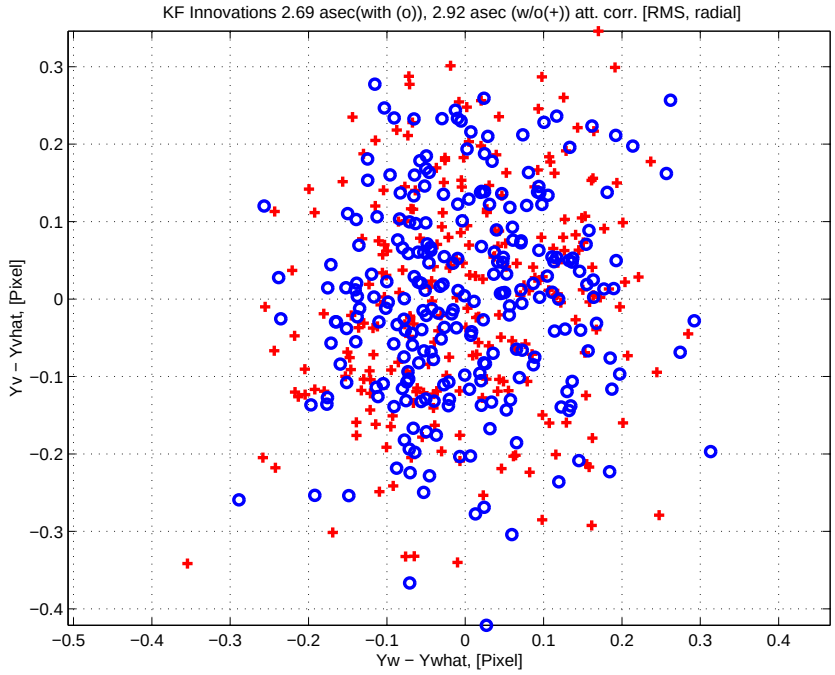

Figure 3.15: KF innovations with (o) and w/o (+) attitude corrections

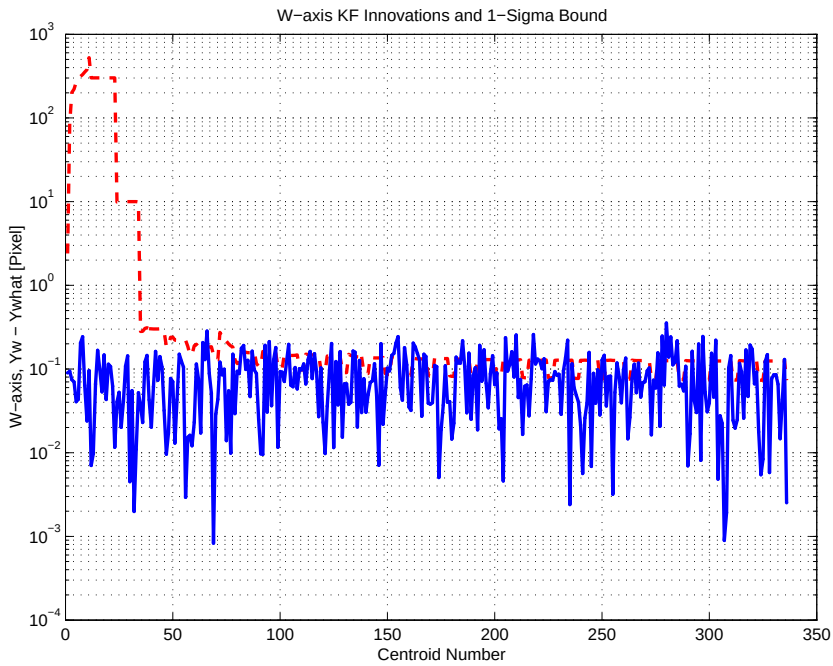

Figure 3.16: W-axis KF innovations and 1-sigma bound

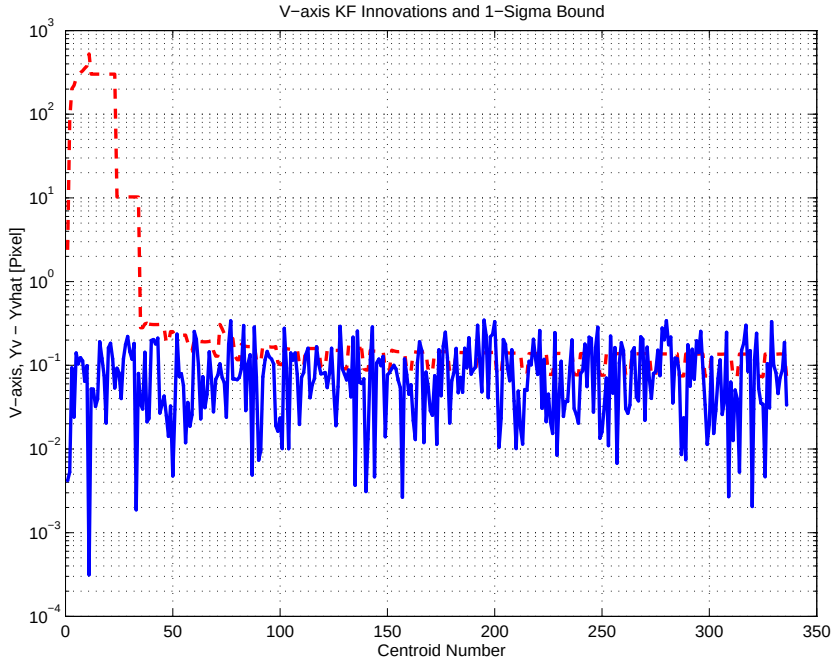

Figure 3.17: V-axis KF innovations and 1-sigma bound

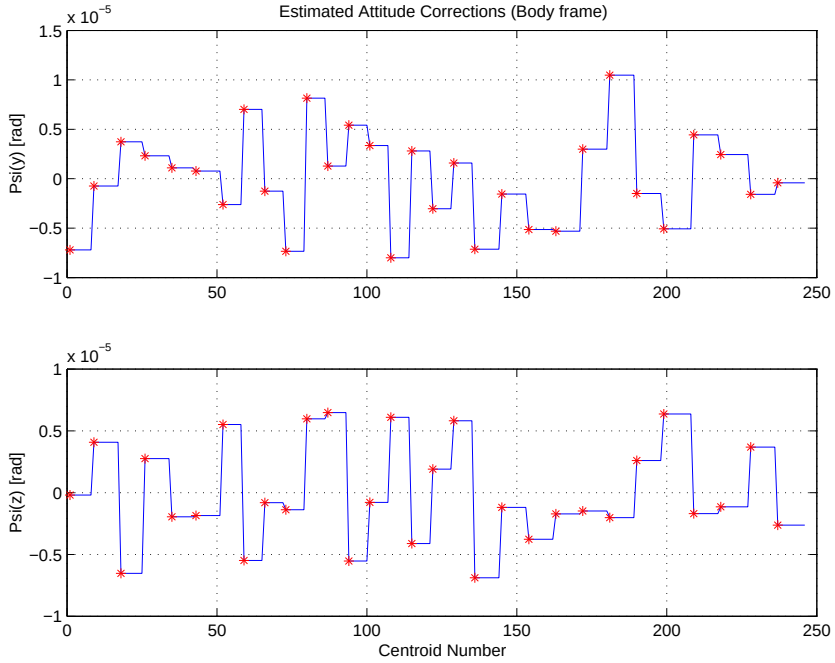

Figure 3.18: Estimated attitude corrections (Body frame)

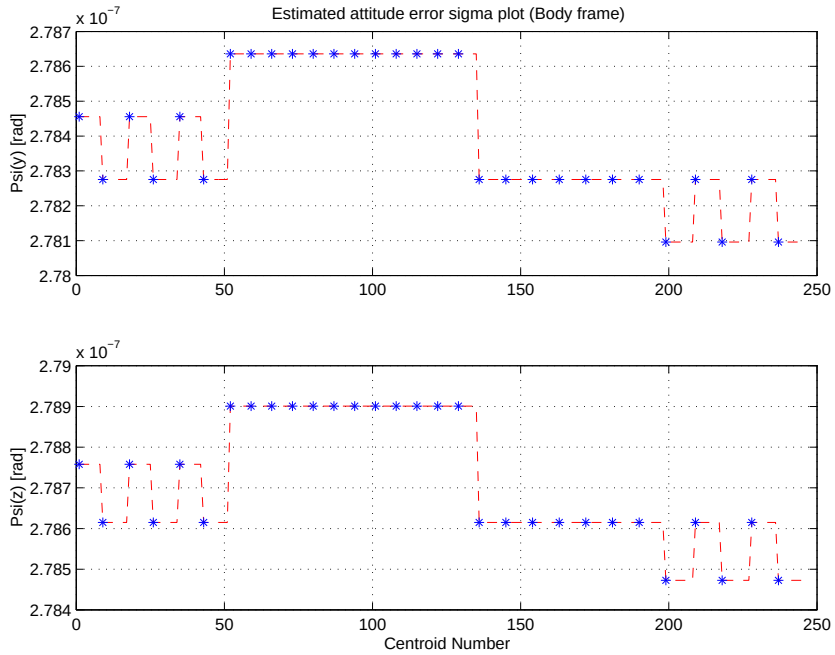

Figure 3.19: Estimated attitude error sigma plot (Body frame)

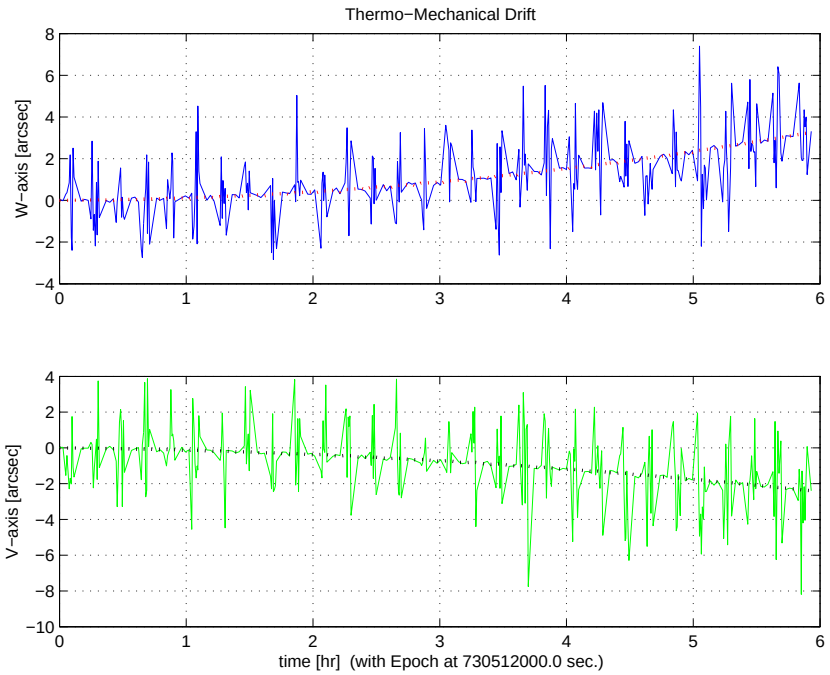

Figure 3.20: Thermo-mechanical boresight drift (equiv. angle in (W,V) coords)

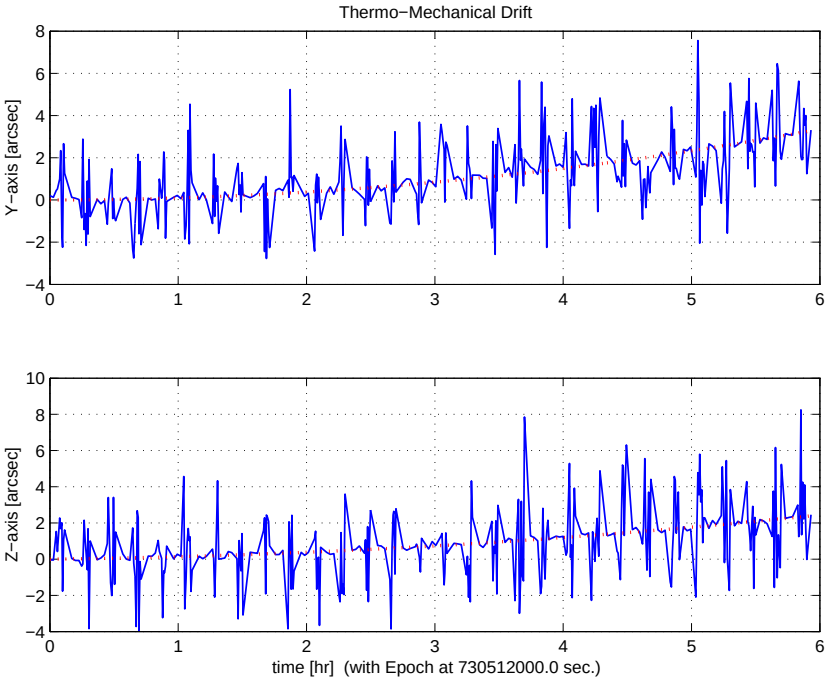

Figure 3.21: Thermo-mechanical boresight drift (equiv. angle in Body frame)

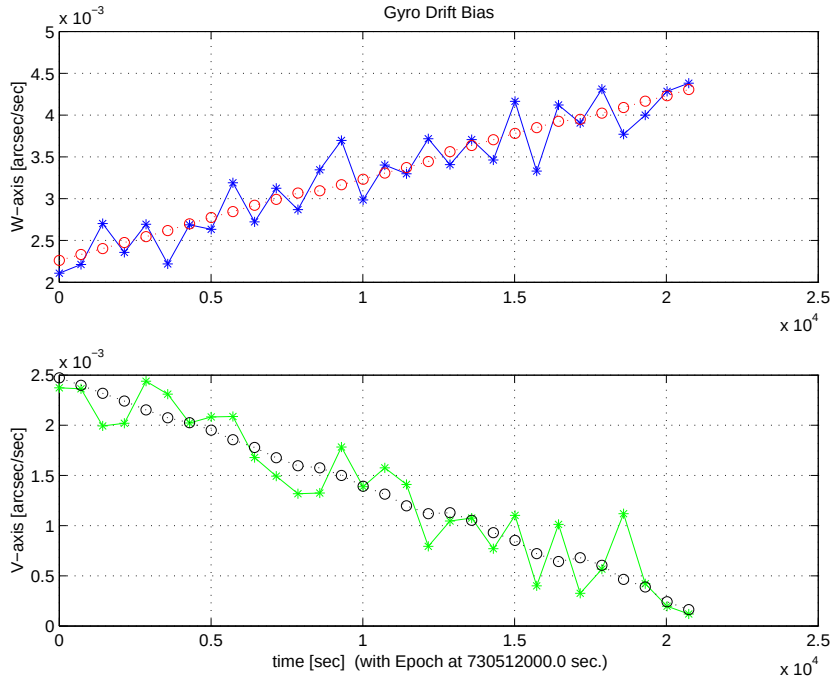

Figure 3.22: Gyro drift bias contribution (equiv. rate in (W,V) coords)

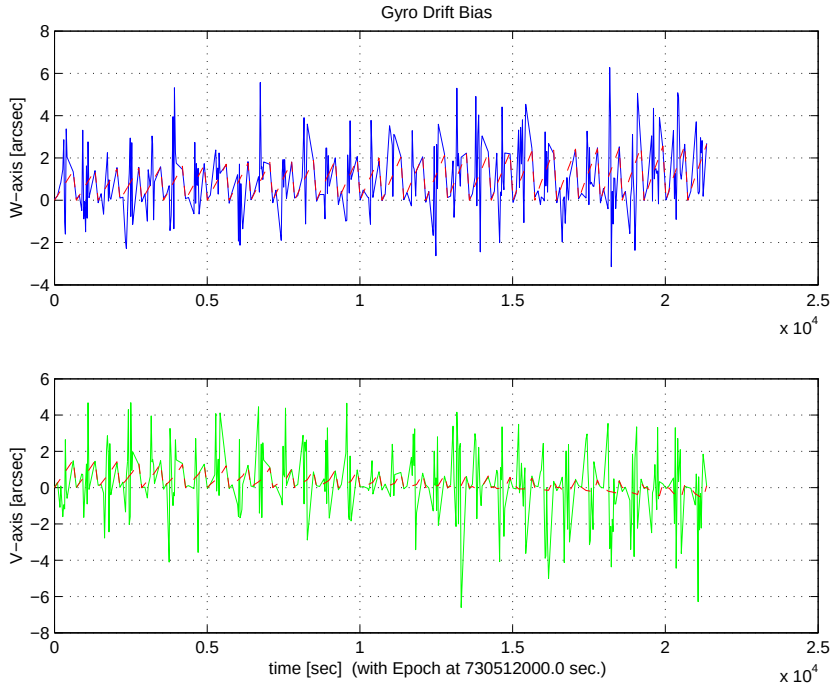

Figure 3.23: Gyro drift bias contribution (equiv. angle in (W,V) coords)

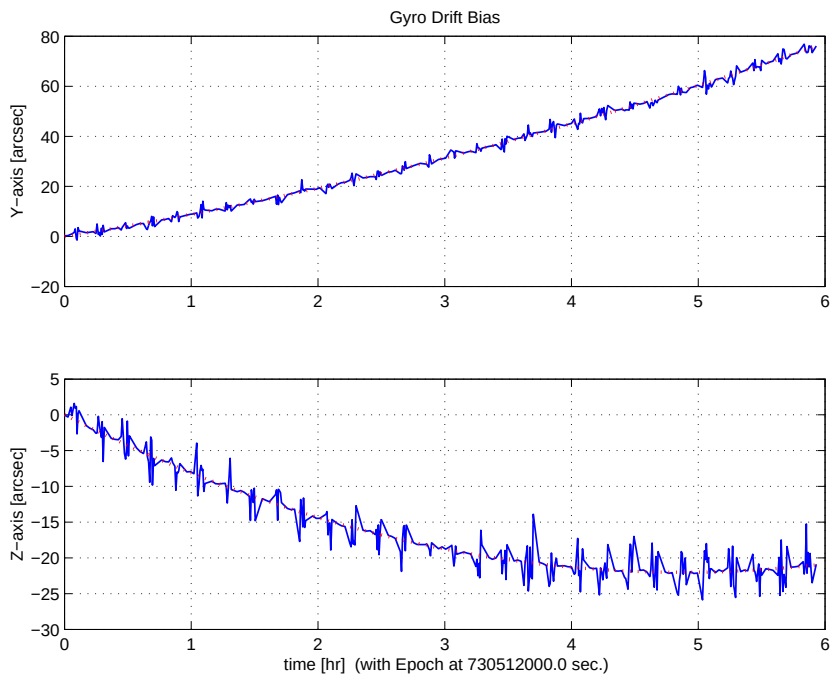

Figure 3.24: Gyro drift bias contribution (equiv. angle in Body frame)

3.2 IPF OUTPUT DATA (IF MINI FILE)

```
OUTPUT FILE NAME: IFmini991087.dat   DATE: 07-Aug-2003   TIME: 10:31
INSTRUMENT NAME:  MIPS_160um_center_large_FOV   NF: 87
IPF FILTER VERSION: IPF.V2.0.1Beta       SW RELEASE DATE: August 5, 2003
--------------------------------------------------------------------------------
---------------------------- IPF BROWN ANGLE SUMMARY ---------------------------
--------------------------------------------------------------------------------
         ------------ WAS ------------           ------------ IS -------------
Frame    theta_Y     theta_Z     angle           theta_Y     theta_Z     angle
Number   (arcmin)    (arcmin)    (deg)           (arcmin)    (arcmin)    (deg)
------  ---------------------------------       ---------------------------------
 087     +6.669000 +11.517000   +0.000000        +6.668431 +11.520707   -0.051814
 088     +6.664000 +11.974000   +0.000000        +6.663796 +12.014610   -0.051814
 089     +6.669000 +11.517000   +0.000000        +6.668431 +11.520707   -0.051814
 091     +7.589000 +11.546000   +0.000000        +7.694403 +11.509241   -0.051814
 092     +5.879000 +11.626000   +0.000000        +5.787480 +11.695169   -0.051814
 001     +0.000000  +0.000000   +0.000000        +9.604416 +10.994042   -0.051814
 001     +0.000000  +0.000000   +0.000000        +9.595146 +11.981851   -0.051814
 001     +0.000000  +0.000000   +0.000000        +3.741715 +11.059564   -0.051814
 001     +0.000000  +0.000000   +0.000000        +3.732445 +12.047370   -0.051814
--------------------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  0              87            +0.000            +0.000     pixels
OFFSET FRAME NAME: MIPS_160um_center_large_FOV
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
WAS(FTB)            +6.669000       +11.517000       +0.000000
IS (EST)            +6.668431       +11.520707       -0.051814
dT_EST              -0.000569        +0.003707       -0.051814
T_sSIGMA            +0.002017        +0.003566       +0.166196
dT_EST/T_sSIGMA     -0.282345        +1.039505       -0.311766
-------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  1              88            +0.000            -1.500     pixels
OFFSET FRAME NAME: MIPS_160um_plusY_edge
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
WAS(FTB)            +6.664000       +11.974000       +0.000000
IS (EST)            +6.663796       +12.014610       -0.051814
dT_EST              -0.000204        +0.040610       -0.051814
T_sSIGMA            +0.003403        +0.004656       +0.166196
dT_EST/T_sSIGMA     -0.060071        +8.722260       -0.311766
-------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  2              89            +0.000            +0.000     pixels
OFFSET FRAME NAME: MIPS_160um_large_only
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
WAS(FTB)            +6.669000       +11.517000       +0.000000
IS (EST)            +6.668431       +11.520707       -0.051814
dT_EST              -0.000569        +0.003707       -0.051814
T_sSIGMA            +0.002017        +0.003566       +0.166196
dT_EST/T_sSIGMA     -0.282345        +1.039505       -0.311766
-------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  3              91            +3.500            +0.000     pixels
OFFSET FRAME NAME: MIPS_160um_small_FOV1
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
WAS(FTB)            +7.589000       +11.546000       +0.000000
IS (EST)            +7.694403       +11.509241       -0.051814
dT_EST              +0.105403        -0.036759       -0.051814
T_sSIGMA            +0.002473        +0.003932       +0.166196
dT_EST/T_sSIGMA    +42.627843        -9.349083       -0.311766
-------------------------------------------------------------------
```

```
OFFSET           NF          Delta_CW          Delta_CV
  4              92            -3.000            -0.500     pixels
OFFSET FRAME NAME: MIPS_160um_small_FOV2
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
WAS(FTB)            +5.879000       +11.626000       +0.000000
IS (EST)            +5.787480       +11.695169       -0.051814
dT_EST              -0.091520        +0.069169       -0.051814
T_sSIGMA            +0.002541        +0.003951       +0.166196
dT_EST/T_sSIGMA    -36.016632       +17.508287       -0.311766
-------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  5               1           +10.000            +1.500     pixels
OFFSET FRAME NAME: CORNER PIXEL (DIAGNOSTICS)
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
WAS(FTB)            +0.000000        +0.000000       +0.000000
IS (EST)            +9.604416       +10.994042       -0.051814
dT_EST              +9.604416       +10.994042       -0.051814
T_sSIGMA            +0.005423        +0.006795       +0.166196
dT_EST/T_sSIGMA    +1771.097889       +1617.867611       -0.311766
-------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  6               1           +10.000            -1.500     pixels
OFFSET FRAME NAME: CORNER PIXEL (DIAGNOSTICS)
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
WAS(FTB)            +0.000000        +0.000000       +0.000000
IS (EST)            +9.595146       +11.981851       -0.051814
dT_EST              +9.595146       +11.981851       -0.051814
T_sSIGMA            +0.005201        +0.006571       +0.166196
dT_EST/T_sSIGMA    +1844.944860       +1823.388319       -0.311766
-------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  7               1           -10.000            +1.500     pixels
OFFSET FRAME NAME: CORNER PIXEL (DIAGNOSTICS)
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
WAS(FTB)            +0.000000        +0.000000       +0.000000
IS (EST)            +3.741715       +11.059564       -0.051814
dT_EST              +3.741715       +11.059564       -0.051814
T_sSIGMA            +0.005202        +0.006671       +0.166196
dT_EST/T_sSIGMA    +719.302109       +1657.908810       -0.311766
-------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  8               1           -10.000            -1.500     pixels
OFFSET FRAME NAME: CORNER PIXEL (DIAGNOSTICS)
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
WAS(FTB)            +0.000000        +0.000000       +0.000000
IS (EST)            +3.732445       +12.047370       -0.051814
dT_EST              +3.732445       +12.047370       -0.051814
T_sSIGMA            +0.005394        +0.006678       +0.166196
dT_EST/T_sSIGMA    +691.914177       +1803.966922       -0.311766
-------------------------------------------------------------------
-------------------------------------------------------------------------------------
-------------------------------------------------------------------------------------
VARNAME             MEAN                      SIGMA                SCALED_SIGMA
a00        +1.0168590821128072E-001 +1.3796153901664589E-003 +1.5249814904092858E-003
b00        +9.9824240374538575E-002 +6.2692708646653527E-003 +6.9298458795993478E-003
c00        +1.1315745088548735E-002 +2.8916988621675937E-003 +3.1963888429159273E-003
a10        -8.5103529410405965E-001 +5.3479970151350651E+000 +5.9115000578973405E+000
b10        +2.3691100961857920E+001 +2.4036429308907206E+001 +2.6569078638063100E+001
c10        -3.0705327653297495E+001 +2.1353241727375799E+001 +2.3603171308892360E+001
d10        +1.4802282063196630E+001 +6.0989435402981549E+000 +6.7415716556219136E+000
del_alpha  -3.0956574109675117E-014 +2.7922358627815586E-003 +3.0864457137471575E-003
beta       +1.0981667194069664E+000 +3.9254618791016776E-003 +4.3390764916119368E-003
del_theta1 -1.1297386637298956E-014 +2.6241699513274374E-003 +2.9006711812483740E-003
del_theta2 -7.0678083480123926E-018 +5.3075835562269583E-007 +5.8668283492185594E-007
```

```
del_theta3 +1.8237254629095527E-017 +9.3840741988321862E-007 +1.0372847070167707E-006
del_arx    -6.7595609353474952E-015 +6.1848009143645335E-005 +6.8364755739165446E-005
del_ary    -8.1473981614023014E-020 +2.4967621487381510E-006 +2.7598387854464255E-006
del_arz    +2.5765154068699715E-018 +2.4940937289129047E-006 +2.7568892019094871E-006
brx        +1.3956411231670024E-008 +1.2469874234819582E-008 +1.3783788968559626E-008
bry        +3.8727366636749887E-012 +5.5707731251999738E-010 +6.1577494450641341E-010
brz        +1.0804247744659930E-010 +5.5621961315619974E-010 +6.1482687183090540E-010
crx        -1.3402815125845399E-012 +1.1406122522331873E-012 +1.2607952801829703E-012
cry        +6.9222132551991423E-014 +5.1916579101708624E-014 +5.7386879517140388E-014
crz        +4.0822859831907151E-014 +5.1838375512490220E-014 +5.7300435840959561E-014
bgx        +8.0826783092467364E-009 +4.9843963083398741E-007 +5.5095877918305650E-007
bgy        +1.0808616837987133E-008 +1.3603988158540027E-009 +1.5037401210070249E-009
bgz        -1.2164084510801989E-008 +1.9276362017582400E-009 +2.1307456765682312E-009
cgx        -4.9556795043019744E-011 +3.3755037792136827E-011 +3.7311708906685745E-011
cgy        +6.0432674837691912E-013 +1.0207559384220809E-013 +1.1283100517827777E-013
cgz        +6.9322332696961655E-013 +1.3480910598758667E-013 +1.4901355322289400E-013
-------------------------------------------------------------------------------
LSQF RESIDUAL SIGMA SCALE =         +1.1053671199081707E+000
-------------------------------------------------------------------------------
-------------------------------------------------------------------------------------------------------
-------------------------------------------------------------------------------------------------------
                    a_mirror(1)               a_mirror(2)               a_mirror(3)
a_mirror_ipf   +0.0000000000000000E+000  +2.0584906497259119E-002  +9.9978810836321663E-001
a_mirror_tpf   -1.8672930468955262E-003  +2.1495416275380031E-002  +9.9976720305070266E-001
beta                beta_0                    beta                      beta_total
               +2.8047410000000001E-006  +1.0981667194069664E+000  +3.0800732227562145E-006
-------------------------------------------------------------------------------------------------------
qT              qT(1)                     qT(2)                     qT(3)                     qT(4)
FrmTbl:   -1.6247706156225429E-006 -9.6996521888884340E-004 -1.6750781782660256E-003 +9.9999812663721077E-001
Estim:    -4.5379004301719064E-004 -9.6912463893322396E-004 -1.6760556852169594E-003 +9.9999802285273098E-001
DelTheta        deltheta(1)               deltheta(2)               deltheta(3)
          -9.0433359427629701E-004 +1.6564670516567505E-007 -1.0782610374803853E-006       [rad]
EulAngT         theta(1)                  theta(2)                  theta(3)                  [rad]
Mean      -9.0433150251900468E-004 -1.9397678168854035E-003 -3.3512377622691848E-003
SigmaT    +2.6241699513274374E-003 +5.3075835562269583E-007 +9.3840741988321862E-007
-------------------------------------------------------------------------------------------------------
qR              qR(1)                     qR(2)                     qR(3)                     qR(4)
ASFILE:   +0.0000000000000000E+000 +0.0000000000000000E+000 +0.0000000000000000E+000 +1.0000000000000000E+000
Estim:    +3.3006887124036789E-005 +8.8397918948803130E-007 +1.6657573049402150E-006 +9.9999999945349471E-001
DelThetaR       delthetaR(1)              delthetaR(2)              delthetaR(3)
          +6.6013777205035430E-005 +1.7678484150841045E-006 +3.3315729628737627E-006       [rad]
EulAngR         angR(1)                   angR(2)                   angR(3)                   [rad]
Mean      +6.6013777205035430E-005 +1.7678484150841045E-006 +3.3315729628737627E-006
SigmaR    +6.1848009143645335E-005 +2.4967621487381510E-006 +2.4940937289129047E-006
-------------------------------------------------------------------------------------------------------
Initial Gyro Bias         Bg0(1)                    Bg0(2)                    Bg0(3)
                  +2.5139469464322443E-006 +2.4888835000837901E-006 +2.5115474422157735E-006
Gyro Bias Correction      Bg(1)                     Bg(2)                     Bg(3)
                  +8.0826783092467364E-009 +1.0808616837987133E-008 -1.2164084510801989E-008
Total Gyro Bias           BgT(1)                    BgT(2)                    BgT(3)
                  +2.5220296247414910E-006 +2.4996921169217770E-006 +2.4993833577049714E-006

Initial Gyro Bias Rate     Cg0(1)                    Cg0(2)                    Cg0(3)
                  +0.0000000000000000E+000 +0.0000000000000000E+000 +0.0000000000000000E+000
Gyro Bias Rate Correction  Cg(1)                     Cg(2)                     Cg(3)
                  -4.9556795043019744E-011 +6.0432674837691912E-013 +6.9322332696961655E-013
Total Gyro Bias Rate       CgT(1)                    CgT(2)                    CgT(3)
                  -4.9556795043019744E-011 +6.0432674837691912E-013 +6.9322332696961655E-013
-------------------------------------------------------------------------------------------------------
-------------------------------------------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  1              88            +0.000            -1.500     pixels
OFFSET FRAME NAME: MIPS_160um_plusY_edge
qT              qT(1)                     qT(2)                     qT(3)                     qT(4)
```

```
WAS(FTB)  -1.6879757291711217E-006 -9.6923788967401584E-004 -1.7415460069063584E-003 +9.9999801379431230E-001
IS (EST)  -4.5385848154770093E-004 -9.6841790881709163E-004 -1.7478905952468800E-003 +9.9999790052664594E-001

DelTheta        deltheta(1)               deltheta(2)               deltheta(3)
Units             rad                       rad                       rad
          -9.0435440189682681E-004 +5.9467245733324307E-008 -1.1813049755025817E-005
EulAngT         theta(1)                  theta(2)                  theta(3)                  [rad]
Mean      -9.0433150251900457E-004 -1.9384195551673798E-003 -3.4949084825120027E-003
sSigmaT   +2.9006711521309568E-003 +9.8995678733074445E-007 +1.3543590302352479E-006
SigmaT    +2.6241699249855851E-003 +8.9559094847419195E-007 +1.2252572071691100E-006
-----------------------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  2              89            +0.000            +0.000     pixels
OFFSET FRAME NAME: MIPS_160um_large_only
qT               qT(1)                     qT(2)                     qT(3)                     qT(4)
WAS(FTB)  -1.6247706156225429E-006 -9.6996521888884340E-004 -1.6750781782660256E-003 +9.9999812663721077E-001
IS (EST)  -4.5379004301719070E-004 -9.6912463893322385E-004 -1.6760556852169596E-003 +9.9999802285273098E-001

DelTheta        deltheta(1)               deltheta(2)               deltheta(3)
Units             rad                       rad                       rad
          -9.0433359427629712E-004 +1.6564670516589168E-007 -1.0782610374808190E-006
EulAngT         theta(1)                  theta(2)                  theta(3)                  [rad]
Mean      -9.0433150251900468E-004 -1.9397678168854033E-003 -3.3512377622691844E-003
sSigmaT   +2.9006711812483740E-003 +5.8668283492185583E-007 +1.0372847070167707E-006
SigmaT    +2.6241699513274374E-003 +5.3075835562269573E-007 +9.3840741988321852E-007
-----------------------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  3              91            +3.500            +0.000     pixels
OFFSET FRAME NAME: MIPS_160um_small_FOV1
qT               qT(1)                     qT(2)                     qT(3)                     qT(4)
WAS(FTB)  -1.8535660093339217E-006 -1.1037735273119842E-003 -1.6792958163857940E-003 +9.9999798082102442E-001
IS (EST)  -4.5403814594640674E-004 -1.1183467983713082E-003 -1.6744552341020449E-003 +9.9999786967246562E-001

DelTheta        deltheta(1)               deltheta(2)               deltheta(3)
Units             rad                       rad                       rad
          -9.0430789757996893E-004 -3.0660618267416431E-005 +1.0692800842912929E-005
EulAngT         theta(1)                  theta(2)                  theta(3)                  [rad]
Mean      -9.0433150251900468E-004 -2.2382112337053762E-003 -3.3479024296332069E-003
sSigmaT   +2.9006710584750712E-003 +7.1926270931033453E-007 +1.1437301430215919E-006
SigmaT    +2.6241698402572774E-003 +6.5070029346457118E-007 +1.0347061373750725E-006
-----------------------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  4              92            -3.000            -0.500     pixels
OFFSET FRAME NAME: MIPS_160um_small_FOV2
qT               qT(1)                     qT(2)                     qT(3)                     qT(4)
WAS(FTB)  -1.4458583985377269E-006 -8.5506456275250009E-004 -1.6909317330203208E-003 +9.9999820480457724E-001
IS (EST)  -4.5359674001689998E-004 -8.4098434440636023E-004 -1.7013724315537598E-003 +9.9999809616177704E-001

DelTheta        deltheta(1)               deltheta(2)               deltheta(3)
Units             rad                       rad                       rad
          -9.0436591124029597E-004 +2.6622022570951232E-005 -2.0120489971598322E-005
EulAngT         theta(1)                  theta(2)                  theta(3)                  [rad]
Mean      -9.0433150251900468E-004 -1.6835097558286658E-003 -3.4019868324249784E-003
sSigmaT   +2.9006710770415850E-003 +7.3915914253468666E-007 +1.1491997342173980E-006
SigmaT    +2.6241698570539720E-003 +6.6870013520584268E-007 +1.0396543496905071E-006
-----------------------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  5               1           +10.000            +1.500     pixels
OFFSET FRAME NAME: CORNER PIXEL (DIAGNOSTICS)
qT               qT(1)                     qT(2)                     qT(3)                     qT(4)
```

```
WAS(FTB)  +0.0000000000000000E+000 +0.0000000000000000E+000 +0.0000000000000000E+000 +1.0000000000000000E+000
IS (EST)  -4.5439839290064616E-004 -1.3961802566953624E-003 -1.5996478627515695E-003 +9.9999764266197477E-001

DelTheta        deltheta(1)               deltheta(2)               deltheta(3)
Units             rad                       rad                       rad
          -9.0433150251900468E-004 -2.7938113201483928E-003 -3.1980372717609206E-003
EulAngT         theta(1)                  theta(2)                  theta(3)                  [rad]
Mean      -9.0433150251900468E-004 -2.7938113201483924E-003 -3.1980372717609201E-003
sSigmaT   +2.9006701068747683E-003 +1.5774460224386669E-006 +1.9766989891533664E-006
SigmaT    +2.6241689793665510E-003 +1.4270788356448621E-006 +1.7882737359851832E-006
-------------------------------------------------------------------------------------------------------
-------------------------------------------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  6               1           +10.000            -1.500     pixels
OFFSET FRAME NAME: CORNER PIXEL (DIAGNOSTICS)
qT               qT(1)                     qT(2)                     qT(3)                     qT(4)
WAS(FTB)  +0.0000000000000000E+000 +0.0000000000000000E+000 +0.0000000000000000E+000 +1.0000000000000000E+000
IS (EST)  -4.5459663006214280E-004 -1.3947667250364182E-003 -1.7433178589893615E-003 +9.9999740440189611E-001

DelTheta        deltheta(1)               deltheta(2)               deltheta(3)
Units             rad                       rad                       rad
          -9.0433150251900446E-004 -2.7911148463586103E-003 -3.4853791882948973E-003
EulAngT         theta(1)                  theta(2)                  theta(3)                  [rad]
Mean      -9.0433150251900468E-004 -2.7911148463586103E-003 -3.4853791882948977E-003
sSigmaT   +2.9006701231306222E-003 +1.5128445879899892E-006 +1.9114848724688908E-006
SigmaT    +2.6241689940728449E-003 +1.3686354160015815E-006 +1.7292760369312316E-006
-------------------------------------------------------------------------------------------------------
-------------------------------------------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  7               1           -10.000            +1.500     pixels
OFFSET FRAME NAME: CORNER PIXEL (DIAGNOSTICS)
qT               qT(1)                     qT(2)                     qT(3)                     qT(4)
WAS(FTB)  +0.0000000000000000E+000 +0.0000000000000000E+000 +0.0000000000000000E+000 +1.0000000000000000E+000
IS (EST)  -4.5304047213508752E-004 -5.4348225966135641E-004 -1.6087933662980317E-003 +9.9999845558144174E-001

DelTheta        deltheta(1)               deltheta(2)               deltheta(3)
Units             rad                       rad                       rad
          -9.0433150251900446E-004 -1.0884207525083684E-003 -3.2170967792898891E-003
EulAngT         theta(1)                  theta(2)                  theta(3)                  [rad]
Mean      -9.0433150251900457E-004 -1.0884207525083687E-003 -3.2170967792898896E-003
sSigmaT   +2.9006700847897826E-003 +1.5131621866969419E-006 +1.9404546011823690E-006
SigmaT    +2.6241689593867767E-003 +1.3689227401866713E-006 +1.7554842786924709E-006
-------------------------------------------------------------------------------------------------------
-------------------------------------------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  8               1           -10.000            -1.500     pixels
OFFSET FRAME NAME: CORNER PIXEL (DIAGNOSTICS)
qT               qT(1)                     qT(2)                     qT(3)                     qT(4)
WAS(FTB)  +0.0000000000000000E+000 +0.0000000000000000E+000 +0.0000000000000000E+000 +1.0000000000000000E+000
IS (EST)  -4.5311618773560060E-004 -5.4206892570882864E-004 -1.7524630019136712E-003 +9.9999821485862017E-001

DelTheta        deltheta(1)               deltheta(2)               deltheta(3)
Units             rad                       rad                       rad
          -9.0433150251900457E-004 -1.0857242680955732E-003 -3.5044377451795279E-003
EulAngT         theta(1)                  theta(2)                  theta(3)                  [rad]
Mean      -9.0433150251900457E-004 -1.0857242680955730E-003 -3.5044377451795279E-003
sSigmaT   +2.9006700718214582E-003 +1.5691603163462806E-006 +1.9426286047200608E-006
SigmaT    +2.6241689476546341E-003 +1.4195829494879854E-006 +1.7574510492780412E-006
-------------------------------------------------------------------------------------------------------
-------------------------------------------------------------------------------------------------------
              q(1)                      q(2)                      q(3)                      q(4)
PCRS1A: +5.2603126189317361E-007 +3.7451819048221893E-004 -1.4045531552277380E-003 +9.9999894348258311E-001
PCRS2A: -5.1968404336718985E-007 +3.8455385122900486E-004 +1.3513933841514693E-003 +9.9999901292650617E-001
-------------------------------------------------------------------------------------
```

```
**********  CS-FILE PARAMETERS:  **********  **********  AS-FILE PARAMETERS:  **********
Row (01) PIX2RADX: +7.7399898172000000E-005  Row (1) TASTART:   +7.3051200000000000E+008
Row (02) PIX2RADY: +8.7086140999000005E-005  Row (2) TASTOP:    +7.3053335000000000E+008
Row (03) CX0:      +1.0500000000000000E+001  Row (3) S/C TIME:  +7.3051200000000000E+008
Row (04) CY0:      +2.0000000000000000E+000  Row (4) QR1:       +0.0000000000000000E+000
Row (05) BETA0:    +2.8047410000000001E-006  Row (5) QR2:       +0.0000000000000000E+000
Row (06) GAMMA_E0: +2.0070000000000000E+003  Row (6) QR3:       +0.0000000000000000E+000
Row (07) D11:      -1.0000000000000000E+000  Row (7) QR4:       +1.0000000000000000E+000
Row (08) D12:      +0.0000000000000000E+000
Row (09) D21:      +0.0000000000000000E+000
Row (10) D22:      -1.0000000000000000E+000
Row (11) DG:       +1.0000000000000000E+000
-------------------------------------------------------------------------------------
-------------------------------------------------------------
INITIAL STA-TO-PCRS ALIGNMENT (R) KNOWLEDGE (1-SIGMA)
    SIGMA(X)        SIGMA(Y)         SIGMA(Z)
1.41451738E+001  7.65467990E-001  7.65467990E-001  [arcsec]
-------------------------------------------------------------
PIX2RADX = 7.739989817200E-005[rad/pixel]
XPIXSIZE = 15.9649[arcsec]
PIX2RADY = 8.708614099900E-005[rad/pixel]
YPIXSIZE = 17.9628[arcsec]
CX0 = 10.5[pixel] = 167.63[arcsec]
CY0 = 2.0[pixel] = 35.93[arcsec]
-------------------------------------------------------------
NOMINAL BETA0 = 2.804741000000E-006[rad/encoder unit]
ENCODER UNIT SIZE = 0.58[arcsec]
GAMMA_E0 = 2007.00[encoder unit] = 1161.09[arcsec]
-------------------------------------------------------------
                | -1 | +0 |
FLIP MATRIX D = |----|----|   and   DG = +1
                | +0 | -1 |
-------------------------------------------------------------
```

3.3 IPF EXECUTION LOG

```
*********************************************************************
IPF EXECUTION-LOG FILE NAME:  LG991087.dat
INSTRUMENT TYPE:              MIPS_160um_center_large_FOV
IPF FILTER EXECUTION DATE:    07-Aug-2003    TIME: 10:14
IPF FILTER VERSION USED:      IPF.V2.0.1Beta
*********************************************************************

------------------- Loading & Preparing Input Files -------------------
AAFILE:  AA991087 Loaded!        AAFILE dimension = 213501 X 21
ASFILE:  AS991087 Loaded!
CAFILE:  CA991087 Loaded!        CAFILE dimension = 246 X 15
CBFILE:  CB991087 Loaded!        CBFILE dimension = 90 X 15
CCFILE:  CC991087 Created!       CCFILE dimension = 336 X 19
CSFILE:  CS991087 Loaded!
Loading Input Files Completed!
---------------------------------------------------------------------

------------------------- Selected Mask Vectors -------------------------
index =   1  2  3  4  5  6  7  8  9 10 11 12 13 14 15 16 17 18 19 20
---------------------------------------------------------------------
mask1 = [ 1  1  1  1  1  1  1  0  0  0  0  0  0  0  0  0  0 ]
```

```
mask2 = [ 1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1 ]
-----------------------------------------------------------------------

---------------  Selected Initial Gyro Bias Parameters  ---------------
User Entered 1 : Use AFILE database - from S/C filter
IPF Linearized Using Following Nominal Gyro Bias Estimates
bg0 = [+2.5139469464322443E-006 +2.4888835000837901E-006 +2.5115474422157735E-006 ]
cg0 = [+0.0000000000000000E+000 +0.0000000000000000E+000 +0.0000000000000000E+000 ]
-----------------------------------------------------------------------

---------------  Gyro Pre-Processor Run Completed  --------------------
     AGFILE CREATED:  AG991087.m     ACFILE CREATED:  AC991087.m
-----------------------------------------------------------------------
Total Gyro Preprocessor Execution Time: 82 seconds

FRAME TABLE ENTRIES FOR PCRS LOADED TO TPCRS
q_PCRS4 = [ +5.2603126189317361E-007     q_PCRS5 = [ +7.3379987833742897E-007
            +3.7451819048221893E-004                 +5.2236196154513707E-004
            -1.4045531552277380E-003                 -1.4047712280184723E-003
            +9.9999894348258311E-001 ];              +9.9999887687698918E-001 ];
q_PCRS8 = [ -5.1968404336718985E-007     q_PCRS9 = [ -7.1963421681856818E-007
            +3.8455385122900486E-004                 +5.3239763239987400E-004
            +1.3513933841514693E-003                 +1.3516841804518383E-003
            +9.9999901292650617E-001 ];              +9.9999894475050310E-001 ];
-------------------------------------------------------------------------------
------ Initial Conditions for State -----  ------   Inital Square-Root Cov (diag)   -----
p1(01)  = a00  = +0.0000000000000000E+000  Sigma_initial(01,01) = 1.0000000000000000E+000
p1(02)  = b00  = +0.0000000000000000E+000  Sigma_initial(02,02) = 1.0000000000000000E+000
p1(03)  = c00  = +0.0000000000000000E+000  Sigma_initial(03,03) = 1.0000000000000000E+000
p1(04)  = a10  = +0.0000000000000000E+000  Sigma_initial(04,04) = 3.6384517097704270E+002
p1(05)  = b10  = +0.0000000000000000E+000  Sigma_initial(05,05) = 3.6384517097704270E+002
p1(06)  = c10  = +0.0000000000000000E+000  Sigma_initial(06,06) = 3.6384517097704270E+002
p1(07)  = d10  = +0.0000000000000000E+000  Sigma_initial(07,07) = 3.6384517097704270E+002
p1(08)  = a20  = +0.0000000000000000E+000  Sigma_initial(08,08) = 9.9999000000000000E+004
p1(09)  = b20  = +0.0000000000000000E+000  Sigma_initial(09,09) = 9.9999000000000000E+004
p1(10)  = c20  = +0.0000000000000000E+000  Sigma_initial(10,10) = 9.9999000000000000E+004
p1(11)  = d20  = +0.0000000000000000E+000  Sigma_initial(11,11) = 9.9999000000000000E+004
p1(12)  = a01  = +0.0000000000000000E+000  Sigma_initial(12,12) = 9.9999000000000000E+004
p1(13)  = b01  = +0.0000000000000000E+000  Sigma_initial(13,13) = 9.9999000000000000E+004
p1(14)  = c01  = +0.0000000000000000E+000  Sigma_initial(14,14) = 9.9999000000000000E+004
p1(15)  = d01  = +0.0000000000000000E+000  Sigma_initial(15,15) = 9.9999000000000000E+004
p1(16)  = e01  = +0.0000000000000000E+000  Sigma_initial(16,16) = 9.9999000000000000E+004
p1(17)  = f01  = +0.0000000000000000E+000  Sigma_initial(17,17) = 9.9999000000000000E+004
-------------------------------------------------------------------------------------------
p2f(01) = am1  = +0.0000000000000000E+000
p2f(02) = am2  = +0.0000000000000000E+000  Sigma_initial(18,18) = 1.0000000000000001E-001
p2f(03) = am3  = +1.0000000000000000E+000
p2f(04) = beta = +1.0000000000000000E+000  Sigma_initial(19,19) = 1.0000000000000001E-001
p2f(05) = qT1  = -1.6247706156225429E-006  Sigma_initial(20,20) = 1.0000000000000001E-001
p2f(06) = qT2  = -9.6996521888884340E-004  Sigma_initial(21,21) = 1.0000000000000000E-002
p2f(07) = aT3  = -1.6750781782660256E-003  Sigma_initial(22,22) = 1.0000000000000000E-002
p2f(08) = qT4  = +9.9999812663721077E-001
p2f(09) = qR1  = +0.0000000000000000E+000  Sigma_initial(23,23) = 3.4288868839039716E-003
p2f(10) = qR2  = +0.0000000000000000E+000  Sigma_initial(24,24) = 1.8555467699985827E-004
p2f(11) = qR3  = +0.0000000000000000E+000  Sigma_initial(25,25) = 1.8555467699985827E-004
p2f(12) = qR4  = +1.0000000000000000E+000
p2f(13) = brx  = +0.0000000000000000E+000  Sigma_initial(26,26) = 4.6838407494145199E-005
p2f(14) = bry  = +0.0000000000000000E+000  Sigma_initial(27,27) = 4.6838407494145199E-005
p2f(15) = brz  = +0.0000000000000000E+000  Sigma_initial(28,28) = 4.6838407494145199E-005
p2f(16) = crx  = +0.0000000000000000E+000  Sigma_initial(29,29) = 2.1938364165875972E-009
p2f(17) = cry  = +0.0000000000000000E+000  Sigma_initial(30,30) = 2.1938364165875972E-009
p2f(18) = crz  = +0.0000000000000000E+000  Sigma_initial(31,31) = 2.1938364165875972E-009
p2f(19) = bgx  = +0.0000000000000000E+000  Sigma_initial(32,32) = 4.6838407494145199E-005
p2f(20) = bgy  = +0.0000000000000000E+000  Sigma_initial(33,33) = 4.6838407494145199E-005
```

```
p2f(21) = bgz  = +0.0000000000000000E+000  Sigma_initial(34,34) = 4.6838407494145199E-005
p2f(22) = cgx  = +0.0000000000000000E+000  Sigma_initial(35,35) = 2.1938364165875972E-009
p2f(23) = cgy  = +0.0000000000000000E+000  Sigma_initial(36,36) = 2.1938364165875972E-009
p2f(24) = cgz  = +0.0000000000000000E+000  Sigma_initial(37,37) = 2.1938364165875972E-009
-------------------------------------------------------------------------------------

--------------------   IPF KALMAN FILTER STARTED  ---------------------
Iteration#001: |dp|= +4.137527534476E+001   RMS(|Res|)=+4.137527534476E+001
Iteration#002: |dp|= +4.371240032856E-001   RMS(|Res|)=+4.371240032856E-001
Iteration#003: |dp|= +1.400464287247E-001   RMS(|Res|)=+1.400464287247E-001
Iteration#004: |dp|= +3.009450405478E-002   RMS(|Res|)=+3.009450405478E-002
Iteration#005: |dp|= +2.326749948517E-003   RMS(|Res|)=+2.326749948517E-003
Iteration#006: |dp|= +1.834765269205E-004   RMS(|Res|)=+1.834765269205E-004
Iteration#007: |dp|= +4.540817172150E-005   RMS(|Res|)=+4.540817172150E-005
Iteration#008: |dp|= +1.587432796966E-006   RMS(|Res|)=+1.587432796966E-006
Iteration#009: |dp|= +3.763129877125E-007   RMS(|Res|)=+3.763129877125E-007
Iteration#010: |dp|= +5.453463773895E-008   RMS(|Res|)=+5.453463773895E-008
Iteration#011: |dp|= +8.065338785474E-010   RMS(|Res|)=+8.065338785474E-010
Iteration#012: |dp|= +3.582508874246E-010   RMS(|Res|)=+3.582508874246E-010
Iteration#013: |dp|= +9.866643390827E-011   RMS(|Res|)=+9.866643390827E-011
Iteration#014: |dp|= +2.373404315136E-010   RMS(|Res|)=+2.373404315136E-010
Iteration#015: |dp|= +2.133219366229E-010   RMS(|Res|)=+2.133219366229E-010
Iteration#016: |dp|= +4.958454715251E-011   RMS(|Res|)=+4.958454715251E-011
Iteration#017: |dp|= +1.300593695252E-010   RMS(|Res|)=+1.300593695252E-010
Iteration#018: |dp|= +1.552922439400E-010   RMS(|Res|)=+1.552922439400E-010
Iteration#019: |dp|= +1.016959933693E-010   RMS(|Res|)=+1.016959933693E-010
Iteration#020: |dp|= +2.456274893508E-010   RMS(|Res|)=+2.456274893508E-010
IPF Kalman Filter Completed with Error |dp1| + |dp2| = +2.4562748935082943E-010
-----------------------------------------------------------------------

-----------------  IPF LEAST SQUARES FILTER STARTED  ------------------
Iteration#001   COND#=+3.942183499198E+010,   |dp|=+4.154187128734E+001
Iteration#002   COND#=+3.942094363745E+010,   |dp|=+1.280509692547E-001
Iteration#003   COND#=+3.942094052429E+010,   |dp|=+6.279360983096E-003
Iteration#004   COND#=+3.942093180866E+010,   |dp|=+2.854248378450E-004
Iteration#005   COND#=+3.942094648365E+010,   |dp|=+5.395802862082E-006
Iteration#006   COND#=+3.942093332236E+010,   |dp|=+1.150834027577E-007
Iteration#007   COND#=+3.942093435222E+010,   |dp|=+2.296231440023E-009
Iteration#008   COND#=+3.942094631964E+010,   |dp|=+1.316382942848E-010
Iteration#009   COND#=+3.942094536198E+010,   |dp|=+1.744356146930E-010
Iteration#010   COND#=+3.942091270643E+010,   |dp|=+2.459107657621E-010
Iteration#011   COND#=+3.942095562400E+010,   |dp|=+2.643153781438E-010
Iteration#012   COND#=+3.942094540649E+010,   |dp|=+1.228273717924E-010
Iteration#013   COND#=+3.942095130736E+010,   |dp|=+5.960471586383E-011
Iteration#014   COND#=+3.942095344114E+010,   |dp|=+1.077026549508E-010
Iteration#015   COND#=+3.942093969056E+010,   |dp|=+2.260484524609E-010
Iteration#016   COND#=+3.942096396743E+010,   |dp|=+1.903705478941E-010
Iteration#017   COND#=+3.942094600651E+010,   |dp|=+6.209417520313E-011
Iteration#018   COND#=+3.942095017314E+010,   |dp|=+1.307336232686E-010
Iteration#019   COND#=+3.942095390685E+010,   |dp|=+2.201190116275E-010
Iteration#020   COND#=+3.942093383878E+010,   |dp|=+1.880325271552E-010
IPF Least Squares Filter Completed with Error |dp1| + |dp2| = +1.8803252715517054E-010
-----------------------------------------------------------------------
Total Execution Time: 1051 seconds
```

4 USER COMMENTS

This section left blank.

IPF TEAM CONTACT INFORMATION

IPF Team email		ipf@sirtfweb.jpl.nasa.gov	
David S. Bayard	X4-8208	David.S.Bayard@jpl.nasa.gov	(TEAM LEADER)
Dhemetrio Boussalis	X4-3977	boussali@grover.jpl.nasa.gov	
Paul Brugarolas	X4-9243	Paul.Brugarolas@jpl.nasa.gov	
Bryan H. Kang	X4-0541	Bryan.H.Kang@jpl.nasa.gov	
Edward.C.Wong	X4-3053	Edward.C.Wong@jpl.nasa.gov	(TASK MANAGER)

ACKNOWLEDGEMENTS

This work was performed at the Jet Propulsion Laboratory, California Institute of Technology, under contract with the National Aeronautics and Space Administration.

References

[1] D.S. Bayard, B.H. Kang, *SIRTF Instrument Pointing Frame Kalman Filter Algorithm*, JPL D-Document D-24809, September 30, 2003.

[2] B.H. Kang, D.S. Bayard, *SIRTF Instrument Pointing Frame (IPF) Software Description Document and User's Guide*, JPL D-Document D-24808, September 30, 2003.

[3] D.S. Bayard, B.H. Kang, *SIRTF Instrument Pointing Frame (IPF) Kalman Filter Unit Test Report*, JPL D-Document D-24810, September 30, 2003.

[4] *Space Infrared Telescope Facility In-Orbit Checkout and Science Verification Mission Plan*, JPL D-Document D-22622, 674-FE-301 Version 1.4, February 8, 2002.

[5] *Space Infrared Telescope Facility Observatory Description Document*, Lockheed Martin LMMS/P458569, 674-SEIT-300 Version 1.2, November 1, 2002.

[6] *SIRTF Software Interface Specification for Science Centroid INPUT Files (CAFILE, CSFILE)*, JPL SOS-SIS-2002, November 18, 2002.

[7] *SIRTF Software Interface Specification for Inferred Frames Offset INPUT Files (OFILE)*, JPL SOS-SIS-2003, November 18, 2002.

[8] *SIRTF Software Interface Specification for PCRS Centroid INPUT Files (CBFILE)*, JPL SIS-FES-015, November 18, 2002.

[9] *SIRTF Software Interface Specification for Attitude INPUT Files (AFILE, ASFILE)*, JPL SIS-FES-014, January 7, 2002.

[10] *SIRTF Software Interface Specification for IPF Filter Output Files (IFFILE, LGFILE, TARFILE)*, JPL SOS-SIS-2005, November 18, 2002.

[11] R.J. Brown, *Focal Surface to Object Space Field of View Conversion.* Systems Engineering Report SER No. S20447-OPT-051, Ball Aerospace & Technologies Corp., November 23, 1999.

This page left blank.

SIRTF INSTRUMENT POINTING FRAME KALMAN FILTER EXECUTION SUMMARY

IPF RUN NUMBER: 992087
REPORT TYPE: COVARIANCE ANALYSIS

PRIME FRAME: MIPS_160um_center_large_FOV (87)
INFERRED FRAMES: (88) (89) (91) (92) (1) (1) (1) (1)

IPF TEAM

Autonomy and Control Section (345)
Jet Propulsion Laboratory
California Institute of Technology
4800 Oak Grove Drive
Pasadena, CA 91109

Contents

1 IPF EXECUTION SUMMARY **4**

2 FLUTE DATA SUMMARY **8**

2.1 FLUTE CONFIGURATION PARAMETERS 8

2.2 FLUTE GENERATED UNIT TEST DATA 11

3 IPF EXECUTION RESULTS **16**

3.1 IPF EXECUTION OUTPUT PLOTS 16

3.2 IPF OUTPUT DATA (IF MINI FILE) 30

3.3 IPF EXECUTION LOG 35

4 USER COMMENTS **38**

List of Figures

1.1 A-priori and a-posteriori IPF frames 4

1.2 A-priori and a-posteriori IPF frames (ZOOMED) 7

2.1 Focal plane survey scenario plot (See key in [3]) 12

2.2 Commanded-only source locations 13

2.3 True (+) and commanded (o) source locations 13

2.4 True (+) and commanded (o) source locations (ZOOMED) 14

2.5 True-sampled (o) and centroided (+) locations on S/I array (W,V) 14

2.6 True (o) and centroided (+) locations on S/I array (W,V) 15

2.7 True (o) and centroided (+) locations on S/I array (W,V) showing prime and inferred frames 15

3.1 TPF coords of measurements and a-priori predicts 17

3.2 Oriented Pixel Coords of measurements and a-priori predicts 17

3.3 A-priori prediction error 18

3.4 Oriented Pixel Coords of measurements and a-priori predicts (PCRS only) 18

3.5 IPF execution convergence, chart 1 19

3.6 IPF execution convergence, chart 2 19

3.7 Parameter uncertainty convergence 20

3.8 IPF parameter symbol table 20
3.9 KF parameter error sigma plots 21
3.10 LS parameter error sigma plot 21
3.11 KF and LS parameter error sigma plot 22
3.12 Oriented Pixel Coords of meas. and a-posteriori predicts 23
3.13 Oriented Pixel Coords of meas. and a-posteriori predicts (attitude corrected) 23
3.14 Array plot with (solid) and w/o (dashed) optical distortion corrections 24
3.15 KF innovations with (o) and w/o (+) attitude corrections 24
3.16 W-axis KF innovations and 1-sigma bound 25
3.17 V-axis KF innovations and 1-sigma bound 25
3.18 Estimated attitude corrections (Body frame) 26
3.19 Estimated attitude error sigma plot (Body frame) 26
3.20 Thermo-mechanical boresight drift (equiv. angle in (W,V) coords) 27
3.21 Thermo-mechanical boresight drift (equiv. angle in Body frame) 27
3.22 Gyro drift bias contribution (equiv. rate in (W,V) coords) 28
3.23 Gyro drift bias contribution (equiv. angle in (W,V) coords) 28
3.24 Gyro drift bias contribution (equiv. angle in Body frame) 29

List of Tables

1.1 IPF filter input files 5
1.2 IPF filter execution configuration 5
1.3 IPF filter execution mask vector assignment 5
1.4 IPF calibration error summary ([arcsec], 1-sigma, radial) 6
1.5 Measurement prediction error summary (1-sigma) 6
1.6 IPF Brown angle summary 7
2.1 FLUTE Parameter Table (1) 8
2.2 FLUTE Parameter Table (2) 9
2.3 FLUTE Parameter Table (3) 10
2.4 Table of figures (FLUTE) 11
3.1 Table of figures (IPF run) 16

1 IPF EXECUTION SUMMARY

This report summarizes the SIRTF Instrument Pointing Frame (IPF) Kalman Filter execution associated with run file: RN992087. In particular, this Focal Point Survey calibrates the instrument: MIPS_160um_center_large_FOV (87), as part of the Covariance Analysis. The main calibration results from the IPF filter execution have been documented in IF992087 typically stored in the mission archive DOM collection IPF_IF. This report only summarizes the main aspects of the run, and does not substitute for the full information contained in the IF file.

Section 1 summarizes the filter execution results. The filter configurations are tabulated in Table 1.2 and the mask vector assignments are tabulated in Table 1.3. A total of 27 state parameters are estimated in this run. The overall End-to-End pointing performances are tabulated in Table 1.4. The prediction residuals throughout the estimation processes are tabulated in Table 1.6. Section 2 documents the FLUTE generated input file data. Section 3 summarizes resulting plots, a mini summary of the IF IPF output file, and the execution log. Section 4 captures the user comments that are specific to this particular run.

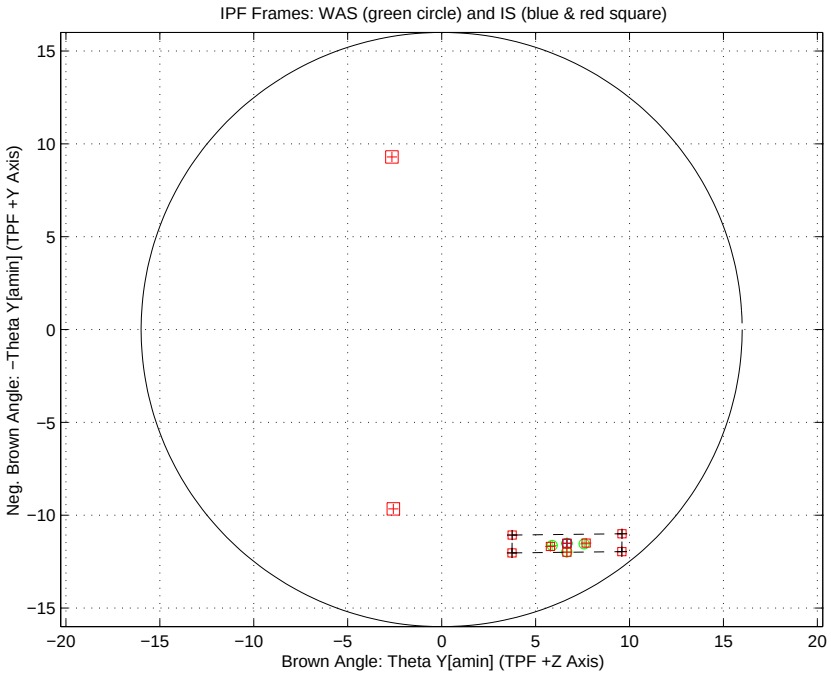

Figure 1.1: A-priori and a-posteriori IPF frames

RAW	FINAL (After Editing)
AA992087	AA992087
AS992087	AS992087
CA992087	CA992087
CB992087	CB992087
CS992087	CS992087

Table 1.1: IPF filter input files

EXECUTION CONFIGURATION ITEM	CURRENT STATUS
IPF Filter Version Used	IPF.V2.0.1Beta
Frame Table Version Used	FTVE2E1
Scan-Mirror Employed?	YES
IPF Filter Mode	NORMAL-MODE(0)
SLIT-MODE Operation	DISABLED
Kalman Filter Operation	ENABLED
Least-Squares Data Analysis	ENABLED
IBAD Screening	ENABLED
User-Specified Data Editing	DISABLED
Total Number of Iterations	20
LS Residual Sigma Scale	1.09736987E+000
Total Number of Maneuvers	30

Table 1.2: IPF filter execution configuration

Con. Plate Scale			Γ Dependent				Γ^2 Dependent				Linear Plate Scale						Mirror	
a_{00}	b_{00}	c_{00}	a_{10}	b_{10}	c_{10}	d_{10}	a_{20}	b_{20}	c_{20}	d_{20}	a_{01}	b_{01}	c_{01}	d_{01}	e_{01}	f_{01}	α	β
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	1	1

IPF (T)			Alignment R									Gyro Drift Bias						
θ_1	θ_2	θ_3	a_{rx}	a_{ry}	a_{rz}	b_{rx}	b_{ry}	b_{rz}	c_{rx}	c_{ry}	c_{rz}	b_{gx}	b_{gy}	b_{gz}	c_{gx}	c_{gy}	c_{gz}	
20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	

Table 1.3: IPF filter execution mask vector assignment

FOCAL PLANE SURVEY ANALYSIS: Covariance Analysis.
INSTRUMENT NAME: MIPS_160um_center_large_FOV NF: 87

```
PIX2RADW: 7.73998982E-005[rad/pixel] = 1.5965E+001[arcsec/pixel]
PIX2RADV: 7.73998982E-005[rad/pixel] = 1.5965E+001[arcsec/pixel]
```

FRAME	DESCRIPTION	IPF[1]	SF[2]	ARW[3]	TOTAL	REQ
087(P)	MIPS_160um_center_large_FOV	0.2262	0.0855	0.0384	0.2449	3.70
088(I)	MIPS_160um_plusY_edge	0.3085	0.0855	0.0384	0.3225	N/A
089(I)	MIPS_160um_large_only	0.2262	0.0855	0.0384	0.2449	N/A
091(I)	MIPS_160um_small_FOV1	0.2508	0.0855	0.0384	0.2678	N/A
092(I)	MIPS_160um_small_FOV2	0.2619	0.0855	0.0384	0.2782	N/A
TR (C)	CORNERS OF INSTRUMENT	0.4584	0.0855	0.0384	0.4679	N/A
BR (C)	CORNERS OF INSTRUMENT	0.4430	0.0855	0.0384	0.4528	N/A
TL (C)	CORNERS OF INSTRUMENT	0.4583	0.0855	0.0384	0.4678	N/A
BL (C)	CORNERS OF INSTRUMENT	0.4702	0.0855	0.0384	0.4795	N/A

Table 1.4: IPF calibration error summary ([arcsec], 1-sigma, radial)

RMS METRIC	A PRIORI[4]	A POSTERIORI[4]	ATT. CORRECTED[5]	UNITS
Radial	23.4028	2.9739	2.5673	arcsec
Radial	1.4659	0.1863	0.1608	pixels
W-Axis	1.1563	0.1355	0.1116	pixels
V-Axis	0.9011	0.1278	0.1158	pixels

Table 1.5: Measurement prediction error summary (1-sigma)

[1]IPF filter removes systematic pointing errors due to: thermomechanical alignment drift (Body to TPF), gyro bias and bias drift, centroiding error, attitude error, and optical distortion. IPF SIGMA presented here is "NOT Scaled" by the Least Squares Scale factor. The Least Squares Scale Factor was: 1.097370.

[2]Error due to gyro Scale Factor: assumes 95 ppm error over 0.250 degree maneuver.

[3]Error due to gyro Angle Random Walk: assumes ARW = 100 $\mu deg/\sqrt{hr}$, with 615 second Maneuver time (max), and 30 independent Maneuvers.

[4]This can be interpreted as estimate of "pixel to sky" pointing reconstruction error if no science data is used.

[5]This can be interpreted as estimate of achieved S/I centroiding error

IPF BROWN ANGLE SUMMARY						
	WAS			IS		
Frame Number	theta_Y (arcmin)	theta_Z (arcmin)	angle (deg)	theta_Y (arcmin)	theta_Z (arcmin)	angle (deg)
087	+6.669000	+11.517000	+0.000000	+6.671708	+11.513092	-0.095758
088	+6.664000	+11.974000	+0.000000	+6.667503	+11.994147	-0.095758
089	+6.669000	+11.517000	+0.000000	+6.671708	+11.513092	-0.095758
091	+7.589000	+11.546000	+0.000000	+7.694970	+11.500994	-0.095758
092	+5.879000	+11.626000	+0.000000	+5.793225	+11.683813	-0.095758
001	+0.000000	+0.000000	+0.000000	+9.599519	+10.997470	-0.095758
001	+0.000000	+0.000000	+0.000000	+9.591109	+11.959581	-0.095758
001	+0.000000	+0.000000	+0.000000	+3.752308	+11.066604	-0.095758
001	+0.000000	+0.000000	+0.000000	+3.743897	+12.028712	-0.095758

Table 1.6: IPF Brown angle summary

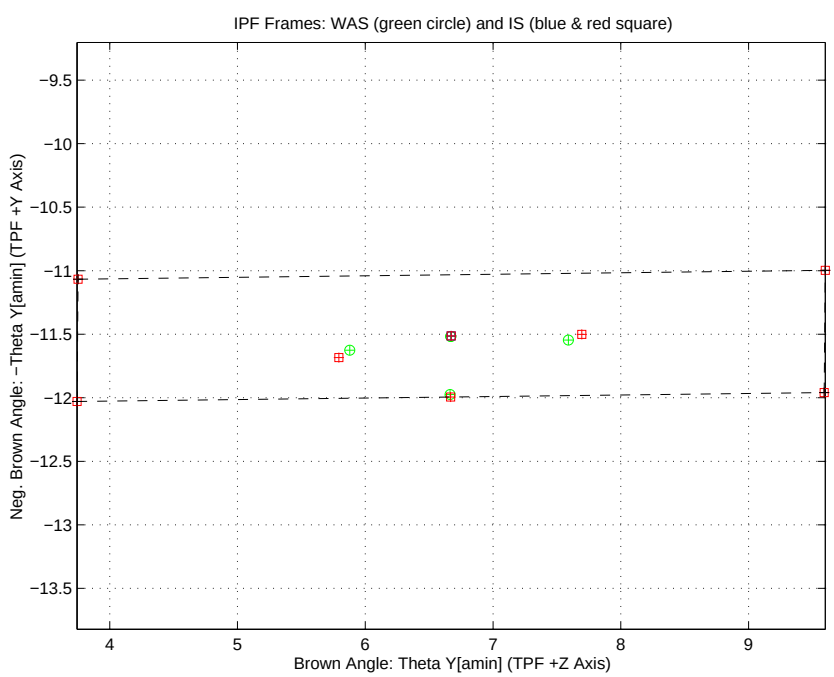

Figure 1.2: A-priori and a-posteriori IPF frames (ZOOMED)

2 FLUTE DATA SUMMARY

2.1 FLUTE CONFIGURATION PARAMETERS

The covariance analysis was performed using the FLUTE generated input data files. The internal configuration parameters, used to produce the data are tabulated in Table 2.1, Table 2.2 and Table 2.3.

NAME	DESCRIPTION	VALUE	UNIT
d2003	days into YEAR2003	+6.0000000000000000E+001	day
tstart	start time	+7.3051200000000000E+008	sec
tdel	data rate	+1.0000000000000001E-001	sec
tshelf	Inertial Hold duration pad	+5.0000000000000000E+000	sec
ipro	slew profile(1-linear, 2-S-curve)	1	int flag
sig_gcf [1]	gcf sigma(1)	+4.8481368110953601E-008	rad/sec
sig_gcf [2]	gcf sigma(2)	+9.6962736221907205E-009	rad/sec
sig_gcf [3]	gcf sigma(3)	+9.6962736221907205E-009	rad/sec
igcf	gcf bias correction flag	1	int flag
SigA [1][1]	Sigma A(1,1)	+9.4017722156391537E-009	rad^2
SigA [2][2]	Sigma A(2,2)	+2.3504430539097885E-011	rad^2
SigA [3][3]	Sigma A(3,3)	+2.3504430539097885E-011	rad^2
NFprime	Prime Frame NF	87	int
ftable [name]	Frame Table row number	87	int
ftable [q0]	Frametable quaternion q0	-1.6247706156225429E-006	N/A
ftable [q1]	Frametable quaternion q1	-9.6996521888884340E-004	N/A
ftable [q2]	Frametable quaternion q2	-1.6750781782660256E-003	N/A
ftable [q3]	Frametable quaternion q3	+9.9999812663721077E-001	N/A
ft_cmd [name]	Command row number	87	int
ft_cmd [q0]	Command quaternion q0	-1.6247706156225429E-006	N/A
ft_cmd [q1]	Command quaternion q1	-9.6996521888884340E-004	N/A
ft_cmd [q2]	Command quaternion q2	-1.6750781782660256E-003	N/A
ft_cmd [q3]	Command quaternion q3	+9.9999812663721077E-001	N/A
ft_true [name]	Truth row number	87	int
ft_true [q0]	Truth quaternion q0	-1.6247706156225429E-006	N/A
ft_true [q1]	Truth quaternion q1	-9.6996521888884340E-004	N/A
ft_true [q2]	Truth quaternion q2	-1.6750781782660256E-003	N/A
ft_true [q3]	Truth quaternion q3	+9.9999812663721077E-001	N/A
ft_prior [name]	Prior row number	87	int
ft_prior [q0]	FTprior quaternion q0	-1.6247706156225429E-006	N/A
ft_prior [q1]	FTprior quaternion q1	-9.6996521888884340E-004	N/A
ft_prior [q2]	FTprior quaternion q2	-1.6750781782660256E-003	N/A
ft_prior [q3]	FTprior quaternion q3	+9.9999812663721077E-001	N/A
ntable [NF]	ntable row number	87	int
ntable [iprime]	Prime frame indication flag	1	int
ntable [SIG_CX]	CX Sigma	+1.0000000000000001E-001	pixel
ntable [SIG_CY]	CY Sigma	+1.0000000000000001E-001	pixel
ntable [PIX2RADX]	Nom. angular pixelsize X-dir	+7.7399898172000000E-005	rad/pixel
ntable [PIX2RADY]	Nom. angular pixelsize Y-dir	+8.7086140999000005E-005	rad/pixel
ntable [CX0]	Center pixel along X-axis	+1.0500000000000000E+001	pixel
ntable [CY0]	Center pixel along Y-axis	+2.0000000000000000E+000	pixel
ntable [BETA0]	Nominal mirror scale factor	+2.8047410000000001E-006	rad/(e.u.)
ntable [GAMMA_E0]	Reference Mirror position	+2.0070000000000000E+003	(e.u.[6])

Table 2.1: FLUTE Parameter Table (1)

[6]encoder units

NAME	DESCRIPTION	VALUE	UNIT
ntable [D11]	x-to-w frame flip parameter	-1	int
ntable [D12]	y-to-w frame flip parameter	0	int
ntable [D21]	x-to-v frame flip parameter	0	int
ntable [D22]	y-to-v frame flip parameter	-1	int
ntable [DG]	Mirror flip parameter	1	int
ntable [sisizew]	Array size (w-direction)	+1.5417075059283244E-003	pixel
ntable [sisizev]	Array size (v-direction)	+2.3271056693257729E-004	pixel
ntable [p2i_w]	w-offset from prime	+0.0000000000000000E+000	pixel
ntable [p2i_v]	v-offset from prime	+0.0000000000000000E+000	pixel
p1true [a00]	True Constant Plate Scales	+1.0000000000000001E-001	N/A
p1true [b00]	True Constant Plate Scales	+1.0000000000000001E-001	N/A
p1true [c00]	True Constant Plate Scales	+1.0000000000000000E-002	N/A
p1true [a10]	True Γ Dependent Plate Scales	+1.0000000000000001E-001	1/rad
p1true [b10]	True Γ Dependent Plate Scales	+1.0000000000000001E-001	1/rad
p1true [c10]	True Γ Dependent Plate Scales	+1.0000000000000000E-002	1/rad
p1true [d10]	True Γ Dependent Plate Scales	+1.0000000000000000E-002	1/rad
p1true [a20]	True Γ^2 Dependent Plate Scales	+1.0000000000000001E-001	$1/\mathrm{rad}^2$
p1true [b20]	True Γ^2 Dependent Plate Scales	+1.0000000000000001E-001	$1/\mathrm{rad}^2$
p1true [c20]	True Γ^2 Dependent Plate Scales	+1.0000000000000000E-002	$1/\mathrm{rad}^2$
p1true [d20]	True Γ^2 Dependent Plate Scales	+1.0000000000000000E-002	$1/\mathrm{rad}^2$
p1true [a01]	True Linear Plate Scales	+2.0000000000000000E+000	N/A
p1true [b01]	True Linear Plate Scales	+2.0000000000000000E+000	N/A
p1true [c01]	True Linear Plate Scales	+2.0000000000000000E+000	N/A
p1true [d01]	True Linear Plate Scales	+2.0000000000000000E+000	N/A
p1true [e01]	True Linear Plate Scales	+2.0000000000000000E+000	N/A
p1true [f01]	True Linear Plate Scales	+2.0000000000000000E+000	N/A
p2true [am1]	True Scan mirror alignment Ux	+0.0000000000000000E+000	N/A
p2true [am2]	True Scan mirror alignment Uy	+2.0000000000000000E-002	N/A
p2true [am3]	True Scan mirror alignment Uz	+9.9979997999599901E-001	N/A
p2true [beta]	True Scan mirror scale factor	+1.1000000000000001E+000	N/A
p2true [qT1]	True IPF q1	-1.6247706156225429E-006	N/A
p2true [qT2]	True IPF q2	-9.6996521888884340E-004	N/A
p2true [qT3]	True IPF q3	-1.6750781782660256E-003	N/A
p2true [qT4]	True IPF q4	+9.9999812663721077E-001	N/A
p2true [qR01]	True Boresight Alignment q1	+2.4240684048319150E-005	N/A
p2true [qR02]	True Boresight Alignment q2	+1.2120342024159575E-006	N/A
p2true [qR03]	True Boresight Alignment q3	+1.2120342024159575E-006	N/A
p2true [qR04]	True Boresight Alignment q4	+9.9999999970472575E-001	N/A
p2true [brx]	True B. Alignment drift rate X	+4.0000000000000001E-010	rad/sec
p2true [bry]	True B. Alignment drift rate Y	+3.0000000000000000E-010	rad/sec
p2true [brz]	True B. Alignment drift rate Z	+2.0000000000000001E-010	rad/sec
p2true [crx]	True B. Alignment drift accel. X	+9.0000000000000000E-013	$\mathrm{rad/sec}^2$
p2true [cry]	True B. Alignment drift accel. Y	+8.0000000000000002E-013	$\mathrm{rad/sec}^2$
p2true [crz]	True B. Alignment drift accel. Z	+7.0000000000000005E-013	$\mathrm{rad/sec}^2$
p2true [bgx]	True Gyro bias correction X	+1.4544410433286078E-006	rad/sec
p2true [bgy]	True Gyro bias correction Y	+1.9392547244381440E-007	rad/sec
p2true [bgz]	True Gyro bias correction Z	+2.4240684055476802E-007	rad/sec
p2true [cgx]	True Gyro bias-rate correction X	+4.9999999999999999E-013	$\mathrm{rad/sec}^2$
p2true [cgy]	True Gyro bias-rate correction Y	+4.0000000000000001E-013	$\mathrm{rad/sec}^2$
p2true [cgz]	True Gyro bias-rate correction Z	+2.9999999999999998E-013	$\mathrm{rad/sec}^2$

Table 2.2: FLUTE Parameter Table (2)

NAME	DESCRIPTION	VALUE	UNIT
p2cmd [am1]	CMD Scan mirror alignment Ux	+0.0000000000000000E+000	N/A
p2cmd [am2]	CMD Scan mirror alignment Uy	+0.0000000000000000E+000	N/A
p2cmd [am3]	CMD Scan mirror alignment Uz	+1.0000000000000000E+000	N/A
p2cmd [beta]	CMD Scan mirror rotation SF	+1.0000000000000000E+000	N/A
p2cmd [qT1]	CMD IPF q1	-1.6247706156225429E-006	N/A
p2cmd [qT2]	CMD IPF q2	-9.6996521888884340E-004	N/A
p2cmd [qT3]	CMD IPF q3	-1.6750781782660256E-003	N/A
p2cmd [qT4]	CMD IPF q4	+9.9999812663721077E-001	N/A
p2cmd [qR01]	CMD Boresight Alignment q1	+0.0000000000000000E+000	N/A
p2cmd [qR02]	CMD Boresight Alignment q2	+0.0000000000000000E+000	N/A
p2cmd [qR03]	CMD Boresight Alignment q3	+0.0000000000000000E+000	N/A
p2cmd [qR04]	CMD Boresight Alignment q4	+1.0000000000000000E+000	N/A
p2cmd [brx]	CMD B. Alignment drift rate X	+0.0000000000000000E+000	rad/sec
p2cmd [bry]	CMD B. Alignment drift rate Y	+0.0000000000000000E+000	rad/sec
p2cmd [brz]	CMD B. Alignment drift rate Z	+0.0000000000000000E+000	rad/sec
p2cmd [crx]	CMD B. Alignment drift accel. X	+0.0000000000000000E+000	rad/sec^2
p2cmd [cry]	CMD B. Alignment drift accel. Y	+0.0000000000000000E+000	rad/sec^2
p2cmd [crz]	CMD B. Alignment drift accel. Z	+0.0000000000000000E+000	rad/sec^2
p2cmd [bgx]	CMD Gyro bias correction X	+0.0000000000000000E+000	rad/sec
p2cmd [bgy]	CMD Gyro bias correction Y	+0.0000000000000000E+000	rad/sec
p2cmd [bgz]	CMD Gyro bias correction Z	+0.0000000000000000E+000	rad/sec
p2cmd [cgx]	CMD Gyro bias-rate correction X	+0.0000000000000000E+000	rad/sec^2
p2cmd [cgy]	CMD Gyro bias-rate correction Y	+0.0000000000000000E+000	rad/sec^2
p2cmd [cgz]	CMD Gyro bias-rate correction Z	+0.0000000000000000E+000	rad/sec^2
a1	Semi-Major Axis of SIRTF (HCO [7])	+1.4960000000000000E+011	m
a2	Semi-Major Axis of Earth (HCO)	+1.4960000000000000E+011	m
e1	Eccentricity (SIRTF in HCO)	+1.6722000000000001E-002	N/A
e2	Eccentricity (Earth in HCO)	+1.6722000000000001E-002	N/A
inc1	inclination (SIRTF in HCO)	+4.0142572795869580E-001	rad
inc2	inclination (Earth in HCO)	+4.0142572795869580E-001	rad
Omega1	Ascending Node Long.(SIRTF in HCO)	+0.0000000000000000E+000	rad
Omega2	Ascending Node Long.(Earth in HCO)	+0.0000000000000000E+000	rad
omega1	Argument of Perigee(SIRTF in HCO)	+1.7627825445142729E+000	rad
omega2	Argument of Perigee(Earth in HCO)	+1.7627825445142729E+000	rad
nu0_1	True Anomaly of SIRTF(HCO)	+8.6071031605199810E-001	rad
nu0_2	True Anomaly of Earth(HCO)	+1.0328523792623976E+000	rad
inav	Velocity Report Flag	+0.0000000000000000E+000	rad
wsize	Array size W-dir	+1.5417075059283244E-003	rad
vsize	Array size V-dir	+2.3271056693257729E-004	rad

Table 2.3: FLUTE Parameter Table (3)

[7] Heliocentric Orbit

2.2 FLUTE GENERATED UNIT TEST DATA

This subsection plots the FLUTE generated IPF filter input files. Seven figures, as tabulated in Table 2.4, show the campaign maneuver senario, the true sampled locations on the array and the actual centroided data superimposed the array plane. All angles shown in FLUTE plots have units of radians.

FIGURE NO.	DESCRIPTION
Figure 2.1	Focal Plane Survey Scenario Plot
Figure 2.2	Commanded-only source locations in TPF
Figure 2.3	True and commanded source locations in TPF
Figure 2.4	True and commanded source locations (ZOOMED) in TPF
Figure 2.5	True-sampled and centroided locations in Focal Plane (W,V) including rectangular array boundary approximation
Figure 2.6	True and centroided locations on S/I Array (W,V) including rectangular array boundary approximation
Figure 2.7	True and centroided locations on S/I Array (W,V) showing Prime and Inferred Frames including rectangular array boundary approximation

Table 2.4: Table of figures (FLUTE)

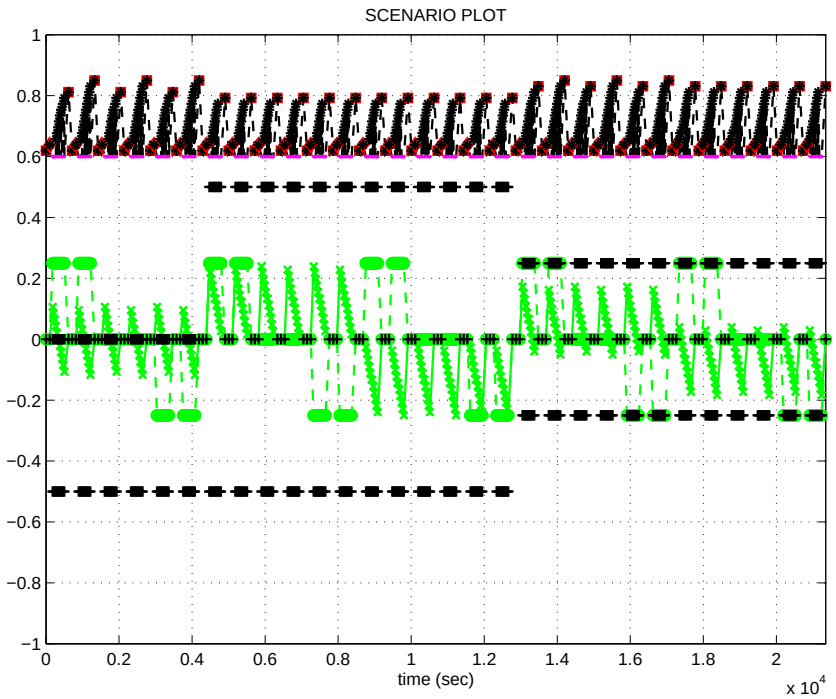

Figure 2.1: Focal plane survey scenario plot (See key in [3])

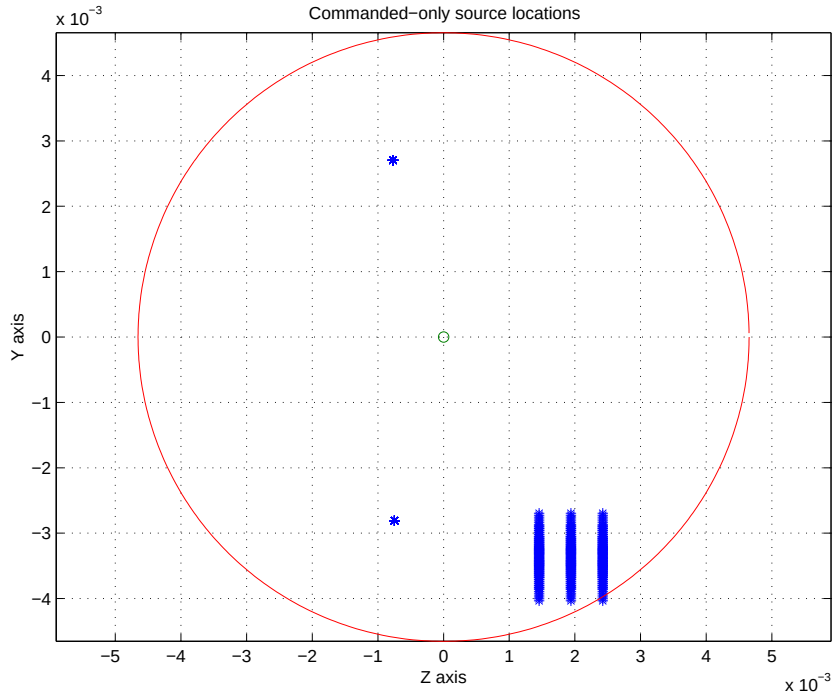

Figure 2.2: Commanded-only source locations

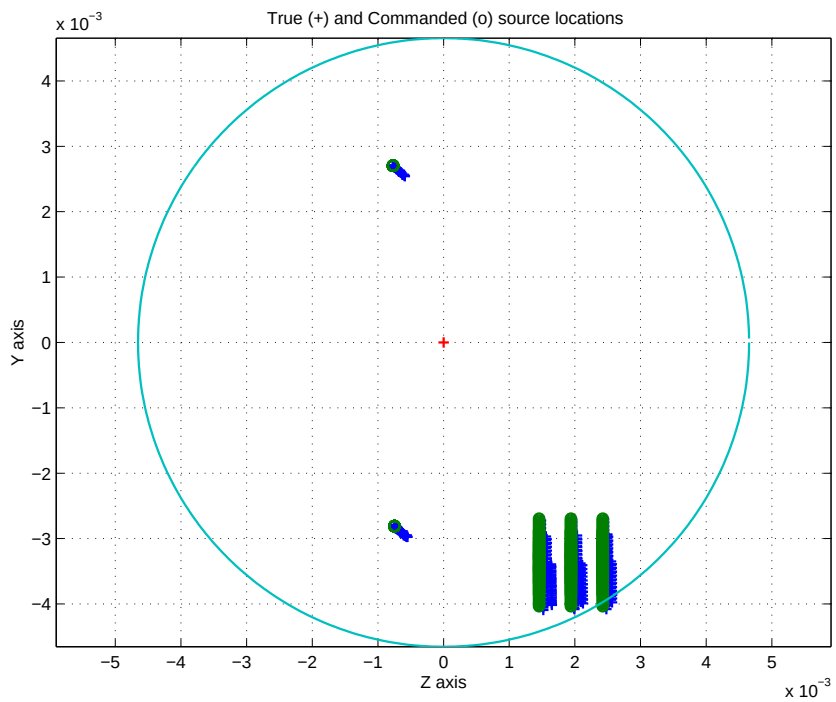

Figure 2.3: True (+) and commanded (o) source locations

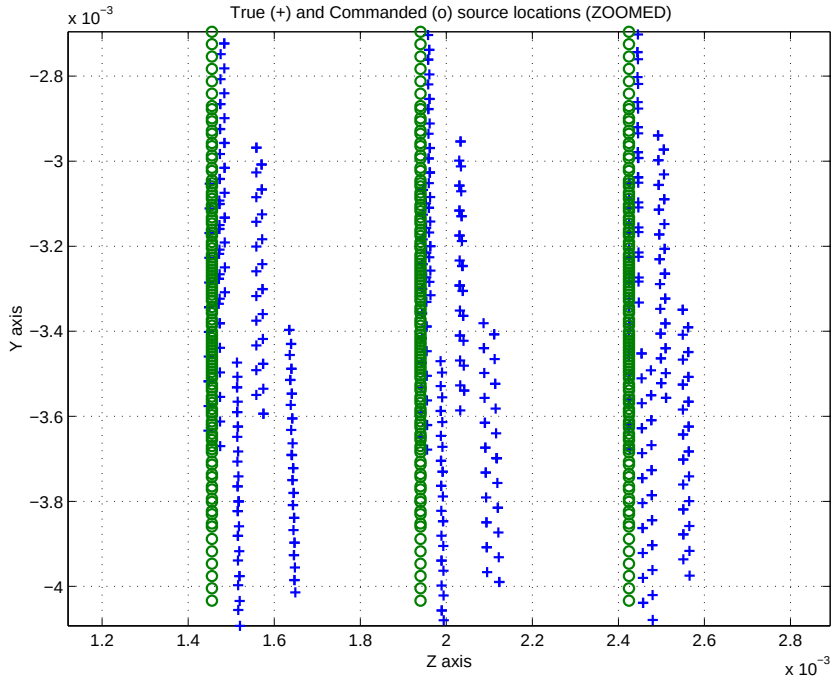

Figure 2.4: True (+) and commanded (o) source locations (ZOOMED)

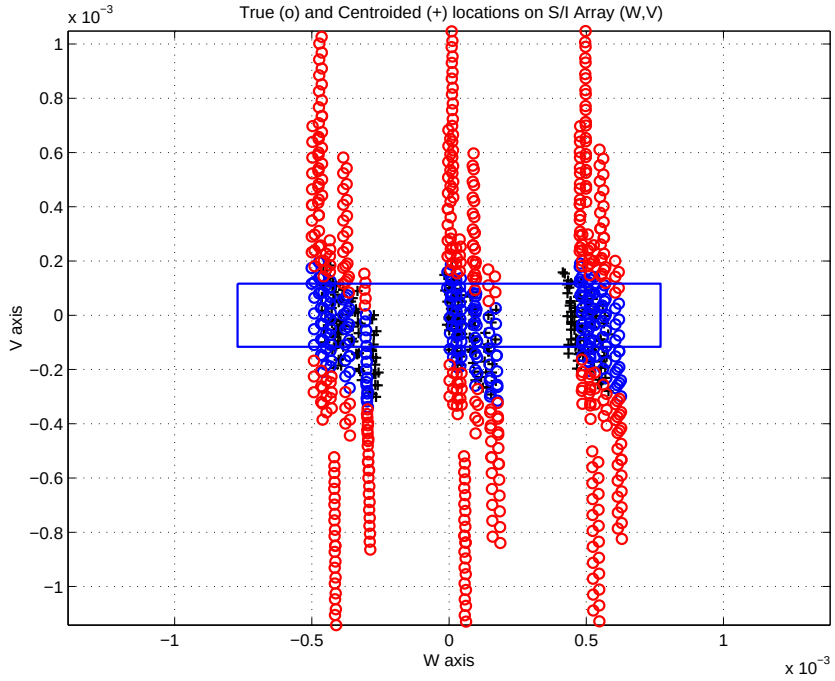

Figure 2.5: True-sampled (o) and centroided (+) locations on S/I array (W,V)

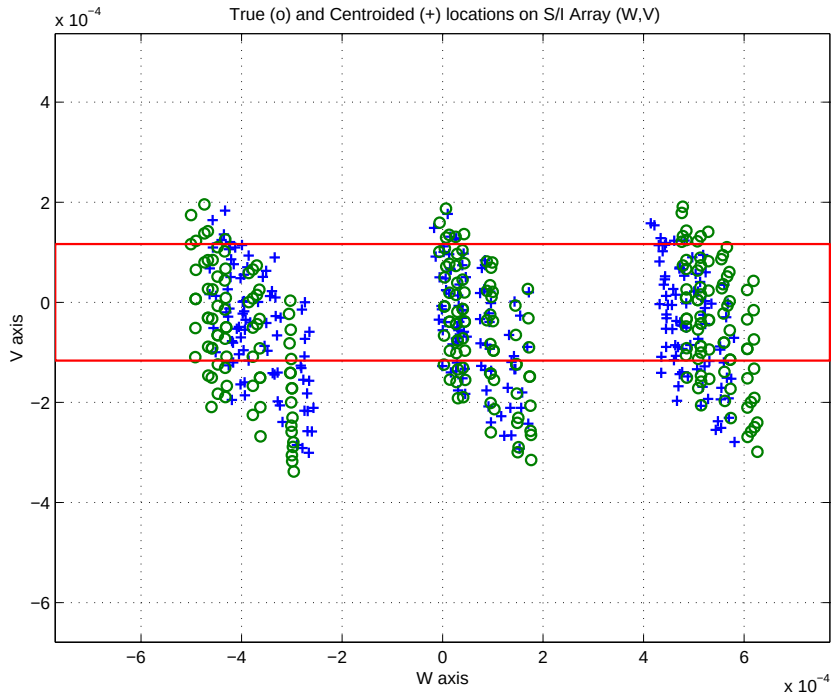

Figure 2.6: True (o) and centroided (+) locations on S/I array (W,V)

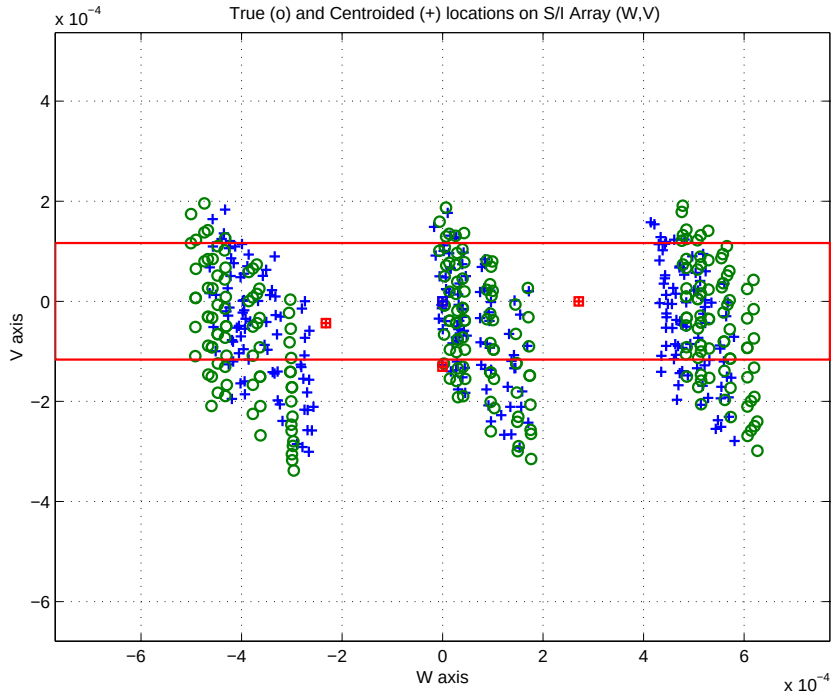

Figure 2.7: True (o) and centroided (+) locations on S/I array (W,V) showing prime and inferred frames

3 IPF EXECUTION RESULTS

3.1 IPF EXECUTION OUTPUT PLOTS

This subsection summarizes the IPF filter results. As shown in Table 3.1, the output plots are segmented to three groups: predicted performance, post-run results and IPF trending plots.

FIGURE NO.	DESCRIPTION
Predicted performance prior to IPF run	
Figure 3.1	Meas. and a-priori predicts in TPF coords
Figure 3.2	Meas. and a-priori predicts in Oriented Pixel Coords including rectangular array boundary approximation
Figure 3.3	A-priori prediction error
Figure 3.4	Oriented Pixel Coords of measurements and a-priori predicts (PCRS only)
IPF filter performance (post run results)	
Figure 3.5	IPF execution convergence, chart 1: (top) normalized residual error vs. iteration number and (bottom) norm of effective parameter corrections
Figure 3.6	IPF execution convergence, chart 2: parameter correction size vs. iteration number
Figure 3.7	Parameter uncertainty convergence: square-root of diagonal elements of covariance matrix vs. maneuver number
Figure 3.8	IPF parameter symbol table
Figure 3.9	KF parameter error sigma plot (a-priori-dashed, a-posteriori-solid). Includes true parameter errors (FLUTE runs only)
Figure 3.10	LS parameter error sigma plot. Includes true parameter errors (FLUTE runs only)
Figure 3.11	KF and LS parameter errors sigma plot (Figure 3.9 & Figure 3.10 combined)
Figure 3.12	Measurements and a-posteriori predicts in Oriented Pixel Coords including rectangular array boundaries (a-priori-dashed, a-posteriori-solid)
Figure 3.13	Attitude corrected meas. and a-posteriori predicts in Oriented Pixel Coords including rectangular array boundaries (a-priori-dashed, a-posteriori-solid)
Figure 3.14	Array plot with (solid) and w/o (dashed) optical distortion corrections
Figure 3.15	KF innovations with (o) and w/o (+) attitude corrections
Figure 3.16	W-axis KF innovations and 1-sigma bound
Figure 3.17	V-axis KF innovations and 1-sigma bound
IPF parameter trending plots	
Figure 3.18	Estimated attitude corrections (Body frame)
Figure 3.19	Estimated attitude error sigma plot (Body frame)
Figure 3.20	Systematic error attributed to thermo-mechanical boresight drift (equiv. angle in (W,V) coords)
Figure 3.21	Systematic error attributed to thermo-mechanical boresight drift (equiv. angle in Body frame)
Figure 3.22	Systematic error attributed to gyro drift bias (equiv. rate in (W,V) coords)
Figure 3.23	Systematic error attributed to gyro drift bias (equiv. angle in (W,V) coords)
Figure 3.24	Systematic error attributed to gyro drift bias (equiv. angle in Body frame)

Table 3.1: Table of figures (IPF run)

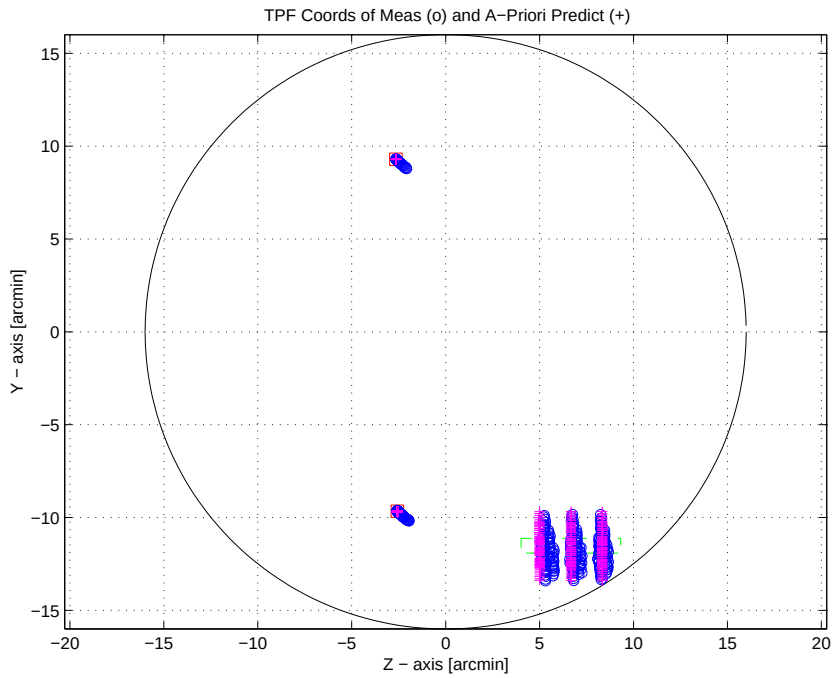

Figure 3.1: TPF coords of measurements and a-priori predicts

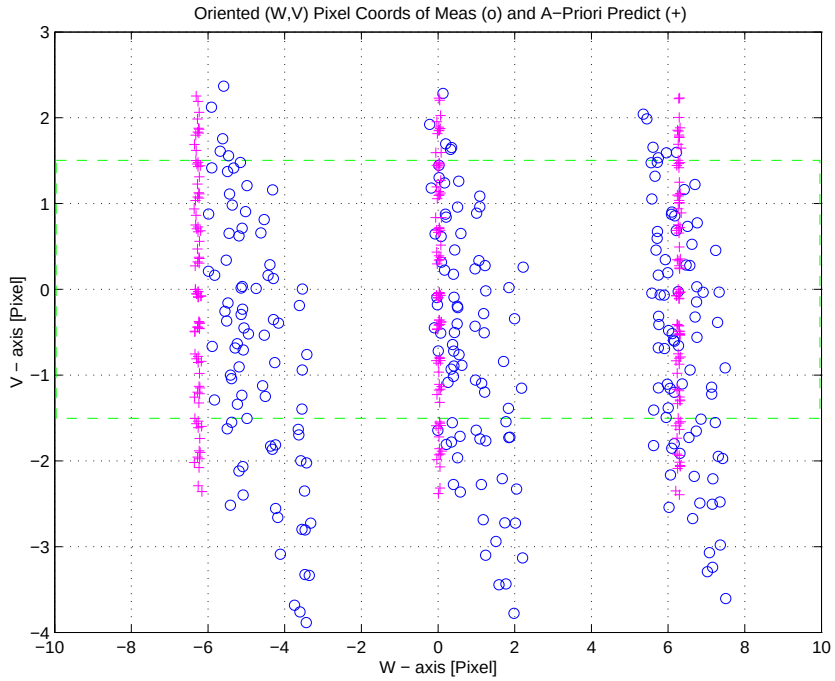

Figure 3.2: Oriented Pixel Coords of measurements and a-priori predicts

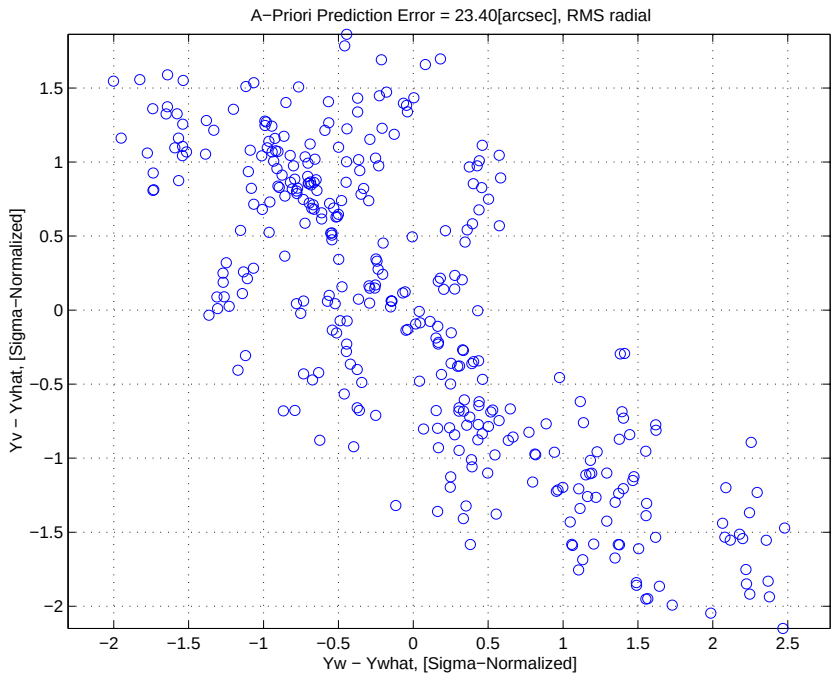

Figure 3.3: A-priori prediction error

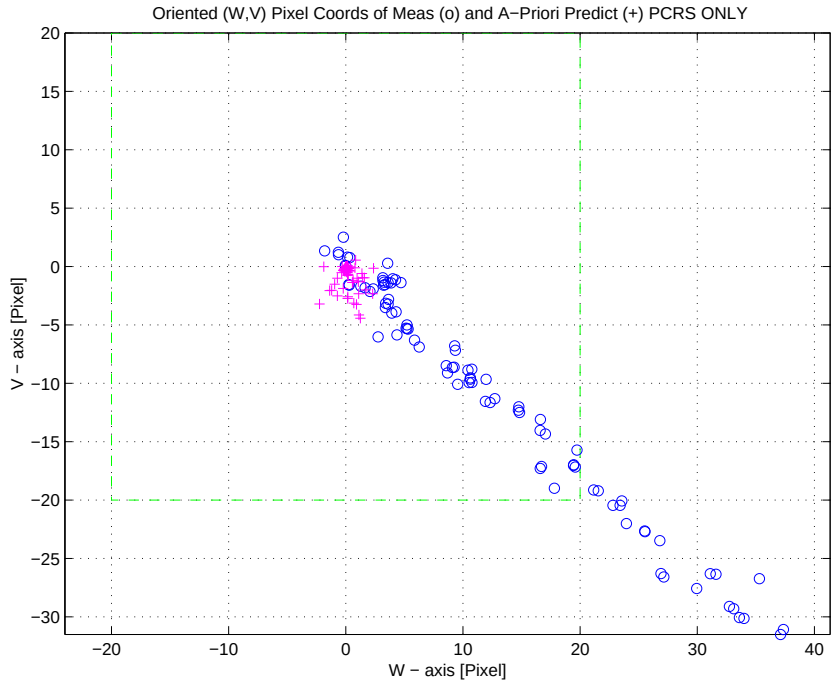

Figure 3.4: Oriented Pixel Coords of measurements and a-priori predicts (PCRS only)

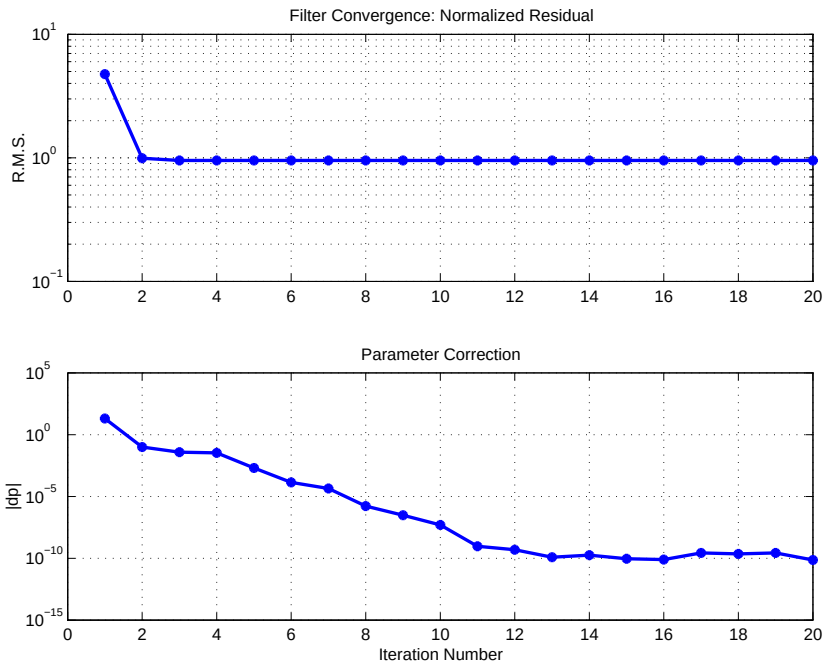

Figure 3.5: IPF execution convergence, chart 1

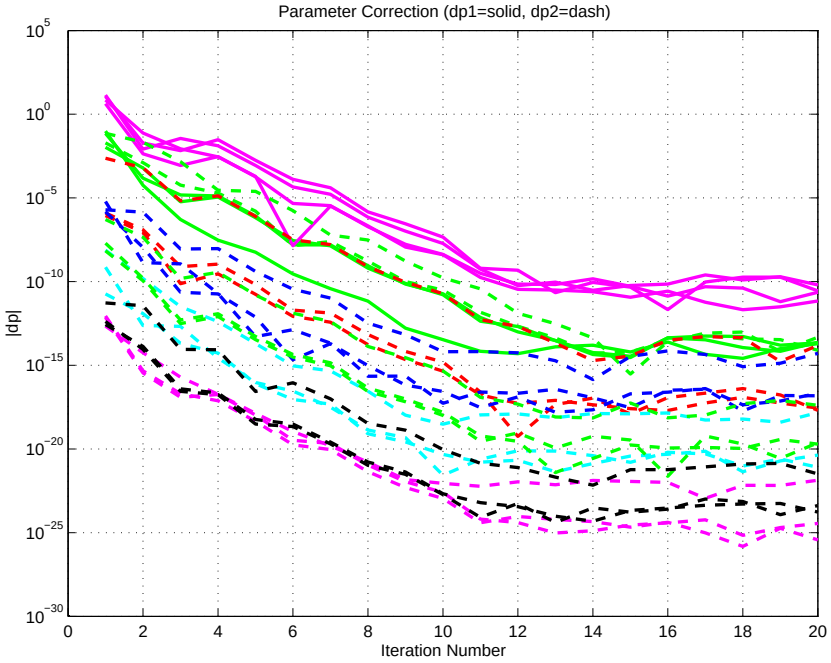

Figure 3.6: IPF execution convergence, chart 2

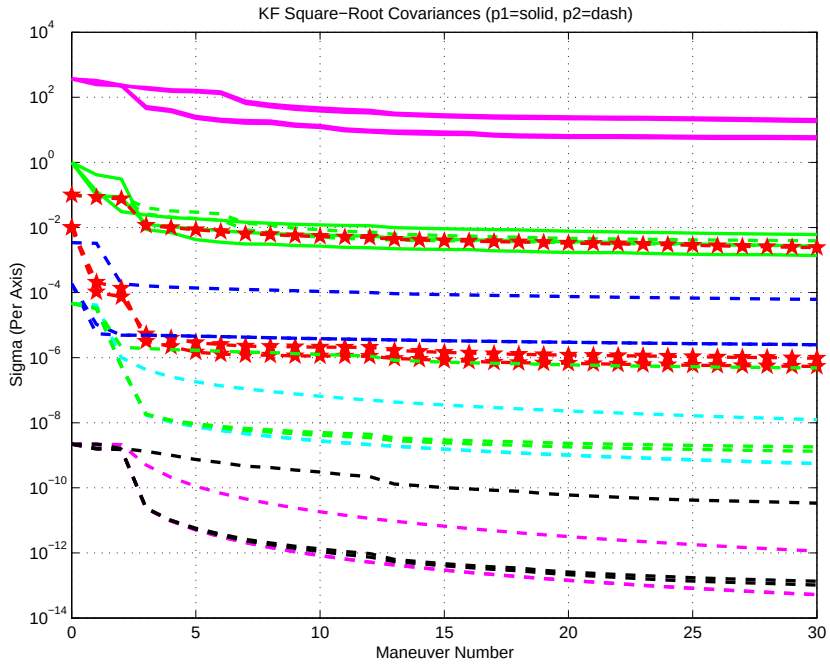

Figure 3.7: Parameter uncertainty convergence

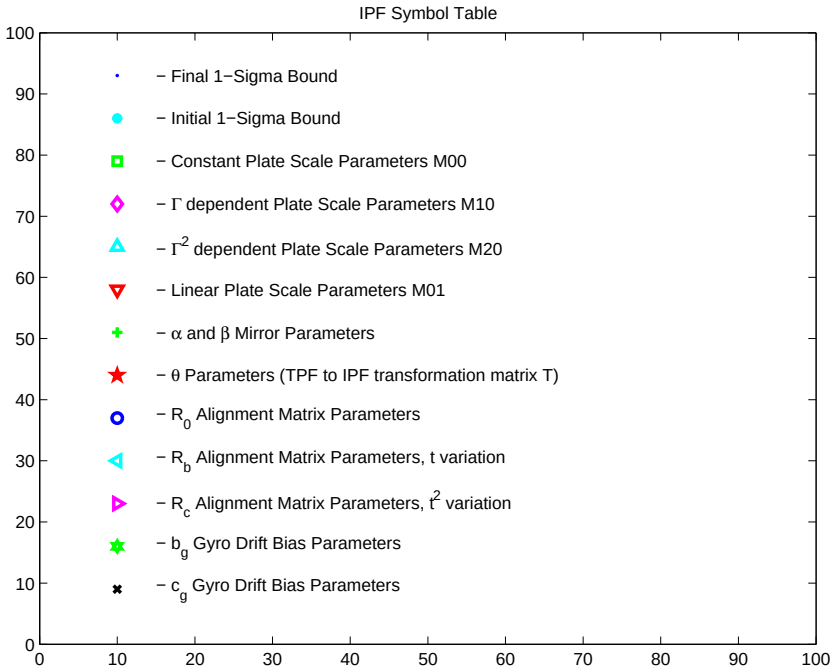

Figure 3.8: IPF parameter symbol table

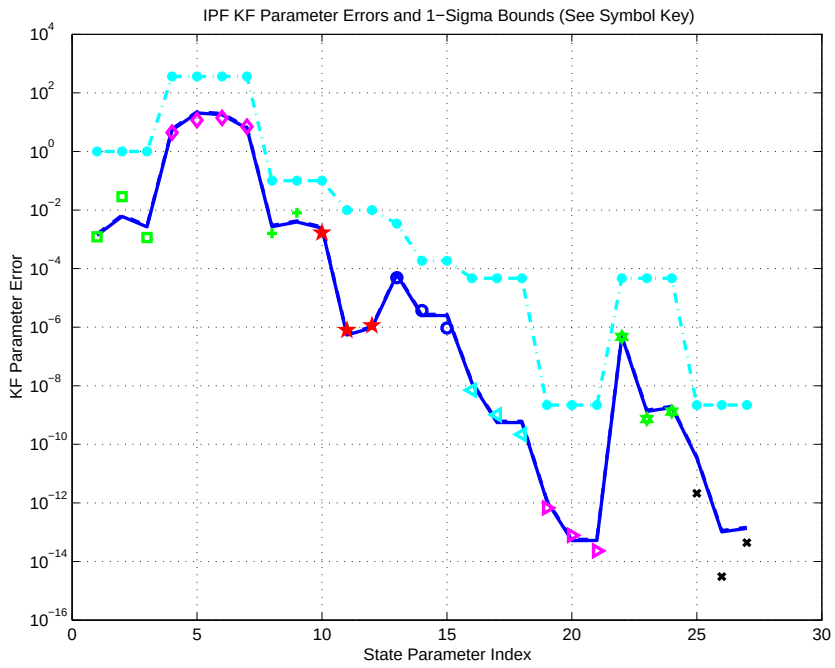

Figure 3.9: KF parameter error sigma plots

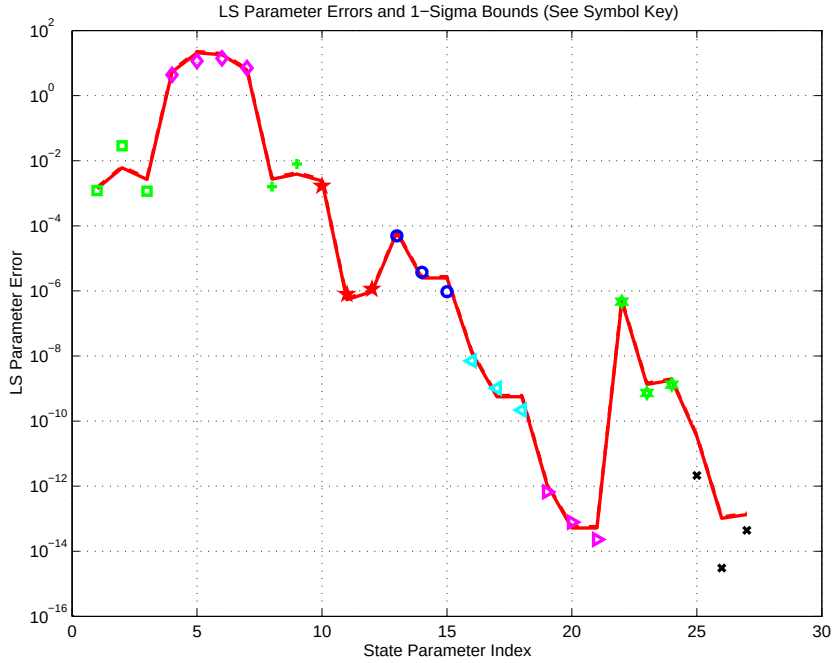

Figure 3.10: LS parameter error sigma plot

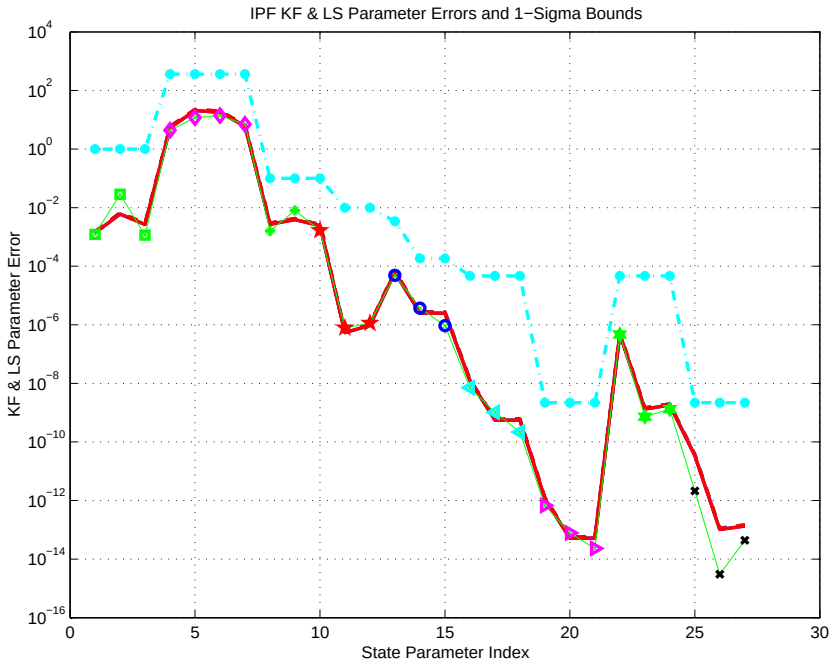

Figure 3.11: KF and LS parameter error sigma plot

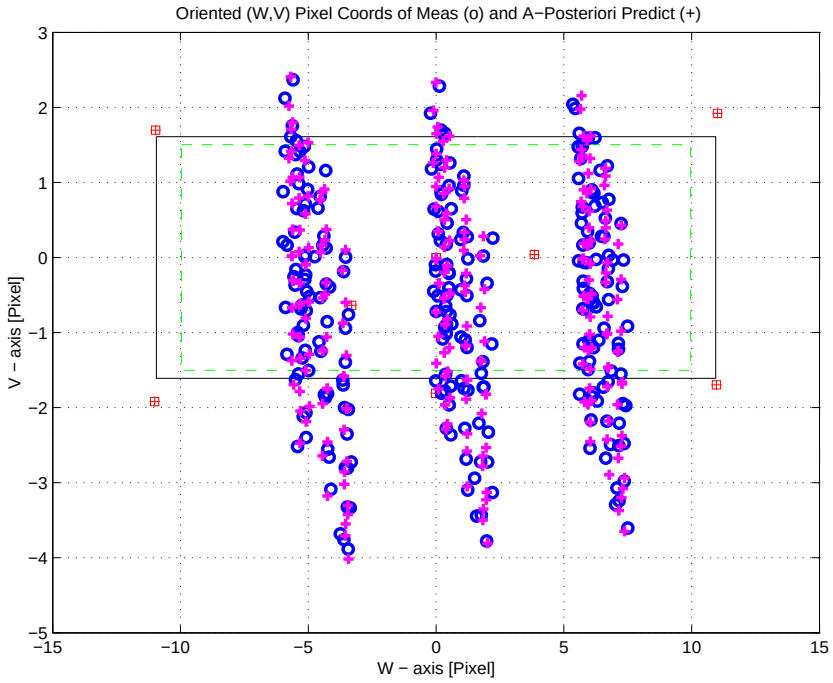

Figure 3.12: Oriented Pixel Coords of meas. and a-posteriori predicts

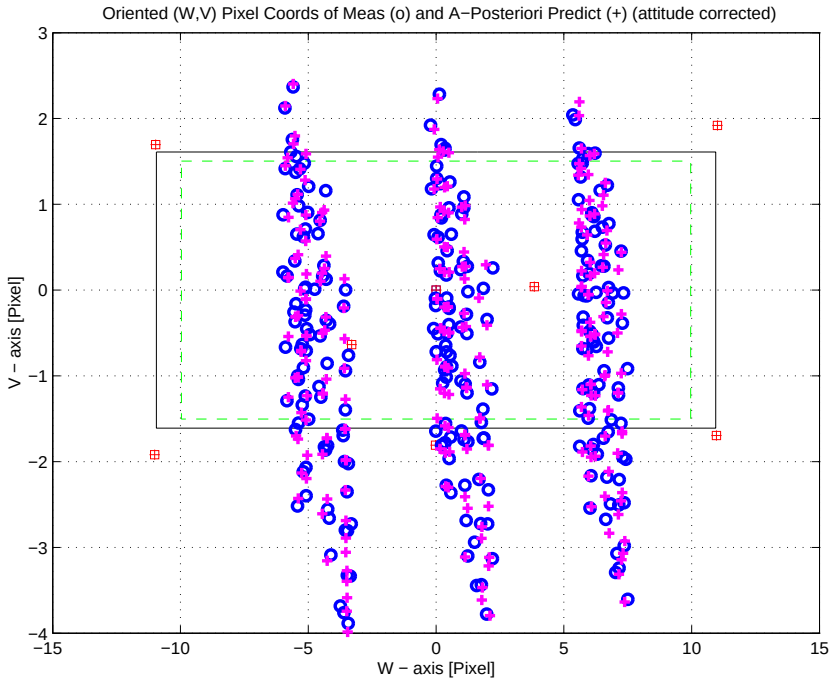

Figure 3.13: Oriented Pixel Coords of meas. and a-posteriori predicts (attitude corrected)

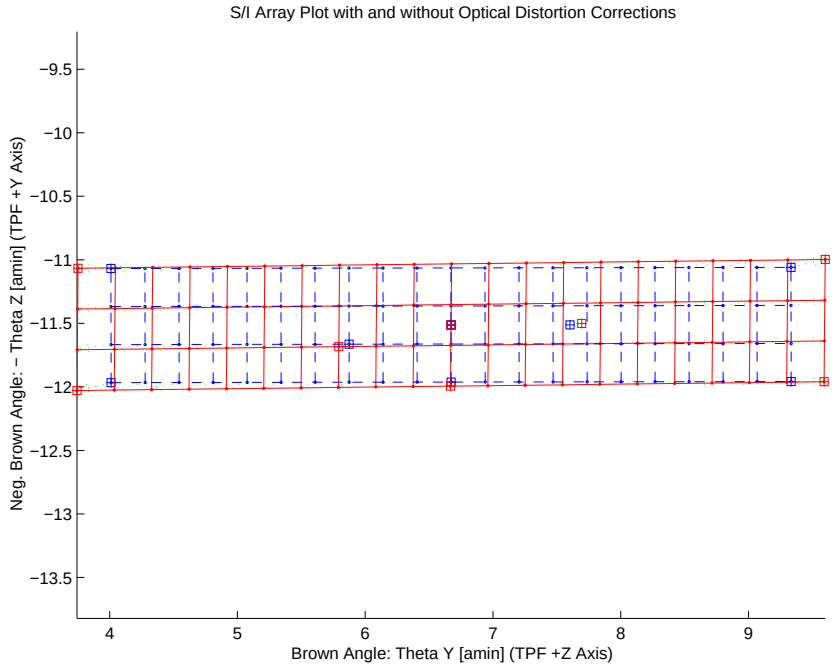

Figure 3.14: Array plot with (solid) and w/o (dashed) optical distortion corrections

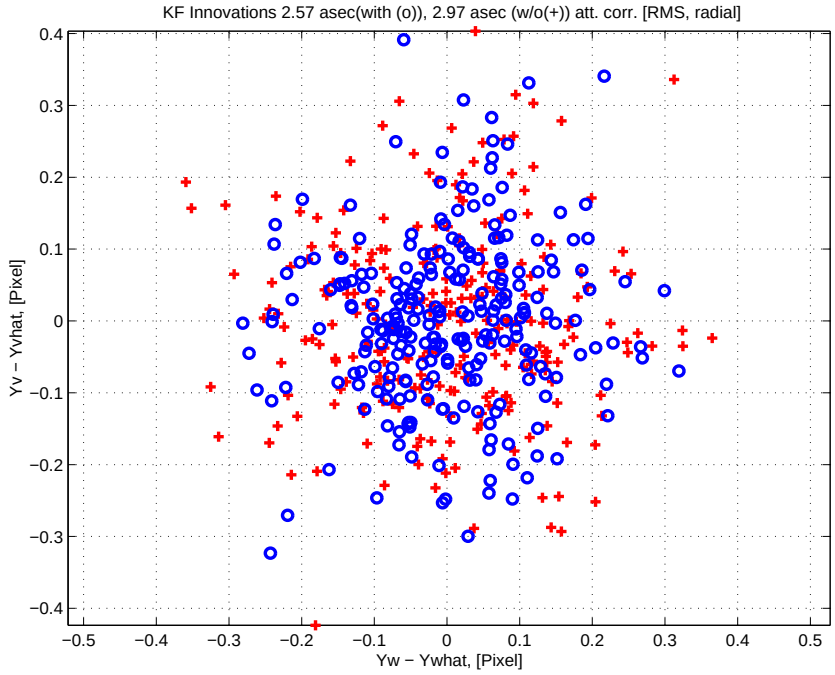

Figure 3.15: KF innovations with (o) and w/o (+) attitude corrections

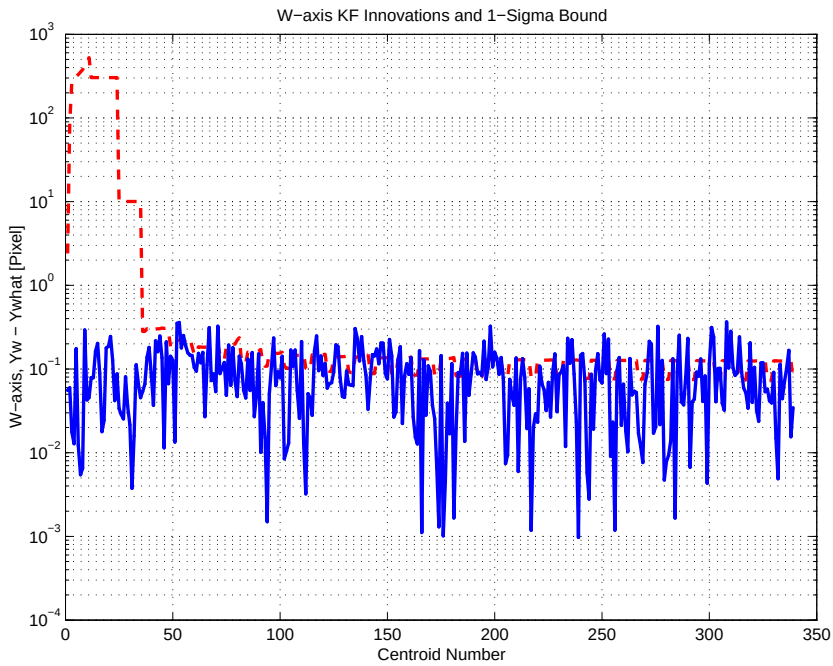

Figure 3.16: W-axis KF innovations and 1-sigma bound

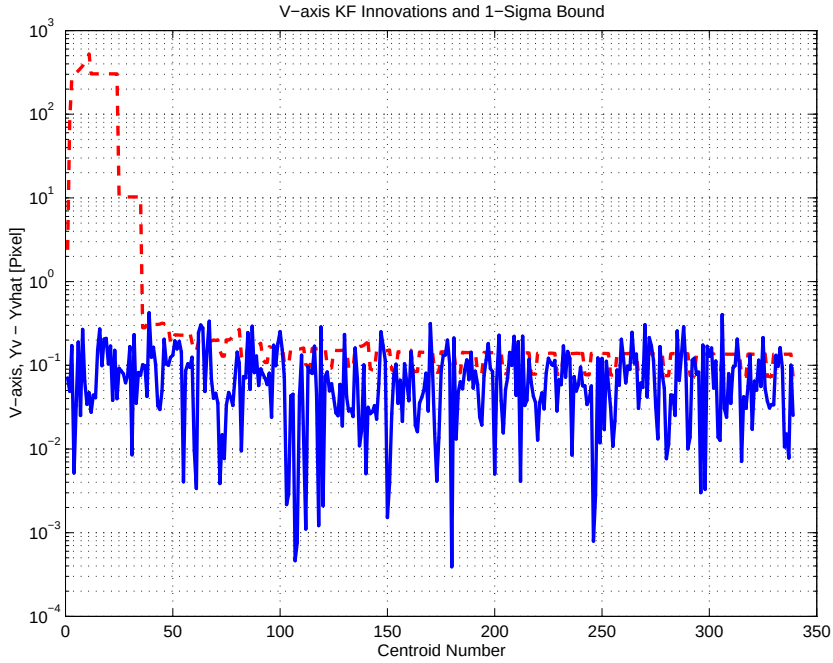

Figure 3.17: V-axis KF innovations and 1-sigma bound

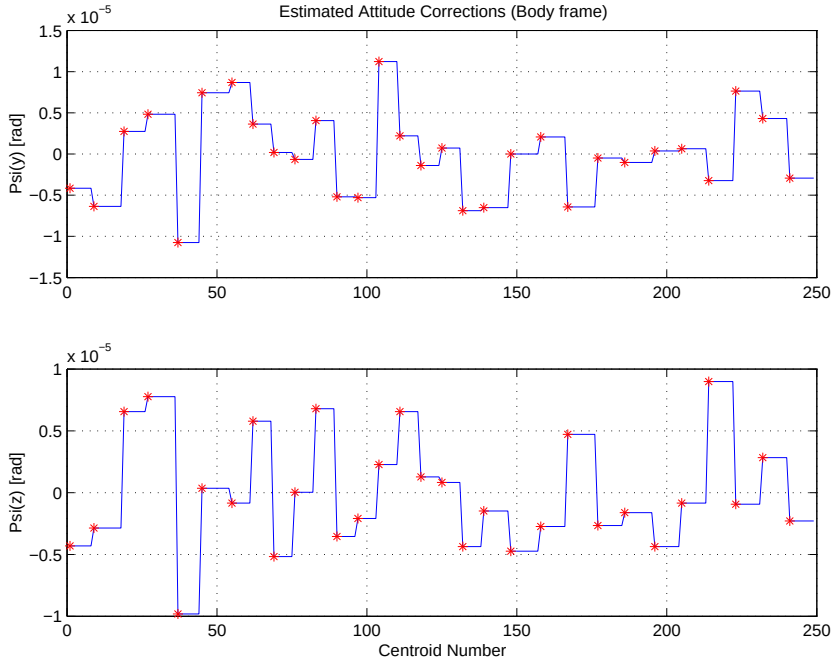

Figure 3.18: Estimated attitude corrections (Body frame)

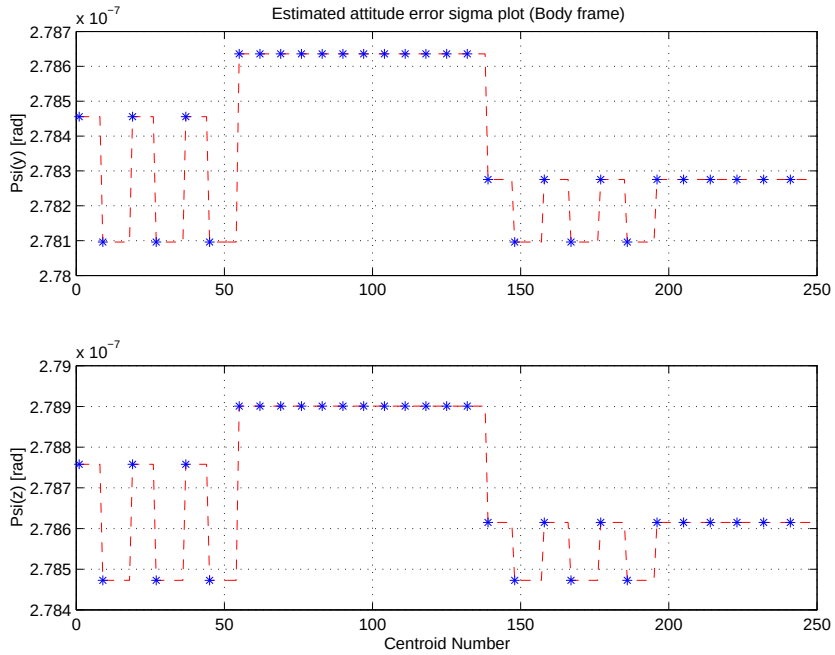

Figure 3.19: Estimated attitude error sigma plot (Body frame)

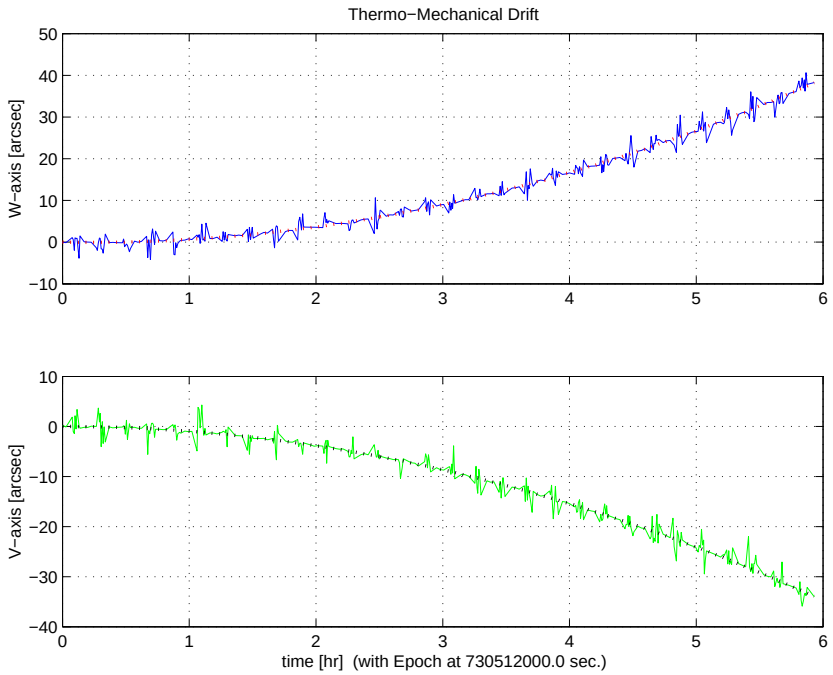

Figure 3.20: Thermo-mechanical boresight drift (equiv. angle in (W,V) coords)

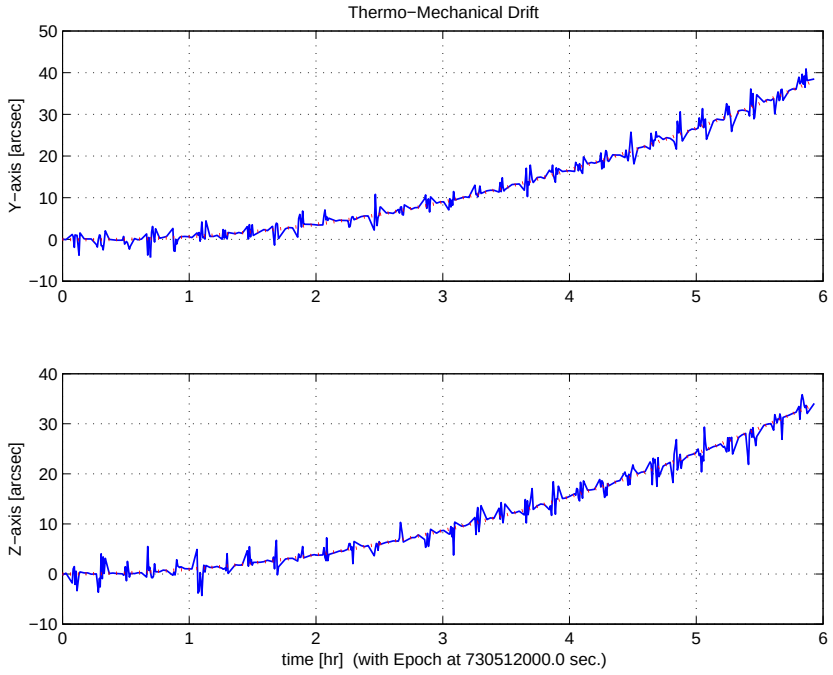

Figure 3.21: Thermo-mechanical boresight drift (equiv. angle in Body frame)

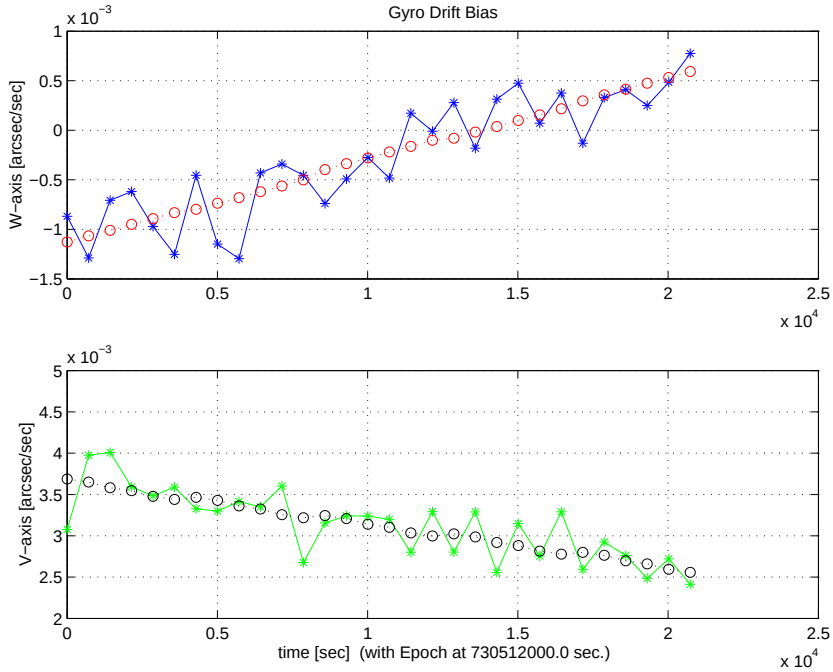

Figure 3.22: Gyro drift bias contribution (equiv. rate in (W,V) coords)

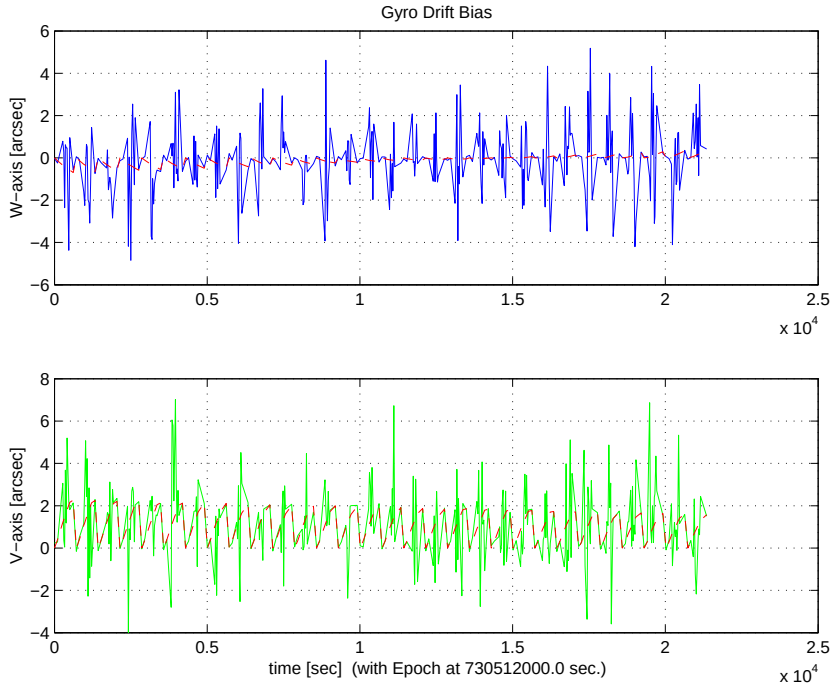

Figure 3.23: Gyro drift bias contribution (equiv. angle in (W,V) coords)

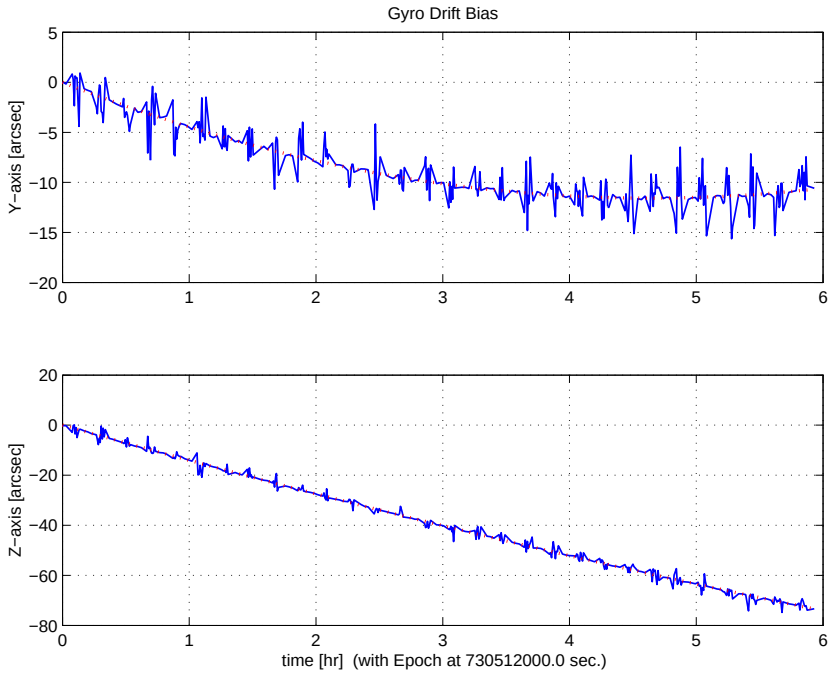

Figure 3.24: Gyro drift bias contribution (equiv. angle in Body frame)

3.2 IPF OUTPUT DATA (IF MINI FILE)

```
OUTPUT FILE NAME: IFmini992087.dat   DATE: 07-Aug-2003   TIME: 11:06
INSTRUMENT NAME:  MIPS_160um_center_large_FOV   NF: 87
IPF FILTER VERSION: IPF.V2.0.1Beta       SW RELEASE DATE: August 5, 2003
-------------------------------------------------------------------------------
---------------------------- IPF BROWN ANGLE SUMMARY ---------------------------
-------------------------------------------------------------------------------
         ------------ WAS ------------           ------------ IS -------------
Frame    theta_Y     theta_Z     angle           theta_Y     theta_Z     angle
Number   (arcmin)    (arcmin)    (deg)           (arcmin)    (arcmin)    (deg)
------  ---------------------------------       ---------------------------------
 087     +6.669000 +11.517000   +0.000000        +6.671708 +11.513092   -0.095758
 088     +6.664000 +11.974000   +0.000000        +6.667503 +11.994147   -0.095758
 089     +6.669000 +11.517000   +0.000000        +6.671708 +11.513092   -0.095758
 091     +7.589000 +11.546000   +0.000000        +7.694970 +11.500994   -0.095758
 092     +5.879000 +11.626000   +0.000000        +5.793225 +11.683813   -0.095758
 001     +0.000000  +0.000000   +0.000000        +9.599519 +10.997470   -0.095758
 001     +0.000000  +0.000000   +0.000000        +9.591109 +11.959581   -0.095758
 001     +0.000000  +0.000000   +0.000000        +3.752308 +11.066604   -0.095758
 001     +0.000000  +0.000000   +0.000000        +3.743897 +12.028712   -0.095758
-------------------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  0              87            +0.000            +0.000     pixels
OFFSET FRAME NAME: MIPS_160um_center_large_FOV
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
WAS(FTB)            +6.669000       +11.517000       +0.000000
IS (EST)            +6.671708       +11.513092       -0.095758
dT_EST              +0.002708        -0.003908       -0.095758
T_sSIGMA            +0.002023        +0.003610       +0.151693
dT_EST/T_sSIGMA     +1.338863        -1.082611       -0.631264
-----------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  1              88            +0.000            -1.500     pixels
OFFSET FRAME NAME: MIPS_160um_plusY_edge
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
WAS(FTB)            +6.664000       +11.974000       +0.000000
IS (EST)            +6.667503       +11.994147       -0.095758
dT_EST              +0.003503        +0.020147       -0.095758
T_sSIGMA            +0.002793        +0.004903       +0.151693
dT_EST/T_sSIGMA     +1.254025        +4.108736       -0.631264
-----------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  2              89            +0.000            +0.000     pixels
OFFSET FRAME NAME: MIPS_160um_large_only
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
WAS(FTB)            +6.669000       +11.517000       +0.000000
IS (EST)            +6.671708       +11.513092       -0.095758
dT_EST              +0.002708        -0.003908       -0.095758
T_sSIGMA            +0.002023        +0.003610       +0.151693
dT_EST/T_sSIGMA     +1.338863        -1.082611       -0.631264
-----------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  3              91            +3.500            +0.000     pixels
OFFSET FRAME NAME: MIPS_160um_small_FOV1
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
WAS(FTB)            +7.589000       +11.546000       +0.000000
IS (EST)            +7.694970       +11.500994       -0.095758
dT_EST              +0.105970        -0.045006       -0.095758
T_sSIGMA            +0.002464        +0.003870       +0.151693
dT_EST/T_sSIGMA    +43.014479       -11.629274       -0.631264
-----------------------------------------------------------------
```

```
OFFSET           NF          Delta_CW          Delta_CV
  4              92            -3.000            -0.500     pixels
OFFSET FRAME NAME: MIPS_160um_small_FOV2
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
WAS(FTB)            +5.879000       +11.626000       +0.000000
IS (EST)            +5.793225       +11.683813       -0.095758
dT_EST              -0.085775        +0.057813       -0.095758
T_sSIGMA            +0.002328        +0.004187       +0.151693
dT_EST/T_sSIGMA    -36.839496       +13.807894       -0.631264
-------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  5               1           +10.000            +1.500     pixels
OFFSET FRAME NAME: CORNER PIXEL (DIAGNOSTICS)
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
WAS(FTB)            +0.000000        +0.000000       +0.000000
IS (EST)            +9.599519       +10.997470       -0.095758
dT_EST              +9.599519       +10.997470       -0.095758
T_sSIGMA            +0.005355        +0.006451       +0.151693
dT_EST/T_sSIGMA    +1792.763469       +1704.689022       -0.631264
-------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  6               1           +10.000            -1.500     pixels
OFFSET FRAME NAME: CORNER PIXEL (DIAGNOSTICS)
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
WAS(FTB)            +0.000000        +0.000000       +0.000000
IS (EST)            +9.591109       +11.959581       -0.095758
dT_EST              +9.591109       +11.959581       -0.095758
T_sSIGMA            +0.004879        +0.006468       +0.151693
dT_EST/T_sSIGMA    +1965.631179       +1849.073059       -0.631264
-------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  7               1           -10.000            +1.500     pixels
OFFSET FRAME NAME: CORNER PIXEL (DIAGNOSTICS)
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
WAS(FTB)            +0.000000        +0.000000       +0.000000
IS (EST)            +3.752308       +11.066604       -0.095758
dT_EST              +3.752308       +11.066604       -0.095758
T_sSIGMA            +0.005334        +0.006466       +0.151693
dT_EST/T_sSIGMA    +703.463174       +1711.449475       -0.631264
-------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  8               1           -10.000            -1.500     pixels
OFFSET FRAME NAME: CORNER PIXEL (DIAGNOSTICS)
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
WAS(FTB)            +0.000000        +0.000000       +0.000000
IS (EST)            +3.743897       +12.028712       -0.095758
dT_EST              +3.743897       +12.028712       -0.095758
T_sSIGMA            +0.004888        +0.007076       +0.151693
dT_EST/T_sSIGMA    +766.002618       +1699.916275       -0.631264
-------------------------------------------------------------------
-------------------------------------------------------------------------------------
-------------------------------------------------------------------------------------
VARNAME             MEAN                      SIGMA                SCALED_SIGMA
a00        +9.8784711461149532E-002 +1.3721173780367230E-003 +1.5057202732813261E-003
b00        +7.1204801961619130E-002 +6.0503732831796858E-003 +6.6394973631472573E-003
c00        +1.1154576631245269E-002 +2.6588155062744951E-003 +2.9177040352338672E-003
a10        -4.2776577028700506E+000 +5.3591402927170257E+000 +5.8809591039862763E+000
b10        -1.1571234772930577E+001 +2.0630726668118211E+001 +2.2639537909766130E+001
c10        +1.3963779641717224E+001 +1.7967276005579851E+001 +1.9716747393690287E+001
d10        -7.0390464460466156E+000 +6.1119509267345391E+000 +6.7070708140528197E+000
del_alpha  -7.7934620562603030E-015 +2.6987825136512754E-003 +2.9615626250548842E-003
beta       +1.0920143032996814E+000 +3.8991876992517673E-003 +4.2788511114793442E-003
del_theta1 +1.5574130526885277E-014 +2.4126251550432524E-003 +2.6475421606969125E-003
del_theta2 +2.7518512269516116E-018 +5.3618249702239098E-007 +5.8839051882018430E-007
```

```
del_theta3 +2.0407141281724231E-018 +9.5690412995389054E-007 +1.0500777638424747E-006
del_arx    +5.1553194967634240E-015 +6.1886777812549147E-005 +6.7912685526761289E-005
del_ary    +1.5153260607701823E-017 +2.4969045245634866E-006 +2.7400278017486712E-006
del_arz    -2.1191917307355340E-017 +2.4942370316542075E-006 +2.7371005753928019E-006
brx        +7.4776957796108530E-009 +1.2487074910545913E-008 +1.3702939812404569E-008
bry        -7.2370222622583822E-010 +5.5709197949952152E-010 +6.1133595495676632E-010
brz        -1.7197599417937508E-011 +5.5628332797225721E-010 +6.1044856513275289E-010
crx        +2.2704110125713665E-013 +1.1393708869495902E-012 +1.2503112858473021E-012
cry        +8.7846187754457997E-013 +5.1956090125440967E-014 +5.7015048037832243E-014
crz        +7.2305669273143225E-013 +5.2036749925094170E-014 +5.7103561671957639E-014
bgx        +4.6677153245269336E-007 +4.8171650913915602E-007 +5.2862118459789947E-007
bgy        -6.7259300602211724E-009 +1.3347966055115829E-009 +1.4647655818641605E-009
bgz        -1.9402899920465108E-008 +1.8120264765511650E-009 +1.9884632649792125E-009
cgx        -1.6243534164985527E-012 +3.3806599764112768E-011 +3.7098344099661952E-011
cgy        +4.0305076096051194E-013 +1.0293411390316306E-013 +1.1295679553159462E-013
cgz        +2.5594820644503995E-013 +1.3442311271603205E-013 +1.4751187416904299E-013
-------------------------------------------------------------------------------
LSQF RESIDUAL SIGMA SCALE =         +1.0973698732944897E+000
-------------------------------------------------------------------------------
-------------------------------------------------------------------------------------------------------
-------------------------------------------------------------------------------------------------------
                    a_mirror(1)               a_mirror(2)               a_mirror(3)
a_mirror_ipf   +0.0000000000000000E+000  +1.8395480617968776E-002  +9.9983078883020704E-001
a_mirror_tpf   -1.8731154357032071E-003  +2.0072854954215749E-002  +9.9979676531410688E-001
beta                beta_0                    beta                      beta_total
               +2.8047410000000001E-006  +1.0920143032996814E+000  +3.0628172890510520E-006
-------------------------------------------------------------------------------------------------------
qT              qT(1)                     qT(2)                     qT(3)                     qT(4)
FrmTbl:   -1.6247706156225429E-006 -9.6996521888884340E-004 -1.6750781782660256E-003 +9.9999812663721077E-001
Estim:    -8.3727218881193518E-004 -9.6895946521206161E-004 -1.6753200608121425E-003 +9.9999777669529366E-001
DelTheta        deltheta(1)               deltheta(2)               deltheta(3)
          -1.6712957402167995E-003 -7.8777429278868151E-007 +1.1368232827023735E-006       [rad]
EulAngT         theta(1)                  theta(2)                  theta(3)                  [rad]
Mean      -1.6712979455810976E-003 -1.9407212378832323E-003 -3.3490226737795444E-003
SigmaT    +2.4126251550432524E-003 +5.3618249702239098E-007 +9.5690412995389054E-007
-------------------------------------------------------------------------------------------------------
qR              qR(1)                     qR(2)                     qR(3)                     qR(4)
ASFILE:   +0.0000000000000000E+000 +0.0000000000000000E+000 +0.0000000000000000E+000 +1.0000000000000000E+000
Estim:    -2.5917498224297821E-007 +3.0689496987361259E-006 +7.4147943584139293E-007 +9.9999999999498246E-001
DelThetaR       delthetaR(1)              delthetaR(2)              delthetaR(3)
          -5.1834541336696026E-007 +6.1378997818258335E-006 +1.4829572809138550E-006       [rad]
EulAngR         angR(1)                   angR(2)                   angR(3)                   [rad]
Mean      -5.1834541336696026E-007 +6.1378997818258335E-006 +1.4829572809138550E-006
SigmaR    +6.1886777812549147E-005 +2.4969045245634866E-006 +2.4942370316542075E-006
-------------------------------------------------------------------------------------------------------
Initial Gyro Bias         Bg0(1)                    Bg0(2)                    Bg0(3)
                  +1.4533739153217648E-006 +1.9992046246169240E-007 +2.6049877787211708E-007
Gyro Bias Correction      Bg(1)                     Bg(2)                     Bg(3)
                  +4.6677153245269336E-007 -6.7259300602211724E-009 -1.9402899920465108E-008
Total Gyro Bias           BgT(1)                    BgT(2)                    BgT(3)
                  +1.9201454477744582E-006 +1.9319453240147122E-007 +2.4109587795165198E-007

Initial Gyro Bias Rate     Cg0(1)                    Cg0(2)                    Cg0(3)
                  +0.0000000000000000E+000 +0.0000000000000000E+000 +0.0000000000000000E+000
Gyro Bias Rate Correction  Cg(1)                     Cg(2)                     Cg(3)
                  -1.6243534164985527E-012 +4.0305076096051194E-013 +2.5594820644503995E-013
Total Gyro Bias Rate       CgT(1)                    CgT(2)                    CgT(3)
                  -1.6243534164985527E-012 +4.0305076096051194E-013 +2.5594820644503995E-013
-------------------------------------------------------------------------------------------------------
-------------------------------------------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  1              88            +0.000            -1.500     pixels
OFFSET FRAME NAME: MIPS_160um_plusY_edge
qT               qT(1)                     qT(2)                     qT(3)                     qT(4)
```

```
WAS(FTB)  -1.6879757291711217E-006 -9.6923788967401584E-004 -1.7415460069063584E-003 +9.9999801379431230E-001
IS (EST)  -8.3733891505112458E-004 -9.6828925079613256E-004 -1.7452859613986058E-003 +9.9999765762544723E-001

DelTheta        deltheta(1)               deltheta(2)               deltheta(3)
Units             rad                       rad                       rad
          -1.6713093058441349E-003 -1.0189505443602644E-006 -5.8603929439187167E-006
EulAngT         theta(1)                  theta(2)                  theta(3)                  [rad]
Mean      -1.6712979455810973E-003 -1.9394979730594415E-003 -3.4889558145296644E-003
sSigmaT   +2.6475421549876144E-003 +8.1254414791182261E-007 +1.4263275677016640E-006
SigmaT    +2.4126251498405417E-003 +7.4044692467493015E-007 +1.2997692049077198E-006
-------------------------------------------------------------------------------------------------------
-------------------------------------------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  2              89            +0.000            +0.000     pixels
OFFSET FRAME NAME: MIPS_160um_large_only
qT               qT(1)                     qT(2)                     qT(3)                     qT(4)
WAS(FTB)  -1.6247706156225429E-006 -9.6996521888884340E-004 -1.6750781782660256E-003 +9.9999812663721077E-001
IS (EST)  -8.3727218881193518E-004 -9.6895946521206161E-004 -1.6753200608121423E-003 +9.9999777669529366E-001

DelTheta        deltheta(1)               deltheta(2)               deltheta(3)
Units             rad                       rad                       rad
          -1.6712957402167995E-003 -7.8777429278868119E-007 +1.1368232827028072E-006
EulAngT         theta(1)                  theta(2)                  theta(3)                  [rad]
Mean      -1.6712979455810973E-003 -1.9407212378832323E-003 -3.3490226737795440E-003
sSigmaT   +2.6475421606969116E-003 +5.8839051882018430E-007 +1.0500777638424745E-006
SigmaT    +2.4126251550432519E-003 +5.3618249702239098E-007 +9.5690412995389033E-007
-------------------------------------------------------------------------------------------------------
-------------------------------------------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  3              91            +3.500            +0.000     pixels
OFFSET FRAME NAME: MIPS_160um_small_FOV1
qT               qT(1)                     qT(2)                     qT(3)                     qT(4)
WAS(FTB)  -1.8535660093339217E-006 -1.1037735273119842E-003 -1.6792958163857940E-003 +9.9999798082102442E-001
IS (EST)  -8.3751930490982872E-004 -1.1177880531357989E-003 -1.6736845447605710E-003 +9.9999762394284053E-001

DelTheta        deltheta(1)               deltheta(2)               deltheta(3)
Units             rad                       rad                       rad
          -1.6712690447101624E-003 -3.0825534439040342E-005 +1.3091804919204893E-005
EulAngT         theta(1)                  theta(2)                  theta(3)                  [rad]
Mean      -1.6712979455810976E-003 -2.2383761498140195E-003 -3.3455034195442510E-003
sSigmaT   +2.6475420987916347E-003 +7.1663158889087217E-007 +1.1257657094456392E-006
SigmaT    +2.4126250986308438E-003 +6.5304470838025025E-007 +1.0258762672843390E-006
-------------------------------------------------------------------------------------------------------
-------------------------------------------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  4              92            -3.000            -0.500     pixels
OFFSET FRAME NAME: MIPS_160um_small_FOV2
qT               qT(1)                     qT(2)                     qT(3)                     qT(4)
WAS(FTB)  -1.4458583985377269E-006 -8.5506456275250009E-004 -1.6909317330203208E-003 +9.9999820480457724E-001
IS (EST)  -8.3707921993642531E-004 -8.4116868943448335E-004 -1.7000438599659847E-003 +9.9999785078993531E-001

DelTheta        deltheta(1)               deltheta(2)               deltheta(3)
Units             rad                       rad                       rad
          -1.6713267052255326E-003 +2.4951074949629184E-005 -1.6817193841699801E-005
EulAngT         theta(1)                  theta(2)                  theta(3)                  [rad]
Mean      -1.6712979455810973E-003 -1.6851807035543195E-003 -3.3986835316631913E-003
sSigmaT   +2.6475420302450635E-003 +6.7729143931053173E-007 +1.2179422287096121E-006
SigmaT    +2.4126250361664252E-003 +6.1719521903511758E-007 +1.1098739434618739E-006
-------------------------------------------------------------------------------------------------------
-------------------------------------------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  5               1           +10.000            +1.500     pixels
OFFSET FRAME NAME: CORNER PIXEL (DIAGNOSTICS)
qT               qT(1)                     qT(2)                     qT(3)                     qT(4)
```

```
WAS(FTB)  +0.0000000000000000E+000 +0.0000000000000000E+000 +0.0000000000000000E+000 +1.0000000000000000E+000
IS (EST)  -8.3788022493859102E-004 -1.3948540785595181E-003 -1.6006810654194275E-003 +9.9999739507608476E-001

DelTheta        deltheta(1)               deltheta(2)               deltheta(3)
Units             rad                       rad                       rad
          -1.6712979455810973E-003 -2.7923868770667183E-003 -3.1990342787081264E-003
EulAngT         theta(1)                  theta(2)                  theta(3)                  [rad]
Mean      -1.6712979455810973E-003 -2.7923868770667174E-003 -3.1990342787081264E-003
sSigmaT   +2.6475413087985239E-003 +1.5575880058555036E-006 +1.8766087175822051E-006
SigmaT    +2.4126243787339977E-003 +1.4193828751461542E-006 +1.7100968080600834E-006
-----------------------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  6               1           +10.000            -1.500     pixels
OFFSET FRAME NAME: CORNER PIXEL (DIAGNOSTICS)
qT               qT(1)                     qT(2)                     qT(3)                     qT(4)
WAS(FTB)  +0.0000000000000000E+000 +0.0000000000000000E+000 +0.0000000000000000E+000 +1.0000000000000000E+000
IS (EST)  -8.3807327703251720E-004 -1.3935135799535846E-003 -1.7406130375957020E-003 +9.9999716300564490E-001

DelTheta        deltheta(1)               deltheta(2)               deltheta(3)
Units             rad                       rad                       rad
          -1.6712979455810976E-003 -2.7899403950448869E-003 -3.4789010228050304E-003
EulAngT         theta(1)                  theta(2)                  theta(3)                  [rad]
Mean      -1.6712979455810976E-003 -2.7899403950448864E-003 -3.4789010228050304E-003
sSigmaT   +2.6475413621847143E-003 +1.4193610810086161E-006 +1.8814297278833605E-006
SigmaT    +2.4126244273832195E-003 +1.2934208561307178E-006 +1.7144900490433466E-006
-----------------------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  7               1           -10.000            +1.500     pixels
OFFSET FRAME NAME: CORNER PIXEL (DIAGNOSTICS)
qT               qT(1)                     qT(2)                     qT(3)                     qT(4)
WAS(FTB)  +0.0000000000000000E+000 +0.0000000000000000E+000 +0.0000000000000000E+000 +1.0000000000000000E+000
IS (EST)  -8.3652609366302024E-004 -5.4440506283967333E-004 -1.6100269353626399E-003 +9.9999820582863530E-001

DelTheta        deltheta(1)               deltheta(2)               deltheta(3)
Units             rad                       rad                       rad
          -1.6712979455810973E-003 -1.0915020479849355E-003 -3.2191447528584047E-003
EulAngT         theta(1)                  theta(2)                  theta(3)                  [rad]
Mean      -1.6712979455810973E-003 -1.0915020479849355E-003 -3.2191447528584051E-003
sSigmaT   +2.6475410052136153E-003 +1.5516122073156259E-006 +1.8809464142208116E-006
SigmaT    +2.4126241020862456E-003 +1.4139373105418177E-006 +1.7140496199097328E-006
-----------------------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  8               1           -10.000            -1.500     pixels
OFFSET FRAME NAME: CORNER PIXEL (DIAGNOSTICS)
qT               qT(1)                     qT(2)                     qT(3)                     qT(4)
WAS(FTB)  +0.0000000000000000E+000 +0.0000000000000000E+000 +0.0000000000000000E+000 +1.0000000000000000E+000
IS (EST)  -8.3660012614061147E-004 -5.4306475598706733E-004 -1.7499585571316687E-003 +9.9999797141091651E-001

DelTheta        deltheta(1)               deltheta(2)               deltheta(3)
Units             rad                       rad                       rad
          -1.6712979455810971E-003 -1.0890555550405300E-003 -3.4990105730357121E-003
EulAngT         theta(1)                  theta(2)                  theta(3)                  [rad]
Mean      -1.6712979455810973E-003 -1.0890555550405300E-003 -3.4990105730357129E-003
sSigmaT   +2.6475410326822833E-003 +1.4217386845498521E-006 +2.0583428864339771E-006
SigmaT    +2.4126241271176128E-003 +1.2955874943801332E-006 +1.8757056636286943E-006
-----------------------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------------------
              q(1)                      q(2)                      q(3)                      q(4)
PCRS1A: +5.2603126189317361E-007 +3.7451819048221893E-004 -1.4045531552277380E-003 +9.9999894348258311E-001
PCRS2A: -5.1968404336718985E-007 +3.8455385122900486E-004 +1.3513933841514693E-003 +9.9999901292650617E-001
-------------------------------------------------------------------------------------
```

```
**********  CS-FILE PARAMETERS:  **********  **********  AS-FILE PARAMETERS:  **********
Row (01) PIX2RADX: +7.7399898172000000E-005  Row (1) TASTART:   +7.3051200000000000E+008
Row (02) PIX2RADY: +8.7086140999000005E-005  Row (2) TASTOP:    +7.3053335000000000E+008
Row (03) CX0:      +1.0500000000000000E+001  Row (3) S/C TIME:  +7.3051200000000000E+008
Row (04) CY0:      +2.0000000000000000E+000  Row (4) QR1:       +0.0000000000000000E+000
Row (05) BETA0:    +2.8047410000000001E-006  Row (5) QR2:       +0.0000000000000000E+000
Row (06) GAMMA_E0: +2.0070000000000000E+003  Row (6) QR3:       +0.0000000000000000E+000
Row (07) D11:      -1.0000000000000000E+000  Row (7) QR4:       +1.0000000000000000E+000
Row (08) D12:      +0.0000000000000000E+000
Row (09) D21:      +0.0000000000000000E+000
Row (10) D22:      -1.0000000000000000E+000
Row (11) DG:       +1.0000000000000000E+000
-------------------------------------------------------------------------------------
-------------------------------------------------------
INITIAL STA-TO-PCRS ALIGNMENT (R) KNOWLEDGE (1-SIGMA)
    SIGMA(X)        SIGMA(Y)         SIGMA(Z)
1.41451738E+001  7.65467990E-001  7.65467990E-001  [arcsec]
-------------------------------------------------------
PIX2RADX = 7.739989817200E-005[rad/pixel]
XPIXSIZE = 15.9649[arcsec]
PIX2RADY = 8.708614099900E-005[rad/pixel]
YPIXSIZE = 17.9628[arcsec]
CX0 = 10.5[pixel] = 167.63[arcsec]
CY0 = 2.0[pixel] = 35.93[arcsec]
-------------------------------------------------------
NOMINAL BETA0 = 2.804741000000E-006[rad/encoder unit]
ENCODER UNIT SIZE = 0.58[arcsec]
GAMMA_E0 = 2007.00[encoder unit] = 1161.09[arcsec]
-------------------------------------------------------
                | -1 | +0 |
FLIP MATRIX D = |----|----|   and   DG = +1
                | +0 | -1 |
-------------------------------------------------------
```

3.3 IPF EXECUTION LOG

```
*********************************************************************
IPF EXECUTION-LOG FILE NAME:  LG992087.dat
INSTRUMENT TYPE:              MIPS_160um_center_large_FOV
IPF FILTER EXECUTION DATE:    07-Aug-2003    TIME: 11:04
IPF FILTER VERSION USED:      IPF.V2.0.1Beta
*********************************************************************

------------------- Loading & Preparing Input Files -------------------
AAFILE:  AA992087 Loaded!        AAFILE dimension = 213501 X 21
ASFILE:  AS992087 Loaded!
CAFILE:  CA992087 Loaded!        CAFILE dimension = 249 X 15
CBFILE:  CB992087 Loaded!        CBFILE dimension = 90 X 15
CCFILE:  CC992087 Created!       CCFILE dimension = 339 X 19
CSFILE:  CS992087 Loaded!
Loading Input Files Completed!
---------------------------------------------------------------------

------------------------- Selected Mask Vectors -------------------------
index =   1  2  3  4  5  6  7  8  9 10 11 12 13 14 15 16 17 18 19 20
---------------------------------------------------------------------
mask1 = [ 1  1  1  1  1  1  1  0  0  0  0  0  0  0  0  0  0 ]
```

```
mask2 = [ 1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1 ]
-----------------------------------------------------------------------

---------------  Selected Initial Gyro Bias Parameters  ---------------
User Entered 1 : Use AFILE database - from S/C filter
IPF Linearized Using Following Nominal Gyro Bias Estimates
bg0 = [+1.4533739153217648E-006 +1.9992046246169240E-007 +2.6049877787211708E-007 ]
cg0 = [+0.0000000000000000E+000 +0.0000000000000000E+000 +0.0000000000000000E+000 ]
-----------------------------------------------------------------------

---------------  Gyro Pre-Processor Run Completed  --------------------
     AGFILE CREATED:  AG992087.m     ACFILE CREATED:  AC992087.m
-----------------------------------------------------------------------
Total Gyro Preprocessor Execution Time: 81 seconds

FRAME TABLE ENTRIES FOR PCRS LOADED TO TPCRS
q_PCRS4 = [ +5.2603126189317361E-007     q_PCRS5 = [ +7.3379987833742897E-007
            +3.7451819048221893E-004                 +5.2236196154513707E-004
            -1.4045531552277380E-003                 -1.4047712280184723E-003
            +9.9999894348258311E-001 ];              +9.9999887687698918E-001 ];
q_PCRS8 = [ -5.1968404336718985E-007     q_PCRS9 = [ -7.1963421681856818E-007
            +3.8455385122900486E-004                 +5.3239763239987400E-004
            +1.3513933841514693E-003                 +1.3516841804518383E-003
            +9.9999901292650617E-001 ];              +9.9999894475050310E-001 ];
-------------------------------------------------------------------------------
------ Initial Conditions for State -----  ------   Inital Square-Root Cov (diag)   -----
p1(01)  = a00  = +0.0000000000000000E+000  Sigma_initial(01,01) = 1.0000000000000000E+000
p1(02)  = b00  = +0.0000000000000000E+000  Sigma_initial(02,02) = 1.0000000000000000E+000
p1(03)  = c00  = +0.0000000000000000E+000  Sigma_initial(03,03) = 1.0000000000000000E+000
p1(04)  = a10  = +0.0000000000000000E+000  Sigma_initial(04,04) = 3.6384517097704270E+002
p1(05)  = b10  = +0.0000000000000000E+000  Sigma_initial(05,05) = 3.6384517097704270E+002
p1(06)  = c10  = +0.0000000000000000E+000  Sigma_initial(06,06) = 3.6384517097704270E+002
p1(07)  = d10  = +0.0000000000000000E+000  Sigma_initial(07,07) = 3.6384517097704270E+002
p1(08)  = a20  = +0.0000000000000000E+000  Sigma_initial(08,08) = 9.9999000000000000E+004
p1(09)  = b20  = +0.0000000000000000E+000  Sigma_initial(09,09) = 9.9999000000000000E+004
p1(10)  = c20  = +0.0000000000000000E+000  Sigma_initial(10,10) = 9.9999000000000000E+004
p1(11)  = d20  = +0.0000000000000000E+000  Sigma_initial(11,11) = 9.9999000000000000E+004
p1(12)  = a01  = +0.0000000000000000E+000  Sigma_initial(12,12) = 9.9999000000000000E+004
p1(13)  = b01  = +0.0000000000000000E+000  Sigma_initial(13,13) = 9.9999000000000000E+004
p1(14)  = c01  = +0.0000000000000000E+000  Sigma_initial(14,14) = 9.9999000000000000E+004
p1(15)  = d01  = +0.0000000000000000E+000  Sigma_initial(15,15) = 9.9999000000000000E+004
p1(16)  = e01  = +0.0000000000000000E+000  Sigma_initial(16,16) = 9.9999000000000000E+004
p1(17)  = f01  = +0.0000000000000000E+000  Sigma_initial(17,17) = 9.9999000000000000E+004
-------------------------------------------------------------------------------------------
p2f(01) = am1  = +0.0000000000000000E+000
p2f(02) = am2  = +0.0000000000000000E+000  Sigma_initial(18,18) = 1.0000000000000001E-001
p2f(03) = am3  = +1.0000000000000000E+000
p2f(04) = beta = +1.0000000000000000E+000  Sigma_initial(19,19) = 1.0000000000000001E-001
p2f(05) = qT1  = -1.6247706156225429E-006  Sigma_initial(20,20) = 1.0000000000000001E-001
p2f(06) = qT2  = -9.6996521888884340E-004  Sigma_initial(21,21) = 1.0000000000000000E-002
p2f(07) = aT3  = -1.6750781782660256E-003  Sigma_initial(22,22) = 1.0000000000000000E-002
p2f(08) = qT4  = +9.9999812663721077E-001
p2f(09) = qR1  = +0.0000000000000000E+000  Sigma_initial(23,23) = 3.4288868839039716E-003
p2f(10) = qR2  = +0.0000000000000000E+000  Sigma_initial(24,24) = 1.8555467699985827E-004
p2f(11) = qR3  = +0.0000000000000000E+000  Sigma_initial(25,25) = 1.8555467699985827E-004
p2f(12) = qR4  = +1.0000000000000000E+000
p2f(13) = brx  = +0.0000000000000000E+000  Sigma_initial(26,26) = 4.6838407494145199E-005
p2f(14) = bry  = +0.0000000000000000E+000  Sigma_initial(27,27) = 4.6838407494145199E-005
p2f(15) = brz  = +0.0000000000000000E+000  Sigma_initial(28,28) = 4.6838407494145199E-005
p2f(16) = crx  = +0.0000000000000000E+000  Sigma_initial(29,29) = 2.1938364165875972E-009
p2f(17) = cry  = +0.0000000000000000E+000  Sigma_initial(30,30) = 2.1938364165875972E-009
p2f(18) = crz  = +0.0000000000000000E+000  Sigma_initial(31,31) = 2.1938364165875972E-009
p2f(19) = bgx  = +0.0000000000000000E+000  Sigma_initial(32,32) = 4.6838407494145199E-005
p2f(20) = bgy  = +0.0000000000000000E+000  Sigma_initial(33,33) = 4.6838407494145199E-005
```

```
p2f(21) = bgz  = +0.0000000000000000E+000  Sigma_initial(34,34) = 4.6838407494145199E-005
p2f(22) = cgx  = +0.0000000000000000E+000  Sigma_initial(35,35) = 2.1938364165875972E-009
p2f(23) = cgy  = +0.0000000000000000E+000  Sigma_initial(36,36) = 2.1938364165875972E-009
p2f(24) = cgz  = +0.0000000000000000E+000  Sigma_initial(37,37) = 2.1938364165875972E-009
-------------------------------------------------------------------------------------

--------------------   IPF KALMAN FILTER STARTED  ---------------------
Iteration#001: |dp|= +1.999847106850E+001   RMS(|Res|)=+1.999847106850E+001
Iteration#002: |dp|= +9.933952346043E-002   RMS(|Res|)=+9.933952346043E-002
Iteration#003: |dp|= +3.861995501547E-002   RMS(|Res|)=+3.861995501547E-002
Iteration#004: |dp|= +3.342539604902E-002   RMS(|Res|)=+3.342539604902E-002
Iteration#005: |dp|= +2.009974237346E-003   RMS(|Res|)=+2.009974237346E-003
Iteration#006: |dp|= +1.387338970076E-004   RMS(|Res|)=+1.387338970076E-004
Iteration#007: |dp|= +4.366552602098E-005   RMS(|Res|)=+4.366552602098E-005
Iteration#008: |dp|= +1.670930077031E-006   RMS(|Res|)=+1.670930077031E-006
Iteration#009: |dp|= +3.047686420586E-007   RMS(|Res|)=+3.047686420586E-007
Iteration#010: |dp|= +5.009943655212E-008   RMS(|Res|)=+5.009943655212E-008
Iteration#011: |dp|= +9.435177411522E-010   RMS(|Res|)=+9.435177411522E-010
Iteration#012: |dp|= +4.900516552601E-010   RMS(|Res|)=+4.900516552601E-010
Iteration#013: |dp|= +1.208566563047E-010   RMS(|Res|)=+1.208566563047E-010
Iteration#014: |dp|= +1.769146037592E-010   RMS(|Res|)=+1.769146037592E-010
Iteration#015: |dp|= +9.212673092940E-011   RMS(|Res|)=+9.212673092940E-011
Iteration#016: |dp|= +7.764744042672E-011   RMS(|Res|)=+7.764744042672E-011
Iteration#017: |dp|= +2.728783030523E-010   RMS(|Res|)=+2.728783030523E-010
Iteration#018: |dp|= +2.279232053297E-010   RMS(|Res|)=+2.279232053297E-010
Iteration#019: |dp|= +2.675309819573E-010   RMS(|Res|)=+2.675309819573E-010
Iteration#020: |dp|= +7.314416978067E-011   RMS(|Res|)=+7.314416978067E-011
IPF Kalman Filter Completed with Error |dp1| + |dp2| = +7.3144169780673638E-011
----------------------------------------------------------------------

-----------------  IPF LEAST SQUARES FILTER STARTED  ------------------
Iteration#001   COND#=+3.381487757819E+010,   |dp|=+2.001876777537E+001
Iteration#002   COND#=+3.381825124828E+010,   |dp|=+1.570094186464E-001
Iteration#003   COND#=+3.381821239213E+010,   |dp|=+7.185341399274E-003
Iteration#004   COND#=+3.381821946841E+010,   |dp|=+1.344697797293E-004
Iteration#005   COND#=+3.381819570833E+010,   |dp|=+2.319059913135E-006
Iteration#006   COND#=+3.381819725876E+010,   |dp|=+4.443215627923E-008
Iteration#007   COND#=+3.381821519873E+010,   |dp|=+8.865756983957E-010
Iteration#008   COND#=+3.381820017364E+010,   |dp|=+6.365981956958E-011
Iteration#009   COND#=+3.381818652444E+010,   |dp|=+4.696427279690E-011
Iteration#010   COND#=+3.381820155494E+010,   |dp|=+1.790252730767E-010
Iteration#011   COND#=+3.381820600108E+010,   |dp|=+2.447886587022E-010
Iteration#012   COND#=+3.381821063869E+010,   |dp|=+1.759607218536E-010
Iteration#013   COND#=+3.381821839033E+010,   |dp|=+7.874052030914E-011
Iteration#014   COND#=+3.381820742519E+010,   |dp|=+1.966787719177E-010
Iteration#015   COND#=+3.381822341074E+010,   |dp|=+1.093661768371E-010
Iteration#016   COND#=+3.381822216200E+010,   |dp|=+1.441532486885E-010
Iteration#017   COND#=+3.381822827104E+010,   |dp|=+1.766151399112E-010
Iteration#018   COND#=+3.381821788174E+010,   |dp|=+2.096103689677E-010
Iteration#019   COND#=+3.381823092639E+010,   |dp|=+2.595734180608E-010
Iteration#020   COND#=+3.381817990897E+010,   |dp|=+1.999649843126E-010
IPF Least Squares Filter Completed with Error |dp1| + |dp2| = +1.9996498431262444E-010
----------------------------------------------------------------------
Total Execution Time: 160 seconds
```

4 USER COMMENTS

This section left blank.

IPF TEAM CONTACT INFORMATION

IPF Team email		ipf@sirtfweb.jpl.nasa.gov	
David S. Bayard	X4-8208	David.S.Bayard@jpl.nasa.gov	(TEAM LEADER)
Dhemetrio Boussalis	X4-3977	boussali@grover.jpl.nasa.gov	
Paul Brugarolas	X4-9243	Paul.Brugarolas@jpl.nasa.gov	
Bryan H. Kang	X4-0541	Bryan.H.Kang@jpl.nasa.gov	
Edward.C.Wong	X4-3053	Edward.C.Wong@jpl.nasa.gov	(TASK MANAGER)

ACKNOWLEDGEMENTS

This work was performed at the Jet Propulsion Laboratory, California Institute of Technology, under contract with the National Aeronautics and Space Administration.

References

[1] D.S. Bayard, B.H. Kang, *SIRTF Instrument Pointing Frame Kalman Filter Algorithm*, JPL D-Document D-24809, September 30, 2003.

[2] B.H. Kang, D.S. Bayard, *SIRTF Instrument Pointing Frame (IPF) Software Description Document and User's Guide*, JPL D-Document D-24808, September 30, 2003.

[3] D.S. Bayard, B.H. Kang, *SIRTF Instrument Pointing Frame (IPF) Kalman Filter Unit Test Report*, JPL D-Document D-24810, September 30, 2003.

[4] *Space Infrared Telescope Facility In-Orbit Checkout and Science Verification Mission Plan*, JPL D-Document D-22622, 674-FE-301 Version 1.4, February 8, 2002.

[5] *Space Infrared Telescope Facility Observatory Description Document*, Lockheed Martin LMMS/P458569, 674-SEIT-300 Version 1.2, November 1, 2002.

[6] *SIRTF Software Interface Specification for Science Centroid INPUT Files (CAFILE, CSFILE)*, JPL SOS-SIS-2002, November 18, 2002.

[7] *SIRTF Software Interface Specification for Inferred Frames Offset INPUT Files (OFILE)*, JPL SOS-SIS-2003, November 18, 2002.

[8] *SIRTF Software Interface Specification for PCRS Centroid INPUT Files (CBFILE)*, JPL SIS-FES-015, November 18, 2002.

[9] *SIRTF Software Interface Specification for Attitude INPUT Files (AFILE, ASFILE)*, JPL SIS-FES-014, January 7, 2002.

[10] *SIRTF Software Interface Specification for IPF Filter Output Files (IFFILE, LGFILE, TARFILE)*, JPL SOS-SIS-2005, November 18, 2002.

[11] R.J. Brown, *Focal Surface to Object Space Field of View Conversion.* Systems Engineering Report SER No. S20447-OPT-051, Ball Aerospace & Technologies Corp., November 23, 1999.

This page left blank.

SIRTF INSTRUMENT POINTING FRAME KALMAN FILTER EXECUTION SUMMARY

IPF RUN NUMBER: 993087
REPORT TYPE: COVARIANCE ANALYSIS

PRIME FRAME: MIPS_160um_center_large_FOV (87)
INFERRED FRAMES: (88) (89) (91) (92) (1) (1) (1) (1)

IPF TEAM

Autonomy and Control Section (345)
Jet Propulsion Laboratory
California Institute of Technology
4800 Oak Grove Drive
Pasadena, CA 91109

Contents

1 IPF EXECUTION SUMMARY **4**

2 FLUTE DATA SUMMARY **8**

2.1 FLUTE CONFIGURATION PARAMETERS 8

2.2 FLUTE GENERATED UNIT TEST DATA 11

3 IPF EXECUTION RESULTS **16**

3.1 IPF EXECUTION OUTPUT PLOTS 16

3.2 IPF OUTPUT DATA (IF MINI FILE) 30

3.3 IPF EXECUTION LOG 35

4 USER COMMENTS **38**

List of Figures

1.1 A-priori and a-posteriori IPF frames 4

1.2 A-priori and a-posteriori IPF frames (ZOOMED) 7

2.1 Focal plane survey scenario plot (See key in [3]) 12

2.2 Commanded-only source locations 13

2.3 True (+) and commanded (o) source locations 13

2.4 True (+) and commanded (o) source locations (ZOOMED) 14

2.5 True-sampled (o) and centroided (+) locations on S/I array (W,V) 14

2.6 True (o) and centroided (+) locations on S/I array (W,V) 15

2.7 True (o) and centroided (+) locations on S/I array (W,V) showing prime and inferred frames 15

3.1 TPF coords of measurements and a-priori predicts 17

3.2 Oriented Pixel Coords of measurements and a-priori predicts 17

3.3 A-priori prediction error 18

3.4 Oriented Pixel Coords of measurements and a-priori predicts (PCRS only) 18

3.5 IPF execution convergence, chart 1 19

3.6 IPF execution convergence, chart 2 19

3.7 Parameter uncertainty convergence 20

3.8 IPF parameter symbol table 20
3.9 KF parameter error sigma plots 21
3.10 LS parameter error sigma plot 21
3.11 KF and LS parameter error sigma plot 22
3.12 Oriented Pixel Coords of meas. and a-posteriori predicts 23
3.13 Oriented Pixel Coords of meas. and a-posteriori predicts (attitude corrected) 23
3.14 Array plot with (solid) and w/o (dashed) optical distortion corrections 24
3.15 KF innovations with (o) and w/o (+) attitude corrections 24
3.16 W-axis KF innovations and 1-sigma bound 25
3.17 V-axis KF innovations and 1-sigma bound 25
3.18 Estimated attitude corrections (Body frame) 26
3.19 Estimated attitude error sigma plot (Body frame) 26
3.20 Thermo-mechanical boresight drift (equiv. angle in (W,V) coords) 27
3.21 Thermo-mechanical boresight drift (equiv. angle in Body frame) 27
3.22 Gyro drift bias contribution (equiv. rate in (W,V) coords) 28
3.23 Gyro drift bias contribution (equiv. angle in (W,V) coords) 28
3.24 Gyro drift bias contribution (equiv. angle in Body frame) 29

List of Tables

1.1 IPF filter input files 5
1.2 IPF filter execution configuration 5
1.3 IPF filter execution mask vector assignment 5
1.4 IPF calibration error summary ([arcsec], 1-sigma, radial) 6
1.5 Measurement prediction error summary (1-sigma) 6
1.6 IPF Brown angle summary 7
2.1 FLUTE Parameter Table (1) 8
2.2 FLUTE Parameter Table (2) 9
2.3 FLUTE Parameter Table (3) 10
2.4 Table of figures (FLUTE) 11
3.1 Table of figures (IPF run) 16

1 IPF EXECUTION SUMMARY

This report summarizes the SIRTF Instrument Pointing Frame (IPF) Kalman Filter execution associated with run file: RN993087. In particular, this Focal Point Survey calibrates the instrument: MIPS_160um_center_large_FOV (87), as part of the Covariance Analysis. The main calibration results from the IPF filter execution have been documented in IF993087 typically stored in the mission archive DOM collection IPF_IF. This report only summarizes the main aspects of the run, and does not substitute for the full information contained in the IF file.

Section 1 summarizes the filter execution results. The filter configurations are tabulated in Table 1.2 and the mask vector assignments are tabulated in Table 1.3. A total of 27 state parameters are estimated in this run. The overall End-to-End pointing performances are tabulated in Table 1.4. The prediction residuals throughout the estimation processes are tabulated in Table 1.6. Section 2 documents the FLUTE generated input file data. Section 3 summarizes resulting plots, a mini summary of the IF IPF output file, and the execution log. Section 4 captures the user comments that are specific to this particular run.

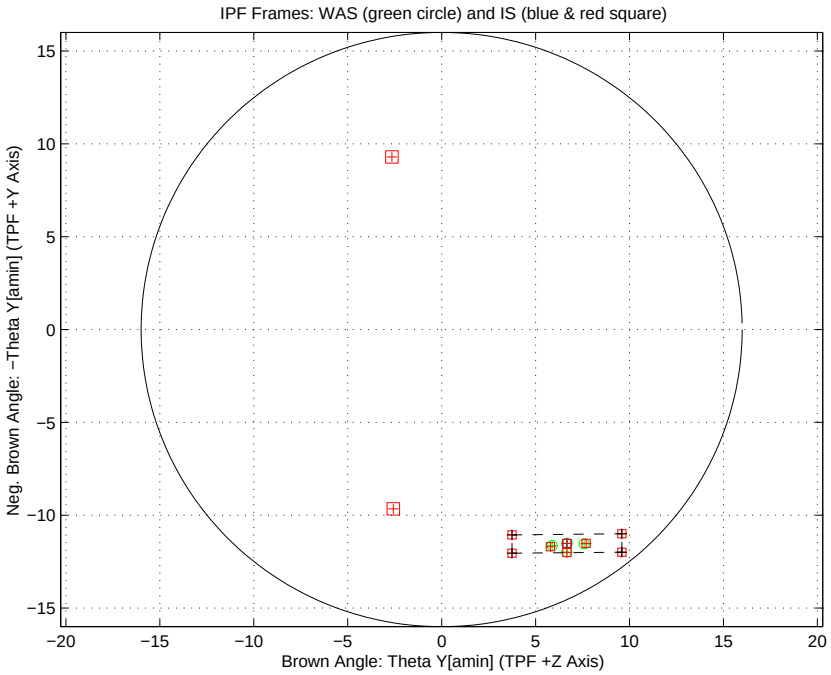

Figure 1.1: A-priori and a-posteriori IPF frames

RAW	FINAL (After Editing)
AA993087	AA993087
AS993087	AS993087
CA993087	CA993087
CB993087	CB993087
CS993087	CS993087

Table 1.1: IPF filter input files

EXECUTION CONFIGURATION ITEM	CURRENT STATUS
IPF Filter Version Used	IPF.V2.0.1Beta
Frame Table Version Used	FTVE2E1
Scan-Mirror Employed?	YES
IPF Filter Mode	NORMAL-MODE(0)
SLIT-MODE Operation	DISABLED
Kalman Filter Operation	ENABLED
Least-Squares Data Analysis	ENABLED
IBAD Screening	ENABLED
User-Specified Data Editing	DISABLED
Total Number of Iterations	20
LS Residual Sigma Scale	1.02801691E+000
Total Number of Maneuvers	30

Table 1.2: IPF filter execution configuration

Con. Plate Scale			Γ Dependent				Γ^2 Dependent				Linear Plate Scale						Mirror	
a_{00}	b_{00}	c_{00}	a_{10}	b_{10}	c_{10}	d_{10}	a_{20}	b_{20}	c_{20}	d_{20}	a_{01}	b_{01}	c_{01}	d_{01}	e_{01}	f_{01}	α	β
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	1	1
IPF (T)			Alignment R									Gyro Drift Bias						
θ_1	θ_2	θ_3	a_{rx}	a_{ry}	a_{rz}	b_{rx}	b_{ry}	b_{rz}	c_{rx}	c_{ry}	c_{rz}	b_{gx}	b_{gy}	b_{gz}	c_{gx}	c_{gy}	c_{gz}	
20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	

Table 1.3: IPF filter execution mask vector assignment

FOCAL PLANE SURVEY ANALYSIS: Covariance Analysis.
INSTRUMENT NAME: MIPS_160um_center_large_FOV NF: 87

```
PIX2RADW: 7.73998982E-005[rad/pixel] = 1.5965E+001[arcsec/pixel]
PIX2RADV: 7.73998982E-005[rad/pixel] = 1.5965E+001[arcsec/pixel]
```

FRAME	DESCRIPTION	IPF[1]	SF[2]	ARW[3]	TOTAL	REQ
087(P)	MIPS_160um_center_large_FOV	0.2322	0.0855	0.0384	0.2504	3.70
088(I)	MIPS_160um_plusY_edge	0.3289	0.0855	0.0384	0.3420	N/A
089(I)	MIPS_160um_large_only	0.2322	0.0855	0.0384	0.2504	N/A
091(I)	MIPS_160um_small_FOV1	0.2647	0.0855	0.0384	0.2808	N/A
092(I)	MIPS_160um_small_FOV2	0.2916	0.0855	0.0384	0.3062	N/A
TR (C)	CORNERS OF INSTRUMENT	0.5227	0.0855	0.0384	0.5310	N/A
BR (C)	CORNERS OF INSTRUMENT	0.5194	0.0855	0.0384	0.5277	N/A
TL (C)	CORNERS OF INSTRUMENT	0.5466	0.0855	0.0384	0.5545	N/A
BL (C)	CORNERS OF INSTRUMENT	0.5699	0.0855	0.0384	0.5775	N/A

Table 1.4: IPF calibration error summary ([arcsec], 1-sigma, radial)

RMS METRIC	A PRIORI[4]	A POSTERIORI[4]	ATT. CORRECTED[5]	UNITS
Radial	7.4107	2.6825	2.3851	arcsec
Radial	0.4642	0.1680	0.1494	pixels
W-Axis	0.3570	0.1202	0.1032	pixels
V-Axis	0.2967	0.1174	0.1080	pixels

Table 1.5: Measurement prediction error summary (1-sigma)

[1]IPF filter removes systematic pointing errors due to: thermomechanical alignment drift (Body to TPF), gyro bias and bias drift, centroiding error, attitude error, and optical distortion. IPF SIGMA presented here is "NOT Scaled" by the Least Squares Scale factor. The Least Squares Scale Factor was: 1.028017.

[2]Error due to gyro Scale Factor: assumes 95 ppm error over 0.250 degree maneuver.

[3]Error due to gyro Angle Random Walk: assumes ARW = 100 $\mu deg/\sqrt{hr}$, with 615 second Maneuver time (max), and 30 independent Maneuvers.

[4]This can be interpreted as estimate of "pixel to sky" pointing reconstruction error if no science data is used.

[5]This can be interpreted as estimate of achieved S/I centroiding error

IPF BROWN ANGLE SUMMARY						
	WAS			IS		
Frame Number	theta_Y (arcmin)	theta_Z (arcmin)	angle (deg)	theta_Y (arcmin)	theta_Z (arcmin)	angle (deg)
087	+6.669000	+11.517000	+0.000000	+6.671200	+11.522275	-0.176138
088	+6.664000	+11.974000	+0.000000	+6.669496	+12.016203	-0.176138
089	+6.669000	+11.517000	+0.000000	+6.671200	+11.522275	-0.176138
091	+7.589000	+11.546000	+0.000000	+7.694744	+11.512445	-0.176138
092	+5.879000	+11.626000	+0.000000	+5.793309	+11.695344	-0.176138
001	+0.000000	+0.000000	+0.000000	+9.597314	+11.000260	-0.176138
001	+0.000000	+0.000000	+0.000000	+9.593905	+11.988116	-0.176138
001	+0.000000	+0.000000	+0.000000	+3.748496	+11.056436	-0.176138
001	+0.000000	+0.000000	+0.000000	+3.745086	+12.044289	-0.176138

Table 1.6: IPF Brown angle summary

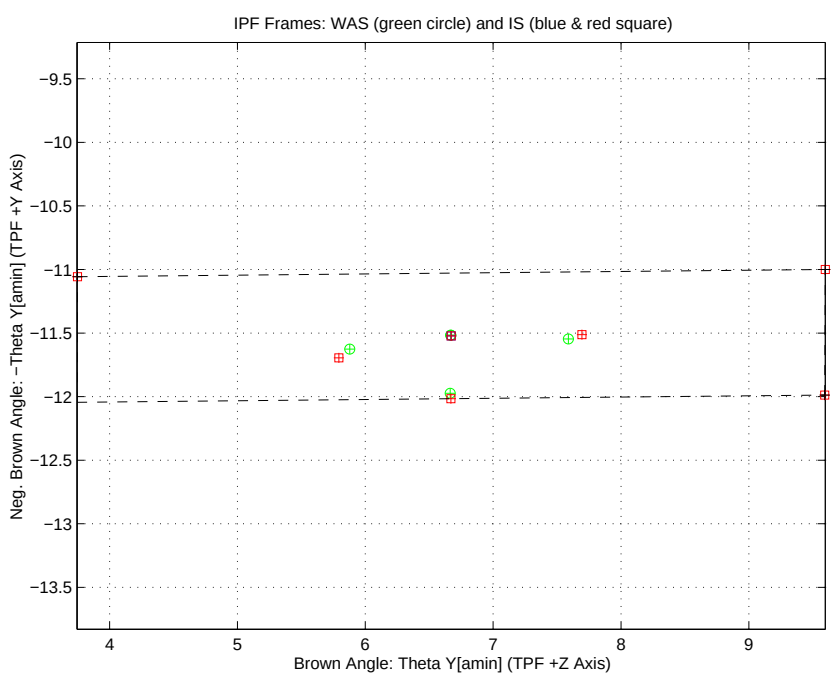

Figure 1.2: A-priori and a-posteriori IPF frames (ZOOMED)

2 FLUTE DATA SUMMARY

2.1 FLUTE CONFIGURATION PARAMETERS

The covariance analysis was performed using the FLUTE generated input data files. The internal configuration parameters, used to produce the data are tabulated in Table 2.1, Table 2.2 and Table 2.3.

NAME	DESCRIPTION	VALUE	UNIT
d2003	days into YEAR2003	+6.0000000000000000E+001	day
tstart	start time	+7.3051200000000000E+008	sec
tdel	data rate	+1.0000000000000001E-001	sec
tshelf	Inertial Hold duration pad	+5.0000000000000000E+000	sec
ipro	slew profile(1-linear, 2-S-curve)	1	int flag
sig_gcf [1]	gcf sigma(1)	+4.8481368110953601E-008	rad/sec
sig_gcf [2]	gcf sigma(2)	+9.6962736221907205E-009	rad/sec
sig_gcf [3]	gcf sigma(3)	+9.6962736221907205E-009	rad/sec
igcf	gcf bias correction flag	1	int flag
SigA [1][1]	Sigma A(1,1)	+9.4017722156391537E-009	rad^2
SigA [2][2]	Sigma A(2,2)	+2.3504430539097885E-011	rad^2
SigA [3][3]	Sigma A(3,3)	+2.3504430539097885E-011	rad^2
NFprime	Prime Frame NF	87	int
ftable [name]	Frame Table row number	87	int
ftable [q0]	Frametable quaternion q0	-1.6247706156225429E-006	N/A
ftable [q1]	Frametable quaternion q1	-9.6996521888884340E-004	N/A
ftable [q2]	Frametable quaternion q2	-1.6750781782660256E-003	N/A
ftable [q3]	Frametable quaternion q3	+9.9999812663721077E-001	N/A
ft_cmd [name]	Command row number	87	int
ft_cmd [q0]	Command quaternion q0	-1.6247706156225429E-006	N/A
ft_cmd [q1]	Command quaternion q1	-9.6996521888884340E-004	N/A
ft_cmd [q2]	Command quaternion q2	-1.6750781782660256E-003	N/A
ft_cmd [q3]	Command quaternion q3	+9.9999812663721077E-001	N/A
ft_true [name]	Truth row number	87	int
ft_true [q0]	Truth quaternion q0	-1.6247706156225429E-006	N/A
ft_true [q1]	Truth quaternion q1	-9.6996521888884340E-004	N/A
ft_true [q2]	Truth quaternion q2	-1.6750781782660256E-003	N/A
ft_true [q3]	Truth quaternion q3	+9.9999812663721077E-001	N/A
ft_prior [name]	Prior row number	87	int
ft_prior [q0]	FTprior quaternion q0	-1.6247706156225429E-006	N/A
ft_prior [q1]	FTprior quaternion q1	-9.6996521888884340E-004	N/A
ft_prior [q2]	FTprior quaternion q2	-1.6750781782660256E-003	N/A
ft_prior [q3]	FTprior quaternion q3	+9.9999812663721077E-001	N/A
ntable [NF]	ntable row number	87	int
ntable [iprime]	Prime frame indication flag	1	int
ntable [SIG_CX]	CX Sigma	+1.0000000000000001E-001	pixel
ntable [SIG_CY]	CY Sigma	+1.0000000000000001E-001	pixel
ntable [PIX2RADX]	Nom. angular pixelsize X-dir	+7.7399898172000000E-005	rad/pixel
ntable [PIX2RADY]	Nom. angular pixelsize Y-dir	+8.7086140999000005E-005	rad/pixel
ntable [CX0]	Center pixel along X-axis	+1.0500000000000000E+001	pixel
ntable [CY0]	Center pixel along Y-axis	+2.0000000000000000E+000	pixel
ntable [BETA0]	Nominal mirror scale factor	+2.8047410000000001E-006	rad/(e.u.)
ntable [GAMMA_E0]	Reference Mirror position	+2.0070000000000000E+003	(e.u.[6])

Table 2.1: FLUTE Parameter Table (1)

[6]encoder units

NAME	DESCRIPTION	VALUE	UNIT
ntable [D11]	x-to-w frame flip parameter	-1	int
ntable [D12]	y-to-w frame flip parameter	0	int
ntable [D21]	x-to-v frame flip parameter	0	int
ntable [D22]	y-to-v frame flip parameter	-1	int
ntable [DG]	Mirror flip parameter	1	int
ntable [sisizew]	Array size (w-direction)	+1.5417075059283244E-003	pixel
ntable [sisizev]	Array size (v-direction)	+2.3271056693257729E-004	pixel
ntable [p2i_w]	w-offset from prime	+0.0000000000000000E+000	pixel
ntable [p2i_v]	v-offset from prime	+0.0000000000000000E+000	pixel
p1true [a00]	True Constant Plate Scales	+1.0000000000000001E-001	N/A
p1true [b00]	True Constant Plate Scales	+1.0000000000000001E-001	N/A
p1true [c00]	True Constant Plate Scales	+1.0000000000000000E-002	N/A
p1true [a10]	True Γ Dependent Plate Scales	+1.0000000000000001E-001	1/rad
p1true [b10]	True Γ Dependent Plate Scales	+1.0000000000000001E-001	1/rad
p1true [c10]	True Γ Dependent Plate Scales	+1.0000000000000000E-002	1/rad
p1true [d10]	True Γ Dependent Plate Scales	+1.0000000000000000E-002	1/rad
p1true [a20]	True Γ^2 Dependent Plate Scales	+1.0000000000000001E-001	$1/\mathrm{rad}^2$
p1true [b20]	True Γ^2 Dependent Plate Scales	+1.0000000000000001E-001	$1/\mathrm{rad}^2$
p1true [c20]	True Γ^2 Dependent Plate Scales	+1.0000000000000000E-002	$1/\mathrm{rad}^2$
p1true [d20]	True Γ^2 Dependent Plate Scales	+1.0000000000000000E-002	$1/\mathrm{rad}^2$
p1true [a01]	True Linear Plate Scales	+2.0000000000000000E+000	N/A
p1true [b01]	True Linear Plate Scales	+2.0000000000000000E+000	N/A
p1true [c01]	True Linear Plate Scales	+2.0000000000000000E+000	N/A
p1true [d01]	True Linear Plate Scales	+2.0000000000000000E+000	N/A
p1true [e01]	True Linear Plate Scales	+2.0000000000000000E+000	N/A
p1true [f01]	True Linear Plate Scales	+2.0000000000000000E+000	N/A
p2true [am1]	True Scan mirror alignment Ux	+0.0000000000000000E+000	N/A
p2true [am2]	True Scan mirror alignment Uy	+2.0000000000000000E-002	N/A
p2true [am3]	True Scan mirror alignment Uz	+9.9979997999599901E-001	N/A
p2true [beta]	True Scan mirror scale factor	+1.1000000000000001E+000	N/A
p2true [qT1]	True IPF q1	-1.6247706156225429E-006	N/A
p2true [qT2]	True IPF q2	-9.6996521888884340E-004	N/A
p2true [qT3]	True IPF q3	-1.6750781782660256E-003	N/A
p2true [qT4]	True IPF q4	+9.9999812663721077E-001	N/A
p2true [qR01]	True Boresight Alignment q1	+4.8481368053692367E-005	N/A
p2true [qR02]	True Boresight Alignment q2	+2.4240684026846184E-006	N/A
p2true [qR03]	True Boresight Alignment q3	+2.4240684026846184E-006	N/A
p2true [qR04]	True Boresight Alignment q4	+9.9999999881890234E-001	N/A
p2true [brx]	True B. Alignment drift rate X	+5.6000000000000000E-011	rad/sec
p2true [bry]	True B. Alignment drift rate Y	+5.6000000000000000E-011	rad/sec
p2true [brz]	True B. Alignment drift rate Z	+5.6000000000000000E-011	rad/sec
p2true [crx]	True B. Alignment drift accel. X	+5.0000000000000002E-014	$\mathrm{rad/sec}^2$
p2true [cry]	True B. Alignment drift accel. Y	+5.0000000000000002E-014	$\mathrm{rad/sec}^2$
p2true [crz]	True B. Alignment drift accel. Z	+5.0000000000000002E-014	$\mathrm{rad/sec}^2$
p2true [bgx]	True Gyro bias correction X	+2.5000000000000002E-006	rad/sec
p2true [bgy]	True Gyro bias correction Y	+2.5000000000000002E-006	rad/sec
p2true [bgz]	True Gyro bias correction Z	+2.5000000000000002E-006	rad/sec
p2true [cgx]	True Gyro bias-rate correction X	+9.9999999999999998E-013	$\mathrm{rad/sec}^2$
p2true [cgy]	True Gyro bias-rate correction Y	+9.9999999999999998E-013	$\mathrm{rad/sec}^2$
p2true [cgz]	True Gyro bias-rate correction Z	+9.9999999999999998E-013	$\mathrm{rad/sec}^2$

Table 2.2: FLUTE Parameter Table (2)

NAME	DESCRIPTION	VALUE	UNIT
p2cmd [am1]	CMD Scan mirror alignment Ux	+0.0000000000000000E+000	N/A
p2cmd [am2]	CMD Scan mirror alignment Uy	+0.0000000000000000E+000	N/A
p2cmd [am3]	CMD Scan mirror alignment Uz	+1.0000000000000000E+000	N/A
p2cmd [beta]	CMD Scan mirror rotation SF	+1.0000000000000000E+000	N/A
p2cmd [qT1]	CMD IPF q1	-1.6247706156225429E-006	N/A
p2cmd [qT2]	CMD IPF q2	-9.6996521888884340E-004	N/A
p2cmd [qT3]	CMD IPF q3	-1.6750781782660256E-003	N/A
p2cmd [qT4]	CMD IPF q4	+9.9999812663721077E-001	N/A
p2cmd [qR01]	CMD Boresight Alignment q1	+0.0000000000000000E+000	N/A
p2cmd [qR02]	CMD Boresight Alignment q2	+0.0000000000000000E+000	N/A
p2cmd [qR03]	CMD Boresight Alignment q3	+0.0000000000000000E+000	N/A
p2cmd [qR04]	CMD Boresight Alignment q4	+1.0000000000000000E+000	N/A
p2cmd [brx]	CMD B. Alignment drift rate X	+0.0000000000000000E+000	rad/sec
p2cmd [bry]	CMD B. Alignment drift rate Y	+0.0000000000000000E+000	rad/sec
p2cmd [brz]	CMD B. Alignment drift rate Z	+0.0000000000000000E+000	rad/sec
p2cmd [crx]	CMD B. Alignment drift accel. X	+0.0000000000000000E+000	rad/sec^2
p2cmd [cry]	CMD B. Alignment drift accel. Y	+0.0000000000000000E+000	rad/sec^2
p2cmd [crz]	CMD B. Alignment drift accel. Z	+0.0000000000000000E+000	rad/sec^2
p2cmd [bgx]	CMD Gyro bias correction X	+0.0000000000000000E+000	rad/sec
p2cmd [bgy]	CMD Gyro bias correction Y	+0.0000000000000000E+000	rad/sec
p2cmd [bgz]	CMD Gyro bias correction Z	+0.0000000000000000E+000	rad/sec
p2cmd [cgx]	CMD Gyro bias-rate correction X	+0.0000000000000000E+000	rad/sec^2
p2cmd [cgy]	CMD Gyro bias-rate correction Y	+0.0000000000000000E+000	rad/sec^2
p2cmd [cgz]	CMD Gyro bias-rate correction Z	+0.0000000000000000E+000	rad/sec^2
a1	Semi-Major Axis of SIRTF (HCO [7])	+1.4960000000000000E+011	m
a2	Semi-Major Axis of Earth (HCO)	+1.4960000000000000E+011	m
e1	Eccentricity (SIRTF in HCO)	+1.6722000000000001E-002	N/A
e2	Eccentricity (Earth in HCO)	+1.6722000000000001E-002	N/A
inc1	inclination (SIRTF in HCO)	+4.0142572795869580E-001	rad
inc2	inclination (Earth in HCO)	+4.0142572795869580E-001	rad
Omega1	Ascending Node Long.(SIRTF in HCO)	+0.0000000000000000E+000	rad
Omega2	Ascending Node Long.(Earth in HCO)	+0.0000000000000000E+000	rad
omega1	Argument of Perigee(SIRTF in HCO)	+1.7627825445142729E+000	rad
omega2	Argument of Perigee(Earth in HCO)	+1.7627825445142729E+000	rad
nu0_1	True Anomaly of SIRTF(HCO)	+8.6071031605199810E-001	rad
nu0_2	True Anomaly of Earth(HCO)	+1.0328523792623976E+000	rad
inav	Velocity Report Flag	+0.0000000000000000E+000	rad
wsize	Array size W-dir	+1.5417075059283244E-003	rad
vsize	Array size V-dir	+2.3271056693257729E-004	rad

Table 2.3: FLUTE Parameter Table (3)

[7] Heliocentric Orbit

2.2 FLUTE GENERATED UNIT TEST DATA

This subsection plots the FLUTE generated IPF filter input files. Seven figures, as tabulated in Table 2.4, show the campaign maneuver senario, the true sampled locations on the array and the actual centroided data superimposed the array plane. All angles shown in FLUTE plots have units of radians.

FIGURE NO.	DESCRIPTION
Figure 2.1	Focal Plane Survey Scenario Plot
Figure 2.2	Commanded-only source locations in TPF
Figure 2.3	True and commanded source locations in TPF
Figure 2.4	True and commanded source locations (ZOOMED) in TPF
Figure 2.5	True-sampled and centroided locations in Focal Plane (W,V) including rectangular array boundary approximation
Figure 2.6	True and centroided locations on S/I Array (W,V) including rectangular array boundary approximation
Figure 2.7	True and centroided locations on S/I Array (W,V) showing Prime and Inferred Frames including rectangular array boundary approximation

Table 2.4: Table of figures (FLUTE)

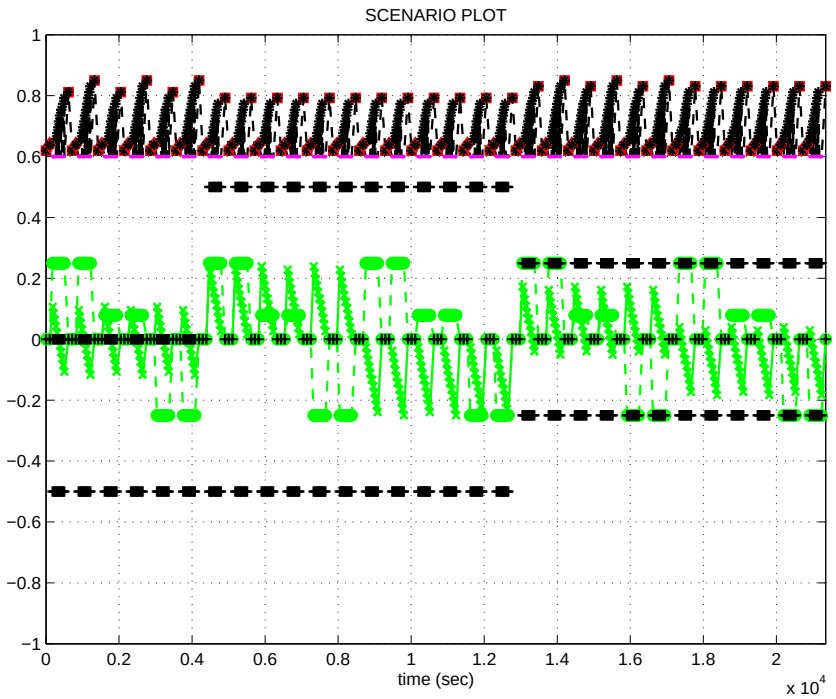

Figure 2.1: Focal plane survey scenario plot (See key in [3])

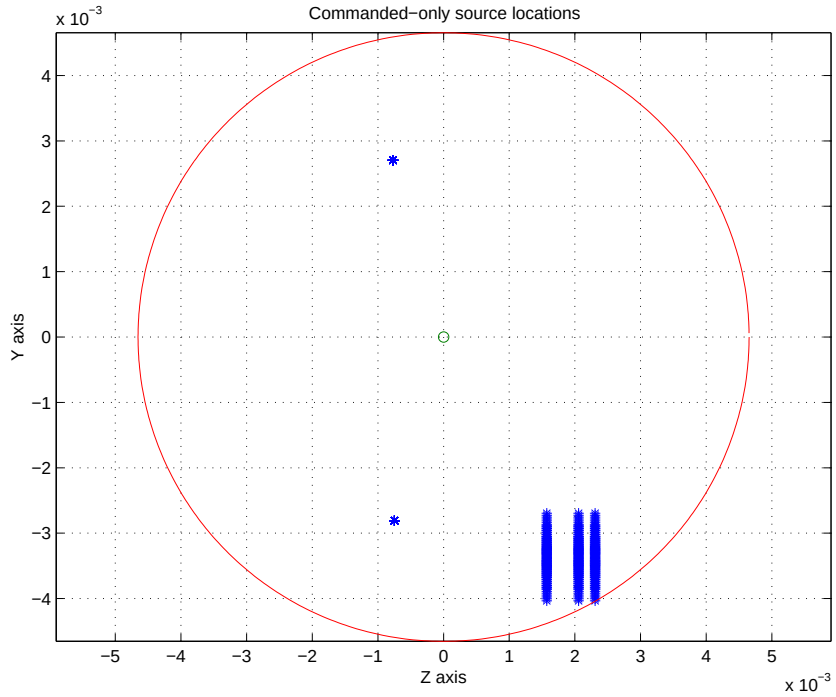

Figure 2.2: Commanded-only source locations

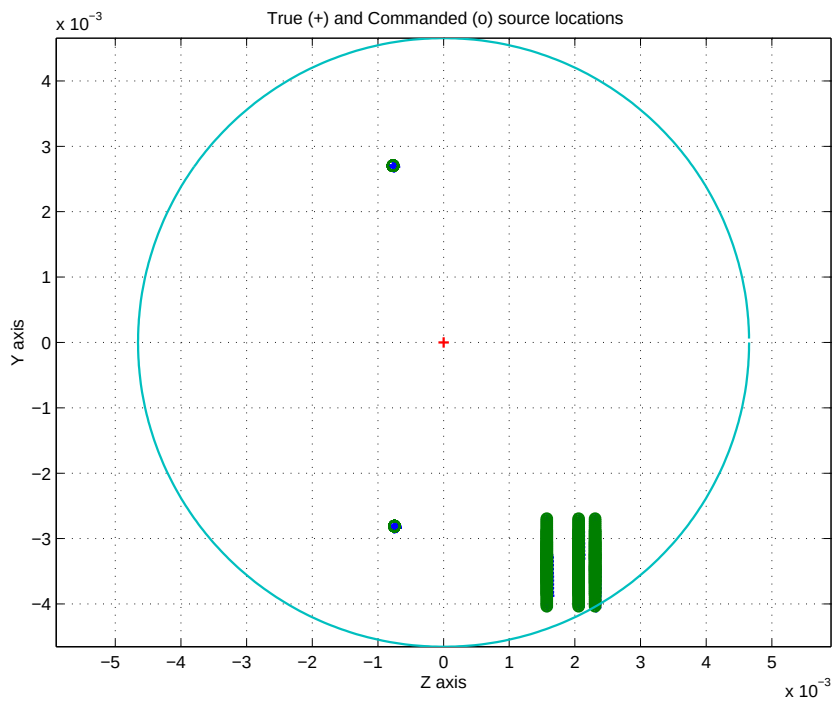

Figure 2.3: True (+) and commanded (o) source locations

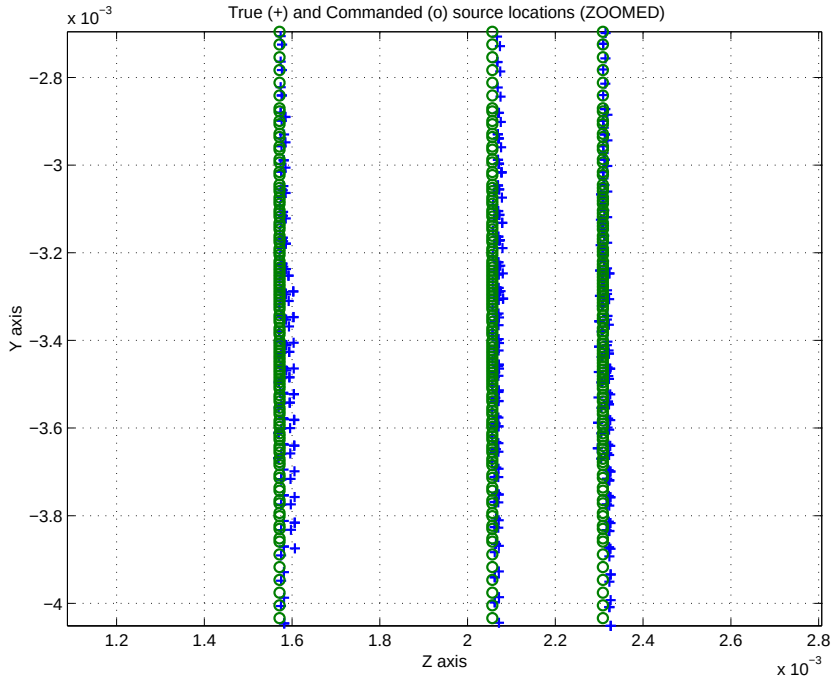

Figure 2.4: True (+) and commanded (o) source locations (ZOOMED)

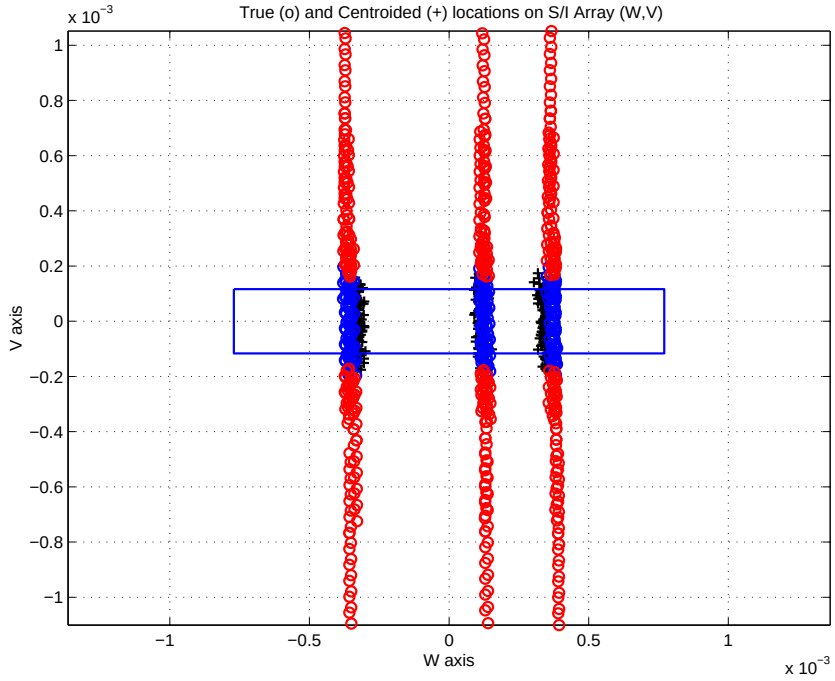

Figure 2.5: True-sampled (o) and centroided (+) locations on S/I array (W,V)

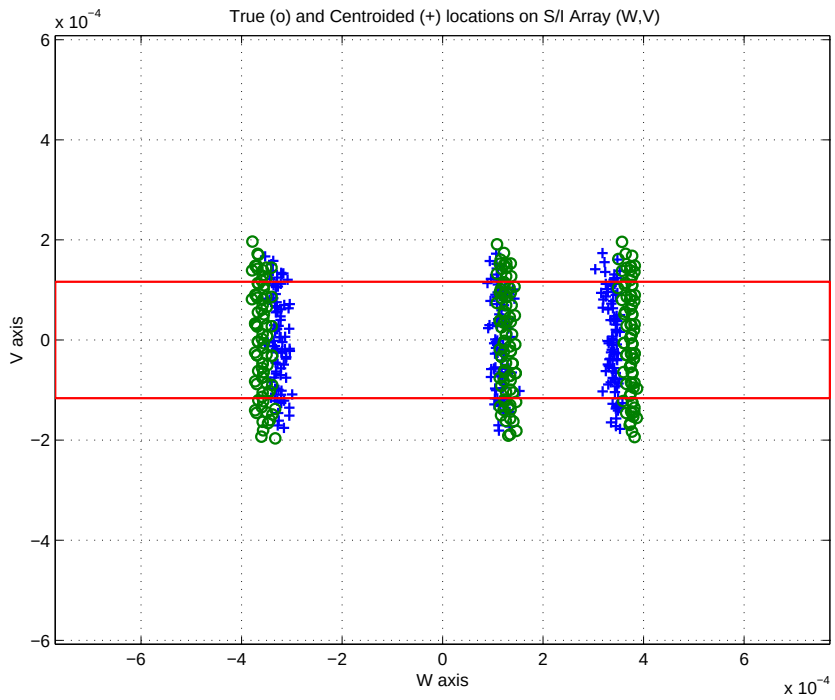

Figure 2.6: True (o) and centroided (+) locations on S/I array (W,V)

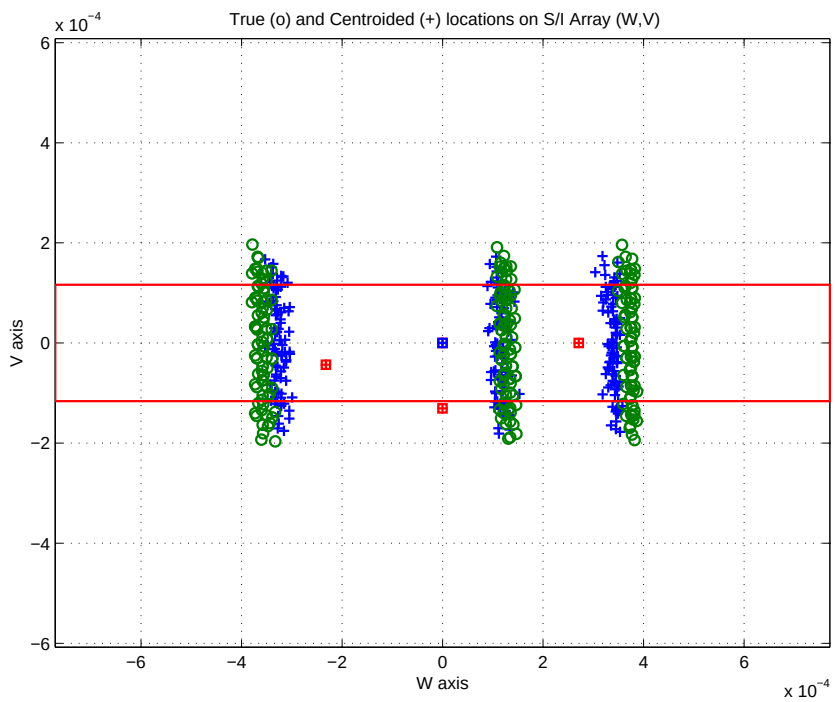

Figure 2.7: True (o) and centroided (+) locations on S/I array (W,V) showing prime and inferred frames

3 IPF EXECUTION RESULTS

3.1 IPF EXECUTION OUTPUT PLOTS

This subsection summarizes the IPF filter results. As shown in Table 3.1, the output plots are segmented to three groups: predicted performance, post-run results and IPF trending plots.

FIGURE NO.	DESCRIPTION
Predicted performance prior to IPF run	
Figure 3.1	Meas. and a-priori predicts in TPF coords
Figure 3.2	Meas. and a-priori predicts in Oriented Pixel Coords including rectangular array boundary approximation
Figure 3.3	A-priori prediction error
Figure 3.4	Oriented Pixel Coords of measurements and a-priori predicts (PCRS only)
IPF filter performance (post run results)	
Figure 3.5	IPF execution convergence, chart 1: (top) normalized residual error vs. iteration number and (bottom) norm of effective parameter corrections
Figure 3.6	IPF execution convergence, chart 2: parameter correction size vs. iteration number
Figure 3.7	Parameter uncertainty convergence: square-root of diagonal elements of covariance matrix vs. maneuver number
Figure 3.8	IPF parameter symbol table
Figure 3.9	KF parameter error sigma plot (a-priori-dashed, a-posteriori-solid). Includes true parameter errors (FLUTE runs only)
Figure 3.10	LS parameter error sigma plot. Includes true parameter errors (FLUTE runs only)
Figure 3.11	KF and LS parameter errors sigma plot (Figure 3.9 & Figure 3.10 combined)
Figure 3.12	Measurements and a-posteriori predicts in Oriented Pixel Coords including rectangular array boundaries (a-priori-dashed, a-posteriori-solid)
Figure 3.13	Attitude corrected meas. and a-posteriori predicts in Oriented Pixel Coords including rectangular array boundaries (a-priori-dashed, a-posteriori-solid)
Figure 3.14	Array plot with (solid) and w/o (dashed) optical distortion corrections
Figure 3.15	KF innovations with (o) and w/o (+) attitude corrections
Figure 3.16	W-axis KF innovations and 1-sigma bound
Figure 3.17	V-axis KF innovations and 1-sigma bound
IPF parameter trending plots	
Figure 3.18	Estimated attitude corrections (Body frame)
Figure 3.19	Estimated attitude error sigma plot (Body frame)
Figure 3.20	Systematic error attributed to thermo-mechanical boresight drift (equiv. angle in (W,V) coords)
Figure 3.21	Systematic error attributed to thermo-mechanical boresight drift (equiv. angle in Body frame)
Figure 3.22	Systematic error attributed to gyro drift bias (equiv. rate in (W,V) coords)
Figure 3.23	Systematic error attributed to gyro drift bias (equiv. angle in (W,V) coords)
Figure 3.24	Systematic error attributed to gyro drift bias (equiv. angle in Body frame)

Table 3.1: Table of figures (IPF run)

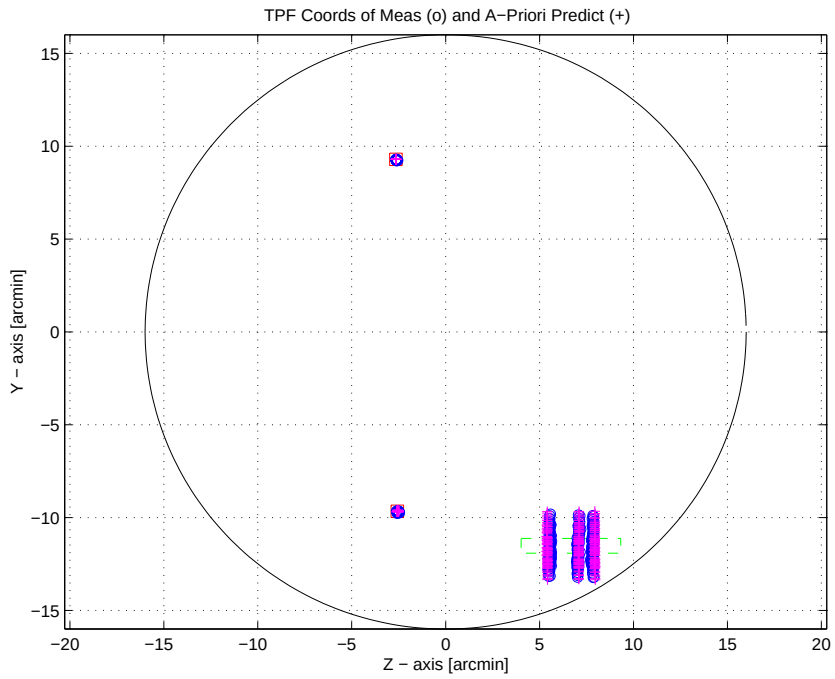

Figure 3.1: TPF coords of measurements and a-priori predicts

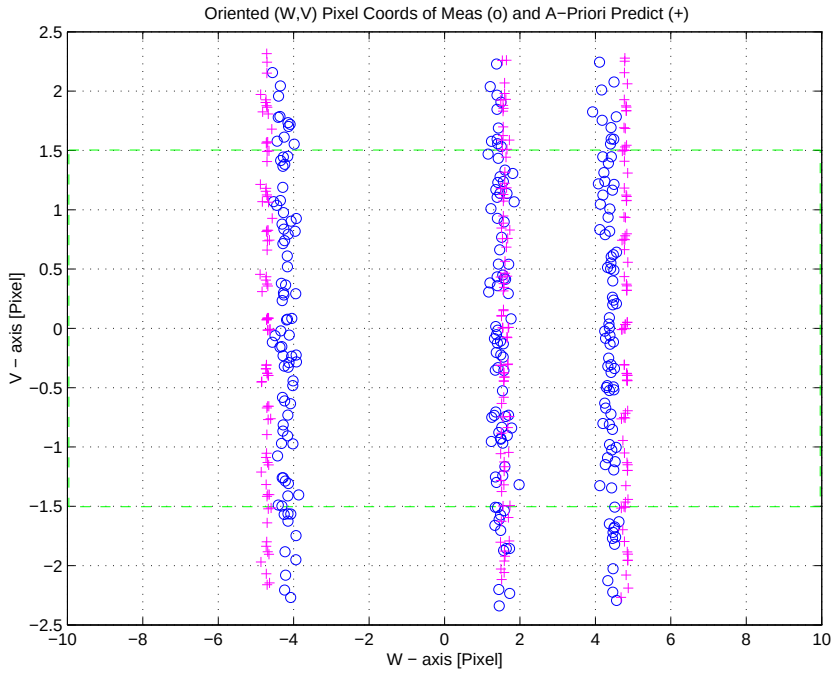

Figure 3.2: Oriented Pixel Coords of measurements and a-priori predicts

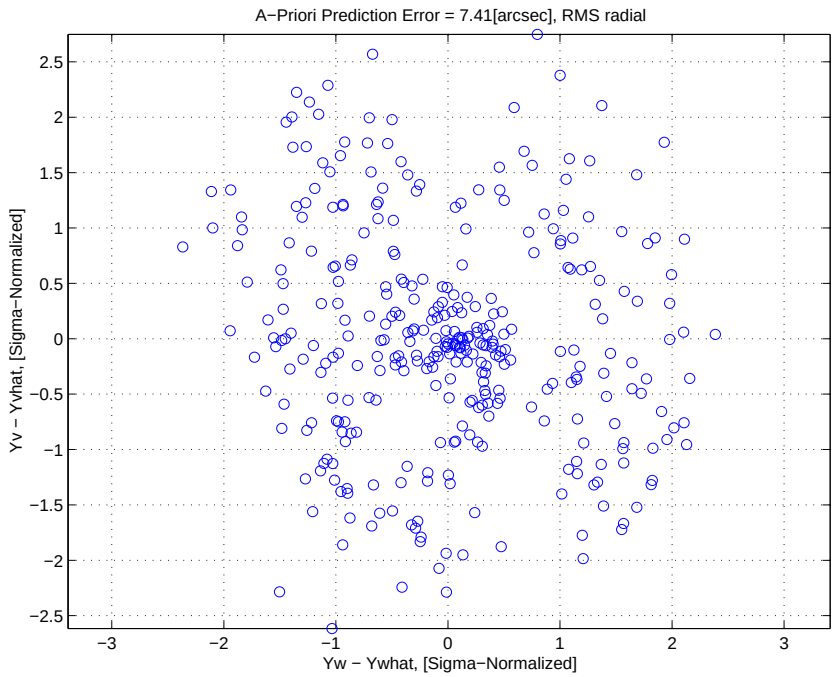

Figure 3.3: A-priori prediction error

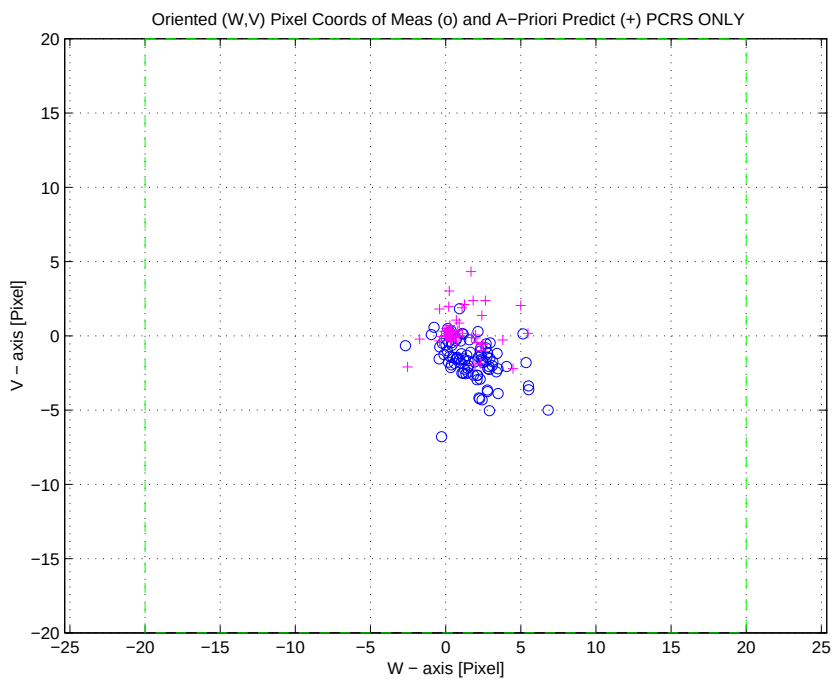

Figure 3.4: Oriented Pixel Coords of measurements and a-priori predicts (PCRS only)

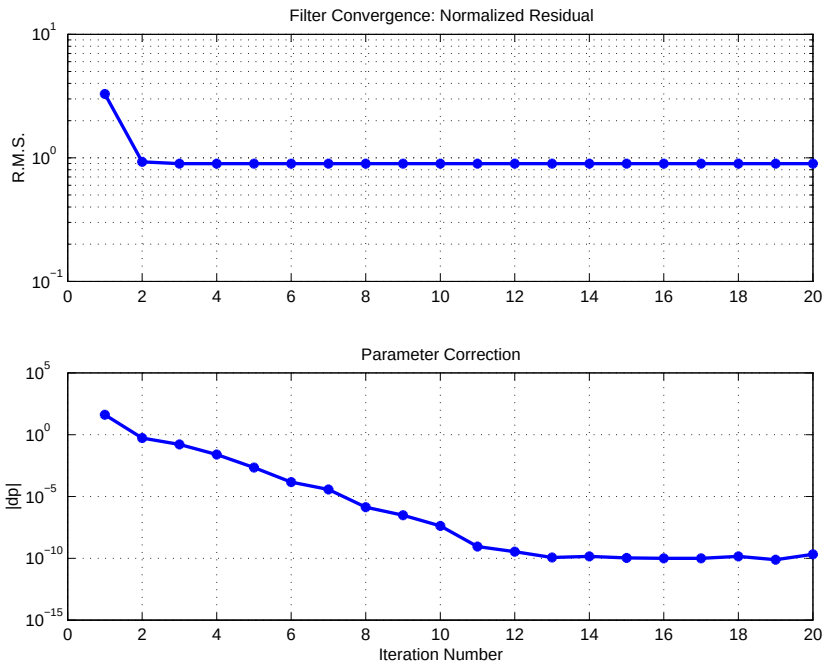

Figure 3.5: IPF execution convergence, chart 1

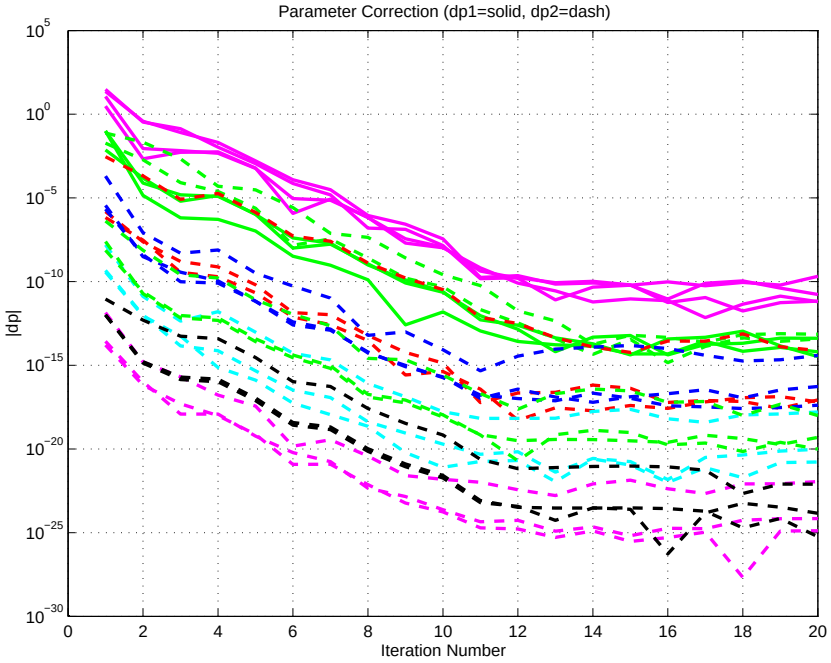

Figure 3.6: IPF execution convergence, chart 2

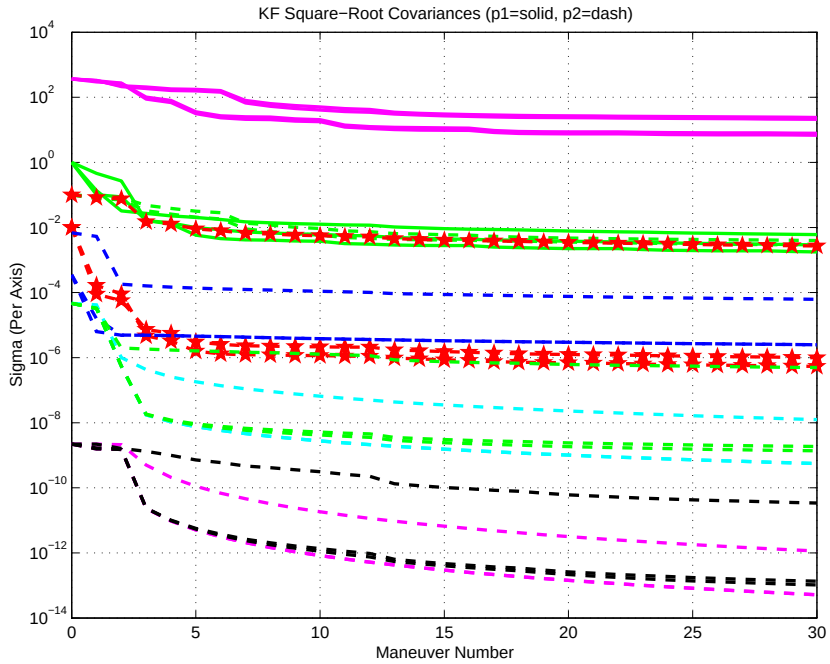

Figure 3.7: Parameter uncertainty convergence

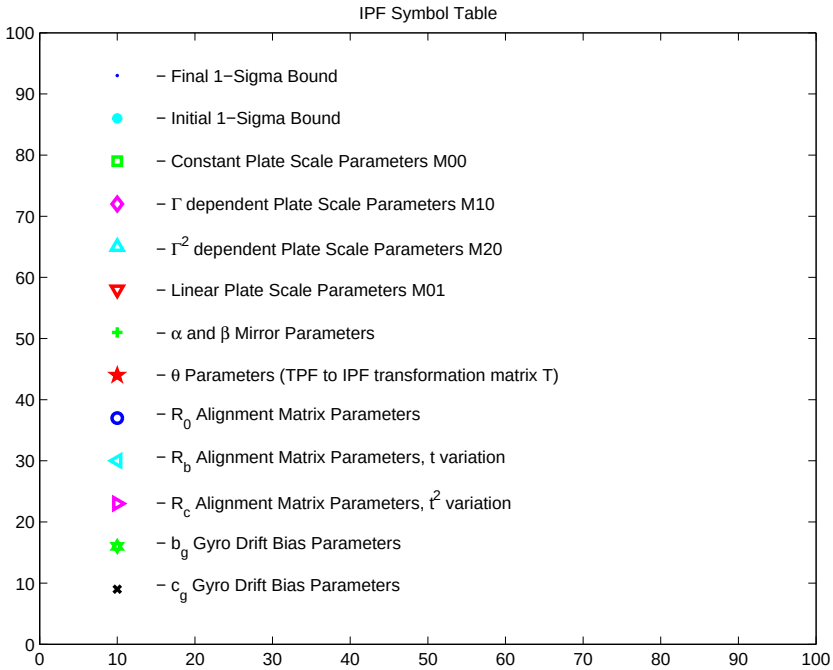

Figure 3.8: IPF parameter symbol table

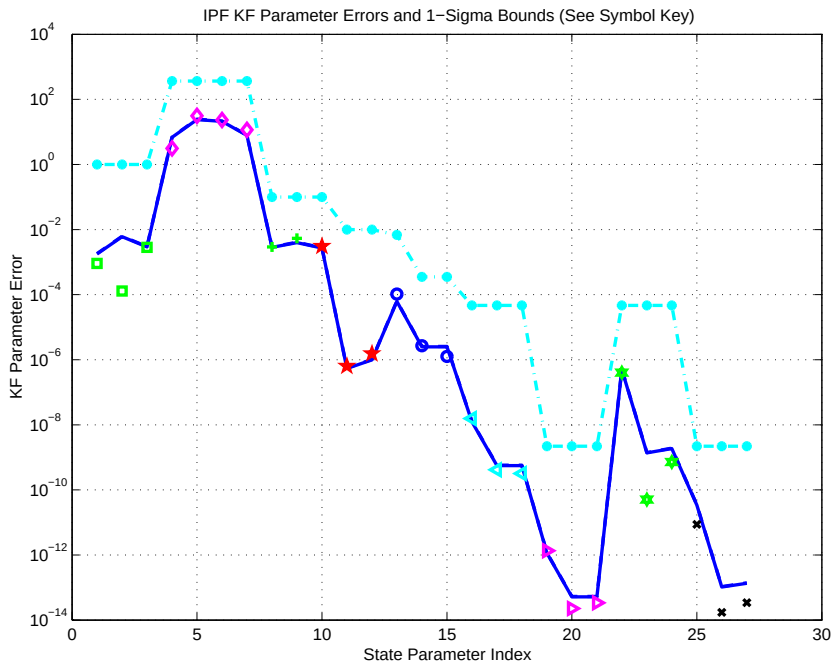

Figure 3.9: KF parameter error sigma plots

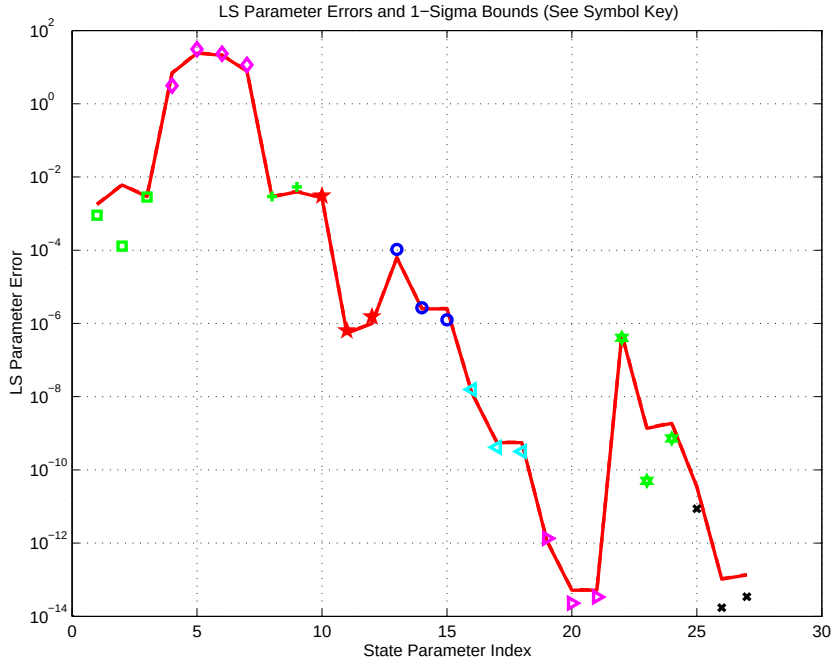

Figure 3.10: LS parameter error sigma plot

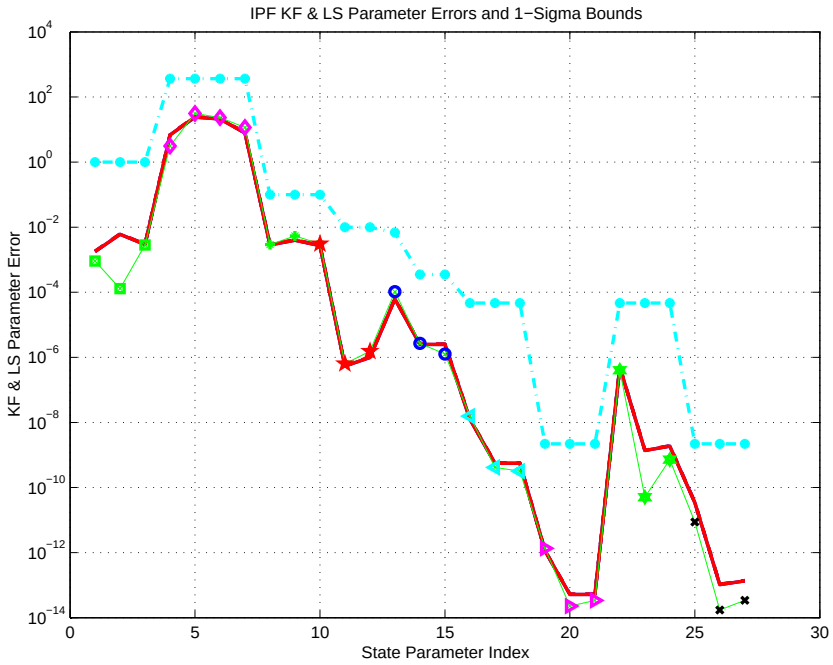

Figure 3.11: KF and LS parameter error sigma plot

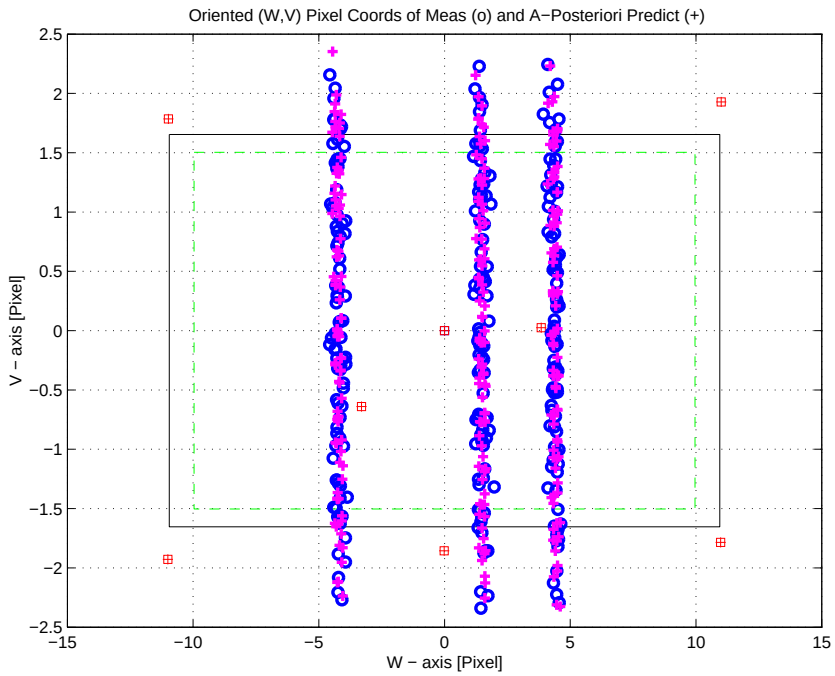

Figure 3.12: Oriented Pixel Coords of meas. and a-posteriori predicts

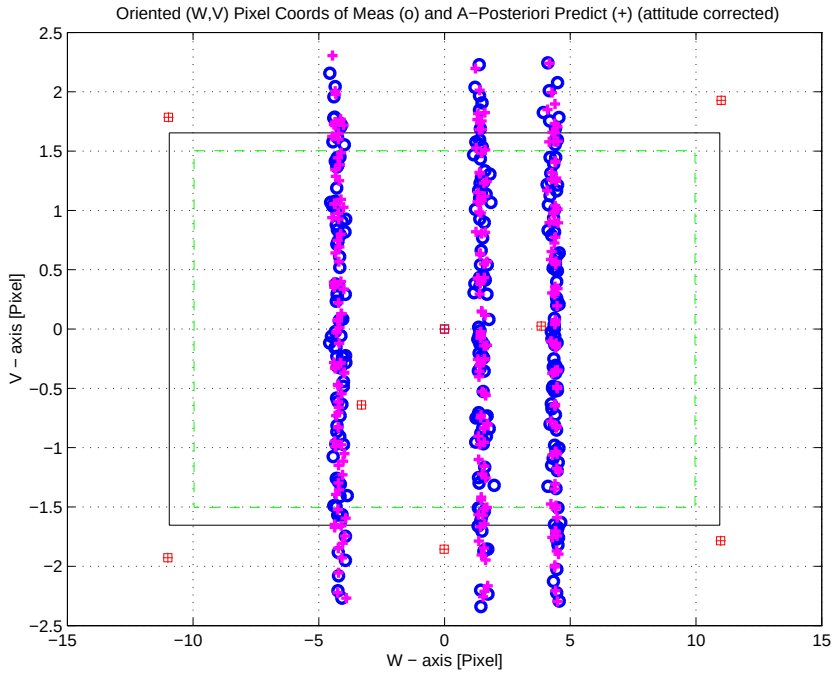

Figure 3.13: Oriented Pixel Coords of meas. and a-posteriori predicts (attitude corrected)

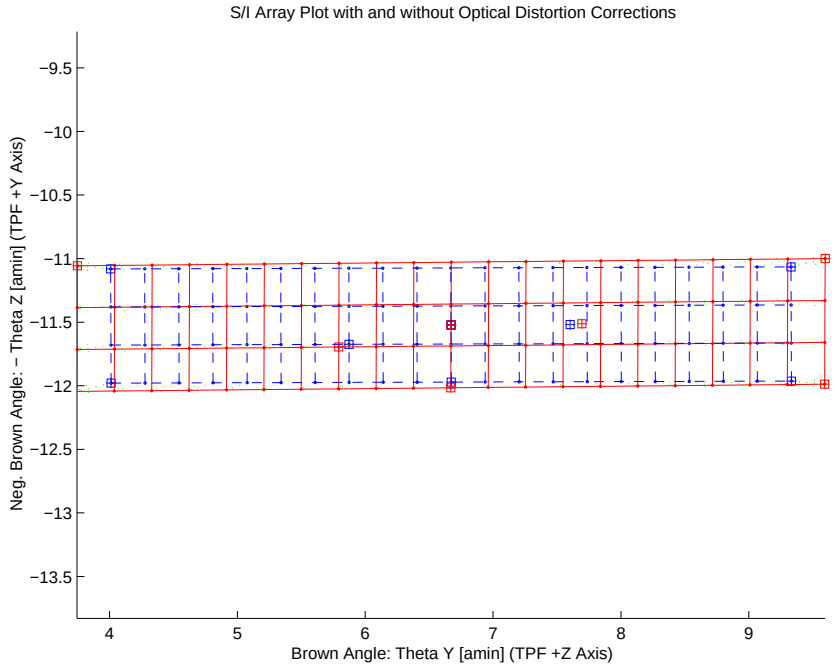

Figure 3.14: Array plot with (solid) and w/o (dashed) optical distortion corrections

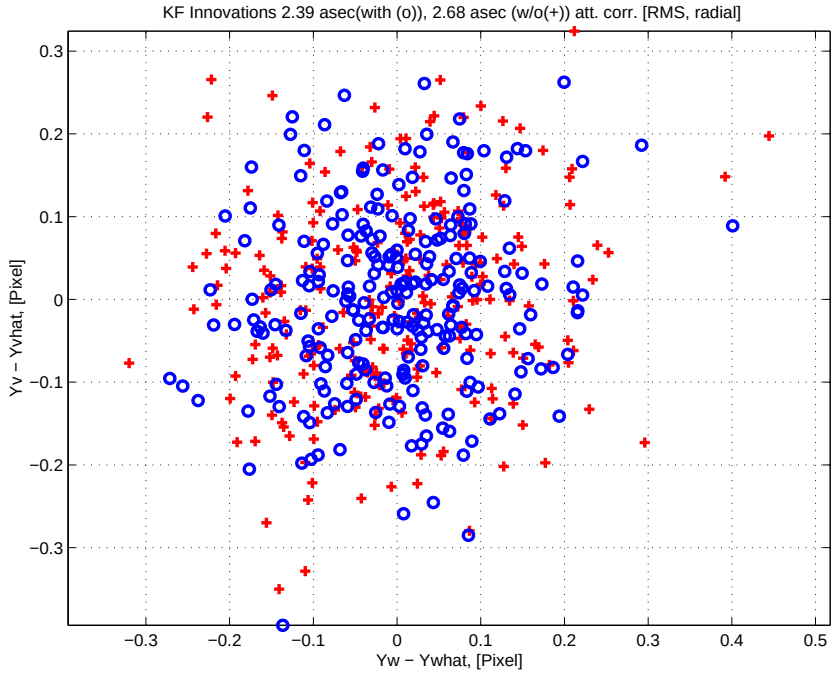

Figure 3.15: KF innovations with (o) and w/o (+) attitude corrections

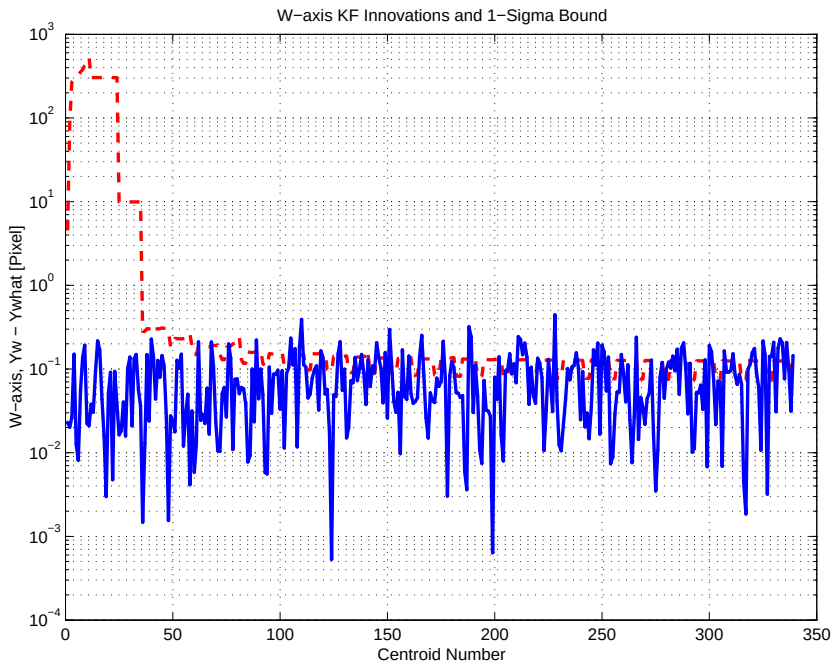

Figure 3.16: W-axis KF innovations and 1-sigma bound

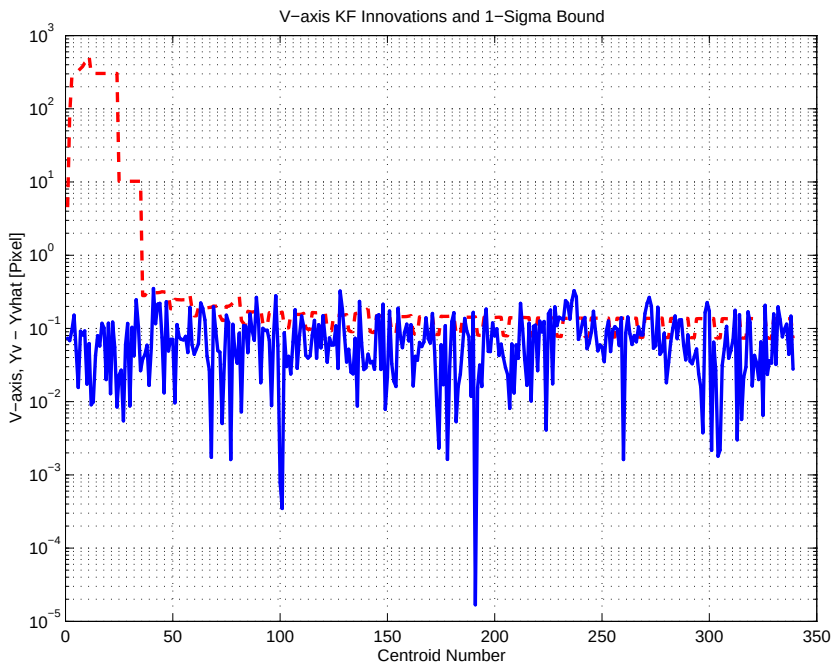

Figure 3.17: V-axis KF innovations and 1-sigma bound

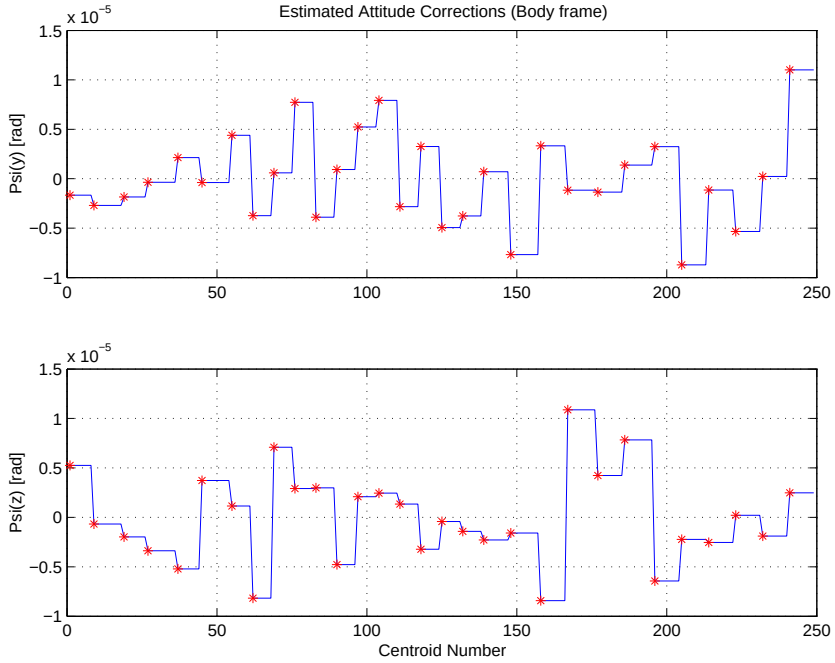

Figure 3.18: Estimated attitude corrections (Body frame)

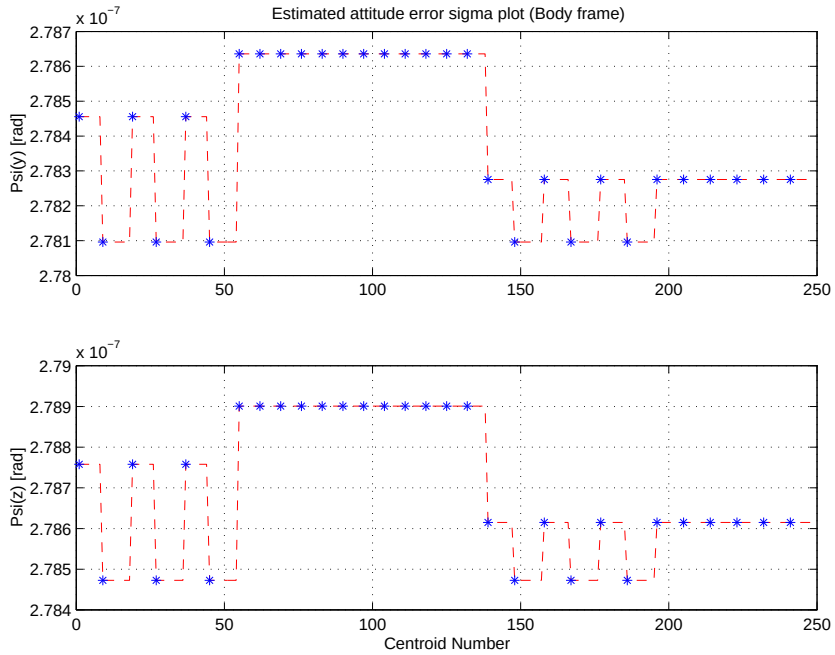

Figure 3.19: Estimated attitude error sigma plot (Body frame)

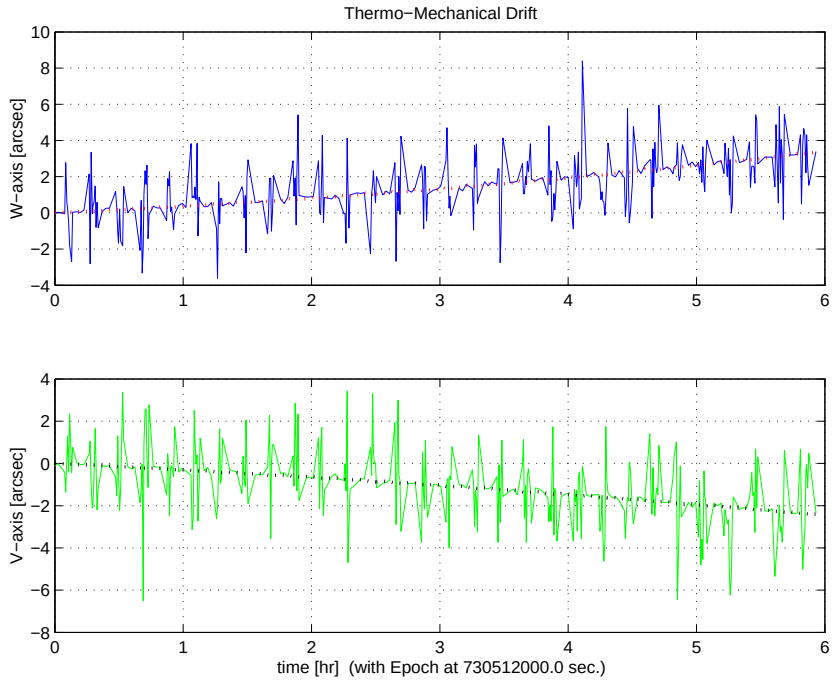

Figure 3.20: Thermo-mechanical boresight drift (equiv. angle in (W,V) coords)

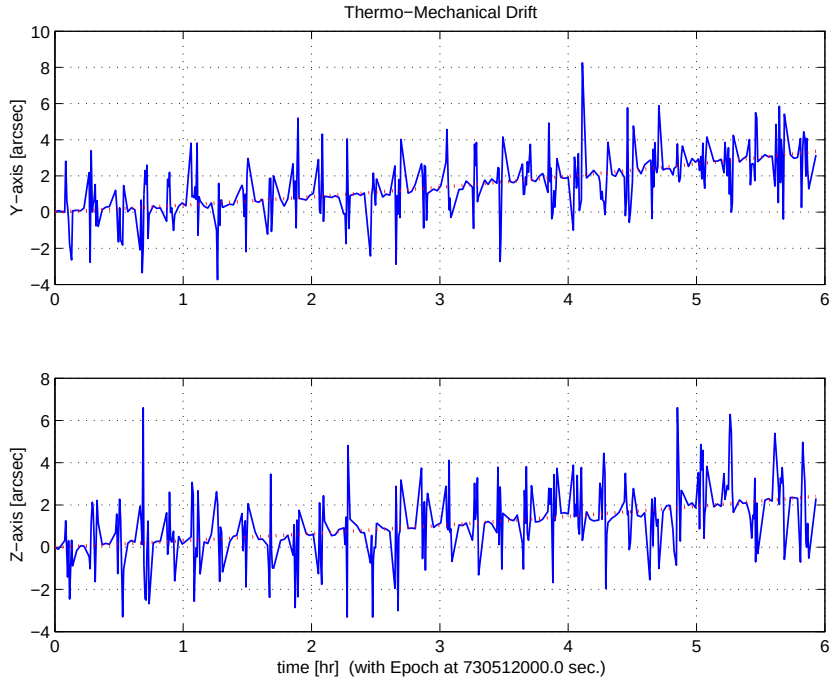

Figure 3.21: Thermo-mechanical boresight drift (equiv. angle in Body frame)

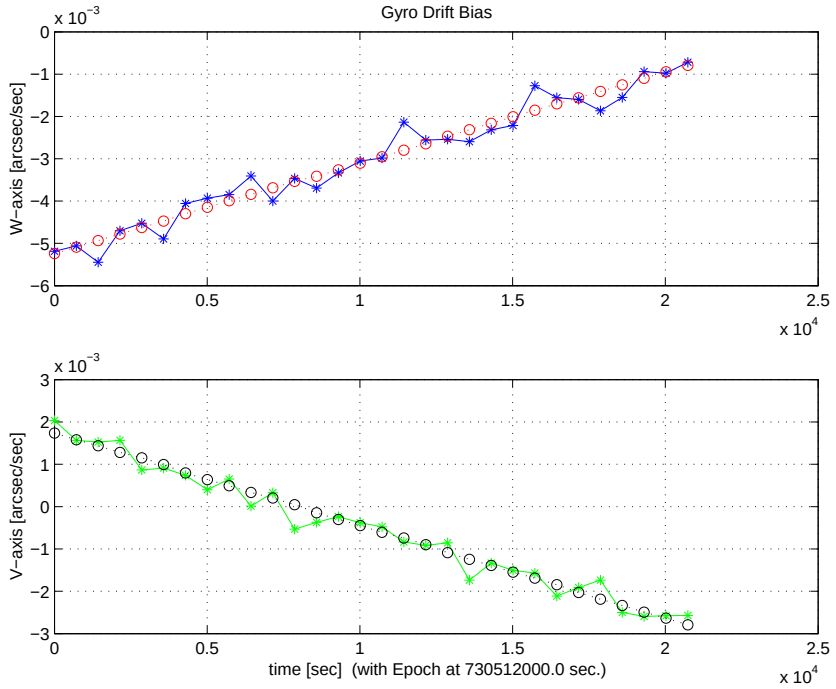

Figure 3.22: Gyro drift bias contribution (equiv. rate in (W,V) coords)

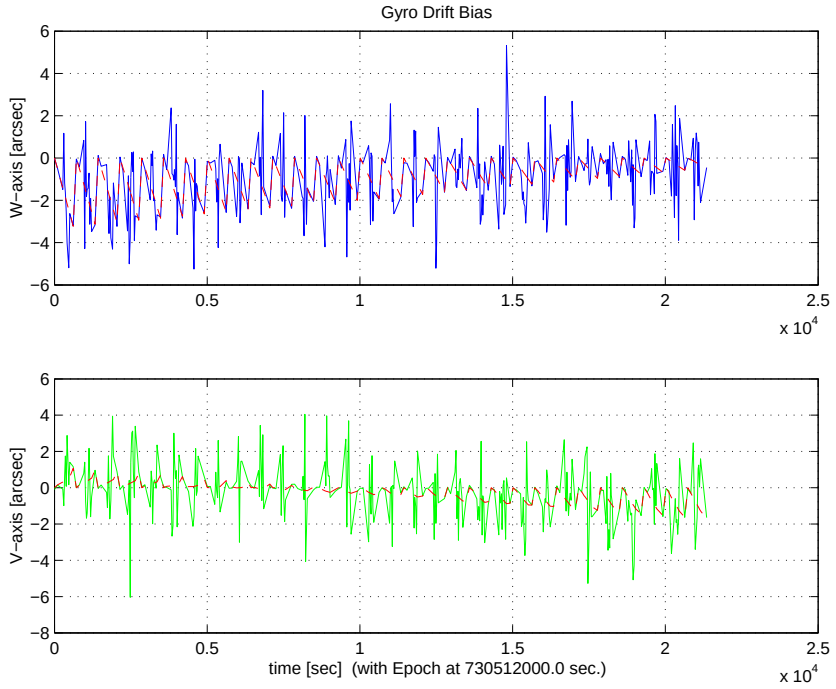

Figure 3.23: Gyro drift bias contribution (equiv. angle in (W,V) coords)

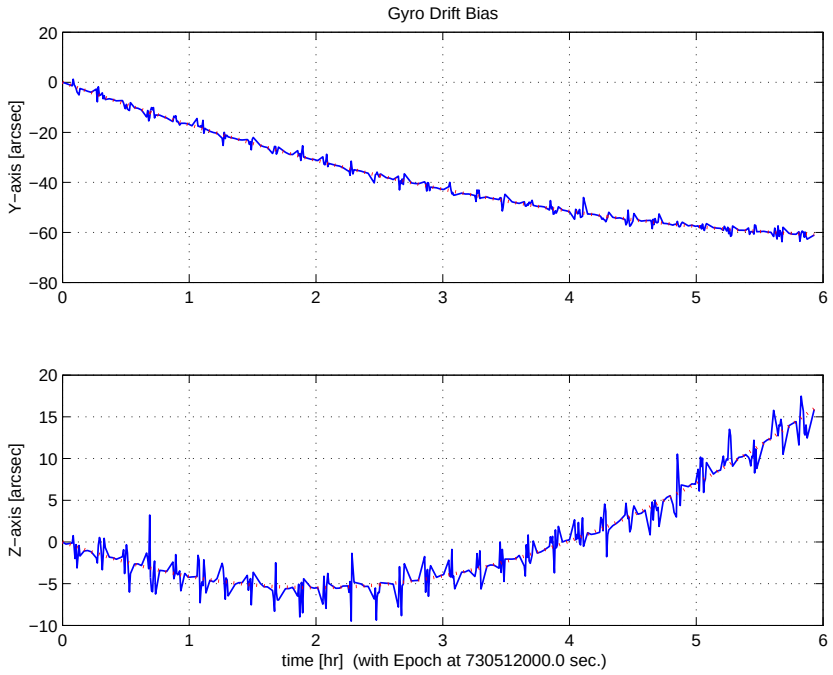

Figure 3.24: Gyro drift bias contribution (equiv. angle in Body frame)

3.2 IPF OUTPUT DATA (IF MINI FILE)

```
OUTPUT FILE NAME: IFmini993087.dat   DATE: 07-Aug-2003   TIME: 11:16
INSTRUMENT NAME:  MIPS_160um_center_large_FOV   NF: 87
IPF FILTER VERSION: IPF.V2.0.1Beta       SW RELEASE DATE: August 5, 2003
-------------------------------------------------------------------------------
---------------------------- IPF BROWN ANGLE SUMMARY ---------------------------
-------------------------------------------------------------------------------
         ------------ WAS ------------           ------------ IS -------------
Frame    theta_Y     theta_Z     angle           theta_Y     theta_Z     angle
Number   (arcmin)    (arcmin)    (deg)           (arcmin)    (arcmin)    (deg)
------  --------------------------------       --------------------------------
 087     +6.669000 +11.517000   +0.000000        +6.671200 +11.522275   -0.176138
 088     +6.664000 +11.974000   +0.000000        +6.669496 +12.016203   -0.176138
 089     +6.669000 +11.517000   +0.000000        +6.671200 +11.522275   -0.176138
 091     +7.589000 +11.546000   +0.000000        +7.694744 +11.512445   -0.176138
 092     +5.879000 +11.626000   +0.000000        +5.793309 +11.695344   -0.176138
 001     +0.000000  +0.000000   +0.000000        +9.597314 +11.000260   -0.176138
 001     +0.000000  +0.000000   +0.000000        +9.593905 +11.988116   -0.176138
 001     +0.000000  +0.000000   +0.000000        +3.748496 +11.056436   -0.176138
 001     +0.000000  +0.000000   +0.000000        +3.745086 +12.044289   -0.176138
-------------------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  0              87            +0.000            +0.000     pixels
OFFSET FRAME NAME: MIPS_160um_center_large_FOV
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
WAS(FTB)            +6.669000       +11.517000       +0.000000
IS (EST)            +6.671200       +11.522275       -0.176138
dT_EST              +0.002200        +0.005275       -0.176138
T_sSIGMA            +0.001902        +0.003495       +0.158554
dT_EST/T_sSIGMA     +1.157093        +1.509292       -1.110904
-------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  1              88            +0.000            -1.500     pixels
OFFSET FRAME NAME: MIPS_160um_plusY_edge
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
WAS(FTB)            +6.664000       +11.974000       +0.000000
IS (EST)            +6.669496       +12.016203       -0.176138
dT_EST              +0.005496        +0.042203       -0.176138
T_sSIGMA            +0.003133        +0.004684       +0.158554
dT_EST/T_sSIGMA     +1.754200        +9.009219       -1.110904
-------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  2              89            +0.000            +0.000     pixels
OFFSET FRAME NAME: MIPS_160um_large_only
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
WAS(FTB)            +6.669000       +11.517000       +0.000000
IS (EST)            +6.671200       +11.522275       -0.176138
dT_EST              +0.002200        +0.005275       -0.176138
T_sSIGMA            +0.001902        +0.003495       +0.158554
dT_EST/T_sSIGMA     +1.157093        +1.509292       -1.110904
-------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  3              91            +3.500            +0.000     pixels
OFFSET FRAME NAME: MIPS_160um_small_FOV1
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
WAS(FTB)            +7.589000       +11.546000       +0.000000
IS (EST)            +7.694744       +11.512445       -0.176138
dT_EST              +0.105744        -0.033555       -0.176138
T_sSIGMA            +0.002398        +0.003848       +0.158554
dT_EST/T_sSIGMA    +44.089241        -8.719404       -1.110904
-------------------------------------------------------------------
```

```
OFFSET           NF          Delta_CW          Delta_CV
  4              92            -3.000            -0.500     pixels
OFFSET FRAME NAME: MIPS_160um_small_FOV2
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
WAS(FTB)            +5.879000       +11.626000       +0.000000
IS (EST)            +5.793309       +11.695344       -0.176138
dT_EST              -0.085691        +0.069344       -0.176138
T_sSIGMA            +0.002660        +0.004228       +0.158554
dT_EST/T_sSIGMA    -32.209222       +16.401465       -1.110904
-------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  5               1           +10.000            +1.500     pixels
OFFSET FRAME NAME: CORNER PIXEL (DIAGNOSTICS)
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
WAS(FTB)            +0.000000        +0.000000       +0.000000
IS (EST)            +9.597314       +11.000260       -0.176138
dT_EST              +9.597314       +11.000260       -0.176138
T_sSIGMA            +0.005695        +0.006912       +0.158554
dT_EST/T_sSIGMA    +1685.344801       +1591.423592       -1.110905
-------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  6               1           +10.000            -1.500     pixels
OFFSET FRAME NAME: CORNER PIXEL (DIAGNOSTICS)
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
WAS(FTB)            +0.000000        +0.000000       +0.000000
IS (EST)            +9.593905       +11.988116       -0.176138
dT_EST              +9.593905       +11.988116       -0.176138
T_sSIGMA            +0.005523        +0.006977       +0.158554
dT_EST/T_sSIGMA    +1737.205861       +1718.144652       -1.110905
-------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  7               1           -10.000            +1.500     pixels
OFFSET FRAME NAME: CORNER PIXEL (DIAGNOSTICS)
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
WAS(FTB)            +0.000000        +0.000000       +0.000000
IS (EST)            +3.748496       +11.056436       -0.176138
dT_EST              +3.748496       +11.056436       -0.176138
T_sSIGMA            +0.005938        +0.007241       +0.158554
dT_EST/T_sSIGMA    +631.256247       +1526.894508       -1.110905
-------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  8               1           -10.000            -1.500     pixels
OFFSET FRAME NAME: CORNER PIXEL (DIAGNOSTICS)
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
WAS(FTB)            +0.000000        +0.000000       +0.000000
IS (EST)            +3.745086       +12.044289       -0.176138
dT_EST              +3.745086       +12.044289       -0.176138
T_sSIGMA            +0.006016        +0.007690       +0.158554
dT_EST/T_sSIGMA    +622.518285       +1566.179491       -1.110905
-------------------------------------------------------------------
-------------------------------------------------------------------------------------
-------------------------------------------------------------------------------------
VARNAME             MEAN                      SIGMA                SCALED_SIGMA
a00        +9.9093787387408400E-002 +1.7729626711291723E-003 +1.8226356041253834E-003
b00        +9.9870232880146195E-002 +6.0589040835700696E-003 +6.2286558451127797E-003
c00        +7.1770868154121519E-003 +2.9154824740154667E-003 +2.9971652798306417E-003
a10        -3.0220098051935902E+000 +6.8409374975699189E+000 +7.0325994177453950E+000
b10        -3.0977771325526078E+001 +2.4045904862525205E+001 +2.4719596779743501E+001
c10        -2.3223211439057707E+001 +2.1116790970417711E+001 +2.1708418171626921E+001
d10        +1.1578958480035238E+001 +7.8015167243811758E+000 +8.0200911048965864E+000
del_alpha  +3.7082966905521708E-014 +2.8496740501891276E-003 +2.9295131074130081E-003
beta       +1.0946475528820658E+000 +3.9527447604768996E-003 +4.0634884489005509E-003
del_theta1 +7.4723213727700966E-015 +2.6918643477867148E-003 +2.7672820650121652E-003
del_theta2 -6.5491859562763456E-018 +5.3805982477113312E-007 +5.5313459766907998E-007
```

```
del_theta3 +8.4694295000365457E-018 +9.8898505947639599E-007 +1.0166933634320216E-006
del_arx    -3.8747928747962651E-015 +6.2192812898722501E-005 +6.3935263249353187E-005
del_ary    +5.3982256761463815E-017 +2.4971201007015007E-006 +2.5670816861682938E-006
del_arz    +4.1378088868964606E-018 +2.4945496779037563E-006 +2.5644392480701242E-006
brx        -1.5535171753232970E-008 +1.2497371347069659E-008 +1.2847509057051108E-008
bry        +4.7070412127910246E-010 +5.5712726310234669E-010 +5.7273624667605057E-010
brz        +3.7438862083171676E-010 +5.5630467323478889E-010 +5.7189061038341011E-010
crx        +1.4016460086928654E-012 +1.1404317708094875E-012 +1.1723831434247335E-012
cry        +2.7304870450535845E-014 +5.1918228073190930E-014 +5.3372816320510963E-014
crz        +1.6228946022112552E-014 +5.1839244681759816E-014 +5.3291620058626190E-014
bgx        -4.2749476557268999E-007 +4.9731724890448601E-007 +5.1125054078082285E-007
bgy        -2.4673873978396996E-008 +1.3684006684258147E-009 +1.4067390247948157E-009
bgz        -7.4130099148363303E-009 +1.8608730107974819E-009 +1.9130089197396204E-009
cgx        +9.7181291165003329E-012 +3.4064547805203959E-011 +3.5018931125410283E-011
cgy        +1.0172189437155128E-012 +1.0360256255265016E-013 +1.0650518607186730E-013
cgz        +1.0343354955741213E-012 +1.3495837236104281E-013 +1.3873948873575940E-013
-------------------------------------------------------------------------------
LSQF RESIDUAL SIGMA SCALE =         +1.0280169085368138E+000
-------------------------------------------------------------------------------
-------------------------------------------------------------------------------------------------------
-------------------------------------------------------------------------------------------------------
                    a_mirror(1)               a_mirror(2)               a_mirror(3)
a_mirror_ipf   +0.0000000000000000E+000  +1.7077924110123183E-002  +9.9985416161962781E-001
a_mirror_tpf   -1.8726255265146951E-003  +2.0157965681925034E-002  +9.9979505384513867E-001
beta                beta_0                    beta                      beta_total
               +2.8047410000000001E-006  +1.0946475528820658E+000  +3.0702028721179981E-006
-------------------------------------------------------------------------------------------------------
qT              qT(1)                     qT(2)                     qT(3)                     qT(4)
FrmTbl:   -1.6247706156225429E-006 -9.6996521888884340E-004 -1.6750781782660256E-003 +9.9999812663721077E-001
Estim:    -1.5387154440668037E-003 -9.6770815576549931E-004 -1.6773348579678026E-003 +9.9999694121706273E-001
DelTheta        deltheta(1)               deltheta(2)               deltheta(3)
          -3.0741887410667018E-003 -6.4002800146811948E-007 -1.5344840034470314E-006       [rad]
EulAngT         theta(1)                  theta(2)                  theta(3)                  [rad]
Mean      -3.0741857642660963E-003 -1.9405734915908810E-003 -3.3516939860958662E-003
SigmaT    +2.6918643477867148E-003 +5.3805982477113312E-007 +9.8898505947639599E-007
-------------------------------------------------------------------------------------------------------
qR              qR(1)                     qR(2)                     qR(3)                     qR(4)
ASFILE:   +0.0000000000000000E+000 +0.0000000000000000E+000 +0.0000000000000000E+000 +1.0000000000000000E+000
Estim:    +1.0081714523826626E-004 +1.0805193080809753E-006 +1.7944024107532609E-006 +9.9999999491575797E-001
DelThetaR       deltheta R(1)             deltheta R(2)             deltheta R(3)
          +2.0163429469590558E-004 +2.1606767921194664E-006 +3.5890226730202829E-006       [rad]
EulAngR         angR(1)                   angR(2)                   angR(3)                   [rad]
Mean      +2.0163429469590558E-004 +2.1606767921194664E-006 +3.5890226730202829E-006
SigmaR    +6.2192812898722501E-005 +2.4971201007015007E-006 +2.4945496779037563E-006
-------------------------------------------------------------------------------------------------------
Initial Gyro Bias         Bg0(1)                    Bg0(2)                    Bg0(3)
                  +2.5251665160679224E-006 +2.5247243427881652E-006 +2.5081344568492892E-006
Gyro Bias Correction      Bg(1)                     Bg(2)                     Bg(3)
                  -4.2749476557268999E-007 -2.4673873978396996E-008 -7.4130099148363303E-009
Total Gyro Bias           BgT(1)                    BgT(2)                    BgT(3)
                  +2.0976717504952323E-006 +2.5000504688097681E-006 +2.5007214469344528E-006

Initial Gyro Bias Rate     Cg0(1)                    Cg0(2)                    Cg0(3)
                  +0.0000000000000000E+000 +0.0000000000000000E+000 +0.0000000000000000E+000
Gyro Bias Rate Correction  Cg(1)                     Cg(2)                     Cg(3)
                  +9.7181291165003329E-012 +1.0172189437155128E-012 +1.0343354955741213E-012
Total Gyro Bias Rate       CgT(1)                    CgT(2)                    CgT(3)
                  +9.7181291165003329E-012 +1.0172189437155128E-012 +1.0343354955741213E-012
-------------------------------------------------------------------------------------------------------
-------------------------------------------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  1              88            +0.000            -1.500     pixels
OFFSET FRAME NAME: MIPS_160um_plusY_edge
qT               qT(1)                     qT(2)                     qT(3)                     qT(4)
```

```
WAS(FTB)  -1.6879757291711217E-006 -9.6923788967401584E-004 -1.7415460069063584E-003 +9.9999801379431230E-001
IS (EST)  -1.5387845261737871E-003 -9.6734967990111137E-004 -1.7491730801247160E-003 +9.9999681838009602E-001

DelTheta        deltheta(1)               deltheta(2)               deltheta(3)
Units             rad                       rad                       rad
          -3.0742095614644757E-003 -1.5985999037032963E-006 -1.2276206356425348E-005
EulAngT         theta(1)                  theta(2)                  theta(3)                  [rad]
Mean      -3.0741857642660967E-003 -1.9400776223060020E-003 -3.4953716400230100E-003
sSigmaT   +2.7672820386046349E-003 +9.1129857532100186E-007 +1.3626296606463269E-006
SigmaT    +2.6918643220988784E-003 +8.8646263281609028E-007 +1.3254934323850476E-006
-----------------------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  2              89            +0.000            +0.000     pixels
OFFSET FRAME NAME: MIPS_160um_large_only
qT               qT(1)                     qT(2)                     qT(3)                     qT(4)
WAS(FTB)  -1.6247706156225429E-006 -9.6996521888884340E-004 -1.6750781782660256E-003 +9.9999812663721077E-001
IS (EST)  -1.5387154440668037E-003 -9.6770815576549920E-004 -1.6773348579678024E-003 +9.9999694121706273E-001

DelTheta        deltheta(1)               deltheta(2)               deltheta(3)
Units             rad                       rad                       rad
          -3.0741887410667018E-003 -6.4002800146790190E-007 -1.5344840034465981E-006
EulAngT         theta(1)                  theta(2)                  theta(3)                  [rad]
Mean      -3.0741857642660967E-003 -1.9405734915908808E-003 -3.3516939860958653E-003
sSigmaT   +2.7672820650121652E-003 +5.5313459766907998E-007 +1.0166933634320214E-006
SigmaT    +2.6918643477867148E-003 +5.3805982477113312E-007 +9.8898505947639577E-007
-----------------------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  3              91            +3.500            +0.000     pixels
OFFSET FRAME NAME: MIPS_160um_small_FOV1
qT               qT(1)                     qT(2)                     qT(3)                     qT(4)
WAS(FTB)  -1.8535660093339217E-006 -1.1037735273119842E-003 -1.6792958163857940E-003 +9.9999798082102442E-001
IS (EST)  -1.5389630885822639E-003 -1.1165782515370987E-003 -1.6761336321929753E-003 +9.9999678770567413E-001

DelTheta        deltheta(1)               deltheta(2)               deltheta(3)
Units             rad                       rad                       rad
          -3.0741642166942943E-003 -3.0759598642913725E-005 +9.7608341006434293E-006
EulAngT         theta(1)                  theta(2)                  theta(3)                  [rad]
Mean      -3.0741857642660963E-003 -2.2383102141019136E-003 -3.3488343987072957E-003
sSigmaT   +2.7672819532546258E-003 +6.9766678099504115E-007 +1.1194410036377252E-006
SigmaT    +2.6918642390749430E-003 +6.7865302136716497E-007 +1.0889324818898516E-006
-----------------------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  4              92            -3.000            -0.500     pixels
OFFSET FRAME NAME: MIPS_160um_small_FOV2
qT               qT(1)                     qT(2)                     qT(3)                     qT(4)
WAS(FTB)  -1.4458583985377269E-006 -8.5506456275250009E-004 -1.6909317330203208E-003 +9.9999820480457724E-001
IS (EST)  -1.5385227878397629E-003 -8.3998571490705870E-004 -1.7023105155295523E-003 +9.9999701475081371E-001

DelTheta        deltheta(1)               deltheta(2)               deltheta(3)
Units             rad                       rad                       rad
          -3.0742202597831211E-003 +2.4926479036463900E-005 -2.0171243694212850E-005
EulAngT         theta(1)                  theta(2)                  theta(3)                  [rad]
Mean      -3.0741857642660967E-003 -1.6852052993614043E-003 -3.4020375862779868E-003
sSigmaT   +2.7672819626415584E-003 +7.7389262499455702E-007 +1.2298458005747929E-006
SigmaT    +2.6918642482060503E-003 +7.5280145547026624E-007 +1.1963283778330495E-006
-----------------------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  5               1           +10.000            +1.500     pixels
OFFSET FRAME NAME: CORNER PIXEL (DIAGNOSTICS)
qT               qT(1)                     qT(2)                     qT(3)                     qT(4)
```

```
WAS(FTB)  +0.0000000000000000E+000 +0.0000000000000000E+000 +0.0000000000000000E+000 +1.0000000000000000E+000
IS (EST)  -1.5393220965653064E-003 -1.3934096246115118E-003 -1.6020643686892283E-003 +9.9999656113751689E-001

DelTheta        deltheta(1)               deltheta(2)               deltheta(3)
Units             rad                       rad                       rad
          -3.0741857642660971E-003 -2.7917454783033739E-003 -3.1998458364305101E-003
EulAngT         theta(1)                  theta(2)                  theta(3)                  [rad]
Mean      -3.0741857642660963E-003 -2.7917454783033739E-003 -3.1998458364305097E-003
sSigmaT   +2.7672810596841698E-003 +1.6564832765077654E-006 +2.0106814132179537E-006
SigmaT    +2.6918633698572790E-003 +1.6113385516834092E-006 +1.9558836012529947E-006
-----------------------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  6               1           +10.000            -1.500     pixels
OFFSET FRAME NAME: CORNER PIXEL (DIAGNOSTICS)
qT               qT(1)                     qT(2)                     qT(3)                     qT(4)
WAS(FTB)  +0.0000000000000000E+000 +0.0000000000000000E+000 +0.0000000000000000E+000 +1.0000000000000000E+000
IS (EST)  -1.5395214193419191E-003 -1.3926925998780806E-003 -1.7457409878658622E-003 +9.9999632132799610E-001

DelTheta        deltheta(1)               deltheta(2)               deltheta(3)
Units             rad                       rad                       rad
          -3.0741857642660967E-003 -2.7907537870641508E-003 -3.4872016189253659E-003
EulAngT         theta(1)                  theta(2)                  theta(3)                  [rad]
Mean      -3.0741857642660963E-003 -2.7907537870641508E-003 -3.4872016189253659E-003
sSigmaT   +2.7672810728267146E-003 +1.6064611855195682E-006 +2.0296321465730495E-006
SigmaT    +2.6918633826416454E-003 +1.5626797304395115E-006 +1.9743178635668980E-006
-----------------------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  7               1           -10.000            +1.500     pixels
OFFSET FRAME NAME: CORNER PIXEL (DIAGNOSTICS)
qT               qT(1)                     qT(2)                     qT(3)                     qT(4)
WAS(FTB)  +0.0000000000000000E+000 +0.0000000000000000E+000 +0.0000000000000000E+000 +1.0000000000000000E+000
IS (EST)  -1.5379667865543737E-003 -5.4272341773610596E-004 -1.6089285847706116E-003 +9.9999737572568881E-001

DelTheta        deltheta(1)               deltheta(2)               deltheta(3)
Units             rad                       rad                       rad
          -3.0741857642660963E-003 -1.0903931604843910E-003 -3.2161868003974126E-003
EulAngT         theta(1)                  theta(2)                  theta(3)                  [rad]
Mean      -3.0741857642660967E-003 -1.0903931604843910E-003 -3.2161868003974122E-003
sSigmaT   +2.7672810061750179E-003 +1.7273384082431035E-006 +2.1063582211655859E-006
SigmaT    +2.6918633178064310E-003 +1.6802626434439104E-006 +2.0489528953016789E-006
-----------------------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  8               1           -10.000            -1.500     pixels
OFFSET FRAME NAME: CORNER PIXEL (DIAGNOSTICS)
qT               qT(1)                     qT(2)                     qT(3)                     qT(4)
WAS(FTB)  +0.0000000000000000E+000 +0.0000000000000000E+000 +0.0000000000000000E+000 +1.0000000000000000E+000
IS (EST)  -1.5380438795796340E-003 -5.4200659228383497E-004 -1.7526048457927376E-003 +9.9999713450896099E-001

DelTheta        deltheta(1)               deltheta(2)               deltheta(3)
Units             rad                       rad                       rad
          -3.0741857642660971E-003 -1.0894014601331762E-003 -3.5035416341273433E-003
EulAngT         theta(1)                  theta(2)                  theta(3)                  [rad]
Mean      -3.0741857642660967E-003 -1.0894014601331762E-003 -3.5035416341273429E-003
sSigmaT   +2.7672810016547652E-003 +1.7499911033945088E-006 +2.2369987947933912E-006
SigmaT    +2.6918633134093701E-003 +1.7022979766794765E-006 +2.1760330751537274E-006
-----------------------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------------------
              q(1)                      q(2)                      q(3)                      q(4)
PCRS1A: +5.2603126189317361E-007 +3.7451819048221893E-004 -1.4045531552277380E-003 +9.9999894348258311E-001
PCRS2A: -5.1968404336718985E-007 +3.8455385122900486E-004 +1.3513933841514693E-003 +9.9999901292650617E-001
-------------------------------------------------------------------------------------
```

```
**********  CS-FILE PARAMETERS:  **********  **********  AS-FILE PARAMETERS:  **********
Row (01) PIX2RADX: +7.7399898172000000E-005  Row (1) TASTART:   +7.3051200000000000E+008
Row (02) PIX2RADY: +8.7086140999000005E-005  Row (2) TASTOP:    +7.3053335000000000E+008
Row (03) CX0:      +1.0500000000000000E+001  Row (3) S/C TIME:  +7.3051200000000000E+008
Row (04) CY0:      +2.0000000000000000E+000  Row (4) QR1:       +0.0000000000000000E+000
Row (05) BETA0:    +2.8047410000000001E-006  Row (5) QR2:       +0.0000000000000000E+000
Row (06) GAMMA_E0: +2.0070000000000000E+003  Row (6) QR3:       +0.0000000000000000E+000
Row (07) D11:      -1.0000000000000000E+000  Row (7) QR4:       +1.0000000000000000E+000
Row (08) D12:      +0.0000000000000000E+000
Row (09) D21:      +0.0000000000000000E+000
Row (10) D22:      -1.0000000000000000E+000
Row (11) DG:       +1.0000000000000000E+000
-------------------------------------------------------------------------------------
-------------------------------------------------------------
INITIAL STA-TO-PCRS ALIGNMENT (R) KNOWLEDGE (1-SIGMA)
    SIGMA(X)        SIGMA(Y)         SIGMA(Z)
2.82857904E+001  1.44427880E+000  1.44427880E+000  [arcsec]
-------------------------------------------------------------
PIX2RADX = 7.739989817200E-005[rad/pixel]
XPIXSIZE = 15.9649[arcsec]
PIX2RADY = 8.708614099900E-005[rad/pixel]
YPIXSIZE = 17.9628[arcsec]
CX0 = 10.5[pixel] = 167.63[arcsec]
CY0 = 2.0[pixel] = 35.93[arcsec]
-------------------------------------------------------------
NOMINAL BETA0 = 2.804741000000E-006[rad/encoder unit]
ENCODER UNIT SIZE = 0.58[arcsec]
GAMMA_E0 = 2007.00[encoder unit] = 1161.09[arcsec]
-------------------------------------------------------------
                | -1 | +0 |
FLIP MATRIX D = |----|----|   and   DG = +1
                | +0 | -1 |
-------------------------------------------------------------
```

3.3 IPF EXECUTION LOG

```
*********************************************************************
IPF EXECUTION-LOG FILE NAME:  LG993087.dat
INSTRUMENT TYPE:              MIPS_160um_center_large_FOV
IPF FILTER EXECUTION DATE:    07-Aug-2003    TIME: 11:14
IPF FILTER VERSION USED:      IPF.V2.0.1Beta
*********************************************************************

------------------- Loading & Preparing Input Files -------------------
AAFILE:  AA993087 Loaded!        AAFILE dimension = 213501 X 21
ASFILE:  AS993087 Loaded!
CAFILE:  CA993087 Loaded!        CAFILE dimension = 249 X 15
CBFILE:  CB993087 Loaded!        CBFILE dimension = 90 X 15
CCFILE:  CC993087 Created!       CCFILE dimension = 339 X 19
CSFILE:  CS993087 Loaded!
Loading Input Files Completed!
---------------------------------------------------------------------

------------------------ Selected Mask Vectors ------------------------
index =   1  2  3  4  5  6  7  8  9 10 11 12 13 14 15 16 17 18 19 20
---------------------------------------------------------------------
mask1 = [ 1  1  1  1  1  1  1  0  0  0  0  0  0  0  0  0  0 ]
```

```
mask2 = [ 1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1 ]
-----------------------------------------------------------------------

---------------  Selected Initial Gyro Bias Parameters  ---------------
User Entered 1 : Use AFILE database - from S/C filter
IPF Linearized Using Following Nominal Gyro Bias Estimates
bg0 = [+2.5251665160679224E-006 +2.5247243427881652E-006 +2.5081344568492892E-006 ]
cg0 = [+0.0000000000000000E+000 +0.0000000000000000E+000 +0.0000000000000000E+000 ]
-----------------------------------------------------------------------

---------------  Gyro Pre-Processor Run Completed  --------------------
     AGFILE CREATED:  AG993087.m     ACFILE CREATED:  AC993087.m
-----------------------------------------------------------------------
Total Gyro Preprocessor Execution Time: 88 seconds

FRAME TABLE ENTRIES FOR PCRS LOADED TO TPCRS
q_PCRS4 = [ +5.2603126189317361E-007     q_PCRS5 = [ +7.3379987833742897E-007
            +3.7451819048221893E-004                 +5.2236196154513707E-004
            -1.4045531552277380E-003                 -1.4047712280184723E-003
            +9.9999894348258311E-001 ];              +9.9999887687698918E-001 ];
q_PCRS8 = [ -5.1968404336718985E-007     q_PCRS9 = [ -7.1963421681856818E-007
            +3.8455385122900486E-004                 +5.3239763239987400E-004
            +1.3513933841514693E-003                 +1.3516841804518383E-003
            +9.9999901292650617E-001 ];              +9.9999894475050310E-001 ];
-------------------------------------------------------------------------------
------ Initial Conditions for State -----  ------   Inital Square-Root Cov (diag)   -----
p1(01)  = a00  = +0.0000000000000000E+000  Sigma_initial(01,01) = 1.0000000000000000E+000
p1(02)  = b00  = +0.0000000000000000E+000  Sigma_initial(02,02) = 1.0000000000000000E+000
p1(03)  = c00  = +0.0000000000000000E+000  Sigma_initial(03,03) = 1.0000000000000000E+000
p1(04)  = a10  = +0.0000000000000000E+000  Sigma_initial(04,04) = 3.6384517097704270E+002
p1(05)  = b10  = +0.0000000000000000E+000  Sigma_initial(05,05) = 3.6384517097704270E+002
p1(06)  = c10  = +0.0000000000000000E+000  Sigma_initial(06,06) = 3.6384517097704270E+002
p1(07)  = d10  = +0.0000000000000000E+000  Sigma_initial(07,07) = 3.6384517097704270E+002
p1(08)  = a20  = +0.0000000000000000E+000  Sigma_initial(08,08) = 9.9999000000000000E+004
p1(09)  = b20  = +0.0000000000000000E+000  Sigma_initial(09,09) = 9.9999000000000000E+004
p1(10)  = c20  = +0.0000000000000000E+000  Sigma_initial(10,10) = 9.9999000000000000E+004
p1(11)  = d20  = +0.0000000000000000E+000  Sigma_initial(11,11) = 9.9999000000000000E+004
p1(12)  = a01  = +0.0000000000000000E+000  Sigma_initial(12,12) = 9.9999000000000000E+004
p1(13)  = b01  = +0.0000000000000000E+000  Sigma_initial(13,13) = 9.9999000000000000E+004
p1(14)  = c01  = +0.0000000000000000E+000  Sigma_initial(14,14) = 9.9999000000000000E+004
p1(15)  = d01  = +0.0000000000000000E+000  Sigma_initial(15,15) = 9.9999000000000000E+004
p1(16)  = e01  = +0.0000000000000000E+000  Sigma_initial(16,16) = 9.9999000000000000E+004
p1(17)  = f01  = +0.0000000000000000E+000  Sigma_initial(17,17) = 9.9999000000000000E+004
-------------------------------------------------------------------------------------------
p2f(01) = am1  = +0.0000000000000000E+000
p2f(02) = am2  = +0.0000000000000000E+000  Sigma_initial(18,18) = 1.0000000000000001E-001
p2f(03) = am3  = +1.0000000000000000E+000
p2f(04) = beta = +1.0000000000000000E+000  Sigma_initial(19,19) = 1.0000000000000001E-001
p2f(05) = qT1  = -1.6247706156225429E-006  Sigma_initial(20,20) = 1.0000000000000001E-001
p2f(06) = qT2  = -9.6996521888884340E-004  Sigma_initial(21,21) = 1.0000000000000000E-002
p2f(07) = aT3  = -1.6750781782660256E-003  Sigma_initial(22,22) = 1.0000000000000000E-002
p2f(08) = qT4  = +9.9999812663721077E-001
p2f(09) = qR1  = +0.0000000000000000E+000  Sigma_initial(23,23) = 6.8566690868928238E-003
p2f(10) = qR2  = +0.0000000000000000E+000  Sigma_initial(24,24) = 3.5010305970939351E-004
p2f(11) = qR3  = +0.0000000000000000E+000  Sigma_initial(25,25) = 3.5010305970939351E-004
p2f(12) = qR4  = +1.0000000000000000E+000
p2f(13) = brx  = +0.0000000000000000E+000  Sigma_initial(26,26) = 4.6838407494145199E-005
p2f(14) = bry  = +0.0000000000000000E+000  Sigma_initial(27,27) = 4.6838407494145199E-005
p2f(15) = brz  = +0.0000000000000000E+000  Sigma_initial(28,28) = 4.6838407494145199E-005
p2f(16) = crx  = +0.0000000000000000E+000  Sigma_initial(29,29) = 2.1938364165875972E-009
p2f(17) = cry  = +0.0000000000000000E+000  Sigma_initial(30,30) = 2.1938364165875972E-009
p2f(18) = crz  = +0.0000000000000000E+000  Sigma_initial(31,31) = 2.1938364165875972E-009
p2f(19) = bgx  = +0.0000000000000000E+000  Sigma_initial(32,32) = 4.6838407494145199E-005
p2f(20) = bgy  = +0.0000000000000000E+000  Sigma_initial(33,33) = 4.6838407494145199E-005
```

```
p2f(21) = bgz  = +0.0000000000000000E+000  Sigma_initial(34,34) = 4.6838407494145199E-005
p2f(22) = cgx  = +0.0000000000000000E+000  Sigma_initial(35,35) = 2.1938364165875972E-009
p2f(23) = cgy  = +0.0000000000000000E+000  Sigma_initial(36,36) = 2.1938364165875972E-009
p2f(24) = cgz  = +0.0000000000000000E+000  Sigma_initial(37,37) = 2.1938364165875972E-009
-------------------------------------------------------------------------------------

--------------------   IPF KALMAN FILTER STARTED  ---------------------
Iteration#001: |dp|= +4.029676007181E+001   RMS(|Res|)=+4.029676007181E+001
Iteration#002: |dp|= +5.282950252704E-001   RMS(|Res|)=+5.282950252704E-001
Iteration#003: |dp|= +1.614164664628E-001   RMS(|Res|)=+1.614164664628E-001
Iteration#004: |dp|= +2.453774636636E-002   RMS(|Res|)=+2.453774636636E-002
Iteration#005: |dp|= +2.180955620480E-003   RMS(|Res|)=+2.180955620480E-003
Iteration#006: |dp|= +1.454485418499E-004   RMS(|Res|)=+1.454485418499E-004
Iteration#007: |dp|= +3.649178633166E-005   RMS(|Res|)=+3.649178633166E-005
Iteration#008: |dp|= +1.353318003041E-006   RMS(|Res|)=+1.353318003041E-006
Iteration#009: |dp|= +3.025645594585E-007   RMS(|Res|)=+3.025645594585E-007
Iteration#010: |dp|= +4.164738120791E-008   RMS(|Res|)=+4.164738120791E-008
Iteration#011: |dp|= +8.773322306149E-010   RMS(|Res|)=+8.773322306149E-010
Iteration#012: |dp|= +3.390032971181E-010   RMS(|Res|)=+3.390032971181E-010
Iteration#013: |dp|= +1.158245964185E-010   RMS(|Res|)=+1.158245964185E-010
Iteration#014: |dp|= +1.411784934518E-010   RMS(|Res|)=+1.411784934518E-010
Iteration#015: |dp|= +1.070416966310E-010   RMS(|Res|)=+1.070416966310E-010
Iteration#016: |dp|= +9.751481343705E-011   RMS(|Res|)=+9.751481343705E-011
Iteration#017: |dp|= +9.840918351524E-011   RMS(|Res|)=+9.840918351524E-011
Iteration#018: |dp|= +1.407523060556E-010   RMS(|Res|)=+1.407523060556E-010
Iteration#019: |dp|= +7.585900090966E-011   RMS(|Res|)=+7.585900090966E-011
Iteration#020: |dp|= +2.067754603427E-010   RMS(|Res|)=+2.067754603427E-010
IPF Kalman Filter Completed with Error |dp1| + |dp2| = +2.0677546034266681E-010
---------------------------------------------------------------------

-----------------  IPF LEAST SQUARES FILTER STARTED  ------------------
Iteration#001   COND#=+3.943750831106E+010,   |dp|=+4.047932360700E+001
Iteration#002   COND#=+3.943727406129E+010,   |dp|=+1.946959761428E-001
Iteration#003   COND#=+3.943726246631E+010,   |dp|=+6.050553728619E-003
Iteration#004   COND#=+3.943727019152E+010,   |dp|=+1.843300528360E-004
Iteration#005   COND#=+3.943726240642E+010,   |dp|=+2.993102454655E-006
Iteration#006   COND#=+3.943726641536E+010,   |dp|=+5.153371987705E-008
Iteration#007   COND#=+3.943726833930E+010,   |dp|=+8.502458336145E-010
Iteration#008   COND#=+3.943728122590E+010,   |dp|=+1.204877082591E-010
Iteration#009   COND#=+3.943728519807E+010,   |dp|=+1.723012490943E-010
Iteration#010   COND#=+3.943727582011E+010,   |dp|=+1.163637850246E-010
Iteration#011   COND#=+3.943726482800E+010,   |dp|=+1.306400441671E-010
Iteration#012   COND#=+3.943726209974E+010,   |dp|=+1.212662529515E-010
Iteration#013   COND#=+3.943728980978E+010,   |dp|=+4.495041018123E-011
Iteration#014   COND#=+3.943727238473E+010,   |dp|=+9.708726932404E-011
Iteration#015   COND#=+3.943728233905E+010,   |dp|=+3.200750364969E-010
Iteration#016   COND#=+3.943727700746E+010,   |dp|=+2.419550499585E-010
Iteration#017   COND#=+3.943727448735E+010,   |dp|=+1.210377920819E-010
Iteration#018   COND#=+3.943727886560E+010,   |dp|=+8.752763969784E-011
Iteration#019   COND#=+3.943727062660E+010,   |dp|=+1.925832426863E-010
Iteration#020   COND#=+3.943725595885E+010,   |dp|=+3.151805131511E-010
IPF Least Squares Filter Completed with Error |dp1| + |dp2| = +3.1518051315114060E-010
---------------------------------------------------------------------
Total Execution Time: 176 seconds
```

4 USER COMMENTS

This section left blank.

IPF TEAM CONTACT INFORMATION

IPF Team email		ipf@sirtfweb.jpl.nasa.gov	
David S. Bayard	X4-8208	David.S.Bayard@jpl.nasa.gov	(TEAM LEADER)
Dhemetrio Boussalis	X4-3977	boussali@grover.jpl.nasa.gov	
Paul Brugarolas	X4-9243	Paul.Brugarolas@jpl.nasa.gov	
Bryan H. Kang	X4-0541	Bryan.H.Kang@jpl.nasa.gov	
Edward.C.Wong	X4-3053	Edward.C.Wong@jpl.nasa.gov	(TASK MANAGER)

ACKNOWLEDGEMENTS

This work was performed at the Jet Propulsion Laboratory, California Institute of Technology, under contract with the National Aeronautics and Space Administration.

References

[1] D.S. Bayard, B.H. Kang, *SIRTF Instrument Pointing Frame Kalman Filter Algorithm*, JPL D-Document D-24809, September 30, 2003.

[2] B.H. Kang, D.S. Bayard, *SIRTF Instrument Pointing Frame (IPF) Software Description Document and User's Guide*, JPL D-Document D-24808, September 30, 2003.

[3] D.S. Bayard, B.H. Kang, *SIRTF Instrument Pointing Frame (IPF) Kalman Filter Unit Test Report*, JPL D-Document D-24810, September 30, 2003.

[4] *Space Infrared Telescope Facility In-Orbit Checkout and Science Verification Mission Plan*, JPL D-Document D-22622, 674-FE-301 Version 1.4, February 8, 2002.

[5] *Space Infrared Telescope Facility Observatory Description Document*, Lockheed Martin LMMS/P458569, 674-SEIT-300 Version 1.2, November 1, 2002.

[6] *SIRTF Software Interface Specification for Science Centroid INPUT Files (CAFILE, CSFILE)*, JPL SOS-SIS-2002, November 18, 2002.

[7] *SIRTF Software Interface Specification for Inferred Frames Offset INPUT Files (OFILE)*, JPL SOS-SIS-2003, November 18, 2002.

[8] *SIRTF Software Interface Specification for PCRS Centroid INPUT Files (CBFILE)*, JPL SIS-FES-015, November 18, 2002.

[9] *SIRTF Software Interface Specification for Attitude INPUT Files (AFILE, ASFILE)*, JPL SIS-FES-014, January 7, 2002.

[10] *SIRTF Software Interface Specification for IPF Filter Output Files (IFFILE, LGFILE, TARFILE)*, JPL SOS-SIS-2005, November 18, 2002.

[11] R.J. Brown, *Focal Surface to Object Space Field of View Conversion.* Systems Engineering Report SER No. S20447-OPT-051, Ball Aerospace & Technologies Corp., November 23, 1999.

This page left blank.

JET PROPULSION LABORATORY **SIRTF IPF REPORT**

JPL ID91M087
August 19, 2003

SIRTF INSTRUMENT POINTING FRAME
KALMAN FILTER EXECUTION SUMMARY

IPF RUN NUMBER: 91M087
REPORT TYPE: COVARIANCE ANALYSIS (MULTI-RUN)

PRIME FRAME: MIPS_160um_center_large_FOV (87)
INFERRED FRAMES: (88) (89) (91) (92) (1) (1) (1) (1)

IPF TEAM

Autonomy and Control Section (345)
Jet Propulsion Laboratory
California Institute of Technology
4800 Oak Grove Drive
Pasadena, CA 91109

Contents

1 IPF MULTI-RUN SUMMARY **3**

2 IPF MULTI-RUN RESULTS **7**

2.1 IPF MULTI-RUN OUTPUT PLOTS 7

2.2 IPF MULTI-RUN OUTPUT DATA (MF MINI FILE) 9

2.3 IPF MULTI-RUN EXECUTION LOG 14

3 USER COMMENTS **22**

List of Figures

1.1 A-priori and a-posteriori IPF frames 3

1.2 A-priori and a-posteriori IPF frames (ZOOMED) 6

2.1 Array plot with (solid) and w/o (dashed) optical distortion corrections 7

2.2 IPF parameter symbol table 7

2.3 KF parameter error sigma plots 8

2.4 KF parameter error 1-sigma bound 8

List of Tables

1.1 IPF filter execution configuration 4

1.2 Merge performance chart 4

1.3 IPF filter execution mask vector assignment 4

1.4 IPF calibration error summary ([arcsec], 1-sigma, radial) 5

1.5 IPF Brown angle summary 6

1 IPF MULTI-RUN SUMMARY

This report summarizes the SIRTF Instrument Pointing Frame (IPF) Kalman Filter execution. This document captures the results generated by a multi-run execution with the MR run number specified as: MR91M087. This multi-run execution merges 3 previously executed IPF runs of the instrument: MIPS_160um_center_large_FOV (87), for the purpose of improving estimation accuracy. The main multi-run calibration results have been documented in MF91M087 typically stored in the mission archive DOM collection IPF_MF. This report only summarizes the main aspects of the run, and does not substitute for the full information contained in the MF file.

Section 1 summarizes the multi-run merge results. The merge configurations are tabulated in Table 1.1. The overall End-to-End pointing performances are tabulated in Table 1.4. Section 2 summarizes resulting plots, a mini summary of the MF Multi-Run output file, and the execution log. Section 3 captures the user comments that are specific to this particular run.

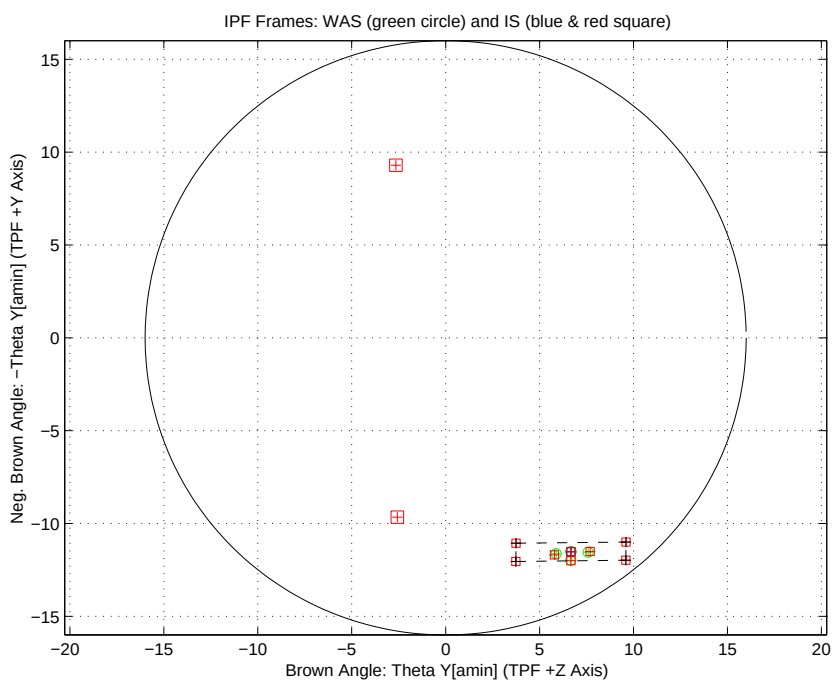

Figure 1.1: A-priori and a-posteriori IPF frames

EXECUTION CONFIGURATION ITEM	CURRENT STATUS
IPF Filter Version Used	IPF.V2.0.1Beta
Frame Table Version Used	FTVE2E1
IPF Filter Mode	NORMAL-MODE(0)
LS Residual Sigma Scale	1.08290159E+000
Merge Data Set #1	991087
Merge Data Set #2	992087
Merge Data Set #3	993087

Table 1.1: IPF filter execution configuration

	BROWN ANGLES AND SIGMAS [arcmin, arcmin, deg]					
RUN#	$-\theta_y$	$-\theta_z$	θ_x	σ_y	σ_z	σ_x
991087	+6.668431	+11.520707	-0.051814	0.002017	0.003566	0.166196
992087	+6.671708	+11.513092	-0.095758	0.002023	0.003610	0.151693
993087	+6.671200	+11.522275	-0.176138	0.001902	0.003495	0.158554
91M087	+6.670579	+11.519239	-0.142547	0.001136	0.002048	0.090605

Table 1.2: Merge performance chart

Con. Plate Scale			Γ Dependent				Γ^2 Dependent				Linear Plate Scale						Mirror	
a_{00}	b_{00}	c_{00}	a_{10}	b_{10}	c_{10}	d_{10}	a_{20}	b_{20}	c_{20}	d_{20}	a_{01}	b_{01}	c_{01}	d_{01}	e_{01}	f_{01}	α	β
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	1	1

IPF (T)			Alignment R									Gyro Drift Bias						
θ_1	θ_2	θ_3	a_{rx}	a_{ry}	a_{rz}	b_{rx}	b_{ry}	b_{rz}	c_{rx}	c_{ry}	c_{rz}	b_{gx}	b_{gy}	b_{gz}	c_{gx}	c_{gy}	c_{gz}	
20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	
1	1	1																

Table 1.3: IPF filter execution mask vector assignment

FOCAL PLANE SURVEY ANALYSIS: MULTI-RUN
INSTRUMENT NAME: MIPS_160um_center_large_FOV NF: 87

```
PIX2RADW: 7.73998982E-005[rad/pixel] = 1.5965E+001[arcsec/pixel]
PIX2RADV: 7.73998982E-005[rad/pixel] = 1.5965E+001[arcsec/pixel]
```

FRAME	DESCRIPTION	IPF[1]	SF[2]	ARW[3]	TOTAL	REQ
087(P)	MIPS_160um_center_large_FOV	0.1298	0.0855	0.0384	0.1601	3.70
088(I)	MIPS_160um_plusY_edge	0.1961	0.0855	0.0384	0.2173	N/A
089(I)	MIPS_160um_large_only	0.1406	0.0855	0.0384	0.1689	N/A
091(I)	MIPS_160um_small_FOV1	0.1584	0.0855	0.0384	0.1841	N/A
092(I)	MIPS_160um_small_FOV2	0.1658	0.0855	0.0384	0.1904	N/A
TR (C)	CORNERS OF INSTRUMENT	0.2978	0.0855	0.0384	0.3122	N/A
BR (C)	CORNERS OF INSTRUMENT	0.2911	0.0855	0.0384	0.3058	N/A
TL (C)	CORNERS OF INSTRUMENT	0.2992	0.0855	0.0384	0.3135	N/A
BL (C)	CORNERS OF INSTRUMENT	0.3071	0.0855	0.0384	0.3211	N/A

Table 1.4: IPF calibration error summary ([arcsec], 1-sigma, radial)

[1]IPF filter removes systematic pointing errors due to: thermomechanical alignment drift (Body to TPF), gyro bias and bias drift, centroiding error, attitude error, and optical distortion. IPF SIGMA presented here is "NOT Scaled" by the Least Squares Scale factor. The Least Squares Scale Factor was: 1.082902.

[2]Error due to gyro Scale Factor: assumes 95 ppm error over 0.250 degree maneuver.

[3]Error due to gyro Angle Random Walk: assumes ARW = 100 $\mu deg/\sqrt{hr}$, with 615 second Maneuver time (max), and 30 independent Maneuvers.

IPF BROWN ANGLE SUMMARY						
	WAS			IS		
Frame Number	theta_Y (arcmin)	theta_Z (arcmin)	angle (deg)	theta_Y (arcmin)	theta_Z (arcmin)	angle (deg)
087	+6.669000	+11.517000	+0.000000	+6.670579	+11.519239	-0.142547
088	+6.664000	+11.974000	+0.000000	+6.667488	+12.008800	-0.142547
089	+6.669000	+11.517000	+0.000000	+6.670579	+11.519239	-0.142547
091	+7.589000	+11.546000	+0.000000	+7.694949	+11.507755	-0.142547
092	+5.879000	+11.626000	+0.000000	+5.791518	+11.692270	-0.142547
001	+0.000000	+0.000000	+0.000000	+9.600441	+10.996865	-0.142547
001	+0.000000	+0.000000	+0.000000	+9.594259	+11.975989	-0.142547
001	+0.000000	+0.000000	+0.000000	+3.746900	+11.062491	-0.142547
001	+0.000000	+0.000000	+0.000000	+3.740718	+12.041612	-0.142547

Table 1.5: IPF Brown angle summary

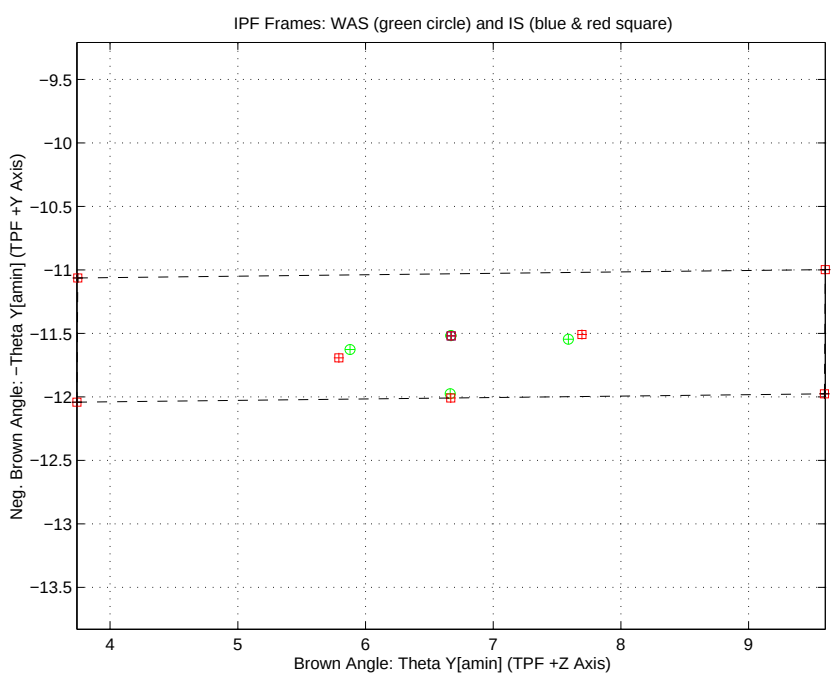

Figure 1.2: A-priori and a-posteriori IPF frames (ZOOMED)

2 IPF MULTI-RUN RESULTS

2.1 IPF MULTI-RUN OUTPUT PLOTS

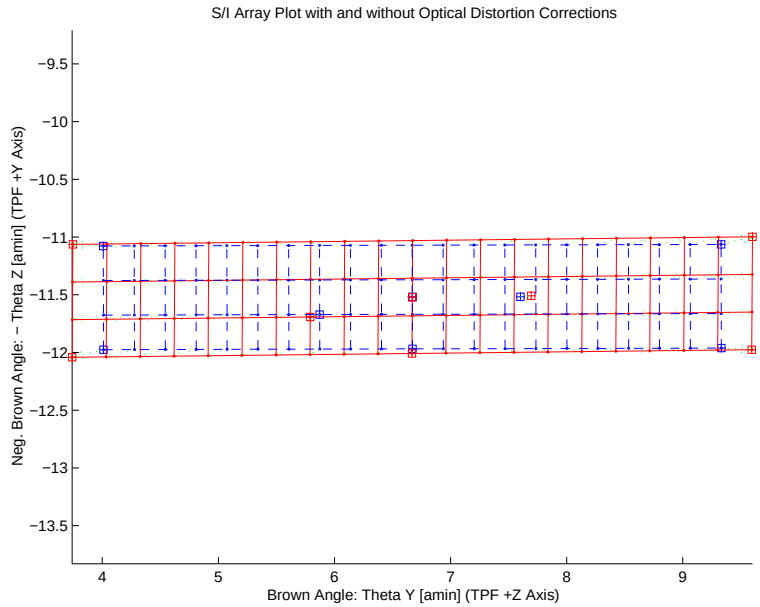

Figure 2.1: Array plot with (solid) and w/o (dashed) optical distortion corrections

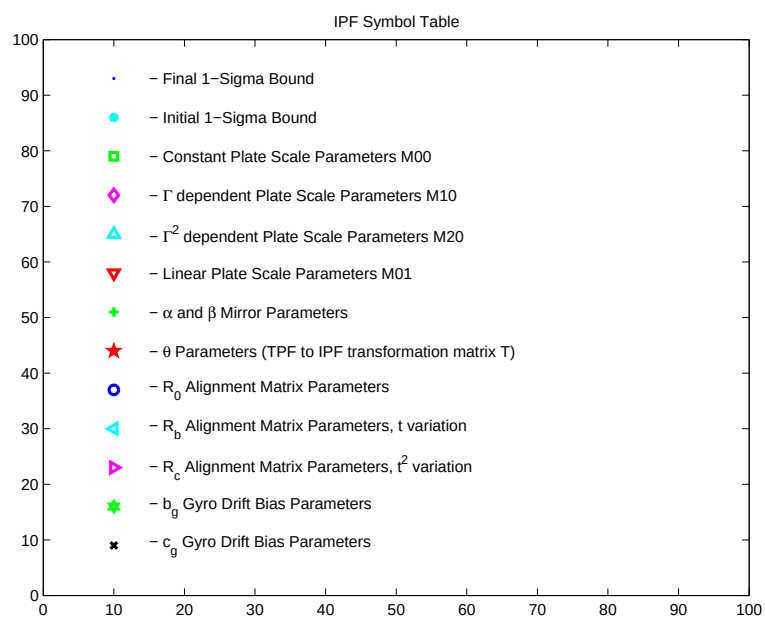

Figure 2.2: IPF parameter symbol table

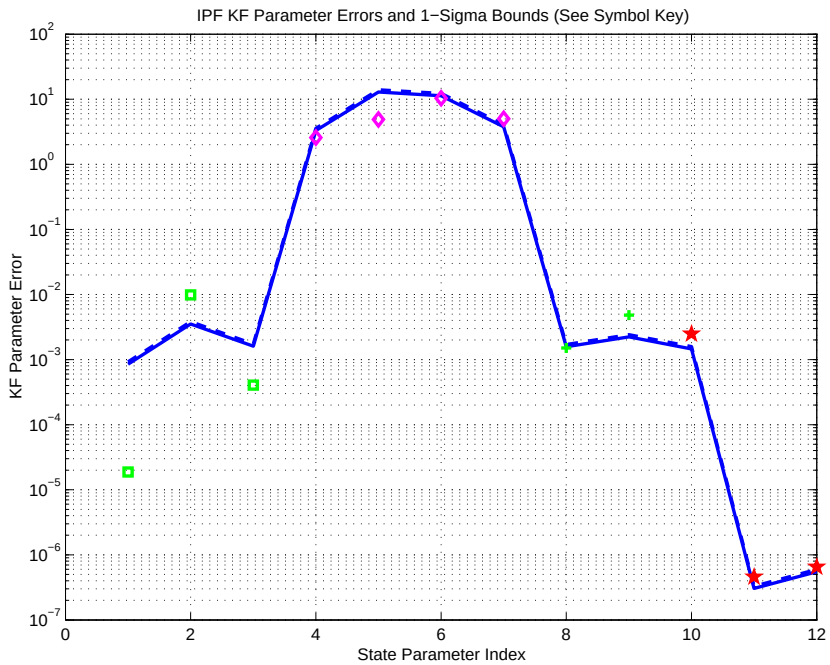

Figure 2.3: KF parameter error sigma plots

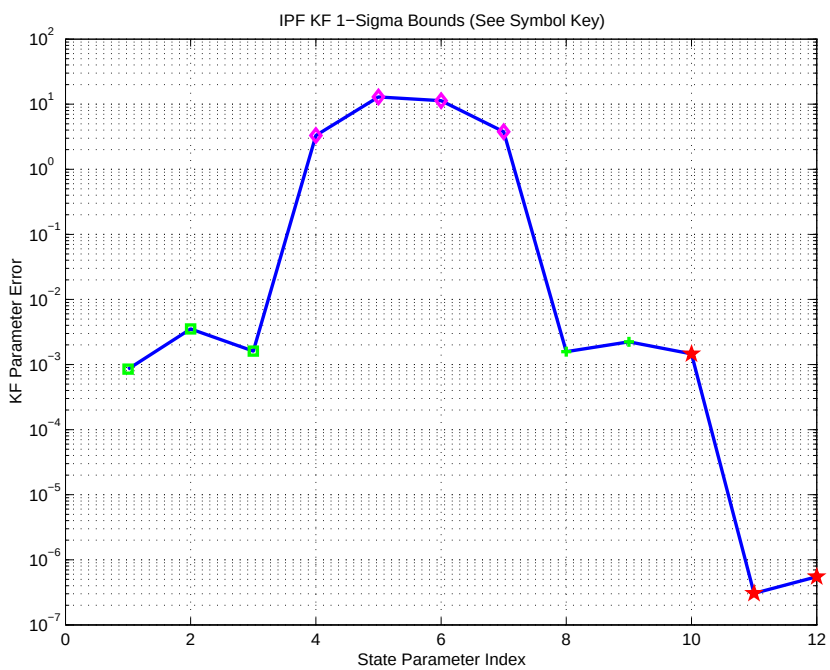

Figure 2.4: KF parameter error 1-sigma bound

2.2 IPF MULTI-RUN OUTPUT DATA (MF MINI FILE)

```
OUTPUT FILE NAME: MF91M087mini.dat   DATE: 07-Aug-2003   TIME: 11:22
INSTRUMENT NAME:  MIPS_160um_center_large_FOV   NF: 87
IPF FILTER VERSION: IPF.V2.0.1Beta       SW RELEASE DATE: August 5, 2003
-------------------------------------------------------------------------------
---------------------------- IPF BROWN ANGLE SUMMARY ---------------------------
-------------------------------------------------------------------------------
         ------------ WAS ------------           ------------ IS -------------
Frame    theta_Y     theta_Z     angle           theta_Y     theta_Z     angle
Number   (arcmin)    (arcmin)    (deg)           (arcmin)    (arcmin)    (deg)
------  --------------------------------       --------------------------------
 087     +6.669000 +11.517000   +0.000000        +6.670579 +11.519239   -0.142547
 088     +6.664000 +11.974000   +0.000000        +6.667488 +12.008800   -0.142547
 089     +6.669000 +11.517000   +0.000000        +6.670579 +11.519239   -0.142547
 091     +7.589000 +11.546000   +0.000000        +7.694949 +11.507755   -0.142547
 092     +5.879000 +11.626000   +0.000000        +5.791518 +11.692270   -0.142547
 001     +0.000000  +0.000000   +0.000000        +9.600441 +10.996865   -0.142547
 001     +0.000000  +0.000000   +0.000000        +9.594259 +11.975989   -0.142547
 001     +0.000000  +0.000000   +0.000000        +3.746900 +11.062491   -0.142547
 001     +0.000000  +0.000000   +0.000000        +3.740718 +12.041612   -0.142547
-------------------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  0              87            +0.000            +0.000     pixels
OFFSET FRAME NAME: MIPS_160um_center_large_FOV
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
WAS(FTB)            +6.669000       +11.517000       +0.000000
IS (EST)            +6.670579       +11.519239       -0.142547
dT_EST              +0.001579        +0.002239       -0.142547
T_sSIGMA            +0.001136        +0.002048       +0.090605
dT_EST/T_sSIGMA     +1.389883        +1.093013       -1.573282
-----------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  1              88            +0.000            -1.500     pixels
OFFSET FRAME NAME: MIPS_160um_plusY_edge
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
WAS(FTB)            +6.664000       +11.974000       +0.000000
IS (EST)            +6.667488       +12.008800       -0.142547
dT_EST              +0.003488        +0.034800       -0.142547
T_sSIGMA            +0.001777        +0.002743       +0.090605
dT_EST/T_sSIGMA     +1.963403       +12.688675       -1.573282
-----------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  2              89            +0.000            +0.000     pixels
OFFSET FRAME NAME: MIPS_160um_large_only
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
WAS(FTB)            +6.669000       +11.517000       +0.000000
IS (EST)            +6.670579       +11.519239       -0.142547
dT_EST              +0.001579        +0.002239       -0.142547
T_sSIGMA            +0.001136        +0.002048       +0.090605
dT_EST/T_sSIGMA     +1.389883        +1.093013       -1.573282
-----------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  3              91            +3.500            +0.000     pixels
OFFSET FRAME NAME: MIPS_160um_small_FOV1
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
WAS(FTB)            +7.589000       +11.546000       +0.000000
IS (EST)            +7.694949       +11.507755       -0.142547
dT_EST              +0.105949        -0.038245       -0.142547
T_sSIGMA            +0.001405        +0.002236       +0.090605
dT_EST/T_sSIGMA    +75.414013       -17.105983       -1.573282
-----------------------------------------------------------------
```

```
OFFSET           NF          Delta_CW          Delta_CV
  4              92            -3.000            -0.500     pixels
OFFSET FRAME NAME: MIPS_160um_small_FOV2
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
WAS(FTB)            +5.879000       +11.626000       +0.000000
IS (EST)            +5.791518       +11.692270       -0.142547
dT_EST              -0.087482        +0.066270       -0.142547
T_sSIGMA            +0.001425        +0.002366       +0.090605
dT_EST/T_sSIGMA    -61.375707       +28.003413       -1.573282
-------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  5               1           +10.000            +1.500     pixels
OFFSET FRAME NAME: CORNER PIXEL (DIAGNOSTICS)
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
WAS(FTB)            +0.000000        +0.000000       +0.000000
IS (EST)            +9.600441       +10.996865       -0.142547
dT_EST              +9.600441       +10.996865       -0.142547
T_sSIGMA            +0.003135        +0.003848       +0.090605
dT_EST/T_sSIGMA    +3061.883195       +2857.873758       -1.573282
-------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  6               1           +10.000            -1.500     pixels
OFFSET FRAME NAME: CORNER PIXEL (DIAGNOSTICS)
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
WAS(FTB)            +0.000000        +0.000000       +0.000000
IS (EST)            +9.594259       +11.975989       -0.142547
dT_EST              +9.594259       +11.975989       -0.142547
T_sSIGMA            +0.002977        +0.003830       +0.090605
dT_EST/T_sSIGMA    +3222.772412       +3126.507661       -1.573282
-------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  7               1           -10.000            +1.500     pixels
OFFSET FRAME NAME: CORNER PIXEL (DIAGNOSTICS)
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
WAS(FTB)            +0.000000        +0.000000       +0.000000
IS (EST)            +3.746900       +11.062491       -0.142547
dT_EST              +3.746900       +11.062491       -0.142547
T_sSIGMA            +0.003135        +0.003878       +0.090605
dT_EST/T_sSIGMA    +1195.079433       +2852.964534       -1.573282
-------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  8               1           -10.000            -1.500     pixels
OFFSET FRAME NAME: CORNER PIXEL (DIAGNOSTICS)
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
WAS(FTB)            +0.000000        +0.000000       +0.000000
IS (EST)            +3.740718       +12.041612       -0.142547
dT_EST              +3.740718       +12.041612       -0.142547
T_sSIGMA            +0.003082        +0.004087       +0.090605
dT_EST/T_sSIGMA    +1213.871336       +2946.384615       -1.573282
-------------------------------------------------------------------
-------------------------------------------------------------------------------------
-------------------------------------------------------------------------------------
VARNAME             MEAN                      SIGMA                 SCALED_SIGMA
a00        +9.9981236262117273E-002 +8.5154820308068122E-004 +9.2214290522827172E-004
b00        +9.0143966162212708E-002 +3.5270340346694831E-003 +3.8194307730351159E-003
c00        +9.5950464253763187E-003 +1.6079885710578263E-003 +1.7412933843612745E-003
a10        -2.4690366344310224E+000 +3.3065525616794393E+000 +3.5806710348118362E+000
b10        -4.8006527293679255E+000 +1.2915060759707526E+001 +1.3985739864250482E+001
c10        -1.0372993539213113E+001 +1.1335359997447528E+001 +1.2275079393085432E+001
d10        +5.0229545264397757E+000 +3.7713178991550054E+000 +4.0839661589147642E+000
del_alpha  -2.0903258694455703E-003 +1.5776005591178824E-003 +1.7083861578378262E-003
beta       +1.0951854038284869E+000 +2.2284227494004235E-003 +2.4131625441457041E-003
del_theta1 -1.5835804589349434E-003 +1.4602919220061932E-003 +1.5813524478925857E-003
del_theta2 -6.2580133749751463E-007 +3.0524845244487113E-007 +3.3055403526848608E-007
```

```
del_theta3 +4.2590915149324827E-007 +5.5025187468441434E-007 +5.9586863138587752E-007
--------------------------------------------------------------------------------
LSQF RESIDUAL SIGMA SCALE =         +1.0829015925254697E+000
--------------------------------------------------------------------------------
-------------------------------------------------------------------------------------------------------
-------------------------------------------------------------------------------------------------------
                    a_mirror(1)               a_mirror(2)               a_mirror(3)
a_mirror_ipf   +0.0000000000000000E+000  +1.8494983143862328E-002  +9.9982895317074505E-001
a_mirror_tpf   -1.8696456431603434E-003  +2.0988793226025874E-002  +9.9977796284179210E-001
beta                beta_0                    beta                      beta_total
               +2.8047410000000001E-006  +1.0951854038284869E+000  +3.0717114047193144E-006
-------------------------------------------------------------------------------------------------------
qT              qT(1)                     qT(2)                     qT(3)                     qT(4)
FrmTbl:   -1.6247706156225429E-006 -9.6996521888884340E-004 -1.6750781782660256E-003 +9.9999812663721077E-001
Estim:    -1.2455792128365179E-003 -9.6811005414947353E-004 -1.6766094070470091E-003 +9.9999735013461100E-001
DelTheta        deltheta(1)               deltheta(2)               deltheta(3)
          -2.4879140532740348E-003 -4.5943127254240590E-007 -6.5129110718703318E-007       [rad]
EulAngT         theta(1)                  theta(2)                  theta(3)                  [rad]
Mean      -2.4879127898110348E-003 -1.9403928948638276E-003 -3.3508107915363999E-003
SigmaT    +1.4602919220061932E-003 +3.0524845244487113E-007 +5.5025187468441434E-007
-------------------------------------------------------------------------------------------------------
Initial Gyro Bias         Bg0(1)                    Bg0(2)                    Bg0(3)
                  +2.5251665160679224E-006 +2.5247243427881652E-006 +2.5081344568492892E-006
Gyro Bias Correction      Bg(1)                     Bg(2)                     Bg(3)
                  +8.0826783092467364E-009 +1.0808616837987133E-008 -1.2164084510801989E-008
Total Gyro Bias           BgT(1)                    BgT(2)                    BgT(3)
                  +2.5332491943771690E-006 +2.5355329596261521E-006 +2.4959703723384871E-006

Initial Gyro Bias Rate     Cg0(1)                    Cg0(2)                    Cg0(3)
                  +0.0000000000000000E+000 +0.0000000000000000E+000 +0.0000000000000000E+000
Gyro Bias Rate Correction  Cg(1)                     Cg(2)                     Cg(3)
                  -4.9556795043019744E-011 +6.0432674837691912E-013 +6.9322332696961655E-013
Total Gyro Bias Rate       CgT(1)                    CgT(2)                    CgT(3)
                  -4.9556795043019744E-011 +6.0432674837691912E-013 +6.9322332696961655E-013
-------------------------------------------------------------------------------------------------------
-------------------------------------------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  1              88            +0.000            -1.500     pixels
OFFSET FRAME NAME: MIPS_160um_plusY_edge
qT              qT(1)                     qT(2)                     qT(3)                     qT(4)
WAS(FTB)  -1.6879757291711217E-006 -9.6923788967401584E-004 -1.7415460069063584E-003 +9.9999801379431230E-001
IS (EST)  -1.2456473581282672E-003 -9.6757180339195655E-004 -1.7478124511906507E-003 +9.9999722865570984E-001

DelTheta        deltheta(1)               deltheta(2)               deltheta(3)
Units             rad                       rad                       rad
          -2.4879324129679645E-003 -1.0147532550800846E-006 -1.0122953141789376E-005
EulAngT         theta(1)                  theta(2)                  theta(3)                  [rad]
Mean      -2.4879127898110348E-003 -1.9394937757041266E-003 -3.4932183827445979E-003
sSigmaT   +1.5813524366641565E-003 +5.1683390843776382E-007 +7.9779586826638154E-007
SigmaT    +1.4602919116373570E-003 +4.7726765941163574E-007 +7.3672056055048927E-007
-------------------------------------------------------------------------------------------------------
-------------------------------------------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  2              89            +0.000            +0.000     pixels
OFFSET FRAME NAME: MIPS_160um_large_only
qT              qT(1)                     qT(2)                     qT(3)                     qT(4)
WAS(FTB)  -1.6247706156225429E-006 -9.6996521888884340E-004 -1.6750781782660256E-003 +9.9999812663721077E-001
IS (EST)  -1.2455792128365179E-003 -9.6811005414947342E-004 -1.6766094070470093E-003 +9.9999735013461100E-001

DelTheta        deltheta(1)               deltheta(2)               deltheta(3)
Units             rad                       rad                       rad
          -2.4879140532740348E-003 -4.5943127254218959E-007 -6.5129110718746708E-007
EulAngT         theta(1)                  theta(2)                  theta(3)                  [rad]
Mean      -2.4879127898110348E-003 -1.9403928948638276E-003 -3.3508107915364003E-003
```

```
sSigmaT   +1.5813524478925859E-003 +3.3055403526848592E-007 +5.9586863138587752E-007
SigmaT    +1.4602919220061935E-003 +3.0524845244487103E-007 +5.5025187468441434E-007
-----------------------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  3              91            +3.500            +0.000     pixels
OFFSET FRAME NAME: MIPS_160um_small_FOV1
qT               qT(1)                    qT(2)                    qT(3)                    qT(4)
WAS(FTB)  -1.8535660093339217E-006 -1.1037735273119842E-003 -1.6792958163857940E-003 +9.9999798082102442E-001
IS (EST)  -1.2458267690948729E-003 -1.1171002931009127E-003 -1.6751241590375989E-003 +9.9999719697689571E-001

DelTheta        deltheta(1)               deltheta(2)               deltheta(3)
Units             rad                       rad                       rad
          -2.4878882305670192E-003 -3.0819406446737253E-005 +1.1125091432074713E-005
EulAngT         theta(1)                  theta(2)                  theta(3)                  [rad]
Mean      -2.4879127898110348E-003 -2.2383700218742862E-003 -3.3474701379575473E-003
sSigmaT   +1.5813523917988805E-003 +4.0866948876290655E-007 +6.5036423073590085E-007
SigmaT    +1.4602918702067448E-003 +3.7738377298885975E-007 +6.0057556035093219E-007
-----------------------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  4              92            -3.000            -0.500     pixels
OFFSET FRAME NAME: MIPS_160um_small_FOV2
qT               qT(1)                    qT(2)                    qT(3)                    qT(4)
WAS(FTB)  -1.4458583985377269E-006 -8.5506456275250009E-004 -1.6909317330203208E-003 +9.9999820480457724E-001
IS (EST)  -1.2453862952218860E-003 -8.4022470838780109E-004 -1.7016167860679071E-003 +9.9999742376454581E-001

DelTheta        deltheta(1)               deltheta(2)               deltheta(3)
Units             rad                       rad                       rad
          -2.4879457561177041E-003 +2.5447553534904845E-005 -1.9277038393748093E-005
EulAngT         theta(1)                  theta(2)                  theta(3)                  [rad]
Mean      -2.4879127898110348E-003 -1.6846842248931257E-003 -3.4011433796908865E-003
sSigmaT   +1.5813523836895090E-003 +4.1461931913222402E-007 +6.8838272584208422E-007
SigmaT    +1.4602918627181869E-003 +3.8287811375849670E-007 +6.3568354741882385E-007
-----------------------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  5               1           +10.000            +1.500     pixels
OFFSET FRAME NAME: CORNER PIXEL (DIAGNOSTICS)
qT               qT(1)                    qT(2)                    qT(3)                    qT(4)
WAS(FTB)  +0.0000000000000000E+000 +0.0000000000000000E+000 +0.0000000000000000E+000 +1.0000000000000000E+000
IS (EST)  -1.2461865937208160E-003 -1.3943345636189925E-003 -1.6011626036312276E-003 +9.9999696955961581E-001

DelTheta        deltheta(1)               deltheta(2)               deltheta(3)
Units             rad                       rad                       rad
          -2.4879127898110353E-003 -2.7926550010327861E-003 -3.1988582300063613E-003
EulAngT         theta(1)                  theta(2)                  theta(3)                  [rad]
Mean      -2.4879127898110348E-003 -2.7926550010327852E-003 -3.1988582300063609E-003
sSigmaT   +1.5813518908627344E-003 +9.1207104363517594E-007 +1.1193140426703704E-006
SigmaT    +1.4602914076197937E-003 +8.4224739342021435E-007 +1.0336248929692514E-006
-----------------------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  6               1           +10.000            -1.500     pixels
OFFSET FRAME NAME: CORNER PIXEL (DIAGNOSTICS)
qT               qT(1)                    qT(2)                    qT(3)                    qT(4)
WAS(FTB)  +0.0000000000000000E+000 +0.0000000000000000E+000 +0.0000000000000000E+000 +1.0000000000000000E+000
IS (EST)  -1.2463835807265118E-003 -1.3932579906514725E-003 -1.7435688658251616E-003 +9.9999673265853772E-001

DelTheta        deltheta(1)               deltheta(2)               deltheta(3)
Units             rad                       rad                       rad
          -2.4879127898110344E-003 -2.7908568109570688E-003 -3.4836738834371187E-003
EulAngT         theta(1)                  theta(2)                  theta(3)                  [rad]
Mean      -2.4879127898110348E-003 -2.7908568109570697E-003 -3.4836738834371195E-003
```

```
sSigmaT   +1.5813519071965060E-003 +8.6598011093546362E-007 +1.1142380769808143E-006
SigmaT    +1.4602914227031325E-003 +7.9968495467430567E-007 +1.0289375181195032E-006
-------------------------------------------------------------------------------------------------------
-------------------------------------------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  7               1           -10.000            +1.500     pixels
OFFSET FRAME NAME: CORNER PIXEL (DIAGNOSTICS)
qT               qT(1)                    qT(2)                    qT(3)                    qT(4)
WAS(FTB)  +0.0000000000000000E+000 +0.0000000000000000E+000 +0.0000000000000000E+000 +1.0000000000000000E+000
IS (EST)  -1.2448311117942000E-003 -5.4296182633187728E-004 -1.6096498020034830E-003 +9.9999778230527758E-001

DelTheta        deltheta(1)               deltheta(2)               deltheta(3)
Units             rad                       rad                       rad
          -2.4879127898110348E-003 -1.0899289445178016E-003 -3.2179481381460406E-003
EulAngT         theta(1)                  theta(2)                  theta(3)                  [rad]
Mean      -2.4879127898110348E-003 -1.0899289445178014E-003 -3.2179481381460406E-003
sSigmaT   +1.5813518168994402E-003 +9.1201380759122870E-007 +1.1279313500264084E-006
SigmaT    +1.4602913393187637E-003 +8.4219453908484141E-007 +1.0415825018743608E-006
-------------------------------------------------------------------------------------------------------
-------------------------------------------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  8               1           -10.000            -1.500     pixels
OFFSET FRAME NAME: CORNER PIXEL (DIAGNOSTICS)
qT               qT(1)                    qT(2)                    qT(3)                    qT(4)
WAS(FTB)  +0.0000000000000000E+000 +0.0000000000000000E+000 +0.0000000000000000E+000 +1.0000000000000000E+000
IS (EST)  -1.2449068468733087E-003 -5.4188544961339576E-004 -1.7520557079751275E-003 +9.9999754343093183E-001

DelTheta        deltheta(1)               deltheta(2)               deltheta(3)
Units             rad                       rad                       rad
          -2.4879127898110353E-003 -1.0881307438922725E-003 -3.5027628504915136E-003
EulAngT         theta(1)                  theta(2)                  theta(3)                  [rad]
Mean      -2.4879127898110348E-003 -1.0881307438922721E-003 -3.5027628504915131E-003
sSigmaT   +1.5813518197936673E-003 +8.9641357478577448E-007 +1.1888342181780901E-006
SigmaT    +1.4602913419914231E-003 +8.2778858298215219E-007 +1.0978229475178548E-006
-------------------------------------------------------------------------------------------------------
-------------------------------------------------------------------------------------------------------
              q(1)                     q(2)                     q(3)                     q(4)
PCRS1A: +5.2603126189317361E-007 +3.7451819048221893E-004 -1.4045531552277380E-003 +9.9999894348258311E-001
PCRS2A: -5.1968404336718985E-007 +3.8455385122900486E-004 +1.3513933841514693E-003 +9.9999901292650617E-001
-----------------------------------------------------------------------------------------
**********  CS-FILE PARAMETERS:  **********  **********  AS-FILE PARAMETERS:  **********
Row (01) PIX2RADX: +7.7399898172000000E-005  Row (1) TASTART:   +7.3051200000000000E+008
Row (02) PIX2RADY: +8.7086140999000005E-005  Row (2) TASTOP:    +7.3053335000000000E+008
Row (03) CX0:      +1.0500000000000000E+001  Row (3) S/C TIME:  +7.3051200000000000E+008
Row (04) CY0:      +2.0000000000000000E+000  Row (4) QR1:       +0.0000000000000000E+000
Row (05) BETA0:    +2.8047410000000001E-006  Row (5) QR2:       +0.0000000000000000E+000
Row (06) GAMMA_E0: +2.0070000000000000E+003  Row (6) QR3:       +0.0000000000000000E+000
Row (07) D11:      -1.0000000000000000E+000  Row (7) QR4:       +1.0000000000000000E+000
Row (08) D12:      +0.0000000000000000E+000
Row (09) D21:      +0.0000000000000000E+000
Row (10) D22:      -1.0000000000000000E+000
Row (11) DG:       +1.0000000000000000E+000
-----------------------------------------------------------------------------------------
-------------------------------------------------------
INITIAL STA-TO-PCRS ALIGNMENT (R) KNOWLEDGE (1-SIGMA)
    SIGMA(X)        SIGMA(Y)         SIGMA(Z)
2.82857904E+001  1.44427880E+000  1.44427880E+000  [arcsec]
-------------------------------------------------------
PIX2RADX = 7.739989817200E-005[rad/pixel]
XPIXSIZE = 15.9649[arcsec]
PIX2RADY = 8.708614099900E-005[rad/pixel]
YPIXSIZE = 17.9628[arcsec]
CX0 = 10.5[pixel] = 167.63[arcsec]
CY0 = 2.0[pixel] = 35.93[arcsec]
```

```
-----------------------------------------------------------
NOMINAL BETA0 = 2.804741000000E-006[rad/encoder unit]
ENCODER UNIT SIZE = 0.58[arcsec]
GAMMA_E0 = 2007.00[encoder unit] = 1161.09[arcsec]
-----------------------------------------------------------
                | -1 | +0 |
FLIP MATRIX D = |----|----|   and   DG = +1
                | +0 | -1 |
-----------------------------------------------------------
```

2.3 IPF MULTI-RUN EXECUTION LOG

```
**************************************************
*****          MULTI_RUN LOG FILE           *****
**************************************************

--------------------------------------------------
MULTI-RUN-LOG FILE NAME:  LG91M087.dat
INSTRUMENT TYPE:              MIPS_160um_center_large_FOV
MULTI-RUN EXECUTION DATE: 07-Aug-2003    TIME: 11:22
--------------------------------------------------


-------------------------------------------------------
MT991087 FILE LOADED!
q_T    = -4.5379004301719064E-004 -9.6912463893322396E-004 -1.6760556852169594E-003 +9.9999802285273098E-001
SigmaT = +2.6241699513274374E-003 +5.3075835562269583E-007 +9.3840741988321862E-007
Sigma Scale = +1.1053671199081707E+000

-------------------------------------------------------
MT992087 FILE LOADED!
q_T    = -8.3727218881193518E-004 -9.6895946521206161E-004 -1.6753200608121425E-003 +9.9999777669529366E-001
SigmaT = +2.4126251550432524E-003 +5.3618249702239098E-007 +9.5690412995389054E-007
Sigma Scale = +1.0973698732944897E+000

-------------------------------------------------------
MT993087 FILE LOADED!
q_T    = -1.5387154440668037E-003 -9.6770815576549931E-004 -1.6773348579678026E-003 +9.9999694121706273E-001
SigmaT = +2.6918643477867148E-003 +5.3805982477113312E-007 +9.8898505947639599E-007
Sigma Scale = +1.0280169085368138E+000

-------------------------------------------------------

-----------------------------------------------------------------
Conditioning Number for LSQ Filter was:  +4.4879729503269278E+007
-----------------------------------------------------------------

Merged q_T    = -1.2455792128365179E-003 -9.6811005414947353E-004 -1.6766094070470091E-003 +9.9999735013461100E-001
Merged SigmaT = +1.4602919220061932E-003 +3.0524845244487113E-007 +5.5025187468441423E-007
Merged Sigma Scale = +1.0829015925254697E+000

*********** Sigma T Ratios for Multi-Run ************
DATA#1 Expected:     1.73205 1.73205 1.73205
DATA#1 Calculated:   1.79702 1.73877 1.70541
-------------------------------------------------------
DATA#2 Expected:     1.73205 1.73205 1.73205
DATA#2 Calculated:   1.65215 1.75654 1.73903
```

```
-----------------------------------------------------
DATA#3 Expected:     1.73205 1.73205 1.73205
DATA#3 Calculated:   1.84337 1.76269 1.79733
-----------------------------------------------------


Merging LG Files!


*********************************************************************
IPF EXECUTION-LOG FILE NAME:  LG991087.dat
INSTRUMENT TYPE:              MIPS_160um_center_large_FOV
IPF FILTER EXECUTION DATE:    07-Aug-2003    TIME: 10:14
IPF FILTER VERSION USED:      IPF.V2.0.1Beta
*********************************************************************

------------------- Loading & Preparing Input Files -------------------
AAFILE:  AA991087 Loaded!        AAFILE dimension = 213501 X 21
ASFILE:  AS991087 Loaded!
CAFILE:  CA991087 Loaded!        CAFILE dimension = 246 X 15
CBFILE:  CB991087 Loaded!        CBFILE dimension = 90 X 15
CCFILE:  CC991087 Created!       CCFILE dimension = 336 X 19
CSFILE:  CS991087 Loaded!
Loading Input Files Completed!
---------------------------------------------------------------------

------------------------ Selected Mask Vectors ------------------------
index =   1  2  3  4  5  6  7  8  9 10 11 12 13 14 15 16 17 18 19 20
---------------------------------------------------------------------
mask1 = [ 1  1  1  1  1  1  1  0  0  0  0  0  0  0  0  0  0 ]
mask2 = [ 1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1 ]
---------------------------------------------------------------------

---------------  Selected Initial Gyro Bias Parameters  ---------------
User Entered 1 : Use AFILE database - from S/C filter
IPF Linearized Using Following Nominal Gyro Bias Estimates
bg0 = [+2.5139469464322443E-006 +2.4888835000837901E-006 +2.5115474422157735E-006 ]
cg0 = [+0.0000000000000000E+000 +0.0000000000000000E+000 +0.0000000000000000E+000 ]
---------------------------------------------------------------------

---------------  Gyro Pre-Processor Run Completed  --------------------
     AGFILE CREATED:  AG991087.m     ACFILE CREATED:  AC991087.m
---------------------------------------------------------------------
Total Gyro Preprocessor Execution Time: 82 seconds

FRAME TABLE ENTRIES FOR PCRS LOADED TO TPCRS
q_PCRS4 = [ +5.2603126189317361E-007     q_PCRS5 = [ +7.3379987833742897E-007
            +3.7451819048221893E-004                 +5.2236196154513707E-004
            -1.4045531552277380E-003                 -1.4047712280184723E-003
            +9.9999894348258311E-001 ];              +9.9999887687698918E-001 ];
q_PCRS8 = [ -5.1968404336718985E-007     q_PCRS9 = [ -7.1963421681856818E-007
            +3.8455385122900486E-004                 +5.3239763239987400E-004
            +1.3513933841514693E-003                 +1.3516841804518383E-003
            +9.9999901292650617E-001 ];              +9.9999894475050310E-001 ];
-------------------------------------------------------------------------------
------ Initial Conditions for State -----  ------   Inital Square-Root Cov (diag)   -----
p1(01)  = a00  = +0.0000000000000000E+000  Sigma_initial(01,01) = 1.0000000000000000E+000
p1(02)  = b00  = +0.0000000000000000E+000  Sigma_initial(02,02) = 1.0000000000000000E+000
p1(03)  = c00  = +0.0000000000000000E+000  Sigma_initial(03,03) = 1.0000000000000000E+000
p1(04)  = a10  = +0.0000000000000000E+000  Sigma_initial(04,04) = 3.6384517097704270E+002
p1(05)  = b10  = +0.0000000000000000E+000  Sigma_initial(05,05) = 3.6384517097704270E+002
p1(06)  = c10  = +0.0000000000000000E+000  Sigma_initial(06,06) = 3.6384517097704270E+002
p1(07)  = d10  = +0.0000000000000000E+000  Sigma_initial(07,07) = 3.6384517097704270E+002
p1(08)  = a20  = +0.0000000000000000E+000  Sigma_initial(08,08) = 9.9999000000000000E+004
```

```
p1(09)  = b20  = +0.0000000000000000E+000  Sigma_initial(09,09) = 9.9999000000000000E+004
p1(10)  = c20  = +0.0000000000000000E+000  Sigma_initial(10,10) = 9.9999000000000000E+004
p1(11)  = d20  = +0.0000000000000000E+000  Sigma_initial(11,11) = 9.9999000000000000E+004
p1(12)  = a01  = +0.0000000000000000E+000  Sigma_initial(12,12) = 9.9999000000000000E+004
p1(13)  = b01  = +0.0000000000000000E+000  Sigma_initial(13,13) = 9.9999000000000000E+004
p1(14)  = c01  = +0.0000000000000000E+000  Sigma_initial(14,14) = 9.9999000000000000E+004
p1(15)  = d01  = +0.0000000000000000E+000  Sigma_initial(15,15) = 9.9999000000000000E+004
p1(16)  = e01  = +0.0000000000000000E+000  Sigma_initial(16,16) = 9.9999000000000000E+004
p1(17)  = f01  = +0.0000000000000000E+000  Sigma_initial(17,17) = 9.9999000000000000E+004
-------------------------------------------------------------------------------------
p2f(01) = am1  = +0.0000000000000000E+000
p2f(02) = am2  = +0.0000000000000000E+000  Sigma_initial(18,18) = 1.0000000000000001E-001
p2f(03) = am3  = +1.0000000000000000E+000
p2f(04) = beta = +1.0000000000000000E+000  Sigma_initial(19,19) = 1.0000000000000001E-001
p2f(05) = qT1  = -1.6247706156225429E-006  Sigma_initial(20,20) = 1.0000000000000001E-001
p2f(06) = qT2  = -9.6996521888884340E-004  Sigma_initial(21,21) = 1.0000000000000000E-002
p2f(07) = aT3  = -1.6750781782660256E-003  Sigma_initial(22,22) = 1.0000000000000000E-002
p2f(08) = qT4  = +9.9999812663721077E-001
p2f(09) = qR1  = +0.0000000000000000E+000  Sigma_initial(23,23) = 3.4288868839039716E-003
p2f(10) = qR2  = +0.0000000000000000E+000  Sigma_initial(24,24) = 1.8555467699985827E-004
p2f(11) = qR3  = +0.0000000000000000E+000  Sigma_initial(25,25) = 1.8555467699985827E-004
p2f(12) = qR4  = +1.0000000000000000E+000
p2f(13) = brx  = +0.0000000000000000E+000  Sigma_initial(26,26) = 4.6838407494145199E-005
p2f(14) = bry  = +0.0000000000000000E+000  Sigma_initial(27,27) = 4.6838407494145199E-005
p2f(15) = brz  = +0.0000000000000000E+000  Sigma_initial(28,28) = 4.6838407494145199E-005
p2f(16) = crx  = +0.0000000000000000E+000  Sigma_initial(29,29) = 2.1938364165875972E-009
p2f(17) = cry  = +0.0000000000000000E+000  Sigma_initial(30,30) = 2.1938364165875972E-009
p2f(18) = crz  = +0.0000000000000000E+000  Sigma_initial(31,31) = 2.1938364165875972E-009
p2f(19) = bgx  = +0.0000000000000000E+000  Sigma_initial(32,32) = 4.6838407494145199E-005
p2f(20) = bgy  = +0.0000000000000000E+000  Sigma_initial(33,33) = 4.6838407494145199E-005
p2f(21) = bgz  = +0.0000000000000000E+000  Sigma_initial(34,34) = 4.6838407494145199E-005
p2f(22) = cgx  = +0.0000000000000000E+000  Sigma_initial(35,35) = 2.1938364165875972E-009
p2f(23) = cgy  = +0.0000000000000000E+000  Sigma_initial(36,36) = 2.1938364165875972E-009
p2f(24) = cgz  = +0.0000000000000000E+000  Sigma_initial(37,37) = 2.1938364165875972E-009
-------------------------------------------------------------------------------------

--------------------   IPF KALMAN FILTER STARTED  ---------------------
Iteration#001: |dp|= +4.137527534476E+001   RMS(|Res|)=+4.137527534476E+001
Iteration#002: |dp|= +4.371240032856E-001   RMS(|Res|)=+4.371240032856E-001
Iteration#003: |dp|= +1.400464287247E-001   RMS(|Res|)=+1.400464287247E-001
Iteration#004: |dp|= +3.009450405478E-002   RMS(|Res|)=+3.009450405478E-002
Iteration#005: |dp|= +2.326749948517E-003   RMS(|Res|)=+2.326749948517E-003
Iteration#006: |dp|= +1.834765269205E-004   RMS(|Res|)=+1.834765269205E-004
Iteration#007: |dp|= +4.540817172150E-005   RMS(|Res|)=+4.540817172150E-005
Iteration#008: |dp|= +1.587432796966E-006   RMS(|Res|)=+1.587432796966E-006
Iteration#009: |dp|= +3.763129877125E-007   RMS(|Res|)=+3.763129877125E-007
Iteration#010: |dp|= +5.453463773895E-008   RMS(|Res|)=+5.453463773895E-008
Iteration#011: |dp|= +8.065338785474E-010   RMS(|Res|)=+8.065338785474E-010
Iteration#012: |dp|= +3.582508874246E-010   RMS(|Res|)=+3.582508874246E-010
Iteration#013: |dp|= +9.866643390827E-011   RMS(|Res|)=+9.866643390827E-011
Iteration#014: |dp|= +2.373404315136E-010   RMS(|Res|)=+2.373404315136E-010
Iteration#015: |dp|= +2.133219366229E-010   RMS(|Res|)=+2.133219366229E-010
Iteration#016: |dp|= +4.958454715251E-011   RMS(|Res|)=+4.958454715251E-011
Iteration#017: |dp|= +1.300593695252E-010   RMS(|Res|)=+1.300593695252E-010
Iteration#018: |dp|= +1.552922439400E-010   RMS(|Res|)=+1.552922439400E-010
Iteration#019: |dp|= +1.016959933693E-010   RMS(|Res|)=+1.016959933693E-010
Iteration#020: |dp|= +2.456274893508E-010   RMS(|Res|)=+2.456274893508E-010
IPF Kalman Filter Completed with Error |dp1| + |dp2| = +2.4562748935082943E-010
-----------------------------------------------------------------------

-----------------  IPF LEAST SQUARES FILTER STARTED  ------------------
Iteration#001   COND#=+3.942183499198E+010,   |dp|=+4.154187128734E+001
Iteration#002   COND#=+3.942094363745E+010,   |dp|=+1.280509692547E-001
Iteration#003   COND#=+3.942094052429E+010,   |dp|=+6.279360983096E-003
```

```
Iteration#004   COND#=+3.942093180866E+010,   |dp|=+2.854248378450E-004
Iteration#005   COND#=+3.942094648365E+010,   |dp|=+5.395802862082E-006
Iteration#006   COND#=+3.942093332236E+010,   |dp|=+1.150834027577E-007
Iteration#007   COND#=+3.942093435222E+010,   |dp|=+2.296231440023E-009
Iteration#008   COND#=+3.942094631964E+010,   |dp|=+1.316382942848E-010
Iteration#009   COND#=+3.942094536198E+010,   |dp|=+1.744356146930E-010
Iteration#010   COND#=+3.942091270643E+010,   |dp|=+2.459107657621E-010
Iteration#011   COND#=+3.942095562400E+010,   |dp|=+2.643153781438E-010
Iteration#012   COND#=+3.942094540649E+010,   |dp|=+1.228273717924E-010
Iteration#013   COND#=+3.942095130736E+010,   |dp|=+5.960471586383E-011
Iteration#014   COND#=+3.942095344114E+010,   |dp|=+1.077026549508E-010
Iteration#015   COND#=+3.942093969056E+010,   |dp|=+2.260484524609E-010
Iteration#016   COND#=+3.942096396743E+010,   |dp|=+1.903705478941E-010
Iteration#017   COND#=+3.942094600651E+010,   |dp|=+6.209417520313E-011
Iteration#018   COND#=+3.942095017314E+010,   |dp|=+1.307336232686E-010
Iteration#019   COND#=+3.942095390685E+010,   |dp|=+2.201190116275E-010
Iteration#020   COND#=+3.942093383878E+010,   |dp|=+1.880325271552E-010
IPF Least Squares Filter Completed with Error |dp1| + |dp2| = +1.8803252715517054E-010
----------------------------------------------------------------------
Total Execution Time: 1051 seconds




**********************************************************************
IPF EXECUTION-LOG FILE NAME:  LG992087.dat
INSTRUMENT TYPE:              MIPS_160um_center_large_FOV
IPF FILTER EXECUTION DATE:    07-Aug-2003    TIME: 11:04
IPF FILTER VERSION USED:      IPF.V2.0.1Beta
**********************************************************************

------------------- Loading & Preparing Input Files -------------------
AAFILE:  AA992087 Loaded!        AAFILE dimension = 213501 X 21
ASFILE:  AS992087 Loaded!
CAFILE:  CA992087 Loaded!        CAFILE dimension = 249 X 15
CBFILE:  CB992087 Loaded!        CBFILE dimension = 90 X 15
CCFILE:  CC992087 Created!       CCFILE dimension = 339 X 19
CSFILE:  CS992087 Loaded!
Loading Input Files Completed!
----------------------------------------------------------------------

------------------------- Selected Mask Vectors ------------------------
index =   1  2  3  4  5  6  7  8  9 10 11 12 13 14 15 16 17 18 19 20
----------------------------------------------------------------------
mask1 = [ 1  1  1  1  1  1  1  0  0  0  0  0  0  0  0  0  0 ]
mask2 = [ 1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1 ]
----------------------------------------------------------------------

---------------  Selected Initial Gyro Bias Parameters  ---------------
User Entered 1 : Use AFILE database - from S/C filter
IPF Linearized Using Following Nominal Gyro Bias Estimates
bg0 = [+1.4533739153217648E-006 +1.9992046246169240E-007 +2.6049877787211708E-007 ]
cg0 = [+0.0000000000000000E+000 +0.0000000000000000E+000 +0.0000000000000000E+000 ]
----------------------------------------------------------------------

---------------  Gyro Pre-Processor Run Completed  --------------------
     AGFILE CREATED:  AG992087.m     ACFILE CREATED:  AC992087.m
----------------------------------------------------------------------
Total Gyro Preprocessor Execution Time: 81 seconds

FRAME TABLE ENTRIES FOR PCRS LOADED TO TPCRS
q_PCRS4 = [ +5.2603126189317361E-007     q_PCRS5 = [ +7.3379987833742897E-007
            +3.7451819048221893E-004                 +5.2236196154513707E-004
            -1.4045531552277380E-003                 -1.4047712280184723E-003
```

```
            +9.9999894348258311E-001 ];              +9.9999887687698918E-001 ];
q_PCRS8 = [ -5.1968404336718985E-007     q_PCRS9 = [ -7.1963421681856818E-007
            +3.8455385122900486E-004                 +5.3239763239987400E-004
            +1.3513933841514693E-003                 +1.3516841804518383E-003
            +9.9999901292650617E-001 ];              +9.9999894475050310E-001 ];
-------------------------------------------------------------------------------
------ Initial Conditions for State -----  ------   Inital Square-Root Cov (diag)   -----
p1(01)  = a00  = +0.0000000000000000E+000  Sigma_initial(01,01) = 1.0000000000000000E+000
p1(02)  = b00  = +0.0000000000000000E+000  Sigma_initial(02,02) = 1.0000000000000000E+000
p1(03)  = c00  = +0.0000000000000000E+000  Sigma_initial(03,03) = 1.0000000000000000E+000
p1(04)  = a10  = +0.0000000000000000E+000  Sigma_initial(04,04) = 3.6384517097704270E+002
p1(05)  = b10  = +0.0000000000000000E+000  Sigma_initial(05,05) = 3.6384517097704270E+002
p1(06)  = c10  = +0.0000000000000000E+000  Sigma_initial(06,06) = 3.6384517097704270E+002
p1(07)  = d10  = +0.0000000000000000E+000  Sigma_initial(07,07) = 3.6384517097704270E+002
p1(08)  = a20  = +0.0000000000000000E+000  Sigma_initial(08,08) = 9.9999000000000000E+004
p1(09)  = b20  = +0.0000000000000000E+000  Sigma_initial(09,09) = 9.9999000000000000E+004
p1(10)  = c20  = +0.0000000000000000E+000  Sigma_initial(10,10) = 9.9999000000000000E+004
p1(11)  = d20  = +0.0000000000000000E+000  Sigma_initial(11,11) = 9.9999000000000000E+004
p1(12)  = a01  = +0.0000000000000000E+000  Sigma_initial(12,12) = 9.9999000000000000E+004
p1(13)  = b01  = +0.0000000000000000E+000  Sigma_initial(13,13) = 9.9999000000000000E+004
p1(14)  = c01  = +0.0000000000000000E+000  Sigma_initial(14,14) = 9.9999000000000000E+004
p1(15)  = d01  = +0.0000000000000000E+000  Sigma_initial(15,15) = 9.9999000000000000E+004
p1(16)  = e01  = +0.0000000000000000E+000  Sigma_initial(16,16) = 9.9999000000000000E+004
p1(17)  = f01  = +0.0000000000000000E+000  Sigma_initial(17,17) = 9.9999000000000000E+004
-------------------------------------------------------------------------------------
p2f(01) = am1  = +0.0000000000000000E+000
p2f(02) = am2  = +0.0000000000000000E+000  Sigma_initial(18,18) = 1.0000000000000001E-001
p2f(03) = am3  = +1.0000000000000000E+000
p2f(04) = beta = +1.0000000000000000E+000  Sigma_initial(19,19) = 1.0000000000000001E-001
p2f(05) = qT1  = -1.6247706156225429E-006  Sigma_initial(20,20) = 1.0000000000000001E-001
p2f(06) = qT2  = -9.6996521888884340E-004  Sigma_initial(21,21) = 1.0000000000000000E-002
p2f(07) = aT3  = -1.6750781782660256E-003  Sigma_initial(22,22) = 1.0000000000000000E-002
p2f(08) = qT4  = +9.9999812663721077E-001
p2f(09) = qR1  = +0.0000000000000000E+000  Sigma_initial(23,23) = 3.4288868839039716E-003
p2f(10) = qR2  = +0.0000000000000000E+000  Sigma_initial(24,24) = 1.8555467699985827E-004
p2f(11) = qR3  = +0.0000000000000000E+000  Sigma_initial(25,25) = 1.8555467699985827E-004
p2f(12) = qR4  = +1.0000000000000000E+000
p2f(13) = brx  = +0.0000000000000000E+000  Sigma_initial(26,26) = 4.6838407494145199E-005
p2f(14) = bry  = +0.0000000000000000E+000  Sigma_initial(27,27) = 4.6838407494145199E-005
p2f(15) = brz  = +0.0000000000000000E+000  Sigma_initial(28,28) = 4.6838407494145199E-005
p2f(16) = crx  = +0.0000000000000000E+000  Sigma_initial(29,29) = 2.1938364165875972E-009
p2f(17) = cry  = +0.0000000000000000E+000  Sigma_initial(30,30) = 2.1938364165875972E-009
p2f(18) = crz  = +0.0000000000000000E+000  Sigma_initial(31,31) = 2.1938364165875972E-009
p2f(19) = bgx  = +0.0000000000000000E+000  Sigma_initial(32,32) = 4.6838407494145199E-005
p2f(20) = bgy  = +0.0000000000000000E+000  Sigma_initial(33,33) = 4.6838407494145199E-005
p2f(21) = bgz  = +0.0000000000000000E+000  Sigma_initial(34,34) = 4.6838407494145199E-005
p2f(22) = cgx  = +0.0000000000000000E+000  Sigma_initial(35,35) = 2.1938364165875972E-009
p2f(23) = cgy  = +0.0000000000000000E+000  Sigma_initial(36,36) = 2.1938364165875972E-009
p2f(24) = cgz  = +0.0000000000000000E+000  Sigma_initial(37,37) = 2.1938364165875972E-009
-------------------------------------------------------------------------------------

--------------------   IPF KALMAN FILTER STARTED  ---------------------
Iteration#001: |dp|= +1.999847106850E+001   RMS(|Res|)=+1.999847106850E+001
Iteration#002: |dp|= +9.933952346043E-002   RMS(|Res|)=+9.933952346043E-002
Iteration#003: |dp|= +3.861995501547E-002   RMS(|Res|)=+3.861995501547E-002
Iteration#004: |dp|= +3.342539604902E-002   RMS(|Res|)=+3.342539604902E-002
Iteration#005: |dp|= +2.009974237346E-003   RMS(|Res|)=+2.009974237346E-003
Iteration#006: |dp|= +1.387338970076E-004   RMS(|Res|)=+1.387338970076E-004
Iteration#007: |dp|= +4.366552602098E-005   RMS(|Res|)=+4.366552602098E-005
Iteration#008: |dp|= +1.670930077031E-006   RMS(|Res|)=+1.670930077031E-006
Iteration#009: |dp|= +3.047686420586E-007   RMS(|Res|)=+3.047686420586E-007
Iteration#010: |dp|= +5.009943655212E-008   RMS(|Res|)=+5.009943655212E-008
Iteration#011: |dp|= +9.435177411522E-010   RMS(|Res|)=+9.435177411522E-010
Iteration#012: |dp|= +4.900516552601E-010   RMS(|Res|)=+4.900516552601E-010
```

```
Iteration#013: |dp|= +1.208566563047E-010   RMS(|Res|)=+1.208566563047E-010
Iteration#014: |dp|= +1.769146037592E-010   RMS(|Res|)=+1.769146037592E-010
Iteration#015: |dp|= +9.212673092940E-011   RMS(|Res|)=+9.212673092940E-011
Iteration#016: |dp|= +7.764744042672E-011   RMS(|Res|)=+7.764744042672E-011
Iteration#017: |dp|= +2.728783030523E-010   RMS(|Res|)=+2.728783030523E-010
Iteration#018: |dp|= +2.279232053297E-010   RMS(|Res|)=+2.279232053297E-010
Iteration#019: |dp|= +2.675309819573E-010   RMS(|Res|)=+2.675309819573E-010
Iteration#020: |dp|= +7.314416978067E-011   RMS(|Res|)=+7.314416978067E-011
IPF Kalman Filter Completed with Error |dp1| + |dp2| = +7.3144169780673638E-011
----------------------------------------------------------------------

-----------------  IPF LEAST SQUARES FILTER STARTED  ------------------
Iteration#001   COND#=+3.381487757819E+010,   |dp|=+2.001876777537E+001
Iteration#002   COND#=+3.381825124828E+010,   |dp|=+1.570094186464E-001
Iteration#003   COND#=+3.381821239213E+010,   |dp|=+7.185341399274E-003
Iteration#004   COND#=+3.381821946841E+010,   |dp|=+1.344697797293E-004
Iteration#005   COND#=+3.381819570833E+010,   |dp|=+2.319059913135E-006
Iteration#006   COND#=+3.381819725876E+010,   |dp|=+4.443215627923E-008
Iteration#007   COND#=+3.381821519873E+010,   |dp|=+8.865756983957E-010
Iteration#008   COND#=+3.381820017364E+010,   |dp|=+6.365981956958E-011
Iteration#009   COND#=+3.381818652444E+010,   |dp|=+4.696427279690E-011
Iteration#010   COND#=+3.381820155494E+010,   |dp|=+1.790252730767E-010
Iteration#011   COND#=+3.381820600108E+010,   |dp|=+2.447886587022E-010
Iteration#012   COND#=+3.381821063869E+010,   |dp|=+1.759607218536E-010
Iteration#013   COND#=+3.381821839033E+010,   |dp|=+7.874052030914E-011
Iteration#014   COND#=+3.381820742519E+010,   |dp|=+1.966787719177E-010
Iteration#015   COND#=+3.381822341074E+010,   |dp|=+1.093661768371E-010
Iteration#016   COND#=+3.381822216200E+010,   |dp|=+1.441532486885E-010
Iteration#017   COND#=+3.381822827104E+010,   |dp|=+1.766151399112E-010
Iteration#018   COND#=+3.381821788174E+010,   |dp|=+2.096103689677E-010
Iteration#019   COND#=+3.381823092639E+010,   |dp|=+2.595734180608E-010
Iteration#020   COND#=+3.381817990897E+010,   |dp|=+1.999649843126E-010
IPF Least Squares Filter Completed with Error |dp1| + |dp2| = +1.9996498431262444E-010
----------------------------------------------------------------------
Total Execution Time: 160 seconds



**********************************************************************
IPF EXECUTION-LOG FILE NAME:  LG993087.dat
INSTRUMENT TYPE:              MIPS_160um_center_large_FOV
IPF FILTER EXECUTION DATE:    07-Aug-2003    TIME: 11:14
IPF FILTER VERSION USED:      IPF.V2.0.1Beta
**********************************************************************

------------------- Loading & Preparing Input Files -------------------
AAFILE:  AA993087 Loaded!        AAFILE dimension = 213501 X 21
ASFILE:  AS993087 Loaded!
CAFILE:  CA993087 Loaded!        CAFILE dimension = 249 X 15
CBFILE:  CB993087 Loaded!        CBFILE dimension = 90 X 15
CCFILE:  CC993087 Created!       CCFILE dimension = 339 X 19
CSFILE:  CS993087 Loaded!
Loading Input Files Completed!
----------------------------------------------------------------------

------------------------ Selected Mask Vectors ------------------------
index =   1  2  3  4  5  6  7  8  9 10 11 12 13 14 15 16 17 18 19 20
----------------------------------------------------------------------
mask1 = [ 1  1  1  1  1  1  1  0  0  0  0  0  0  0  0  0  0 ]
mask2 = [ 1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1 ]
----------------------------------------------------------------------

---------------  Selected Initial Gyro Bias Parameters  ---------------
```

```
User Entered 1 : Use AFILE database - from S/C filter
IPF Linearized Using Following Nominal Gyro Bias Estimates
bg0 = [+2.5251665160679224E-006 +2.5247243427881652E-006 +2.5081344568492892E-006 ]
cg0 = [+0.0000000000000000E+000 +0.0000000000000000E+000 +0.0000000000000000E+000 ]
-----------------------------------------------------------------------

---------------  Gyro Pre-Processor Run Completed  --------------------
     AGFILE CREATED:  AG993087.m     ACFILE CREATED:  AC993087.m
-----------------------------------------------------------------------
Total Gyro Preprocessor Execution Time: 88 seconds

FRAME TABLE ENTRIES FOR PCRS LOADED TO TPCRS
q_PCRS4 = [ +5.2603126189317361E-007     q_PCRS5 = [ +7.3379987833742897E-007
            +3.7451819048221893E-004                 +5.2236196154513707E-004
            -1.4045531552277380E-003                 -1.4047712280184723E-003
            +9.9999894348258311E-001 ];              +9.9999887687698918E-001 ];
q_PCRS8 = [ -5.1968404336718985E-007     q_PCRS9 = [ -7.1963421681856818E-007
            +3.8455385122900486E-004                 +5.3239763239987400E-004
            +1.3513933841514693E-003                 +1.3516841804518383E-003
            +9.9999901292650617E-001 ];              +9.9999894475050310E-001 ];
-------------------------------------------------------------------------------
------ Initial Conditions for State -----  ------   Inital Square-Root Cov (diag)   -----
p1(01)  = a00  = +0.0000000000000000E+000  Sigma_initial(01,01) = 1.0000000000000000E+000
p1(02)  = b00  = +0.0000000000000000E+000  Sigma_initial(02,02) = 1.0000000000000000E+000
p1(03)  = c00  = +0.0000000000000000E+000  Sigma_initial(03,03) = 1.0000000000000000E+000
p1(04)  = a10  = +0.0000000000000000E+000  Sigma_initial(04,04) = 3.6384517097704270E+002
p1(05)  = b10  = +0.0000000000000000E+000  Sigma_initial(05,05) = 3.6384517097704270E+002
p1(06)  = c10  = +0.0000000000000000E+000  Sigma_initial(06,06) = 3.6384517097704270E+002
p1(07)  = d10  = +0.0000000000000000E+000  Sigma_initial(07,07) = 3.6384517097704270E+002
p1(08)  = a20  = +0.0000000000000000E+000  Sigma_initial(08,08) = 9.9999000000000000E+004
p1(09)  = b20  = +0.0000000000000000E+000  Sigma_initial(09,09) = 9.9999000000000000E+004
p1(10)  = c20  = +0.0000000000000000E+000  Sigma_initial(10,10) = 9.9999000000000000E+004
p1(11)  = d20  = +0.0000000000000000E+000  Sigma_initial(11,11) = 9.9999000000000000E+004
p1(12)  = a01  = +0.0000000000000000E+000  Sigma_initial(12,12) = 9.9999000000000000E+004
p1(13)  = b01  = +0.0000000000000000E+000  Sigma_initial(13,13) = 9.9999000000000000E+004
p1(14)  = c01  = +0.0000000000000000E+000  Sigma_initial(14,14) = 9.9999000000000000E+004
p1(15)  = d01  = +0.0000000000000000E+000  Sigma_initial(15,15) = 9.9999000000000000E+004
p1(16)  = e01  = +0.0000000000000000E+000  Sigma_initial(16,16) = 9.9999000000000000E+004
p1(17)  = f01  = +0.0000000000000000E+000  Sigma_initial(17,17) = 9.9999000000000000E+004
-------------------------------------------------------------------------------------------
p2f(01) = am1  = +0.0000000000000000E+000
p2f(02) = am2  = +0.0000000000000000E+000  Sigma_initial(18,18) = 1.0000000000000001E-001
p2f(03) = am3  = +1.0000000000000000E+000
p2f(04) = beta = +1.0000000000000000E+000  Sigma_initial(19,19) = 1.0000000000000001E-001
p2f(05) = qT1  = -1.6247706156225429E-006  Sigma_initial(20,20) = 1.0000000000000001E-001
p2f(06) = qT2  = -9.6996521888884340E-004  Sigma_initial(21,21) = 1.0000000000000000E-002
p2f(07) = aT3  = -1.6750781782660256E-003  Sigma_initial(22,22) = 1.0000000000000000E-002
p2f(08) = qT4  = +9.9999812663721077E-001
p2f(09) = qR1  = +0.0000000000000000E+000  Sigma_initial(23,23) = 6.8566690868928238E-003
p2f(10) = qR2  = +0.0000000000000000E+000  Sigma_initial(24,24) = 3.5010305970939351E-004
p2f(11) = qR3  = +0.0000000000000000E+000  Sigma_initial(25,25) = 3.5010305970939351E-004
p2f(12) = qR4  = +1.0000000000000000E+000
p2f(13) = brx  = +0.0000000000000000E+000  Sigma_initial(26,26) = 4.6838407494145199E-005
p2f(14) = bry  = +0.0000000000000000E+000  Sigma_initial(27,27) = 4.6838407494145199E-005
p2f(15) = brz  = +0.0000000000000000E+000  Sigma_initial(28,28) = 4.6838407494145199E-005
p2f(16) = crx  = +0.0000000000000000E+000  Sigma_initial(29,29) = 2.1938364165875972E-009
p2f(17) = cry  = +0.0000000000000000E+000  Sigma_initial(30,30) = 2.1938364165875972E-009
p2f(18) = crz  = +0.0000000000000000E+000  Sigma_initial(31,31) = 2.1938364165875972E-009
p2f(19) = bgx  = +0.0000000000000000E+000  Sigma_initial(32,32) = 4.6838407494145199E-005
p2f(20) = bgy  = +0.0000000000000000E+000  Sigma_initial(33,33) = 4.6838407494145199E-005
p2f(21) = bgz  = +0.0000000000000000E+000  Sigma_initial(34,34) = 4.6838407494145199E-005
p2f(22) = cgx  = +0.0000000000000000E+000  Sigma_initial(35,35) = 2.1938364165875972E-009
p2f(23) = cgy  = +0.0000000000000000E+000  Sigma_initial(36,36) = 2.1938364165875972E-009
p2f(24) = cgz  = +0.0000000000000000E+000  Sigma_initial(37,37) = 2.1938364165875972E-009
```

```
-----------------------------------------------------------------------------------------

--------------------   IPF KALMAN FILTER STARTED  ---------------------
Iteration#001: |dp|= +4.029676007181E+001   RMS(|Res|)=+4.029676007181E+001
Iteration#002: |dp|= +5.282950252704E-001   RMS(|Res|)=+5.282950252704E-001
Iteration#003: |dp|= +1.614164664628E-001   RMS(|Res|)=+1.614164664628E-001
Iteration#004: |dp|= +2.453774636636E-002   RMS(|Res|)=+2.453774636636E-002
Iteration#005: |dp|= +2.180955620480E-003   RMS(|Res|)=+2.180955620480E-003
Iteration#006: |dp|= +1.454485418499E-004   RMS(|Res|)=+1.454485418499E-004
Iteration#007: |dp|= +3.649178633166E-005   RMS(|Res|)=+3.649178633166E-005
Iteration#008: |dp|= +1.353318003041E-006   RMS(|Res|)=+1.353318003041E-006
Iteration#009: |dp|= +3.025645594585E-007   RMS(|Res|)=+3.025645594585E-007
Iteration#010: |dp|= +4.164738120791E-008   RMS(|Res|)=+4.164738120791E-008
Iteration#011: |dp|= +8.773322306149E-010   RMS(|Res|)=+8.773322306149E-010
Iteration#012: |dp|= +3.390032971181E-010   RMS(|Res|)=+3.390032971181E-010
Iteration#013: |dp|= +1.158245964185E-010   RMS(|Res|)=+1.158245964185E-010
Iteration#014: |dp|= +1.411784934518E-010   RMS(|Res|)=+1.411784934518E-010
Iteration#015: |dp|= +1.070416966310E-010   RMS(|Res|)=+1.070416966310E-010
Iteration#016: |dp|= +9.751481343705E-011   RMS(|Res|)=+9.751481343705E-011
Iteration#017: |dp|= +9.840918351524E-011   RMS(|Res|)=+9.840918351524E-011
Iteration#018: |dp|= +1.407523060556E-010   RMS(|Res|)=+1.407523060556E-010
Iteration#019: |dp|= +7.585900090966E-011   RMS(|Res|)=+7.585900090966E-011
Iteration#020: |dp|= +2.067754603427E-010   RMS(|Res|)=+2.067754603427E-010
IPF Kalman Filter Completed with Error |dp1| + |dp2| = +2.0677546034266681E-010
-----------------------------------------------------------------------

-----------------  IPF LEAST SQUARES FILTER STARTED  ------------------
Iteration#001   COND#=+3.943750831106E+010,   |dp|=+4.047932360700E+001
Iteration#002   COND#=+3.943727406129E+010,   |dp|=+1.946959761428E-001
Iteration#003   COND#=+3.943726246631E+010,   |dp|=+6.050553728619E-003
Iteration#004   COND#=+3.943727019152E+010,   |dp|=+1.843300528360E-004
Iteration#005   COND#=+3.943726240642E+010,   |dp|=+2.993102454655E-006
Iteration#006   COND#=+3.943726641536E+010,   |dp|=+5.153371987705E-008
Iteration#007   COND#=+3.943726833930E+010,   |dp|=+8.502458336145E-010
Iteration#008   COND#=+3.943728122590E+010,   |dp|=+1.204877082591E-010
Iteration#009   COND#=+3.943728519807E+010,   |dp|=+1.723012490943E-010
Iteration#010   COND#=+3.943727582011E+010,   |dp|=+1.163637850246E-010
Iteration#011   COND#=+3.943726482800E+010,   |dp|=+1.306400441671E-010
Iteration#012   COND#=+3.943726209974E+010,   |dp|=+1.212662529515E-010
Iteration#013   COND#=+3.943728980978E+010,   |dp|=+4.495041018123E-011
Iteration#014   COND#=+3.943727238473E+010,   |dp|=+9.708726932404E-011
Iteration#015   COND#=+3.943728233905E+010,   |dp|=+3.200750364969E-010
Iteration#016   COND#=+3.943727700746E+010,   |dp|=+2.419550499585E-010
Iteration#017   COND#=+3.943727448735E+010,   |dp|=+1.210377920819E-010
Iteration#018   COND#=+3.943727886560E+010,   |dp|=+8.752763969784E-011
Iteration#019   COND#=+3.943727062660E+010,   |dp|=+1.925832426863E-010
Iteration#020   COND#=+3.943725595885E+010,   |dp|=+3.151805131511E-010
IPF Least Squares Filter Completed with Error |dp1| + |dp2| = +3.1518051315114060E-010
-----------------------------------------------------------------------
Total Execution Time: 176 seconds
```

3 USER COMMENTS

This section left blank.

IPF TEAM CONTACT INFORMATION

IPF Team email		ipf@sirtfweb.jpl.nasa.gov	
David S. Bayard	X4-8208	David.S.Bayard@jpl.nasa.gov	(TEAM LEADER)
Dhemetrio Boussalis	X4-3977	boussali@grover.jpl.nasa.gov	
Paul Brugarolas	X4-9243	Paul.Brugarolas@jpl.nasa.gov	
Bryan H. Kang	X4-0541	Bryan.H.Kang@jpl.nasa.gov	
Edward.C.Wong	X4-3053	Edward.C.Wong@jpl.nasa.gov	(TASK MANAGER)

ACKNOWLEDGEMENTS

This work was performed at the Jet Propulsion Laboratory, California Institute of Technology, under contract with the National Aeronautics and Space Administration.

References

[1] D.S. Bayard, B.H. Kang, *SIRTF Instrument Pointing Frame Kalman Filter Algorithm*, JPL D-Document D-24809, September 30, 2003.

[2] B.H. Kang, D.S. Bayard, *SIRTF Instrument Pointing Frame (IPF) Software Description Document and User's Guide*, JPL D-Document D-24808, September 30, 2003.

[3] D.S. Bayard, B.H. Kang, *SIRTF Instrument Pointing Frame (IPF) Kalman Filter Unit Test Report*, JPL D-Document D-24810, September 30, 2003.

[4] *Space Infrared Telescope Facility In-Orbit Checkout and Science Verification Mission Plan*, JPL D-Document D-22622, 674-FE-301 Version 1.4, February 8, 2002.

[5] *Space Infrared Telescope Facility Observatory Description Document*, Lockheed Martin LMMS/P458569, 674-SEIT-300 Version 1.2, November 1, 2002.

[6] *SIRTF Software Interface Specification for Science Centroid INPUT Files (CAFILE, CSFILE)*, JPL SOS-SIS-2002, November 18, 2002.

[7] *SIRTF Software Interface Specification for Inferred Frames Offset INPUT Files (OFILE)*, JPL SOS-SIS-2003, November 18, 2002.

[8] *SIRTF Software Interface Specification for PCRS Centroid INPUT Files (CBFILE)*, JPL SIS-FES-015, November 18, 2002.

[9] *SIRTF Software Interface Specification for Attitude INPUT Files (AFILE, ASFILE)*, JPL SIS-FES-014, January 7, 2002.

[10] *SIRTF Software Interface Specification for IPF Filter Output Files (IFFILE, LGFILE, TARFILE)*, JPL SOS-SIS-2005, November 18, 2002.

[11] R.J. Brown, *Focal Surface to Object Space Field of View Conversion.* Systems Engineering Report SER No. S20447-OPT-051, Ball Aerospace & Technologies Corp., November 23, 1999.

This page left blank.

JET PROPULSION LABORATORY **SIRTF IPF REPORT**
JPL ID991095
August 5, 2003

SIRTF INSTRUMENT POINTING FRAME KALMAN FILTER EXECUTION SUMMARY

IPF RUN NUMBER: 991095
REPORT TYPE: COVARIANCE ANALYSIS

PRIME FRAME: MIPS_24um_center (95)
INFERRED FRAMES: (96) (99) (100) (103) (104) (1) (1) (1) (1)

IPF TEAM

Autonomy and Control Section (345)
Jet Propulsion Laboratory
California Institute of Technology
4800 Oak Grove Drive
Pasadena, CA 91109

Contents

1 IPF EXECUTION SUMMARY **4**

2 FLUTE DATA SUMMARY **8**

2.1 FLUTE CONFIGURATION PARAMETERS 8

2.2 FLUTE GENERATED UNIT TEST DATA 11

3 IPF EXECUTION RESULTS **15**

3.1 IPF EXECUTION OUTPUT PLOTS 15

3.2 IPF OUTPUT DATA (IF MINI FILE) 29

3.3 IPF EXECUTION LOG 34

4 USER COMMENTS **38**

List of Figures

1.1 A-priori and a-posteriori IPF frames 4

1.2 A-priori and a-posteriori IPF frames (ZOOMED) 7

2.1 Focal plane survey scenario plot (See key in [3]) 11

2.2 Commanded-only source locations 12

2.3 True (+) and commanded (o) source locations 12

2.4 True (+) and commanded (o) source locations (ZOOMED) 13

2.5 True-sampled (o) and centroided (+) locations on S/I array (W,V) 13

2.6 True (o) and centroided (+) locations on S/I array (W,V) 14

2.7 True (o) and centroided (+) locations on S/I array (W,V) showing prime and inferred frames 14

3.1 TPF coords of measurements and a-priori predicts 16

3.2 Oriented Pixel Coords of measurements and a-priori predicts 16

3.3 A-priori prediction error 17

3.4 Oriented Pixel Coords of measurements and a-priori predicts (PCRS only) 17

3.5 IPF execution convergence, chart 1 18

3.6 IPF execution convergence, chart 2 18

3.7 Parameter uncertainty convergence 19

3.8 IPF parameter symbol table 19

3.9 KF parameter error sigma plots . . . 20
3.10 LS parameter error sigma plot . . . 20
3.11 KF and LS parameter error sigma plot . . . 21
3.12 Oriented Pixel Coords of meas. and a-posteriori predicts . . . 22
3.13 Oriented Pixel Coords of meas. and a-posteriori predicts (attitude corrected) . . . 22
3.14 Array plot with (solid) and w/o (dashed) optical distortion corrections . . . 23
3.15 KF innovations with (o) and w/o (+) attitude corrections . . . 23
3.16 W-axis KF innovations and 1-sigma bound . . . 24
3.17 V-axis KF innovations and 1-sigma bound . . . 24
3.18 Estimated attitude corrections (Body frame) . . . 25
3.19 Estimated attitude error sigma plot (Body frame) . . . 25
3.20 Thermo-mechanical boresight drift (equiv. angle in (W,V) coords) . . . 26
3.21 Thermo-mechanical boresight drift (equiv. angle in Body frame) . . . 26
3.22 Gyro drift bias contribution (equiv. rate in (W,V) coords) . . . 27
3.23 Gyro drift bias contribution (equiv. angle in (W,V) coords) . . . 27
3.24 Gyro drift bias contribution (equiv. angle in Body frame) . . . 28

List of Tables

1.1 IPF filter input files . . . 5
1.2 IPF filter execution configuration . . . 5
1.3 IPF filter execution mask vector assignment . . . 5
1.4 IPF calibration error summary ([arcsec], 1-sigma, radial) . . . 6
1.5 Measurement prediction error summary (1-sigma) . . . 6
1.6 IPF Brown angle summary . . . 7
2.1 FLUTE Parameter Table (1) . . . 8
2.2 FLUTE Parameter Table (2) . . . 9
2.3 FLUTE Parameter Table (3) . . . 10
2.4 Table of figures (FLUTE) . . . 11
3.1 Table of figures (IPF run) . . . 15

1 IPF EXECUTION SUMMARY

This report summarizes the SIRTF Instrument Pointing Frame (IPF) Kalman Filter execution associated with run file: RN991095. In particular, this Focal Point Survey calibrates the instrument: MIPS_24um_center (95), as part of the Covariance Analysis. The main calibration results from the IPF filter execution have been documented in IF991095 typically stored in the mission archive DOM collection IPF_IF. This report only summarizes the main aspects of the run, and does not substitute for the full information contained in the IF file.

Section 1 summarizes the filter execution results. The filter configurations are tabulated in Table 1.2 and the mask vector assignments are tabulated in Table 1.3. A total of 37 state parameters are estimated in this run. The overall End-to-End pointing performances are tabulated in Table 1.4. The prediction residuals throughout the estimation processes are tabulated in Table 1.6. Section 2 documents the FLUTE generated input file data. Section 3 summarizes resulting plots, a mini summary of the IF IPF output file, and the execution log. Section 4 captures the user comments that are specific to this particular run.

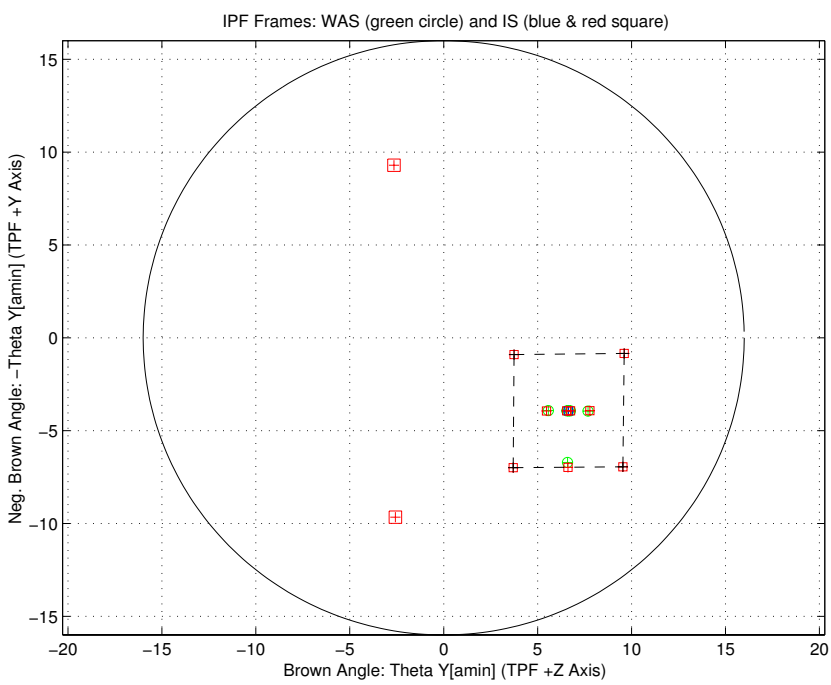

Figure 1.1: A-priori and a-posteriori IPF frames

RAW	FINAL (After Editing)
AA991095	AA991095
AS991095	AS991095
CA991095	CA991095
CB991095	CB991095
CS991095	CS991095

Table 1.1: IPF filter input files

EXECUTION CONFIGURATION ITEM	CURRENT STATUS
IPF Filter Version Used	IPF.V2.0.1Beta
Frame Table Version Used	FTVE2E1
Scan-Mirror Employed?	YES
IPF Filter Mode	NORMAL-MODE(0)
SLIT-MODE Operation	DISABLED
Kalman Filter Operation	ENABLED
Least-Squares Data Analysis	ENABLED
IBAD Screening	ENABLED
User-Specified Data Editing	DISABLED
Total Number of Iterations	25
LS Residual Sigma Scale	1.12502842E+000
Total Number of Maneuvers	14

Table 1.2: IPF filter execution configuration

Con. Plate Scale			Γ Dependent				Γ^2 Dependent				Linear Plate Scale						Mirror	
a_{00}	b_{00}	c_{00}	a_{10}	b_{10}	c_{10}	d_{10}	a_{20}	b_{20}	c_{20}	d_{20}	a_{01}	b_{01}	c_{01}	d_{01}	e_{01}	f_{01}	α	β
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
IPF (T)			Alignment R									Gyro Drift Bias						
θ_1	θ_2	θ_3	a_{rx}	a_{ry}	a_{rz}	b_{rx}	b_{ry}	b_{rz}	c_{rx}	c_{ry}	c_{rz}	b_{gx}	b_{gy}	b_{gz}	c_{gx}	c_{gy}	c_{gz}	
20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	

Table 1.3: IPF filter execution mask vector assignment

FOCAL PLANE SURVEY ANALYSIS: Covariance Analysis.
INSTRUMENT NAME: MIPS_24um_center NF: 95

```
PIX2RADW: 1.20874169E-005[rad/pixel] = 2.4932E+000[arcsec/pixel]
PIX2RADV: 1.20874169E-005[rad/pixel] = 2.4932E+000[arcsec/pixel]
```

FRAME	DESCRIPTION	IPF[1]	SF[2]	ARW[3]	TOTAL	REQ
095(P)	MIPS_24um_center	0.0548	0.0855	0.0703	0.1235	0.14
096(I)	MIPS_24um_plusY_edge	0.0973	0.0855	0.0703	0.1473	N/A
099(I)	MIPS_24um_small_FOV1	0.0547	0.0855	0.0703	0.1234	N/A
100(I)	MIPS_24um_small_FOV2	0.0525	0.0855	0.0703	0.1225	N/A
103(I)	MIPS_24um_large_FOV1	0.0549	0.0855	0.0703	0.1235	N/A
104(I)	MIPS_24um_large_FOV2	0.0547	0.0855	0.0703	0.1234	N/A
TR (C)	CORNERS OF INSTRUMENT	0.1210	0.0855	0.0703	0.1640	N/A
BR (C)	CORNERS OF INSTRUMENT	0.1166	0.0855	0.0703	0.1608	N/A
TL (C)	CORNERS OF INSTRUMENT	0.1127	0.0855	0.0703	0.1579	N/A
BL (C)	CORNERS OF INSTRUMENT	0.1193	0.0855	0.0703	0.1627	N/A

Table 1.4: IPF calibration error summary ([arcsec], 1-sigma, radial)

RMS METRIC	A PRIORI[4]	A POSTERIORI[4]	ATT. CORRECTED[5]	UNITS
Radial	13.7662	1.2918	0.3992	arcsec
Radial	5.5215	0.5181	0.1601	pixels
W-Axis	3.9682	0.3399	0.1131	pixels
V-Axis	3.8393	0.3911	0.1133	pixels

Table 1.5: Measurement prediction error summary (1-sigma)

[1]IPF filter removes systematic pointing errors due to: thermomechanical alignment drift (Body to TPF), gyro bias and bias drift, centroiding error, attitude error, and optical distortion. IPF SIGMA presented here is "NOT Scaled" by the Least Squares Scale factor. The Least Squares Scale Factor was: 1.125028.

[2]Error due to gyro Scale Factor: assumes 95 ppm error over 0.250 degree maneuver.

[3]Error due to gyro Angle Random Walk: assumes ARW = 100 $\mu deg/\sqrt{hr}$, with 960 second Maneuver time (max), and 14 independent Maneuvers.

[4]This can be interpreted as estimate of "pixel to sky" pointing reconstruction error if no science data is used.

[5]This can be interpreted as estimate of achieved S/I centroiding error

IPF BROWN ANGLE SUMMARY						
	WAS			IS		
Frame Number	theta_Y (arcmin)	theta_Z (arcmin)	angle (deg)	theta_Y (arcmin)	theta_Z (arcmin)	angle (deg)
095	+6.641000	+3.931000	+0.000000	+6.641111	+3.932233	+0.016691
096	+6.595000	+6.712000	-0.000000	+6.618045	+6.975361	+0.016691
099	+7.687000	+3.943000	-0.000000	+7.784631	+3.921390	+0.016691
100	+5.574000	+3.918000	+0.000000	+5.475980	+3.941639	+0.016691
103	+6.746000	+3.932000	+0.000000	+6.755408	+3.931220	+0.016691
104	+6.558000	+3.930000	+0.000000	+6.549682	+3.933031	+0.016691
001	+0.000000	+0.000000	+0.000000	+9.608774	+0.843807	+0.016691
001	+0.000000	+0.000000	+0.000000	+9.544149	+6.948933	+0.016691
001	+0.000000	+0.000000	+0.000000	+3.749581	+0.904283	+0.016691
001	+0.000000	+0.000000	+0.000000	+3.699961	+6.991274	+0.016691

Table 1.6: IPF Brown angle summary

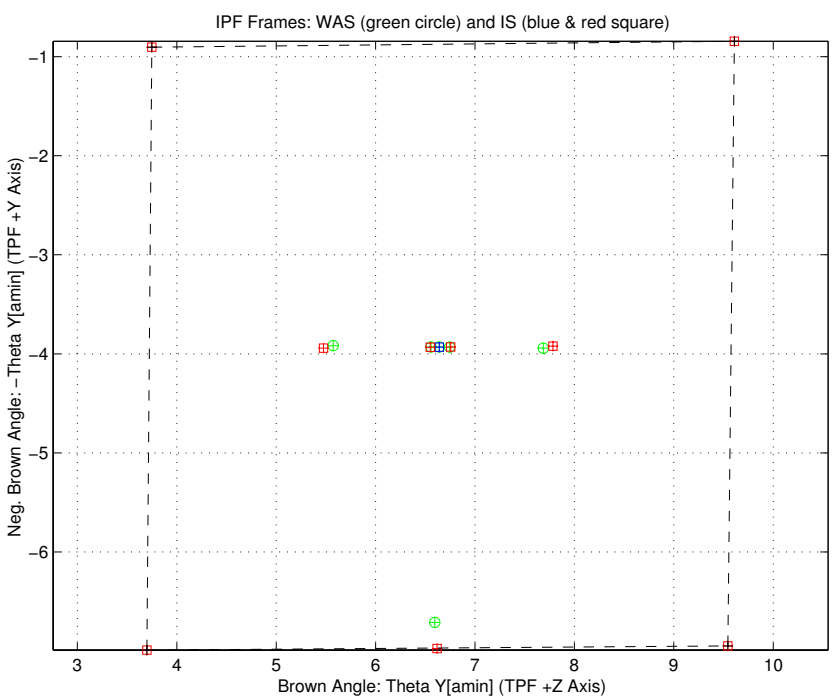

Figure 1.2: A-priori and a-posteriori IPF frames (ZOOMED)

2 FLUTE DATA SUMMARY

2.1 FLUTE CONFIGURATION PARAMETERS

The covariance analysis was performed using the FLUTE generated input data files. The internal configuration parameters, used to produce the data are tabulated in Table 2.1, Table 2.2 and Table 2.3.

NAME	DESCRIPTION	VALUE	UNIT
d2003	days into YEAR2003	+6.0000000000000000E+001	day
tstart	start time	+7.3051200000000000E+008	sec
tdel	data rate	+1.0000000000000001E-001	sec
tshelf	Inertial Hold duration pad	+5.0000000000000000E+000	sec
ipro	slew profile(1-linear, 2-S-curve)	1	int flag
sig_gcf [1]	gcf sigma(1)	+4.8481368110953601E-008	rad/sec
sig_gcf [2]	gcf sigma(2)	+9.6962736221907205E-009	rad/sec
sig_gcf [3]	gcf sigma(3)	+9.6962736221907205E-009	rad/sec
igcf	gcf bias correction flag	1	int flag
SigA [1][1]	Sigma A(1,1)	+9.4017722156391537E-009	rad^2
SigA [2][2]	Sigma A(2,2)	+2.3504430539097885E-011	rad^2
SigA [3][3]	Sigma A(3,3)	+2.3504430539097885E-011	rad^2
NFprime	Prime Frame NF	95	int
ftable [name]	Frame Table row number	95	int
ftable [q0]	Frametable quaternion q0	-5.5224103706934371E-007	N/A
ftable [q1]	Frametable quaternion q1	-9.6589398881636961E-004	N/A
ftable [q2]	Frametable quaternion q2	-5.7174047628006817E-004	N/A
ftable [q3]	Frametable quaternion q3	+9.9999937008046424E-001	N/A
ft_cmd [name]	Command row number	95	int
ft_cmd [q0]	Command quaternion q0	-5.5224103706934371E-007	N/A
ft_cmd [q1]	Command quaternion q1	-9.6589398881636961E-004	N/A
ft_cmd [q2]	Command quaternion q2	-5.7174047628006817E-004	N/A
ft_cmd [q3]	Command quaternion q3	+9.9999937008046424E-001	N/A
ft_true [name]	Truth row number	95	int
ft_true [q0]	Truth quaternion q0	-5.5224103706934371E-007	N/A
ft_true [q1]	Truth quaternion q1	-9.6589398881636961E-004	N/A
ft_true [q2]	Truth quaternion q2	-5.7174047628006817E-004	N/A
ft_true [q3]	Truth quaternion q3	+9.9999937008046424E-001	N/A
ft_prior [name]	Prior row number	95	int
ft_prior [q0]	FTprior quaternion q0	-5.5224103706934371E-007	N/A
ft_prior [q1]	FTprior quaternion q1	-9.6589398881636961E-004	N/A
ft_prior [q2]	FTprior quaternion q2	-5.7174047628006817E-004	N/A
ft_prior [q3]	FTprior quaternion q3	+9.9999937008046424E-001	N/A
ntable [NF]	ntable row number	95	int
ntable [iprime]	Prime frame indication flag	1	int
ntable [SIG_CX]	CX Sigma	+1.0000000000000001E-001	pixel
ntable [SIG_CY]	CY Sigma	+1.0000000000000001E-001	pixel
ntable [PIX2RADX]	Nom. angular pixelsize X-dir	+1.2087416876100000E-005	rad/pixel
ntable [PIX2RADY]	Nom. angular pixelsize Y-dir	+1.2595908372599999E-005	rad/pixel
ntable [CX0]	Center pixel along X-axis	+6.4500000000000000E+001	pixel
ntable [CY0]	Center pixel along Y-axis	+6.4500000000000000E+001	pixel
ntable [BETA0]	Nominal mirror scale factor	+2.8047410000000001E-006	rad/(e.u.)
ntable [GAMMA_E0]	Reference Mirror position	+2.0070000000000000E+003	(e.u.[6])

Table 2.1: FLUTE Parameter Table (1)

[6] encoder units

NAME	DESCRIPTION	VALUE	UNIT
ntable [D11]	x-to-w frame flip parameter	-1	int
ntable [D12]	y-to-w frame flip parameter	0	int
ntable [D21]	x-to-v frame flip parameter	0	int
ntable [D22]	y-to-v frame flip parameter	-1	int
ntable [DG]	Mirror flip parameter	1	int
ntable [sisizew]	Array size (w-direction)	+1.5707963267948967E-003	pixel
ntable [sisizev]	Array size (v-direction)	+1.5707963267948967E-003	pixel
ntable [p2i_w]	w-offset from prime	+0.0000000000000000E+000	pixel
ntable [p2i_v]	v-offset from prime	+0.0000000000000000E+000	pixel
p1true [a00]	True Constant Plate Scales	+1.0000000000000001E-001	N/A
p1true [b00]	True Constant Plate Scales	+1.0000000000000001E-001	N/A
p1true [c00]	True Constant Plate Scales	+1.0000000000000000E-002	N/A
p1true [a10]	True Γ Dependent Plate Scales	+1.0000000000000001E-001	1/rad
p1true [b10]	True Γ Dependent Plate Scales	+1.0000000000000001E-001	1/rad
p1true [c10]	True Γ Dependent Plate Scales	+1.0000000000000000E-002	1/rad
p1true [d10]	True Γ Dependent Plate Scales	+1.0000000000000000E-002	1/rad
p1true [a20]	True Γ^2 Dependent Plate Scales	+1.0000000000000001E-001	$1/\mathrm{rad}^2$
p1true [b20]	True Γ^2 Dependent Plate Scales	+1.0000000000000001E-001	$1/\mathrm{rad}^2$
p1true [c20]	True Γ^2 Dependent Plate Scales	+1.0000000000000000E-002	$1/\mathrm{rad}^2$
p1true [d20]	True Γ^2 Dependent Plate Scales	+1.0000000000000000E-002	$1/\mathrm{rad}^2$
p1true [a01]	True Linear Plate Scales	+2.0000000000000000E+000	N/A
p1true [b01]	True Linear Plate Scales	+2.0000000000000000E+000	N/A
p1true [c01]	True Linear Plate Scales	+2.0000000000000000E+000	N/A
p1true [d01]	True Linear Plate Scales	+2.0000000000000000E+000	N/A
p1true [e01]	True Linear Plate Scales	+2.0000000000000000E+000	N/A
p1true [f01]	True Linear Plate Scales	+2.0000000000000000E+000	N/A
p2true [am1]	True Scan mirror alignment Ux	+0.0000000000000000E+000	N/A
p2true [am2]	True Scan mirror alignment Uy	+2.0000000000000000E-002	N/A
p2true [am3]	True Scan mirror alignment Uz	+9.9979997999599901E-001	N/A
p2true [beta]	True Scan mirror scale factor	+1.1000000000000001E+000	N/A
p2true [qT1]	True IPF q1	-5.5224103706934371E-007	N/A
p2true [qT2]	True IPF q2	-9.6589398881636961E-004	N/A
p2true [qT3]	True IPF q3	-5.7174047628006817E-004	N/A
p2true [qT4]	True IPF q4	+9.9999937008046424E-001	N/A
p2true [qR01]	True Boresight Alignment q1	+2.4240684048319150E-005	N/A
p2true [qR02]	True Boresight Alignment q2	+1.2120342024159575E-006	N/A
p2true [qR03]	True Boresight Alignment q3	+1.2120342024159575E-006	N/A
p2true [qR04]	True Boresight Alignment q4	+9.9999999970472575E-001	N/A
p2true [brx]	True B. Alignment drift rate X	+5.6000000000000000E-011	rad/sec
p2true [bry]	True B. Alignment drift rate Y	+5.6000000000000000E-011	rad/sec
p2true [brz]	True B. Alignment drift rate Z	+5.6000000000000000E-011	rad/sec
p2true [crx]	True B. Alignment drift accel. X	+5.0000000000000002E-014	$\mathrm{rad/sec}^2$
p2true [cry]	True B. Alignment drift accel. Y	+5.0000000000000002E-014	$\mathrm{rad/sec}^2$
p2true [crz]	True B. Alignment drift accel. Z	+5.0000000000000002E-014	$\mathrm{rad/sec}^2$
p2true [bgx]	True Gyro bias correction X	+2.5000000000000002E-006	rad/sec
p2true [bgy]	True Gyro bias correction Y	+2.5000000000000002E-006	rad/sec
p2true [bgz]	True Gyro bias correction Z	+2.5000000000000002E-006	rad/sec
p2true [cgx]	True Gyro bias-rate correction X	+4.9999999999999999E-013	$\mathrm{rad/sec}^2$
p2true [cgy]	True Gyro bias-rate correction Y	+4.9999999999999999E-013	$\mathrm{rad/sec}^2$
p2true [cgz]	True Gyro bias-rate correction Z	+4.9999999999999999E-013	$\mathrm{rad/sec}^2$

Table 2.2: FLUTE Parameter Table (2)

NAME	DESCRIPTION	VALUE	UNIT
p2cmd [am1]	CMD Scan mirror alignment Ux	+0.0000000000000000E+000	N/A
p2cmd [am2]	CMD Scan mirror alignment Uy	+0.0000000000000000E+000	N/A
p2cmd [am3]	CMD Scan mirror alignment Uz	+1.0000000000000000E+000	N/A
p2cmd [beta]	CMD Scan mirror rotation SF	+1.0000000000000000E+000	N/A
p2cmd [qT1]	CMD IPF q1	-5.5224103706934371E-007	N/A
p2cmd [qT2]	CMD IPF q2	-9.6589398881636961E-004	N/A
p2cmd [qT3]	CMD IPF q3	-5.7174047628006817E-004	N/A
p2cmd [qT4]	CMD IPF q4	+9.9999937008046424E-001	N/A
p2cmd [qR01]	CMD Boresight Alignment q1	+0.0000000000000000E+000	N/A
p2cmd [qR02]	CMD Boresight Alignment q2	+0.0000000000000000E+000	N/A
p2cmd [qR03]	CMD Boresight Alignment q3	+0.0000000000000000E+000	N/A
p2cmd [qR04]	CMD Boresight Alignment q4	+1.0000000000000000E+000	N/A
p2cmd [brx]	CMD B. Alignment drift rate X	+0.0000000000000000E+000	rad/sec
p2cmd [bry]	CMD B. Alignment drift rate Y	+0.0000000000000000E+000	rad/sec
p2cmd [brz]	CMD B. Alignment drift rate Z	+0.0000000000000000E+000	rad/sec
p2cmd [crx]	CMD B. Alignment drift accel. X	+0.0000000000000000E+000	rad/sec^2
p2cmd [cry]	CMD B. Alignment drift accel. Y	+0.0000000000000000E+000	rad/sec^2
p2cmd [crz]	CMD B. Alignment drift accel. Z	+0.0000000000000000E+000	rad/sec^2
p2cmd [bgx]	CMD Gyro bias correction X	+0.0000000000000000E+000	rad/sec
p2cmd [bgy]	CMD Gyro bias correction Y	+0.0000000000000000E+000	rad/sec
p2cmd [bgz]	CMD Gyro bias correction Z	+0.0000000000000000E+000	rad/sec
p2cmd [cgx]	CMD Gyro bias-rate correction X	+0.0000000000000000E+000	rad/sec^2
p2cmd [cgy]	CMD Gyro bias-rate correction Y	+0.0000000000000000E+000	rad/sec^2
p2cmd [cgz]	CMD Gyro bias-rate correction Z	+0.0000000000000000E+000	rad/sec^2
a1	Semi-Major Axis of SIRTF (HCO [7])	+1.4960000000000000E+011	m
a2	Semi-Major Axis of Earth (HCO)	+1.4960000000000000E+011	m
e1	Eccentricity (SIRTF in HCO)	+1.6722000000000001E-002	N/A
e2	Eccentricity (Earth in HCO)	+1.6722000000000001E-002	N/A
inc1	inclination (SIRTF in HCO)	+4.0142572795869580E-001	rad
inc2	inclination (Earth in HCO)	+4.0142572795869580E-001	rad
Omega1	Ascending Node Long.(SIRTF in HCO)	+0.0000000000000000E+000	rad
Omega2	Ascending Node Long.(Earth in HCO)	+0.0000000000000000E+000	rad
omega1	Argument of Perigee(SIRTF in HCO)	+1.7627825445142729E+000	rad
omega2	Argument of Perigee(Earth in HCO)	+1.7627825445142729E+000	rad
nu0_1	True Anomaly of SIRTF(HCO)	+8.6071031605199810E-001	rad
nu0_2	True Anomaly of Earth(HCO)	+1.0328523792623976E+000	rad
inav	Velocity Report Flag	+0.0000000000000000E+000	rad
wsize	Array size W-dir	+1.5707963267948967E-003	rad
vsize	Array size V-dir	+1.5707963267948967E-003	rad

Table 2.3: FLUTE Parameter Table (3)

[7] Heliocentric Orbit

2.2 FLUTE GENERATED UNIT TEST DATA

This subsection plots the FLUTE generated IPF filter input files. Seven figures, as tabulated in Table 2.4, show the campaign maneuver senario, the true sampled locations on the array and the actual centroided data superimposed the array plane. All angles shown in FLUTE plots have units of radians.

FIGURE NO.	DESCRIPTION
Figure 2.1	Focal Plane Survey Scenario Plot
Figure 2.2	Commanded-only source locations in TPF
Figure 2.3	True and commanded source locations in TPF
Figure 2.4	True and commanded source locations (ZOOMED) in TPF
Figure 2.5	True-sampled and centroided locations in Focal Plane (W,V) including rectangular array boundary approximation
Figure 2.6	True and centroided locations on S/I Array (W,V) including rectangular array boundary approximation
Figure 2.7	True and centroided locations on S/I Array (W,V) showing Prime and Inferred Frames including rectangular array boundary approximation

Table 2.4: Table of figures (FLUTE)

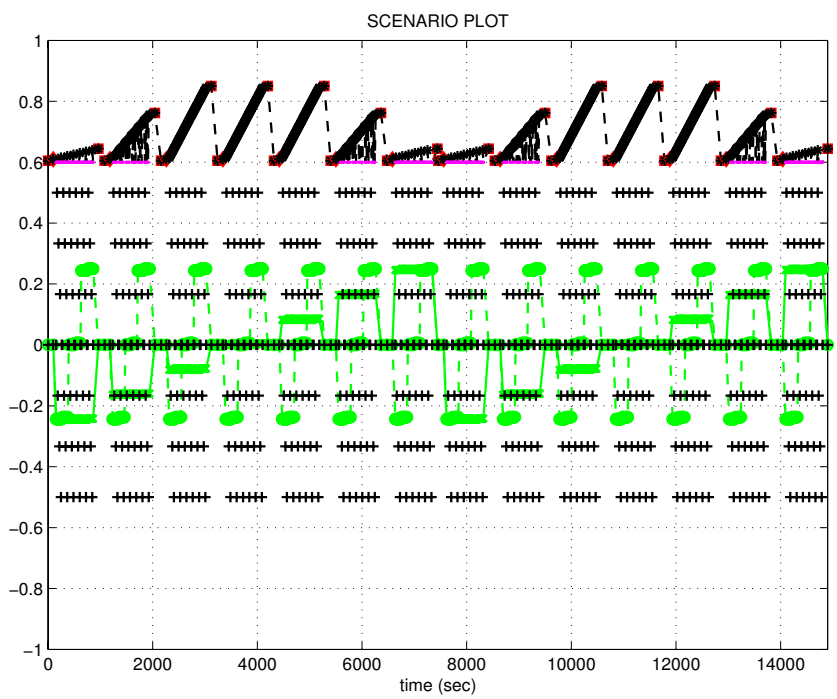

Figure 2.1: Focal plane survey scenario plot (See key in [3])

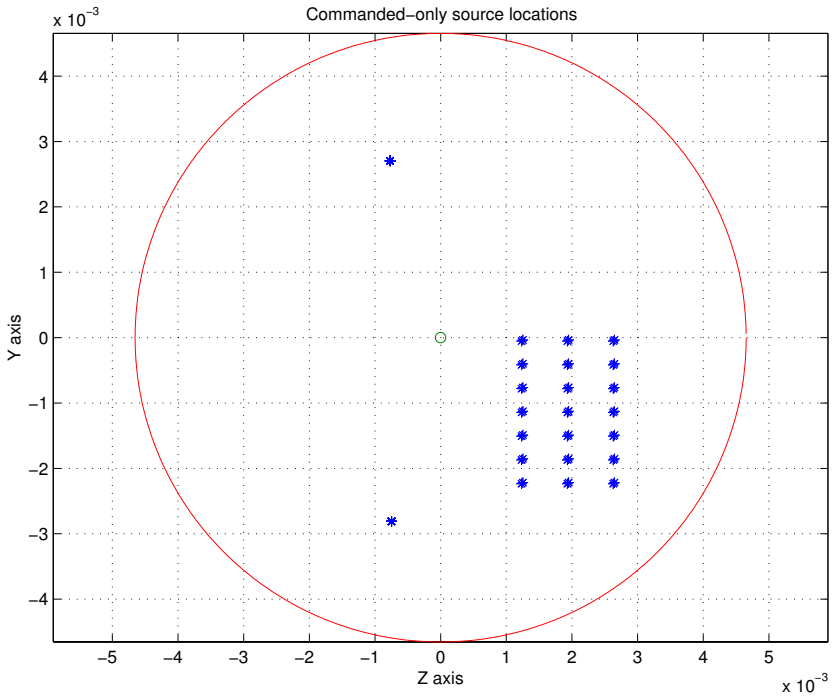

Figure 2.2: Commanded-only source locations

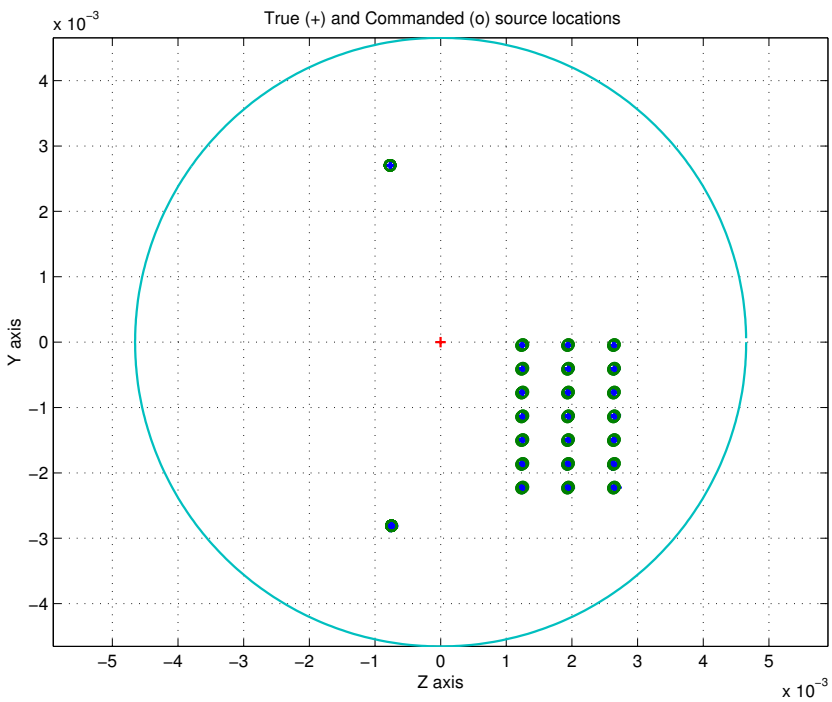

Figure 2.3: True (+) and commanded (o) source locations

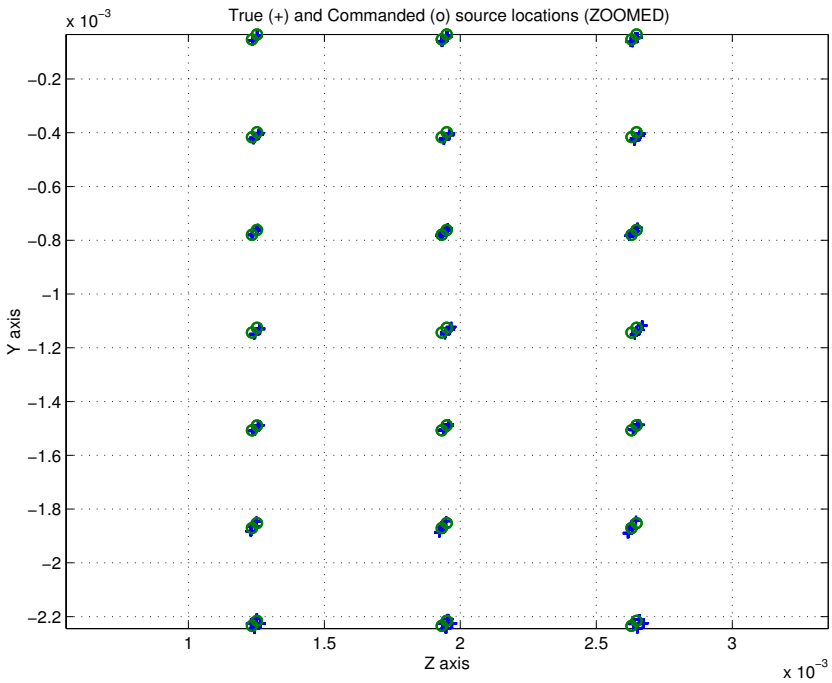

Figure 2.4: True (+) and commanded (o) source locations (ZOOMED)

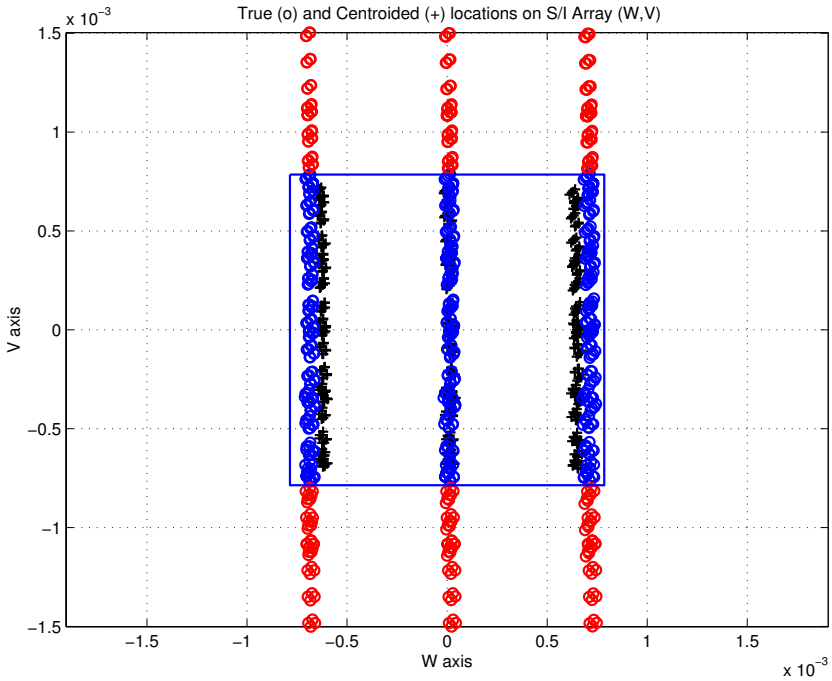

Figure 2.5: True-sampled (o) and centroided (+) locations on S/I array (W,V)

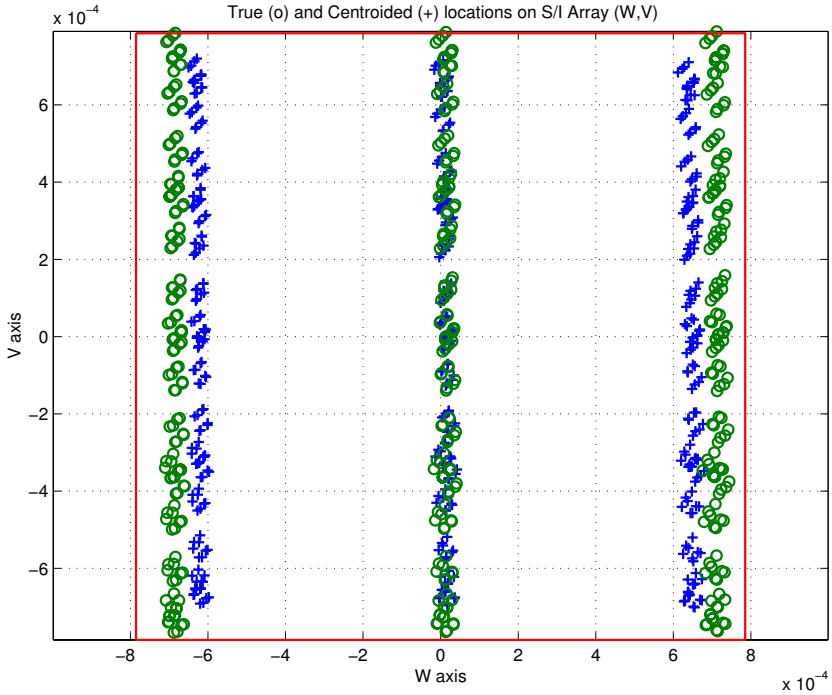

Figure 2.6: True (o) and centroided (+) locations on S/I array (W,V)

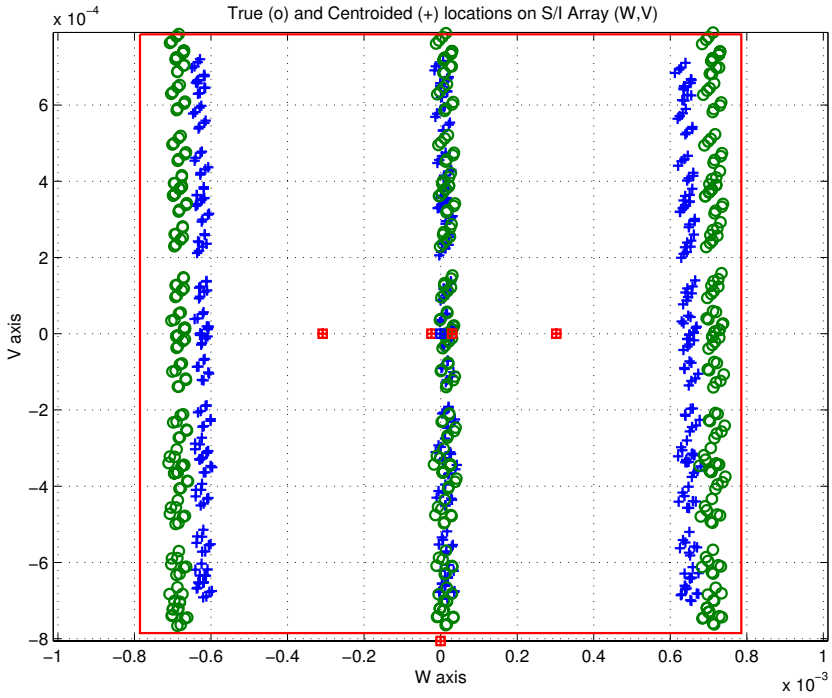

Figure 2.7: True (o) and centroided (+) locations on S/I array (W,V) showing prime and inferred frames

3 IPF EXECUTION RESULTS

3.1 IPF EXECUTION OUTPUT PLOTS

This subsection summarizes the IPF filter results. As shown in Table 3.1, the output plots are segmented to three groups: predicted performance, post-run results and IPF trending plots.

FIGURE NO.	DESCRIPTION
Predicted performance prior to IPF run	
Figure 3.1	Meas. and a-priori predicts in TPF coords
Figure 3.2	Meas. and a-priori predicts in Oriented Pixel Coords including rectangular array boundary approximation
Figure 3.3	A-priori prediction error
Figure 3.4	Oriented Pixel Coords of measurements and a-priori predicts (PCRS only)
IPF filter performance (post run results)	
Figure 3.5	IPF execution convergence, chart 1: (top) normalized residual error vs. iteration number and (bottom) norm of effective parameter corrections
Figure 3.6	IPF execution convergence, chart 2: parameter correction size vs. iteration number
Figure 3.7	Parameter uncertainty convergence: square-root of diagonal elements of covariance matrix vs. maneuver number
Figure 3.8	IPF parameter symbol table
Figure 3.9	KF parameter error sigma plot (a-priori-dashed, a-posteriori-solid). Includes true parameter errors (FLUTE runs only)
Figure 3.10	LS parameter error sigma plot. Includes true parameter errors (FLUTE runs only)
Figure 3.11	KF and LS parameter errors sigma plot (Figure 3.9 & Figure 3.10 combined)
Figure 3.12	Measurements and a-posteriori predicts in Oriented Pixel Coords including rectangular array boundaries (a-priori-dashed, a-posteriori-solid)
Figure 3.13	Attitude corrected meas. and a-posteriori predicts in Oriented Pixel Coords including rectangular array boundaries (a-priori-dashed, a-posteriori-solid)
Figure 3.14	Array plot with (solid) and w/o (dashed) optical distortion corrections
Figure 3.15	KF innovations with (o) and w/o (+) attitude corrections
Figure 3.16	W-axis KF innovations and 1-sigma bound
Figure 3.17	V-axis KF innovations and 1-sigma bound
IPF parameter trending plots	
Figure 3.18	Estimated attitude corrections (Body frame)
Figure 3.19	Estimated attitude error sigma plot (Body frame)
Figure 3.20	Systematic error attributed to thermo-mechanical boresight drift (equiv. angle in (W,V) coords)
Figure 3.21	Systematic error attributed to thermo-mechanical boresight drift (equiv. angle in Body frame)
Figure 3.22	Systematic error attributed to gyro drift bias (equiv. rate in (W,V) coords)
Figure 3.23	Systematic error attributed to gyro drift bias (equiv. angle in (W,V) coords)
Figure 3.24	Systematic error attributed to gyro drift bias (equiv. angle in Body frame)

Table 3.1: Table of figures (IPF run)

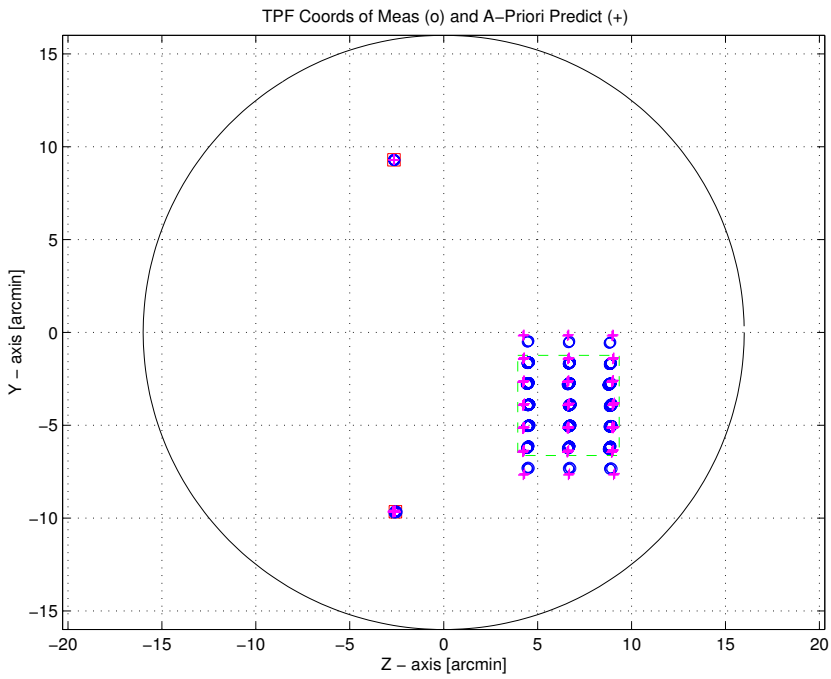

Figure 3.1: TPF coords of measurements and a-priori predicts

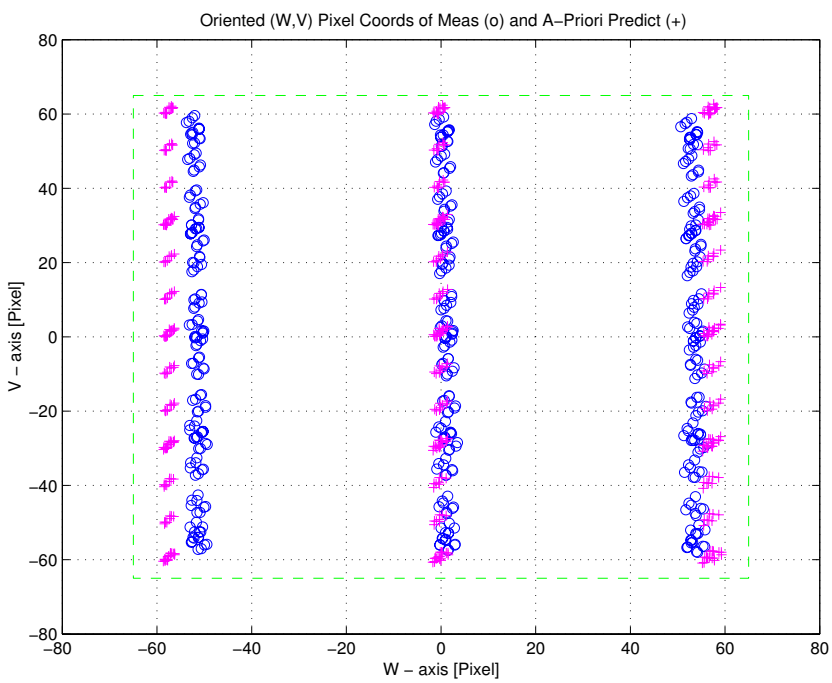

Figure 3.2: Oriented Pixel Coords of measurements and a-priori predicts

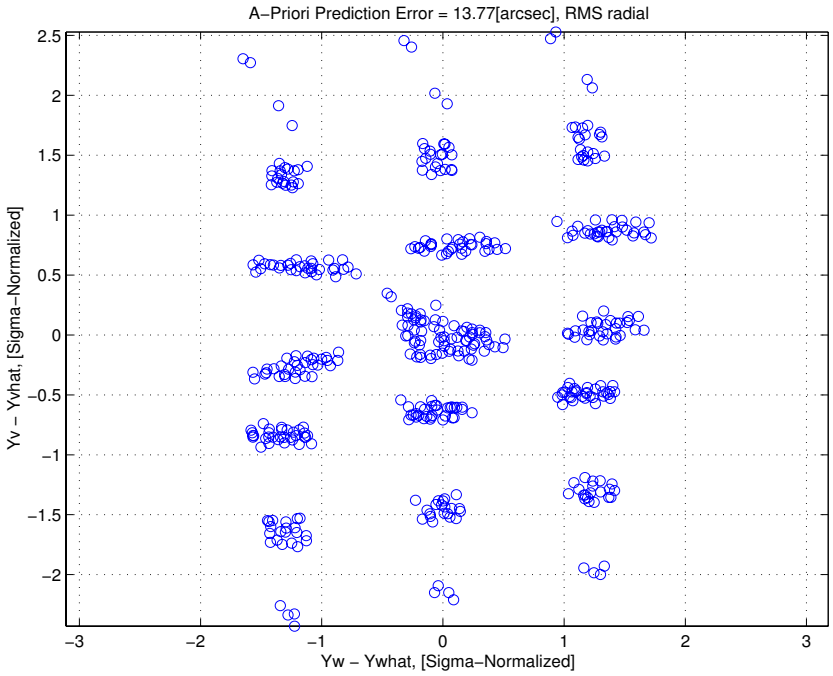

Figure 3.3: A-priori prediction error

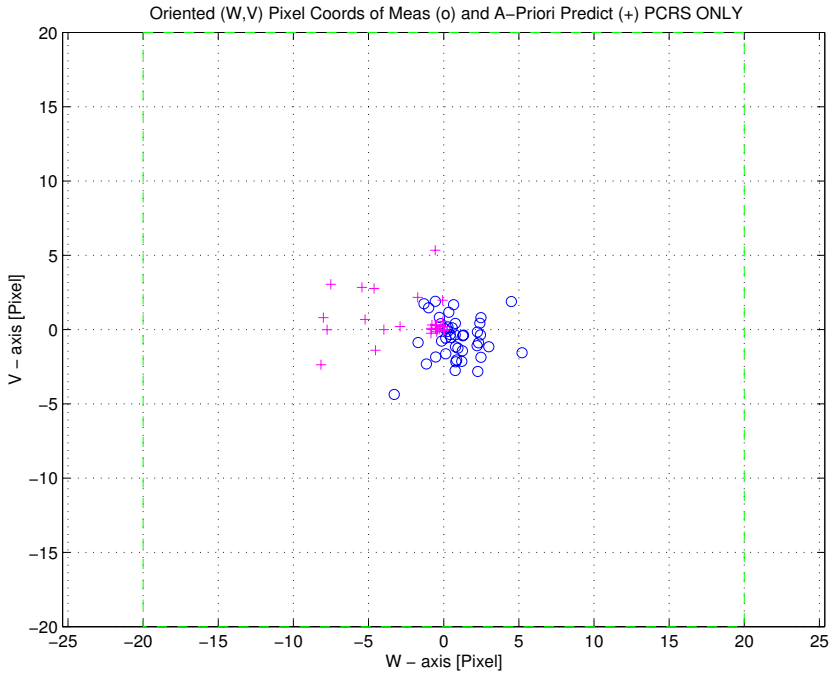

Figure 3.4: Oriented Pixel Coords of measurements and a-priori predicts (PCRS only)

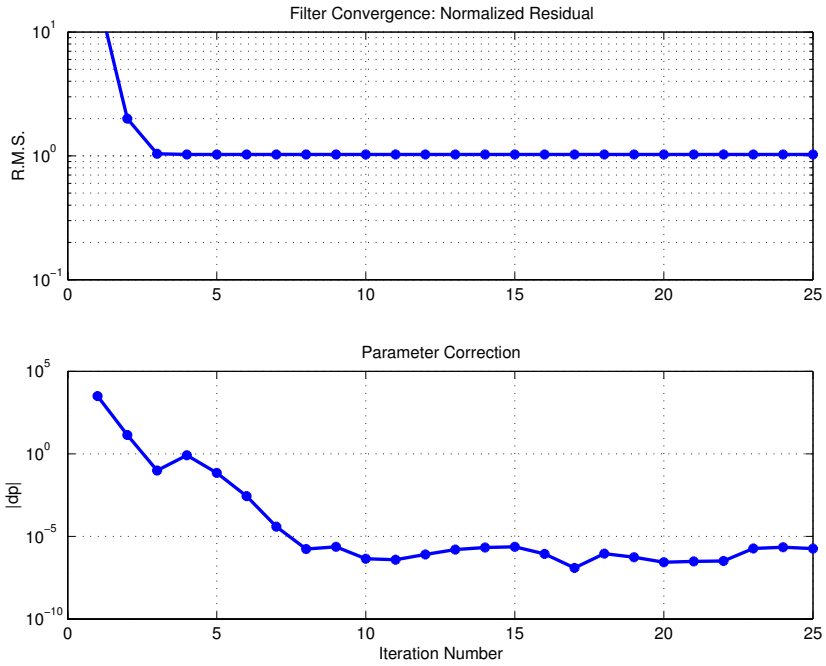

Figure 3.5: IPF execution convergence, chart 1

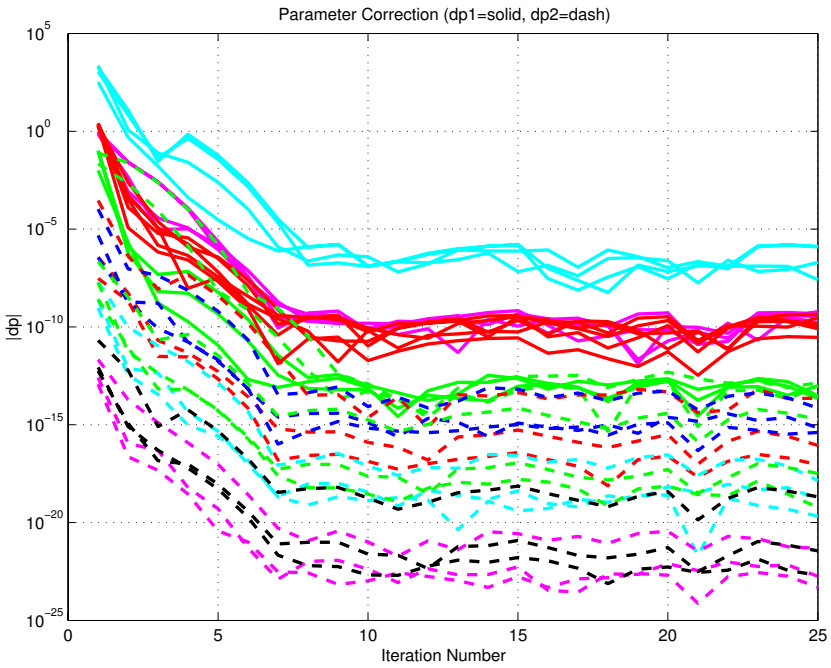

Figure 3.6: IPF execution convergence, chart 2

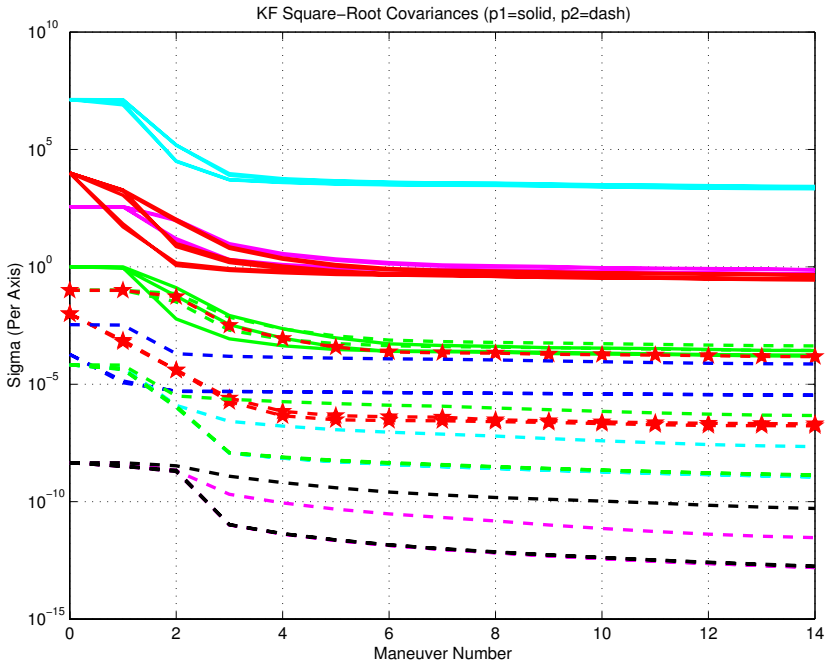

Figure 3.7: Parameter uncertainty convergence

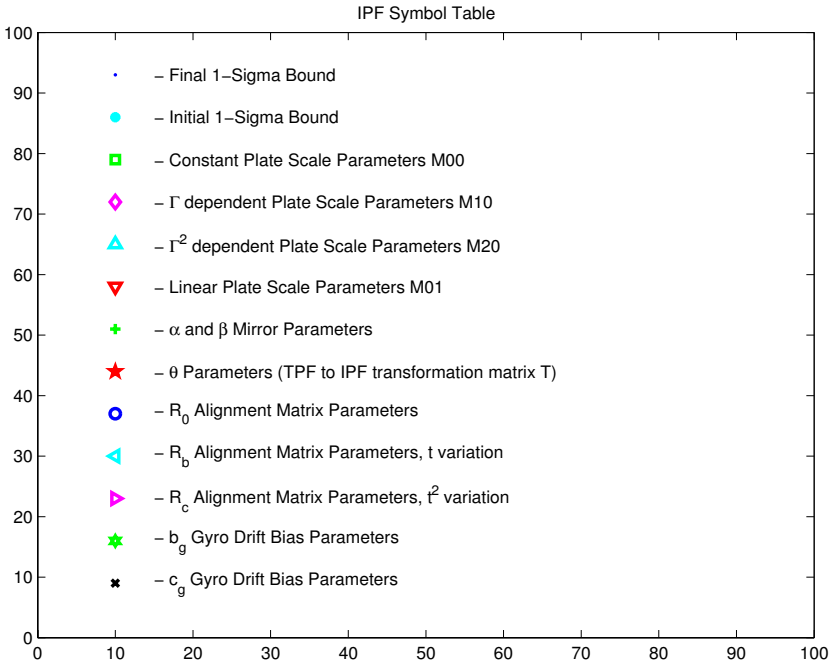

Figure 3.8: IPF parameter symbol table

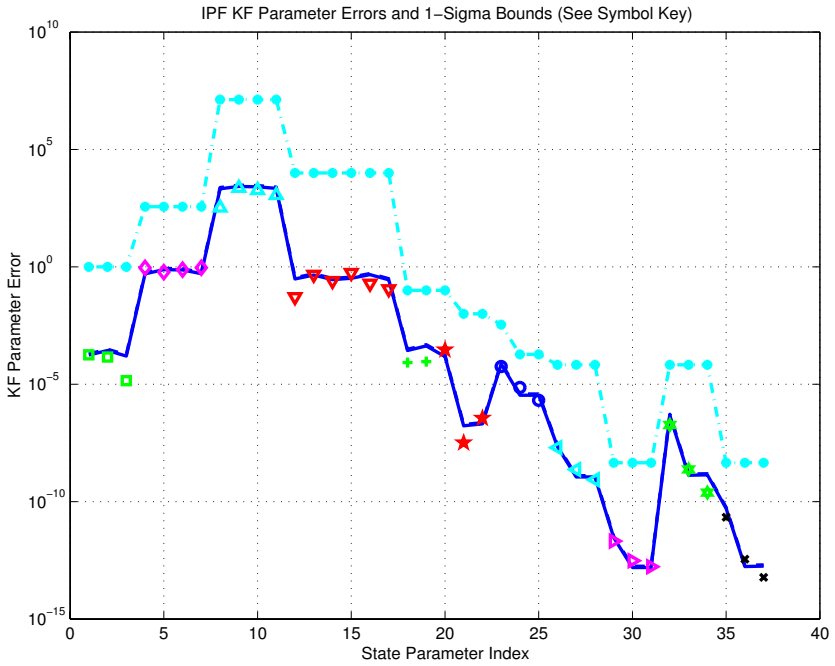

Figure 3.9: KF parameter error sigma plots

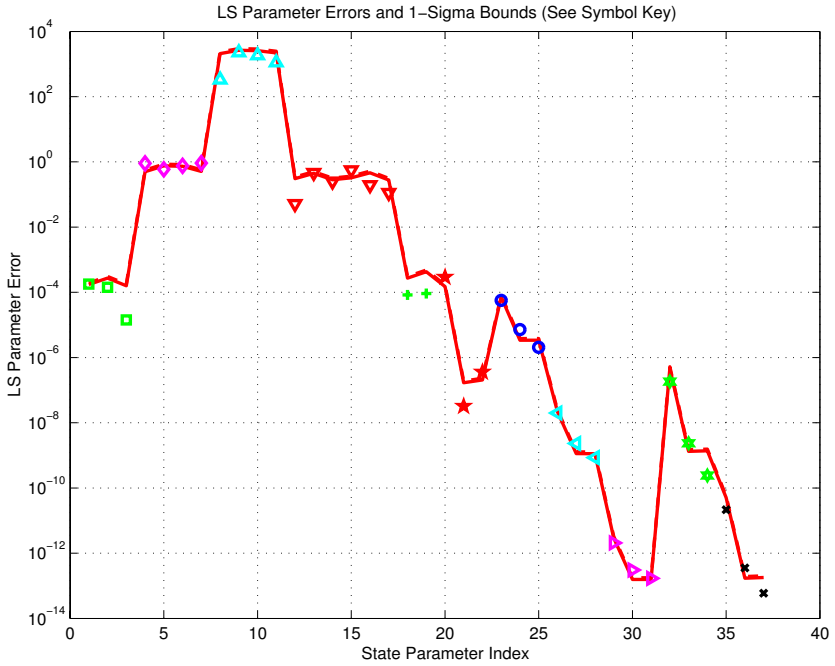

Figure 3.10: LS parameter error sigma plot

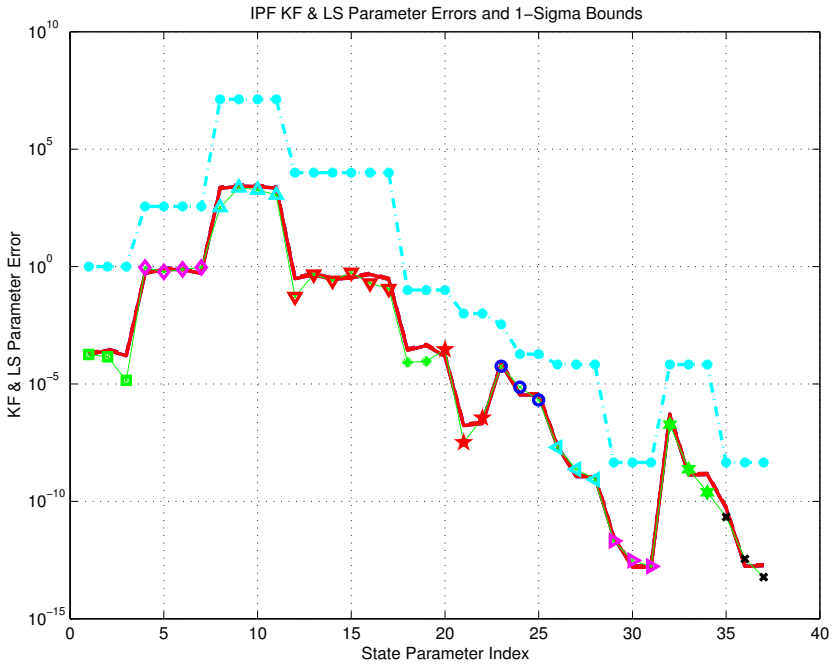

Figure 3.11: KF and LS parameter error sigma plot

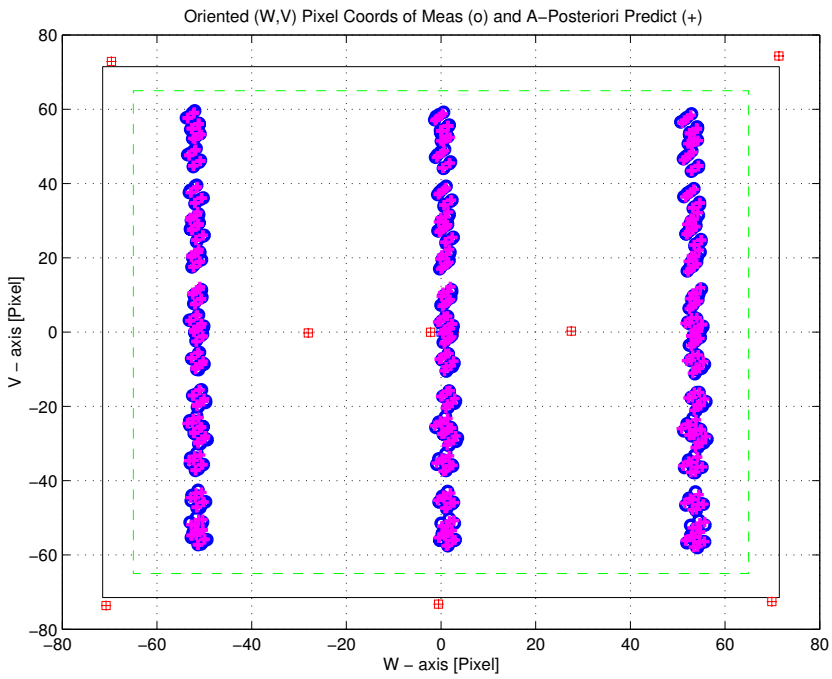

Figure 3.12: Oriented Pixel Coords of meas. and a-posteriori predicts

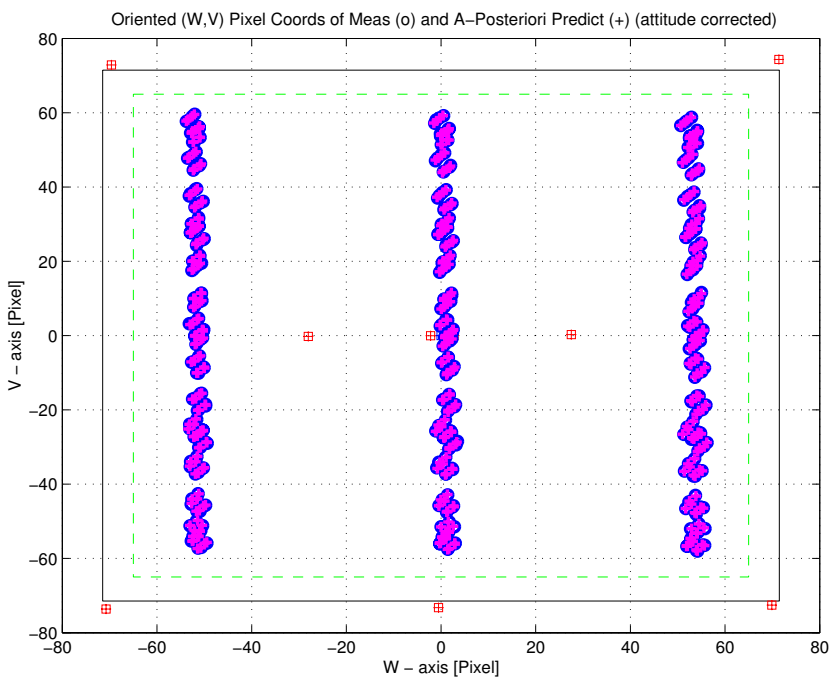

Figure 3.13: Oriented Pixel Coords of meas. and a-posteriori predicts (attitude corrected)

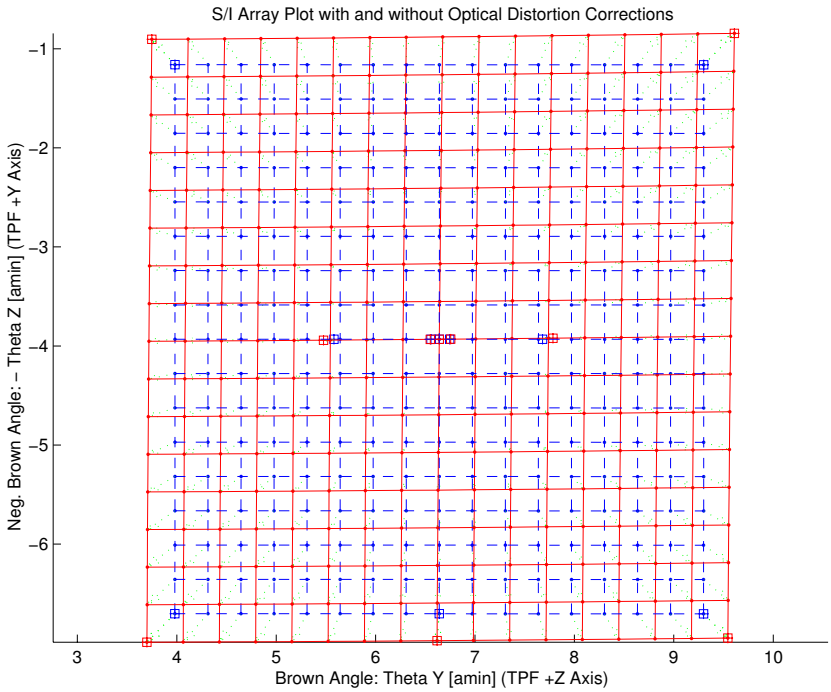

Figure 3.14: Array plot with (solid) and w/o (dashed) optical distortion corrections

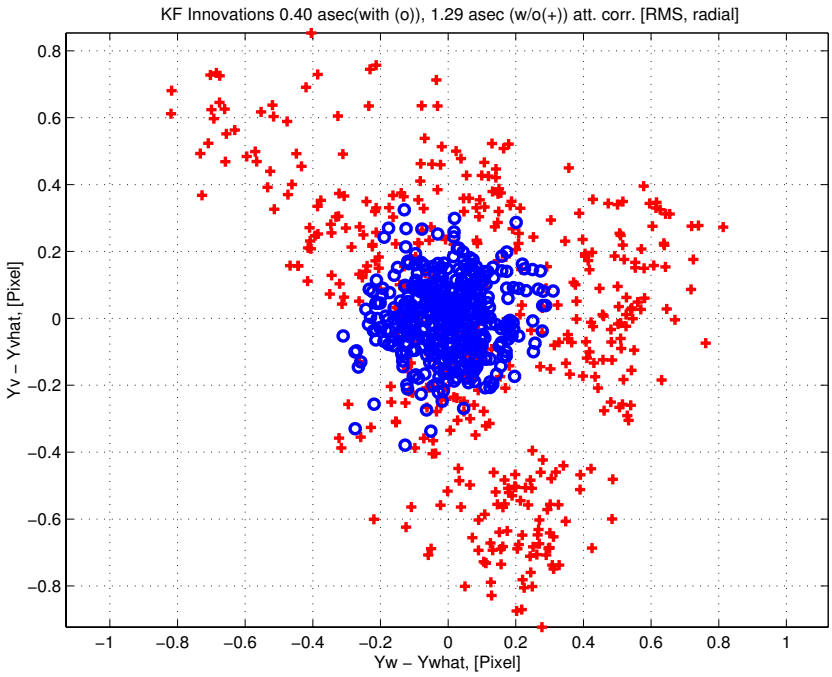

Figure 3.15: KF innovations with (o) and w/o (+) attitude corrections

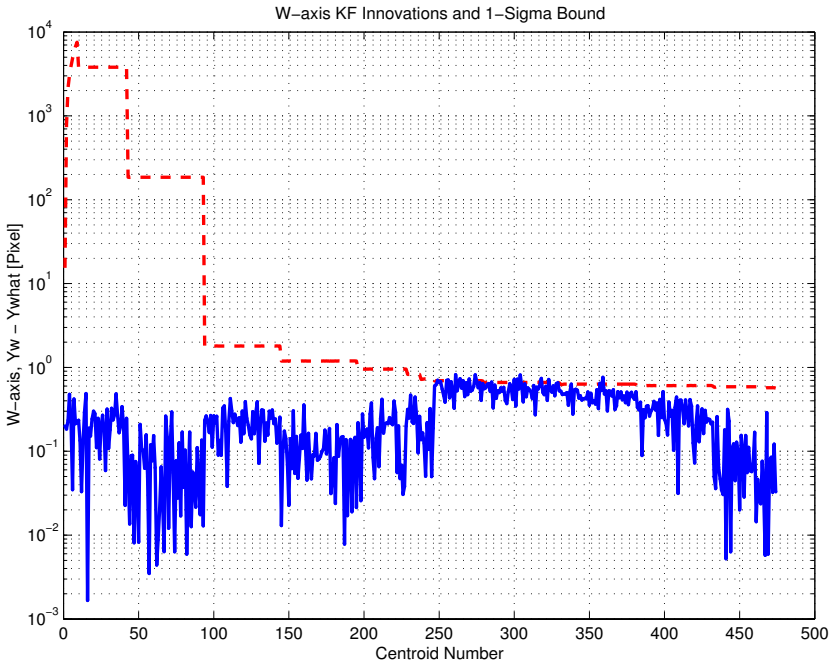

Figure 3.16: W-axis KF innovations and 1-sigma bound

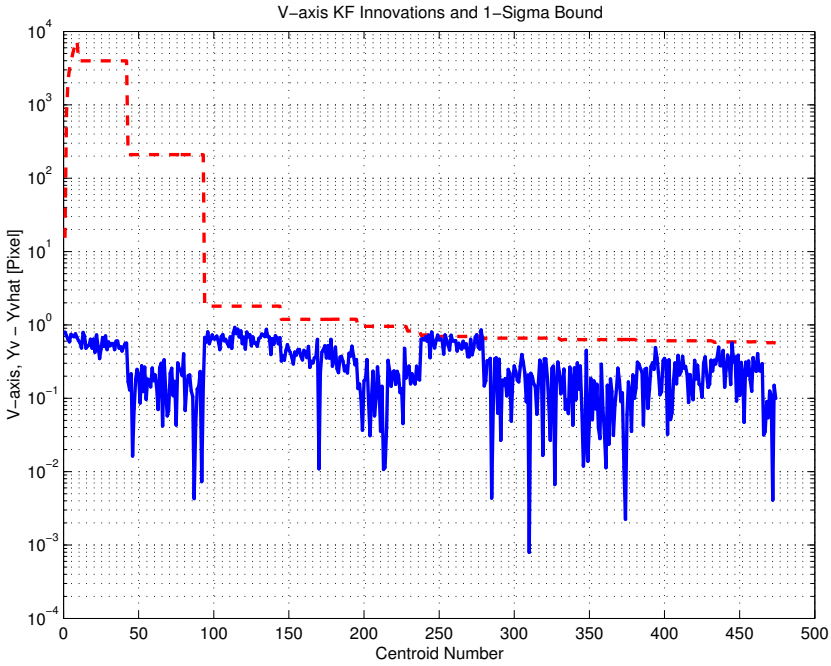

Figure 3.17: V-axis KF innovations and 1-sigma bound

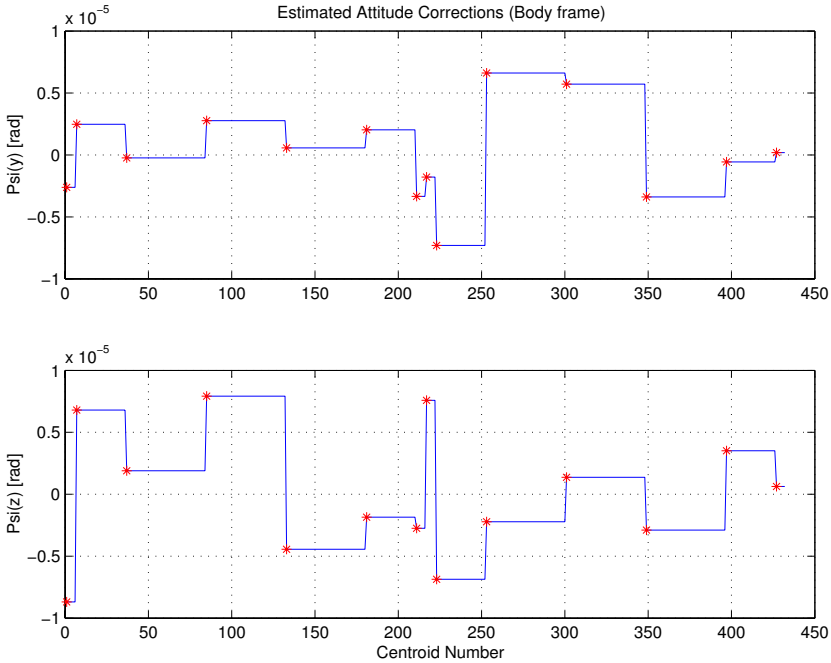

Figure 3.18: Estimated attitude corrections (Body frame)

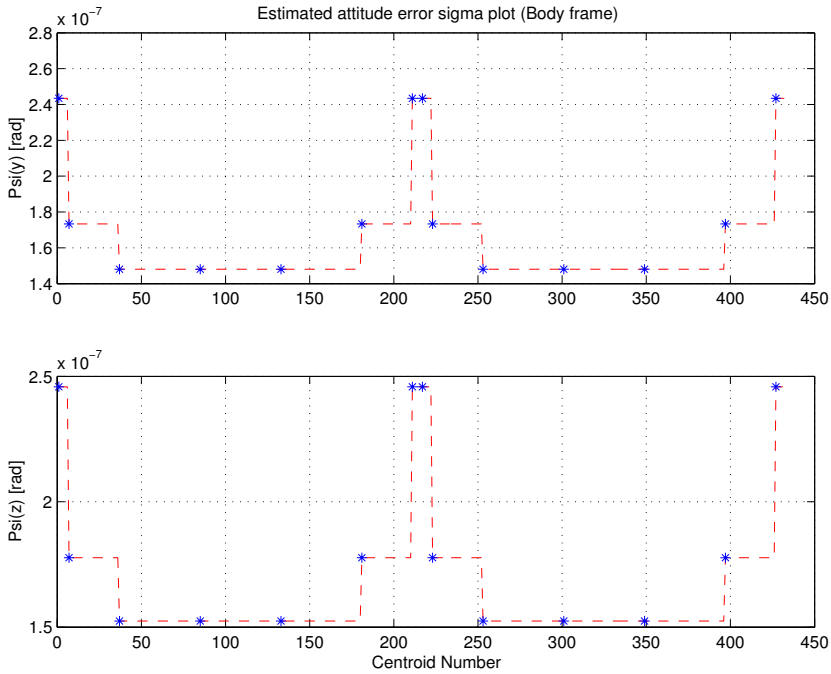

Figure 3.19: Estimated attitude error sigma plot (Body frame)

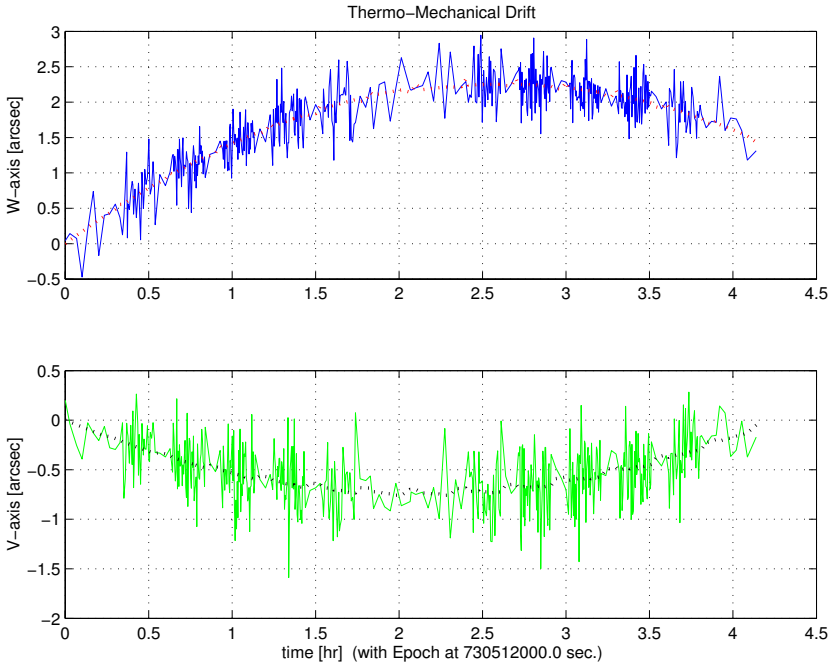

Figure 3.20: Thermo-mechanical boresight drift (equiv. angle in (W,V) coords)

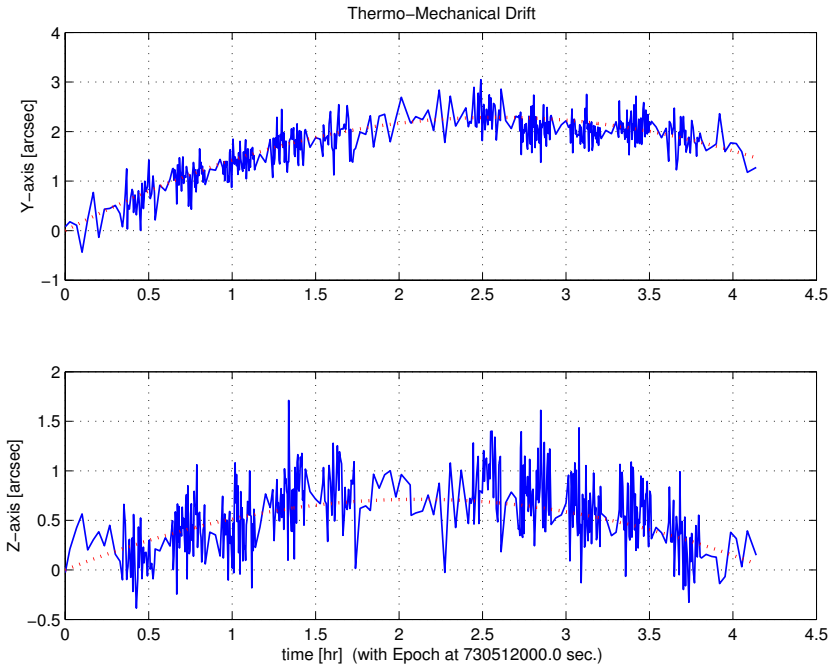

Figure 3.21: Thermo-mechanical boresight drift (equiv. angle in Body frame)

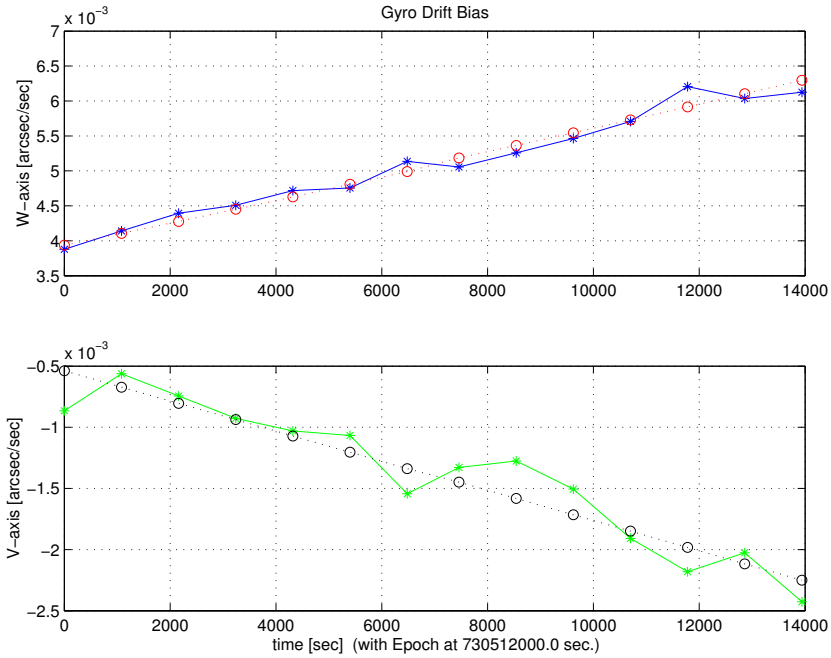

Figure 3.22: Gyro drift bias contribution (equiv. rate in (W,V) coords)

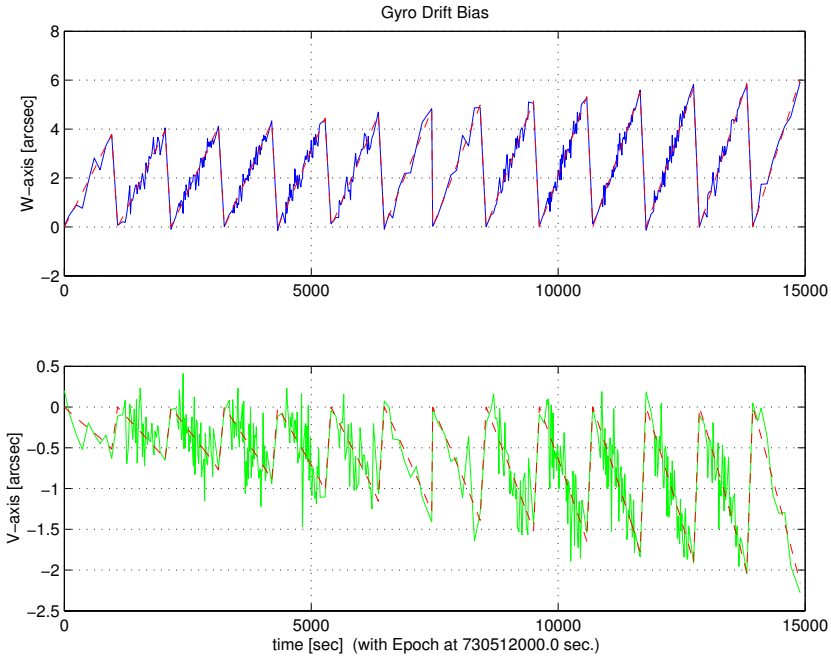

Figure 3.23: Gyro drift bias contribution (equiv. angle in (W,V) coords)

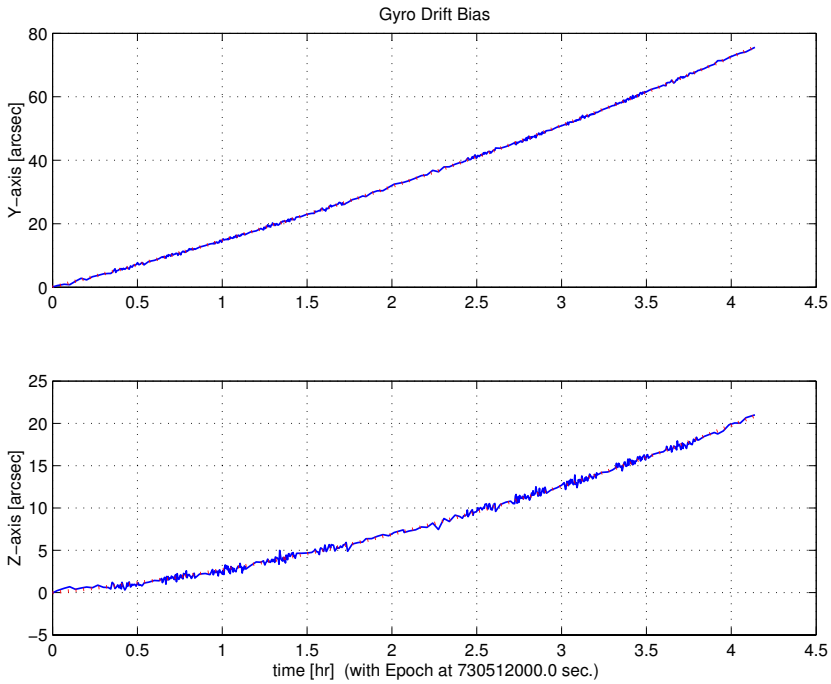

Figure 3.24: Gyro drift bias contribution (equiv. angle in Body frame)

3.2 IPF OUTPUT DATA (IF MINI FILE)

```
OUTPUT FILE NAME: IFmini991095.dat   DATE: 05-Aug-2003   TIME: 21:42
INSTRUMENT NAME:  MIPS_24um_center   NF: 95
IPF FILTER VERSION: IPF.V2.0.1Beta       SW RELEASE DATE: August 5, 2003
--------------------------------------------------------------------------------
---------------------------- IPF BROWN ANGLE SUMMARY ---------------------------
--------------------------------------------------------------------------------
         ------------ WAS ------------           ------------ IS -------------
Frame    theta_Y     theta_Z     angle           theta_Y     theta_Z     angle
Number   (arcmin)    (arcmin)    (deg)           (arcmin)    (arcmin)    (deg)
------  --------------------------------       --------------------------------
 095     +6.641000  +3.931000   +0.000000        +6.641111  +3.932233   +0.016691
 096     +6.595000  +6.712000   -0.000000        +6.618045  +6.975361   +0.016691
 099     +7.687000  +3.943000   -0.000000        +7.784631  +3.921390   +0.016691
 100     +5.574000  +3.918000   +0.000000        +5.475980  +3.941639   +0.016691
 103     +6.746000  +3.932000   +0.000000        +6.755408  +3.931220   +0.016691
 104     +6.558000  +3.930000   +0.000000        +6.549682  +3.933031   +0.016691
 001     +0.000000  +0.000000   +0.000000        +9.608774  +0.843807   +0.016691
 001     +0.000000  +0.000000   +0.000000        +9.544149  +6.948933   +0.016691
 001     +0.000000  +0.000000   +0.000000        +3.749581  +0.904283   +0.016691
 001     +0.000000  +0.000000   +0.000000        +3.699961  +6.991274   +0.016691
--------------------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  0              95            +0.000            +0.000     pixels
OFFSET FRAME NAME: MIPS_24um_center
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
WAS(FTB)            +6.641000        +3.931000       +0.000000
IS (EST)            +6.641111        +3.932233       +0.016691
dT_EST              +0.000111        +0.001233       +0.016691
T_sSIGMA            +0.000653        +0.000793       +0.009652
dT_EST/T_sSIGMA     +0.169368        +1.554636       +1.729313
-------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  1              96            +0.000           -64.000     pixels
OFFSET FRAME NAME: MIPS_24um_plusY_edge
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
WAS(FTB)            +6.595000        +6.712000       -0.000000
IS (EST)            +6.618045        +6.975361       +0.016691
dT_EST              +0.023045        +0.263361       +0.016691
T_sSIGMA            +0.001229        +0.001348       +0.009652
dT_EST/T_sSIGMA    +18.757968       +195.324120       +1.729314
-------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  2              99           +25.000            +0.000     pixels
OFFSET FRAME NAME: MIPS_24um_small_FOV1
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
WAS(FTB)            +7.687000        +3.943000       -0.000000
IS (EST)            +7.784631        +3.921390       +0.016691
dT_EST              +0.097631        -0.021610       +0.016691
T_sSIGMA            +0.000654        +0.000790       +0.009652
dT_EST/T_sSIGMA    +149.346668       -27.351019       +1.729314
-------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  3             100           -25.500            +0.000     pixels
OFFSET FRAME NAME: MIPS_24um_small_FOV2
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
WAS(FTB)            +5.574000        +3.918000       +0.000000
IS (EST)            +5.475980        +3.941639       +0.016691
dT_EST              -0.098020        +0.023639       +0.016691
T_sSIGMA            +0.000628        +0.000759       +0.009652
dT_EST/T_sSIGMA    -156.096434       +31.152524       +1.729313
-------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  4             103            +2.500            +0.000     pixels
OFFSET FRAME NAME: MIPS_24um_large_FOV1
```

```
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
WAS(FTB)            +6.746000        +3.932000       +0.000000
IS (EST)            +6.755408        +3.931220       +0.016691
dT_EST              +0.009408        -0.000780       +0.016691
T_sSIGMA            +0.000654        +0.000794       +0.009652
dT_EST/T_sSIGMA    +14.382693        -0.981727       +1.729313
-----------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  5             104            -2.000            +0.000     pixels
OFFSET FRAME NAME: MIPS_24um_large_FOV2
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
WAS(FTB)            +6.558000        +3.930000       +0.000000
IS (EST)            +6.549682        +3.933031       +0.016691
dT_EST              -0.008318        +0.003031       +0.016691
T_sSIGMA            +0.000652        +0.000791       +0.009652
dT_EST/T_sSIGMA    -12.764356        +3.829302       +1.729313
-----------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  6               1           +64.000           +64.000     pixels
OFFSET FRAME NAME: CORNER PIXEL (DIAGNOSTICS)
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
WAS(FTB)            +0.000000        +0.000000       +0.000000
IS (EST)            +9.608774        +0.843807       +0.016691
dT_EST              +9.608774        +0.843807       +0.016691
T_sSIGMA            +0.001582        +0.001628       +0.009652
dT_EST/T_sSIGMA    +6074.913827       +518.409962       +1.729315
-----------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  7               1           +64.000           -64.000     pixels
OFFSET FRAME NAME: CORNER PIXEL (DIAGNOSTICS)
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
WAS(FTB)            +0.000000        +0.000000       +0.000000
IS (EST)            +9.544149        +6.948933       +0.016691
dT_EST              +9.544149        +6.948933       +0.016691
T_sSIGMA            +0.001496        +0.001595       +0.009652
dT_EST/T_sSIGMA    +6378.896190       +4357.851831       +1.729315
-----------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  8               1           -64.000           +64.000     pixels
OFFSET FRAME NAME: CORNER PIXEL (DIAGNOSTICS)
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
WAS(FTB)            +0.000000        +0.000000       +0.000000
IS (EST)            +3.749581        +0.904283       +0.016691
dT_EST              +3.749581        +0.904283       +0.016691
T_sSIGMA            +0.001449        +0.001538       +0.009652
dT_EST/T_sSIGMA    +2587.265561       +588.093853       +1.729315
-----------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  9               1           -64.000           -64.000     pixels
OFFSET FRAME NAME: CORNER PIXEL (DIAGNOSTICS)
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
WAS(FTB)            +0.000000        +0.000000       +0.000000
IS (EST)            +3.699961        +6.991274       +0.016691
dT_EST              +3.699961        +6.991274       +0.016691
T_sSIGMA            +0.001555        +0.001608       +0.009652
dT_EST/T_sSIGMA    +2379.601679       +4349.019953       +1.729315
-----------------------------------------------------------------
-------------------------------------------------------------------------------
-------------------------------------------------------------------------------
VARNAME             MEAN                     SIGMA                 SCALED_SIGMA
a00        +1.0017847104128118E-001 +1.7447930652372362E-004 +1.9629417912081742E-004
b00        +9.9857079033987411E-002 +2.7389518853457290E-004 +3.0813987211271567E-004
c00        +9.9857841173256051E-003 +1.5852180433205965E-004 +1.7834153558996170E-004
a10        +9.9963029864107578E-001 +5.0018962900375219E-001 +5.6272754968044203E-001
b10        +6.8984316170071902E-001 +7.5708531007742474E-001 +8.5174249271715896E-001
c10        +7.6884724024437689E-001 +7.3434694730785255E-001 +8.2616118830156837E-001
d10        +9.2496011502265629E-001 +5.1166920647623926E-001 +5.7564240062472449E-001
a20        -3.3054384657566243E+002 +2.0987512242834891E+003 +2.3611547808021746E+003
```

```
b20        +2.2710611782966525E+003 +2.6567031466066878E+003 +2.9888665522632950E+003
c20        -1.8379514563129278E+003 +2.5590093642974434E+003 +2.8789582703834981E+003
d20        +1.1167713002555929E+003 +2.1860615870103934E+003 +2.4593814205205540E+003
a01        +1.9484922747036248E+000 +3.0555144454395855E-001 +3.4375405989925356E-001
b01        +2.4604185140619670E+000 +4.4595305179621858E-001 +5.0170985873823226E-001
c01        +1.7492124723813389E+000 +2.8431056582092984E-001 +3.1985746759949657E-001
d01        +2.5560408827877112E+000 +3.2420065273272469E-001 +3.6473494918407734E-001
e01        +2.1944640205947166E+000 +4.6062412452953683E-001 +5.1821523256384949E-001
f01        +2.1128848772350692E+000 +2.7835766572191900E-001 +3.1316028578690902E-001
del_alpha  +9.7101417618344898E-014 +2.7256708575263029E-004 +3.0664571873393633E-004
beta       +1.1000920263285241E+000 +4.2729516658701145E-004 +4.8071920755878261E-004
del_theta1 -2.2871996993838878E-014 +1.4973533883221575E-004 +1.6845651216209327E-004
del_theta2 +9.0660120101444905E-018 +1.6881829681581167E-007 +1.8992538229471094E-007
del_theta3 -8.7474420915015356E-017 +2.0499032761154080E-007 +2.3061994506920910E-007
del_arx    +7.0990322588492319E-015 +7.2282803569624263E-005 +8.1320208533276558E-005
del_ary    +6.8348415973396519E-016 +3.4062034813332439E-006 +3.8320757321205249E-006
del_arz    -4.0414493600256273E-016 +3.4047165321493002E-006 +3.8304028720245521E-006
brx        -1.9819354972179571E-008 +2.1985765498545561E-008 +2.4734611094370642E-008
bry        +2.3780509322415510E-009 +1.1303261347248942E-009 +1.2716490291899543E-009
brz        +9.0751675976722572E-010 +1.1290265487486977E-009 +1.2701869580281818E-009
crx        +2.1178513642499728E-012 +2.9244079535609258E-012 +3.2900420691469208E-012
cry        -2.5502544994697585E-013 +1.5629135512612073E-013 +1.7583221683650293E-013
crz        -1.1917760637055323E-013 +1.5608989658369953E-013 +1.7560557025015791E-013
bgx        +2.2463333334022776E-007 +4.6377272785529821E-007 +5.2175750079909937E-007
bgy        +1.8275281016563494E-008 +1.3251018437683919E-009 +1.4907772380367154E-009
bgz        +2.6237650690920771E-009 +1.3742048351481108E-009 +1.5460194990090672E-009
cgx        -2.1063048197094546E-011 +5.0626060898833677E-011 +5.6955757472052268E-011
cgy        +8.5289246807484838E-013 +1.7130973939394889E-013 +1.9272832601019162E-013
cgz        +5.5944436732964080E-013 +1.7947285319163464E-013 +2.0191206105540552E-013
-------------------------------------------------------------------------------
LSQF RESIDUAL SIGMA SCALE =         +1.1250284233226688E+000
-------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------------
                    a_mirror(1)                a_mirror(2)                a_mirror(3)
a_mirror_ipf   +0.0000000000000000E+000  +2.0083432207034409E-002  +9.9979830753546750E-001
a_mirror_tpf   -1.9088008036579826E-003  +1.9794372317572122E-002  +9.9980225009951107E-001
beta                beta_0                     beta                      beta_total
               +2.8047410000000001E-006  +1.1000920263285241E+000  +3.0854732100166912E-006
-----------------------------------------------------------------------------------------------------
qT              qT(1)                      qT(2)                      qT(3)                      qT(4)
FrmTbl:   -5.5224103706934371E-007 -9.6589398881636961E-004 -5.7174047628006817E-004 +9.9999937008046424E-001
Estim:    +1.4510453874923350E-004 -9.6599336627449701E-004 -5.7177904348510019E-004 +9.9999935943490215E-001
DelTheta        deltheta(1)                deltheta(2)                deltheta(3)
          +2.9131341622516259E-004 -3.2167338266954286E-008 -3.5852934947754515E-007       [rad]
EulAngT         theta(1)                   theta(2)                   theta(3)                   [rad]
Mean      +2.9131410882893196E-004 -1.9318207610871999E-003 -1.1438400782834333E-003
SigmaT    +1.4973533883221575E-004 +1.6881829681581167E-007 +2.0499032761154080E-007
-----------------------------------------------------------------------------------------------------
qR              qR(1)                      qR(2)                      qR(3)                      qR(4)
ASFILE:   +0.0000000000000000E+000 +0.0000000000000000E+000 +0.0000000000000000E+000 +1.0000000000000000E+000
Estim:    +5.2495135971495827E-005 -2.4052361893128234E-006 +1.7717388088944691E-007 +9.9999999861922217E-001
DelThetaR       deltheta R(1)              deltheta R(2)              deltheta R(3)
          +1.0499027113983199E-004 -4.8104909735359424E-006 +3.5409523489211961E-007       [rad]
EulAngR         angR(1)                    angR(2)                    angR(3)                    [rad]
Mean      +1.0499027113983199E-004 -4.8104909735359424E-006 +3.5409523489211961E-007
SigmaR    +7.2282803569624263E-005 +3.4062034813332439E-006 +3.4047165321493002E-006
-----------------------------------------------------------------------------------------------------
Initial Gyro Bias         Bg0(1)                     Bg0(2)                     Bg0(3)
                    +2.4582663655968712E-006 +2.4793742961420354E-006 +2.4976176758578363E-006
Gyro Bias Correction      Bg(1)                      Bg(2)                      Bg(3)
                    +2.2463333334022776E-007 +1.8275281016563494E-008 +2.6237650690920771E-009
Total Gyro Bias           BgT(1)                     BgT(2)                     BgT(3)
                    +2.6828996989370990E-006 +2.4976495771585991E-006 +2.5002414409269283E-006

Initial Gyro Bias Rate     Cg0(1)                     Cg0(2)                     Cg0(3)
                    +0.0000000000000000E+000 +0.0000000000000000E+000 +0.0000000000000000E+000
Gyro Bias Rate Correction  Cg(1)                      Cg(2)                      Cg(3)
```

```
                  -2.1063048197094546E-011 +8.5289246807484838E-013 +5.5944436732964080E-013
Total Gyro Bias Rate       CgT(1)                   CgT(2)                   CgT(3)
                  -2.1063048197094546E-011 +8.5289246807484838E-013 +5.5944436732964080E-013
-----------------------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  1              96            +0.000           -64.000     pixels
OFFSET FRAME NAME: MIPS_24um_plusY_edge
qT               qT(1)                    qT(2)                    qT(3)                    qT(4)
WAS(FTB)  -9.3639450226028116E-007 -9.5920326392183247E-004 -9.7622022412795586E-004 +9.9999906346070921E-001
IS (EST)  +1.4468037500129608E-004 -9.6270268630143404E-004 -1.0143842495060132E-003 +9.9999901164737204E-001

DelTheta        deltheta(1)               deltheta(2)               deltheta(3)
Units             rad                       rad                       rad
          +2.9116714246919979E-004 -6.7034052089031509E-006 -7.6608415885881338E-005
EulAngT         theta(1)                  theta(2)                  theta(3)                  [rad]
Mean      +2.9131410882893201E-004 -1.9251111357299071E-003 -2.0290502144061232E-003
sSigmaT   +1.6845645244929723E-004 +3.5736277360800847E-007 +3.9221248245078690E-007
SigmaT    +1.4973528575551581E-004 +3.1764777333586837E-007 +3.4862450967454057E-007
-----------------------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  2              99           +25.000            +0.000     pixels
OFFSET FRAME NAME: MIPS_24um_small_FOV1
qT               qT(1)                    qT(2)                    qT(3)                    qT(4)
WAS(FTB)  -6.4117382846981564E-007 -1.1180284132340469E-003 -5.7348571352373249E-004 +9.9999921056278462E-001
IS (EST)  +1.4501117827978903E-004 -1.1323113892338270E-003 -5.7017768347590169E-004 +9.9999918586971126E-001

DelTheta        deltheta(1)               deltheta(2)               deltheta(3)
Units             rad                       rad                       rad
          +2.9132816512432409E-004 -2.8399845793231449E-005 +6.2861845283510255E-006
EulAngT         theta(1)                  theta(2)                  theta(3)                  [rad]
Mean      +2.9131410882893196E-004 -2.2644575057624533E-003 -1.1406860061260421E-003
sSigmaT   +1.6845649867954388E-004 +1.9016055798045444E-007 +2.2983424313973420E-007
SigmaT    +1.4973532684803018E-004 +1.6902733658837931E-007 +2.0429194354124825E-007
-----------------------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  3             100           -25.500            +0.000     pixels
OFFSET FRAME NAME: MIPS_24um_small_FOV2
qT               qT(1)                    qT(2)                    qT(3)                    qT(4)
WAS(FTB)  -4.6198041860920160E-007 -8.1070521711647421E-004 -5.6984978266998100E-004 +9.9999950901391088E-001
IS (EST)  +1.4520038901489615E-004 -7.9653229295302314E-004 -5.7317198286516483E-004 +9.9999950796339465E-001

DelTheta        deltheta(1)               deltheta(2)               deltheta(3)
Units             rad                       rad                       rad
          +2.9130295933233721E-004 +2.8512848977866270E-005 -6.8764108508032863E-006
EulAngT         theta(1)                  theta(2)                  theta(3)                  [rad]
Mean      +2.9131410882893196E-004 -1.5928980260865319E-003 -1.1465764211241560E-003
sSigmaT   +1.6845650672371083E-004 +1.8266175731444702E-007 +2.2073394851477005E-007
SigmaT    +1.4973533399822016E-004 +1.6236190439968812E-007 +1.9620299713215465E-007
-----------------------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  4             103            +2.500            +0.000     pixels
OFFSET FRAME NAME: MIPS_24um_large_FOV1
qT               qT(1)                    qT(2)                    qT(3)                    qT(4)
WAS(FTB)  -5.6111515131371191E-007 -9.8116560995659325E-004 -5.7188591179032191E-004 +9.9999935512990956E-001
IS (EST)  +1.4509517353874301E-004 -9.8261716212673790E-004 -5.7162941045143883E-004 +9.9999934332514462E-001

DelTheta        deltheta(1)               deltheta(2)               deltheta(3)
Units             rad                       rad                       rad
          +2.9131455381324535E-004 -2.7365614206183226E-006 +2.2676273566199052E-007
EulAngT         theta(1)                  theta(2)                  theta(3)                  [rad]
Mean      +2.9131410882893196E-004 -1.9650684170795267E-003 -1.1435456733001341E-003
sSigmaT   +1.6845651165311556E-004 +1.9026766261452271E-007 +2.3098382925365007E-007
SigmaT    +1.4973533837980255E-004 +1.6912253830226309E-007 +2.0531377204805226E-007
-----------------------------------------------------------------------------------------------------------
```

```
-----------------------------------------------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  5             104            -2.000            +0.000     pixels
OFFSET FRAME NAME: MIPS_24um_large_FOV2
qT               qT(1)                     qT(2)                     qT(3)                     qT(4)
WAS(FTB)  -5.4520033785992621E-007 -9.5382213577026277E-004 -5.7159503889057917E-004 +9.9999938175088265E-001
IS (EST)  +1.4511203527994054E-004 -9.5269561073110093E-004 -5.7189706943792625E-004 +9.9999937212345913E-001

DelTheta        deltheta(1)               deltheta(2)               deltheta(3)
Units             rad                       rad                       rad
          +2.9131242708483918E-004 +2.4196729888382608E-006 -8.8158025892807909E-007
EulAngT         theta(1)                  theta(2)                  theta(3)                  [rad]
Mean      +2.9131410882893196E-004 -1.9052251994402232E-003 -1.1440722419152306E-003
sSigmaT   +1.6845651243514804E-004 +1.8956482568126830E-007 +2.3021998363057301E-007
SigmaT    +1.4973533907492497E-004 +1.6849781014545915E-007 +2.0463481531483380E-007
-----------------------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  6               1           +64.000           +64.000     pixels
OFFSET FRAME NAME: CORNER PIXEL (DIAGNOSTICS)
qT               qT(1)                     qT(2)                     qT(3)                     qT(4)
WAS(FTB)  +0.0000000000000000E+000 +0.0000000000000000E+000 +0.0000000000000000E+000 +1.0000000000000000E+000
IS (EST)  +1.4548539512439278E-004 -1.3975569702967018E-003 -1.2252306968373375E-004 +9.9999900532781127E-001

DelTheta        deltheta(1)               deltheta(2)               deltheta(3)
Units             rad                       rad                       rad
          +2.9131410882893201E-004 -2.7950791491462837E-003 -2.4545350514573538E-004
EulAngT         theta(1)                  theta(2)                  theta(3)                  [rad]
Mean      +2.9131410882893196E-004 -2.7950791491462837E-003 -2.4545350514573538E-004
sSigmaT   +1.6845636436936195E-004 +4.6010185970635906E-007 +4.7347374312805602E-007
SigmaT    +1.4973520746421805E-004 +4.0896909817397342E-007 +4.2085491647374961E-007
-----------------------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  7               1           +64.000            -64.000     pixels
OFFSET FRAME NAME: CORNER PIXEL (DIAGNOSTICS)
qT               qT(1)                     qT(2)                     qT(3)                     qT(4)
WAS(FTB)  +0.0000000000000000E+000 +0.0000000000000000E+000 +0.0000000000000000E+000 +1.0000000000000000E+000
IS (EST)  +1.4425387253851662E-004 -1.3882862082997916E-003 -1.0104779730493976E-003 +9.9999851539214302E-001

DelTheta        deltheta(1)               deltheta(2)               deltheta(3)
Units             rad                       rad                       rad
          +2.9131410882893196E-004 -2.7762803302265374E-003 -2.0213626436624585E-003
EulAngT         theta(1)                  theta(2)                  theta(3)                  [rad]
Mean      +2.9131410882893196E-004 -2.7762803302265374E-003 -2.0213626436624585E-003
sSigmaT   +1.6845638288299759E-004 +4.3522895616195560E-007 +4.6384382075936503E-007
SigmaT    +1.4973522392036729E-004 +3.8686040915886067E-007 +4.1229520174205429E-007
-----------------------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  8               1            -64.000           +64.000     pixels
OFFSET FRAME NAME: CORNER PIXEL (DIAGNOSTICS)
qT               qT(1)                     qT(2)                     qT(3)                     qT(4)
WAS(FTB)  +0.0000000000000000E+000 +0.0000000000000000E+000 +0.0000000000000000E+000 +1.0000000000000000E+000
IS (EST)  +1.4558530456298621E-004 -5.4537359146879282E-004 -1.3144311288958377E-004 +9.9999983204762244E-001

DelTheta        deltheta(1)               deltheta(2)               deltheta(3)
Units             rad                       rad                       rad
          +2.9131410882893201E-004 -1.0907089436323330E-003 -2.6304513788637989E-004
EulAngT         theta(1)                  theta(2)                  theta(3)                  [rad]
Mean      +2.9131410882893201E-004 -1.0907089436323326E-003 -2.6304513788637989E-004
sSigmaT   +1.6845639152055159E-004 +4.2156822242062697E-007 +4.4728428423462484E-007
SigmaT    +1.4973523159799910E-004 +3.7471784150622941E-007 +3.9757598560364500E-007
-----------------------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  9               1            -64.000            -64.000     pixels
OFFSET FRAME NAME: CORNER PIXEL (DIAGNOSTICS)
```

```
qT              qT(1)                    qT(2)                    qT(3)                    qT(4)
WAS(FTB)  +0.0000000000000000E+000 +0.0000000000000000E+000 +0.0000000000000000E+000 +1.0000000000000000E+000
IS (EST)  +1.4510975813337586E-004 -5.3828529956594616E-004 -1.0167608463953416E-003 +9.9999932769451172E-001

DelTheta        deltheta(1)               deltheta(2)               deltheta(3)
Units             rad                       rad                       rad
          +2.9131410882893207E-004 -1.0762749992936219E-003 -2.0336791262474466E-003
EulAngT         theta(1)                  theta(2)                  theta(3)                  [rad]
Mean      +2.9131410882893201E-004 -1.0762749992936221E-003 -2.0336791262474466E-003
sSigmaT   +1.6845640070651876E-004 +4.5229208274313220E-007 +4.6761779624702138E-007
SigmaT    +1.4973523976309695E-004 +4.0202724959368474E-007 +4.1564976186642013E-007
-------------------------------------------------------------------------------------------------------
-------------------------------------------------------------------------------------------------------
               q(1)                      q(2)                      q(3)                      q(4)
PCRS1A: +5.2603126189317361E-007 +3.7451819048221893E-004 -1.4045531552277380E-003 +9.9999894348258311E-001
PCRS2A: -5.1968404336718985E-007 +3.8455385122900486E-004 +1.3513933841514693E-003 +9.9999901292650617E-001
-------------------------------------------------------------------------------------------
**********  CS-FILE PARAMETERS:  **********  **********  AS-FILE PARAMETERS:  **********
Row (01) PIX2RADX: +1.2087416876100000E-005  Row (1) TASTART:   +7.3051200000000000E+008
Row (02) PIX2RADY: +1.2595908372599999E-005  Row (2) TASTOP:    +7.3052690000000000E+008
Row (03) CX0:      +6.4500000000000000E+001  Row (3) S/C TIME:  +7.3051200000000000E+008
Row (04) CY0:      +6.4500000000000000E+001  Row (4) QR1:       +0.0000000000000000E+000
Row (05) BETA0:    +2.8047410000000001E-006  Row (5) QR2:       +0.0000000000000000E+000
Row (06) GAMMA_E0: +2.0070000000000000E+003  Row (6) QR3:       +0.0000000000000000E+000
Row (07) D11:      -1.0000000000000000E+000  Row (7) QR4:       +1.0000000000000000E+000
Row (08) D12:      +0.0000000000000000E+000
Row (09) D21:      +0.0000000000000000E+000
Row (10) D22:      -1.0000000000000000E+000
Row (11) DG:       +1.0000000000000000E+000
-------------------------------------------------------------------------------------------
-----------------------------------------------------------
INITIAL STA-TO-PCRS ALIGNMENT (R) KNOWLEDGE (1-SIGMA)
    SIGMA(X)        SIGMA(Y)         SIGMA(Z)
1.41451738E+001  7.65467990E-001  7.65467990E-001  [arcsec]
-----------------------------------------------------------
PIX2RADX = 1.208741687610E-005[rad/pixel]
XPIXSIZE = 2.4932[arcsec]
PIX2RADY = 1.259590837260E-005[rad/pixel]
YPIXSIZE = 2.5981[arcsec]
CX0 = 64.5[pixel] = 160.81[arcsec]
CY0 = 64.5[pixel] = 167.58[arcsec]
-----------------------------------------------------------
NOMINAL BETA0 = 2.804741000000E-006[rad/encoder unit]
ENCODER UNIT SIZE = 0.58[arcsec]
GAMMA_E0 = 2007.00[encoder unit] = 1161.09[arcsec]
-----------------------------------------------------------
                | -1 | +0 |
FLIP MATRIX D = |----|----|   and   DG = +1
                | +0 | -1 |
-----------------------------------------------------------
```

3.3 IPF EXECUTION LOG

```
*********************************************************************
IPF EXECUTION-LOG FILE NAME:  LG991095.dat
INSTRUMENT TYPE:              MIPS_24um_center
IPF FILTER EXECUTION DATE:    05-Aug-2003    TIME: 21:38
IPF FILTER VERSION USED:      IPF.V2.0.1Beta
*********************************************************************
```

```
------------------- Loading & Preparing Input Files -------------------
AAFILE:  AA991095 Loaded!        AAFILE dimension = 149001 X 21
ASFILE:  AS991095 Loaded!
CAFILE:  CA991095 Loaded!        CAFILE dimension = 432 X 15
CBFILE:  CB991095 Loaded!        CBFILE dimension = 42 X 15
CCFILE:  CC991095 Created!       CCFILE dimension = 474 X 19
CSFILE:  CS991095 Loaded!
Loading Input Files Completed!
-----------------------------------------------------------------------

------------------------ Selected Mask Vectors ------------------------
index =   1  2  3  4  5  6  7  8  9 10 11 12 13 14 15 16 17 18 19 20
-----------------------------------------------------------------------
mask1 = [ 1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1 ]
mask2 = [ 1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1 ]
-----------------------------------------------------------------------

---------------  Selected Initial Gyro Bias Parameters  ---------------
IPF>> RNFILE FLAG SET TO USE PREVIOUS AG & AC FILE!
AGFILE USED: AG991095     ACFILE USED: AC991095
IPF Linearized Using Following Nominal Gyro Bias Estimates
bg0 = [+2.4582663655968712E-006 +2.4793742961420354E-006 +2.4976176758578363E-006 ]
cg0 = [+0.0000000000000000E+000 +0.0000000000000000E+000 +0.0000000000000000E+000 ]
-----------------------------------------------------------------------

IPF>> GYRO PREPROCESSOR BYPASSED!
IPF>> LOADING PREVIOUS AG & AC FILE!

FRAME TABLE ENTRIES FOR PCRS LOADED TO TPCRS
q_PCRS4 = [ +5.2603126189317361E-007     q_PCRS5 = [ +7.3379987833742897E-007
            +3.7451819048221893E-004                 +5.2236196154513707E-004
            -1.4045531552277380E-003                 -1.4047712280184723E-003
            +9.9999894348258311E-001 ];              +9.9999887687698918E-001 ];
q_PCRS8 = [ -5.1968404336718985E-007     q_PCRS9 = [ -7.1963421681856818E-007
            +3.8455385122900486E-004                 +5.3239763239987400E-004
            +1.3513933841514693E-003                 +1.3516841804518383E-003
            +9.9999901292650617E-001 ];              +9.9999894475050310E-001 ];
-------------------------------------------------------------------------------
------ Initial Conditions for State -----  ------   Inital Square-Root Cov (diag)   -----
p1(01)  = a00  = +0.0000000000000000E+000  Sigma_initial(01,01) = 1.0000000000000000E+000
p1(02)  = b00  = +0.0000000000000000E+000  Sigma_initial(02,02) = 1.0000000000000000E+000
p1(03)  = c00  = +0.0000000000000000E+000  Sigma_initial(03,03) = 1.0000000000000000E+000
p1(04)  = a10  = +0.0000000000000000E+000  Sigma_initial(04,04) = 3.6384517097704270E+002
p1(05)  = b10  = +0.0000000000000000E+000  Sigma_initial(05,05) = 3.6384517097704270E+002
p1(06)  = c10  = +0.0000000000000000E+000  Sigma_initial(06,06) = 3.6384517097704270E+002
p1(07)  = d10  = +0.0000000000000000E+000  Sigma_initial(07,07) = 3.6384517097704270E+002
p1(08)  = a20  = +0.0000000000000000E+000  Sigma_initial(08,08) = 1.3238330844331343E+007
p1(09)  = b20  = +0.0000000000000000E+000  Sigma_initial(09,09) = 1.3238330844331343E+007
p1(10)  = c20  = +0.0000000000000000E+000  Sigma_initial(10,10) = 1.3238330844331343E+007
p1(11)  = d20  = +0.0000000000000000E+000  Sigma_initial(11,11) = 1.3238330844331343E+007
p1(12)  = a01  = +0.0000000000000000E+000  Sigma_initial(12,12) = 1.0000000000000000E+004
p1(13)  = b01  = +0.0000000000000000E+000  Sigma_initial(13,13) = 1.0000000000000000E+004
p1(14)  = c01  = +0.0000000000000000E+000  Sigma_initial(14,14) = 1.0000000000000000E+004
p1(15)  = d01  = +0.0000000000000000E+000  Sigma_initial(15,15) = 1.0000000000000000E+004
p1(16)  = e01  = +0.0000000000000000E+000  Sigma_initial(16,16) = 1.0000000000000000E+004
p1(17)  = f01  = +0.0000000000000000E+000  Sigma_initial(17,17) = 1.0000000000000000E+004
-------------------------------------------------------------------------------------------
p2f(01) = am1  = +0.0000000000000000E+000
p2f(02) = am2  = +0.0000000000000000E+000  Sigma_initial(18,18) = 1.0000000000000001E-001
p2f(03) = am3  = +1.0000000000000000E+000
p2f(04) = beta = +1.0000000000000000E+000  Sigma_initial(19,19) = 1.0000000000000001E-001
p2f(05) = qT1  = -5.5224103706934371E-007  Sigma_initial(20,20) = 1.0000000000000001E-001
p2f(06) = qT2  = -9.6589398881636961E-004  Sigma_initial(21,21) = 1.0000000000000000E-002
p2f(07) = aT3  = -5.7174047628006817E-004  Sigma_initial(22,22) = 1.0000000000000000E-002
p2f(08) = qT4  = +9.9999937008046424E-001
p2f(09) = qR1  = +0.0000000000000000E+000  Sigma_initial(23,23) = 3.4288868839039716E-003
p2f(10) = qR2  = +0.0000000000000000E+000  Sigma_initial(24,24) = 1.8555467699985827E-004
p2f(11) = qR3  = +0.0000000000000000E+000  Sigma_initial(25,25) = 1.8555467699985827E-004
```

```
p2f(12) = qR4  = +1.0000000000000000E+000
p2f(13) = brx  = +0.0000000000000000E+000  Sigma_initial(26,26) = 6.7114093959731537E-005
p2f(14) = bry  = +0.0000000000000000E+000  Sigma_initial(27,27) = 6.7114093959731537E-005
p2f(15) = brz  = +0.0000000000000000E+000  Sigma_initial(28,28) = 6.7114093959731537E-005
p2f(16) = crx  = +0.0000000000000000E+000  Sigma_initial(29,29) = 4.5043016080356737E-009
p2f(17) = cry  = +0.0000000000000000E+000  Sigma_initial(30,30) = 4.5043016080356737E-009
p2f(18) = crz  = +0.0000000000000000E+000  Sigma_initial(31,31) = 4.5043016080356737E-009
p2f(19) = bgx  = +0.0000000000000000E+000  Sigma_initial(32,32) = 6.7114093959731537E-005
p2f(20) = bgy  = +0.0000000000000000E+000  Sigma_initial(33,33) = 6.7114093959731537E-005
p2f(21) = bgz  = +0.0000000000000000E+000  Sigma_initial(34,34) = 6.7114093959731537E-005
p2f(22) = cgx  = +0.0000000000000000E+000  Sigma_initial(35,35) = 4.5043016080356737E-009
p2f(23) = cgy  = +0.0000000000000000E+000  Sigma_initial(36,36) = 4.5043016080356737E-009
p2f(24) = cgz  = +0.0000000000000000E+000  Sigma_initial(37,37) = 4.5043016080356737E-009
--------------------------------------------------------------------------------------

--------------------   IPF KALMAN FILTER STARTED  ---------------------
Iteration#001: |dp|= +3.136219263208E+003   RMS(|Res|)=+3.136219263208E+003
Iteration#002: |dp|= +1.379890498077E+001   RMS(|Res|)=+1.379890498077E+001
Iteration#003: |dp|= +9.830901580851E-002   RMS(|Res|)=+9.830901580851E-002
Iteration#004: |dp|= +8.172273105503E-001   RMS(|Res|)=+8.172273105503E-001
Iteration#005: |dp|= +6.964494745514E-002   RMS(|Res|)=+6.964494745514E-002
Iteration#006: |dp|= +2.750847999648E-003   RMS(|Res|)=+2.750847999648E-003
Iteration#007: |dp|= +3.914500766379E-005   RMS(|Res|)=+3.914500766379E-005
Iteration#008: |dp|= +1.728921133155E-006   RMS(|Res|)=+1.728921133155E-006
Iteration#009: |dp|= +2.366387844766E-006   RMS(|Res|)=+2.366387844766E-006
Iteration#010: |dp|= +4.424385829053E-007   RMS(|Res|)=+4.424385829053E-007
Iteration#011: |dp|= +3.897003643676E-007   RMS(|Res|)=+3.897003643676E-007
Iteration#012: |dp|= +8.127892945278E-007   RMS(|Res|)=+8.127892945278E-007
Iteration#013: |dp|= +1.584513669626E-006   RMS(|Res|)=+1.584513669626E-006
Iteration#014: |dp|= +2.119071531128E-006   RMS(|Res|)=+2.119071531128E-006
Iteration#015: |dp|= +2.367526536459E-006   RMS(|Res|)=+2.367526536459E-006
Iteration#016: |dp|= +8.719548153950E-007   RMS(|Res|)=+8.719548153950E-007
Iteration#017: |dp|= +1.231693233202E-007   RMS(|Res|)=+1.231693233202E-007
Iteration#018: |dp|= +9.147149207192E-007   RMS(|Res|)=+9.147149207192E-007
Iteration#019: |dp|= +5.535627389322E-007   RMS(|Res|)=+5.535627389322E-007
Iteration#020: |dp|= +2.742907176399E-007   RMS(|Res|)=+2.742907176399E-007
Iteration#021: |dp|= +3.054115708920E-007   RMS(|Res|)=+3.054115708920E-007
Iteration#022: |dp|= +3.245014548972E-007   RMS(|Res|)=+3.245014548972E-007
Iteration#023: |dp|= +1.869249742040E-006   RMS(|Res|)=+1.869249742040E-006
Iteration#024: |dp|= +2.203383761894E-006   RMS(|Res|)=+2.203383761894E-006
Iteration#025: |dp|= +1.813571801694E-006   RMS(|Res|)=+1.813571801694E-006
IPF Kalman Filter Completed with Error |dp1| + |dp2| = +1.8135718016940001E-006
----------------------------------------------------------------------

-----------------  IPF LEAST SQUARES FILTER STARTED  ------------------
Iteration#001   COND#=+1.571988770362E+012,   |dp|=+3.135179836901E+003
Iteration#002   COND#=+1.571989273295E+012,   |dp|=+1.598694123393E+001
Iteration#003   COND#=+1.571989272655E+012,   |dp|=+2.287588387184E-002
Iteration#004   COND#=+1.571989277419E+012,   |dp|=+2.116182767216E-003
Iteration#005   COND#=+1.571989279165E+012,   |dp|=+7.927992189079E-005
Iteration#006   COND#=+1.571989280408E+012,   |dp|=+1.450568192233E-006
Iteration#007   COND#=+1.571989277798E+012,   |dp|=+4.795100932354E-008
Iteration#008   COND#=+1.571989273445E+012,   |dp|=+1.134975818328E-007
Iteration#009   COND#=+1.571989269168E+012,   |dp|=+6.629818756727E-008
Iteration#010   COND#=+1.571989274939E+012,   |dp|=+9.155340425099E-008
Iteration#011   COND#=+1.571989280075E+012,   |dp|=+1.025535672956E-007
Iteration#012   COND#=+1.571989270783E+012,   |dp|=+1.393199233679E-007
Iteration#013   COND#=+1.571989278079E+012,   |dp|=+1.538824474536E-008
Iteration#014   COND#=+1.571989276816E+012,   |dp|=+6.875998764586E-008
Iteration#015   COND#=+1.571989272449E+012,   |dp|=+3.929231977738E-008
Iteration#016   COND#=+1.571989276204E+012,   |dp|=+8.871462548943E-008
Iteration#017   COND#=+1.571989274690E+012,   |dp|=+7.875629633004E-008
Iteration#018   COND#=+1.571989274914E+012,   |dp|=+3.527463973771E-008
Iteration#019   COND#=+1.571989275874E+012,   |dp|=+4.807581430322E-008
Iteration#020   COND#=+1.571989280842E+012,   |dp|=+7.313823132831E-008
Iteration#021   COND#=+1.571989269595E+012,   |dp|=+9.592392240910E-008
Iteration#022   COND#=+1.571989276512E+012,   |dp|=+1.235954492925E-007
Iteration#023   COND#=+1.571989277018E+012,   |dp|=+2.551876437337E-008
```

```
Iteration#024   COND#=+1.571989273122E+012,   |dp|=+4.580802225882E-008
Iteration#025   COND#=+1.571989278072E+012,   |dp|=+9.542420247573E-008
IPF Least Squares Filter Completed with Error |dp1| + |dp2| = +9.5424202475733262E-008
----------------------------------------------------------------------
Total Execution Time: 275 seconds
```

4 USER COMMENTS

This section left blank.

IPF TEAM CONTACT INFORMATION

IPF Team email		ipf@sirtfweb.jpl.nasa.gov	
David S. Bayard	X4-8208	David.S.Bayard@jpl.nasa.gov	(TEAM LEADER)
Dhemetrio Boussalis	X4-3977	boussali@grover.jpl.nasa.gov	
Paul Brugarolas	X4-9243	Paul.Brugarolas@jpl.nasa.gov	
Bryan H. Kang	X4-0541	Bryan.H.Kang@jpl.nasa.gov	
Edward.C.Wong	X4-3053	Edward.C.Wong@jpl.nasa.gov	(TASK MANAGER)

ACKNOWLEDGEMENTS

This work was performed at the Jet Propulsion Laboratory, California Institute of Technology, under contract with the National Aeronautics and Space Administration.

References

[1] D.S. Bayard, B.H. Kang, *SIRTF Instrument Pointing Frame Kalman Filter Algorithm*, JPL D-Document D-24809, September 30, 2003.

[2] B.H. Kang, D.S. Bayard, *SIRTF Instrument Pointing Frame (IPF) Software Description Document and User's Guide*, JPL D-Document D-24808, September 30, 2003.

[3] D.S. Bayard, B.H. Kang, *SIRTF Instrument Pointing Frame (IPF) Kalman Filter Unit Test Report*, JPL D-Document D-24810, September 30, 2003.

[4] *Space Infrared Telescope Facility In-Orbit Checkout and Science Verification Mission Plan*, JPL D-Document D-22622, 674-FE-301 Version 1.4, February 8, 2002.

[5] *Space Infrared Telescope Facility Observatory Description Document*, Lockheed Martin LMMS/P458569, 674-SEIT-300 Version 1.2, November 1, 2002.

[6] *SIRTF Software Interface Specification for Science Centroid INPUT Files (CAFILE, CS-FILE)*, JPL SOS-SIS-2002, November 18, 2002.

[7] *SIRTF Software Interface Specification for Inferred Frames Offset INPUT Files (OFILE)*, JPL SOS-SIS-2003, November 18, 2002.

[8] *SIRTF Software Interface Specification for PCRS Centroid INPUT Files (CBFILE)*, JPL SIS-FES-015, November 18, 2002.

[9] *SIRTF Software Interface Specification for Attitude INPUT Files (AFILE, ASFILE)*, JPL SIS-FES-014, January 7, 2002.

[10] *SIRTF Software Interface Specification for IPF Filter Output Files (IFFILE, LGFILE, TARFILE)*, JPL SOS-SIS-2005, November 18, 2002.

[11] R.J. Brown, *Focal Surface to Object Space Field of View Conversion.* Systems Engineering Report SER No. S20447-OPT-051, Ball Aerospace & Technologies Corp., November 23, 1999.

This page left blank.

SIRTF INSTRUMENT POINTING FRAME KALMAN FILTER EXECUTION SUMMARY

IPF RUN NUMBER: 992095
REPORT TYPE: COVARIANCE ANALYSIS

PRIME FRAME: MIPS_24um_center (95)
INFERRED FRAMES: (96) (99) (100) (103) (104) (1) (1) (1) (1)

IPF TEAM

Autonomy and Control Section (345)
Jet Propulsion Laboratory
California Institute of Technology
4800 Oak Grove Drive
Pasadena, CA 91109

Contents

1 IPF EXECUTION SUMMARY **4**

2 FLUTE DATA SUMMARY **8**

2.1 FLUTE CONFIGURATION PARAMETERS 8

2.2 FLUTE GENERATED UNIT TEST DATA 11

3 IPF EXECUTION RESULTS **15**

3.1 IPF EXECUTION OUTPUT PLOTS 15

3.2 IPF OUTPUT DATA (IF MINI FILE) 29

3.3 IPF EXECUTION LOG 34

4 USER COMMENTS **37**

List of Figures

1.1 A-priori and a-posteriori IPF frames 4

1.2 A-priori and a-posteriori IPF frames (ZOOMED) 7

2.1 Focal plane survey scenario plot (See key in [3]) 11

2.2 Commanded-only source locations 12

2.3 True (+) and commanded (o) source locations 12

2.4 True (+) and commanded (o) source locations (ZOOMED) 13

2.5 True-sampled (o) and centroided (+) locations on S/I array (W,V) 13

2.6 True (o) and centroided (+) locations on S/I array (W,V) 14

2.7 True (o) and centroided (+) locations on S/I array (W,V) showing prime and inferred frames 14

3.1 TPF coords of measurements and a-priori predicts 16

3.2 Oriented Pixel Coords of measurements and a-priori predicts 16

3.3 A-priori prediction error 17

3.4 Oriented Pixel Coords of measurements and a-priori predicts (PCRS only) 17

3.5 IPF execution convergence, chart 1 18

3.6 IPF execution convergence, chart 2 18

3.7 Parameter uncertainty convergence 19

3.8 IPF parameter symbol table 19

3.9 KF parameter error sigma plots . . . 20
3.10 LS parameter error sigma plot . . . 20
3.11 KF and LS parameter error sigma plot . . . 21
3.12 Oriented Pixel Coords of meas. and a-posteriori predicts . . . 22
3.13 Oriented Pixel Coords of meas. and a-posteriori predicts (attitude corrected) . . . 22
3.14 Array plot with (solid) and w/o (dashed) optical distortion corrections . . . 23
3.15 KF innovations with (o) and w/o (+) attitude corrections . . . 23
3.16 W-axis KF innovations and 1-sigma bound . . . 24
3.17 V-axis KF innovations and 1-sigma bound . . . 24
3.18 Estimated attitude corrections (Body frame) . . . 25
3.19 Estimated attitude error sigma plot (Body frame) . . . 25
3.20 Thermo-mechanical boresight drift (equiv. angle in (W,V) coords) . . . 26
3.21 Thermo-mechanical boresight drift (equiv. angle in Body frame) . . . 26
3.22 Gyro drift bias contribution (equiv. rate in (W,V) coords) . . . 27
3.23 Gyro drift bias contribution (equiv. angle in (W,V) coords) . . . 27
3.24 Gyro drift bias contribution (equiv. angle in Body frame) . . . 28

List of Tables

1.1 IPF filter input files . . . 5
1.2 IPF filter execution configuration . . . 5
1.3 IPF filter execution mask vector assignment . . . 5
1.4 IPF calibration error summary ([arcsec], 1-sigma, radial) . . . 6
1.5 Measurement prediction error summary (1-sigma) . . . 6
1.6 IPF Brown angle summary . . . 7
2.1 FLUTE Parameter Table (1) . . . 8
2.2 FLUTE Parameter Table (2) . . . 9
2.3 FLUTE Parameter Table (3) . . . 10
2.4 Table of figures (FLUTE) . . . 11
3.1 Table of figures (IPF run) . . . 15

1 IPF EXECUTION SUMMARY

This report summarizes the SIRTF Instrument Pointing Frame (IPF) Kalman Filter execution associated with run file: RN992095. In particular, this Focal Point Survey calibrates the instrument: MIPS_24um_center (95), as part of the Covariance Analysis. The main calibration results from the IPF filter execution have been documented in IF992095 typically stored in the mission archive DOM collection IPF_IF. This report only summarizes the main aspects of the run, and does not substitute for the full information contained in the IF file.

Section 1 summarizes the filter execution results. The filter configurations are tabulated in Table 1.2 and the mask vector assignments are tabulated in Table 1.3. A total of 37 state parameters are estimated in this run. The overall End-to-End pointing performances are tabulated in Table 1.4. The prediction residuals throughout the estimation processes are tabulated in Table 1.6. Section 2 documents the FLUTE generated input file data. Section 3 summarizes resulting plots, a mini summary of the IF IPF output file, and the execution log. Section 4 captures the user comments that are specific to this particular run.

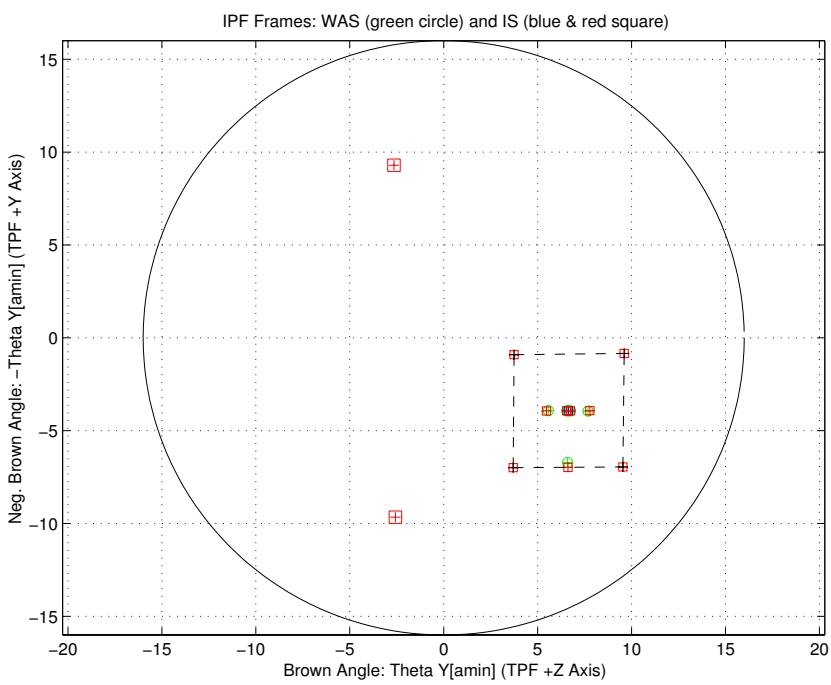

Figure 1.1: A-priori and a-posteriori IPF frames

RAW	FINAL (After Editing)
AA992095	AA992095
AS992095	AS992095
CA992095	CA992095
CB992095	CB992095
CS992095	CS992095

Table 1.1: IPF filter input files

EXECUTION CONFIGURATION ITEM	CURRENT STATUS
IPF Filter Version Used	IPF.V2.0.1Beta
Frame Table Version Used	FTVE2E1
Scan-Mirror Employed?	YES
IPF Filter Mode	NORMAL-MODE(0)
SLIT-MODE Operation	DISABLED
Kalman Filter Operation	ENABLED
Least-Squares Data Analysis	ENABLED
IBAD Screening	ENABLED
User-Specified Data Editing	DISABLED
Total Number of Iterations	20
LS Residual Sigma Scale	1.13479102E+000
Total Number of Maneuvers	14

Table 1.2: IPF filter execution configuration

Con. Plate Scale			Γ Dependent				Γ^2 Dependent				Linear Plate Scale						Mirror	
a_{00}	b_{00}	c_{00}	a_{10}	b_{10}	c_{10}	d_{10}	a_{20}	b_{20}	c_{20}	d_{20}	a_{01}	b_{01}	c_{01}	d_{01}	e_{01}	f_{01}	α	β
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
IPF (T)			Alignment R									Gyro Drift Bias						
θ_1	θ_2	θ_3	a_{rx}	a_{ry}	a_{rz}	b_{rx}	b_{ry}	b_{rz}	c_{rx}	c_{ry}	c_{rz}	b_{gx}	b_{gy}	b_{gz}	c_{gx}	c_{gy}	c_{gz}	
20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	

Table 1.3: IPF filter execution mask vector assignment

FOCAL PLANE SURVEY ANALYSIS: Covariance Analysis.
INSTRUMENT NAME: MIPS_24um_center NF: 95

```
PIX2RADW: 1.20874169E-005[rad/pixel] = 2.4932E+000[arcsec/pixel]
PIX2RADV: 1.20874169E-005[rad/pixel] = 2.4932E+000[arcsec/pixel]
```

FRAME	DESCRIPTION	IPF[1]	SF[2]	ARW[3]	TOTAL	REQ
095(P)	MIPS_24um_center	0.0544	0.0855	0.0703	0.1233	0.14
096(I)	MIPS_24um_plusY_edge	0.0926	0.0855	0.0703	0.1443	N/A
099(I)	MIPS_24um_small_FOV1	0.0555	0.0855	0.0703	0.1238	N/A
100(I)	MIPS_24um_small_FOV2	0.0512	0.0855	0.0703	0.1219	N/A
103(I)	MIPS_24um_large_FOV1	0.0547	0.0855	0.0703	0.1234	N/A
104(I)	MIPS_24um_large_FOV2	0.0542	0.0855	0.0703	0.1232	N/A
TR (C)	CORNERS OF INSTRUMENT	0.1275	0.0855	0.0703	0.1688	N/A
BR (C)	CORNERS OF INSTRUMENT	0.1091	0.0855	0.0703	0.1554	N/A
TL (C)	CORNERS OF INSTRUMENT	0.1259	0.0855	0.0703	0.1676	N/A
BL (C)	CORNERS OF INSTRUMENT	0.1165	0.0855	0.0703	0.1607	N/A

Table 1.4: IPF calibration error summary ([arcsec], 1-sigma, radial)

RMS METRIC	A PRIORI[4]	A POSTERIORI[4]	ATT. CORRECTED[5]	UNITS
Radial	24.5101	1.9672	0.3985	arcsec
Radial	9.8307	0.7890	0.1598	pixels
W-Axis	6.6821	0.3457	0.1110	pixels
V-Axis	7.2106	0.7093	0.1150	pixels

Table 1.5: Measurement prediction error summary (1-sigma)

[1]IPF filter removes systematic pointing errors due to: thermomechanical alignment drift (Body to TPF), gyro bias and bias drift, centroiding error, attitude error, and optical distortion. IPF SIGMA presented here is "NOT Scaled" by the Least Squares Scale factor. The Least Squares Scale Factor was: 1.134791.

[2]Error due to gyro Scale Factor: assumes 95 ppm error over 0.250 degree maneuver.

[3]Error due to gyro Angle Random Walk: assumes ARW = 100 $\mu deg/\sqrt{hr}$, with 960 second Maneuver time (max), and 14 independent Maneuvers.

[4]This can be interpreted as estimate of "pixel to sky" pointing reconstruction error if no science data is used.

[5]This can be interpreted as estimate of achieved S/I centroiding error

IPF BROWN ANGLE SUMMARY						
	WAS			IS		
Frame Number	theta_Y (arcmin)	theta_Z (arcmin)	angle (deg)	theta_Y (arcmin)	theta_Z (arcmin)	angle (deg)
095	+6.641000	+3.931000	+0.000000	+6.640699	+3.931685	+0.007771
096	+6.595000	+6.712000	-0.000000	+6.618371	+6.975996	+0.007771
099	+7.687000	+3.943000	-0.000000	+7.784118	+3.920819	+0.007771
100	+5.574000	+3.918000	+0.000000	+5.475973	+3.941611	+0.007771
103	+6.746000	+3.932000	+0.000000	+6.754973	+3.930649	+0.007771
104	+6.558000	+3.930000	+0.000000	+6.549291	+3.932506	+0.007771
001	+0.000000	+0.000000	+0.000000	+9.610300	+0.843451	+0.007771
001	+0.000000	+0.000000	+0.000000	+9.543426	+6.951110	+0.007771
001	+0.000000	+0.000000	+0.000000	+3.749635	+0.906557	+0.007771
001	+0.000000	+0.000000	+0.000000	+3.703246	+6.993520	+0.007771

Table 1.6: IPF Brown angle summary

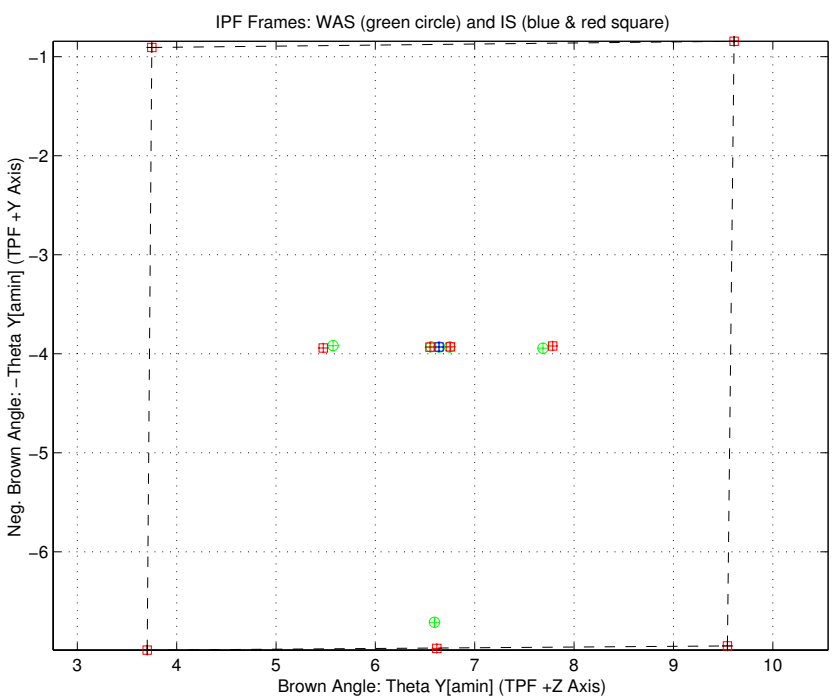

Figure 1.2: A-priori and a-posteriori IPF frames (ZOOMED)

2 FLUTE DATA SUMMARY

2.1 FLUTE CONFIGURATION PARAMETERS

The covariance analysis was performed using the FLUTE generated input data files. The internal configuration parameters, used to produce the data are tabulated in Table 2.1, Table 2.2 and Table 2.3.

NAME	DESCRIPTION	VALUE	UNIT
d2003	days into YEAR2003	+6.0000000000000000E+001	day
tstart	start time	+7.3051200000000000E+008	sec
tdel	data rate	+1.0000000000000001E-001	sec
tshelf	Inertial Hold duration pad	+5.0000000000000000E+000	sec
ipro	slew profile(1-linear, 2-S-curve)	1	int flag
sig_gcf [1]	gcf sigma(1)	+4.8481368110953601E-008	rad/sec
sig_gcf [2]	gcf sigma(2)	+9.6962736221907205E-009	rad/sec
sig_gcf [3]	gcf sigma(3)	+9.6962736221907205E-009	rad/sec
igcf	gcf bias correction flag	1	int flag
SigA [1][1]	Sigma A(1,1)	+9.4017722156391537E-009	rad^2
SigA [2][2]	Sigma A(2,2)	+2.3504430539097885E-011	rad^2
SigA [3][3]	Sigma A(3,3)	+2.3504430539097885E-011	rad^2
NFprime	Prime Frame NF	95	int
ftable [name]	Frame Table row number	95	int
ftable [q0]	Frametable quaternion q0	-5.5224103706934371E-007	N/A
ftable [q1]	Frametable quaternion q1	-9.6589398881636961E-004	N/A
ftable [q2]	Frametable quaternion q2	-5.7174047628006817E-004	N/A
ftable [q3]	Frametable quaternion q3	+9.9999937008046424E-001	N/A
ft_cmd [name]	Command row number	95	int
ft_cmd [q0]	Command quaternion q0	-5.5224103706934371E-007	N/A
ft_cmd [q1]	Command quaternion q1	-9.6589398881636961E-004	N/A
ft_cmd [q2]	Command quaternion q2	-5.7174047628006817E-004	N/A
ft_cmd [q3]	Command quaternion q3	+9.9999937008046424E-001	N/A
ft_true [name]	Truth row number	95	int
ft_true [q0]	Truth quaternion q0	-5.5224103706934371E-007	N/A
ft_true [q1]	Truth quaternion q1	-9.6589398881636961E-004	N/A
ft_true [q2]	Truth quaternion q2	-5.7174047628006817E-004	N/A
ft_true [q3]	Truth quaternion q3	+9.9999937008046424E-001	N/A
ft_prior [name]	Prior row number	95	int
ft_prior [q0]	FTprior quaternion q0	-5.5224103706934371E-007	N/A
ft_prior [q1]	FTprior quaternion q1	-9.6589398881636961E-004	N/A
ft_prior [q2]	FTprior quaternion q2	-5.7174047628006817E-004	N/A
ft_prior [q3]	FTprior quaternion q3	+9.9999937008046424E-001	N/A
ntable [NF]	ntable row number	95	int
ntable [iprime]	Prime frame indication flag	1	int
ntable [SIG_CX]	CX Sigma	+1.0000000000000001E-001	pixel
ntable [SIG_CY]	CY Sigma	+1.0000000000000001E-001	pixel
ntable [PIX2RADX]	Nom. angular pixelsize X-dir	+1.2087416876100000E-005	rad/pixel
ntable [PIX2RADY]	Nom. angular pixelsize Y-dir	+1.2595908372599999E-005	rad/pixel
ntable [CX0]	Center pixel along X-axis	+6.4500000000000000E+001	pixel
ntable [CY0]	Center pixel along Y-axis	+6.4500000000000000E+001	pixel
ntable [BETA0]	Nominal mirror scale factor	+2.8047410000000001E-006	rad/(e.u.)
ntable [GAMMA_E0]	Reference Mirror position	+2.0070000000000000E+003	(e.u.[6])

Table 2.1: FLUTE Parameter Table (1)

[6] encoder units

NAME	DESCRIPTION	VALUE	UNIT
ntable [D11]	x-to-w frame flip parameter	-1	int
ntable [D12]	y-to-w frame flip parameter	0	int
ntable [D21]	x-to-v frame flip parameter	0	int
ntable [D22]	y-to-v frame flip parameter	-1	int
ntable [DG]	Mirror flip parameter	1	int
ntable [sisizew]	Array size (w-direction)	+1.5707963267948967E-003	pixel
ntable [sisizev]	Array size (v-direction)	+1.5707963267948967E-003	pixel
ntable [p2i_w]	w-offset from prime	+0.0000000000000000E+000	pixel
ntable [p2i_v]	v-offset from prime	+0.0000000000000000E+000	pixel
p1true [a00]	True Constant Plate Scales	+1.0000000000000001E-001	N/A
p1true [b00]	True Constant Plate Scales	+1.0000000000000001E-001	N/A
p1true [c00]	True Constant Plate Scales	+1.0000000000000000E-002	N/A
p1true [a10]	True Γ Dependent Plate Scales	+1.0000000000000001E-001	1/rad
p1true [b10]	True Γ Dependent Plate Scales	+1.0000000000000001E-001	1/rad
p1true [c10]	True Γ Dependent Plate Scales	+1.0000000000000000E-002	1/rad
p1true [d10]	True Γ Dependent Plate Scales	+1.0000000000000000E-002	1/rad
p1true [a20]	True Γ^2 Dependent Plate Scales	+1.0000000000000001E-001	$1/\mathrm{rad}^2$
p1true [b20]	True Γ^2 Dependent Plate Scales	+1.0000000000000001E-001	$1/\mathrm{rad}^2$
p1true [c20]	True Γ^2 Dependent Plate Scales	+1.0000000000000000E-002	$1/\mathrm{rad}^2$
p1true [d20]	True Γ^2 Dependent Plate Scales	+1.0000000000000000E-002	$1/\mathrm{rad}^2$
p1true [a01]	True Linear Plate Scales	+2.0000000000000000E+000	N/A
p1true [b01]	True Linear Plate Scales	+2.0000000000000000E+000	N/A
p1true [c01]	True Linear Plate Scales	+2.0000000000000000E+000	N/A
p1true [d01]	True Linear Plate Scales	+2.0000000000000000E+000	N/A
p1true [e01]	True Linear Plate Scales	+2.0000000000000000E+000	N/A
p1true [f01]	True Linear Plate Scales	+2.0000000000000000E+000	N/A
p2true [am1]	True Scan mirror alignment Ux	+0.0000000000000000E+000	N/A
p2true [am2]	True Scan mirror alignment Uy	+2.0000000000000000E-002	N/A
p2true [am3]	True Scan mirror alignment Uz	+9.9979997999599901E-001	N/A
p2true [beta]	True Scan mirror scale factor	+1.1000000000000001E+000	N/A
p2true [qT1]	True IPF q1	-5.5224103706934371E-007	N/A
p2true [qT2]	True IPF q2	-9.6589398881636961E-004	N/A
p2true [qT3]	True IPF q3	-5.7174047628006817E-004	N/A
p2true [qT4]	True IPF q4	+9.9999937008046424E-001	N/A
p2true [qR01]	True Boresight Alignment q1	+2.4240683335224579E-004	N/A
p2true [qR02]	True Boresight Alignment q2	+1.6968478334657203E-005	N/A
p2true [qR03]	True Boresight Alignment q3	+1.9392546668179664E-005	N/A
p2true [qR04]	True Boresight Alignment q4	+9.9999997028746312E-001	N/A
p2true [brx]	True B. Alignment drift rate X	+4.0000000000000001E-010	rad/sec
p2true [bry]	True B. Alignment drift rate Y	+3.0000000000000000E-010	rad/sec
p2true [brz]	True B. Alignment drift rate Z	+2.0000000000000001E-010	rad/sec
p2true [crx]	True B. Alignment drift accel. X	+9.0000000000000000E-013	$\mathrm{rad/sec}^2$
p2true [cry]	True B. Alignment drift accel. Y	+8.0000000000000002E-013	$\mathrm{rad/sec}^2$
p2true [crz]	True B. Alignment drift accel. Z	+7.0000000000000005E-013	$\mathrm{rad/sec}^2$
p2true [bgx]	True Gyro bias correction X	+1.4544410433286078E-006	rad/sec
p2true [bgy]	True Gyro bias correction Y	+1.9392547244381440E-007	rad/sec
p2true [bgz]	True Gyro bias correction Z	+2.4240684055476802E-007	rad/sec
p2true [cgx]	True Gyro bias-rate correction X	+4.9999999999999999E-013	$\mathrm{rad/sec}^2$
p2true [cgy]	True Gyro bias-rate correction Y	+4.0000000000000001E-013	$\mathrm{rad/sec}^2$
p2true [cgz]	True Gyro bias-rate correction Z	+2.9999999999999998E-013	$\mathrm{rad/sec}^2$

Table 2.2: FLUTE Parameter Table (2)

NAME	DESCRIPTION	VALUE	UNIT
p2cmd [am1]	CMD Scan mirror alignment Ux	+0.0000000000000000E+000	N/A
p2cmd [am2]	CMD Scan mirror alignment Uy	+0.0000000000000000E+000	N/A
p2cmd [am3]	CMD Scan mirror alignment Uz	+1.0000000000000000E+000	N/A
p2cmd [beta]	CMD Scan mirror rotation SF	+1.0000000000000000E+000	N/A
p2cmd [qT1]	CMD IPF q1	-5.5224103706934371E-007	N/A
p2cmd [qT2]	CMD IPF q2	-9.6589398881636961E-004	N/A
p2cmd [qT3]	CMD IPF q3	-5.7174047628006817E-004	N/A
p2cmd [qT4]	CMD IPF q4	+9.9999937008046424E-001	N/A
p2cmd [qR01]	CMD Boresight Alignment q1	+0.0000000000000000E+000	N/A
p2cmd [qR02]	CMD Boresight Alignment q2	+0.0000000000000000E+000	N/A
p2cmd [qR03]	CMD Boresight Alignment q3	+0.0000000000000000E+000	N/A
p2cmd [qR04]	CMD Boresight Alignment q4	+1.0000000000000000E+000	N/A
p2cmd [brx]	CMD B. Alignment drift rate X	+0.0000000000000000E+000	rad/sec
p2cmd [bry]	CMD B. Alignment drift rate Y	+0.0000000000000000E+000	rad/sec
p2cmd [brz]	CMD B. Alignment drift rate Z	+0.0000000000000000E+000	rad/sec
p2cmd [crx]	CMD B. Alignment drift accel. X	+0.0000000000000000E+000	rad/sec^2
p2cmd [cry]	CMD B. Alignment drift accel. Y	+0.0000000000000000E+000	rad/sec^2
p2cmd [crz]	CMD B. Alignment drift accel. Z	+0.0000000000000000E+000	rad/sec^2
p2cmd [bgx]	CMD Gyro bias correction X	+0.0000000000000000E+000	rad/sec
p2cmd [bgy]	CMD Gyro bias correction Y	+0.0000000000000000E+000	rad/sec
p2cmd [bgz]	CMD Gyro bias correction Z	+0.0000000000000000E+000	rad/sec
p2cmd [cgx]	CMD Gyro bias-rate correction X	+0.0000000000000000E+000	rad/sec^2
p2cmd [cgy]	CMD Gyro bias-rate correction Y	+0.0000000000000000E+000	rad/sec^2
p2cmd [cgz]	CMD Gyro bias-rate correction Z	+0.0000000000000000E+000	rad/sec^2
a1	Semi-Major Axis of SIRTF (HCO [7])	+1.4960000000000000E+011	m
a2	Semi-Major Axis of Earth (HCO)	+1.4960000000000000E+011	m
e1	Eccentricity (SIRTF in HCO)	+1.6722000000000001E-002	N/A
e2	Eccentricity (Earth in HCO)	+1.6722000000000001E-002	N/A
inc1	inclination (SIRTF in HCO)	+4.0142572795869580E-001	rad
inc2	inclination (Earth in HCO)	+4.0142572795869580E-001	rad
Omega1	Ascending Node Long.(SIRTF in HCO)	+0.0000000000000000E+000	rad
Omega2	Ascending Node Long.(Earth in HCO)	+0.0000000000000000E+000	rad
omega1	Argument of Perigee(SIRTF in HCO)	+1.7627825445142729E+000	rad
omega2	Argument of Perigee(Earth in HCO)	+1.7627825445142729E+000	rad
nu0_1	True Anomaly of SIRTF(HCO)	+8.6071031605199810E-001	rad
nu0_2	True Anomaly of Earth(HCO)	+1.0328523792623976E+000	rad
inav	Velocity Report Flag	+0.0000000000000000E+000	rad
wsize	Array size W-dir	+1.5707963267948967E-003	rad
vsize	Array size V-dir	+1.5707963267948967E-003	rad

Table 2.3: FLUTE Parameter Table (3)

[7] Heliocentric Orbit

2.2 FLUTE GENERATED UNIT TEST DATA

This subsection plots the FLUTE generated IPF filter input files. Seven figures, as tabulated in Table 2.4, show the campaign maneuver senario, the true sampled locations on the array and the actual centroided data superimposed the array plane. All angles shown in FLUTE plots have units of radians.

FIGURE NO.	DESCRIPTION
Figure 2.1	Focal Plane Survey Scenario Plot
Figure 2.2	Commanded-only source locations in TPF
Figure 2.3	True and commanded source locations in TPF
Figure 2.4	True and commanded source locations (ZOOMED) in TPF
Figure 2.5	True-sampled and centroided locations in Focal Plane (W,V) including rectangular array boundary approximation
Figure 2.6	True and centroided locations on S/I Array (W,V) including rectangular array boundary approximation
Figure 2.7	True and centroided locations on S/I Array (W,V) showing Prime and Inferred Frames including rectangular array boundary approximation

Table 2.4: Table of figures (FLUTE)

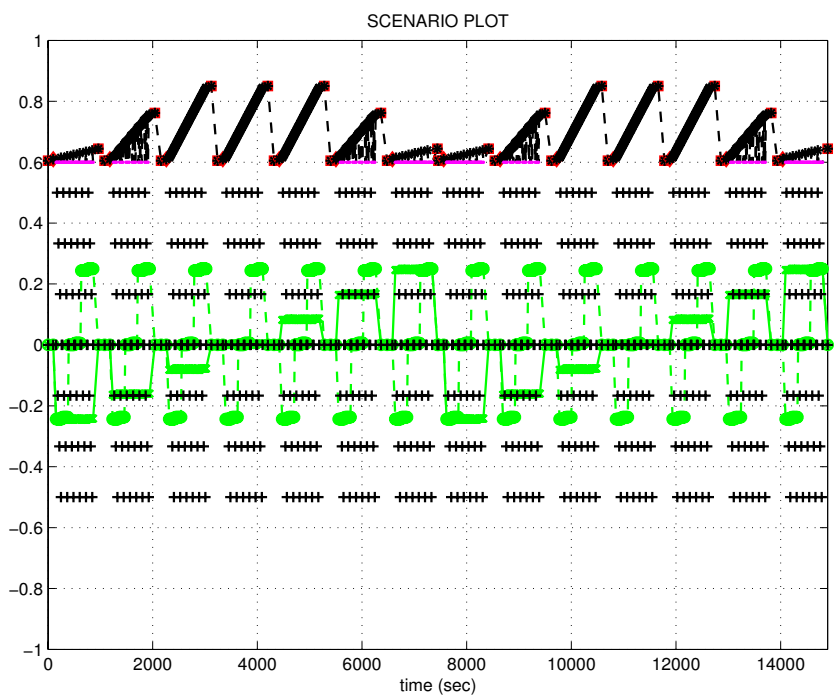

Figure 2.1: Focal plane survey scenario plot (See key in [3])

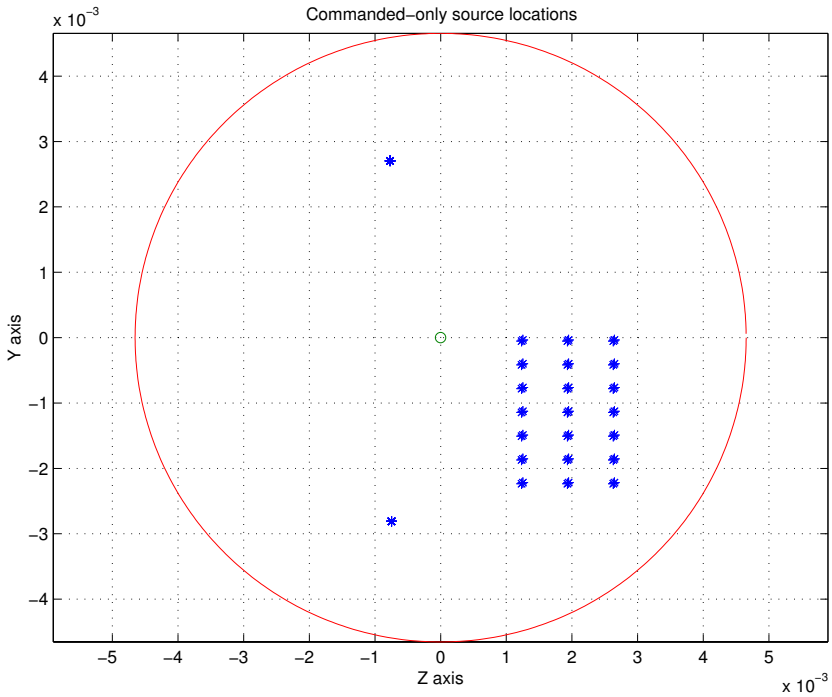

Figure 2.2: Commanded-only source locations

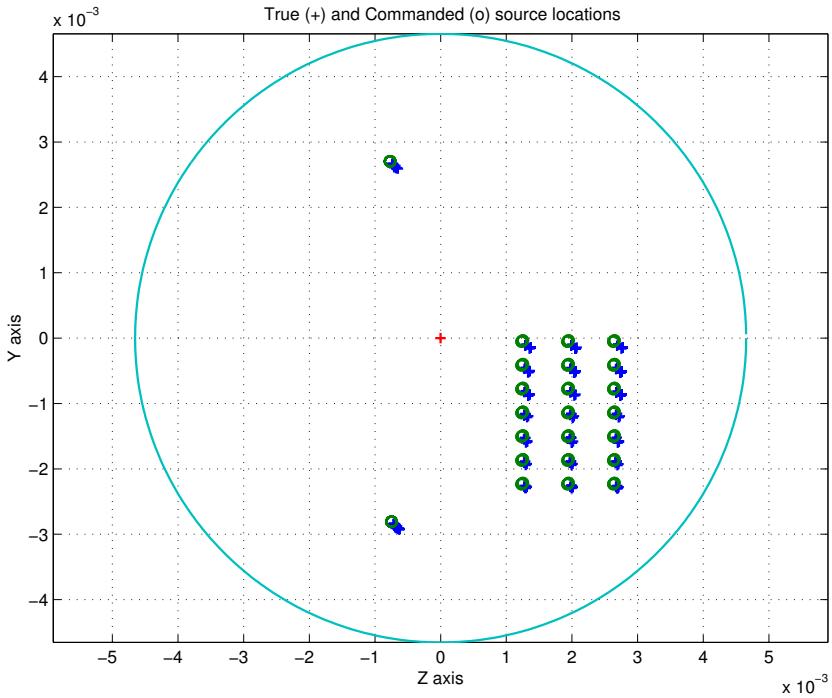

Figure 2.3: True (+) and commanded (o) source locations

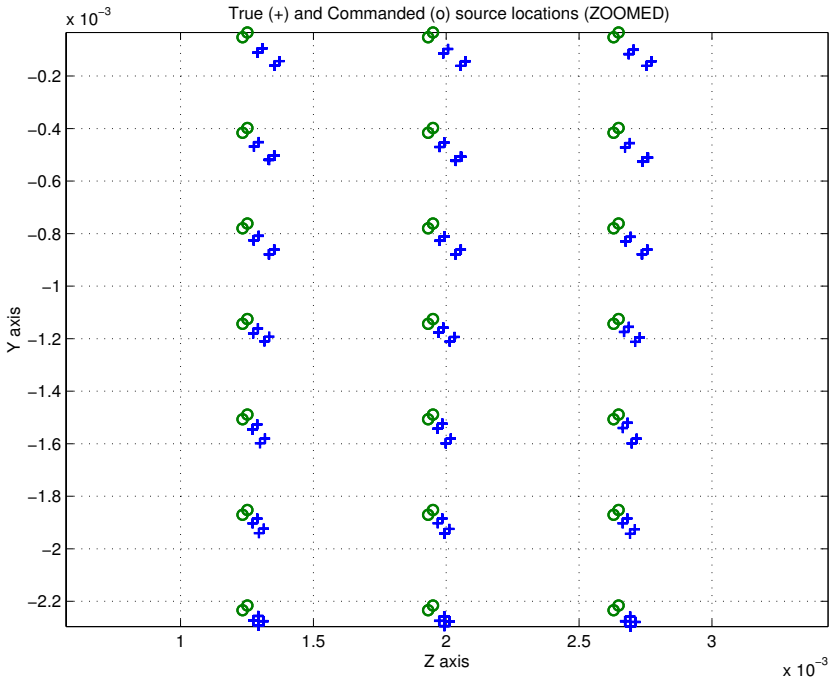

Figure 2.4: True (+) and commanded (o) source locations (ZOOMED)

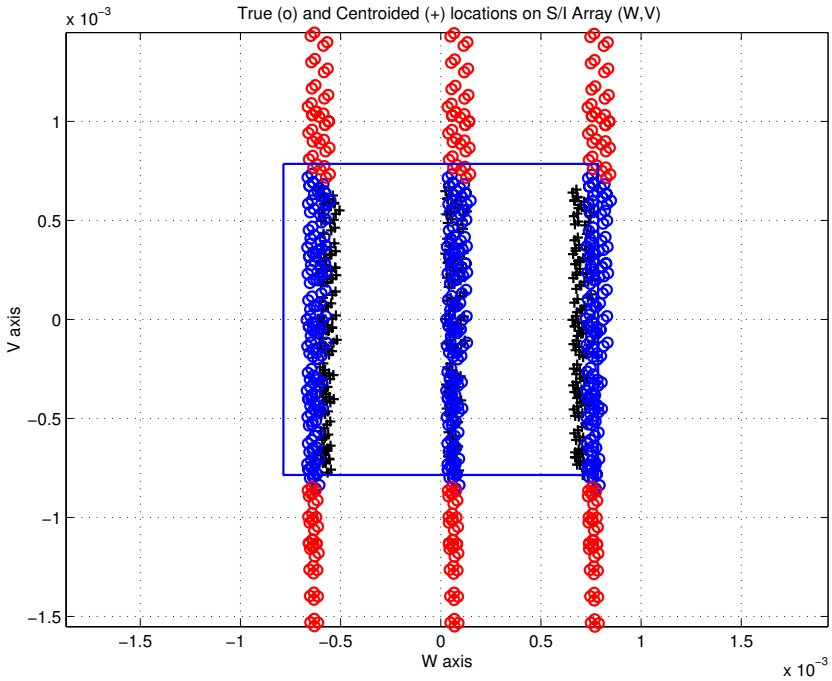

Figure 2.5: True-sampled (o) and centroided (+) locations on S/I array (W,V)

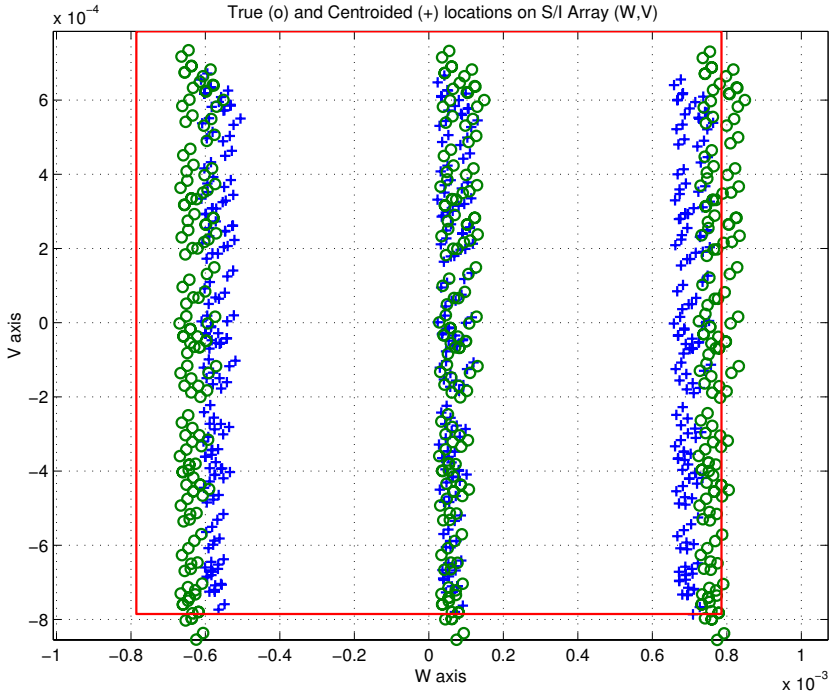

Figure 2.6: True (o) and centroided (+) locations on S/I array (W,V)

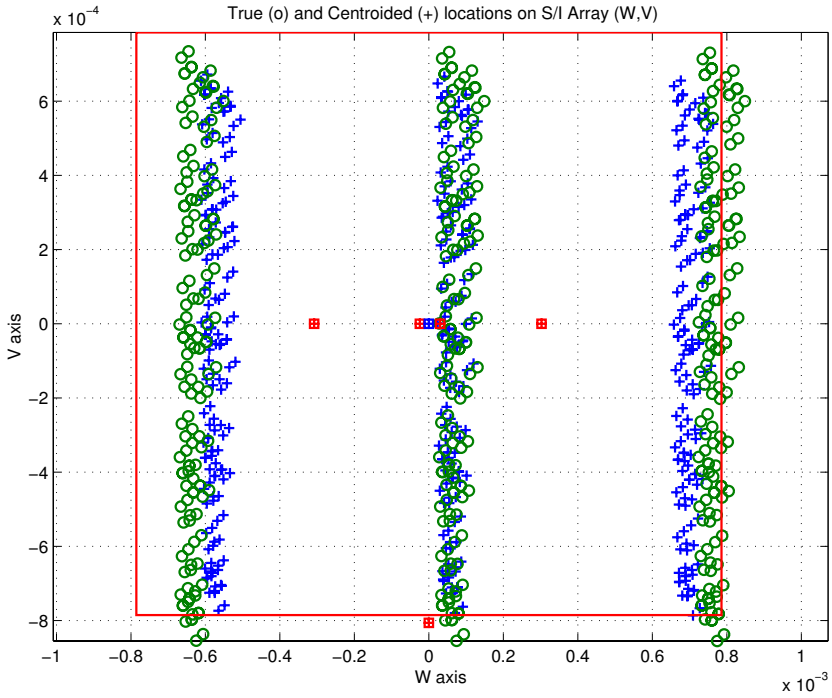

Figure 2.7: True (o) and centroided (+) locations on S/I array (W,V) showing prime and inferred frames

3 IPF EXECUTION RESULTS

3.1 IPF EXECUTION OUTPUT PLOTS

This subsection summarizes the IPF filter results. As shown in Table 3.1, the output plots are segmented to three groups: predicted performance, post-run results and IPF trending plots.

FIGURE NO.	DESCRIPTION
Predicted performance prior to IPF run	
Figure 3.1	Meas. and a-priori predicts in TPF coords
Figure 3.2	Meas. and a-priori predicts in Oriented Pixel Coords including rectangular array boundary approximation
Figure 3.3	A-priori prediction error
Figure 3.4	Oriented Pixel Coords of measurements and a-priori predicts (PCRS only)
IPF filter performance (post run results)	
Figure 3.5	IPF execution convergence, chart 1: (top) normalized residual error vs. iteration number and (bottom) norm of effective parameter corrections
Figure 3.6	IPF execution convergence, chart 2: parameter correction size vs. iteration number
Figure 3.7	Parameter uncertainty convergence: square-root of diagonal elements of covariance matrix vs. maneuver number
Figure 3.8	IPF parameter symbol table
Figure 3.9	KF parameter error sigma plot (a-priori-dashed, a-posteriori-solid). Includes true parameter errors (FLUTE runs only)
Figure 3.10	LS parameter error sigma plot. Includes true parameter errors (FLUTE runs only)
Figure 3.11	KF and LS parameter errors sigma plot (Figure 3.9 & Figure 3.10 combined)
Figure 3.12	Measurements and a-posteriori predicts in Oriented Pixel Coords including rectangular array boundaries (a-priori-dashed, a-posteriori-solid)
Figure 3.13	Attitude corrected meas. and a-posteriori predicts in Oriented Pixel Coords including rectangular array boundaries (a-priori-dashed, a-posteriori-solid)
Figure 3.14	Array plot with (solid) and w/o (dashed) optical distortion corrections
Figure 3.15	KF innovations with (o) and w/o (+) attitude corrections
Figure 3.16	W-axis KF innovations and 1-sigma bound
Figure 3.17	V-axis KF innovations and 1-sigma bound
IPF parameter trending plots	
Figure 3.18	Estimated attitude corrections (Body frame)
Figure 3.19	Estimated attitude error sigma plot (Body frame)
Figure 3.20	Systematic error attributed to thermo-mechanical boresight drift (equiv. angle in (W,V) coords)
Figure 3.21	Systematic error attributed to thermo-mechanical boresight drift (equiv. angle in Body frame)
Figure 3.22	Systematic error attributed to gyro drift bias (equiv. rate in (W,V) coords)
Figure 3.23	Systematic error attributed to gyro drift bias (equiv. angle in (W,V) coords)
Figure 3.24	Systematic error attributed to gyro drift bias (equiv. angle in Body frame)

Table 3.1: Table of figures (IPF run)

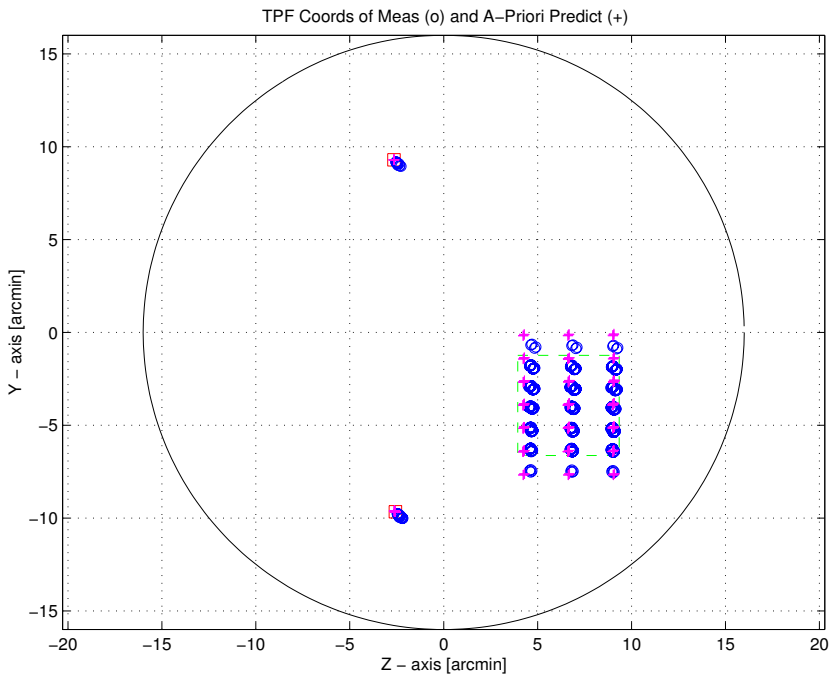

Figure 3.1: TPF coords of measurements and a-priori predicts

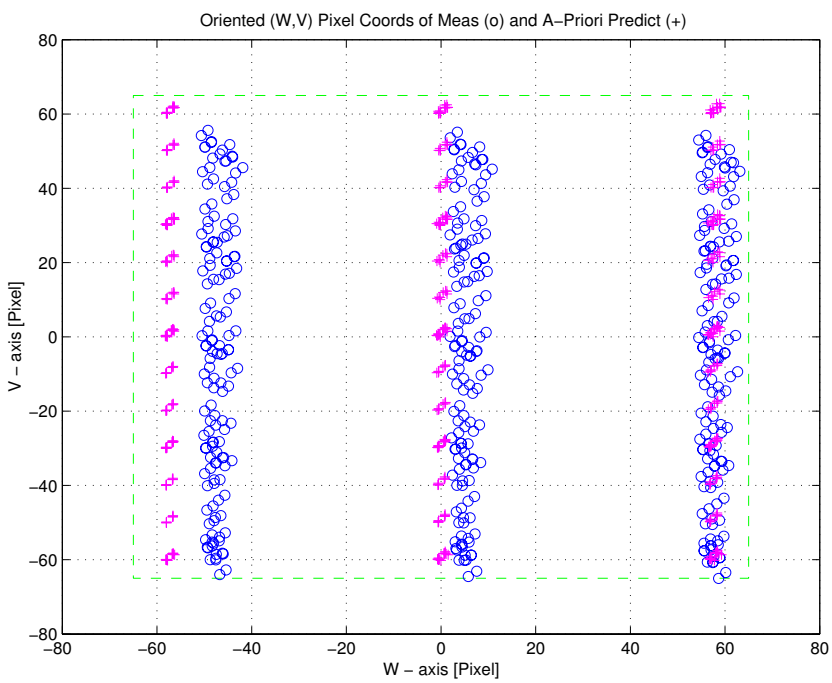

Figure 3.2: Oriented Pixel Coords of measurements and a-priori predicts

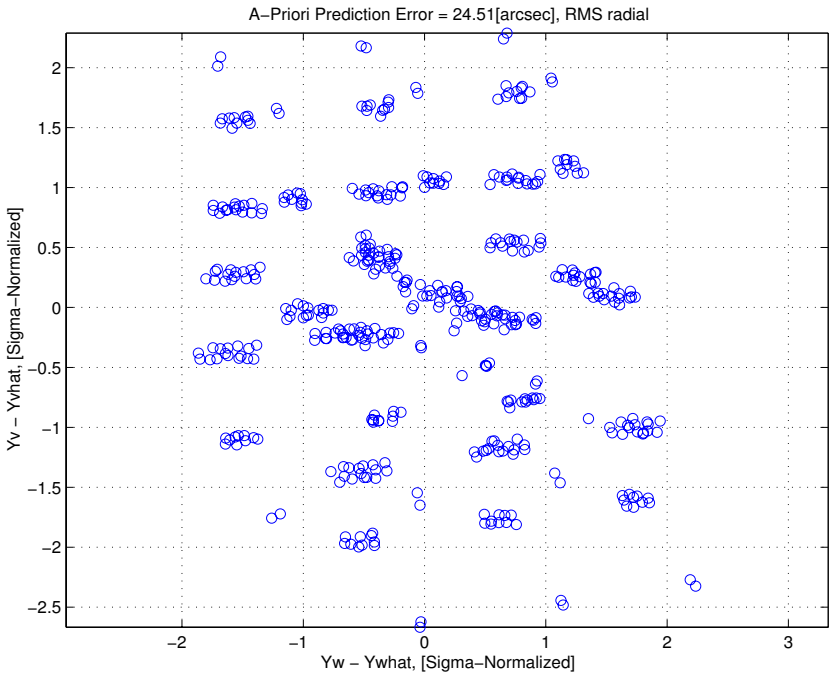

Figure 3.3: A-priori prediction error

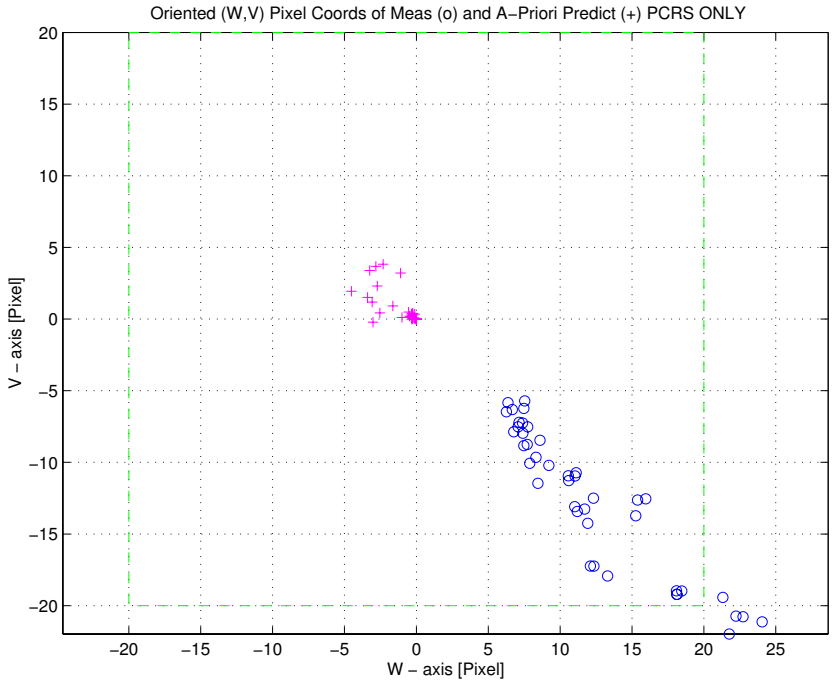

Figure 3.4: Oriented Pixel Coords of measurements and a-priori predicts (PCRS only)

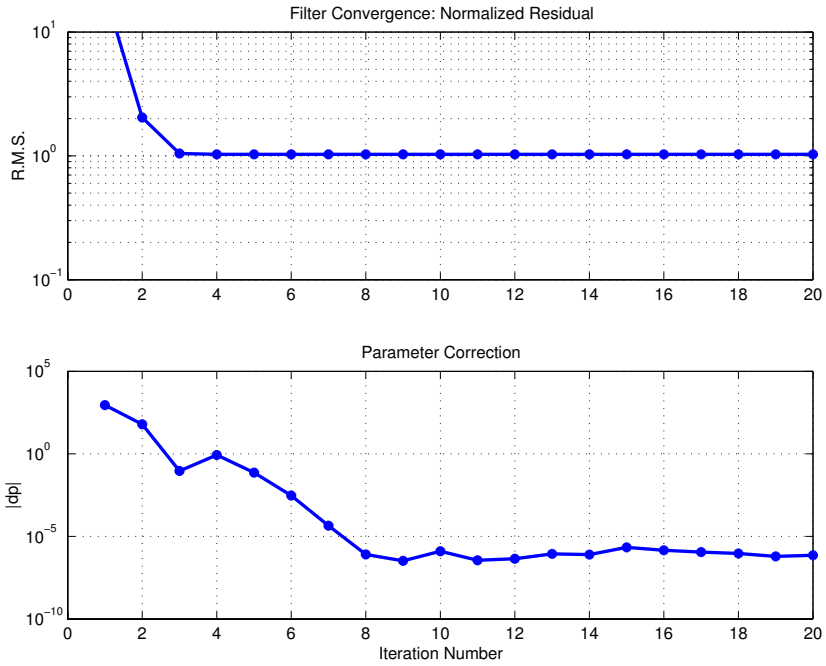

Figure 3.5: IPF execution convergence, chart 1

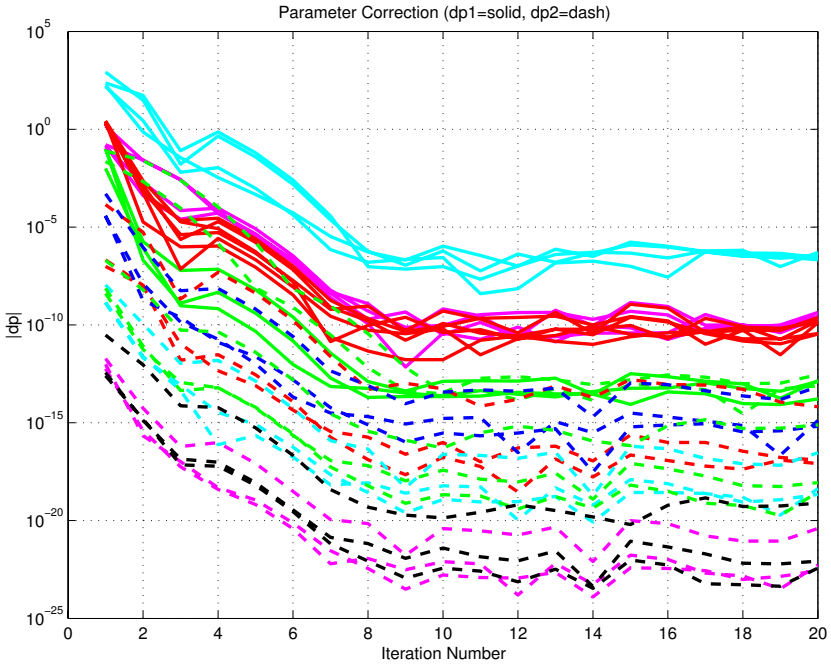

Figure 3.6: IPF execution convergence, chart 2

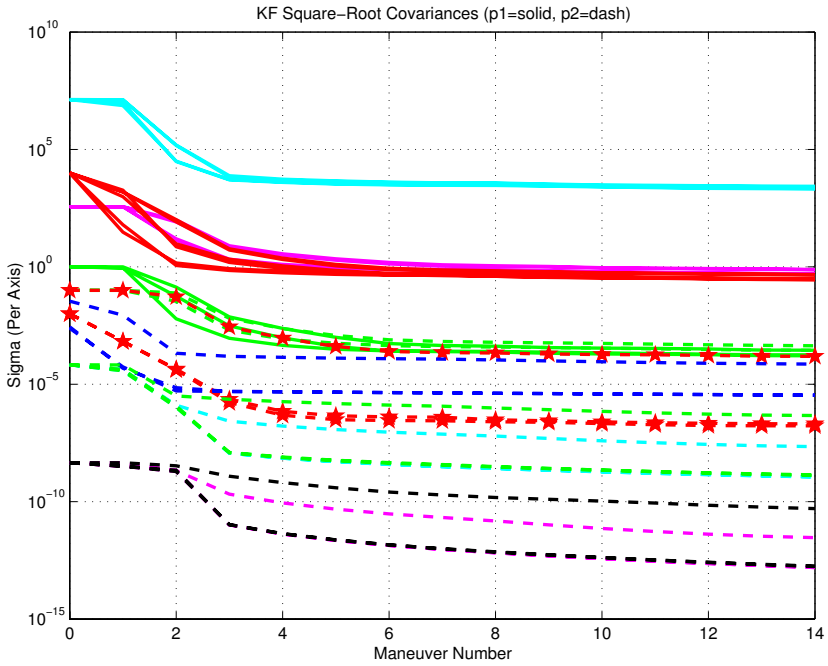

Figure 3.7: Parameter uncertainty convergence

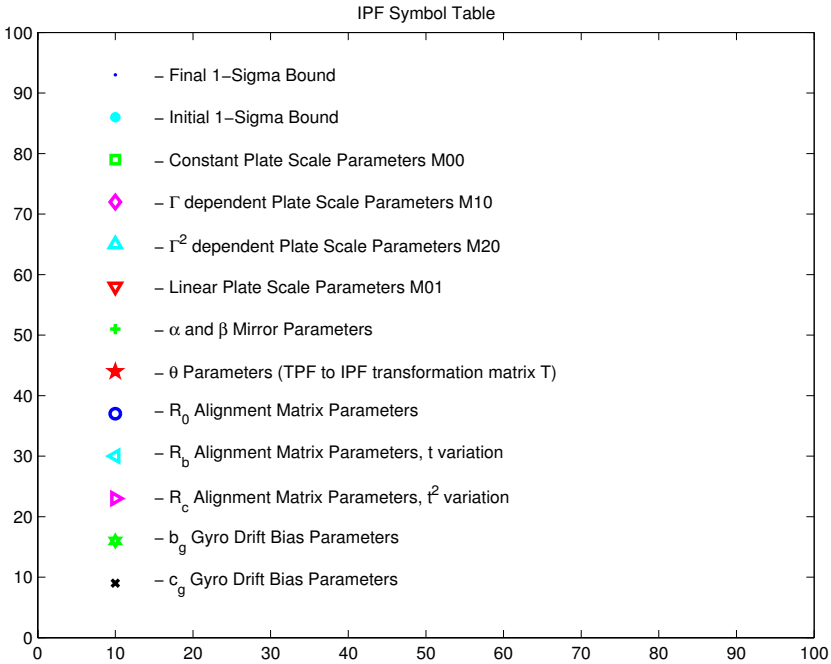

Figure 3.8: IPF parameter symbol table

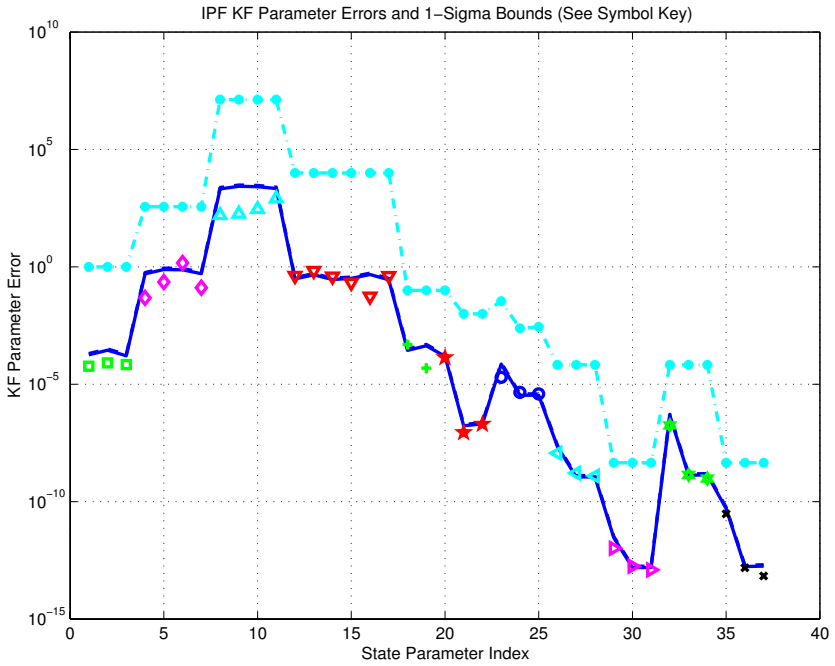

Figure 3.9: KF parameter error sigma plots

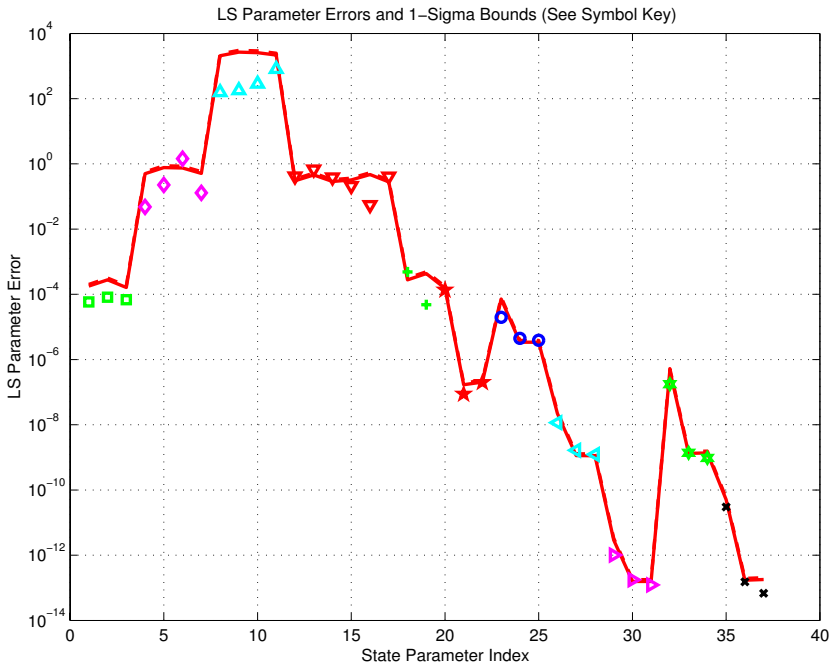

Figure 3.10: LS parameter error sigma plot

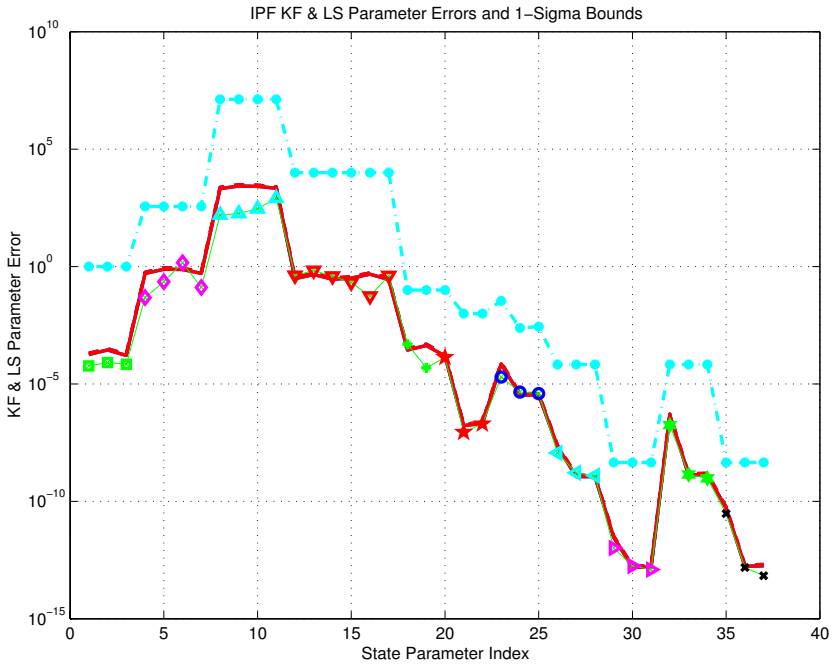

Figure 3.11: KF and LS parameter error sigma plot

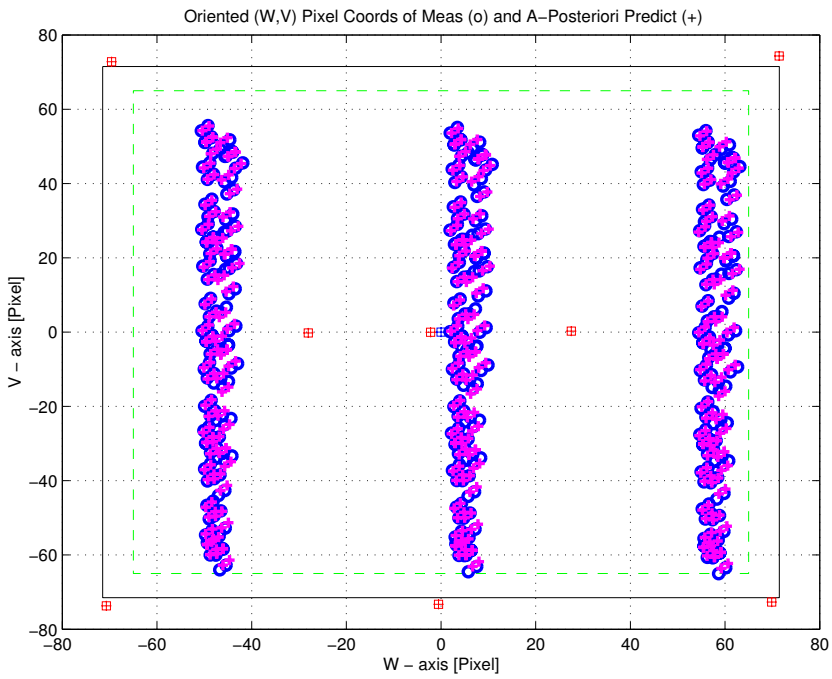

Figure 3.12: Oriented Pixel Coords of meas. and a-posteriori predicts

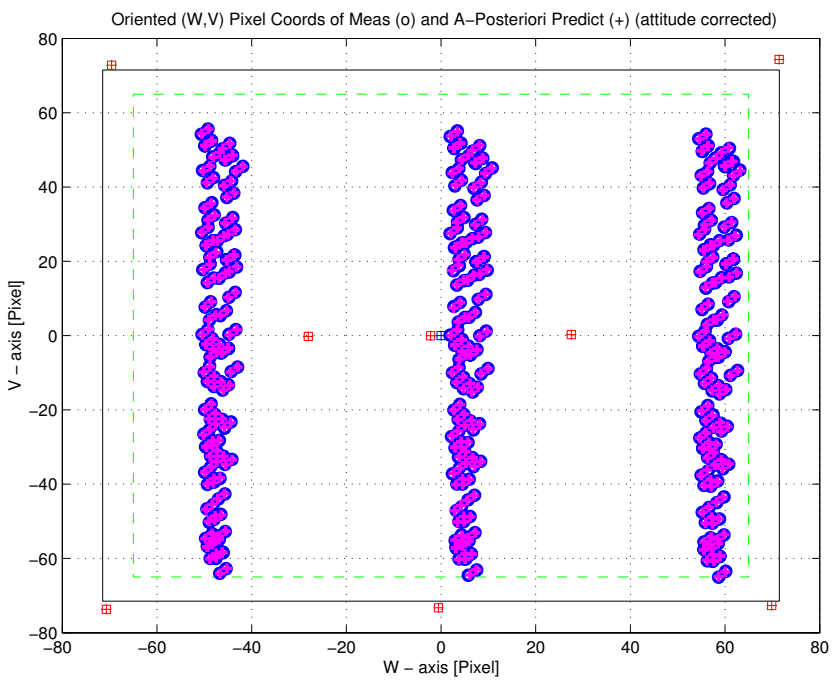

Figure 3.13: Oriented Pixel Coords of meas. and a-posteriori predicts (attitude corrected)

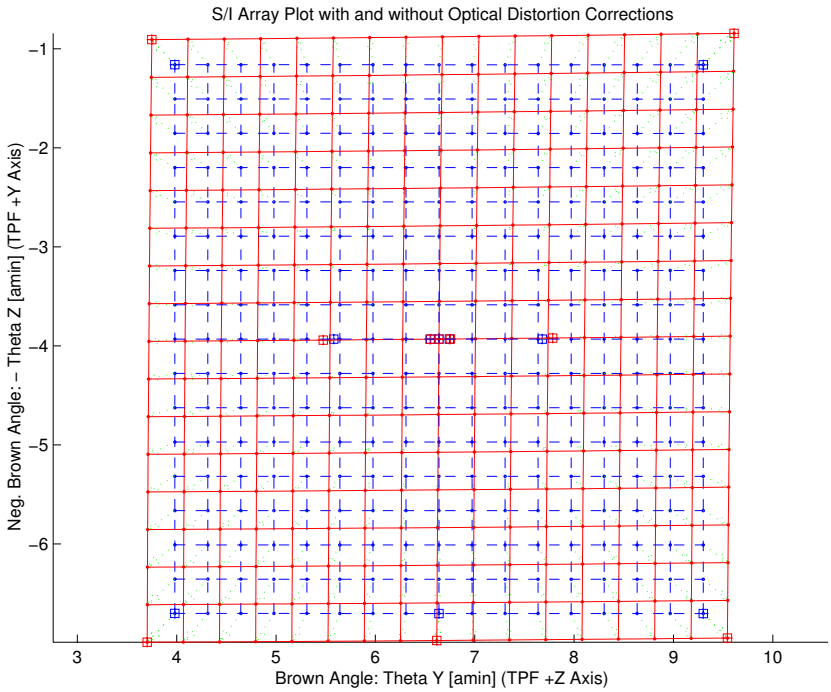

Figure 3.14: Array plot with (solid) and w/o (dashed) optical distortion corrections

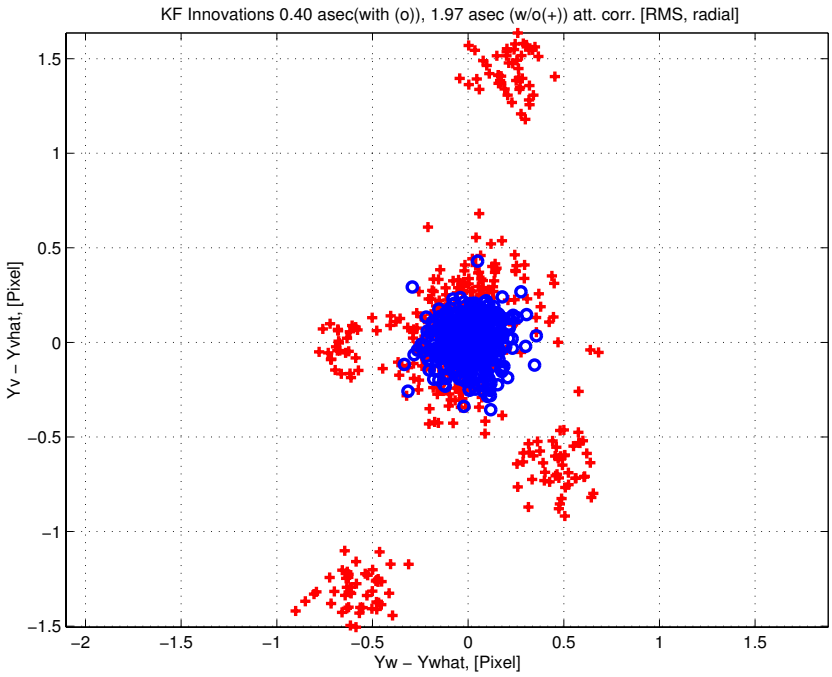

Figure 3.15: KF innovations with (o) and w/o (+) attitude corrections

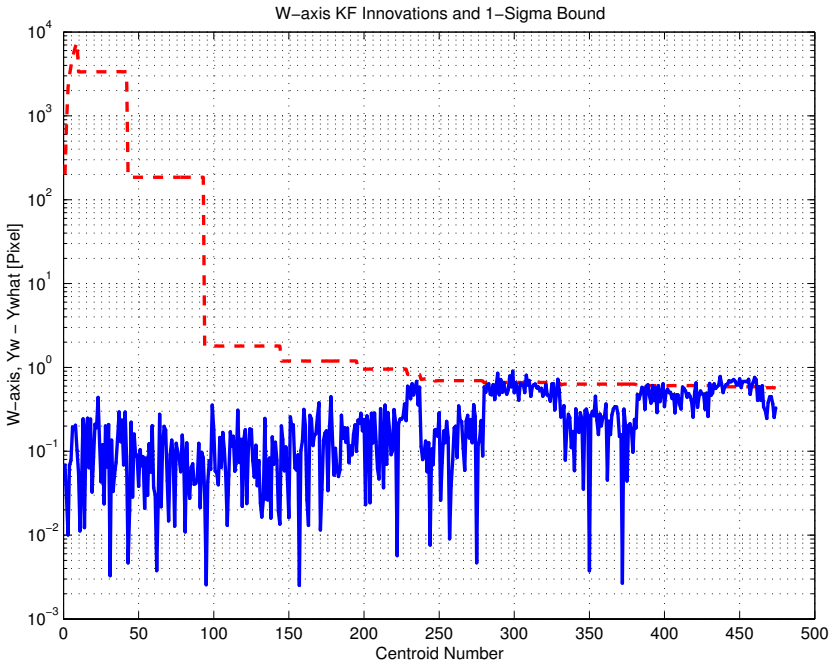

Figure 3.16: W-axis KF innovations and 1-sigma bound

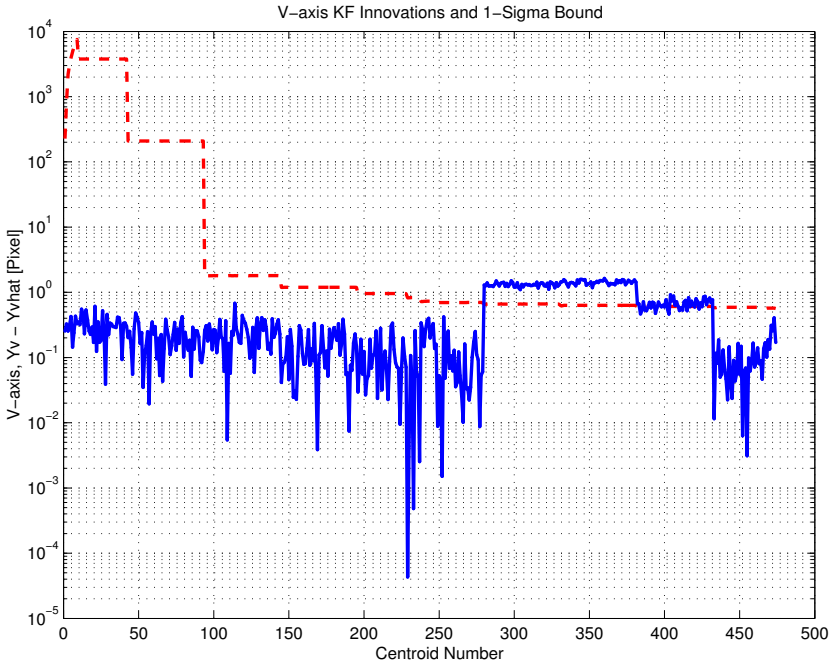

Figure 3.17: V-axis KF innovations and 1-sigma bound

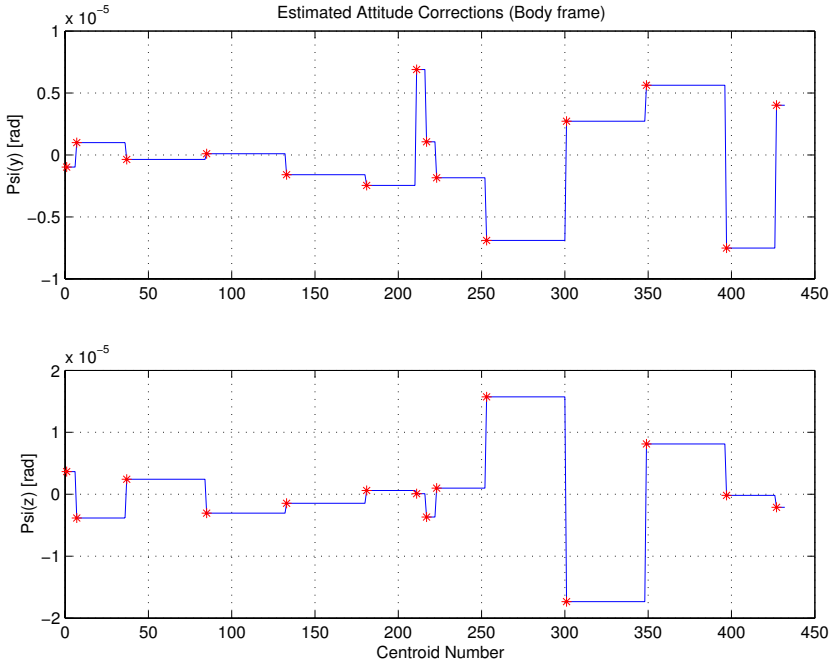

Figure 3.18: Estimated attitude corrections (Body frame)

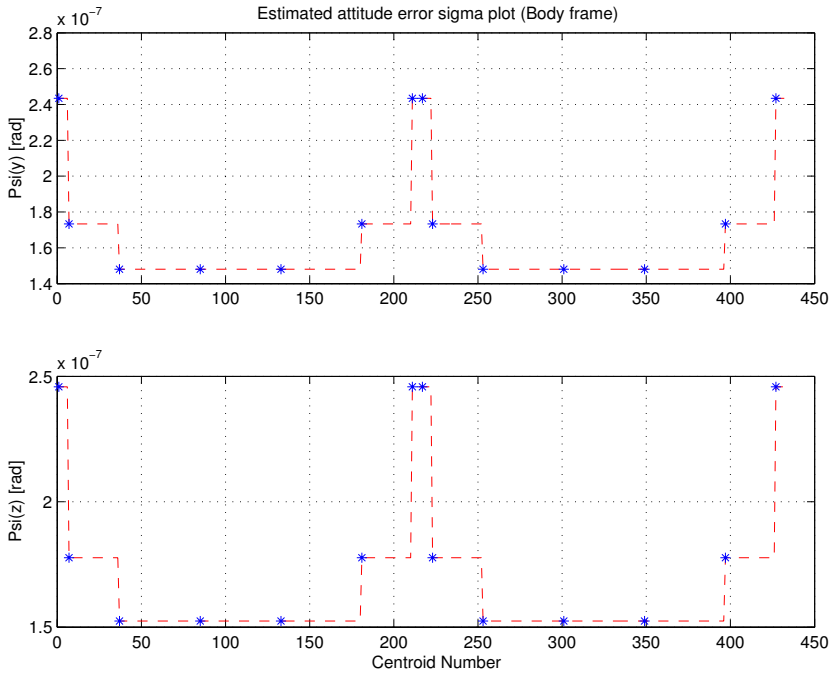

Figure 3.19: Estimated attitude error sigma plot (Body frame)

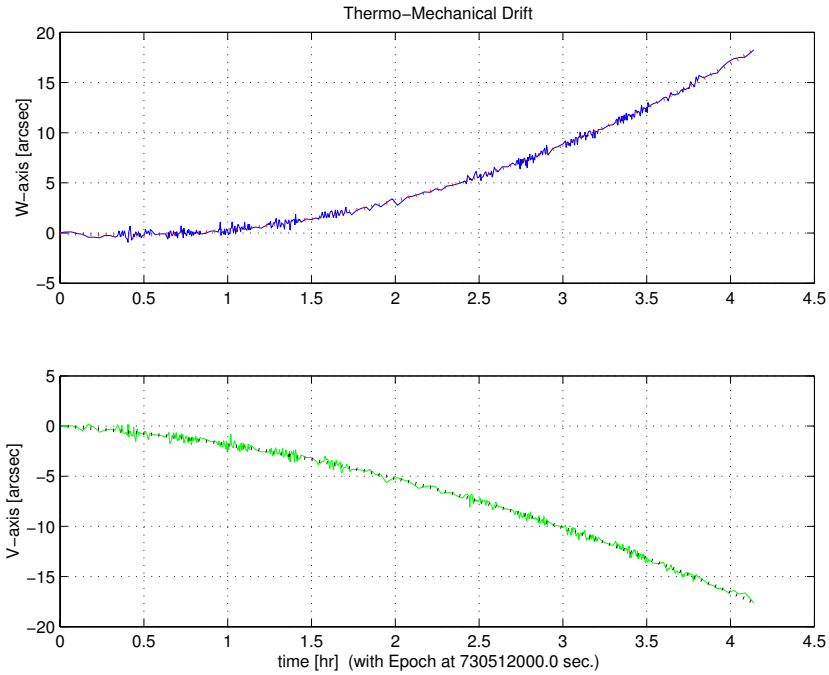

Figure 3.20: Thermo-mechanical boresight drift (equiv. angle in (W,V) coords)

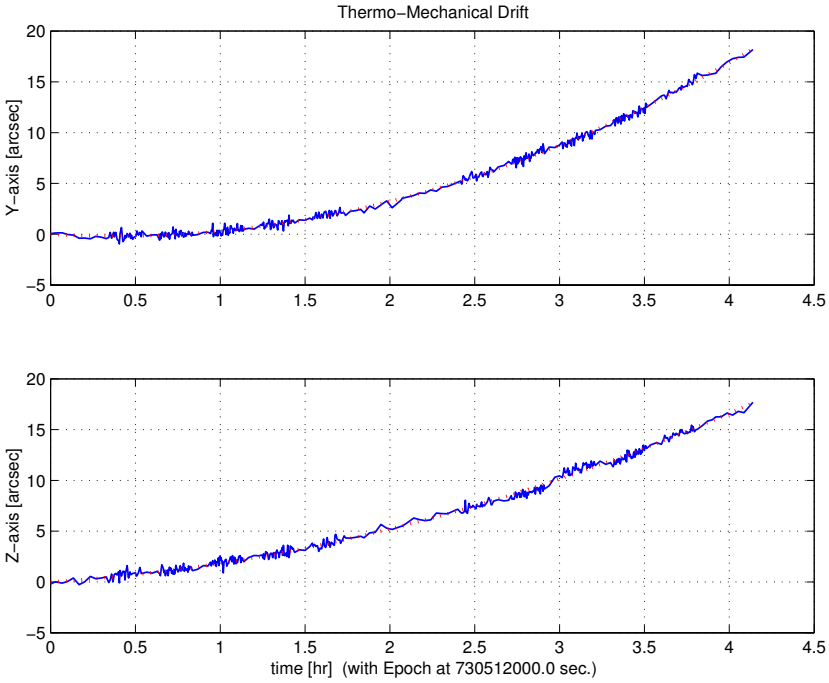

Figure 3.21: Thermo-mechanical boresight drift (equiv. angle in Body frame)

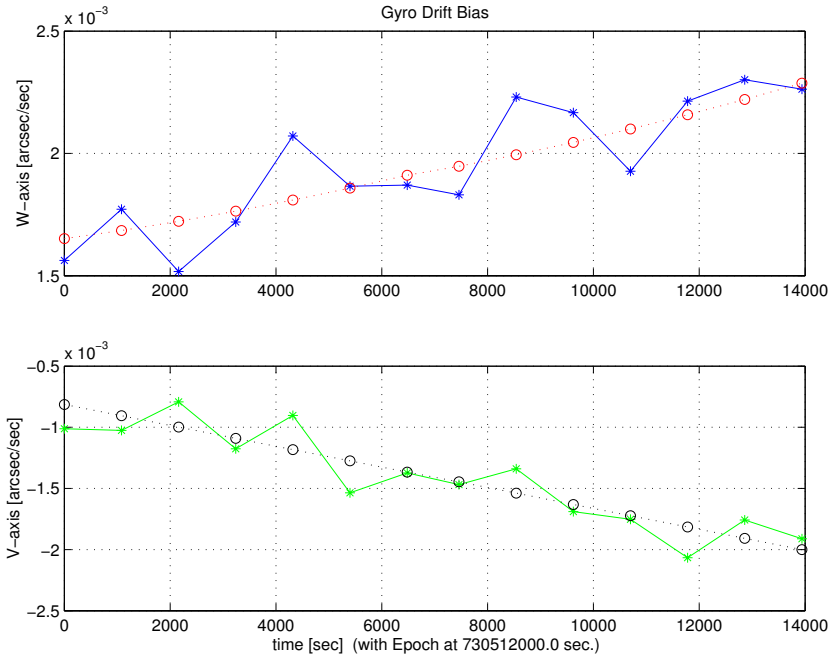

Figure 3.22: Gyro drift bias contribution (equiv. rate in (W,V) coords)

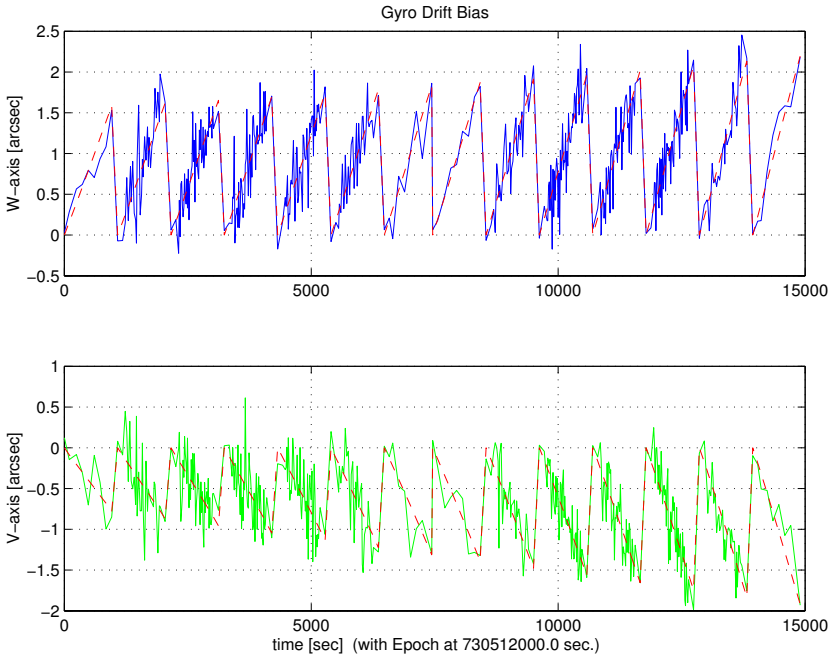

Figure 3.23: Gyro drift bias contribution (equiv. angle in (W,V) coords)

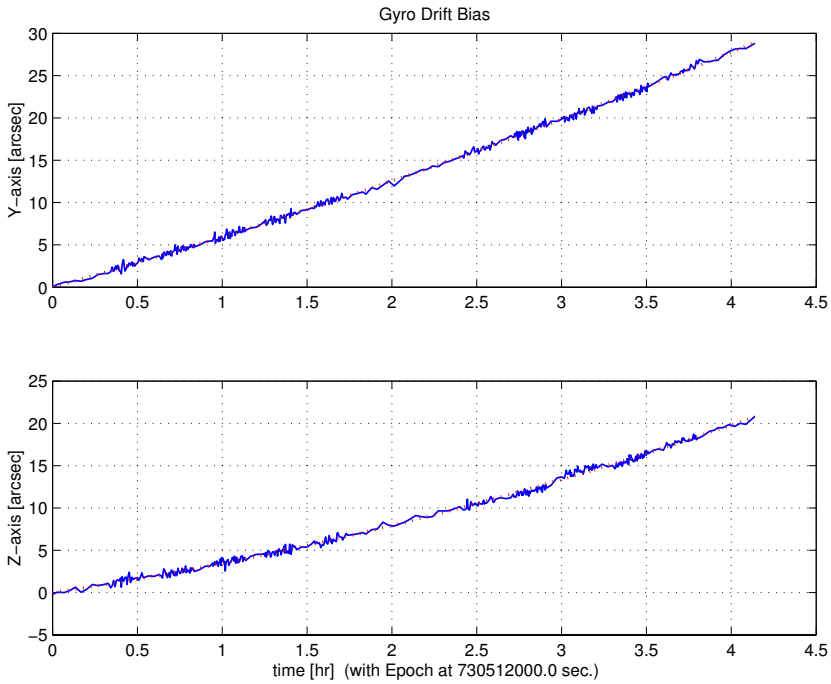

Figure 3.24: Gyro drift bias contribution (equiv. angle in Body frame)

3.2 IPF OUTPUT DATA (IF MINI FILE)

```
OUTPUT FILE NAME: IFmini992095.dat   DATE: 05-Aug-2003   TIME: 21:47
INSTRUMENT NAME:  MIPS_24um_center   NF: 95
IPF FILTER VERSION: IPF.V2.0.1Beta       SW RELEASE DATE: August 5, 2003
--------------------------------------------------------------------------------
---------------------------- IPF BROWN ANGLE SUMMARY ----------------------------
--------------------------------------------------------------------------------
         ------------ WAS ------------           ------------ IS -------------
Frame    theta_Y     theta_Z     angle           theta_Y     theta_Z     angle
Number   (arcmin)    (arcmin)    (deg)           (arcmin)    (arcmin)    (deg)
------  --------------------------------       --------------------------------
 095     +6.641000  +3.931000   +0.000000        +6.640699  +3.931685   +0.007771
 096     +6.595000  +6.712000   -0.000000        +6.618371  +6.975996   +0.007771
 099     +7.687000  +3.943000   -0.000000        +7.784118  +3.920819   +0.007771
 100     +5.574000  +3.918000   +0.000000        +5.475973  +3.941611   +0.007771
 103     +6.746000  +3.932000   +0.000000        +6.754973  +3.930649   +0.007771
 104     +6.558000  +3.930000   +0.000000        +6.549291  +3.932506   +0.007771
 001     +0.000000  +0.000000   +0.000000        +9.610300  +0.843451   +0.007771
 001     +0.000000  +0.000000   +0.000000        +9.543426  +6.951110   +0.007771
 001     +0.000000  +0.000000   +0.000000        +3.749635  +0.906557   +0.007771
 001     +0.000000  +0.000000   +0.000000        +3.703246  +6.993520   +0.007771
--------------------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  0              95            +0.000            +0.000     pixels
OFFSET FRAME NAME: MIPS_24um_center
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
WAS(FTB)            +6.641000        +3.931000       +0.000000
IS (EST)            +6.640699        +3.931685       +0.007771
dT_EST              -0.000301        +0.000685       +0.007771
T_sSIGMA            +0.000656        +0.000793       +0.009936
dT_EST/T_sSIGMA     -0.458352        +0.863752       +0.782104
-------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  1              96            +0.000           -64.000     pixels
OFFSET FRAME NAME: MIPS_24um_plusY_edge
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
WAS(FTB)            +6.595000        +6.712000       -0.000000
IS (EST)            +6.618371        +6.975996       +0.007771
dT_EST              +0.023371        +0.263996       +0.007771
T_sSIGMA            +0.001170        +0.001304       +0.009936
dT_EST/T_sSIGMA    +19.968942       +202.502213       +0.782104
-------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  2              99           +25.000            +0.000     pixels
OFFSET FRAME NAME: MIPS_24um_small_FOV1
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
WAS(FTB)            +7.687000        +3.943000       -0.000000
IS (EST)            +7.784118        +3.920819       +0.007771
dT_EST              +0.097118        -0.022181       +0.007771
T_sSIGMA            +0.000676        +0.000803       +0.009936
dT_EST/T_sSIGMA    +143.692625       -27.608700       +0.782104
-------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  3             100           -25.500            +0.000     pixels
OFFSET FRAME NAME: MIPS_24um_small_FOV2
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
WAS(FTB)            +5.574000        +3.918000       +0.000000
IS (EST)            +5.475973        +3.941611       +0.007771
dT_EST              -0.098027        +0.023611       +0.007771
T_sSIGMA            +0.000613        +0.000750       +0.009936
dT_EST/T_sSIGMA    -159.829737       +31.502224       +0.782104
-------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  4             103            +2.500            +0.000     pixels
OFFSET FRAME NAME: MIPS_24um_large_FOV1
```

```
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
WAS(FTB)            +6.746000        +3.932000       +0.000000
IS (EST)            +6.754973        +3.930649       +0.007771
dT_EST              +0.008973        -0.001351       +0.007771
T_sSIGMA            +0.000660        +0.000796       +0.009936
dT_EST/T_sSIGMA    +13.601959        -1.696226       +0.782104
-----------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  5             104            -2.000            +0.000     pixels
OFFSET FRAME NAME: MIPS_24um_large_FOV2
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
WAS(FTB)            +6.558000        +3.930000       +0.000000
IS (EST)            +6.549291        +3.932506       +0.007771
dT_EST              -0.008709        +0.002506       +0.007771
T_sSIGMA            +0.000653        +0.000791       +0.009936
dT_EST/T_sSIGMA    -13.338082        +3.169465       +0.782104
-----------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  6               1           +64.000           +64.000     pixels
OFFSET FRAME NAME: CORNER PIXEL (DIAGNOSTICS)
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
WAS(FTB)            +0.000000        +0.000000       +0.000000
IS (EST)            +9.610300        +0.843451       +0.007771
dT_EST              +9.610300        +0.843451       +0.007771
T_sSIGMA            +0.001698        +0.001712       +0.009936
dT_EST/T_sSIGMA    +5658.269397       +492.557224       +0.782104
-----------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  7               1           +64.000           -64.000     pixels
OFFSET FRAME NAME: CORNER PIXEL (DIAGNOSTICS)
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
WAS(FTB)            +0.000000        +0.000000       +0.000000
IS (EST)            +9.543426        +6.951110       +0.007771
dT_EST              +9.543426        +6.951110       +0.007771
T_sSIGMA            +0.001404        +0.001513       +0.009936
dT_EST/T_sSIGMA    +6796.186708       +4594.463059       +0.782104
-----------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  8               1           -64.000           +64.000     pixels
OFFSET FRAME NAME: CORNER PIXEL (DIAGNOSTICS)
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
WAS(FTB)            +0.000000        +0.000000       +0.000000
IS (EST)            +3.749635        +0.906557       +0.007771
dT_EST              +3.749635        +0.906557       +0.007771
T_sSIGMA            +0.001646        +0.001720       +0.009936
dT_EST/T_sSIGMA    +2277.634370       +527.183763       +0.782104
-----------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  9               1           -64.000           -64.000     pixels
OFFSET FRAME NAME: CORNER PIXEL (DIAGNOSTICS)
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
WAS(FTB)            +0.000000        +0.000000       +0.000000
IS (EST)            +3.703246        +6.993520       +0.007771
dT_EST              +3.703246        +6.993520       +0.007771
T_sSIGMA            +0.001524        +0.001592       +0.009936
dT_EST/T_sSIGMA    +2430.382355       +4392.699371       +0.782104
-----------------------------------------------------------------
-------------------------------------------------------------------------------
-------------------------------------------------------------------------------
VARNAME              MEAN                      SIGMA                 SCALED_SIGMA
a00        +9.9941549824022674E-002 +1.7803492901727206E-004 +2.0203243859916886E-004
b00        +1.0008144851748121E-001 +2.7861402383646622E-004 +3.1616869214550223E-004
c00        +1.0068290461441431E-002 +1.6202768069296890E-004 +1.8386755695446822E-004
a10        +1.4783304074612613E-001 +5.0047177211057647E-001 +5.6793087248479168E-001
b10        -1.2503532092030156E-001 +7.7000510751776596E-001 +8.7379488095022773E-001
c10        -1.4364405148645503E+000 +7.4839190738577765E-001 +8.4926841553863508E-001
d10        +1.3880540442279313E-001 +5.1162423528873990E-001 +5.8058658754424053E-001
a20        +1.5697890956008371E+002 +2.0810923388960637E+003 +2.3616048968482469E+003
```

```
b20        -1.8028631739963180E+002 +2.6759231768233653E+003 +3.0366135898265834E+003
c20        +2.8578906800973050E+002 +2.5784737836239792E+003 +2.9260288935720005E+003
d20        +8.0546874137460873E+002 +2.1675494952178992E+003 +2.4597157014103977E+003
a01        +2.4133136120691487E+000 +3.0374769568536769E-001 +3.4469015724571422E-001
b01        +2.6808273589718032E+000 +4.5773480819118967E-001 +5.1943334963004473E-001
c01        +2.3885499040592126E+000 +2.8811291426097951E-001 +3.2694794769408358E-001
d01        +1.7896664519589061E+000 +3.2247888258578716E-001 +3.6594613992415492E-001
e01        +1.9451272401763113E+000 +4.7175941185953246E-001 +5.3534834392437924E-001
f01        +2.4113990481736129E+000 +2.8117808042258918E-001 +3.1907836053282429E-001
del_alpha  +7.7329778051891257E-014 +2.7713923101941251E-004 +3.1449511050114418E-004
beta       +1.0999517987262484E+000 +4.3392305694674892E-004 +4.9241198816021511E-004
del_theta1 -6.5993150072211904E-015 +1.5281663096158353E-004 +1.7341494043948387E-004
del_theta2 -8.2614167370366107E-018 +1.6818068219964485E-007 +1.9084992780697381E-007
del_theta3 -1.2510782510064423E-017 +2.0337582301989784E-007 +2.3078905753846058E-007
del_arx    -6.9277005329158522E-014 +7.2078391704978210E-005 +8.1793911603998242E-005
del_ary    -6.6925587233955487E-016 +3.4067849387698580E-006 +3.8659889537508735E-006
del_arz    +1.3093094367895705E-015 +3.4051681561821076E-006 +3.8641542433898735E-006
brx        -1.1191439553320800E-008 +2.1922069310426569E-008 +2.4876967381472674E-008
bry        -1.3429287139354779E-009 +1.1304510505686617E-009 +1.2828257001255189E-009
brz        +1.4329352804112203E-009 +1.1290796880216901E-009 +1.2812694902227904E-009
crx        +1.9148872755295432E-012 +2.9173573853983793E-012 +3.3105909615081722E-012
cry        +9.7676422000785957E-013 +1.5630214167147157E-013 +1.7737026669129981E-013
crz        +5.7724836352765918E-013 +1.5608957981935986E-013 +1.7712905341044343E-013
bgx        +1.9309519205716171E-007 +4.6365017290052598E-007 +5.2614605237903582E-007
bgy        +7.5579347730378424E-009 +1.3257477623975293E-009 +1.5044466548391719E-009
bgz        +4.0168819441406447E-009 +1.3723001978433699E-009 +1.5572739405171476E-009
cgx        -2.9618614922539090E-011 +5.0572611032069192E-011 +5.7389344829884127E-011
cgy        +2.4850605914165516E-013 +1.7129755914400067E-013 +1.9438693177219370E-013
cgz        +3.6773709901529979E-013 +1.7924348896947154E-013 +2.0340390157940500E-013
-------------------------------------------------------------------------------
LSQF RESIDUAL SIGMA SCALE =         +1.1347910194609547E+000
-------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------------
                    a_mirror(1)                a_mirror(2)                a_mirror(3)
a_mirror_ipf   +0.0000000000000000E+000  +2.0487375177329972E-002  +9.9979011170262289E-001
a_mirror_tpf   -1.9080226302437607E-003  +2.0353970490904819E-002  +9.9979101583025709E-001
beta                beta_0                     beta                      beta_total
               +2.8047410000000001E-006  +1.0999517987262484E+000  +3.0850799079112566E-006
-----------------------------------------------------------------------------------------------------
qT              qT(1)                     qT(2)                     qT(3)                     qT(4)
FrmTbl:   -5.5224103706934371E-007 -9.6589398881636961E-004 -5.7174047628006817E-004 +9.9999937008046424E-001
Estim:    +6.7261867600461016E-005 -9.6588902719713511E-004 -5.7177464878591198E-004 +9.9999936780378973E-001
DelTheta        deltheta(1)                deltheta(2)                deltheta(3)
          +1.3562806024536441E-004 +8.7476531979380035E-008 -1.9934411459171689E-007       [rad]
EulAngT         theta(1)                   theta(2)                   theta(3)                [rad]
Mean      +1.3562844533653018E-004 -1.9317011172170389E-003 -1.1436808927514672E-003
SigmaT    +1.5281663096158353E-004 +1.6818068219964485E-007 +2.0337582301989784E-007
-----------------------------------------------------------------------------------------------------
qR              qR(1)                     qR(2)                     qR(3)                     qR(4)
ASFILE:   +0.0000000000000000E+000 +0.0000000000000000E+000 +0.0000000000000000E+000 +1.0000000000000000E+000
Estim:    +2.5219894953504068E-004 +1.9216147463272381E-005 +1.7440672600820199E-005 +9.9999996786112566E-001
DelThetaR       deltheta R(1)              deltheta R(2)              deltheta R(3)
          +5.0439857490471799E-004 +3.8423496662210363E-005 +3.4891036697837181E-005       [rad]
EulAngR         angR(1)                    angR(2)                    angR(3)                 [rad]
Mean      +5.0439857490471799E-004 +3.8423496662210363E-005 +3.4891036697837181E-005
SigmaR    +7.2078391704978210E-005 +3.4067849387698580E-006 +3.4051681561821076E-006
-----------------------------------------------------------------------------------------------------
Initial Gyro Bias         Bg0(1)                    Bg0(2)                    Bg0(3)
                    +1.4373545441551276E-006 +1.8774821168585316E-007 +2.3743402797237056E-007
Gyro Bias Correction      Bg(1)                     Bg(2)                     Bg(3)
                    +1.9309519205716171E-007 +7.5579347730378424E-009 +4.0168819441406447E-009
Total Gyro Bias           BgT(1)                    BgT(2)                    BgT(3)
                    +1.6304497362122892E-006 +1.9530614645889099E-007 +2.4145090991651119E-007

Initial Gyro Bias Rate     Cg0(1)                    Cg0(2)                    Cg0(3)
                    +0.0000000000000000E+000 +0.0000000000000000E+000 +0.0000000000000000E+000
Gyro Bias Rate Correction  Cg(1)                     Cg(2)                     Cg(3)
```

```
                  -2.9618614922539090E-011 +2.4850605914165516E-013 +3.6773709901529979E-013
Total Gyro Bias Rate       CgT(1)                   CgT(2)                   CgT(3)
                  -2.9618614922539090E-011 +2.4850605914165516E-013 +3.6773709901529979E-013
-----------------------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  1              96            +0.000           -64.000     pixels
OFFSET FRAME NAME: MIPS_24um_plusY_edge
qT               qT(1)                    qT(2)                    qT(3)                    qT(4)
WAS(FTB)  -9.3639450226028116E-007 -9.5920326392183247E-004 -9.7622022412795586E-004 +9.9999906346070921E-001
IS (EST)  +6.6837482782132980E-005 -9.6267115021056926E-004 -1.0145515653931236E-003 +9.9999901974058381E-001

DelTheta        deltheta(1)               deltheta(2)               deltheta(3)
Units             rad                       rad                       rad
          +1.3548112452122117E-004 -6.7982517163230723E-006 -7.6793181149780988E-005
EulAngT         theta(1)                  theta(2)                  theta(3)                  [rad]
Mean      +1.3562844533653018E-004 -1.9252059822101395E-003 -2.0292349800263669E-003
sSigmaT   +1.7341486775232046E-004 +3.4044097485995918E-007 +3.7922214476654192E-007
SigmaT    +1.5281656690823610E-004 +3.0000323321352553E-007 +3.3417795723011534E-007
-----------------------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  2              99           +25.000            +0.000     pixels
OFFSET FRAME NAME: MIPS_24um_small_FOV1
qT               qT(1)                    qT(2)                    qT(3)                    qT(4)
WAS(FTB)  -6.4117382846981564E-007 -1.1180284132340469E-003 -5.7348571352373249E-004 +9.9999921056278462E-001
IS (EST)  +6.7168546057206293E-005 -1.1321923492705625E-003 -5.7018286615948715E-004 +9.9999919425986028E-001

DelTheta        deltheta(1)               deltheta(2)               deltheta(3)
Units             rad                       rad                       rad
          +1.3564287265212314E-004 -2.8250552245880060E-005 +6.4521102870447523E-006
EulAngT         theta(1)                  theta(2)                  theta(3)                  [rad]
Mean      +1.3562844533653018E-004 -2.2643082122127379E-003 -1.1405200799441543E-003
sSigmaT   +1.7341492529975881E-004 +1.9660405184387214E-007 +2.3369904668621468E-007
SigmaT    +1.5281661762016224E-004 +1.7325132863429114E-007 +2.0594016226637549E-007
-----------------------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  3             100           -25.500            +0.000     pixels
OFFSET FRAME NAME: MIPS_24um_small_FOV2
qT               qT(1)                    qT(2)                    qT(3)                    qT(4)
WAS(FTB)  -4.6198041860920160E-007 -8.1070521711647421E-004 -5.6984978266998100E-004 +9.9999950901391088E-001
IS (EST)  +6.7357599045025647E-005 -7.9648665262010520E-004 -5.7322990369732593E-004 +9.9999951623960470E-001

DelTheta        deltheta(1)               deltheta(2)               deltheta(3)
Units             rad                       rad                       rad
          +1.3561730907658357E-004 +2.8514889607945443E-005 -6.8682471969804256E-006
EulAngT         theta(1)                  theta(2)                  theta(3)                  [rad]
Mean      +1.3562844533653018E-004 -1.5928959854565432E-003 -1.1465682574599565E-003
sSigmaT   +1.7341493613752887E-004 +1.7840791243087779E-007 +2.1802447537694223E-007
SigmaT    +1.5281662717061680E-004 +1.5721653535434623E-007 +1.9212742402606218E-007
-----------------------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  4             103            +2.500            +0.000     pixels
OFFSET FRAME NAME: MIPS_24um_large_FOV1
qT               qT(1)                    qT(2)                    qT(3)                    qT(4)
WAS(FTB)  -5.6111515131371191E-007 -9.8116560995659325E-004 -5.7188591179032191E-004 +9.9999935512990956E-001
IS (EST)  +6.7252510321254465E-005 -9.8250944394059144E-004 -5.7162282477929839E-004 +9.9999935169960896E-001

DelTheta        deltheta(1)               deltheta(2)               deltheta(3)
Units             rad                       rad                       rad
          +1.3562921637391942E-004 -2.6101365989729255E-006 +3.9291845227373945E-007
EulAngT         theta(1)                  theta(2)                  theta(3)                  [rad]
Mean      +1.3562844533653021E-004 -1.9649419922577798E-003 -1.1433795172628158E-003
sSigmaT   +1.7341493978925566E-004 +1.9189416669965689E-007 +2.3164322662435397E-007
SigmaT    +1.5281663038858973E-004 +1.6910088589774876E-007 +2.0412853349367226E-007
-----------------------------------------------------------------------------------------------------------
```

```
-----------------------------------------------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  5             104            -2.000            +0.000     pixels
OFFSET FRAME NAME: MIPS_24um_large_FOV2
qT               qT(1)                     qT(2)                     qT(3)                     qT(4)
WAS(FTB)  -5.4520033785992621E-007 -9.5382213577026277E-004 -5.7159503889057917E-004 +9.9999938175088265E-001
IS (EST)  +6.7269357229891673E-005 -9.5259428038406988E-004 -5.7189493131067407E-004 +9.9999938048738701E-001

DelTheta        deltheta(1)               deltheta(2)               deltheta(3)
Units             rad                       rad                       rad
          +1.3562705470210735E-004 +2.5332815406401734E-006 -7.2897883812553783E-007
EulAngT         theta(1)                  theta(2)                  theta(3)                  [rad]
Mean      +1.3562844533653018E-004 -1.9051115908886558E-003 -1.1439196402173077E-003
sSigmaT   +1.7341494082166630E-004 +1.8992847003266200E-007 +2.3000101992551461E-007
SigmaT    +1.5281663129837014E-004 +1.6736867562001089E-007 +2.0268138889111852E-007
-----------------------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  6               1           +64.000           +64.000     pixels
OFFSET FRAME NAME: CORNER PIXEL (DIAGNOSTICS)
qT               qT(1)                     qT(2)                     qT(3)                     qT(4)
WAS(FTB)  +0.0000000000000000E+000 +0.0000000000000000E+000 +0.0000000000000000E+000 +1.0000000000000000E+000
IS (EST)  +6.7642685641769394E-005 -1.3977693233660359E-003 -1.2258001037837799E-004 +9.9999901331927643E-001

DelTheta        deltheta(1)               deltheta(2)               deltheta(3)
Units             rad                       rad                       rad
          +1.3562844533653015E-004 -2.7955229462890007E-003 -2.4534983776304970E-004
EulAngT         theta(1)                  theta(2)                  theta(3)                  [rad]
Mean      +1.3562844533653018E-004 -2.7955229462890020E-003 -2.4534983776304970E-004
sSigmaT   +1.7341479618253152E-004 +4.9405971155190054E-007 +4.9811438324707816E-007
SigmaT    +1.5281650383954090E-004 +4.3537506296673671E-007 +4.3894811882075963E-007
-----------------------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  7               1           +64.000            -64.000     pixels
OFFSET FRAME NAME: CORNER PIXEL (DIAGNOSTICS)
qT               qT(1)                     qT(2)                     qT(3)                     qT(4)
WAS(FTB)  +0.0000000000000000E+000 +0.0000000000000000E+000 +0.0000000000000000E+000 +1.0000000000000000E+000
IS (EST)  +6.6410822800963833E-005 -1.3881024386120122E-003 -1.0109026353038290E-003 +9.9999852341745199E-001

DelTheta        deltheta(1)               deltheta(2)               deltheta(3)
Units             rad                       rad                       rad
          +1.3562844533653021E-004 -2.7760700738361840E-003 -2.0219958244165996E-003
EulAngT         theta(1)                  theta(2)                  theta(3)                  [rad]
Mean      +1.3562844533653018E-004 -2.7760700738361844E-003 -2.0219958244165992E-003
sSigmaT   +1.7341479285070739E-004 +4.0847466282364835E-007 +4.4009404330204540E-007
SigmaT    +1.5281650090347244E-004 +3.5995584721641599E-007 +3.8781946257478988E-007
-----------------------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  8               1            -64.000           +64.000     pixels
OFFSET FRAME NAME: CORNER PIXEL (DIAGNOSTICS)
qT               qT(1)                     qT(2)                     qT(3)                     qT(4)
WAS(FTB)  +0.0000000000000000E+000 +0.0000000000000000E+000 +0.0000000000000000E+000 +1.0000000000000000E+000
IS (EST)  +6.7742304092228574E-005 -5.4537119975779853E-004 -1.3181636251217884E-004 +9.9999984030282785E-001

DelTheta        deltheta(1)               deltheta(2)               deltheta(3)
Units             rad                       rad                       rad
          +1.3562844533653018E-004 -1.0907245825077711E-003 -2.6370673224599723E-004
EulAngT         theta(1)                  theta(2)                  theta(3)                  [rad]
Mean      +1.3562844533653021E-004 -1.0907245825077711E-003 -2.6370673224599729E-004
sSigmaT   +1.7341483080777890E-004 +4.7888484512816790E-007 +5.0021785680299302E-007
SigmaT    +1.5281653435198484E-004 +4.2200267442691472E-007 +4.4080174078272588E-007
-----------------------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  9               1            -64.000            -64.000     pixels
OFFSET FRAME NAME: CORNER PIXEL (DIAGNOSTICS)
```

```
qT              qT(1)                    qT(2)                    qT(3)                    qT(4)
WAS(FTB)  +0.0000000000000000E+000 +0.0000000000000000E+000 +0.0000000000000000E+000 +1.0000000000000000E+000
IS (EST)  +6.7266316480556283E-005 -5.3868401690695879E-004 -1.0171293802220271E-003 +9.9999933537107721E-001

DelTheta        deltheta(1)               deltheta(2)               deltheta(3)
Units             rad                       rad                       rad
          +1.3562844533653015E-004 -1.0772306890114419E-003 -2.0343324625245749E-003
EulAngT         theta(1)                  theta(2)                  theta(3)                [rad]
Mean      +1.3562844533653018E-004 -1.0772306890114423E-003 -2.0343324625245757E-003
sSigmaT   +1.7341481782119820E-004 +4.4323506833149963E-007 +4.6311670582507361E-007
SigmaT    +1.5281652290795642E-004 +3.9058739515055723E-007 +4.0810748224378973E-007
-------------------------------------------------------------------------------------------------------
-------------------------------------------------------------------------------------------------------
               q(1)                     q(2)                     q(3)                     q(4)
PCRS1A: +5.2603126189317361E-007 +3.7451819048221893E-004 -1.4045531552277380E-003 +9.9999894348258311E-001
PCRS2A: -5.1968404336718985E-007 +3.8455385122900486E-004 +1.3513933841514693E-003 +9.9999901292650617E-001
-----------------------------------------------------------------------------------------
**********  CS-FILE PARAMETERS:  **********  **********  AS-FILE PARAMETERS:  **********
Row (01) PIX2RADX: +1.2087416876100000E-005  Row (1) TASTART:   +7.3051200000000000E+008
Row (02) PIX2RADY: +1.2595908372599999E-005  Row (2) TASTOP:    +7.3052690000000000E+008
Row (03) CX0:      +6.4500000000000000E+001  Row (3) S/C TIME:  +7.3051200000000000E+008
Row (04) CY0:      +6.4500000000000000E+001  Row (4) QR1:       +0.0000000000000000E+000
Row (05) BETA0:    +2.8047410000000001E-006  Row (5) QR2:       +0.0000000000000000E+000
Row (06) GAMMA_E0: +2.0070000000000000E+003  Row (6) QR3:       +0.0000000000000000E+000
Row (07) D11:      -1.0000000000000000E+000  Row (7) QR4:       +1.0000000000000000E+000
Row (08) D12:      +0.0000000000000000E+000
Row (09) D21:      +0.0000000000000000E+000
Row (10) D22:      -1.0000000000000000E+000
Row (11) DG:       +1.0000000000000000E+000
-----------------------------------------------------------------------------------------
-------------------------------------------------------------
INITIAL STA-TO-PCRS ALIGNMENT (R) KNOWLEDGE (1-SIGMA)
    SIGMA(X)        SIGMA(Y)         SIGMA(Z)
1.41421656E+002  9.90383438E+000  1.13175056E+001  [arcsec]
-------------------------------------------------------------
PIX2RADX = 1.208741687610E-005[rad/pixel]
XPIXSIZE = 2.4932[arcsec]
PIX2RADY = 1.259590837260E-005[rad/pixel]
YPIXSIZE = 2.5981[arcsec]
CX0 = 64.5[pixel] = 160.81[arcsec]
CY0 = 64.5[pixel] = 167.58[arcsec]
-------------------------------------------------------------
NOMINAL BETA0 = 2.804741000000E-006[rad/encoder unit]
ENCODER UNIT SIZE = 0.58[arcsec]
GAMMA_E0 = 2007.00[encoder unit] = 1161.09[arcsec]
-------------------------------------------------------------
                | -1 | +0 |
FLIP MATRIX D = |----|----|   and   DG = +1
                | +0 | -1 |
-------------------------------------------------------------
```

3.3 IPF EXECUTION LOG

```
*********************************************************************
IPF EXECUTION-LOG FILE NAME:  LG992095.dat
INSTRUMENT TYPE:              MIPS_24um_center
IPF FILTER EXECUTION DATE:    05-Aug-2003    TIME: 21:45
IPF FILTER VERSION USED:      IPF.V2.0.1Beta
*********************************************************************
```

```
------------------- Loading & Preparing Input Files -------------------
AAFILE:  AA992095 Loaded!        AAFILE dimension = 149001 X 21
ASFILE:  AS992095 Loaded!
CAFILE:  CA992095 Loaded!        CAFILE dimension = 432 X 15
CBFILE:  CB992095 Loaded!        CBFILE dimension = 42 X 15
CCFILE:  CC992095 Created!       CCFILE dimension = 474 X 19
CSFILE:  CS992095 Loaded!
Loading Input Files Completed!
----------------------------------------------------------------------

------------------------ Selected Mask Vectors ------------------------
index =   1  2  3  4  5  6  7  8  9 10 11 12 13 14 15 16 17 18 19 20
----------------------------------------------------------------------
mask1 = [ 1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1 ]
mask2 = [ 1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1 ]
----------------------------------------------------------------------

---------------  Selected Initial Gyro Bias Parameters  ---------------
IPF>> RNFILE FLAG SET TO USE PREVIOUS AG & AC FILE!
AGFILE USED: AG992095     ACFILE USED: AC992095
IPF Linearized Using Following Nominal Gyro Bias Estimates
bg0 = [+1.4373545441551276E-006 +1.8774821168585316E-007 +2.3743402797237056E-007 ]
cg0 = [+0.0000000000000000E+000 +0.0000000000000000E+000 +0.0000000000000000E+000 ]
----------------------------------------------------------------------

IPF>> GYRO PREPROCESSOR BYPASSED!
IPF>> LOADING PREVIOUS AG & AC FILE!

FRAME TABLE ENTRIES FOR PCRS LOADED TO TPCRS
q_PCRS4 = [ +5.2603126189317361E-007     q_PCRS5 = [ +7.3379987833742897E-007
            +3.7451819048221893E-004                 +5.2236196154513707E-004
            -1.4045531552277380E-003                 -1.4047712280184723E-003
            +9.9999894348258311E-001 ];              +9.9999887687698918E-001 ];
q_PCRS8 = [ -5.1968404336718985E-007     q_PCRS9 = [ -7.1963421681856818E-007
            +3.8455385122900486E-004                 +5.3239763239987400E-004
            +1.3513933841514693E-003                 +1.3516841804518383E-003
            +9.9999901292650617E-001 ];              +9.9999894475050310E-001 ];
-------------------------------------------------------------------------------
------ Initial Conditions for State -----  ------   Inital Square-Root Cov (diag)   -----
p1(01)  = a00  = +0.0000000000000000E+000  Sigma_initial(01,01) = 1.0000000000000000E+000
p1(02)  = b00  = +0.0000000000000000E+000  Sigma_initial(02,02) = 1.0000000000000000E+000
p1(03)  = c00  = +0.0000000000000000E+000  Sigma_initial(03,03) = 1.0000000000000000E+000
p1(04)  = a10  = +0.0000000000000000E+000  Sigma_initial(04,04) = 3.6384517097704270E+002
p1(05)  = b10  = +0.0000000000000000E+000  Sigma_initial(05,05) = 3.6384517097704270E+002
p1(06)  = c10  = +0.0000000000000000E+000  Sigma_initial(06,06) = 3.6384517097704270E+002
p1(07)  = d10  = +0.0000000000000000E+000  Sigma_initial(07,07) = 3.6384517097704270E+002
p1(08)  = a20  = +0.0000000000000000E+000  Sigma_initial(08,08) = 1.3238330844331343E+007
p1(09)  = b20  = +0.0000000000000000E+000  Sigma_initial(09,09) = 1.3238330844331343E+007
p1(10)  = c20  = +0.0000000000000000E+000  Sigma_initial(10,10) = 1.3238330844331343E+007
p1(11)  = d20  = +0.0000000000000000E+000  Sigma_initial(11,11) = 1.3238330844331343E+007
p1(12)  = a01  = +0.0000000000000000E+000  Sigma_initial(12,12) = 1.0000000000000000E+004
p1(13)  = b01  = +0.0000000000000000E+000  Sigma_initial(13,13) = 1.0000000000000000E+004
p1(14)  = c01  = +0.0000000000000000E+000  Sigma_initial(14,14) = 1.0000000000000000E+004
p1(15)  = d01  = +0.0000000000000000E+000  Sigma_initial(15,15) = 1.0000000000000000E+004
p1(16)  = e01  = +0.0000000000000000E+000  Sigma_initial(16,16) = 1.0000000000000000E+004
p1(17)  = f01  = +0.0000000000000000E+000  Sigma_initial(17,17) = 1.0000000000000000E+004
-------------------------------------------------------------------------------------------
p2f(01) = am1  = +0.0000000000000000E+000
p2f(02) = am2  = +0.0000000000000000E+000  Sigma_initial(18,18) = 1.0000000000000001E-001
p2f(03) = am3  = +1.0000000000000000E+000
p2f(04) = beta = +1.0000000000000000E+000  Sigma_initial(19,19) = 1.0000000000000001E-001
p2f(05) = qT1  = -5.5224103706934371E-007  Sigma_initial(20,20) = 1.0000000000000001E-001
p2f(06) = qT2  = -9.6589398881636961E-004  Sigma_initial(21,21) = 1.0000000000000000E-002
p2f(07) = aT3  = -5.7174047628006817E-004  Sigma_initial(22,22) = 1.0000000000000000E-002
p2f(08) = qT4  = +9.9999937008046424E-001
p2f(09) = qR1  = +0.0000000000000000E+000  Sigma_initial(23,23) = 3.4281576788666959E-002
p2f(10) = qR2  = +0.0000000000000000E+000  Sigma_initial(24,24) = 2.4007572013584836E-003
p2f(11) = qR3  = +0.0000000000000000E+000  Sigma_initial(25,25) = 2.7434407822204804E-003
```

```
p2f(12) = qR4  = +1.0000000000000000E+000
p2f(13) = brx  = +0.0000000000000000E+000  Sigma_initial(26,26) = 6.7114093959731537E-005
p2f(14) = bry  = +0.0000000000000000E+000  Sigma_initial(27,27) = 6.7114093959731537E-005
p2f(15) = brz  = +0.0000000000000000E+000  Sigma_initial(28,28) = 6.7114093959731537E-005
p2f(16) = crx  = +0.0000000000000000E+000  Sigma_initial(29,29) = 4.5043016080356737E-009
p2f(17) = cry  = +0.0000000000000000E+000  Sigma_initial(30,30) = 4.5043016080356737E-009
p2f(18) = crz  = +0.0000000000000000E+000  Sigma_initial(31,31) = 4.5043016080356737E-009
p2f(19) = bgx  = +0.0000000000000000E+000  Sigma_initial(32,32) = 6.7114093959731537E-005
p2f(20) = bgy  = +0.0000000000000000E+000  Sigma_initial(33,33) = 6.7114093959731537E-005
p2f(21) = bgz  = +0.0000000000000000E+000  Sigma_initial(34,34) = 6.7114093959731537E-005
p2f(22) = cgx  = +0.0000000000000000E+000  Sigma_initial(35,35) = 4.5043016080356737E-009
p2f(23) = cgy  = +0.0000000000000000E+000  Sigma_initial(36,36) = 4.5043016080356737E-009
p2f(24) = cgz  = +0.0000000000000000E+000  Sigma_initial(37,37) = 4.5043016080356737E-009
-------------------------------------------------------------------------------------

--------------------   IPF KALMAN FILTER STARTED  ---------------------
Iteration#001: |dp|= +8.995620338807E+002   RMS(|Res|)=+8.995620338807E+002
Iteration#002: |dp|= +6.206741320894E+001   RMS(|Res|)=+6.206741320894E+001
Iteration#003: |dp|= +9.198999486148E-002   RMS(|Res|)=+9.198999486148E-002
Iteration#004: |dp|= +8.559577287929E-001   RMS(|Res|)=+8.559577287929E-001
Iteration#005: |dp|= +7.330465728150E-002   RMS(|Res|)=+7.330465728150E-002
Iteration#006: |dp|= +2.959038572417E-003   RMS(|Res|)=+2.959038572417E-003
Iteration#007: |dp|= +4.447902728312E-005   RMS(|Res|)=+4.447902728312E-005
Iteration#008: |dp|= +8.088665818209E-007   RMS(|Res|)=+8.088665818209E-007
Iteration#009: |dp|= +3.332218434641E-007   RMS(|Res|)=+3.332218434641E-007
Iteration#010: |dp|= +1.255350362538E-006   RMS(|Res|)=+1.255350362538E-006
Iteration#011: |dp|= +3.602891689822E-007   RMS(|Res|)=+3.602891689822E-007
Iteration#012: |dp|= +4.449169632109E-007   RMS(|Res|)=+4.449169632109E-007
Iteration#013: |dp|= +8.673440166915E-007   RMS(|Res|)=+8.673440166915E-007
Iteration#014: |dp|= +7.905291132501E-007   RMS(|Res|)=+7.905291132501E-007
Iteration#015: |dp|= +2.162578022016E-006   RMS(|Res|)=+2.162578022016E-006
Iteration#016: |dp|= +1.432400507425E-006   RMS(|Res|)=+1.432400507425E-006
Iteration#017: |dp|= +1.127249033003E-006   RMS(|Res|)=+1.127249033003E-006
Iteration#018: |dp|= +9.340496407877E-007   RMS(|Res|)=+9.340496407877E-007
Iteration#019: |dp|= +6.140073887679E-007   RMS(|Res|)=+6.140073887679E-007
Iteration#020: |dp|= +7.173512987442E-007   RMS(|Res|)=+7.173512987442E-007
IPF Kalman Filter Completed with Error |dp1| + |dp2| = +7.1735129874422374E-007
-----------------------------------------------------------------------

-----------------  IPF LEAST SQUARES FILTER STARTED  ------------------
Iteration#001   COND#=+1.583410296552E+012,   |dp|=+8.991584318763E+002
Iteration#002   COND#=+1.583396592726E+012,   |dp|=+5.982879368359E+001
Iteration#003   COND#=+1.583396583318E+012,   |dp|=+1.051969278209E-001
Iteration#004   COND#=+1.583396595619E+012,   |dp|=+1.010761544029E-003
Iteration#005   COND#=+1.583396585873E+012,   |dp|=+2.638693177388E-005
Iteration#006   COND#=+1.583396586931E+012,   |dp|=+5.078966708484E-007
Iteration#007   COND#=+1.583396579504E+012,   |dp|=+4.568369652983E-008
Iteration#008   COND#=+1.583396581767E+012,   |dp|=+1.242395858235E-007
Iteration#009   COND#=+1.583396591042E+012,   |dp|=+9.295086369855E-008
Iteration#010   COND#=+1.583396586318E+012,   |dp|=+4.720643432318E-008
Iteration#011   COND#=+1.583396591160E+012,   |dp|=+2.885988791128E-008
Iteration#012   COND#=+1.583396583738E+012,   |dp|=+1.751180286711E-008
Iteration#013   COND#=+1.583396579751E+012,   |dp|=+7.024603574500E-008
Iteration#014   COND#=+1.583396591879E+012,   |dp|=+1.213526518144E-007
Iteration#015   COND#=+1.583396574429E+012,   |dp|=+5.441543227604E-008
Iteration#016   COND#=+1.583396595929E+012,   |dp|=+6.485744501380E-008
Iteration#017   COND#=+1.583396577863E+012,   |dp|=+7.902682541105E-008
Iteration#018   COND#=+1.583396591847E+012,   |dp|=+5.895473036351E-008
Iteration#019   COND#=+1.583396578782E+012,   |dp|=+3.707788599400E-008
Iteration#020   COND#=+1.583396577973E+012,   |dp|=+6.675522964076E-008
IPF Least Squares Filter Completed with Error |dp1| + |dp2| = +6.6755229640760468E-008
-----------------------------------------------------------------------
Total Execution Time: 148 seconds
```

4 USER COMMENTS

This section left blank.

IPF TEAM CONTACT INFORMATION

IPF Team email		ipf@sirtfweb.jpl.nasa.gov	
David S. Bayard	X4-8208	David.S.Bayard@jpl.nasa.gov	(TEAM LEADER)
Dhemetrio Boussalis	X4-3977	boussali@grover.jpl.nasa.gov	
Paul Brugarolas	X4-9243	Paul.Brugarolas@jpl.nasa.gov	
Bryan H. Kang	X4-0541	Bryan.H.Kang@jpl.nasa.gov	
Edward.C.Wong	X4-3053	Edward.C.Wong@jpl.nasa.gov	(TASK MANAGER)

ACKNOWLEDGEMENTS

This work was performed at the Jet Propulsion Laboratory, California Institute of Technology, under contract with the National Aeronautics and Space Administration.

References

[1] D.S. Bayard, B.H. Kang, *SIRTF Instrument Pointing Frame Kalman Filter Algorithm*, JPL D-Document D-24809, September 30, 2003.

[2] B.H. Kang, D.S. Bayard, *SIRTF Instrument Pointing Frame (IPF) Software Description Document and User's Guide*, JPL D-Document D-24808, September 30, 2003.

[3] D.S. Bayard, B.H. Kang, *SIRTF Instrument Pointing Frame (IPF) Kalman Filter Unit Test Report*, JPL D-Document D-24810, September 30, 2003.

[4] *Space Infrared Telescope Facility In-Orbit Checkout and Science Verification Mission Plan*, JPL D-Document D-22622, 674-FE-301 Version 1.4, February 8, 2002.

[5] *Space Infrared Telescope Facility Observatory Description Document*, Lockheed Martin LMMS/P458569, 674-SEIT-300 Version 1.2, November 1, 2002.

[6] *SIRTF Software Interface Specification for Science Centroid INPUT Files (CAFILE, CS-FILE)*, JPL SOS-SIS-2002, November 18, 2002.

[7] *SIRTF Software Interface Specification for Inferred Frames Offset INPUT Files (OFILE)*, JPL SOS-SIS-2003, November 18, 2002.

[8] *SIRTF Software Interface Specification for PCRS Centroid INPUT Files (CBFILE)*, JPL SIS-FES-015, November 18, 2002.

[9] *SIRTF Software Interface Specification for Attitude INPUT Files (AFILE, ASFILE)*, JPL SIS-FES-014, January 7, 2002.

[10] *SIRTF Software Interface Specification for IPF Filter Output Files (IFFILE, LGFILE, TARFILE)*, JPL SOS-SIS-2005, November 18, 2002.

[11] R.J. Brown, *Focal Surface to Object Space Field of View Conversion.* Systems Engineering Report SER No. S20447-OPT-051, Ball Aerospace & Technologies Corp., November 23, 1999.

JET PROPULSION LABORATORY **SIRTF IPF REPORT**
JPL ID91M095
August 19, 2003

SIRTF INSTRUMENT POINTING FRAME KALMAN FILTER EXECUTION SUMMARY

IPF RUN NUMBER: 91M095
REPORT TYPE: COVARIANCE ANALYSIS (MULTI-RUN)

PRIME FRAME: MIPS_24um_center (95)
INFERRED FRAMES: (96) (99) (100) (103) (104) (1) (1) (1) (1)

IPF TEAM

Autonomy and Control Section (345)
Jet Propulsion Laboratory
California Institute of Technology
4800 Oak Grove Drive
Pasadena, CA 91109

Contents

1 IPF MULTI-RUN SUMMARY **3**

2 IPF MULTI-RUN RESULTS **7**

2.1 IPF MULTI-RUN OUTPUT PLOTS 7

2.2 IPF MULTI-RUN OUTPUT DATA (MF MINI FILE) 9

2.3 IPF MULTI-RUN EXECUTION LOG 14

3 USER COMMENTS **20**

List of Figures

1.1 A-priori and a-posteriori IPF frames 3

1.2 A-priori and a-posteriori IPF frames (ZOOMED) 6

2.1 Array plot with (solid) and w/o (dashed) optical distortion corrections 7

2.2 IPF parameter symbol table 7

2.3 KF parameter error sigma plots 8

2.4 KF parameter error 1-sigma bound 8

List of Tables

1.1 IPF filter execution configuration 4

1.2 Merge performance chart 4

1.3 IPF filter execution mask vector assignment 4

1.4 IPF calibration error summary ([arcsec], 1-sigma, radial) 5

1.5 IPF Brown angle summary 6

1 IPF MULTI-RUN SUMMARY

This report summarizes the SIRTF Instrument Pointing Frame (IPF) Kalman Filter execution. This document captures the results generated by a multi-run execution with the MR run number specified as: MR91M095. This multi-run execution merges 2 previously executed IPF runs of the instrument: MIPS_24um_center (95), for the purpose of improving estimation accuracy. The main multi-run calibration results have been documented in MF91M095 typically stored in the mission archive DOM collection IPF_MF. This report only summarizes the main aspects of the run, and does not substitute for the full information contained in the MF file.

Section 1 summarizes the multi-run merge results. The merge configurations are tabulated in Table 1.1. The overall End-to-End pointing performances are tabulated in Table 1.4. Section 2 summarizes resulting plots, a mini summary of the MF Multi-Run output file, and the execution log. Section 3 captures the user comments that are specific to this particular run.

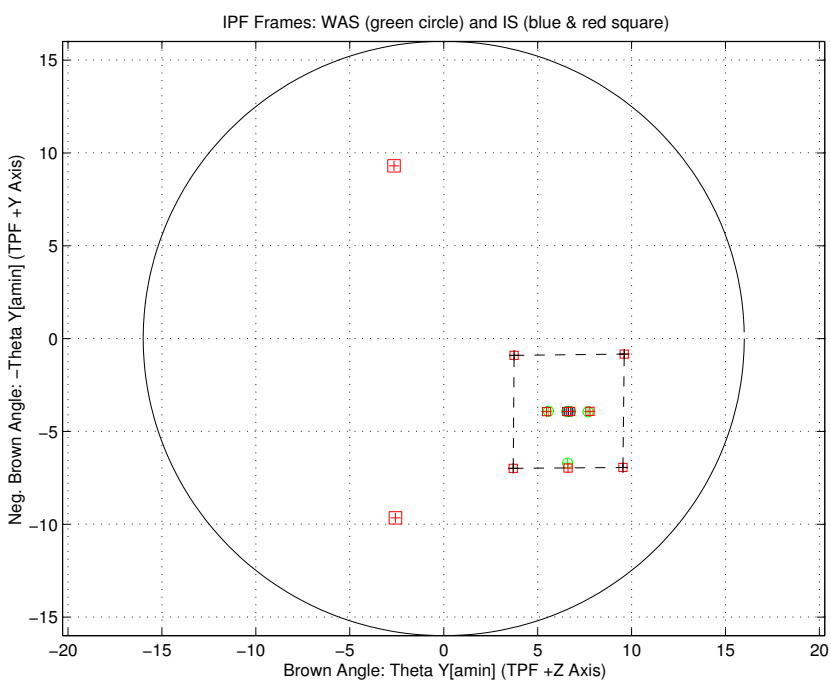

Figure 1.1: A-priori and a-posteriori IPF frames

EXECUTION CONFIGURATION ITEM	CURRENT STATUS
IPF Filter Version Used	IPF.V2.0.1Beta
Frame Table Version Used	FTVE2E1
IPF Filter Mode	NORMAL-MODE(0)
LS Residual Sigma Scale	1.12991961E+000
Merge Data Set #1	991095
Merge Data Set #2	992095

Table 1.1: IPF filter execution configuration

	BROWN ANGLES AND SIGMAS [arcmin, arcmin, deg]					
RUN#	$-\theta_y$	$-\theta_z$	θ_x	σ_y	σ_z	σ_x
991095	+6.641111	+3.932233	+0.016691	0.000653	0.000793	0.009652
992095	+6.640699	+3.931685	+0.007771	0.000656	0.000793	0.009936
91M095	+6.640939	+3.931967	+0.013121	0.000461	0.000559	0.006887

Table 1.2: Merge performance chart

Con. Plate Scale			Γ Dependent				Γ^2 Dependent				Linear Plate Scale						Mirror	
a_{00}	b_{00}	c_{00}	a_{10}	b_{10}	c_{10}	d_{10}	a_{20}	b_{20}	c_{20}	d_{20}	a_{01}	b_{01}	c_{01}	d_{01}	e_{01}	f_{01}	α	β
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
IPF (T)			Alignment R									Gyro Drift Bias						
θ_1	θ_2	θ_3	a_{rx}	a_{ry}	a_{rz}	b_{rx}	b_{ry}	b_{rz}	c_{rx}	c_{ry}	c_{rz}	b_{gx}	b_{gy}	b_{gz}	c_{gx}	c_{gy}	c_{gz}	
20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	
1	1	1																

Table 1.3: IPF filter execution mask vector assignment

FOCAL PLANE SURVEY ANALYSIS: MULTI-RUN
INSTRUMENT NAME: MIPS_24um_center NF: 95

```
PIX2RADW: 1.20874169E-005[rad/pixel] = 2.4932E+000[arcsec/pixel]
PIX2RADV: 1.20874169E-005[rad/pixel] = 2.4932E+000[arcsec/pixel]
```

FRAME	DESCRIPTION	IPF[1]	SF[2]	ARW[3]	TOTAL	REQ
095(P)	MIPS_24um_center	0.0385	0.0855	0.0703	0.1172	0.14
096(I)	MIPS_24um_plusY_edge	0.0755	0.0855	0.0703	0.1340	N/A
099(I)	MIPS_24um_small_FOV1	0.0439	0.0855	0.0703	0.1190	N/A
100(I)	MIPS_24um_small_FOV2	0.0413	0.0855	0.0703	0.1181	N/A
103(I)	MIPS_24um_large_FOV1	0.0436	0.0855	0.0703	0.1189	N/A
104(I)	MIPS_24um_large_FOV2	0.0433	0.0855	0.0703	0.1188	N/A
TR (C)	CORNERS OF INSTRUMENT	0.0988	0.0855	0.0703	0.1484	N/A
BR (C)	CORNERS OF INSTRUMENT	0.0897	0.0855	0.0703	0.1424	N/A
TL (C)	CORNERS OF INSTRUMENT	0.0945	0.0855	0.0703	0.1455	N/A
BL (C)	CORNERS OF INSTRUMENT	0.0940	0.0855	0.0703	0.1452	N/A

Table 1.4: IPF calibration error summary ([arcsec], 1-sigma, radial)

[1]IPF filter removes systematic pointing errors due to: thermomechanical alignment drift (Body to TPF), gyro bias and bias drift, centroiding error, attitude error, and optical distortion. IPF SIGMA presented here is "NOT Scaled" by the Least Squares Scale factor. The Least Squares Scale Factor was: 1.129920.

[2]Error due to gyro Scale Factor: assumes 95 ppm error over 0.250 degree maneuver.

[3]Error due to gyro Angle Random Walk: assumes ARW = 100 $\mu deg/\sqrt{hr}$, with 960 second Maneuver time (max), and 14 independent Maneuvers.

IPF BROWN ANGLE SUMMARY						
	WAS			IS		
Frame Number	theta_Y (arcmin)	theta_Z (arcmin)	angle (deg)	theta_Y (arcmin)	theta_Z (arcmin)	angle (deg)
095	+6.641000	+3.931000	+0.000000	+6.640939	+3.931967	+0.013121
096	+6.595000	+6.712000	-0.000000	+6.618191	+6.975709	+0.013121
099	+7.687000	+3.943000	-0.000000	+7.784406	+3.921131	+0.013121
100	+5.574000	+3.918000	+0.000000	+5.475998	+3.941596	+0.013121
103	+6.746000	+3.932000	+0.000000	+6.755225	+3.930945	+0.013121
104	+6.558000	+3.930000	+0.000000	+6.549520	+3.932774	+0.013121
001	+0.000000	+0.000000	+0.000000	+9.609562	+0.843660	+0.013121
001	+0.000000	+0.000000	+0.000000	+9.543703	+6.950029	+0.013121
001	+0.000000	+0.000000	+0.000000	+3.749543	+0.905238	+0.013121
001	+0.000000	+0.000000	+0.000000	+3.701561	+6.992338	+0.013121

Table 1.5: IPF Brown angle summary

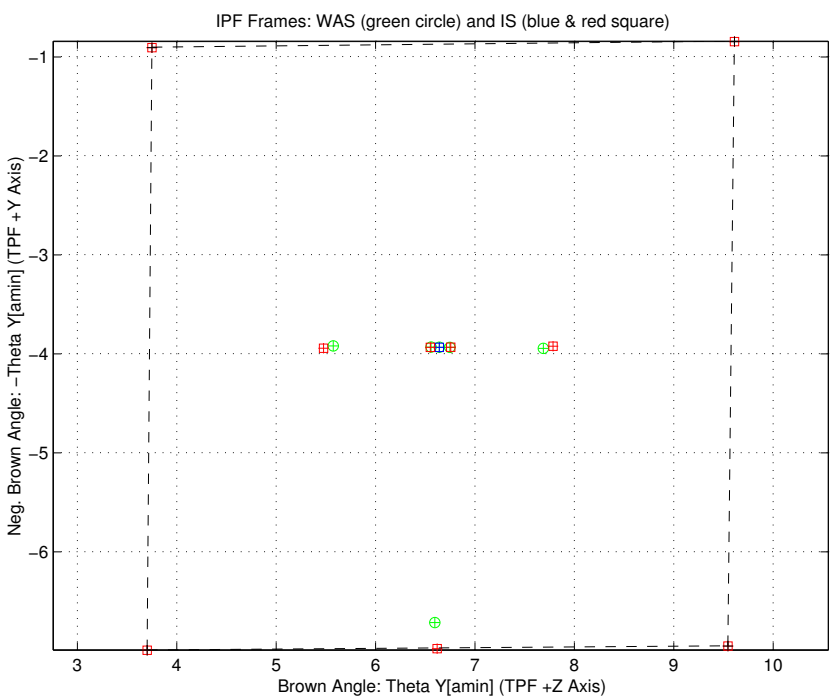

Figure 1.2: A-priori and a-posteriori IPF frames (ZOOMED)

2 IPF MULTI-RUN RESULTS

2.1 IPF MULTI-RUN OUTPUT PLOTS

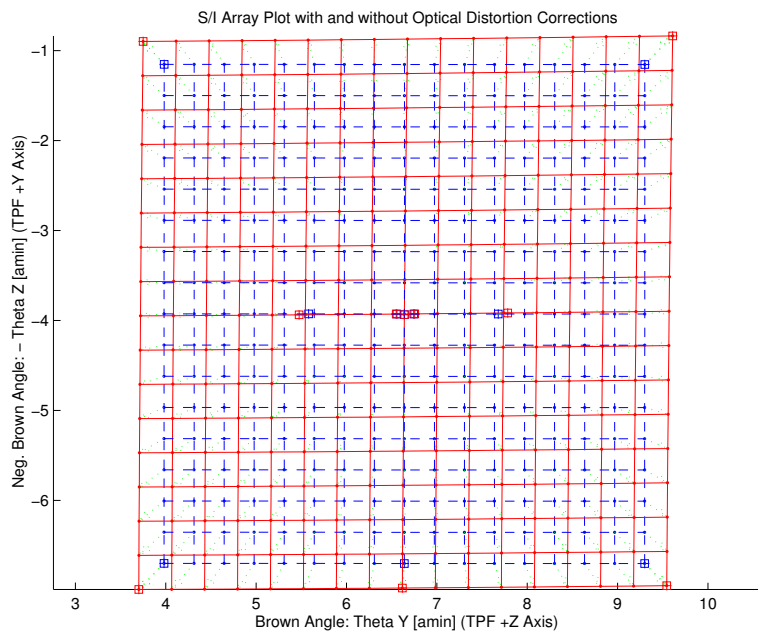

Figure 2.1: Array plot with (solid) and w/o (dashed) optical distortion corrections

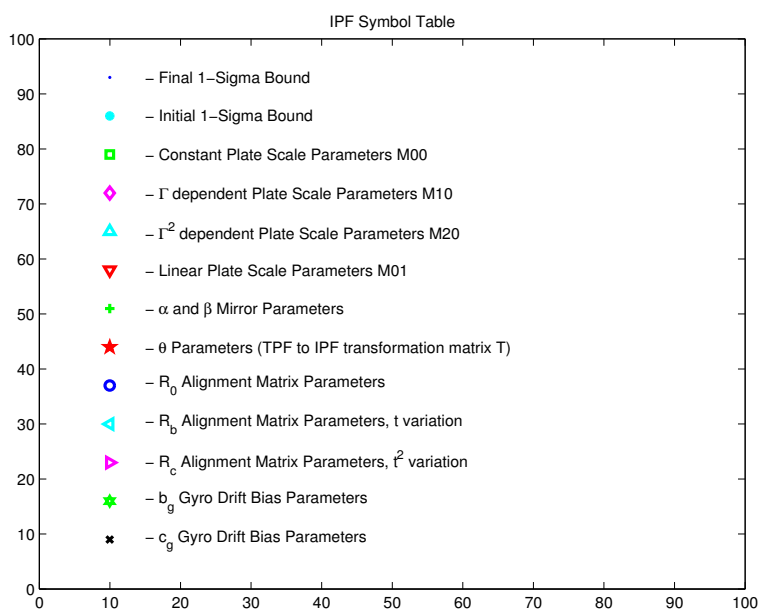

Figure 2.2: IPF parameter symbol table

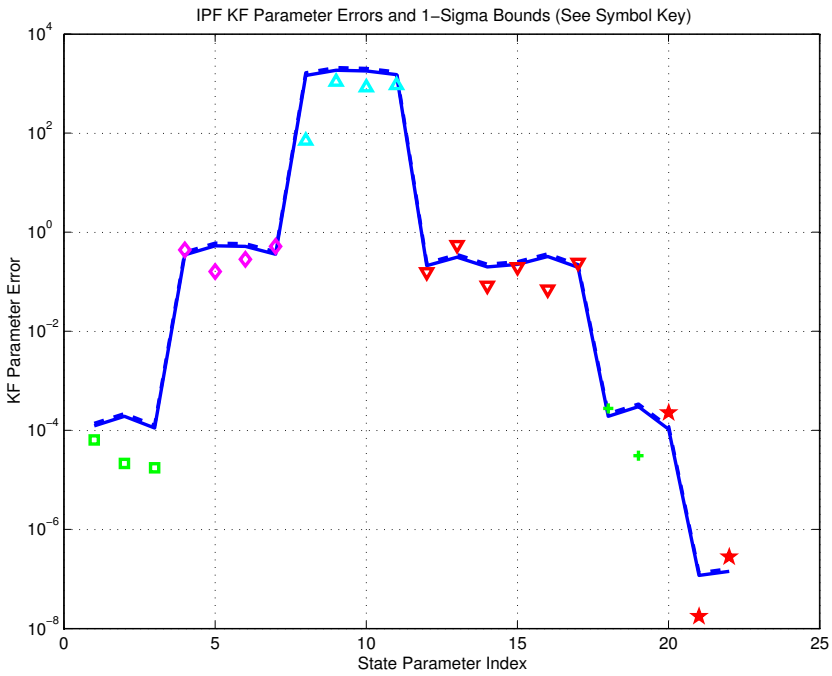

Figure 2.3: KF parameter error sigma plots

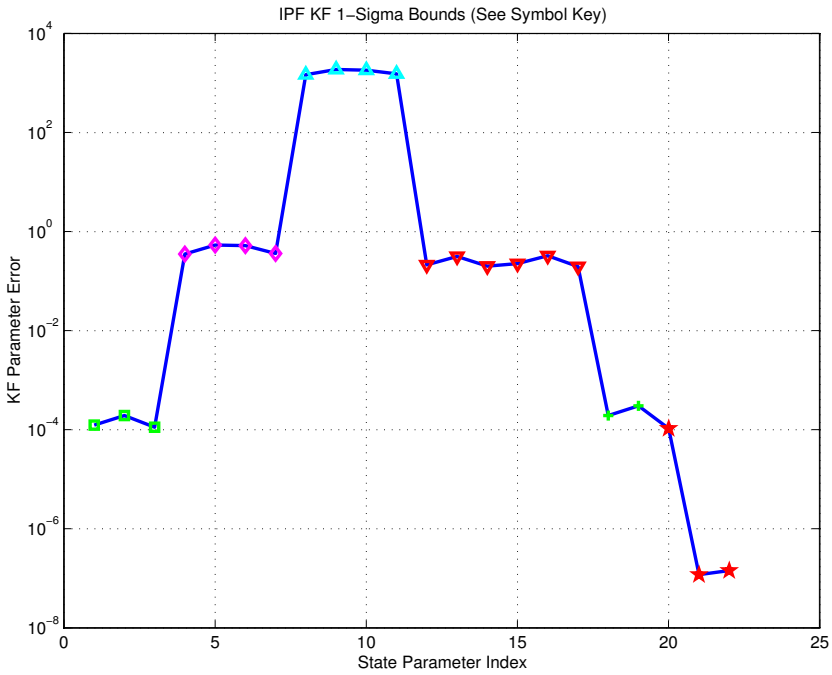

Figure 2.4: KF parameter error 1-sigma bound

2.2 IPF MULTI-RUN OUTPUT DATA (MF MINI FILE)

```
OUTPUT FILE NAME: MF91M095mini.dat   DATE: 06-Aug-2003   TIME: 12:11
INSTRUMENT NAME:  MIPS_24um_center   NF: 95
IPF FILTER VERSION: IPF.V2.0.1Beta       SW RELEASE DATE: August 5, 2003
--------------------------------------------------------------------------------
---------------------------- IPF BROWN ANGLE SUMMARY ---------------------------
--------------------------------------------------------------------------------
         ------------ WAS ------------           ------------ IS -------------
Frame    theta_Y     theta_Z     angle           theta_Y     theta_Z     angle
Number   (arcmin)    (arcmin)    (deg)           (arcmin)    (arcmin)    (deg)
------  --------------------------------       --------------------------------
 095     +6.641000  +3.931000   +0.000000        +6.640939  +3.931967   +0.013121
 096     +6.595000  +6.712000   -0.000000        +6.618191  +6.975709   +0.013121
 099     +7.687000  +3.943000   -0.000000        +7.784406  +3.921131   +0.013121
 100     +5.574000  +3.918000   +0.000000        +5.475998  +3.941596   +0.013121
 103     +6.746000  +3.932000   +0.000000        +6.755225  +3.930945   +0.013121
 104     +6.558000  +3.930000   +0.000000        +6.549520  +3.932774   +0.013121
 001     +0.000000  +0.000000   +0.000000        +9.609562  +0.843660   +0.013121
 001     +0.000000  +0.000000   +0.000000        +9.543703  +6.950029   +0.013121
 001     +0.000000  +0.000000   +0.000000        +3.749543  +0.905238   +0.013121
 001     +0.000000  +0.000000   +0.000000        +3.701561  +6.992338   +0.013121
--------------------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  0              95            +0.000            +0.000     pixels
OFFSET FRAME NAME: MIPS_24um_center
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
WAS(FTB)            +6.641000        +3.931000       +0.000000
IS (EST)            +6.640939        +3.931967       +0.013121
dT_EST              -0.000061        +0.000967       +0.013121
T_sSIGMA            +0.000461        +0.000559       +0.006887
dT_EST/T_sSIGMA     -0.132686        +1.730362       +1.905171
-------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  1              96            +0.000           -64.000     pixels
OFFSET FRAME NAME: MIPS_24um_plusY_edge
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
WAS(FTB)            +6.595000        +6.712000       -0.000000
IS (EST)            +6.618191        +6.975709       +0.013121
dT_EST              +0.023191        +0.263709       +0.013121
T_sSIGMA            +0.000844        +0.000934       +0.006887
dT_EST/T_sSIGMA    +27.463096       +282.364321       +1.905172
-------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  2              99           +25.000            +0.000     pixels
OFFSET FRAME NAME: MIPS_24um_small_FOV1
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
WAS(FTB)            +7.687000        +3.943000       -0.000000
IS (EST)            +7.784406        +3.921131       +0.013121
dT_EST              +0.097406        -0.021869       +0.013121
T_sSIGMA            +0.000468        +0.000561       +0.006887
dT_EST/T_sSIGMA    +207.954921       -38.950500       +1.905171
-------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  3             100           -25.500            +0.000     pixels
OFFSET FRAME NAME: MIPS_24um_small_FOV2
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
WAS(FTB)            +5.574000        +3.918000       +0.000000
IS (EST)            +5.475998        +3.941596       +0.013121
dT_EST              -0.098002        +0.023596       +0.013121
T_sSIGMA            +0.000437        +0.000531       +0.006887
dT_EST/T_sSIGMA    -224.132436       +44.408912       +1.905171
-------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  4             103            +2.500            +0.000     pixels
OFFSET FRAME NAME: MIPS_24um_large_FOV1
```

```
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
WAS(FTB)            +6.746000        +3.932000       +0.000000
IS (EST)            +6.755225        +3.930945       +0.013121
dT_EST              +0.009225        -0.001055       +0.013121
T_sSIGMA            +0.000463        +0.000560       +0.006887
dT_EST/T_sSIGMA    +19.942217        -1.882530       +1.905171
-----------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  5             104            -2.000            +0.000     pixels
OFFSET FRAME NAME: MIPS_24um_large_FOV2
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
WAS(FTB)            +6.558000        +3.930000       +0.000000
IS (EST)            +6.549520        +3.932774       +0.013121
dT_EST              -0.008480        +0.002774       +0.013121
T_sSIGMA            +0.000459        +0.000557       +0.006887
dT_EST/T_sSIGMA    -18.461424        +4.977637       +1.905171
-----------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  6               1           +64.000           +64.000     pixels
OFFSET FRAME NAME: CORNER PIXEL (DIAGNOSTICS)
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
WAS(FTB)            +0.000000        +0.000000       +0.000000
IS (EST)            +9.609562        +0.843660       +0.013121
dT_EST              +9.609562        +0.843660       +0.013121
T_sSIGMA            +0.001154        +0.001176       +0.006887
dT_EST/T_sSIGMA    +8328.356508       +717.487653       +1.905173
-----------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  7               1           +64.000           -64.000     pixels
OFFSET FRAME NAME: CORNER PIXEL (DIAGNOSTICS)
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
WAS(FTB)            +0.000000        +0.000000       +0.000000
IS (EST)            +9.543703        +6.950029       +0.013121
dT_EST              +9.543703        +6.950029       +0.013121
T_sSIGMA            +0.001020        +0.001093       +0.006887
dT_EST/T_sSIGMA    +9359.643163       +6358.362570       +1.905172
-----------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  8               1           -64.000           +64.000     pixels
OFFSET FRAME NAME: CORNER PIXEL (DIAGNOSTICS)
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
WAS(FTB)            +0.000000        +0.000000       +0.000000
IS (EST)            +3.749543        +0.905238       +0.013121
dT_EST              +3.749543        +0.905238       +0.013121
T_sSIGMA            +0.001084        +0.001142       +0.006887
dT_EST/T_sSIGMA    +3457.479872       +792.400724       +1.905172
-----------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  9               1           -64.000           -64.000     pixels
OFFSET FRAME NAME: CORNER PIXEL (DIAGNOSTICS)
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
WAS(FTB)            +0.000000        +0.000000       +0.000000
IS (EST)            +3.701561        +6.992338       +0.013121
dT_EST              +3.701561        +6.992338       +0.013121
T_sSIGMA            +0.001086        +0.001129       +0.006887
dT_EST/T_sSIGMA    +3407.195761       +6195.481332       +1.905172
-----------------------------------------------------------------
-------------------------------------------------------------------------------
-------------------------------------------------------------------------------
VARNAME             MEAN                     SIGMA                 SCALED_SIGMA
a00        +1.0006443686248150E-001 +1.2395358480413686E-004 +1.4005758679068038E-004
b00        +9.9978339770635180E-002 +1.9429862915719631E-004 +2.1954183220674415E-004
c00        +1.0017748253440057E-002 +1.1269824997553151E-004 +1.2733996319708708E-004
a10        +5.4389370140514393E-001 +3.5334997940910379E-001 +3.9925707261129578E-001
b10        +2.6204211239487613E-001 +5.3810755555651824E-001 +6.0801828187677098E-001
c10        -2.7589744024993790E-001 +5.2239473154902594E-001 +5.9026405382734881E-001
d10        +5.3191581191939363E-001 +3.6137827527803096E-001 +4.0832840158673661E-001
a20        -7.1007990165182605E+001 +1.4770082084141795E+003 +1.6689005458566801E+003
```

```
b20        +1.0982456378897027E+003 +1.8842834000691103E+003 +2.1290887735149231E+003
c20        -8.4846538223707580E+002 +1.8157093441293621E+003 +2.0516056026445817E+003
d20        +9.3906705500252872E+002 +1.5388286487029100E+003 +1.7387526739323498E+003
a01        +2.1580658426616512E+000 +2.1383486897461859E-001 +2.4161621277521036E-001
b01        +2.5577297029519994E+000 +3.1674517792273499E-001 +3.5789658941725411E-001
c01        +2.0840601334662683E+000 +2.0183580883230323E-001 +2.2805823936165853E-001
d01        +2.2003872687075972E+000 +2.2699708080842931E-001 +2.5648845409993032E-001
e01        +2.0705885472364143E+000 +3.2682141574029738E-001 +3.6928192817035876E-001
f01        +2.2451252027879809E+000 +1.9738601054343372E-001 +2.2303032499331538E-001
del_alpha  +1.9555174680830508E-004 +1.9367673944054034E-004 +2.1883914681767368E-004
beta       +1.1000311287102478E+000 +3.0341554480527253E-004 +3.4283517550020686E-004
del_theta1 -6.2309030083073771E-005 +1.0638081926830968E-004 +1.2020177432607588E-004
del_theta2 +4.9976159354448863E-008 +1.1865127115087093E-007 +1.3406639859021684E-007
del_theta3 +7.7284077627000688E-008 +1.4384055970925850E-007 +1.6252826981432457E-007
-------------------------------------------------------------------------------
LSQF RESIDUAL SIGMA SCALE =         +1.1299196147653978E+000
-------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------------------
                    a_mirror(1)               a_mirror(2)               a_mirror(3)
a_mirror_ipf   +0.0000000000000000E+000  +2.0278944124790626E-002  +9.9979436106890684E-001
a_mirror_tpf   -1.9084475911937380E-003  +2.0052181684862207E-002  +9.9979711333723520E-001
beta                beta_0                    beta                      beta_total
               +2.8047410000000001E-006  +1.1000311287102478E+000  +3.0853024079699093E-006
-----------------------------------------------------------------------------------------------------------
qT               qT(1)                     qT(2)                     qT(3)                     qT(4)
FrmTbl:   -5.5224103706934371E-007 -9.6589398881636961E-004 -5.7174047628006817E-004 +9.9999937008046424E-001
Estim:    +1.1395002055851884E-004 -9.6595056985035812E-004 -5.7177049262253053E-004 +9.9999936351649388E-001
DelTheta        deltheta(1)               deltheta(2)               deltheta(3)
          +2.2900438614153302E-004 +1.7788713247521496E-008 -2.8123227273568191E-007       [rad]
EulAngT         theta(1)                  theta(2)                  theta(3)                  [rad]
Mean      +2.2900492942350546E-004 -1.9317708050357323E-003 -1.1437627810624309E-003
SigmaT    +1.0638081926830968E-004 +1.1865127115087093E-007 +1.4384055970925850E-007
-----------------------------------------------------------------------------------------------------------
Initial Gyro Bias         Bg0(1)                    Bg0(2)                    Bg0(3)
                  +1.4373545441551276E-006 +1.8774821168585316E-007 +2.3743402797237056E-007
Gyro Bias Correction      Bg(1)                     Bg(2)                     Bg(3)
                  +2.2463333334022776E-007 +1.8275281016563494E-008 +2.6237650690920771E-009
Total Gyro Bias           BgT(1)                    BgT(2)                    BgT(3)
                  +1.6619878774953553E-006 +2.0602349270241666E-007 +2.4005779304146261E-007

Initial Gyro Bias Rate     Cg0(1)                    Cg0(2)                    Cg0(3)
                  +0.0000000000000000E+000 +0.0000000000000000E+000 +0.0000000000000000E+000
Gyro Bias Rate Correction  Cg(1)                     Cg(2)                     Cg(3)
                  -2.1063048197094546E-011 +8.5289246807484838E-013 +5.5944436732964080E-013
Total Gyro Bias Rate       CgT(1)                    CgT(2)                    CgT(3)
                  -2.1063048197094546E-011 +8.5289246807484838E-013 +5.5944436732964080E-013
-----------------------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  1              96            +0.000           -64.000     pixels
OFFSET FRAME NAME: MIPS_24um_plusY_edge
qT               qT(1)                     qT(2)                     qT(3)                     qT(4)
WAS(FTB)  -9.3639450226028116E-007 -9.5920326392183247E-004 -9.7622022412795586E-004 +9.9999906346070921E-001
IS (EST)  +1.1352574559793271E-004 -9.6269240407319463E-004 -1.0144649303010819E-003 +9.9999901559758819E-001

DelTheta        deltheta(1)               deltheta(2)               deltheta(3)
Units             rad                       rad                       rad
          +2.2885776857114527E-004 -6.7460356843784837E-006 -7.6709798074784576E-005
EulAngT         theta(1)                  theta(2)                  theta(3)                  [rad]
Mean      +2.2900492942350549E-004 -1.9251537661904730E-003 -2.0291515967891622E-003
sSigmaT   +1.2020172784256031E-004 +2.4563982565165651E-007 +2.7167008872581078E-007
SigmaT    +1.0638077812952869E-004 +2.1739584165255688E-007 +2.4043311150255312E-007
-----------------------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  2              99           +25.000            +0.000     pixels
OFFSET FRAME NAME: MIPS_24um_small_FOV1
```

```
qT              qT(1)                   qT(2)                   qT(3)                   qT(4)
WAS(FTB)  -6.4117382846981564E-007 -1.1180284132340469E-003 -5.7348571352373249E-004 +9.9999921056278462E-001
IS (EST)  +1.1385667513128932E-004 -1.1322608805335321E-003 -5.7017535906531754E-004 +9.9999918996067994E-001

DelTheta        deltheta(1)             deltheta(2)             deltheta(3)
Units             rad                     rad                     rad
          +2.2901915389100401E-004 -2.8334365306324009E-005 +6.3613935985956739E-006
EulAngT         theta(1)                theta(2)                theta(3)                [rad]
Mean      +2.2900492942350546E-004 -2.2643920252744831E-003 -1.1406107968639318E-003
sSigmaT   +1.2020176424050078E-004 +1.3625243922538805E-007 +1.6332036715719186E-007
SigmaT    +1.0638081034238702E-004 +1.2058595801408208E-007 +1.4454158067793313E-007
-----------------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------------
OFFSET          NF          Delta_CW          Delta_CV
  3             100          -25.500            +0.000     pixels
OFFSET FRAME NAME: MIPS_24um_small_FOV2
qT              qT(1)                   qT(2)                   qT(3)                   qT(4)
WAS(FTB)  -4.6198041860920160E-007 -8.1070521711647421E-004 -5.6984978266998100E-004 +9.9999950901391088E-001
IS (EST)  +1.1404581805504068E-004 -7.9651706708160790E-004 -5.7319053526306988E-004 +9.9999951200324255E-001

DelTheta        deltheta(1)             deltheta(2)             deltheta(3)
Units             rad                     rad                     rad
          +2.2899380023559565E-004 +2.8507584640780015E-005 -6.8638855443008988E-006
EulAngT         theta(1)                theta(2)                theta(3)                [rad]
Mean      +2.2900492942350546E-004 -1.5929032904237576E-003 -1.1465638958018270E-003
sSigmaT   +1.2020177092403207E-004 +1.2719080384354504E-007 +1.5456118878403955E-007
SigmaT    +1.0638081625743726E-004 +1.1256624115685727E-007 +1.3678954393240681E-007
-----------------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------------
OFFSET          NF          Delta_CW          Delta_CV
  4             103           +2.500            +0.000     pixels
OFFSET FRAME NAME: MIPS_24um_large_FOV1
qT              qT(1)                   qT(2)                   qT(3)                   qT(4)
WAS(FTB)  -5.6111515131371191E-007 -9.8116560995659325E-004 -5.7188591179032191E-004 +9.9999935512990956E-001
IS (EST)  +1.1394065875768008E-004 -9.8257273378647442E-004 -5.7162002092405004E-004 +9.9999934740923746E-001

DelTheta        deltheta(1)             deltheta(2)             deltheta(3)
Units             rad                     rad                     rad
          +2.2900553141535365E-004 -2.6833325350833050E-006 +3.0677332714779336E-007
EulAngT         theta(1)                theta(2)                theta(3)                [rad]
Mean      +2.2900492942350549E-004 -1.9650151881939492E-003 -1.1434656625542005E-003
sSigmaT   +1.2020177391628091E-004 +1.3455537503349215E-007 +1.6295829969484254E-007
SigmaT    +1.0638081890563346E-004 +1.1908402445197795E-007 +1.4422114419942798E-007
-----------------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------------
OFFSET          NF          Delta_CW          Delta_CV
  5             104           -2.000            +0.000     pixels
OFFSET FRAME NAME: MIPS_24um_large_FOV2
qT              qT(1)                   qT(2)                   qT(3)                   qT(4)
WAS(FTB)  -5.4520033785992621E-007 -9.5382213577026277E-004 -5.7159503889057917E-004 +9.9999938175088265E-001
IS (EST)  +1.1395751409839679E-004 -9.5265425755005414E-004 -5.7188942331671069E-004 +9.9999937620282442E-001

DelTheta        deltheta(1)             deltheta(2)             deltheta(3)
Units             rad                     rad                     rad
          +2.2900339010186059E-004 +2.4667355106936733E-006 -8.0692156445085662E-007
EulAngT         theta(1)                theta(2)                theta(3)                [rad]
Mean      +2.2900492942350546E-004 -1.9051781369184878E-003 -1.1439975830851801E-003
sSigmaT   +1.2020177455823347E-004 +1.3361566677809400E-007 +1.6210965737467037E-007
SigmaT    +1.0638081947377349E-004 +1.1825236506389551E-007 +1.4347007986787517E-007
-----------------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------------
OFFSET          NF          Delta_CW          Delta_CV
  6               1           +64.000           +64.000     pixels
OFFSET FRAME NAME: CORNER PIXEL (DIAGNOSTICS)
qT              qT(1)                   qT(2)                   qT(3)                   qT(4)
WAS(FTB)  +0.0000000000000000E+000 +0.0000000000000000E+000 +0.0000000000000000E+000 +1.0000000000000000E+000
IS (EST)  +1.1433085205019629E-004 -1.3976676860074748E-003 -1.2254528958867284E-004 +9.9999900921758289E-001
```

```
DelTheta        deltheta(1)               deltheta(2)               deltheta(3)
Units             rad                       rad                       rad
          +2.2900492942350546E-004 -2.7953082213353388E-003 -2.4541089067293178E-004
EulAngT         theta(1)                  theta(2)                  theta(3)                  [rad]
Mean      +2.2900492942350546E-004 -2.7953082213353392E-003 -2.4541089067293178E-004
sSigmaT   +1.2020167151894109E-004 +3.3563743564249510E-007 +3.4204197056021675E-007
SigmaT    +1.0638072828207185E-004 +2.9704541036061454E-007 +3.0271354359242096E-007
-----------------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  7               1           +64.000           -64.000     pixels
OFFSET FRAME NAME: CORNER PIXEL (DIAGNOSTICS)
qT              qT(1)                     qT(2)                     qT(3)                     qT(4)
WAS(FTB)  +0.0000000000000000E+000 +0.0000000000000000E+000 +0.0000000000000000E+000 +1.0000000000000000E+000
IS (EST)  +1.1309917315018485E-004 -1.3881899801887038E-003 -1.0106806760139554E-003 +9.9999851932976724E-001

DelTheta        deltheta(1)               deltheta(2)               deltheta(3)
Units             rad                       rad                       rad
          +2.2900492942350552E-004 -2.7761508011471636E-003 -2.0216815330569944E-003
EulAngT         theta(1)                  theta(2)                  theta(3)                  [rad]
Mean      +2.2900492942350549E-004 -2.7761508011471640E-003 -2.0216815330569944E-003
sSigmaT   +1.2020167699693808E-004 +2.9660861562143087E-007 +3.1795631513357021E-007
SigmaT    +1.0638073313020168E-004 +2.6250417440803073E-007 +2.8139728789431329E-007
-----------------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  8               1           -64.000           +64.000     pixels
OFFSET FRAME NAME: CORNER PIXEL (DIAGNOSTICS)
qT              qT(1)                     qT(2)                     qT(3)                     qT(4)
WAS(FTB)  +0.0000000000000000E+000 +0.0000000000000000E+000 +0.0000000000000000E+000 +1.0000000000000000E+000
IS (EST)  +1.1443064497270712E-004 -5.4536397062584444E-004 -1.3159906402018017E-004 +9.9999983608271337E-001

DelTheta        deltheta(1)               deltheta(2)               deltheta(3)
Units             rad                       rad                       rad
          +2.2900492942350549E-004 -1.0906978607839607E-003 -2.6332305726994919E-004
EulAngT         theta(1)                  theta(2)                  theta(3)                  [rad]
Mean      +2.2900492942350549E-004 -1.0906978607839605E-003 -2.6332305726994919E-004
sSigmaT   +1.2020169334306356E-004 +3.1546036452088634E-007 +3.3231047021058822E-007
SigmaT    +1.0638074759682857E-004 +2.7918832490255030E-007 +2.9410098370545143E-007
-----------------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  9               1           -64.000           -64.000     pixels
OFFSET FRAME NAME: CORNER PIXEL (DIAGNOSTICS)
qT              qT(1)                     qT(2)                     qT(3)                     qT(4)
WAS(FTB)  +0.0000000000000000E+000 +0.0000000000000000E+000 +0.0000000000000000E+000 +1.0000000000000000E+000
IS (EST)  +1.1395486938646581E-004 -5.3848630943881942E-004 -1.0169323237155831E-003 +9.9999933144749220E-001

DelTheta        deltheta(1)               deltheta(2)               deltheta(3)
Units             rad                       rad                       rad
          +2.2900492942350549E-004 -1.0767403381413308E-003 -2.0339885955034790E-003
EulAngT         theta(1)                  theta(2)                  theta(3)                  [rad]
Mean      +2.2900492942350549E-004 -1.0767403381413308E-003 -2.0339885955034795E-003
sSigmaT   +1.2020169215178770E-004 +3.1601951091973311E-007 +3.2830194884676536E-007
SigmaT    +1.0638074654252715E-004 +2.7968317992722639E-007 +2.9055336729854878E-007
-----------------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------------
              q(1)                      q(2)                      q(3)                      q(4)
PCRS1A: +5.2603126189317361E-007 +3.7451819048221893E-004 -1.4045531552277380E-003 +9.9999894348258311E-001
PCRS2A: -5.1968404336718985E-007 +3.8455385122900486E-004 +1.3513933841514693E-003 +9.9999901292650617E-001
-------------------------------------------------------------------------------------
**********  CS-FILE PARAMETERS:  **********  **********  AS-FILE PARAMETERS:  **********
Row (01) PIX2RADX: +1.2087416876100000E-005  Row (1) TASTART:   +7.3051200000000000E+008
Row (02) PIX2RADY: +1.2595908372599999E-005  Row (2) TASTOP:    +7.3052690000000000E+008
Row (03) CX0:      +6.4500000000000000E+001  Row (3) S/C TIME:  +7.3051200000000000E+008
Row (04) CY0:      +6.4500000000000000E+001  Row (4) QR1:       +0.0000000000000000E+000
Row (05) BETA0:    +2.8047410000000001E-006  Row (5) QR2:       +0.0000000000000000E+000
Row (06) GAMMA_E0: +2.0070000000000000E+003  Row (6) QR3:       +0.0000000000000000E+000
```

```
Row (07) D11:      -1.0000000000000000E+000  Row (7) QR4:       +1.0000000000000000E+000
Row (08) D12:      +0.0000000000000000E+000
Row (09) D21:      +0.0000000000000000E+000
Row (10) D22:      -1.0000000000000000E+000
Row (11) DG:       +1.0000000000000000E+000
-------------------------------------------------------------------------------------------
-------------------------------------------------------------
INITIAL STA-TO-PCRS ALIGNMENT (R) KNOWLEDGE (1-SIGMA)
    SIGMA(X)        SIGMA(Y)         SIGMA(Z)
1.41421656E+002  9.90383438E+000  1.13175056E+001  [arcsec]
-------------------------------------------------------------
PIX2RADX = 1.208741687610E-005[rad/pixel]
XPIXSIZE = 2.4932[arcsec]
PIX2RADY = 1.259590837260E-005[rad/pixel]
YPIXSIZE = 2.5981[arcsec]
CX0 = 64.5[pixel] = 160.81[arcsec]
CY0 = 64.5[pixel] = 167.58[arcsec]
-------------------------------------------------------------
NOMINAL BETA0 = 2.804741000000E-006[rad/encoder unit]
ENCODER UNIT SIZE = 0.58[arcsec]
GAMMA_E0 = 2007.00[encoder unit] = 1161.09[arcsec]
-------------------------------------------------------------
                | -1 | +0 |
FLIP MATRIX D = |----|----|   and   DG = +1
                | +0 | -1 |
-------------------------------------------------------------
```

2.3 IPF MULTI-RUN EXECUTION LOG

```
************************************************
*****          MULTI_RUN LOG FILE           *****
************************************************

-----------------------------------------------
MULTI-RUN-LOG FILE NAME:  LG91M095.dat
INSTRUMENT TYPE:              MIPS_24um_center
MULTI-RUN EXECUTION DATE: 06-Aug-2003    TIME: 12:11
-----------------------------------------------


-------------------------------------------------------
MT991095 FILE LOADED!
q_T    = +1.4510453874923350E-004 -9.6599336627449701E-004 -5.7177904348510019E-004 +9.9999935943490215E-001
SigmaT = +1.4973533883221575E-004 +1.6881829681581167E-007 +2.0499032761154080E-007
Sigma Scale = +1.1250284233226688E+000

-------------------------------------------------------
MT992095 FILE LOADED!
q_T    = +6.7261867600461016E-005 -9.6588902719713511E-004 -5.7177464878591198E-004 +9.9999936780378973E-001
SigmaT = +1.5281663096158353E-004 +1.6818068219964485E-007 +2.0337582301989784E-007
Sigma Scale = +1.1347910194609547E+000

-------------------------------------------------------

----------------------------------------------------------------
Conditioning Number for LSQ Filter was:  +2.5008059237304192E+010
----------------------------------------------------------------

Merged q_T    = +1.1395002055851884E-004 -9.6595056985035812E-004 -5.7177049262253053E-004 +9.9999936351649388E-001
Merged SigmaT = +1.0638081926830968E-004 +1.1865127115087093E-007 +1.4384055970925852E-007
```

```
Merged Sigma Scale = +1.1299196147653978E+000

*********** Sigma T Ratios for Multi-Run ************
DATA#1 Expected:     1.41421 1.41421 1.41421
DATA#1 Calculated:   1.40754 1.42281 1.42512
----------------------------------------------------
DATA#2 Expected:     1.41421 1.41421 1.41421
DATA#2 Calculated:   1.43651 1.41744 1.41390
----------------------------------------------------


Merging LG Files!


*********************************************************************
IPF EXECUTION-LOG FILE NAME:  LG991095.dat
INSTRUMENT TYPE:              MIPS_24um_center
IPF FILTER EXECUTION DATE:    05-Aug-2003    TIME: 21:38
IPF FILTER VERSION USED:      IPF.V2.0.1Beta
*********************************************************************

------------------- Loading & Preparing Input Files -------------------
AAFILE:  AA991095 Loaded!        AAFILE dimension = 149001 X 21
ASFILE:  AS991095 Loaded!
CAFILE:  CA991095 Loaded!        CAFILE dimension = 432 X 15
CBFILE:  CB991095 Loaded!        CBFILE dimension = 42 X 15
CCFILE:  CC991095 Created!       CCFILE dimension = 474 X 19
CSFILE:  CS991095 Loaded!
Loading Input Files Completed!
---------------------------------------------------------------------

------------------------ Selected Mask Vectors ------------------------
index =   1  2  3  4  5  6  7  8  9 10 11 12 13 14 15 16 17 18 19 20
---------------------------------------------------------------------
mask1 = [ 1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1 ]
mask2 = [ 1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1 ]
---------------------------------------------------------------------

---------------  Selected Initial Gyro Bias Parameters  ---------------
IPF>> RNFILE FLAG SET TO USE PREVIOUS AG & AC FILE!
AGFILE USED: AG991095     ACFILE USED: AC991095
IPF Linearized Using Following Nominal Gyro Bias Estimates
bg0 = [+2.4582663655968712E-006 +2.4793742961420354E-006 +2.4976176758578363E-006 ]
cg0 = [+0.0000000000000000E+000 +0.0000000000000000E+000 +0.0000000000000000E+000 ]
---------------------------------------------------------------------

IPF>> GYRO PREPROCESSOR BYPASSED!
IPF>> LOADING PREVIOUS AG & AC FILE!

FRAME TABLE ENTRIES FOR PCRS LOADED TO TPCRS
q_PCRS4 = [ +5.2603126189317361E-007     q_PCRS5 = [ +7.3379987833742897E-007
            +3.7451819048221893E-004                 +5.2236196154513707E-004
            -1.4045531552277380E-003                 -1.4047712280184723E-003
            +9.9999894348258311E-001 ];              +9.9999887687698918E-001 ];
q_PCRS8 = [ -5.1968404336718985E-007     q_PCRS9 = [ -7.1963421681856818E-007
            +3.8455385122900486E-004                 +5.3239763239987400E-004
            +1.3513933841514693E-003                 +1.3516841804518383E-003
            +9.9999901292650617E-001 ];              +9.9999894475050310E-001 ];
-------------------------------------------------------------------------------
------ Initial Conditions for State -----  ------   Inital Square-Root Cov (diag)   -----
p1(01)  = a00  = +0.0000000000000000E+000  Sigma_initial(01,01) = 1.0000000000000000E+000
p1(02)  = b00  = +0.0000000000000000E+000  Sigma_initial(02,02) = 1.0000000000000000E+000
p1(03)  = c00  = +0.0000000000000000E+000  Sigma_initial(03,03) = 1.0000000000000000E+000
p1(04)  = a10  = +0.0000000000000000E+000  Sigma_initial(04,04) = 3.6384517097704270E+002
p1(05)  = b10  = +0.0000000000000000E+000  Sigma_initial(05,05) = 3.6384517097704270E+002
p1(06)  = c10  = +0.0000000000000000E+000  Sigma_initial(06,06) = 3.6384517097704270E+002
p1(07)  = d10  = +0.0000000000000000E+000  Sigma_initial(07,07) = 3.6384517097704270E+002
p1(08)  = a20  = +0.0000000000000000E+000  Sigma_initial(08,08) = 1.3238330844331343E+007
```

```
p1(09)  = b20  = +0.0000000000000000E+000  Sigma_initial(09,09) = 1.3238330844331343E+007
p1(10)  = c20  = +0.0000000000000000E+000  Sigma_initial(10,10) = 1.3238330844331343E+007
p1(11)  = d20  = +0.0000000000000000E+000  Sigma_initial(11,11) = 1.3238330844331343E+007
p1(12)  = a01  = +0.0000000000000000E+000  Sigma_initial(12,12) = 1.0000000000000000E+004
p1(13)  = b01  = +0.0000000000000000E+000  Sigma_initial(13,13) = 1.0000000000000000E+004
p1(14)  = c01  = +0.0000000000000000E+000  Sigma_initial(14,14) = 1.0000000000000000E+004
p1(15)  = d01  = +0.0000000000000000E+000  Sigma_initial(15,15) = 1.0000000000000000E+004
p1(16)  = e01  = +0.0000000000000000E+000  Sigma_initial(16,16) = 1.0000000000000000E+004
p1(17)  = f01  = +0.0000000000000000E+000  Sigma_initial(17,17) = 1.0000000000000000E+004
-------------------------------------------------------------------------------------
p2f(01) = am1  = +0.0000000000000000E+000
p2f(02) = am2  = +0.0000000000000000E+000  Sigma_initial(18,18) = 1.0000000000000001E-001
p2f(03) = am3  = +1.0000000000000000E+000
p2f(04) = beta = +1.0000000000000000E+000  Sigma_initial(19,19) = 1.0000000000000001E-001
p2f(05) = qT1  = -5.5224103706934371E-007  Sigma_initial(20,20) = 1.0000000000000001E-001
p2f(06) = qT2  = -9.6589398881636961E-004  Sigma_initial(21,21) = 1.0000000000000000E-002
p2f(07) = aT3  = -5.7174047628006817E-004  Sigma_initial(22,22) = 1.0000000000000000E-002
p2f(08) = qT4  = +9.9999937008046424E-001
p2f(09) = qR1  = +0.0000000000000000E+000  Sigma_initial(23,23) = 3.4288868839039716E-003
p2f(10) = qR2  = +0.0000000000000000E+000  Sigma_initial(24,24) = 1.8555467699985827E-004
p2f(11) = qR3  = +0.0000000000000000E+000  Sigma_initial(25,25) = 1.8555467699985827E-004
p2f(12) = qR4  = +1.0000000000000000E+000
p2f(13) = brx  = +0.0000000000000000E+000  Sigma_initial(26,26) = 6.7114093959731537E-005
p2f(14) = bry  = +0.0000000000000000E+000  Sigma_initial(27,27) = 6.7114093959731537E-005
p2f(15) = brz  = +0.0000000000000000E+000  Sigma_initial(28,28) = 6.7114093959731537E-005
p2f(16) = crx  = +0.0000000000000000E+000  Sigma_initial(29,29) = 4.5043016080356737E-009
p2f(17) = cry  = +0.0000000000000000E+000  Sigma_initial(30,30) = 4.5043016080356737E-009
p2f(18) = crz  = +0.0000000000000000E+000  Sigma_initial(31,31) = 4.5043016080356737E-009
p2f(19) = bgx  = +0.0000000000000000E+000  Sigma_initial(32,32) = 6.7114093959731537E-005
p2f(20) = bgy  = +0.0000000000000000E+000  Sigma_initial(33,33) = 6.7114093959731537E-005
p2f(21) = bgz  = +0.0000000000000000E+000  Sigma_initial(34,34) = 6.7114093959731537E-005
p2f(22) = cgx  = +0.0000000000000000E+000  Sigma_initial(35,35) = 4.5043016080356737E-009
p2f(23) = cgy  = +0.0000000000000000E+000  Sigma_initial(36,36) = 4.5043016080356737E-009
p2f(24) = cgz  = +0.0000000000000000E+000  Sigma_initial(37,37) = 4.5043016080356737E-009
-------------------------------------------------------------------------------------

--------------------   IPF KALMAN FILTER STARTED  ---------------------
Iteration#001: |dp|= +3.136219263208E+003   RMS(|Res|)=+3.136219263208E+003
Iteration#002: |dp|= +1.379890498077E+001   RMS(|Res|)=+1.379890498077E+001
Iteration#003: |dp|= +9.830901580851E-002   RMS(|Res|)=+9.830901580851E-002
Iteration#004: |dp|= +8.172273105503E-001   RMS(|Res|)=+8.172273105503E-001
Iteration#005: |dp|= +6.964494745514E-002   RMS(|Res|)=+6.964494745514E-002
Iteration#006: |dp|= +2.750847999648E-003   RMS(|Res|)=+2.750847999648E-003
Iteration#007: |dp|= +3.914500766379E-005   RMS(|Res|)=+3.914500766379E-005
Iteration#008: |dp|= +1.728921133155E-006   RMS(|Res|)=+1.728921133155E-006
Iteration#009: |dp|= +2.366387844766E-006   RMS(|Res|)=+2.366387844766E-006
Iteration#010: |dp|= +4.424385829053E-007   RMS(|Res|)=+4.424385829053E-007
Iteration#011: |dp|= +3.897003643676E-007   RMS(|Res|)=+3.897003643676E-007
Iteration#012: |dp|= +8.127892945278E-007   RMS(|Res|)=+8.127892945278E-007
Iteration#013: |dp|= +1.584513669626E-006   RMS(|Res|)=+1.584513669626E-006
Iteration#014: |dp|= +2.119071531128E-006   RMS(|Res|)=+2.119071531128E-006
Iteration#015: |dp|= +2.367526536459E-006   RMS(|Res|)=+2.367526536459E-006
Iteration#016: |dp|= +8.719548153950E-007   RMS(|Res|)=+8.719548153950E-007
Iteration#017: |dp|= +1.231693233202E-007   RMS(|Res|)=+1.231693233202E-007
Iteration#018: |dp|= +9.147149207192E-007   RMS(|Res|)=+9.147149207192E-007
Iteration#019: |dp|= +5.535627389322E-007   RMS(|Res|)=+5.535627389322E-007
Iteration#020: |dp|= +2.742907176399E-007   RMS(|Res|)=+2.742907176399E-007
Iteration#021: |dp|= +3.054115708920E-007   RMS(|Res|)=+3.054115708920E-007
Iteration#022: |dp|= +3.245014548972E-007   RMS(|Res|)=+3.245014548972E-007
Iteration#023: |dp|= +1.869249742040E-006   RMS(|Res|)=+1.869249742040E-006
Iteration#024: |dp|= +2.203383761894E-006   RMS(|Res|)=+2.203383761894E-006
Iteration#025: |dp|= +1.813571801694E-006   RMS(|Res|)=+1.813571801694E-006
IPF Kalman Filter Completed with Error |dp1| + |dp2| = +1.8135718016940001E-006
-----------------------------------------------------------------------

-----------------  IPF LEAST SQUARES FILTER STARTED  ------------------
Iteration#001   COND#=+1.571988770362E+012,   |dp|=+3.135179836901E+003
Iteration#002   COND#=+1.571989273295E+012,   |dp|=+1.598694123393E+001
```

```
Iteration#003   COND#=+1.571989272655E+012,   |dp|=+2.287588387184E-002
Iteration#004   COND#=+1.571989277419E+012,   |dp|=+2.116182767216E-003
Iteration#005   COND#=+1.571989279165E+012,   |dp|=+7.927992189079E-005
Iteration#006   COND#=+1.571989280408E+012,   |dp|=+1.450568192233E-006
Iteration#007   COND#=+1.571989277798E+012,   |dp|=+4.795100932354E-008
Iteration#008   COND#=+1.571989273445E+012,   |dp|=+1.134975818328E-007
Iteration#009   COND#=+1.571989269168E+012,   |dp|=+6.629818756727E-008
Iteration#010   COND#=+1.571989274939E+012,   |dp|=+9.155340425099E-008
Iteration#011   COND#=+1.571989280075E+012,   |dp|=+1.025535672956E-007
Iteration#012   COND#=+1.571989270783E+012,   |dp|=+1.393199233679E-007
Iteration#013   COND#=+1.571989278079E+012,   |dp|=+1.538824474536E-008
Iteration#014   COND#=+1.571989276816E+012,   |dp|=+6.875998764586E-008
Iteration#015   COND#=+1.571989272449E+012,   |dp|=+3.929231977738E-008
Iteration#016   COND#=+1.571989276204E+012,   |dp|=+8.871462548943E-008
Iteration#017   COND#=+1.571989274690E+012,   |dp|=+7.875629633004E-008
Iteration#018   COND#=+1.571989274914E+012,   |dp|=+3.527463973771E-008
Iteration#019   COND#=+1.571989275874E+012,   |dp|=+4.807581430322E-008
Iteration#020   COND#=+1.571989280842E+012,   |dp|=+7.313823132831E-008
Iteration#021   COND#=+1.571989269595E+012,   |dp|=+9.592392240910E-008
Iteration#022   COND#=+1.571989276512E+012,   |dp|=+1.235954492925E-007
Iteration#023   COND#=+1.571989277018E+012,   |dp|=+2.551876437337E-008
Iteration#024   COND#=+1.571989273122E+012,   |dp|=+4.580802225882E-008
Iteration#025   COND#=+1.571989278072E+012,   |dp|=+9.542420247573E-008
IPF Least Squares Filter Completed with Error |dp1| + |dp2| = +9.5424202475733262E-008
-----------------------------------------------------------------------
Total Execution Time: 275 seconds




***********************************************************************
IPF EXECUTION-LOG FILE NAME:  LG992095.dat
INSTRUMENT TYPE:              MIPS_24um_center
IPF FILTER EXECUTION DATE:    05-Aug-2003    TIME: 21:45
IPF FILTER VERSION USED:      IPF.V2.0.1Beta
***********************************************************************

------------------- Loading & Preparing Input Files -------------------
AAFILE:  AA992095 Loaded!        AAFILE dimension = 149001 X 21
ASFILE:  AS992095 Loaded!
CAFILE:  CA992095 Loaded!        CAFILE dimension = 432 X 15
CBFILE:  CB992095 Loaded!        CBFILE dimension = 42 X 15
CCFILE:  CC992095 Created!       CCFILE dimension = 474 X 19
CSFILE:  CS992095 Loaded!
Loading Input Files Completed!
-----------------------------------------------------------------------

------------------------- Selected Mask Vectors -------------------------
index =   1  2  3  4  5  6  7  8  9 10 11 12 13 14 15 16 17 18 19 20
-----------------------------------------------------------------------
mask1 = [ 1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1 ]
mask2 = [ 1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1 ]
-----------------------------------------------------------------------

---------------  Selected Initial Gyro Bias Parameters  ---------------
IPF>> RNFILE FLAG SET TO USE PREVIOUS AG & AC FILE!
AGFILE USED: AG992095     ACFILE USED: AC992095
IPF Linearized Using Following Nominal Gyro Bias Estimates
bg0 = [+1.4373545441551276E-006 +1.8774821168585316E-007 +2.3743402797237056E-007 ]
cg0 = [+0.0000000000000000E+000 +0.0000000000000000E+000 +0.0000000000000000E+000 ]
-----------------------------------------------------------------------

IPF>> GYRO PREPROCESSOR BYPASSED!
IPF>> LOADING PREVIOUS AG & AC FILE!

FRAME TABLE ENTRIES FOR PCRS LOADED TO TPCRS
q_PCRS4 = [ +5.2603126189317361E-007     q_PCRS5 = [ +7.3379987833742897E-007
            +3.7451819048221893E-004                 +5.2236196154513707E-004
```

```
            -1.4045531552277380E-003                 -1.4047712280184723E-003
            +9.9999894348258311E-001 ];              +9.9999887687698918E-001 ];
q_PCRS8 = [ -5.1968404336718985E-007     q_PCRS9 = [ -7.1963421681856818E-007
            +3.8455385122900486E-004                 +5.3239763239987400E-004
            +1.3513933841514693E-003                 +1.3516841804518383E-003
            +9.9999901292650617E-001 ];              +9.9999894475050310E-001 ];
-------------------------------------------------------------------------------
------ Initial Conditions for State -----  ------   Inital Square-Root Cov (diag)   -----
p1(01)  = a00  = +0.0000000000000000E+000  Sigma_initial(01,01) = 1.0000000000000000E+000
p1(02)  = b00  = +0.0000000000000000E+000  Sigma_initial(02,02) = 1.0000000000000000E+000
p1(03)  = c00  = +0.0000000000000000E+000  Sigma_initial(03,03) = 1.0000000000000000E+000
p1(04)  = a10  = +0.0000000000000000E+000  Sigma_initial(04,04) = 3.6384517097704270E+002
p1(05)  = b10  = +0.0000000000000000E+000  Sigma_initial(05,05) = 3.6384517097704270E+002
p1(06)  = c10  = +0.0000000000000000E+000  Sigma_initial(06,06) = 3.6384517097704270E+002
p1(07)  = d10  = +0.0000000000000000E+000  Sigma_initial(07,07) = 3.6384517097704270E+002
p1(08)  = a20  = +0.0000000000000000E+000  Sigma_initial(08,08) = 1.3238330844331343E+007
p1(09)  = b20  = +0.0000000000000000E+000  Sigma_initial(09,09) = 1.3238330844331343E+007
p1(10)  = c20  = +0.0000000000000000E+000  Sigma_initial(10,10) = 1.3238330844331343E+007
p1(11)  = d20  = +0.0000000000000000E+000  Sigma_initial(11,11) = 1.3238330844331343E+007
p1(12)  = a01  = +0.0000000000000000E+000  Sigma_initial(12,12) = 1.0000000000000000E+004
p1(13)  = b01  = +0.0000000000000000E+000  Sigma_initial(13,13) = 1.0000000000000000E+004
p1(14)  = c01  = +0.0000000000000000E+000  Sigma_initial(14,14) = 1.0000000000000000E+004
p1(15)  = d01  = +0.0000000000000000E+000  Sigma_initial(15,15) = 1.0000000000000000E+004
p1(16)  = e01  = +0.0000000000000000E+000  Sigma_initial(16,16) = 1.0000000000000000E+004
p1(17)  = f01  = +0.0000000000000000E+000  Sigma_initial(17,17) = 1.0000000000000000E+004
-------------------------------------------------------------------------------------------
p2f(01) = am1  = +0.0000000000000000E+000
p2f(02) = am2  = +0.0000000000000000E+000  Sigma_initial(18,18) = 1.0000000000000001E-001
p2f(03) = am3  = +1.0000000000000000E+000
p2f(04) = beta = +1.0000000000000000E+000  Sigma_initial(19,19) = 1.0000000000000001E-001
p2f(05) = qT1  = -5.5224103706934371E-007  Sigma_initial(20,20) = 1.0000000000000001E-001
p2f(06) = qT2  = -9.6589398881636961E-004  Sigma_initial(21,21) = 1.0000000000000000E-002
p2f(07) = aT3  = -5.7174047628006817E-004  Sigma_initial(22,22) = 1.0000000000000000E-002
p2f(08) = qT4  = +9.9999937008046424E-001
p2f(09) = qR1  = +0.0000000000000000E+000  Sigma_initial(23,23) = 3.4281576788666959E-002
p2f(10) = qR2  = +0.0000000000000000E+000  Sigma_initial(24,24) = 2.4007572013584836E-003
p2f(11) = qR3  = +0.0000000000000000E+000  Sigma_initial(25,25) = 2.7434407822204804E-003
p2f(12) = qR4  = +1.0000000000000000E+000
p2f(13) = brx  = +0.0000000000000000E+000  Sigma_initial(26,26) = 6.7114093959731537E-005
p2f(14) = bry  = +0.0000000000000000E+000  Sigma_initial(27,27) = 6.7114093959731537E-005
p2f(15) = brz  = +0.0000000000000000E+000  Sigma_initial(28,28) = 6.7114093959731537E-005
p2f(16) = crx  = +0.0000000000000000E+000  Sigma_initial(29,29) = 4.5043016080356737E-009
p2f(17) = cry  = +0.0000000000000000E+000  Sigma_initial(30,30) = 4.5043016080356737E-009
p2f(18) = crz  = +0.0000000000000000E+000  Sigma_initial(31,31) = 4.5043016080356737E-009
p2f(19) = bgx  = +0.0000000000000000E+000  Sigma_initial(32,32) = 6.7114093959731537E-005
p2f(20) = bgy  = +0.0000000000000000E+000  Sigma_initial(33,33) = 6.7114093959731537E-005
p2f(21) = bgz  = +0.0000000000000000E+000  Sigma_initial(34,34) = 6.7114093959731537E-005
p2f(22) = cgx  = +0.0000000000000000E+000  Sigma_initial(35,35) = 4.5043016080356737E-009
p2f(23) = cgy  = +0.0000000000000000E+000  Sigma_initial(36,36) = 4.5043016080356737E-009
p2f(24) = cgz  = +0.0000000000000000E+000  Sigma_initial(37,37) = 4.5043016080356737E-009
-------------------------------------------------------------------------------------------

--------------------   IPF KALMAN FILTER STARTED  ---------------------
Iteration#001: |dp|= +8.995620338807E+002   RMS(|Res|)=+8.995620338807E+002
Iteration#002: |dp|= +6.206741320894E+001   RMS(|Res|)=+6.206741320894E+001
Iteration#003: |dp|= +9.198999486148E-002   RMS(|Res|)=+9.198999486148E-002
Iteration#004: |dp|= +8.559577287929E-001   RMS(|Res|)=+8.559577287929E-001
Iteration#005: |dp|= +7.330465728150E-002   RMS(|Res|)=+7.330465728150E-002
Iteration#006: |dp|= +2.959038572417E-003   RMS(|Res|)=+2.959038572417E-003
Iteration#007: |dp|= +4.447902728312E-005   RMS(|Res|)=+4.447902728312E-005
Iteration#008: |dp|= +8.088665818209E-007   RMS(|Res|)=+8.088665818209E-007
Iteration#009: |dp|= +3.332218434641E-007   RMS(|Res|)=+3.332218434641E-007
Iteration#010: |dp|= +1.255350362538E-006   RMS(|Res|)=+1.255350362538E-006
Iteration#011: |dp|= +3.602891689822E-007   RMS(|Res|)=+3.602891689822E-007
Iteration#012: |dp|= +4.449169632109E-007   RMS(|Res|)=+4.449169632109E-007
Iteration#013: |dp|= +8.673440166915E-007   RMS(|Res|)=+8.673440166915E-007
Iteration#014: |dp|= +7.905291132501E-007   RMS(|Res|)=+7.905291132501E-007
Iteration#015: |dp|= +2.162578022016E-006   RMS(|Res|)=+2.162578022016E-006
```

```
Iteration#016: |dp|= +1.432400507425E-006   RMS(|Res|)=+1.432400507425E-006
Iteration#017: |dp|= +1.127249033003E-006   RMS(|Res|)=+1.127249033003E-006
Iteration#018: |dp|= +9.340496407877E-007   RMS(|Res|)=+9.340496407877E-007
Iteration#019: |dp|= +6.140073887679E-007   RMS(|Res|)=+6.140073887679E-007
Iteration#020: |dp|= +7.173512987442E-007   RMS(|Res|)=+7.173512987442E-007
IPF Kalman Filter Completed with Error |dp1| + |dp2| = +7.1735129874422374E-007
-----------------------------------------------------------------------

-----------------  IPF LEAST SQUARES FILTER STARTED  ------------------
Iteration#001   COND#=+1.583410296552E+012,   |dp|=+8.991584318763E+002
Iteration#002   COND#=+1.583396592726E+012,   |dp|=+5.982879368359E+001
Iteration#003   COND#=+1.583396583318E+012,   |dp|=+1.051969278209E-001
Iteration#004   COND#=+1.583396595619E+012,   |dp|=+1.010761544029E-003
Iteration#005   COND#=+1.583396585873E+012,   |dp|=+2.638693177388E-005
Iteration#006   COND#=+1.583396586931E+012,   |dp|=+5.078966708484E-007
Iteration#007   COND#=+1.583396579504E+012,   |dp|=+4.568369652983E-008
Iteration#008   COND#=+1.583396581767E+012,   |dp|=+1.242395858235E-007
Iteration#009   COND#=+1.583396591042E+012,   |dp|=+9.295086369855E-008
Iteration#010   COND#=+1.583396586318E+012,   |dp|=+4.720643432318E-008
Iteration#011   COND#=+1.583396591160E+012,   |dp|=+2.885988791128E-008
Iteration#012   COND#=+1.583396583738E+012,   |dp|=+1.751180286711E-008
Iteration#013   COND#=+1.583396579751E+012,   |dp|=+7.024603574500E-008
Iteration#014   COND#=+1.583396591879E+012,   |dp|=+1.213526518144E-007
Iteration#015   COND#=+1.583396574429E+012,   |dp|=+5.441543227604E-008
Iteration#016   COND#=+1.583396595929E+012,   |dp|=+6.485744501380E-008
Iteration#017   COND#=+1.583396577863E+012,   |dp|=+7.902682541105E-008
Iteration#018   COND#=+1.583396591847E+012,   |dp|=+5.895473036351E-008
Iteration#019   COND#=+1.583396578782E+012,   |dp|=+3.707788599400E-008
Iteration#020   COND#=+1.583396577973E+012,   |dp|=+6.675522964076E-008
IPF Least Squares Filter Completed with Error |dp1| + |dp2| = +6.6755229640760468E-008
-----------------------------------------------------------------------
Total Execution Time: 148 seconds
```

3 USER COMMENTS

This section left blank.

IPF TEAM CONTACT INFORMATION

IPF Team email		ipf@sirtfweb.jpl.nasa.gov	
David S. Bayard	X4-8208	David.S.Bayard@jpl.nasa.gov	(TEAM LEADER)
Dhemetrio Boussalis	X4-3977	boussali@grover.jpl.nasa.gov	
Paul Brugarolas	X4-9243	Paul.Brugarolas@jpl.nasa.gov	
Bryan H. Kang	X4-0541	Bryan.H.Kang@jpl.nasa.gov	
Edward.C.Wong	X4-3053	Edward.C.Wong@jpl.nasa.gov	(TASK MANAGER)

ACKNOWLEDGEMENTS

This work was performed at the Jet Propulsion Laboratory, California Institute of Technology, under contract with the National Aeronautics and Space Administration.

References

[1] D.S. Bayard, B.H. Kang, *SIRTF Instrument Pointing Frame Kalman Filter Algorithm*, JPL D-Document D-24809, September 30, 2003.

[2] B.H. Kang, D.S. Bayard, *SIRTF Instrument Pointing Frame (IPF) Software Description Document and User's Guide*, JPL D-Document D-24808, September 30, 2003.

[3] D.S. Bayard, B.H. Kang, *SIRTF Instrument Pointing Frame (IPF) Kalman Filter Unit Test Report*, JPL D-Document D-24810, September 30, 2003.

[4] *Space Infrared Telescope Facility In-Orbit Checkout and Science Verification Mission Plan*, JPL D-Document D-22622, 674-FE-301 Version 1.4, February 8, 2002.

[5] *Space Infrared Telescope Facility Observatory Description Document*, Lockheed Martin LMMS/P458569, 674-SEIT-300 Version 1.2, November 1, 2002.

[6] *SIRTF Software Interface Specification for Science Centroid INPUT Files (CAFILE, CS-FILE)*, JPL SOS-SIS-2002, November 18, 2002.

[7] *SIRTF Software Interface Specification for Inferred Frames Offset INPUT Files (OFILE)*, JPL SOS-SIS-2003, November 18, 2002.

[8] *SIRTF Software Interface Specification for PCRS Centroid INPUT Files (CBFILE)*, JPL SIS-FES-015, November 18, 2002.

[9] *SIRTF Software Interface Specification for Attitude INPUT Files (AFILE, ASFILE)*, JPL SIS-FES-014, January 7, 2002.

[10] *SIRTF Software Interface Specification for IPF Filter Output Files (IFFILE, LGFILE, TARFILE)*, JPL SOS-SIS-2005, November 18, 2002.

[11] R.J. Brown, *Focal Surface to Object Space Field of View Conversion.* Systems Engineering Report SER No. S20447-OPT-051, Ball Aerospace & Technologies Corp., November 23, 1999.

This page left blank.

SIRTF INSTRUMENT POINTING FRAME KALMAN FILTER EXECUTION SUMMARY

IPF RUN NUMBER: 991107
REPORT TYPE: COVARIANCE ANALYSIS

PRIME FRAME: MIPS_70um_center (107)
INFERRED FRAMES: (108) (111) (112) (115) (1) (1) (1) (1)

IPF TEAM

Autonomy and Control Section (345)
Jet Propulsion Laboratory
California Institute of Technology
4800 Oak Grove Drive
Pasadena, CA 91109

Contents

1 IPF EXECUTION SUMMARY **4**

2 FLUTE DATA SUMMARY **8**

2.1 FLUTE CONFIGURATION PARAMETERS 8

2.2 FLUTE GENERATED UNIT TEST DATA 11

3 IPF EXECUTION RESULTS **15**

3.1 IPF EXECUTION OUTPUT PLOTS 15

3.2 IPF OUTPUT DATA (IF MINI FILE) 29

3.3 IPF EXECUTION LOG 34

4 USER COMMENTS **37**

List of Figures

1.1 A-priori and a-posteriori IPF frames 4

1.2 A-priori and a-posteriori IPF frames (ZOOMED) 7

2.1 Focal plane survey scenario plot (See key in [3]) 11

2.2 Commanded-only source locations 12

2.3 True (+) and commanded (o) source locations 12

2.4 True (+) and commanded (o) source locations (ZOOMED) 13

2.5 True-sampled (o) and centroided (+) locations on S/I array (W,V) 13

2.6 True (o) and centroided (+) locations on S/I array (W,V) 14

2.7 True (o) and centroided (+) locations on S/I array (W,V) showing prime and inferred frames 14

3.1 TPF coords of measurements and a-priori predicts 16

3.2 Oriented Pixel Coords of measurements and a-priori predicts 16

3.3 A-priori prediction error 17

3.4 Oriented Pixel Coords of measurements and a-priori predicts (PCRS only) 17

3.5 IPF execution convergence, chart 1 18

3.6 IPF execution convergence, chart 2 18

3.7 Parameter uncertainty convergence 19

3.8 IPF parameter symbol table 19

3.9 KF parameter error sigma plots . . . 20
3.10 LS parameter error sigma plot . . . 20
3.11 KF and LS parameter error sigma plot . . . 21
3.12 Oriented Pixel Coords of meas. and a-posteriori predicts . . . 22
3.13 Oriented Pixel Coords of meas. and a-posteriori predicts (attitude corrected) . . . 22
3.14 Array plot with (solid) and w/o (dashed) optical distortion corrections . . . 23
3.15 KF innovations with (o) and w/o (+) attitude corrections . . . 23
3.16 W-axis KF innovations and 1-sigma bound . . . 24
3.17 V-axis KF innovations and 1-sigma bound . . . 24
3.18 Estimated attitude corrections (Body frame) . . . 25
3.19 Estimated attitude error sigma plot (Body frame) . . . 25
3.20 Thermo-mechanical boresight drift (equiv. angle in (W,V) coords) . . . 26
3.21 Thermo-mechanical boresight drift (equiv. angle in Body frame) . . . 26
3.22 Gyro drift bias contribution (equiv. rate in (W,V) coords) . . . 27
3.23 Gyro drift bias contribution (equiv. angle in (W,V) coords) . . . 27
3.24 Gyro drift bias contribution (equiv. angle in Body frame) . . . 28

List of Tables

1.1 IPF filter input files . . . 5
1.2 IPF filter execution configuration . . . 5
1.3 IPF filter execution mask vector assignment . . . 5
1.4 IPF calibration error summary ([arcsec], 1-sigma, radial) . . . 6
1.5 Measurement prediction error summary (1-sigma) . . . 6
1.6 IPF Brown angle summary . . . 7
2.1 FLUTE Parameter Table (1) . . . 8
2.2 FLUTE Parameter Table (2) . . . 9
2.3 FLUTE Parameter Table (3) . . . 10
2.4 Table of figures (FLUTE) . . . 11
3.1 Table of figures (IPF run) . . . 15

1 IPF EXECUTION SUMMARY

This report summarizes the SIRTF Instrument Pointing Frame (IPF) Kalman Filter execution associated with run file: RN991107. In particular, this Focal Point Survey calibrates the instrument: MIPS_70um_center (107), as part of the Covariance Analysis. The main calibration results from the IPF filter execution have been documented in IF991107 typically stored in the mission archive DOM collection IPF_IF. This report only summarizes the main aspects of the run, and does not substitute for the full information contained in the IF file.

Section 1 summarizes the filter execution results. The filter configurations are tabulated in Table 1.2 and the mask vector assignments are tabulated in Table 1.3. A total of 37 state parameters are estimated in this run. The overall End-to-End pointing performances are tabulated in Table 1.4. The prediction residuals throughout the estimation processes are tabulated in Table 1.6. Section 2 documents the FLUTE generated input file data. Section 3 summarizes resulting plots, a mini summary of the IF IPF output file, and the execution log. Section 4 captures the user comments that are specific to this particular run.

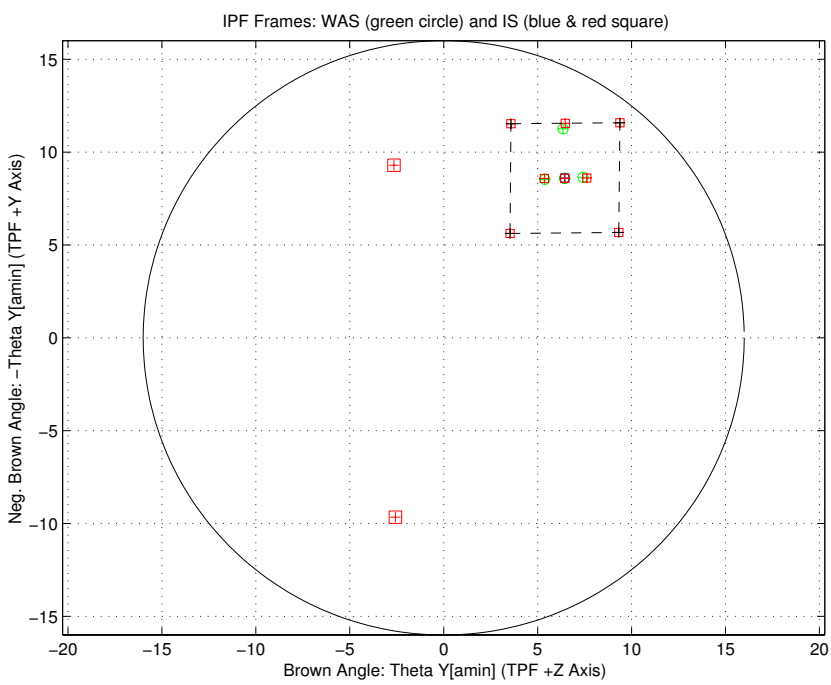

Figure 1.1: A-priori and a-posteriori IPF frames

RAW	FINAL (After Editing)
AA991107	AA991107
AS991107	AS991107
CA991107	CA991107
CB991107	CB991107
CS991107	CS991107

Table 1.1: IPF filter input files

EXECUTION CONFIGURATION ITEM	CURRENT STATUS
IPF Filter Version Used	IPF.V2.0.1Beta
Frame Table Version Used	FTVE2E1
Scan-Mirror Employed?	YES
IPF Filter Mode	NORMAL-MODE(0)
SLIT-MODE Operation	DISABLED
Kalman Filter Operation	ENABLED
Least-Squares Data Analysis	ENABLED
IBAD Screening	ENABLED
User-Specified Data Editing	DISABLED
Total Number of Iterations	20
LS Residual Sigma Scale	1.07363991E+000
Total Number of Maneuvers	14

Table 1.2: IPF filter execution configuration

Con. Plate Scale			Γ Dependent				Γ^2 Dependent				Linear Plate Scale						Mirror	
a_{00}	b_{00}	c_{00}	a_{10}	b_{10}	c_{10}	d_{10}	a_{20}	b_{20}	c_{20}	d_{20}	a_{01}	b_{01}	c_{01}	d_{01}	e_{01}	f_{01}	α	β
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
IPF (T)			Alignment R									Gyro Drift Bias						
θ_1	θ_2	θ_3	a_{rx}	a_{ry}	a_{rz}	b_{rx}	b_{ry}	b_{rz}	c_{rx}	c_{ry}	c_{rz}	b_{gx}	b_{gy}	b_{gz}	c_{gx}	c_{gy}	c_{gz}	
20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	

Table 1.3: IPF filter execution mask vector assignment

FOCAL PLANE SURVEY ANALYSIS: Covariance Analysis.
INSTRUMENT NAME: MIPS_70um_center NF: 107

```
PIX2RADW: 4.79044679E-005[rad/pixel] = 9.8810E+000[arcsec/pixel]
PIX2RADV: 4.79044679E-005[rad/pixel] = 9.8810E+000[arcsec/pixel]
```

FRAME	DESCRIPTION	IPF[1]	SF[2]	ARW[3]	TOTAL	REQ
107(P)	MIPS_70um_center	0.2741	0.0855	0.0708	0.2957	2.60
108(I)	MIPS_70um_minusY_edge	0.4370	0.0855	0.0708	0.4509	N/A
111(I)	MIPS_70um_default_small_FOV1	0.3241	0.0855	0.0708	0.3426	N/A
112(I)	MIPS_70um_default_small_FOV2	0.2266	0.0855	0.0708	0.2523	N/A
115(I)	MIPS_70um_default_large_FOV1	0.2741	0.0855	0.0708	0.2957	N/A
TR (C)	CORNERS OF INSTRUMENT	0.6322	0.0855	0.0708	0.6418	N/A
BR (C)	CORNERS OF INSTRUMENT	0.5906	0.0855	0.0708	0.6010	N/A
TL (C)	CORNERS OF INSTRUMENT	0.5123	0.0855	0.0708	0.5242	N/A
BL (C)	CORNERS OF INSTRUMENT	0.5148	0.0855	0.0708	0.5266	N/A

Table 1.4: IPF calibration error summary ([arcsec], 1-sigma, radial)

RMS METRIC	A PRIORI[4]	A POSTERIORI[4]	ATT. CORRECTED[5]	UNITS
Radial	12.4171	1.9197	1.4950	arcsec
Radial	1.2567	0.1943	0.1513	pixels
W-Axis	0.8909	0.1323	0.1053	pixels
V-Axis	0.8863	0.1423	0.1087	pixels

Table 1.5: Measurement prediction error summary (1-sigma)

[1]IPF filter removes systematic pointing errors due to: thermomechanical alignment drift (Body to TPF), gyro bias and bias drift, centroiding error, attitude error, and optical distortion. IPF SIGMA presented here is "NOT Scaled" by the Least Squares Scale factor. The Least Squares Scale Factor was: 1.073640.

[2]Error due to gyro Scale Factor: assumes 95 ppm error over 0.250 degree maneuver.

[3]Error due to gyro Angle Random Walk: assumes ARW = 100 $\mu deg/\sqrt{hr}$, with 975 second Maneuver time (max), and 14 independent Maneuvers.

[4]This can be interpreted as estimate of "pixel to sky" pointing reconstruction error if no science data is used.

[5]This can be interpreted as estimate of achieved S/I centroiding error

IPF BROWN ANGLE SUMMARY						
	WAS			IS		
Frame Number	theta_Y (arcmin)	theta_Z (arcmin)	angle (deg)	theta_Y (arcmin)	theta_Z (arcmin)	angle (deg)
107	+6.445000	-8.592000	+0.000000	+6.441205	-8.595346	-0.011234
108	+6.348000	-11.259000	-0.000000	+6.469974	-11.550016	-0.011234
111	+7.423000	-8.647000	-0.000000	+7.619206	-8.607530	-0.011234
112	+5.385000	-8.533000	+0.000000	+5.356957	-8.585905	-0.011234
115	+6.445000	-8.592000	+0.000000	+6.441205	-8.595346	-0.011234
001	+0.000000	+0.000000	+0.000000	+9.380011	-11.585965	-0.011234
001	+0.000000	+0.000000	+0.000000	+9.318369	-5.671111	-0.011234
001	+0.000000	+0.000000	+0.000000	+3.581361	-11.526390	-0.011234
001	+0.000000	+0.000000	+0.000000	+3.535646	-5.620737	-0.011234

Table 1.6: IPF Brown angle summary

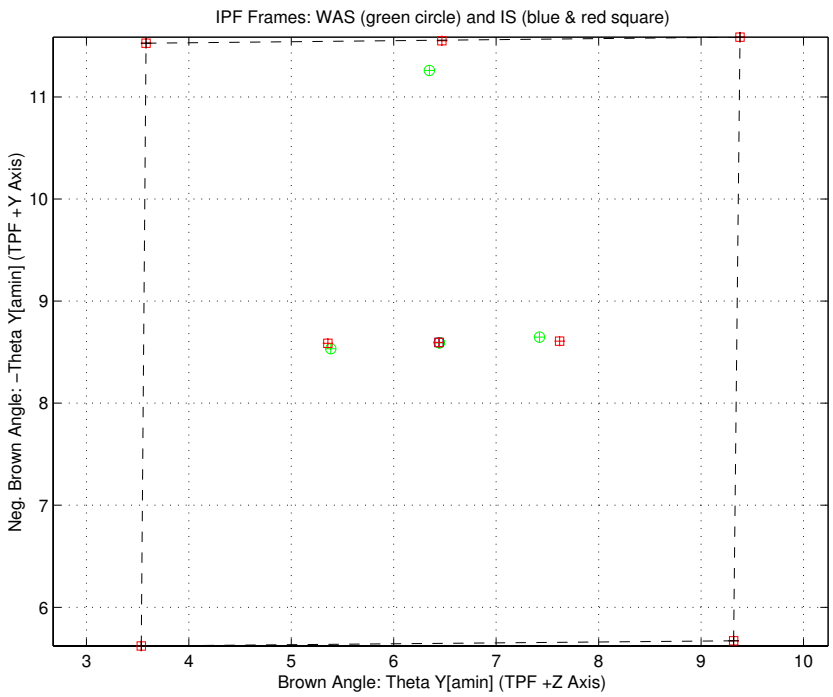

Figure 1.2: A-priori and a-posteriori IPF frames (ZOOMED)

2 FLUTE DATA SUMMARY

2.1 FLUTE CONFIGURATION PARAMETERS

The covariance analysis was performed using the FLUTE generated input data files. The internal configuration parameters, used to produce the data are tabulated in Table 2.1, Table 2.2 and Table 2.3.

NAME	DESCRIPTION	VALUE	UNIT
d2003	days into YEAR2003	+6.0000000000000000E+001	day
tstart	start time	+7.3051200000000000E+008	sec
tdel	data rate	+1.0000000000000001E-001	sec
tshelf	Inertial Hold duration pad	+5.0000000000000000E+000	sec
ipro	slew profile(1-linear, 2-S-curve)	1	int flag
sig_gcf [1]	gcf sigma(1)	+4.8481368110953601E-008	rad/sec
sig_gcf [2]	gcf sigma(2)	+9.6962736221907205E-009	rad/sec
sig_gcf [3]	gcf sigma(3)	+9.6962736221907205E-009	rad/sec
igcf	gcf bias correction flag	1	int flag
SigA [1][1]	Sigma A(1,1)	+9.4017722156391537E-009	rad^2
SigA [2][2]	Sigma A(2,2)	+2.3504430539097885E-011	rad^2
SigA [3][3]	Sigma A(3,3)	+2.3504430539097885E-011	rad^2
NFprime	Prime Frame NF	107	int
ftable [name]	Frame Table row number	107	int
ftable [q0]	Frametable quaternion q0	+1.1714108883076305E-006	N/A
ftable [q1]	Frametable quaternion q1	-9.3738638321546567E-004	N/A
ftable [q2]	Frametable quaternion q2	+1.2496548701431507E-003	N/A
ftable [q3]	Frametable quaternion q3	+9.9999877983330654E-001	N/A
ft_cmd [name]	Command row number	107	int
ft_cmd [q0]	Command quaternion q0	+1.1714108883076305E-006	N/A
ft_cmd [q1]	Command quaternion q1	-9.3738638321546567E-004	N/A
ft_cmd [q2]	Command quaternion q2	+1.2496548701431507E-003	N/A
ft_cmd [q3]	Command quaternion q3	+9.9999877983330654E-001	N/A
ft_true [name]	Truth row number	107	int
ft_true [q0]	Truth quaternion q0	+1.1714108883076305E-006	N/A
ft_true [q1]	Truth quaternion q1	-9.3738638321546567E-004	N/A
ft_true [q2]	Truth quaternion q2	+1.2496548701431507E-003	N/A
ft_true [q3]	Truth quaternion q3	+9.9999877983330654E-001	N/A
ft_prior [name]	Prior row number	107	int
ft_prior [q0]	FTprior quaternion q0	+1.1714108883076305E-006	N/A
ft_prior [q1]	FTprior quaternion q1	-9.3738638321546567E-004	N/A
ft_prior [q2]	FTprior quaternion q2	+1.2496548701431507E-003	N/A
ft_prior [q3]	FTprior quaternion q3	+9.9999877983330654E-001	N/A
ntable [NF]	ntable row number	107	int
ntable [iprime]	Prime frame indication flag	1	int
ntable [SIG_CX]	CX Sigma	+1.0000000000000001E-001	pixel
ntable [SIG_CY]	CY Sigma	+1.0000000000000001E-001	pixel
ntable [PIX2RADX]	Nom. angular pixelsize X-dir	+4.7904467948999998E-005	rad/pixel
ntable [PIX2RADY]	Nom. angular pixelsize Y-dir	+4.8792938470999998E-005	rad/pixel
ntable [CX0]	Center pixel along X-axis	+1.6500000000000000E+001	pixel
ntable [CY0]	Center pixel along Y-axis	+1.6500000000000000E+001	pixel
ntable [BETA0]	Nominal mirror scale factor	+2.8047410000000001E-006	rad/(e.u.)
ntable [GAMMA_E0]	Reference Mirror position	+2.0070000000000000E+003	(e.u.[6])

Table 2.1: FLUTE Parameter Table (1)

[6] encoder units

NAME	DESCRIPTION	VALUE	UNIT
ntable [D11]	x-to-w frame flip parameter	-1	int
ntable [D12]	y-to-w frame flip parameter	0	int
ntable [D21]	x-to-v frame flip parameter	0	int
ntable [D22]	y-to-v frame flip parameter	-1	int
ntable [DG]	Mirror flip parameter	1	int
ntable [sisizew]	Array size (w-direction)	+1.5126186850617522E-003	pixel
ntable [sisizev]	Array size (v-direction)	+1.5126186850617522E-003	pixel
ntable [p2i_w]	w-offset from prime	+0.0000000000000000E+000	pixel
ntable [p2i_v]	v-offset from prime	+0.0000000000000000E+000	pixel
p1true [a00]	True Constant Plate Scales	+1.0000000000000001E-001	N/A
p1true [b00]	True Constant Plate Scales	+1.0000000000000001E-001	N/A
p1true [c00]	True Constant Plate Scales	+1.0000000000000000E-002	N/A
p1true [a10]	True Γ Dependent Plate Scales	+1.0000000000000001E-001	1/rad
p1true [b10]	True Γ Dependent Plate Scales	+1.0000000000000001E-001	1/rad
p1true [c10]	True Γ Dependent Plate Scales	+1.0000000000000000E-002	1/rad
p1true [d10]	True Γ Dependent Plate Scales	+1.0000000000000000E-002	1/rad
p1true [a20]	True Γ^2 Dependent Plate Scales	+1.0000000000000001E-001	$1/\mathrm{rad}^2$
p1true [b20]	True Γ^2 Dependent Plate Scales	+1.0000000000000001E-001	$1/\mathrm{rad}^2$
p1true [c20]	True Γ^2 Dependent Plate Scales	+1.0000000000000000E-002	$1/\mathrm{rad}^2$
p1true [d20]	True Γ^2 Dependent Plate Scales	+1.0000000000000000E-002	$1/\mathrm{rad}^2$
p1true [a01]	True Linear Plate Scales	+2.0000000000000000E+000	N/A
p1true [b01]	True Linear Plate Scales	+2.0000000000000000E+000	N/A
p1true [c01]	True Linear Plate Scales	+2.0000000000000000E+000	N/A
p1true [d01]	True Linear Plate Scales	+2.0000000000000000E+000	N/A
p1true [e01]	True Linear Plate Scales	+2.0000000000000000E+000	N/A
p1true [f01]	True Linear Plate Scales	+2.0000000000000000E+000	N/A
p2true [am1]	True Scan mirror alignment Ux	+0.0000000000000000E+000	N/A
p2true [am2]	True Scan mirror alignment Uy	+2.0000000000000000E-002	N/A
p2true [am3]	True Scan mirror alignment Uz	+9.9979997999599901E-001	N/A
p2true [beta]	True Scan mirror scale factor	+1.1000000000000001E+000	N/A
p2true [qT1]	True IPF q1	+1.1714108883076305E-006	N/A
p2true [qT2]	True IPF q2	-9.3738638321546567E-004	N/A
p2true [qT3]	True IPF q3	+1.2496548701431507E-003	N/A
p2true [qT4]	True IPF q4	+9.9999877983330654E-001	N/A
p2true [qR01]	True Boresight Alignment q1	+2.4240684048319150E-005	N/A
p2true [qR02]	True Boresight Alignment q2	+1.2120342024159575E-006	N/A
p2true [qR03]	True Boresight Alignment q3	+1.2120342024159575E-006	N/A
p2true [qR04]	True Boresight Alignment q4	+9.9999999970472575E-001	N/A
p2true [brx]	True B. Alignment drift rate X	+5.6000000000000000E-011	rad/sec
p2true [bry]	True B. Alignment drift rate Y	+5.6000000000000000E-011	rad/sec
p2true [brz]	True B. Alignment drift rate Z	+5.6000000000000000E-011	rad/sec
p2true [crx]	True B. Alignment drift accel. X	+5.0000000000000002E-014	$\mathrm{rad/sec}^2$
p2true [cry]	True B. Alignment drift accel. Y	+5.0000000000000002E-014	$\mathrm{rad/sec}^2$
p2true [crz]	True B. Alignment drift accel. Z	+5.0000000000000002E-014	$\mathrm{rad/sec}^2$
p2true [bgx]	True Gyro bias correction X	+2.5000000000000002E-006	rad/sec
p2true [bgy]	True Gyro bias correction Y	+2.5000000000000002E-006	rad/sec
p2true [bgz]	True Gyro bias correction Z	+2.5000000000000002E-006	rad/sec
p2true [cgx]	True Gyro bias-rate correction X	+4.9999999999999999E-013	$\mathrm{rad/sec}^2$
p2true [cgy]	True Gyro bias-rate correction Y	+4.9999999999999999E-013	$\mathrm{rad/sec}^2$
p2true [cgz]	True Gyro bias-rate correction Z	+4.9999999999999999E-013	$\mathrm{rad/sec}^2$

Table 2.2: FLUTE Parameter Table (2)

NAME	DESCRIPTION	VALUE	UNIT
p2cmd [am1]	CMD Scan mirror alignment Ux	+0.0000000000000000E+000	N/A
p2cmd [am2]	CMD Scan mirror alignment Uy	+0.0000000000000000E+000	N/A
p2cmd [am3]	CMD Scan mirror alignment Uz	+1.0000000000000000E+000	N/A
p2cmd [beta]	CMD Scan mirror rotation SF	+1.0000000000000000E+000	N/A
p2cmd [qT1]	CMD IPF q1	+1.1714108883076305E-006	N/A
p2cmd [qT2]	CMD IPF q2	-9.3738638321546567E-004	N/A
p2cmd [qT3]	CMD IPF q3	+1.2496548701431507E-003	N/A
p2cmd [qT4]	CMD IPF q4	+9.9999877983330654E-001	N/A
p2cmd [qR01]	CMD Boresight Alignment q1	+0.0000000000000000E+000	N/A
p2cmd [qR02]	CMD Boresight Alignment q2	+0.0000000000000000E+000	N/A
p2cmd [qR03]	CMD Boresight Alignment q3	+0.0000000000000000E+000	N/A
p2cmd [qR04]	CMD Boresight Alignment q4	+1.0000000000000000E+000	N/A
p2cmd [brx]	CMD B. Alignment drift rate X	+0.0000000000000000E+000	rad/sec
p2cmd [bry]	CMD B. Alignment drift rate Y	+0.0000000000000000E+000	rad/sec
p2cmd [brz]	CMD B. Alignment drift rate Z	+0.0000000000000000E+000	rad/sec
p2cmd [crx]	CMD B. Alignment drift accel. X	+0.0000000000000000E+000	rad/sec^2
p2cmd [cry]	CMD B. Alignment drift accel. Y	+0.0000000000000000E+000	rad/sec^2
p2cmd [crz]	CMD B. Alignment drift accel. Z	+0.0000000000000000E+000	rad/sec^2
p2cmd [bgx]	CMD Gyro bias correction X	+0.0000000000000000E+000	rad/sec
p2cmd [bgy]	CMD Gyro bias correction Y	+0.0000000000000000E+000	rad/sec
p2cmd [bgz]	CMD Gyro bias correction Z	+0.0000000000000000E+000	rad/sec
p2cmd [cgx]	CMD Gyro bias-rate correction X	+0.0000000000000000E+000	rad/sec^2
p2cmd [cgy]	CMD Gyro bias-rate correction Y	+0.0000000000000000E+000	rad/sec^2
p2cmd [cgz]	CMD Gyro bias-rate correction Z	+0.0000000000000000E+000	rad/sec^2
a1	Semi-Major Axis of SIRTF (HCO [7])	+1.4960000000000000E+011	m
a2	Semi-Major Axis of Earth (HCO)	+1.4960000000000000E+011	m
e1	Eccentricity (SIRTF in HCO)	+1.6722000000000001E-002	N/A
e2	Eccentricity (Earth in HCO)	+1.6722000000000001E-002	N/A
inc1	inclination (SIRTF in HCO)	+4.0142572795869580E-001	rad
inc2	inclination (Earth in HCO)	+4.0142572795869580E-001	rad
Omega1	Ascending Node Long.(SIRTF in HCO)	+0.0000000000000000E+000	rad
Omega2	Ascending Node Long.(Earth in HCO)	+0.0000000000000000E+000	rad
omega1	Argument of Perigee(SIRTF in HCO)	+1.7627825445142729E+000	rad
omega2	Argument of Perigee(Earth in HCO)	+1.7627825445142729E+000	rad
nu0_1	True Anomaly of SIRTF(HCO)	+8.6071031605199810E-001	rad
nu0_2	True Anomaly of Earth(HCO)	+1.0328523792623976E+000	rad
inav	Velocity Report Flag	+0.0000000000000000E+000	rad
wsize	Array size W-dir	+1.5126186850617522E-003	rad
vsize	Array size V-dir	+1.5126186850617522E-003	rad

Table 2.3: FLUTE Parameter Table (3)

[7] Heliocentric Orbit

2.2 FLUTE GENERATED UNIT TEST DATA

This subsection plots the FLUTE generated IPF filter input files. Seven figures, as tabulated in Table 2.4, show the campaign maneuver senario, the true sampled locations on the array and the actual centroided data superimposed the array plane. All angles shown in FLUTE plots have units of radians.

FIGURE NO.	DESCRIPTION
Figure 2.1	Focal Plane Survey Scenario Plot
Figure 2.2	Commanded-only source locations in TPF
Figure 2.3	True and commanded source locations in TPF
Figure 2.4	True and commanded source locations (ZOOMED) in TPF
Figure 2.5	True-sampled and centroided locations in Focal Plane (W,V) including rectangular array boundary approximation
Figure 2.6	True and centroided locations on S/I Array (W,V) including rectangular array boundary approximation
Figure 2.7	True and centroided locations on S/I Array (W,V) showing Prime and Inferred Frames including rectangular array boundary approximation

Table 2.4: Table of figures (FLUTE)

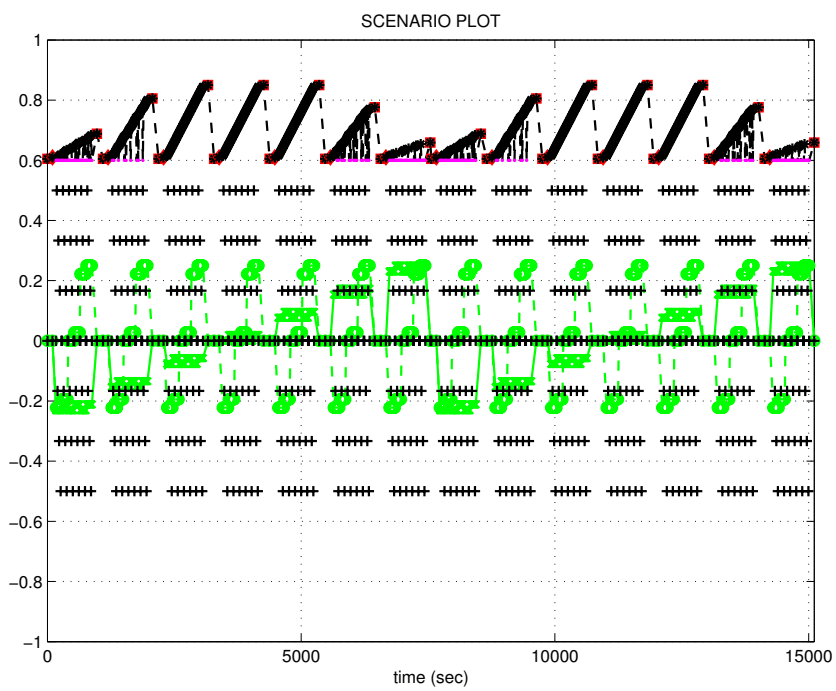

Figure 2.1: Focal plane survey scenario plot (See key in [3])

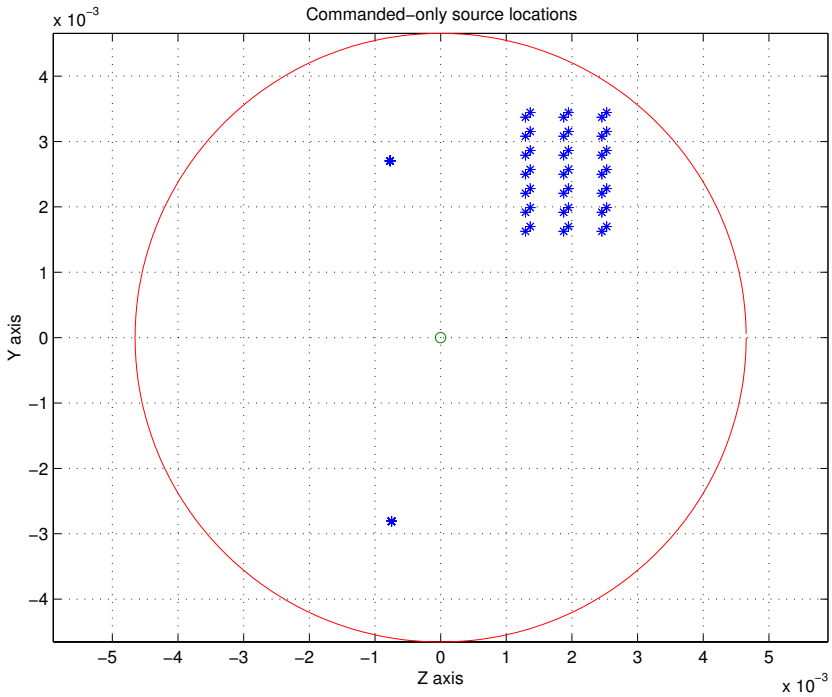

Figure 2.2: Commanded-only source locations

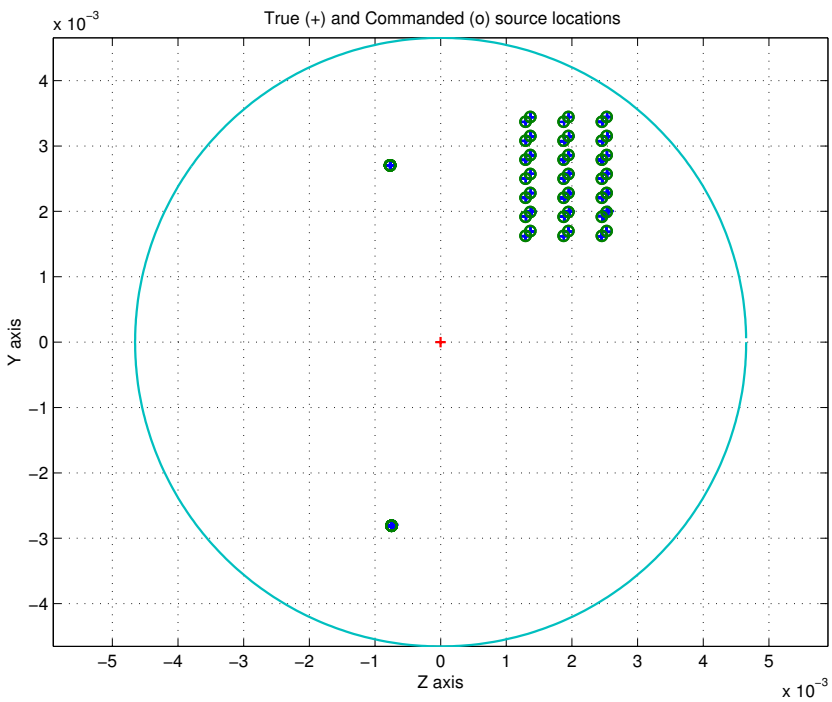

Figure 2.3: True (+) and commanded (o) source locations

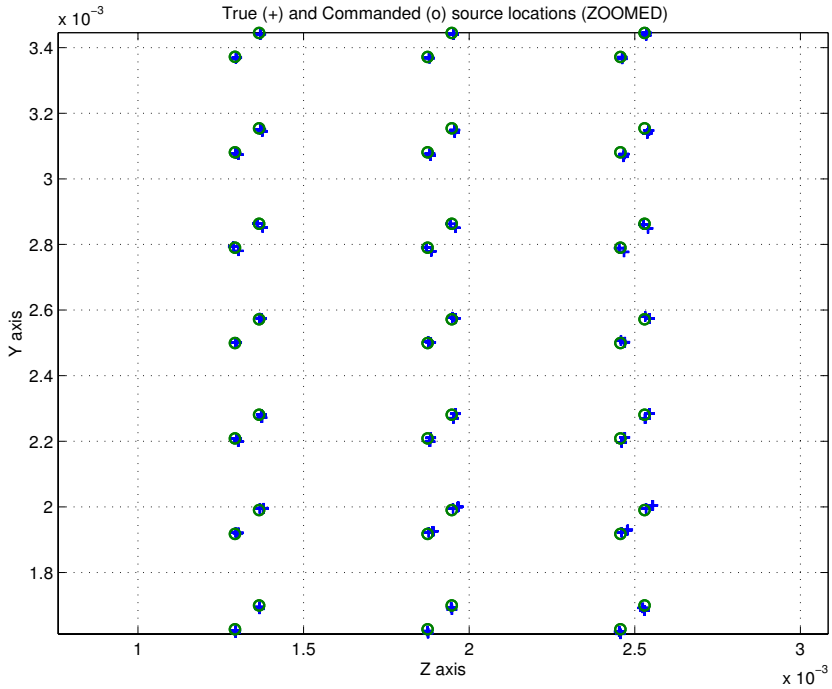

Figure 2.4: True (+) and commanded (o) source locations (ZOOMED)

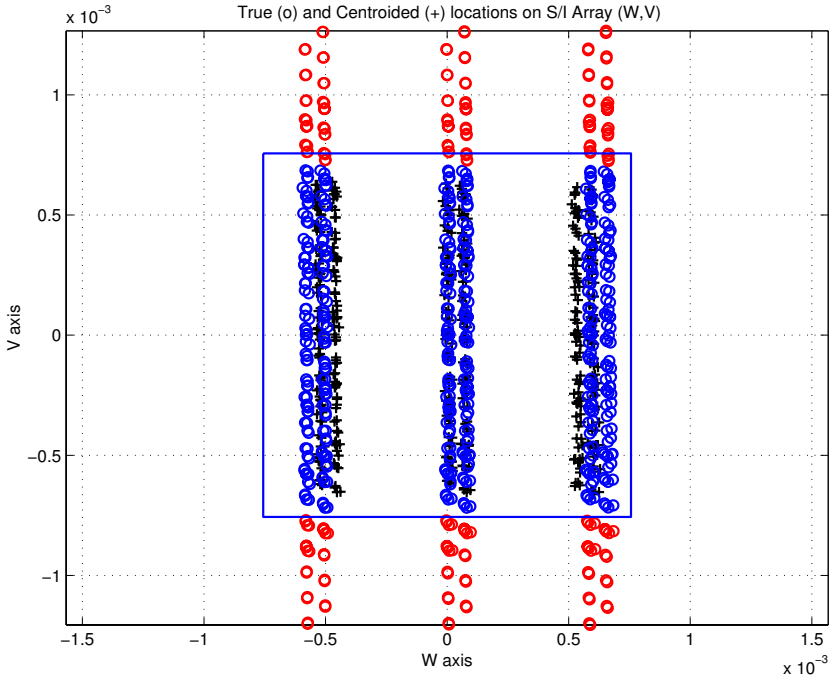

Figure 2.5: True-sampled (o) and centroided (+) locations on S/I array (W,V)

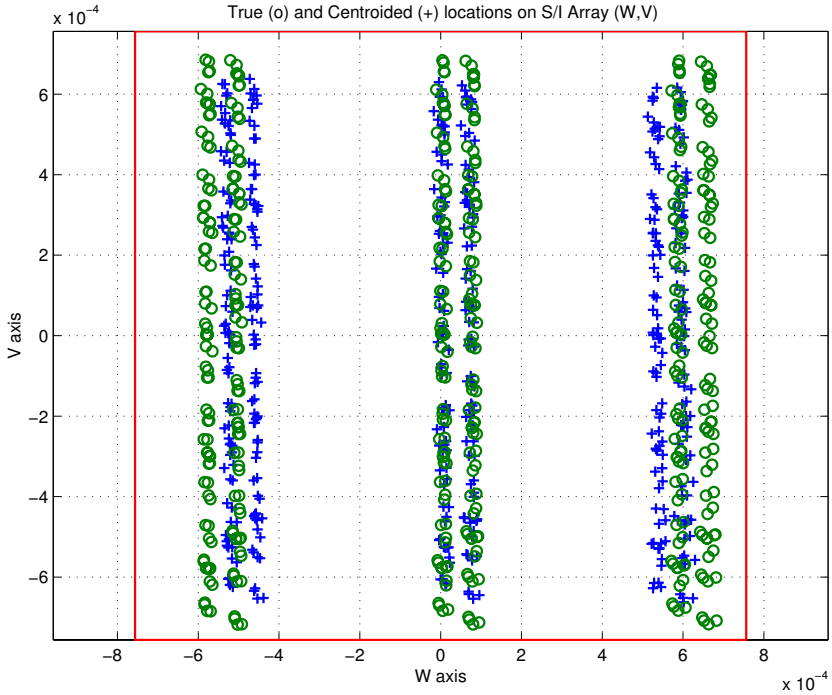

Figure 2.6: True (o) and centroided (+) locations on S/I array (W,V)

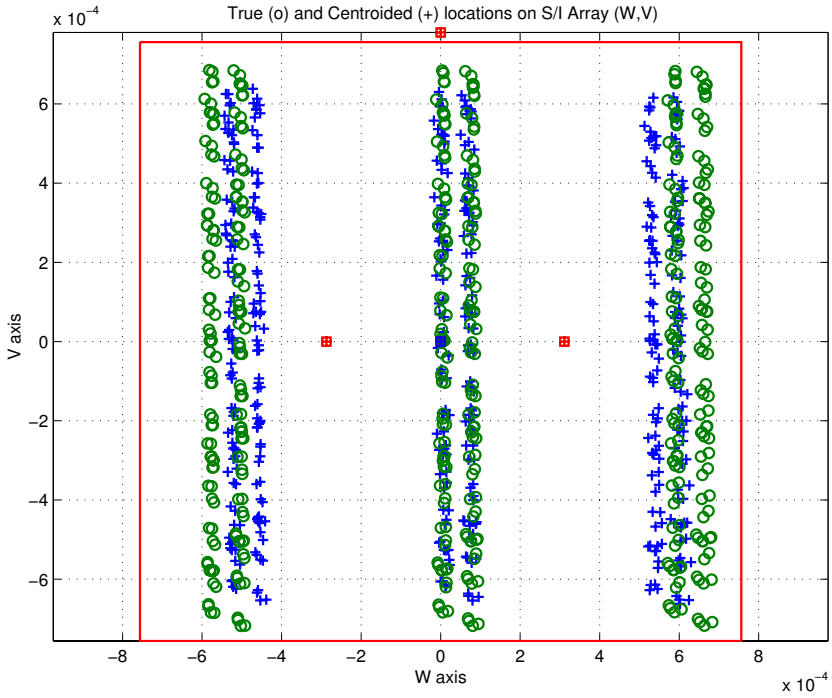

Figure 2.7: True (o) and centroided (+) locations on S/I array (W,V) showing prime and inferred frames

3 IPF EXECUTION RESULTS

3.1 IPF EXECUTION OUTPUT PLOTS

This subsection summarizes the IPF filter results. As shown in Table 3.1, the output plots are segmented to three groups: predicted performance, post-run results and IPF trending plots.

FIGURE NO.	DESCRIPTION
Predicted performance prior to IPF run	
Figure 3.1	Meas. and a-priori predicts in TPF coords
Figure 3.2	Meas. and a-priori predicts in Oriented Pixel Coords including rectangular array boundary approximation
Figure 3.3	A-priori prediction error
Figure 3.4	Oriented Pixel Coords of measurements and a-priori predicts (PCRS only)
IPF filter performance (post run results)	
Figure 3.5	IPF execution convergence, chart 1: (top) normalized residual error vs. iteration number and (bottom) norm of effective parameter corrections
Figure 3.6	IPF execution convergence, chart 2: parameter correction size vs. iteration number
Figure 3.7	Parameter uncertainty convergence: square-root of diagonal elements of covariance matrix vs. maneuver number
Figure 3.8	IPF parameter symbol table
Figure 3.9	KF parameter error sigma plot (a-priori-dashed, a-posteriori-solid). Includes true parameter errors (FLUTE runs only)
Figure 3.10	LS parameter error sigma plot. Includes true parameter errors (FLUTE runs only)
Figure 3.11	KF and LS parameter errors sigma plot (Figure 3.9 & Figure 3.10 combined)
Figure 3.12	Measurements and a-posteriori predicts in Oriented Pixel Coords including rectangular array boundaries (a-priori-dashed, a-posteriori-solid)
Figure 3.13	Attitude corrected meas. and a-posteriori predicts in Oriented Pixel Coords including rectangular array boundaries (a-priori-dashed, a-posteriori-solid)
Figure 3.14	Array plot with (solid) and w/o (dashed) optical distortion corrections
Figure 3.15	KF innovations with (o) and w/o (+) attitude corrections
Figure 3.16	W-axis KF innovations and 1-sigma bound
Figure 3.17	V-axis KF innovations and 1-sigma bound
IPF parameter trending plots	
Figure 3.18	Estimated attitude corrections (Body frame)
Figure 3.19	Estimated attitude error sigma plot (Body frame)
Figure 3.20	Systematic error attributed to thermo-mechanical boresight drift (equiv. angle in (W,V) coords)
Figure 3.21	Systematic error attributed to thermo-mechanical boresight drift (equiv. angle in Body frame)
Figure 3.22	Systematic error attributed to gyro drift bias (equiv. rate in (W,V) coords)
Figure 3.23	Systematic error attributed to gyro drift bias (equiv. angle in (W,V) coords)
Figure 3.24	Systematic error attributed to gyro drift bias (equiv. angle in Body frame)

Table 3.1: Table of figures (IPF run)

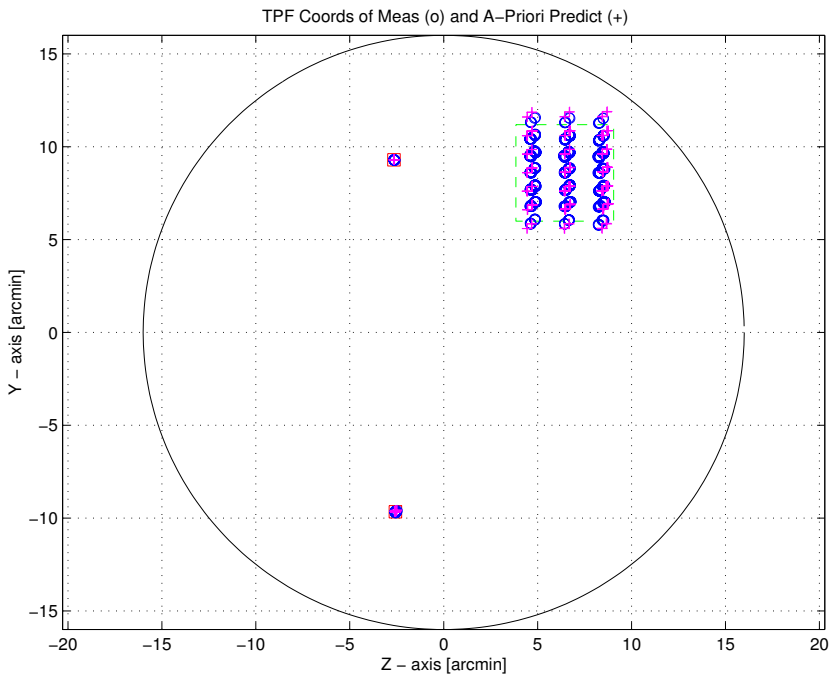

Figure 3.1: TPF coords of measurements and a-priori predicts

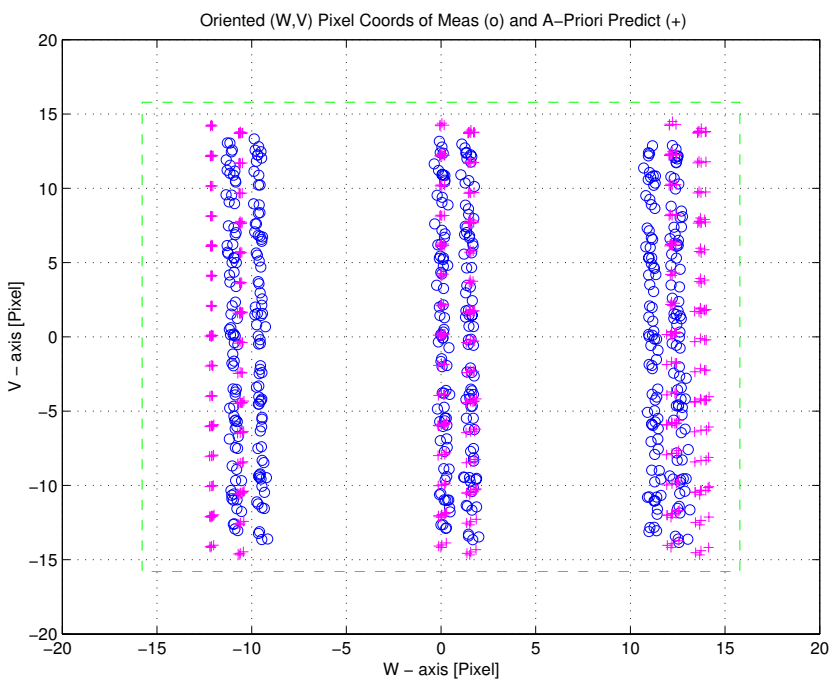

Figure 3.2: Oriented Pixel Coords of measurements and a-priori predicts

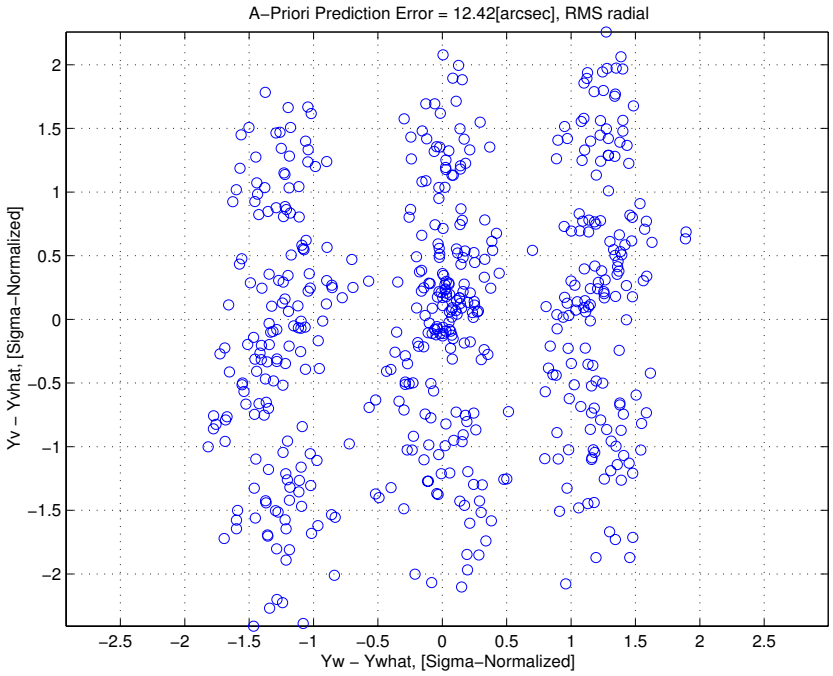

Figure 3.3: A-priori prediction error

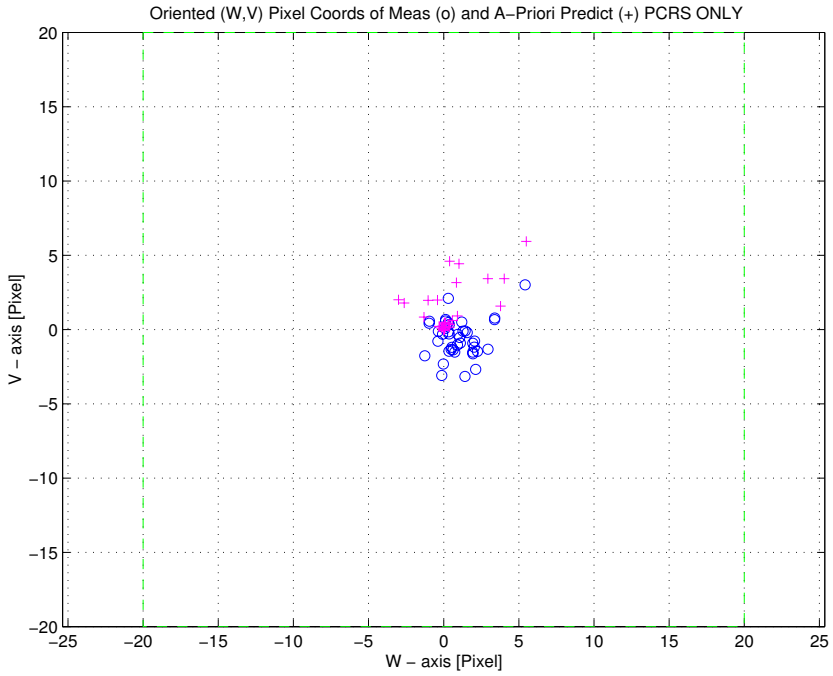

Figure 3.4: Oriented Pixel Coords of measurements and a-priori predicts (PCRS only)

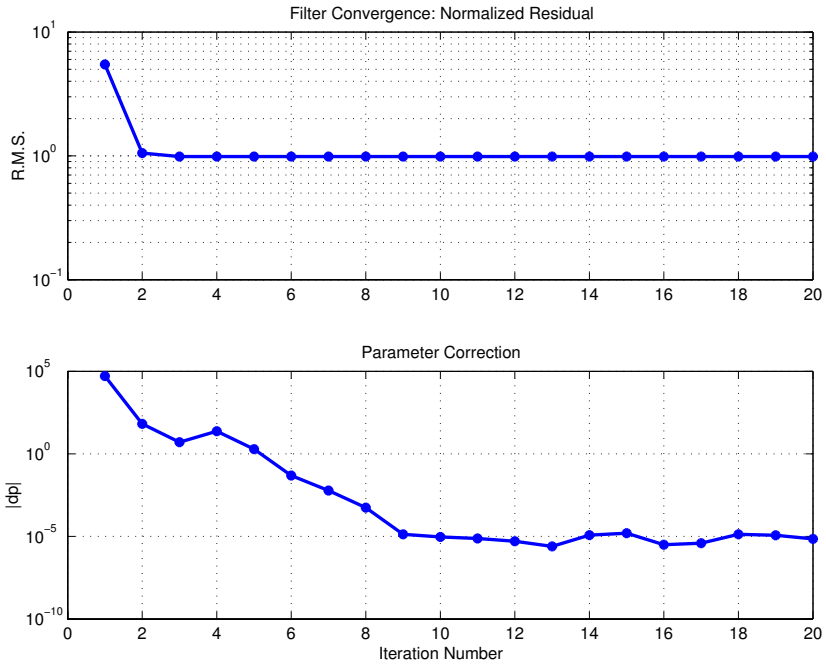

Figure 3.5: IPF execution convergence, chart 1

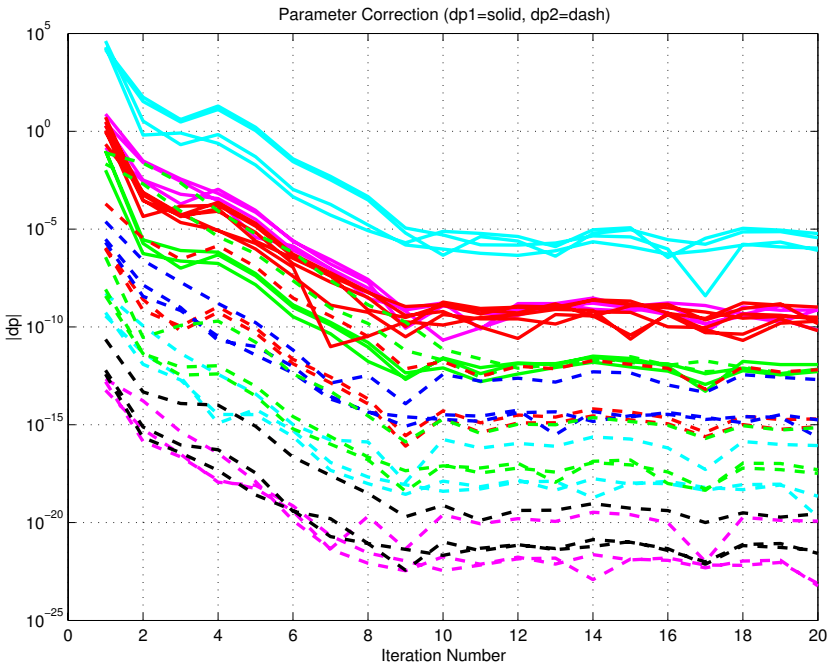

Figure 3.6: IPF execution convergence, chart 2

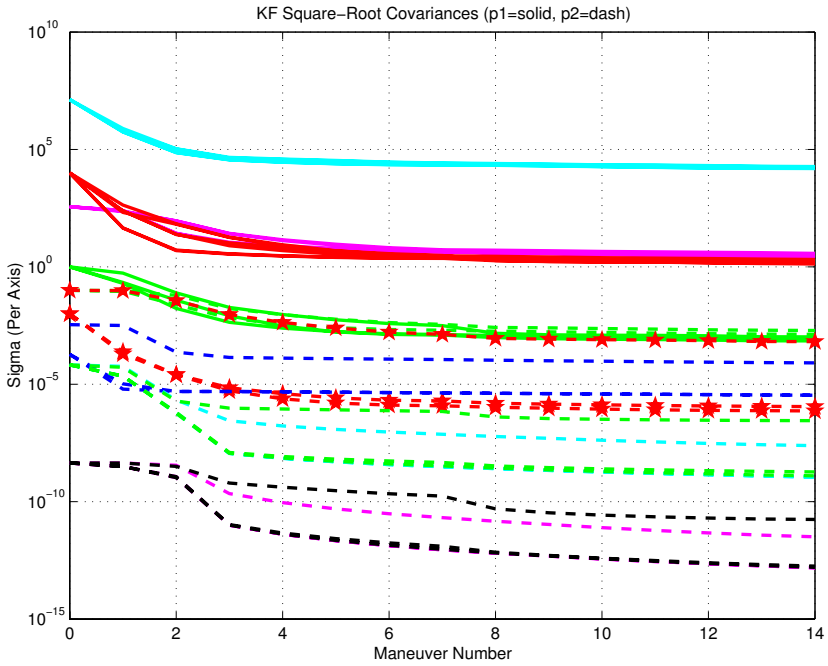

Figure 3.7: Parameter uncertainty convergence

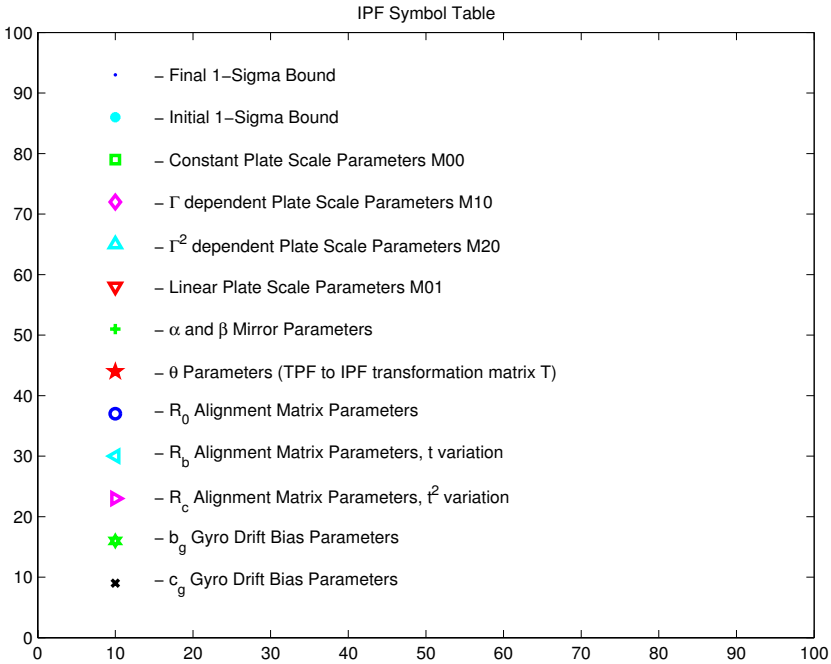

Figure 3.8: IPF parameter symbol table

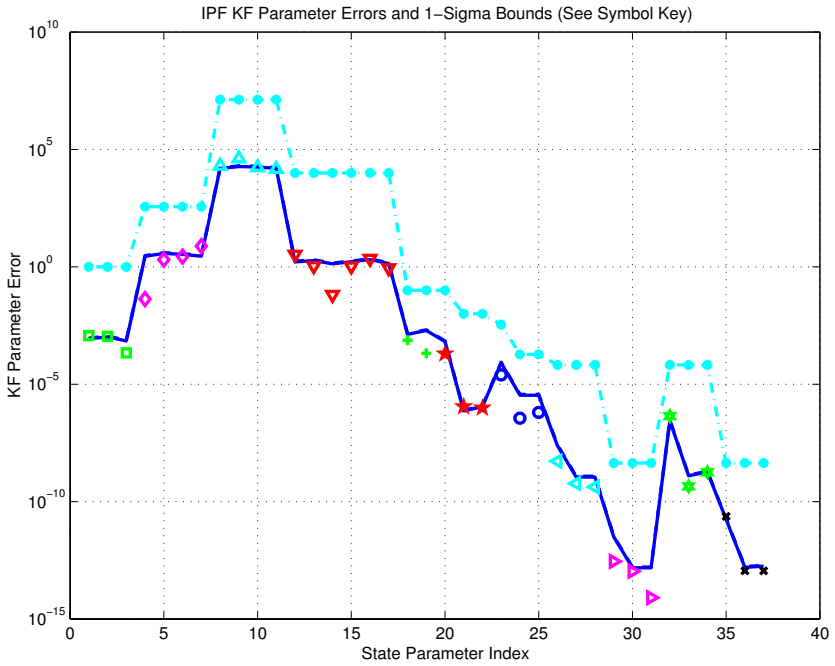

Figure 3.9: KF parameter error sigma plots

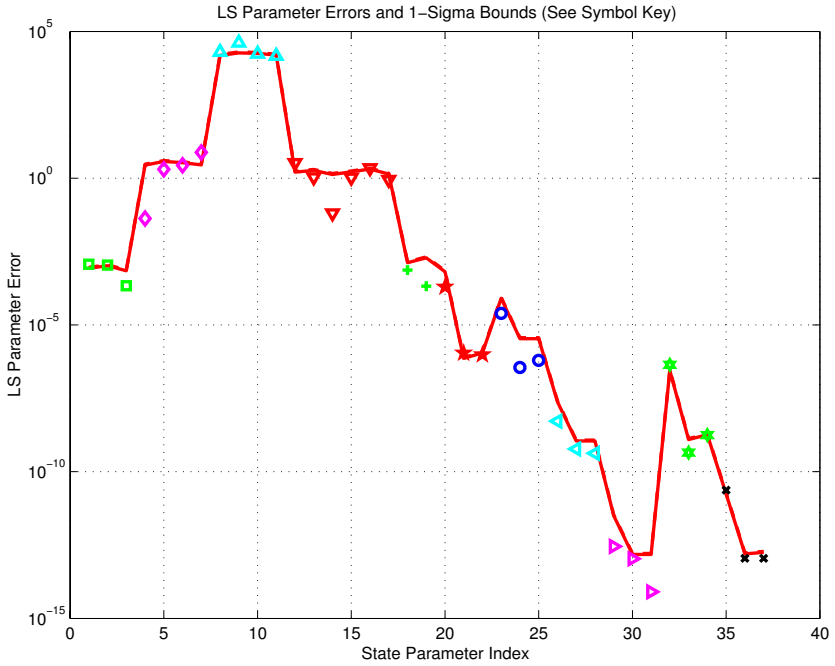

Figure 3.10: LS parameter error sigma plot

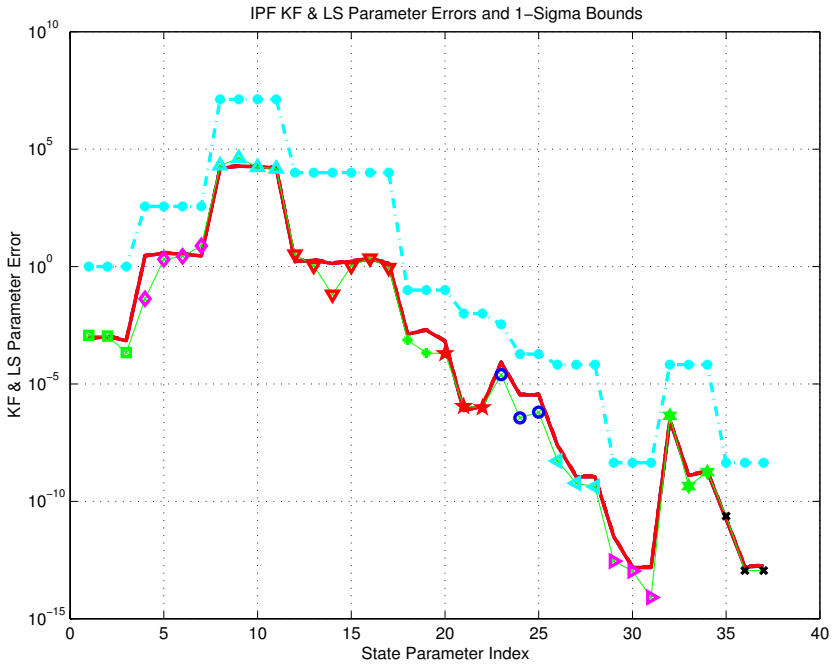

Figure 3.11: KF and LS parameter error sigma plot

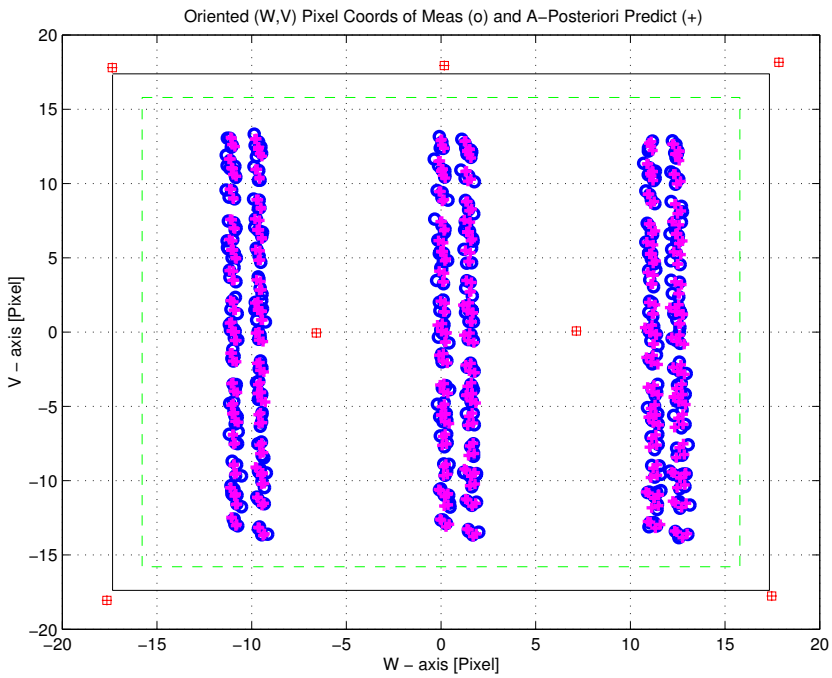

Figure 3.12: Oriented Pixel Coords of meas. and a-posteriori predicts

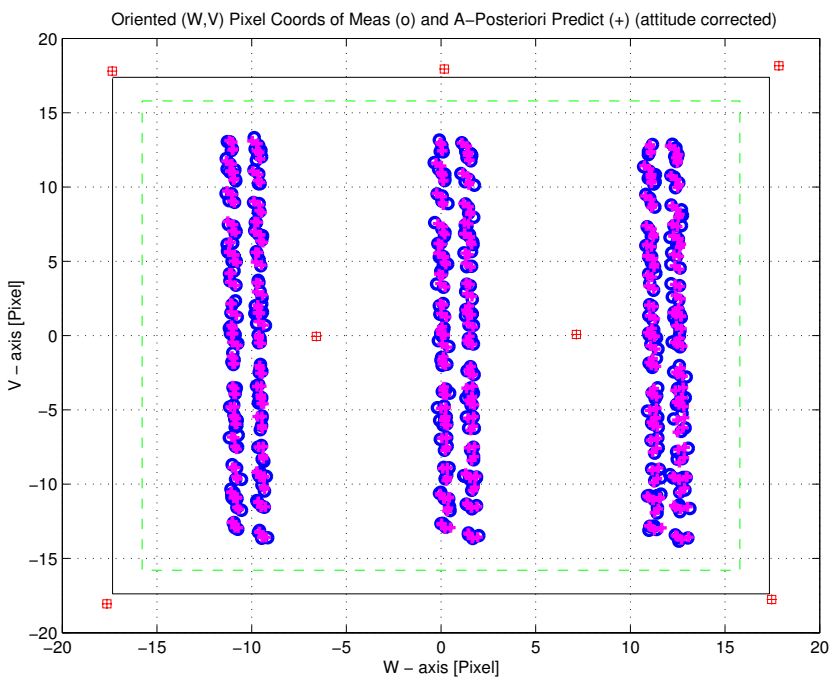

Figure 3.13: Oriented Pixel Coords of meas. and a-posteriori predicts (attitude corrected)

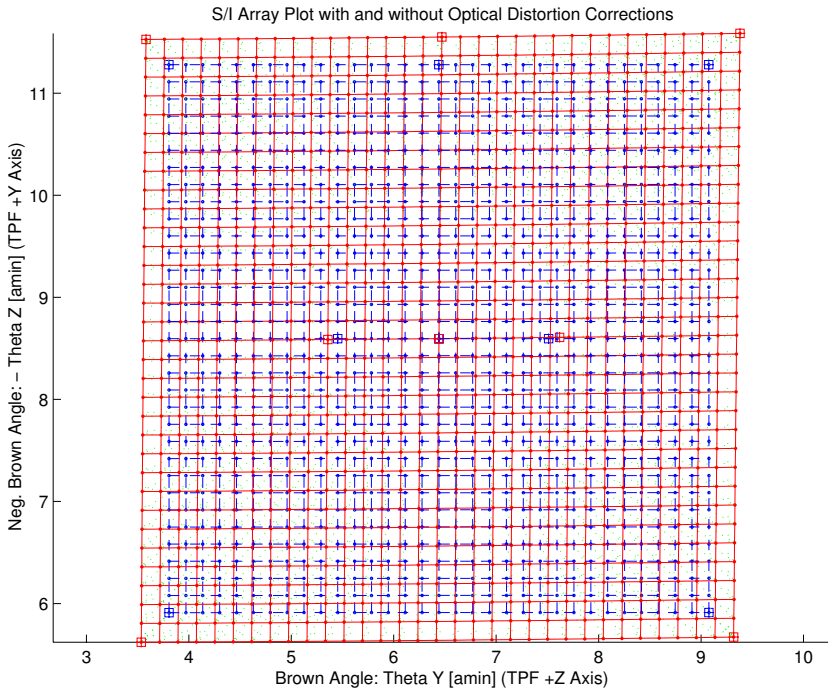

Figure 3.14: Array plot with (solid) and w/o (dashed) optical distortion corrections

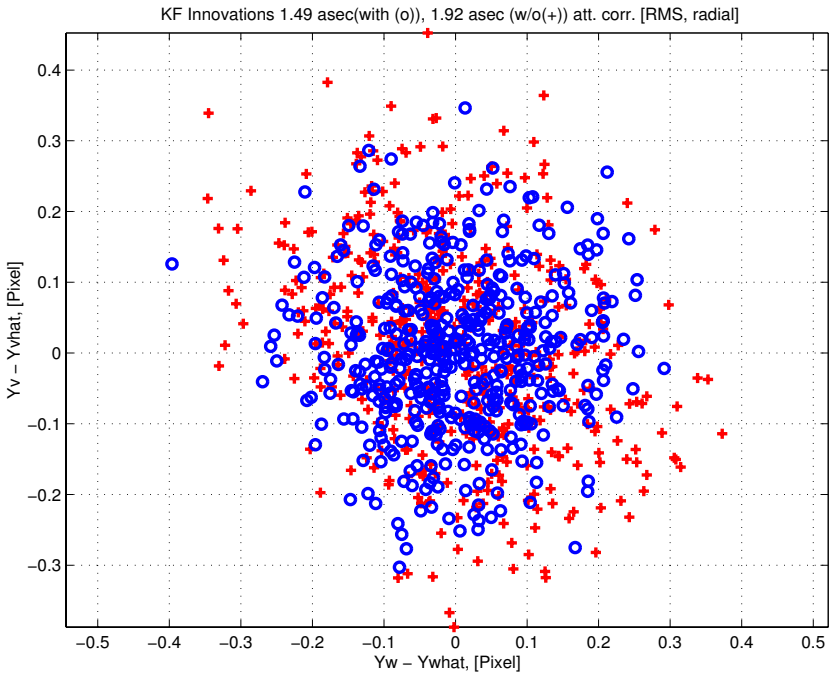

Figure 3.15: KF innovations with (o) and w/o (+) attitude corrections

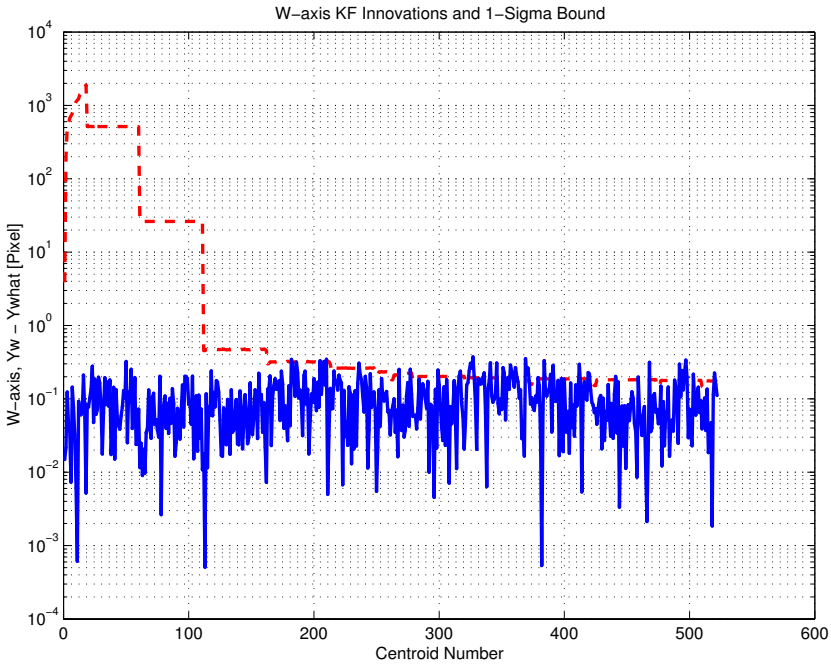

Figure 3.16: W-axis KF innovations and 1-sigma bound

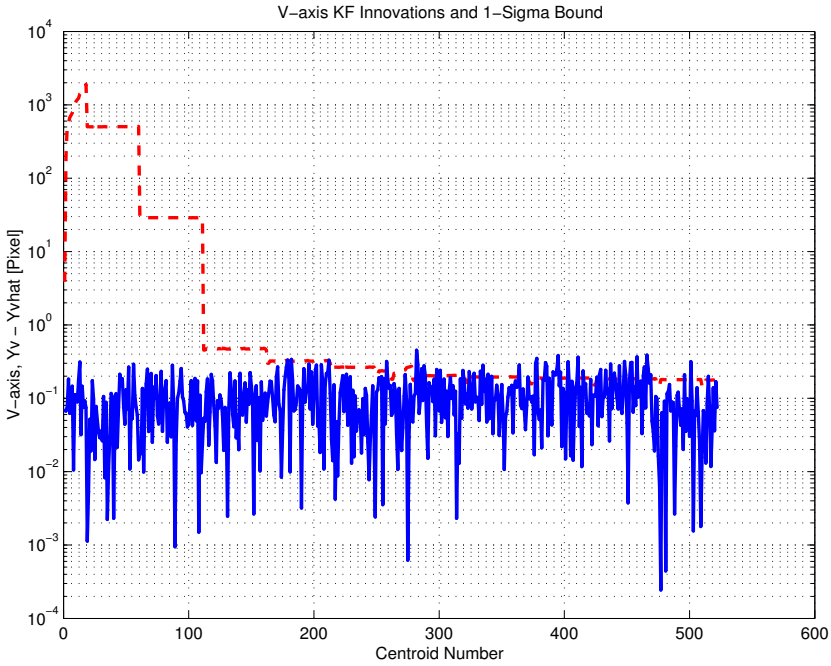

Figure 3.17: V-axis KF innovations and 1-sigma bound

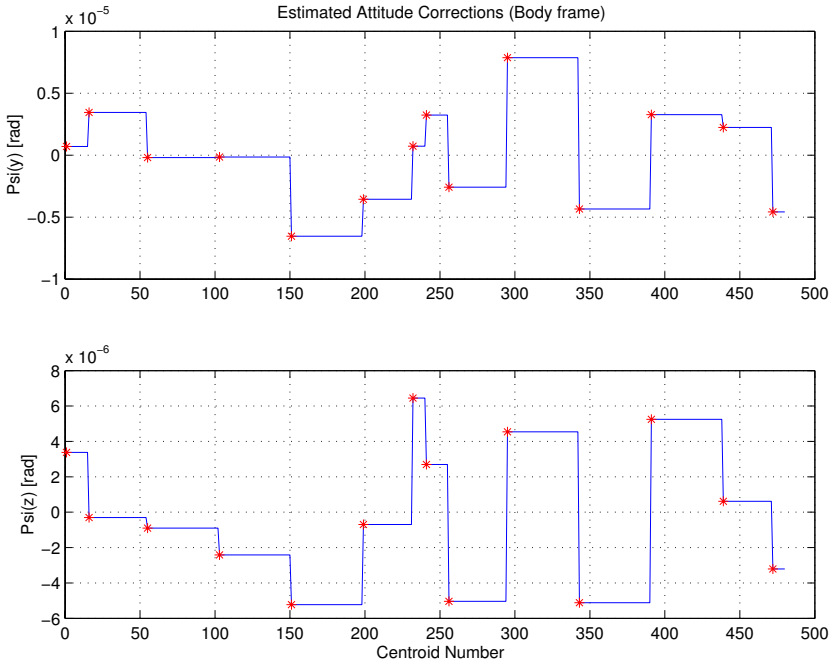

Figure 3.18: Estimated attitude corrections (Body frame)

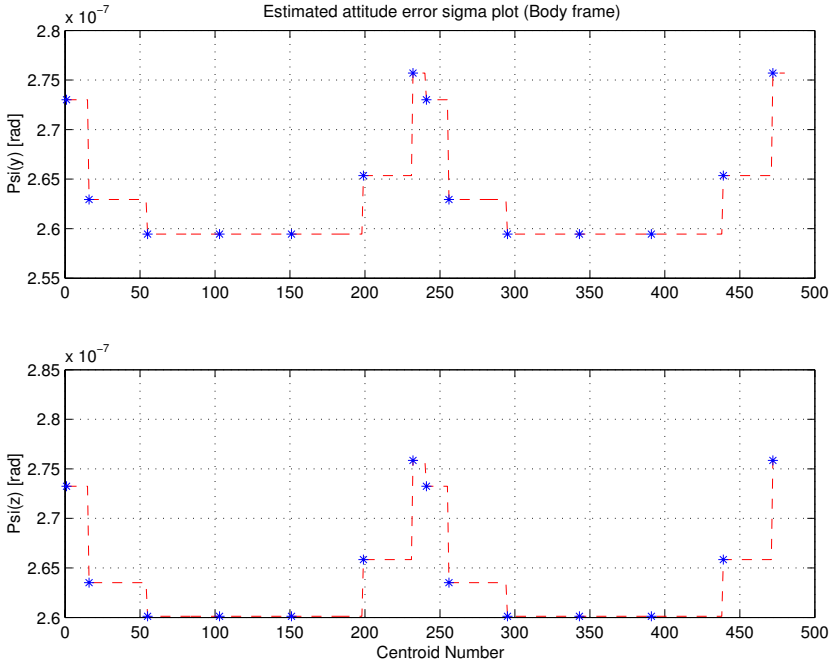

Figure 3.19: Estimated attitude error sigma plot (Body frame)

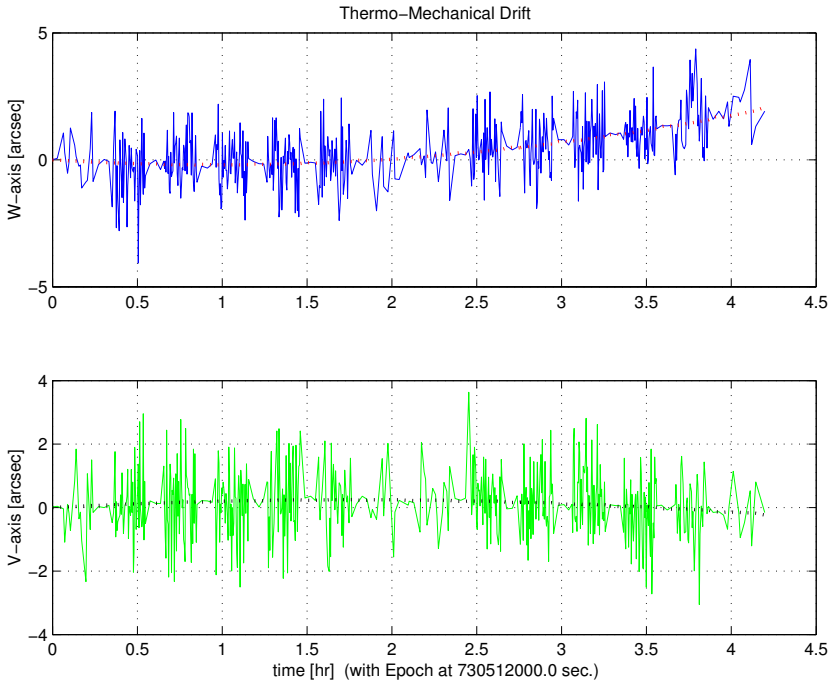

Figure 3.20: Thermo-mechanical boresight drift (equiv. angle in (W,V) coords)

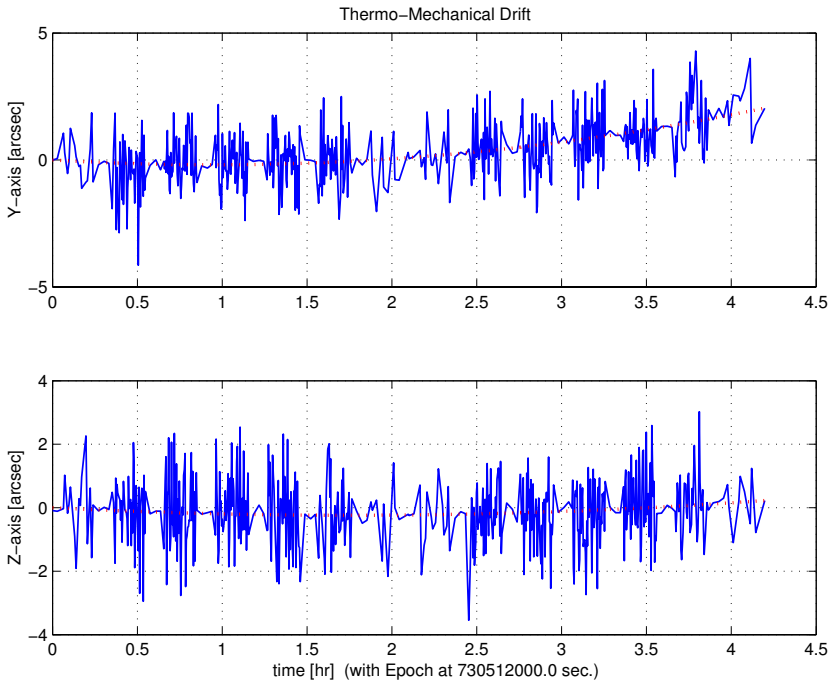

Figure 3.21: Thermo-mechanical boresight drift (equiv. angle in Body frame)

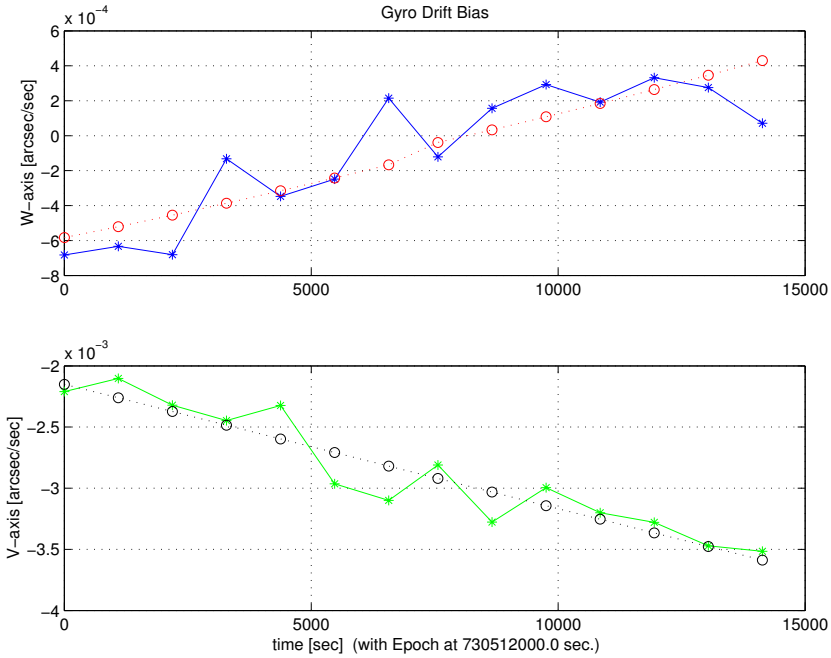

Figure 3.22: Gyro drift bias contribution (equiv. rate in (W,V) coords)

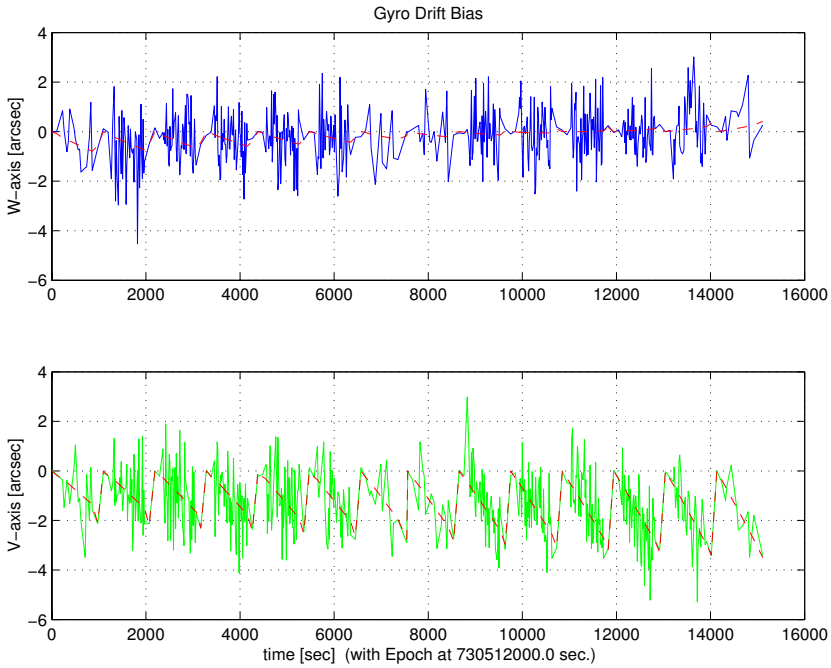

Figure 3.23: Gyro drift bias contribution (equiv. angle in (W,V) coords)

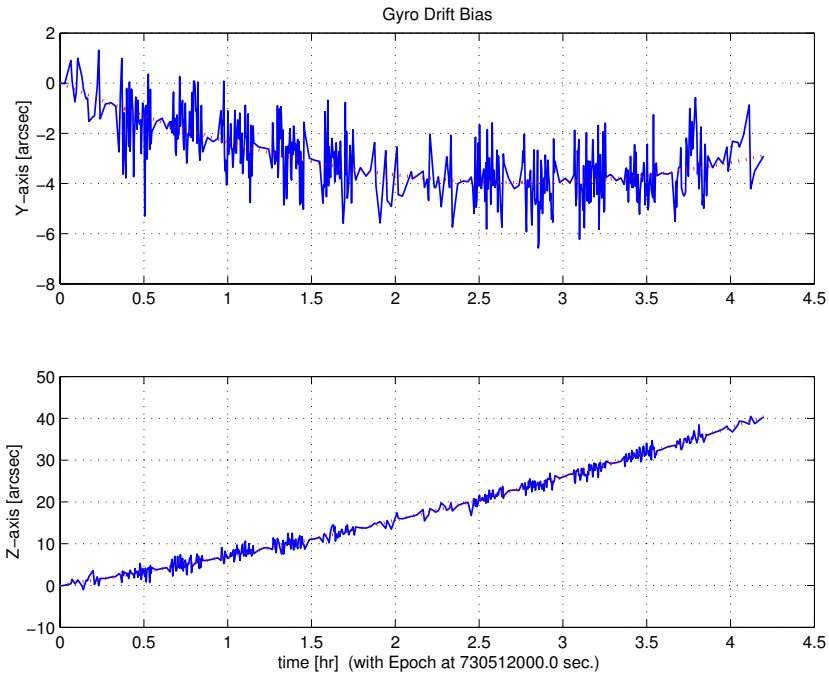

Figure 3.24: Gyro drift bias contribution (equiv. angle in Body frame)

3.2 IPF OUTPUT DATA (IF MINI FILE)

```
OUTPUT FILE NAME: IFmini991107.dat   DATE: 05-Aug-2003   TIME: 21:59
INSTRUMENT NAME:  MIPS_70um_center   NF: 107
IPF FILTER VERSION: IPF.V2.0.1Beta       SW RELEASE DATE: August 5, 2003
-------------------------------------------------------------------------------
---------------------------- IPF BROWN ANGLE SUMMARY ---------------------------
-------------------------------------------------------------------------------
         ------------ WAS ------------           ------------ IS -------------
Frame    theta_Y     theta_Z     angle           theta_Y     theta_Z     angle
Number   (arcmin)    (arcmin)    (deg)           (arcmin)    (arcmin)    (deg)
------  --------------------------------       --------------------------------
 107     +6.445000  -8.592000   +0.000000        +6.441205  -8.595346   -0.011234
 108     +6.348000 -11.259000   -0.000000        +6.469974 -11.550016   -0.011234
 111     +7.423000  -8.647000   -0.000000        +7.619206  -8.607530   -0.011234
 112     +5.385000  -8.533000   +0.000000        +5.356957  -8.585905   -0.011234
 115     +6.445000  -8.592000   +0.000000        +6.441205  -8.595346   -0.011234
 001     +0.000000  +0.000000   +0.000000        +9.380011 -11.585965   -0.011234
 001     +0.000000  +0.000000   +0.000000        +9.318369  -5.671111   -0.011234
 001     +0.000000  +0.000000   +0.000000        +3.581361 -11.526390   -0.011234
 001     +0.000000  +0.000000   +0.000000        +3.535646  -5.620737   -0.011234
-------------------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  0             107            +0.000            +0.000     pixels
OFFSET FRAME NAME: MIPS_70um_center
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
WAS(FTB)            +6.445000        -8.592000       +0.000000
IS (EST)            +6.441205        -8.595346       -0.011234
dT_EST              -0.003795        -0.003346       -0.011234
T_sSIGMA            +0.002683        +0.004105       +0.040149
dT_EST/T_sSIGMA     -1.414677        -0.815168       -0.279817
-----------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  1             108            +0.000           +16.000     pixels
OFFSET FRAME NAME: MIPS_70um_minusY_edge
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
WAS(FTB)            +6.348000       -11.259000       -0.000000
IS (EST)            +6.469974       -11.550016       -0.011234
dT_EST              +0.121974        -0.291016       -0.011234
T_sSIGMA            +0.004903        +0.006092       +0.040149
dT_EST/T_sSIGMA    +24.875056       -47.767480       -0.279817
-----------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  2             111            +6.500            +0.000     pixels
OFFSET FRAME NAME: MIPS_70um_default_small_FOV1
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
WAS(FTB)            +7.423000        -8.647000       -0.000000
IS (EST)            +7.619206        -8.607530       -0.011234
dT_EST              +0.196206        +0.039470       -0.011234
T_sSIGMA            +0.003052        +0.004932       +0.040149
dT_EST/T_sSIGMA    +64.286574        +8.003255       -0.279817
-----------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  3             112            -6.000            +0.000     pixels
OFFSET FRAME NAME: MIPS_70um_default_small_FOV2
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
WAS(FTB)            +5.385000        -8.533000       +0.000000
IS (EST)            +5.356957        -8.585905       -0.011234
dT_EST              -0.028043        -0.052905       -0.011234
T_sSIGMA            +0.002275        +0.003356       +0.040149
dT_EST/T_sSIGMA    -12.326319       -15.763920       -0.279817
-----------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  4             115            +0.000            +0.000     pixels
OFFSET FRAME NAME: MIPS_70um_default_large_FOV1
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
```

```
WAS(FTB)            +6.445000        -8.592000       +0.000000
IS (EST)            +6.441205        -8.595346       -0.011234
dT_EST              -0.003795        -0.003346       -0.011234
T_sSIGMA            +0.002683        +0.004105       +0.040149
dT_EST/T_sSIGMA     -1.414677        -0.815168       -0.279817
-------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  5               1           +16.000           +16.000     pixels
OFFSET FRAME NAME: CORNER PIXEL (DIAGNOSTICS)
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
WAS(FTB)            +0.000000        +0.000000       +0.000000
IS (EST)            +9.380011       -11.585965       -0.011234
dT_EST              +9.380011       -11.585965       -0.011234
T_sSIGMA            +0.007008        +0.008880       +0.040149
dT_EST/T_sSIGMA    +1338.491457       -1304.778081       -0.279817
-------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  6               1           +16.000           -16.000     pixels
OFFSET FRAME NAME: CORNER PIXEL (DIAGNOSTICS)
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
WAS(FTB)            +0.000000        +0.000000       +0.000000
IS (EST)            +9.318369        -5.671111       -0.011234
dT_EST              +9.318369        -5.671111       -0.011234
T_sSIGMA            +0.006308        +0.008479       +0.040149
dT_EST/T_sSIGMA    +1477.135709       -668.816263       -0.279817
-------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  7               1           -16.000           +16.000     pixels
OFFSET FRAME NAME: CORNER PIXEL (DIAGNOSTICS)
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
WAS(FTB)            +0.000000        +0.000000       +0.000000
IS (EST)            +3.581361       -11.526390       -0.011234
dT_EST              +3.581361       -11.526390       -0.011234
T_sSIGMA            +0.006221        +0.006732       +0.040149
dT_EST/T_sSIGMA    +575.643531       -1712.055176       -0.279817
-------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  8               1           -16.000           -16.000     pixels
OFFSET FRAME NAME: CORNER PIXEL (DIAGNOSTICS)
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
WAS(FTB)            +0.000000        +0.000000       +0.000000
IS (EST)            +3.535646        -5.620737       -0.011234
dT_EST              +3.535646        -5.620737       -0.011234
T_sSIGMA            +0.006270        +0.006748       +0.040149
dT_EST/T_sSIGMA    +563.898877       -832.887305       -0.279816
-------------------------------------------------------------------
-------------------------------------------------------------------------------------
-------------------------------------------------------------------------------------
VARNAME             MEAN                     SIGMA                SCALED_SIGMA
a00        +9.8831807200754393E-002 +8.4952250684316218E-004 +9.1208126999373269E-004
b00        +1.0109254822840279E-001 +1.0415648045133496E-003 +1.1182655456787047E-003
c00        +1.0216353427575948E-002 +6.9912327744531635E-004 +7.5060665448882383E-004
a10        +1.4204493595225509E-001 +2.7886584101545342E+000 +2.9940149717328510E+000
b10        -1.9091359980297127E+000 +3.7280031859871929E+000 +4.0025330147534621E+000
c10        +2.7473423905770815E+000 +3.3761306567614202E+000 +3.6247486232312722E+000
d10        -7.5703613510838217E+000 +2.8439022099975979E+000 +3.0533269201677187E+000
a20        +1.9882503530007234E+004 +1.5255769634055252E+004 +1.6379203176461357E+004
b20        -4.1158884471409307E+004 +1.8653432027166724E+004 +2.0027069131225497E+004
c20        -1.7145443556683153E+004 +1.7902241271226478E+004 +1.9220560753676386E+004
d20        +1.4580408066995227E+004 +1.5546569860517149E+004 +1.6691417906182225E+004
a01        +5.3045716350494176E+000 +1.6138515417469992E+000 +1.7326954282209486E+000
b01        +9.2233363325871243E-001 +1.8415333334195856E+000 +1.9771436871315506E+000
c01        +1.9360366362600681E+000 +1.3448887409488892E+000 +1.4439262302810270E+000
d01        +3.0496788790078599E+000 +1.6457190615127868E+000 +1.7669096693568764E+000
e01        -2.1826280191239189E-001 +2.0451967065375816E+000 +2.1958048132445560E+000
f01        +1.1157203145560075E+000 +1.3776659002972900E+000 +1.4791170967789236E+000
del_alpha  +6.0220171948024981E-013 +1.3186185134179921E-003 +1.4157214654909299E-003
beta       +1.0997917687320438E+000 +1.9337064488118699E-003 +2.0761044226848399E-003
```

```
del_theta1 +6.4594190456526701E-013 +6.5266370470858201E-004 +7.0072580287660149E-004
del_theta2 -8.0198355289413958E-016 +7.2688705076347485E-007 +7.8041494964741120E-007
del_theta3 -1.9894061661836779E-015 +1.1122240688221774E-006 +1.1941281520351912E-006
del_arx    -2.0488461526858327E-013 +8.1240265422670850E-005 +8.7222791467510101E-005
del_ary    +1.7853658818272472E-015 +3.4059383653936958E-006 +3.6567513689218561E-006
del_arz    -2.2753729595062023E-016 +3.4009489464945463E-006 +3.6513945296510781E-006
brx        +5.2992399604333891E-009 +2.4201749258821601E-008 +2.5983963958863251E-008
bry        -5.3836797020277157E-010 +1.1142706299167023E-009 +1.1963254217098353E-009
brz        -3.6610429945942205E-010 +1.1124022158773719E-009 +1.1943194178239591E-009
crx        -2.3457783598494607E-013 +3.1629363075997705E-012 +3.3958546608318225E-012
cry        +1.5802519762064538E-013 +1.5192303205835484E-013 +1.6311063086014831E-013
crz        +5.8056447091130079E-014 +1.5166916520467499E-013 +1.6283806927355296E-013
bgx        +3.6608892841697107E-007 +2.7850693215408716E-007 +2.9901615829473864E-007
bgy        -3.8612760686212014E-009 +1.2463755675015807E-009 +1.3381585553517006E-009
bgz        +8.3294187515633201E-009 +1.8295833455619351E-009 +1.9643137032125633E-009
cgx        -2.2979419526555039E-011 +1.7428842800656700E-011 +1.8712301261111712E-011
cgy        +3.8843107731920028E-013 +1.5859788149241508E-013 +1.7027701562311090E-013
cgz        +6.1185050350764278E-013 +1.7825246684682764E-013 +1.9137896292509381E-013
-------------------------------------------------------------------------------
LSQF RESIDUAL SIGMA SCALE =         +1.0736399125940050E+000
-------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------------
                    a_mirror(1)               a_mirror(2)               a_mirror(3)
a_mirror_ipf   +0.0000000000000000E+000  +1.9258693009799845E-002  +9.9981453417299060E-001
a_mirror_tpf   -1.9219512248847609E-003  +1.9449986360951462E-002  +9.9980898382343419E-001
beta                beta_0                    beta                      beta_total
               +2.8047410000000001E-006  +1.0997917687320438E+000  +3.0846310652252811E-006
-----------------------------------------------------------------------------------------------------
qT               qT(1)                     qT(2)                     qT(3)                     qT(4)
FrmTbl:   +1.1714108883076305E-006 -9.3738638321546567E-004 +1.2496548701431507E-003 +9.9999877983330654E-001
Estim:    -9.6866059879698914E-005 -9.3695692196613665E-004 +1.2500497270103955E-003 +9.9999877505143620E-001
DelTheta        deltheta(1)               deltheta(2)               deltheta(3)
          -1.9607288843390475E-004 +1.1040348516924848E-006 +9.7341346544401923E-007       [rad]
EulAngT         theta(1)                  theta(2)                  theta(3)                  [rad]
Mean      -1.9607471336678678E-004 -1.8736704699979954E-003 +2.5002849040299791E-003
SigmaT    +6.5266370470858201E-004 +7.2688705076347485E-007 +1.1122240688221774E-006
-----------------------------------------------------------------------------------------------------
qR               qR(1)                     qR(2)                     qR(3)                     qR(4)
ASFILE:   +0.0000000000000000E+000 +0.0000000000000000E+000 +0.0000000000000000E+000 +1.0000000000000000E+000
Estim:    +1.1887061843663394E-005 +1.0334464539797768E-006 +1.5240137847866160E-006 +9.9999999992765376E-001
DelThetaR       deltheta R(1)             deltheta R(2)             deltheta R(3)
          +2.3774126837870434E-005 +2.0668566757192721E-006 +3.0480521386477692E-006       [rad]
EulAngR         angR(1)                   angR(2)                   angR(3)                   [rad]
Mean      +2.3774126837870434E-005 +2.0668566757192721E-006 +3.0480521386477692E-006
SigmaR    +8.1240265422670850E-005 +3.4059383653936958E-006 +3.4009489464945463E-006
-----------------------------------------------------------------------------------------------------
Initial Gyro Bias         Bg0(1)                    Bg0(2)                    Bg0(3)
                  +2.5698065383442246E-006 +2.5043076857825201E-006 +2.4899044449250012E-006
Gyro Bias Correction      Bg(1)                     Bg(2)                     Bg(3)
                  +3.6608892841697107E-007 -3.8612760686212014E-009 +8.3294187515633201E-009
Total Gyro Bias           BgT(1)                    BgT(2)                    BgT(3)
                  +2.9358954667611959E-006 +2.5004464097138988E-006 +2.4982338636765644E-006

Initial Gyro Bias Rate     Cg0(1)                    Cg0(2)                    Cg0(3)
                  +0.0000000000000000E+000 +0.0000000000000000E+000 +0.0000000000000000E+000
Gyro Bias Rate Correction  Cg(1)                     Cg(2)                     Cg(3)
                  -2.2979419526555039E-011 +3.8843107731920028E-013 +6.1185050350764278E-013
Total Gyro Bias Rate       CgT(1)                    CgT(2)                    CgT(3)
                  -2.2979419526555039E-011 +3.8843107731920028E-013 +6.1185050350764278E-013
-----------------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  1             108            +0.000           +16.000     pixels
OFFSET FRAME NAME: MIPS_70um_minusY_edge
qT               qT(1)                     qT(2)                     qT(3)                     qT(4)
WAS(FTB)  +1.5119196953387772E-006 -9.2327780520473960E-004 +1.6375537408473187E-003 +9.9999823298521595E-001
IS (EST)  -9.6456374149448158E-005 -9.4118280205983612E-004 +1.6797879542481680E-003 +9.9999814159003808E-001
```

```
DelTheta        deltheta(1)               deltheta(2)               deltheta(3)
Units             rad                       rad                       rad
          -1.9591839645470162E-004 -3.5480822460873948E-005 +8.4653011035921164E-005
EulAngT         theta(1)                  theta(2)                  theta(3)                  [rad]
Mean      -1.9607471336678678E-004 -1.8820391644545260E-003 +3.3597635022737235E-003
sSigmaT   +7.0072525872219484E-004 +1.4263612278193715E-006 +1.7721923312293761E-006
SigmaT    +6.5266319787719439E-004 +1.3285285048440140E-006 +1.6506393907689302E-006
-----------------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  2             111            +6.500            +0.000     pixels
OFFSET FRAME NAME: MIPS_70um_default_small_FOV1
qT               qT(1)                     qT(2)                     qT(3)                     qT(4)
WAS(FTB)  +1.3578036248737386E-006 -1.0796305229011367E-003 +1.2576541056642260E-003 +9.9999862635017700E-001
IS (EST)  -9.6649887797970084E-005 -1.1082902728332825E-003 +1.2518047297823947E-003 +9.9999859766721111E-001

DelTheta        deltheta(1)               deltheta(2)               deltheta(3)
Units             rad                       rad                       rad
          -1.9609950469808054E-004 -5.7074105423055528E-005 -1.1481365486306844E-005
EulAngT         theta(1)                  theta(2)                  theta(3)                  [rad]
Mean      -1.9607471336678681E-004 -2.2163372782063881E-003 +2.5038289466657307E-003
sSigmaT   +7.0072554832501183E-004 +8.8780753770115812E-007 +1.4345905885905032E-006
SigmaT    +6.5266346761643716E-004 +8.2691368613163778E-007 +1.3361934218004347E-006
-----------------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  3             112            -6.000            +0.000     pixels
OFFSET FRAME NAME: MIPS_70um_default_small_FOV2
qT               qT(1)                     qT(2)                     qT(3)                     qT(4)
WAS(FTB)  +9.7202971260263934E-007 -7.8321581857721488E-004 +1.2410738430199599E-003 +9.9999892315329675E-001
IS (EST)  -9.7064287383216607E-005 -7.7925949945333028E-004 +1.2486921821837913E-003 +9.9999891204990354E-001

DelTheta        deltheta(1)               deltheta(2)               deltheta(3)
Units             rad                       rad                       rad
          -1.9605060680590961E-004 +8.1574763573977192E-006 +1.5389449412851983E-005
EulAngT         theta(1)                  theta(2)                  theta(3)                  [rad]
Mean      -1.9607471336678681E-004 -1.5582755271220197E-003 +2.4975385526414657E-003
sSigmaT   +7.0072596427697437E-004 +6.6179342243302550E-007 +9.7624624739741432E-007
SigmaT    +6.5266385503866102E-004 +6.1640165820035179E-007 +9.0928647113977036E-007
-----------------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  4             115            +0.000            +0.000     pixels
OFFSET FRAME NAME: MIPS_70um_default_large_FOV1
qT               qT(1)                     qT(2)                     qT(3)                     qT(4)
WAS(FTB)  +1.1714108883076305E-006 -9.3738638321546567E-004 +1.2496548701431507E-003 +9.9999877983330654E-001
IS (EST)  -9.6866059879698954E-005 -9.3695692196613686E-004 +1.2500497270103959E-003 +9.9999877505143620E-001

DelTheta        deltheta(1)               deltheta(2)               deltheta(3)
Units             rad                       rad                       rad
          -1.9607288843390483E-004 +1.1040348516920514E-006 +9.7341346544488659E-007
EulAngT         theta(1)                  theta(2)                  theta(3)                  [rad]
Mean      -1.9607471336678681E-004 -1.8736704699979954E-003 +2.5002849040299795E-003
sSigmaT   +7.0072580287660149E-004 +7.8041494964741141E-007 +1.1941281520351914E-006
SigmaT    +6.5266370470858201E-004 +7.2688705076347496E-007 +1.1122240688221776E-006
-----------------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  5              1           +16.000           +16.000     pixels
OFFSET FRAME NAME: CORNER PIXEL (DIAGNOSTICS)
qT               qT(1)                     qT(2)                     qT(3)                     qT(4)
WAS(FTB)  +0.0000000000000000E+000 +0.0000000000000000E+000 +0.0000000000000000E+000 +1.0000000000000000E+000
IS (EST)  -9.5738186969549825E-005 -1.3644301523501612E-003 +1.6849742034371978E-003 +9.9999764501047317E-001

DelTheta        deltheta(1)               deltheta(2)               deltheta(3)
Units             rad                       rad                       rad
          -1.9607471336678675E-004 -2.7285346311227759E-003 +3.3702206523092584E-003
```

```
EulAngT         theta(1)                theta(2)                theta(3)                [rad]
Mean      -1.9607471336678681E-004 -2.7285346311227768E-003 +3.3702206523092593E-003
sSigmaT   +7.0072446863119126E-004 +2.0385147898544837E-006 +2.5829838059037195E-006
SigmaT    +6.5266246197776077E-004 +1.8986950521700139E-006 +2.4058194703874333E-006
-----------------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------------
OFFSET          NF          Delta_CW          Delta_CV
  6              1           +16.000           -16.000     pixels
OFFSET FRAME NAME: CORNER PIXEL (DIAGNOSTICS)
qT              qT(1)                   qT(2)                   qT(3)                   qT(4)
WAS(FTB)  +0.0000000000000000E+000 +0.0000000000000000E+000 +0.0000000000000000E+000 +1.0000000000000000E+000
IS (EST)  -9.6919340566216963E-005 -1.3553817589451447E-003 +8.2469589142125546E-004 +9.9999873671101003E-001

DelTheta        deltheta(1)               deltheta(2)               deltheta(3)
Units             rad                       rad                       rad
          -1.9607471336678683E-004 -2.7106035547493782E-003 +1.6496592331435068E-003
EulAngT         theta(1)                theta(2)                theta(3)                [rad]
Mean      -1.9607471336678681E-004 -2.7106035547493773E-003 +1.6496592331435066E-003
sSigmaT   +7.0072506279308402E-004 +1.8350403006083137E-006 +2.4665357671579978E-006
SigmaT    +6.5266301538666985E-004 +1.7091766793344157E-006 +2.2973584888425377E-006
-----------------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------------
OFFSET          NF          Delta_CW          Delta_CV
  7              1           -16.000           +16.000     pixels
OFFSET FRAME NAME: CORNER PIXEL (DIAGNOSTICS)
qT              qT(1)                   qT(2)                   qT(3)                   qT(4)
WAS(FTB)  +0.0000000000000000E+000 +0.0000000000000000E+000 +0.0000000000000000E+000 +1.0000000000000000E+000
IS (EST)  -9.7163965941003607E-005 -5.2105139710486280E-004 +1.6763933413758145E-003 +9.9999845438379076E-001

DelTheta        deltheta(1)               deltheta(2)               deltheta(3)
Units             rad                       rad                       rad
          -1.9607471336678681E-004 -1.0417756019069138E-003 +3.3528908570348379E-003
EulAngT         theta(1)                theta(2)                theta(3)                [rad]
Mean      -1.9607471336678678E-004 -1.0417756019069134E-003 +3.3528908570348379E-003
sSigmaT   +7.0072554311072471E-004 +1.8097582013548779E-006 +1.9584011678571993E-006
SigmaT    +6.5266346275979288E-004 +1.6856286545666402E-006 +1.8240763452296926E-006
-----------------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------------
OFFSET          NF          Delta_CW          Delta_CV
  8              1           -16.000           -16.000     pixels
OFFSET FRAME NAME: CORNER PIXEL (DIAGNOSTICS)
qT              qT(1)                   qT(2)                   qT(3)                   qT(4)
WAS(FTB)  +0.0000000000000000E+000 +0.0000000000000000E+000 +0.0000000000000000E+000 +1.0000000000000000E+000
IS (EST)  -9.7616918948038997E-005 -5.1431886822291743E-004 +8.1745250690725866E-004 +9.9999952885910792E-001

DelTheta        deltheta(1)               deltheta(2)               deltheta(3)
Units             rad                       rad                       rad
          -1.9607471336678683E-004 -1.0284778387372321E-003 +1.6350062491796164E-003
EulAngT         theta(1)                theta(2)                theta(3)                [rad]
Mean      -1.9607471336678681E-004 -1.0284778387372323E-003 +1.6350062491796162E-003
sSigmaT   +7.0072609582380759E-004 +1.8238692798647722E-006 +1.9630581955369231E-006
SigmaT    +6.5266397756282544E-004 +1.6987718679889140E-006 +1.8284139519310603E-006
-----------------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------------
              q(1)                    q(2)                    q(3)                    q(4)
PCRS1A: +5.2603126189317361E-007 +3.7451819048221893E-004 -1.4045531552277380E-003 +9.9999894348258311E-001
PCRS2A: -5.1968404336718985E-007 +3.8455385122900486E-004 +1.3513933841514693E-003 +9.9999901292650617E-001
-----------------------------------------------------------------------------------------------
**********  CS-FILE PARAMETERS:  **********  **********  AS-FILE PARAMETERS:  **********
Row (01) PIX2RADX: +4.7904467948999998E-005  Row (1) TASTART:   +7.3051200000000000E+008
Row (02) PIX2RADY: +4.8792938470999998E-005  Row (2) TASTOP:    +7.3052711000000000E+008
Row (03) CX0:      +1.6500000000000000E+001  Row (3) S/C TIME:  +7.3051200000000000E+008
Row (04) CY0:      +1.6500000000000000E+001  Row (4) QR1:       +0.0000000000000000E+000
Row (05) BETA0:    +2.8047410000000001E-006  Row (5) QR2:       +0.0000000000000000E+000
Row (06) GAMMA_E0: +2.0070000000000000E+003  Row (6) QR3:       +0.0000000000000000E+000
Row (07) D11:      -1.0000000000000000E+000  Row (7) QR4:       +1.0000000000000000E+000
Row (08) D12:      +0.0000000000000000E+000
Row (09) D21:      +0.0000000000000000E+000
```

```
Row (10) D22:      -1.0000000000000000E+000
Row (11) DG:       +1.0000000000000000E+000
-------------------------------------------------------------------------------------
-------------------------------------------------------
INITIAL STA-TO-PCRS ALIGNMENT (R) KNOWLEDGE (1-SIGMA)
    SIGMA(X)        SIGMA(Y)         SIGMA(Z)
1.41451738E+001  7.65467990E-001  7.65467990E-001  [arcsec]
-------------------------------------------------------
PIX2RADX = 4.790446794900E-005[rad/pixel]
XPIXSIZE = 9.8810[arcsec]
PIX2RADY = 4.879293847100E-005[rad/pixel]
YPIXSIZE = 10.0643[arcsec]
CX0 = 16.5[pixel] = 163.04[arcsec]
CY0 = 16.5[pixel] = 166.06[arcsec]
-------------------------------------------------------
NOMINAL BETA0 = 2.804741000000E-006[rad/encoder unit]
ENCODER UNIT SIZE = 0.58[arcsec]
GAMMA_E0 = 2007.00[encoder unit] = 1161.09[arcsec]
-------------------------------------------------------
                | -1 | +0 |
FLIP MATRIX D = |----|----|   and   DG = +1
                | +0 | -1 |
-------------------------------------------------------
```

3.3 IPF EXECUTION LOG

```
*********************************************************************
IPF EXECUTION-LOG FILE NAME:  LG991107.dat
INSTRUMENT TYPE:              MIPS_70um_center
IPF FILTER EXECUTION DATE:    05-Aug-2003    TIME: 21:53
IPF FILTER VERSION USED:      IPF.V2.0.1Beta
*********************************************************************

------------------- Loading & Preparing Input Files -------------------
AAFILE:  AA991107 Loaded!        AAFILE dimension = 151101 X 21
ASFILE:  AS991107 Loaded!
CAFILE:  CA991107 Loaded!        CAFILE dimension = 480 X 15
CBFILE:  CB991107 Loaded!        CBFILE dimension = 42 X 15
CCFILE:  CC991107 Created!       CCFILE dimension = 522 X 19
CSFILE:  CS991107 Loaded!
Loading Input Files Completed!
---------------------------------------------------------------------

------------------------ Selected Mask Vectors ------------------------
index =   1  2  3  4  5  6  7  8  9 10 11 12 13 14 15 16 17 18 19 20
---------------------------------------------------------------------
mask1 = [ 1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1 ]
mask2 = [ 1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1 ]
---------------------------------------------------------------------

---------------  Selected Initial Gyro Bias Parameters  ---------------
User Entered 1 : Use AFILE database - from S/C filter
IPF Linearized Using Following Nominal Gyro Bias Estimates
bg0 = [+2.5698065383442246E-006 +2.5043076857825201E-006 +2.4899044449250012E-006 ]
cg0 = [+0.0000000000000000E+000 +0.0000000000000000E+000 +0.0000000000000000E+000 ]
---------------------------------------------------------------------

---------------  Gyro Pre-Processor Run Completed  --------------------
     AGFILE CREATED:  AG991107.m     ACFILE CREATED:  AC991107.m
---------------------------------------------------------------------
```

```
Total Gyro Preprocessor Execution Time: 88 seconds

FRAME TABLE ENTRIES FOR PCRS LOADED TO TPCRS
q_PCRS4 = [ +5.2603126189317361E-007     q_PCRS5 = [ +7.3379987833742897E-007
            +3.7451819048221893E-004                 +5.2236196154513707E-004
            -1.4045531552277380E-003                 -1.4047712280184723E-003
            +9.9999894348258311E-001 ];              +9.9999887687698918E-001 ];
q_PCRS8 = [ -5.1968404336718985E-007     q_PCRS9 = [ -7.1963421681856818E-007
            +3.8455385122900486E-004                 +5.3239763239987400E-004
            +1.3513933841514693E-003                 +1.3516841804518383E-003
            +9.9999901292650617E-001 ];              +9.9999894475050310E-001 ];
-------------------------------------------------------------------------------
------ Initial Conditions for State -----  ------   Inital Square-Root Cov (diag)   -----
p1(01)  = a00  = +0.0000000000000000E+000  Sigma_initial(01,01) = 1.0000000000000000E+000
p1(02)  = b00  = +0.0000000000000000E+000  Sigma_initial(02,02) = 1.0000000000000000E+000
p1(03)  = c00  = +0.0000000000000000E+000  Sigma_initial(03,03) = 1.0000000000000000E+000
p1(04)  = a10  = +0.0000000000000000E+000  Sigma_initial(04,04) = 3.6384517097704270E+002
p1(05)  = b10  = +0.0000000000000000E+000  Sigma_initial(05,05) = 3.6384517097704270E+002
p1(06)  = c10  = +0.0000000000000000E+000  Sigma_initial(06,06) = 3.6384517097704270E+002
p1(07)  = d10  = +0.0000000000000000E+000  Sigma_initial(07,07) = 3.6384517097704270E+002
p1(08)  = a20  = +0.0000000000000000E+000  Sigma_initial(08,08) = 1.3238330844331343E+007
p1(09)  = b20  = +0.0000000000000000E+000  Sigma_initial(09,09) = 1.3238330844331343E+007
p1(10)  = c20  = +0.0000000000000000E+000  Sigma_initial(10,10) = 1.3238330844331343E+007
p1(11)  = d20  = +0.0000000000000000E+000  Sigma_initial(11,11) = 1.3238330844331343E+007
p1(12)  = a01  = +0.0000000000000000E+000  Sigma_initial(12,12) = 1.0000000000000000E+004
p1(13)  = b01  = +0.0000000000000000E+000  Sigma_initial(13,13) = 1.0000000000000000E+004
p1(14)  = c01  = +0.0000000000000000E+000  Sigma_initial(14,14) = 1.0000000000000000E+004
p1(15)  = d01  = +0.0000000000000000E+000  Sigma_initial(15,15) = 1.0000000000000000E+004
p1(16)  = e01  = +0.0000000000000000E+000  Sigma_initial(16,16) = 1.0000000000000000E+004
p1(17)  = f01  = +0.0000000000000000E+000  Sigma_initial(17,17) = 1.0000000000000000E+004
-----------------------------------------------------------------------------------------
p2f(01) = am1  = +0.0000000000000000E+000
p2f(02) = am2  = +0.0000000000000000E+000  Sigma_initial(18,18) = 1.0000000000000001E-001
p2f(03) = am3  = +1.0000000000000000E+000
p2f(04) = beta = +1.0000000000000000E+000  Sigma_initial(19,19) = 1.0000000000000001E-001
p2f(05) = qT1  = +1.1714108883076305E-006  Sigma_initial(20,20) = 1.0000000000000001E-001
p2f(06) = qT2  = -9.3738638321546567E-004  Sigma_initial(21,21) = 1.0000000000000000E-002
p2f(07) = aT3  = +1.2496548701431507E-003  Sigma_initial(22,22) = 1.0000000000000000E-002
p2f(08) = qT4  = +9.9999877983330654E-001
p2f(09) = qR1  = +0.0000000000000000E+000  Sigma_initial(23,23) = 3.4288868839039716E-003
p2f(10) = qR2  = +0.0000000000000000E+000  Sigma_initial(24,24) = 1.8555467699985827E-004
p2f(11) = qR3  = +0.0000000000000000E+000  Sigma_initial(25,25) = 1.8555467699985827E-004
p2f(12) = qR4  = +1.0000000000000000E+000
p2f(13) = brx  = +0.0000000000000000E+000  Sigma_initial(26,26) = 6.6181336863004636E-005
p2f(14) = bry  = +0.0000000000000000E+000  Sigma_initial(27,27) = 6.6181336863004636E-005
p2f(15) = brz  = +0.0000000000000000E+000  Sigma_initial(28,28) = 6.6181336863004636E-005
p2f(16) = crx  = +0.0000000000000000E+000  Sigma_initial(29,29) = 4.3799693489744957E-009
p2f(17) = cry  = +0.0000000000000000E+000  Sigma_initial(30,30) = 4.3799693489744957E-009
p2f(18) = crz  = +0.0000000000000000E+000  Sigma_initial(31,31) = 4.3799693489744957E-009
p2f(19) = bgx  = +0.0000000000000000E+000  Sigma_initial(32,32) = 6.6181336863004636E-005
p2f(20) = bgy  = +0.0000000000000000E+000  Sigma_initial(33,33) = 6.6181336863004636E-005
p2f(21) = bgz  = +0.0000000000000000E+000  Sigma_initial(34,34) = 6.6181336863004636E-005
p2f(22) = cgx  = +0.0000000000000000E+000  Sigma_initial(35,35) = 4.3799693489744957E-009
p2f(23) = cgy  = +0.0000000000000000E+000  Sigma_initial(36,36) = 4.3799693489744957E-009
p2f(24) = cgz  = +0.0000000000000000E+000  Sigma_initial(37,37) = 4.3799693489744957E-009
-----------------------------------------------------------------------------------------

--------------------   IPF KALMAN FILTER STARTED  ---------------------
Iteration#001: |dp|= +5.096910571965E+004   RMS(|Res|)=+5.096910571965E+004
Iteration#002: |dp|= +6.489483560050E+001   RMS(|Res|)=+6.489483560050E+001
Iteration#003: |dp|= +5.045548016368E+000   RMS(|Res|)=+5.045548016368E+000
Iteration#004: |dp|= +2.345670709654E+001   RMS(|Res|)=+2.345670709654E+001
Iteration#005: |dp|= +1.929677950377E+000   RMS(|Res|)=+1.929677950377E+000
Iteration#006: |dp|= +4.840273908660E-002   RMS(|Res|)=+4.840273908660E-002
Iteration#007: |dp|= +5.985941209625E-003   RMS(|Res|)=+5.985941209625E-003
Iteration#008: |dp|= +5.516117322077E-004   RMS(|Res|)=+5.516117322077E-004
Iteration#009: |dp|= +1.331056979242E-005   RMS(|Res|)=+1.331056979242E-005
Iteration#010: |dp|= +9.248450832335E-006   RMS(|Res|)=+9.248450832335E-006
```

```
Iteration#011: |dp|= +7.501216719705E-006   RMS(|Res|)=+7.501216719705E-006
Iteration#012: |dp|= +5.081768960798E-006   RMS(|Res|)=+5.081768960798E-006
Iteration#013: |dp|= +2.491338169810E-006   RMS(|Res|)=+2.491338169810E-006
Iteration#014: |dp|= +1.205220480205E-005   RMS(|Res|)=+1.205220480205E-005
Iteration#015: |dp|= +1.562119011600E-005   RMS(|Res|)=+1.562119011600E-005
Iteration#016: |dp|= +3.119868065772E-006   RMS(|Res|)=+3.119868065772E-006
Iteration#017: |dp|= +3.879003319789E-006   RMS(|Res|)=+3.879003319789E-006
Iteration#018: |dp|= +1.331610779788E-005   RMS(|Res|)=+1.331610779788E-005
Iteration#019: |dp|= +1.178439151713E-005   RMS(|Res|)=+1.178439151713E-005
Iteration#020: |dp|= +7.084106904167E-006   RMS(|Res|)=+7.084106904167E-006
IPF Kalman Filter Completed with Error |dp1| + |dp2| = +7.0841069041665971E-006
----------------------------------------------------------------------

-----------------  IPF LEAST SQUARES FILTER STARTED  ------------------
Iteration#001   COND#=+9.540024242997E+012,   |dp|=+5.094834567957E+004
Iteration#002   COND#=+9.539973450586E+012,   |dp|=+7.838442318469E+000
Iteration#003   COND#=+9.539973869395E+012,   |dp|=+2.106939850796E-002
Iteration#004   COND#=+9.539973230270E+012,   |dp|=+1.579070583161E-003
Iteration#005   COND#=+9.539973601515E+012,   |dp|=+5.444620061094E-005
Iteration#006   COND#=+9.539973611154E+012,   |dp|=+1.143316920668E-006
Iteration#007   COND#=+9.539974195204E+012,   |dp|=+8.864149789266E-007
Iteration#008   COND#=+9.539973775278E+012,   |dp|=+5.794827102648E-007
Iteration#009   COND#=+9.539972983912E+012,   |dp|=+3.676571144226E-007
Iteration#010   COND#=+9.539973511440E+012,   |dp|=+1.936347397819E-007
Iteration#011   COND#=+9.539973177128E+012,   |dp|=+3.758529524527E-007
Iteration#012   COND#=+9.539972881399E+012,   |dp|=+8.195333278696E-007
Iteration#013   COND#=+9.539972824435E+012,   |dp|=+8.489615678661E-007
Iteration#014   COND#=+9.539973939870E+012,   |dp|=+5.485065636936E-007
Iteration#015   COND#=+9.539973873888E+012,   |dp|=+6.361971747107E-007
Iteration#016   COND#=+9.539974001887E+012,   |dp|=+7.964711178785E-007
Iteration#017   COND#=+9.539974750374E+012,   |dp|=+3.553018654431E-007
Iteration#018   COND#=+9.539974109827E+012,   |dp|=+3.149466630615E-007
Iteration#019   COND#=+9.539974684211E+012,   |dp|=+4.286757294353E-007
Iteration#020   COND#=+9.539973996782E+012,   |dp|=+6.610618830752E-007
IPF Least Squares Filter Completed with Error |dp1| + |dp2| = +6.6106188307519166E-007
----------------------------------------------------------------------
Total Execution Time: 370 seconds
```

4 USER COMMENTS

This section left blank.

IPF TEAM CONTACT INFORMATION

IPF Team email		ipf@sirtfweb.jpl.nasa.gov	
David S. Bayard	X4-8208	David.S.Bayard@jpl.nasa.gov	(TEAM LEADER)
Dhemetrio Boussalis	X4-3977	boussali@grover.jpl.nasa.gov	
Paul Brugarolas	X4-9243	Paul.Brugarolas@jpl.nasa.gov	
Bryan H. Kang	X4-0541	Bryan.H.Kang@jpl.nasa.gov	
Edward.C.Wong	X4-3053	Edward.C.Wong@jpl.nasa.gov	(TASK MANAGER)

ACKNOWLEDGEMENTS

This work was performed at the Jet Propulsion Laboratory, California Institute of Technology, under contract with the National Aeronautics and Space Administration.

References

[1] D.S. Bayard, B.H. Kang, *SIRTF Instrument Pointing Frame Kalman Filter Algorithm*, JPL D-Document D-24809, September 30, 2003.

[2] B.H. Kang, D.S. Bayard, *SIRTF Instrument Pointing Frame (IPF) Software Description Document and User's Guide*, JPL D-Document D-24808, September 30, 2003.

[3] D.S. Bayard, B.H. Kang, *SIRTF Instrument Pointing Frame (IPF) Kalman Filter Unit Test Report*, JPL D-Document D-24810, September 30, 2003.

[4] *Space Infrared Telescope Facility In-Orbit Checkout and Science Verification Mission Plan*, JPL D-Document D-22622, 674-FE-301 Version 1.4, February 8, 2002.

[5] *Space Infrared Telescope Facility Observatory Description Document*, Lockheed Martin LMMS/P458569, 674-SEIT-300 Version 1.2, November 1, 2002.

[6] *SIRTF Software Interface Specification for Science Centroid INPUT Files (CAFILE, CS-FILE)*, JPL SOS-SIS-2002, November 18, 2002.

[7] *SIRTF Software Interface Specification for Inferred Frames Offset INPUT Files (OFILE)*, JPL SOS-SIS-2003, November 18, 2002.

[8] *SIRTF Software Interface Specification for PCRS Centroid INPUT Files (CBFILE)*, JPL SIS-FES-015, November 18, 2002.

[9] *SIRTF Software Interface Specification for Attitude INPUT Files (AFILE, ASFILE)*, JPL SIS-FES-014, January 7, 2002.

[10] *SIRTF Software Interface Specification for IPF Filter Output Files (IFFILE, LGFILE, TARFILE)*, JPL SOS-SIS-2005, November 18, 2002.

[11] R.J. Brown, *Focal Surface to Object Space Field of View Conversion.* Systems Engineering Report SER No. S20447-OPT-051, Ball Aerospace & Technologies Corp., November 23, 1999.

SIRTF INSTRUMENT POINTING FRAME KALMAN FILTER EXECUTION SUMMARY

IPF RUN NUMBER: 992107
REPORT TYPE: COVARIANCE ANALYSIS

PRIME FRAME: MIPS_70um_center (107)
INFERRED FRAMES: (108) (111) (112) (115) (1) (1) (1) (1)

IPF TEAM

Autonomy and Control Section (345)
Jet Propulsion Laboratory
California Institute of Technology
4800 Oak Grove Drive
Pasadena, CA 91109

Contents

1 IPF EXECUTION SUMMARY **4**

2 FLUTE DATA SUMMARY **8**

2.1 FLUTE CONFIGURATION PARAMETERS 8

2.2 FLUTE GENERATED UNIT TEST DATA 11

3 IPF EXECUTION RESULTS **15**

3.1 IPF EXECUTION OUTPUT PLOTS 15

3.2 IPF OUTPUT DATA (IF MINI FILE) 29

3.3 IPF EXECUTION LOG 34

4 USER COMMENTS **37**

List of Figures

1.1 A-priori and a-posteriori IPF frames 4

1.2 A-priori and a-posteriori IPF frames (ZOOMED) 7

2.1 Focal plane survey scenario plot (See key in [3]) 11

2.2 Commanded-only source locations 12

2.3 True (+) and commanded (o) source locations 12

2.4 True (+) and commanded (o) source locations (ZOOMED) 13

2.5 True-sampled (o) and centroided (+) locations on S/I array (W,V) 13

2.6 True (o) and centroided (+) locations on S/I array (W,V) 14

2.7 True (o) and centroided (+) locations on S/I array (W,V) showing prime and inferred frames 14

3.1 TPF coords of measurements and a-priori predicts 16

3.2 Oriented Pixel Coords of measurements and a-priori predicts 16

3.3 A-priori prediction error 17

3.4 Oriented Pixel Coords of measurements and a-priori predicts (PCRS only) 17

3.5 IPF execution convergence, chart 1 18

3.6 IPF execution convergence, chart 2 18

3.7 Parameter uncertainty convergence 19

3.8 IPF parameter symbol table 19

3.9 KF parameter error sigma plots . . . 20
3.10 LS parameter error sigma plot . . . 20
3.11 KF and LS parameter error sigma plot . . . 21
3.12 Oriented Pixel Coords of meas. and a-posteriori predicts . . . 22
3.13 Oriented Pixel Coords of meas. and a-posteriori predicts (attitude corrected) . . . 22
3.14 Array plot with (solid) and w/o (dashed) optical distortion corrections . . . 23
3.15 KF innovations with (o) and w/o (+) attitude corrections . . . 23
3.16 W-axis KF innovations and 1-sigma bound . . . 24
3.17 V-axis KF innovations and 1-sigma bound . . . 24
3.18 Estimated attitude corrections (Body frame) . . . 25
3.19 Estimated attitude error sigma plot (Body frame) . . . 25
3.20 Thermo-mechanical boresight drift (equiv. angle in (W,V) coords) . . . 26
3.21 Thermo-mechanical boresight drift (equiv. angle in Body frame) . . . 26
3.22 Gyro drift bias contribution (equiv. rate in (W,V) coords) . . . 27
3.23 Gyro drift bias contribution (equiv. angle in (W,V) coords) . . . 27
3.24 Gyro drift bias contribution (equiv. angle in Body frame) . . . 28

List of Tables

1.1 IPF filter input files . . . 5
1.2 IPF filter execution configuration . . . 5
1.3 IPF filter execution mask vector assignment . . . 5
1.4 IPF calibration error summary ([arcsec], 1-sigma, radial) . . . 6
1.5 Measurement prediction error summary (1-sigma) . . . 6
1.6 IPF Brown angle summary . . . 7
2.1 FLUTE Parameter Table (1) . . . 8
2.2 FLUTE Parameter Table (2) . . . 9
2.3 FLUTE Parameter Table (3) . . . 10
2.4 Table of figures (FLUTE) . . . 11
3.1 Table of figures (IPF run) . . . 15

1 IPF EXECUTION SUMMARY

This report summarizes the SIRTF Instrument Pointing Frame (IPF) Kalman Filter execution associated with run file: RN992107. In particular, this Focal Point Survey calibrates the instrument: MIPS_70um_center (107), as part of the Covariance Analysis. The main calibration results from the IPF filter execution have been documented in IF992107 typically stored in the mission archive DOM collection IPF_IF. This report only summarizes the main aspects of the run, and does not substitute for the full information contained in the IF file.

Section 1 summarizes the filter execution results. The filter configurations are tabulated in Table 1.2 and the mask vector assignments are tabulated in Table 1.3. A total of 37 state parameters are estimated in this run. The overall End-to-End pointing performances are tabulated in Table 1.4. The prediction residuals throughout the estimation processes are tabulated in Table 1.6. Section 2 documents the FLUTE generated input file data. Section 3 summarizes resulting plots, a mini summary of the IF IPF output file, and the execution log. Section 4 captures the user comments that are specific to this particular run.

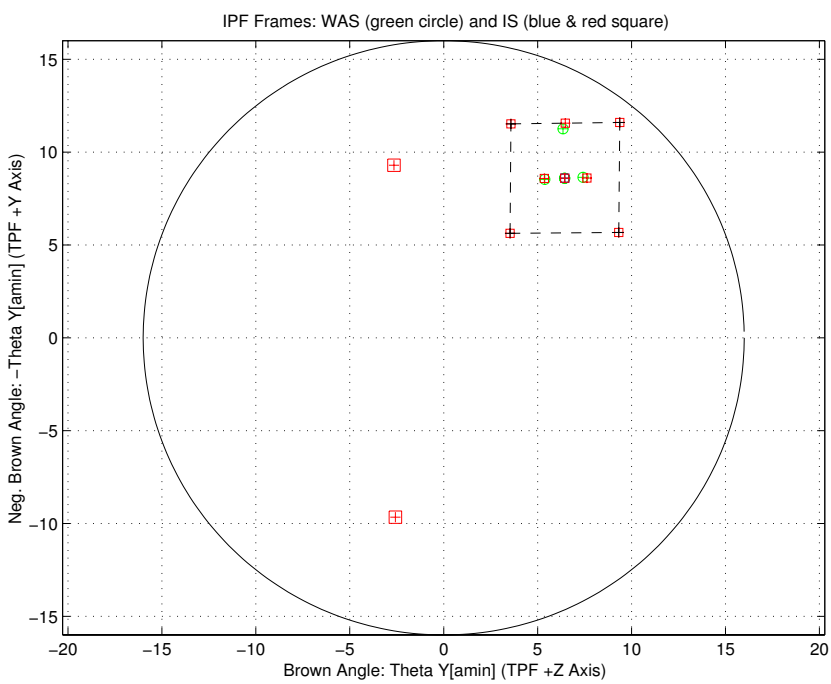

Figure 1.1: A-priori and a-posteriori IPF frames

RAW	FINAL (After Editing)
AA992107	AA992107
AS992107	AS992107
CA992107	CA992107
CB992107	CB992107
CS992107	CS992107

Table 1.1: IPF filter input files

EXECUTION CONFIGURATION ITEM	CURRENT STATUS
IPF Filter Version Used	IPF.V2.0.1Beta
Frame Table Version Used	FTVE2E1
Scan-Mirror Employed?	YES
IPF Filter Mode	NORMAL-MODE(0)
SLIT-MODE Operation	DISABLED
Kalman Filter Operation	ENABLED
Least-Squares Data Analysis	ENABLED
IBAD Screening	ENABLED
User-Specified Data Editing	DISABLED
Total Number of Iterations	20
LS Residual Sigma Scale	1.07049539E+000
Total Number of Maneuvers	14

Table 1.2: IPF filter execution configuration

Con. Plate Scale			Γ Dependent				Γ^2 Dependent				Linear Plate Scale						Mirror	
a_{00}	b_{00}	c_{00}	a_{10}	b_{10}	c_{10}	d_{10}	a_{20}	b_{20}	c_{20}	d_{20}	a_{01}	b_{01}	c_{01}	d_{01}	e_{01}	f_{01}	α	β
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
IPF (T)			Alignment R									Gyro Drift Bias						
θ_1	θ_2	θ_3	a_{rx}	a_{ry}	a_{rz}	b_{rx}	b_{ry}	b_{rz}	c_{rx}	c_{ry}	c_{rz}	b_{gx}	b_{gy}	b_{gz}	c_{gx}	c_{gy}	c_{gz}	
20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	

Table 1.3: IPF filter execution mask vector assignment

FOCAL PLANE SURVEY ANALYSIS: Covariance Analysis.
INSTRUMENT NAME: MIPS_70um_center NF: 107

```
PIX2RADW: 4.79044679E-005[rad/pixel] = 9.8810E+000[arcsec/pixel]
PIX2RADV: 4.79044679E-005[rad/pixel] = 9.8810E+000[arcsec/pixel]
```

FRAME	DESCRIPTION	IPF[1]	SF[2]	ARW[3]	TOTAL	REQ
107(P)	MIPS_70um_center	0.2718	0.0855	0.0708	0.2936	2.60
108(I)	MIPS_70um_minusY_edge	0.4731	0.0855	0.0708	0.4859	N/A
111(I)	MIPS_70um_default_small_FOV1	0.3249	0.0855	0.0708	0.3433	N/A
112(I)	MIPS_70um_default_small_FOV2	0.2225	0.0855	0.0708	0.2487	N/A
115(I)	MIPS_70um_default_large_FOV1	0.2718	0.0855	0.0708	0.2936	N/A
TR (C)	CORNERS OF INSTRUMENT	0.6472	0.0855	0.0708	0.6567	N/A
BR (C)	CORNERS OF INSTRUMENT	0.5567	0.0855	0.0708	0.5677	N/A
TL (C)	CORNERS OF INSTRUMENT	0.5836	0.0855	0.0708	0.5941	N/A
BL (C)	CORNERS OF INSTRUMENT	0.5083	0.0855	0.0708	0.5203	N/A

Table 1.4: IPF calibration error summary ([arcsec], 1-sigma, radial)

RMS METRIC	A PRIORI[4]	A POSTERIORI[4]	ATT. CORRECTED[5]	UNITS
Radial	22.3440	1.8759	1.4915	arcsec
Radial	2.2613	0.1898	0.1509	pixels
W-Axis	1.5600	0.1322	0.1033	pixels
V-Axis	1.6370	0.1363	0.1101	pixels

Table 1.5: Measurement prediction error summary (1-sigma)

[1]IPF filter removes systematic pointing errors due to: thermomechanical alignment drift (Body to TPF), gyro bias and bias drift, centroiding error, attitude error, and optical distortion. IPF SIGMA presented here is "NOT Scaled" by the Least Squares Scale factor. The Least Squares Scale Factor was: 1.070495.

[2]Error due to gyro Scale Factor: assumes 95 ppm error over 0.250 degree maneuver.

[3]Error due to gyro Angle Random Walk: assumes ARW = 100 $\mu deg/\sqrt{hr}$, with 975 second Maneuver time (max), and 14 independent Maneuvers.

[4]This can be interpreted as estimate of "pixel to sky" pointing reconstruction error if no science data is used.

[5]This can be interpreted as estimate of achieved S/I centroiding error

IPF BROWN ANGLE SUMMARY						
	WAS			IS		
Frame Number	theta_Y (arcmin)	theta_Z (arcmin)	angle (deg)	theta_Y (arcmin)	theta_Z (arcmin)	angle (deg)
107	+6.445000	-8.592000	+0.000000	+6.444083	-8.594608	-0.039787
108	+6.348000	-11.259000	-0.000000	+6.470013	-11.556576	-0.039787
111	+7.423000	-8.647000	-0.000000	+7.622128	-8.607305	-0.039787
112	+5.385000	-8.533000	+0.000000	+5.358933	-8.583754	-0.039787
115	+6.445000	-8.592000	+0.000000	+6.444083	-8.594608	-0.039787
001	+0.000000	+0.000000	+0.000000	+9.377372	-11.595419	-0.039787
001	+0.000000	+0.000000	+0.000000	+9.318468	-5.674528	-0.039787
001	+0.000000	+0.000000	+0.000000	+3.578200	-11.523640	-0.039787
001	+0.000000	+0.000000	+0.000000	+3.531061	-5.626091	-0.039787

Table 1.6: IPF Brown angle summary

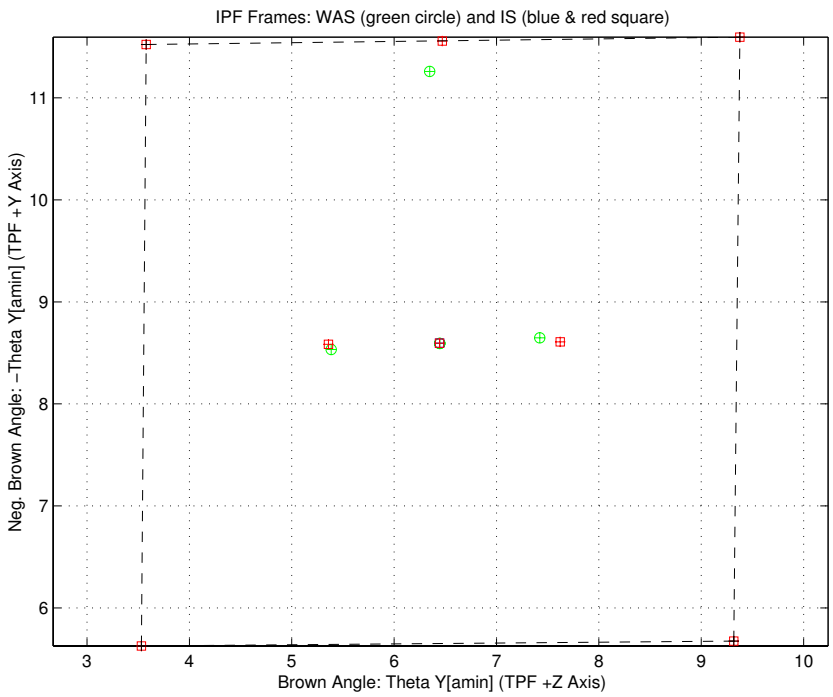

Figure 1.2: A-priori and a-posteriori IPF frames (ZOOMED)

2 FLUTE DATA SUMMARY

2.1 FLUTE CONFIGURATION PARAMETERS

The covariance analysis was performed using the FLUTE generated input data files. The internal configuration parameters, used to produce the data are tabulated in Table 2.1, Table 2.2 and Table 2.3.

NAME	DESCRIPTION	VALUE	UNIT
d2003	days into YEAR2003	+6.0000000000000000E+001	day
tstart	start time	+7.3051200000000000E+008	sec
tdel	data rate	+1.0000000000000001E-001	sec
tshelf	Inertial Hold duration pad	+5.0000000000000000E+000	sec
ipro	slew profile(1-linear, 2-S-curve)	1	int flag
sig_gcf [1]	gcf sigma(1)	+4.8481368110953601E-008	rad/sec
sig_gcf [2]	gcf sigma(2)	+9.6962736221907205E-009	rad/sec
sig_gcf [3]	gcf sigma(3)	+9.6962736221907205E-009	rad/sec
igcf	gcf bias correction flag	1	int flag
SigA [1][1]	Sigma A(1,1)	+9.4017722156391537E-009	rad^2
SigA [2][2]	Sigma A(2,2)	+2.3504430539097885E-011	rad^2
SigA [3][3]	Sigma A(3,3)	+2.3504430539097885E-011	rad^2
NFprime	Prime Frame NF	107	int
ftable [name]	Frame Table row number	107	int
ftable [q0]	Frametable quaternion q0	+1.1714108883076305E-006	N/A
ftable [q1]	Frametable quaternion q1	-9.3738638321546567E-004	N/A
ftable [q2]	Frametable quaternion q2	+1.2496548701431507E-003	N/A
ftable [q3]	Frametable quaternion q3	+9.9999877983330654E-001	N/A
ft_cmd [name]	Command row number	107	int
ft_cmd [q0]	Command quaternion q0	+1.1714108883076305E-006	N/A
ft_cmd [q1]	Command quaternion q1	-9.3738638321546567E-004	N/A
ft_cmd [q2]	Command quaternion q2	+1.2496548701431507E-003	N/A
ft_cmd [q3]	Command quaternion q3	+9.9999877983330654E-001	N/A
ft_true [name]	Truth row number	107	int
ft_true [q0]	Truth quaternion q0	+1.1714108883076305E-006	N/A
ft_true [q1]	Truth quaternion q1	-9.3738638321546567E-004	N/A
ft_true [q2]	Truth quaternion q2	+1.2496548701431507E-003	N/A
ft_true [q3]	Truth quaternion q3	+9.9999877983330654E-001	N/A
ft_prior [name]	Prior row number	107	int
ft_prior [q0]	FTprior quaternion q0	+1.1714108883076305E-006	N/A
ft_prior [q1]	FTprior quaternion q1	-9.3738638321546567E-004	N/A
ft_prior [q2]	FTprior quaternion q2	+1.2496548701431507E-003	N/A
ft_prior [q3]	FTprior quaternion q3	+9.9999877983330654E-001	N/A
ntable [NF]	ntable row number	107	int
ntable [iprime]	Prime frame indication flag	1	int
ntable [SIG_CX]	CX Sigma	+1.0000000000000001E-001	pixel
ntable [SIG_CY]	CY Sigma	+1.0000000000000001E-001	pixel
ntable [PIX2RADX]	Nom. angular pixelsize X-dir	+4.7904467948999998E-005	rad/pixel
ntable [PIX2RADY]	Nom. angular pixelsize Y-dir	+4.8792938470999998E-005	rad/pixel
ntable [CX0]	Center pixel along X-axis	+1.6500000000000000E+001	pixel
ntable [CY0]	Center pixel along Y-axis	+1.6500000000000000E+001	pixel
ntable [BETA0]	Nominal mirror scale factor	+2.8047410000000001E-006	rad/(e.u.)
ntable [GAMMA_E0]	Reference Mirror position	+2.0070000000000000E+003	(e.u.[6])

Table 2.1: FLUTE Parameter Table (1)

[6] encoder units

NAME	DESCRIPTION	VALUE	UNIT
ntable [D11]	x-to-w frame flip parameter	-1	int
ntable [D12]	y-to-w frame flip parameter	0	int
ntable [D21]	x-to-v frame flip parameter	0	int
ntable [D22]	y-to-v frame flip parameter	-1	int
ntable [DG]	Mirror flip parameter	1	int
ntable [sisizew]	Array size (w-direction)	+1.5126186850617522E-003	pixel
ntable [sisizev]	Array size (v-direction)	+1.5126186850617522E-003	pixel
ntable [p2i_w]	w-offset from prime	+0.0000000000000000E+000	pixel
ntable [p2i_v]	v-offset from prime	+0.0000000000000000E+000	pixel
p1true [a00]	True Constant Plate Scales	+1.0000000000000001E-001	N/A
p1true [b00]	True Constant Plate Scales	+1.0000000000000001E-001	N/A
p1true [c00]	True Constant Plate Scales	+1.0000000000000000E-002	N/A
p1true [a10]	True Γ Dependent Plate Scales	+1.0000000000000001E-001	1/rad
p1true [b10]	True Γ Dependent Plate Scales	+1.0000000000000001E-001	1/rad
p1true [c10]	True Γ Dependent Plate Scales	+1.0000000000000000E-002	1/rad
p1true [d10]	True Γ Dependent Plate Scales	+1.0000000000000000E-002	1/rad
p1true [a20]	True Γ^2 Dependent Plate Scales	+1.0000000000000001E-001	$1/\mathrm{rad}^2$
p1true [b20]	True Γ^2 Dependent Plate Scales	+1.0000000000000001E-001	$1/\mathrm{rad}^2$
p1true [c20]	True Γ^2 Dependent Plate Scales	+1.0000000000000000E-002	$1/\mathrm{rad}^2$
p1true [d20]	True Γ^2 Dependent Plate Scales	+1.0000000000000000E-002	$1/\mathrm{rad}^2$
p1true [a01]	True Linear Plate Scales	+2.0000000000000000E+000	N/A
p1true [b01]	True Linear Plate Scales	+2.0000000000000000E+000	N/A
p1true [c01]	True Linear Plate Scales	+2.0000000000000000E+000	N/A
p1true [d01]	True Linear Plate Scales	+2.0000000000000000E+000	N/A
p1true [e01]	True Linear Plate Scales	+2.0000000000000000E+000	N/A
p1true [f01]	True Linear Plate Scales	+2.0000000000000000E+000	N/A
p2true [am1]	True Scan mirror alignment Ux	+0.0000000000000000E+000	N/A
p2true [am2]	True Scan mirror alignment Uy	+2.0000000000000000E-002	N/A
p2true [am3]	True Scan mirror alignment Uz	+9.9979997999599901E-001	N/A
p2true [beta]	True Scan mirror scale factor	+1.1000000000000001E+000	N/A
p2true [qT1]	True IPF q1	+1.1714108883076305E-006	N/A
p2true [qT2]	True IPF q2	-9.3738638321546567E-004	N/A
p2true [qT3]	True IPF q3	+1.2496548701431507E-003	N/A
p2true [qT4]	True IPF q4	+9.9999877983330654E-001	N/A
p2true [qR01]	True Boresight Alignment q1	+2.4240683335224579E-004	N/A
p2true [qR02]	True Boresight Alignment q2	+1.6968478334657203E-005	N/A
p2true [qR03]	True Boresight Alignment q3	+1.9392546668179664E-005	N/A
p2true [qR04]	True Boresight Alignment q4	+9.9999997028746312E-001	N/A
p2true [brx]	True B. Alignment drift rate X	+4.0000000000000001E-010	rad/sec
p2true [bry]	True B. Alignment drift rate Y	+3.0000000000000000E-010	rad/sec
p2true [brz]	True B. Alignment drift rate Z	+2.0000000000000001E-010	rad/sec
p2true [crx]	True B. Alignment drift accel. X	+9.0000000000000000E-013	$\mathrm{rad/sec}^2$
p2true [cry]	True B. Alignment drift accel. Y	+8.0000000000000002E-013	$\mathrm{rad/sec}^2$
p2true [crz]	True B. Alignment drift accel. Z	+7.0000000000000005E-013	$\mathrm{rad/sec}^2$
p2true [bgx]	True Gyro bias correction X	+1.4544410433286078E-006	rad/sec
p2true [bgy]	True Gyro bias correction Y	+1.9392547244381440E-007	rad/sec
p2true [bgz]	True Gyro bias correction Z	+2.4240684055476802E-007	rad/sec
p2true [cgx]	True Gyro bias-rate correction X	+4.9999999999999999E-013	$\mathrm{rad/sec}^2$
p2true [cgy]	True Gyro bias-rate correction Y	+4.0000000000000001E-013	$\mathrm{rad/sec}^2$
p2true [cgz]	True Gyro bias-rate correction Z	+2.9999999999999998E-013	$\mathrm{rad/sec}^2$

Table 2.2: FLUTE Parameter Table (2)

NAME	DESCRIPTION	VALUE	UNIT
p2cmd [am1]	CMD Scan mirror alignment Ux	+0.0000000000000000E+000	N/A
p2cmd [am2]	CMD Scan mirror alignment Uy	+0.0000000000000000E+000	N/A
p2cmd [am3]	CMD Scan mirror alignment Uz	+1.0000000000000000E+000	N/A
p2cmd [beta]	CMD Scan mirror rotation SF	+1.0000000000000000E+000	N/A
p2cmd [qT1]	CMD IPF q1	+1.1714108883076305E-006	N/A
p2cmd [qT2]	CMD IPF q2	-9.3738638321546567E-004	N/A
p2cmd [qT3]	CMD IPF q3	+1.2496548701431507E-003	N/A
p2cmd [qT4]	CMD IPF q4	+9.9999877983330654E-001	N/A
p2cmd [qR01]	CMD Boresight Alignment q1	+0.0000000000000000E+000	N/A
p2cmd [qR02]	CMD Boresight Alignment q2	+0.0000000000000000E+000	N/A
p2cmd [qR03]	CMD Boresight Alignment q3	+0.0000000000000000E+000	N/A
p2cmd [qR04]	CMD Boresight Alignment q4	+1.0000000000000000E+000	N/A
p2cmd [brx]	CMD B. Alignment drift rate X	+0.0000000000000000E+000	rad/sec
p2cmd [bry]	CMD B. Alignment drift rate Y	+0.0000000000000000E+000	rad/sec
p2cmd [brz]	CMD B. Alignment drift rate Z	+0.0000000000000000E+000	rad/sec
p2cmd [crx]	CMD B. Alignment drift accel. X	+0.0000000000000000E+000	rad/sec^2
p2cmd [cry]	CMD B. Alignment drift accel. Y	+0.0000000000000000E+000	rad/sec^2
p2cmd [crz]	CMD B. Alignment drift accel. Z	+0.0000000000000000E+000	rad/sec^2
p2cmd [bgx]	CMD Gyro bias correction X	+0.0000000000000000E+000	rad/sec
p2cmd [bgy]	CMD Gyro bias correction Y	+0.0000000000000000E+000	rad/sec
p2cmd [bgz]	CMD Gyro bias correction Z	+0.0000000000000000E+000	rad/sec
p2cmd [cgx]	CMD Gyro bias-rate correction X	+0.0000000000000000E+000	rad/sec^2
p2cmd [cgy]	CMD Gyro bias-rate correction Y	+0.0000000000000000E+000	rad/sec^2
p2cmd [cgz]	CMD Gyro bias-rate correction Z	+0.0000000000000000E+000	rad/sec^2
a1	Semi-Major Axis of SIRTF (HCO [7])	+1.4960000000000000E+011	m
a2	Semi-Major Axis of Earth (HCO)	+1.4960000000000000E+011	m
e1	Eccentricity (SIRTF in HCO)	+1.6722000000000001E-002	N/A
e2	Eccentricity (Earth in HCO)	+1.6722000000000001E-002	N/A
inc1	inclination (SIRTF in HCO)	+4.0142572795869580E-001	rad
inc2	inclination (Earth in HCO)	+4.0142572795869580E-001	rad
Omega1	Ascending Node Long.(SIRTF in HCO)	+0.0000000000000000E+000	rad
Omega2	Ascending Node Long.(Earth in HCO)	+0.0000000000000000E+000	rad
omega1	Argument of Perigee(SIRTF in HCO)	+1.7627825445142729E+000	rad
omega2	Argument of Perigee(Earth in HCO)	+1.7627825445142729E+000	rad
nu0_1	True Anomaly of SIRTF(HCO)	+8.6071031605199810E-001	rad
nu0_2	True Anomaly of Earth(HCO)	+1.0328523792623976E+000	rad
inav	Velocity Report Flag	+0.0000000000000000E+000	rad
wsize	Array size W-dir	+1.5126186850617522E-003	rad
vsize	Array size V-dir	+1.5126186850617522E-003	rad

Table 2.3: FLUTE Parameter Table (3)

[7] Heliocentric Orbit

2.2 FLUTE GENERATED UNIT TEST DATA

This subsection plots the FLUTE generated IPF filter input files. Seven figures, as tabulated in Table 2.4, show the campaign maneuver senario, the true sampled locations on the array and the actual centroided data superimposed the array plane. All angles shown in FLUTE plots have units of radians.

FIGURE NO.	DESCRIPTION
Figure 2.1	Focal Plane Survey Scenario Plot
Figure 2.2	Commanded-only source locations in TPF
Figure 2.3	True and commanded source locations in TPF
Figure 2.4	True and commanded source locations (ZOOMED) in TPF
Figure 2.5	True-sampled and centroided locations in Focal Plane (W,V) including rectangular array boundary approximation
Figure 2.6	True and centroided locations on S/I Array (W,V) including rectangular array boundary approximation
Figure 2.7	True and centroided locations on S/I Array (W,V) showing Prime and Inferred Frames including rectangular array boundary approximation

Table 2.4: Table of figures (FLUTE)

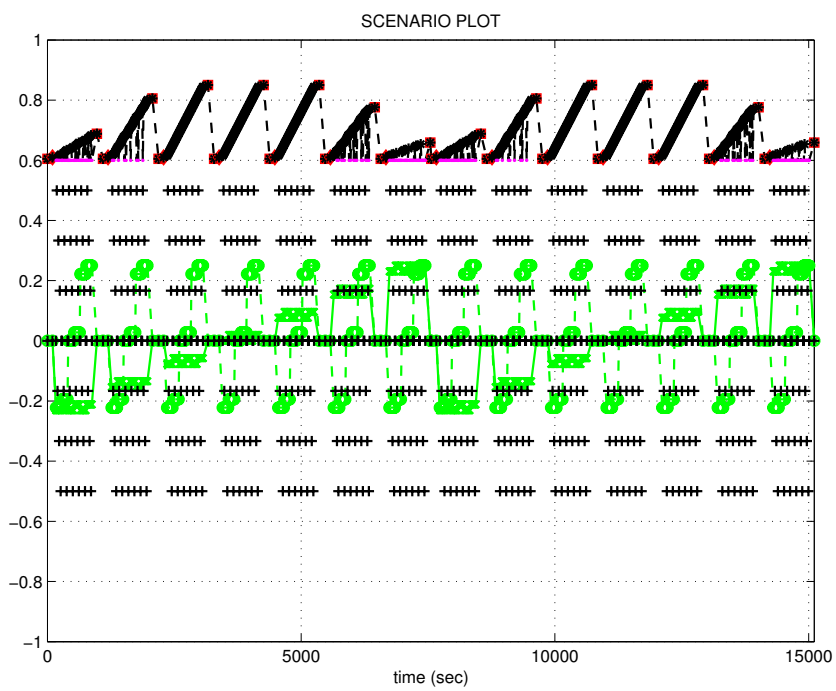

Figure 2.1: Focal plane survey scenario plot (See key in [3])

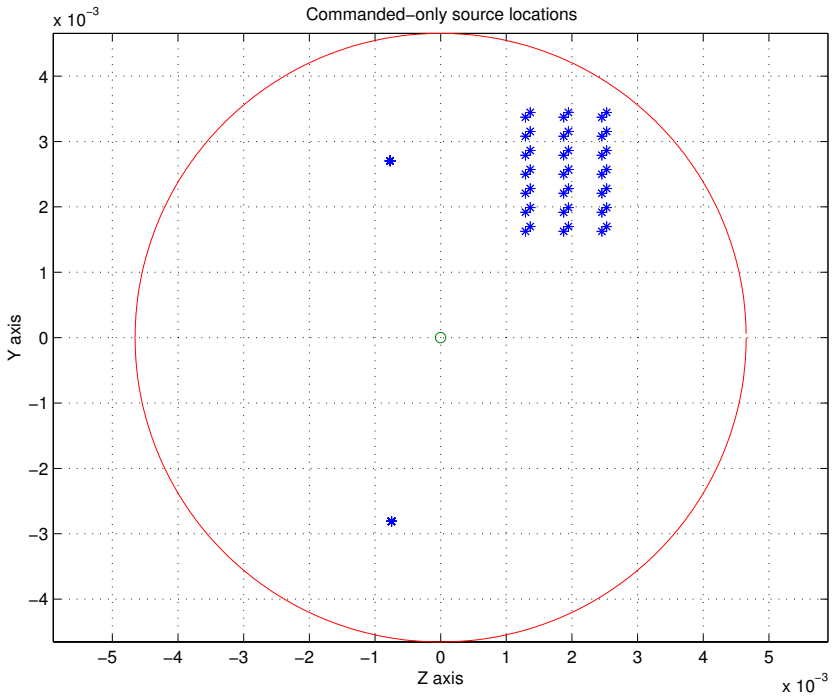

Figure 2.2: Commanded-only source locations

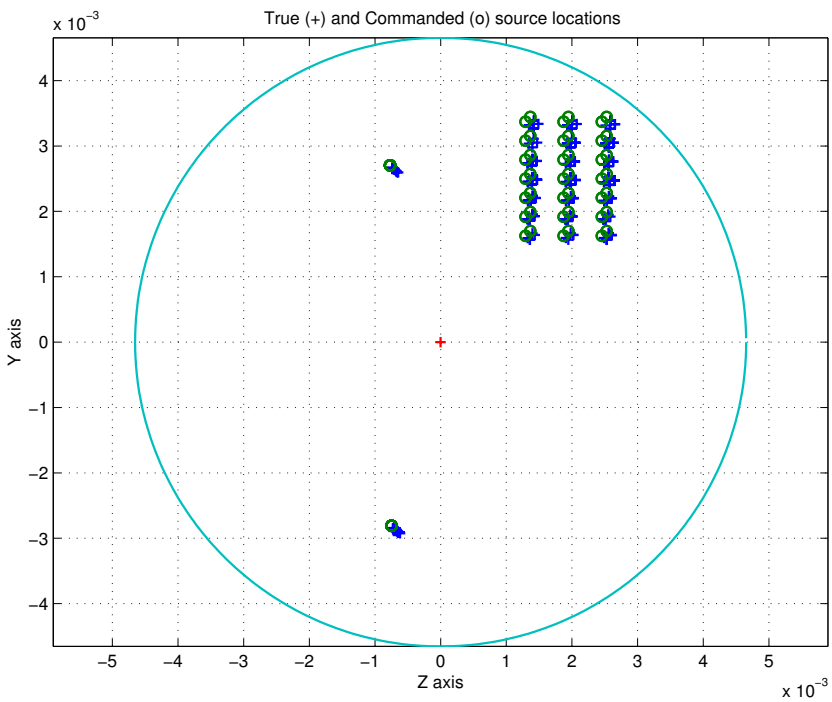

Figure 2.3: True (+) and commanded (o) source locations

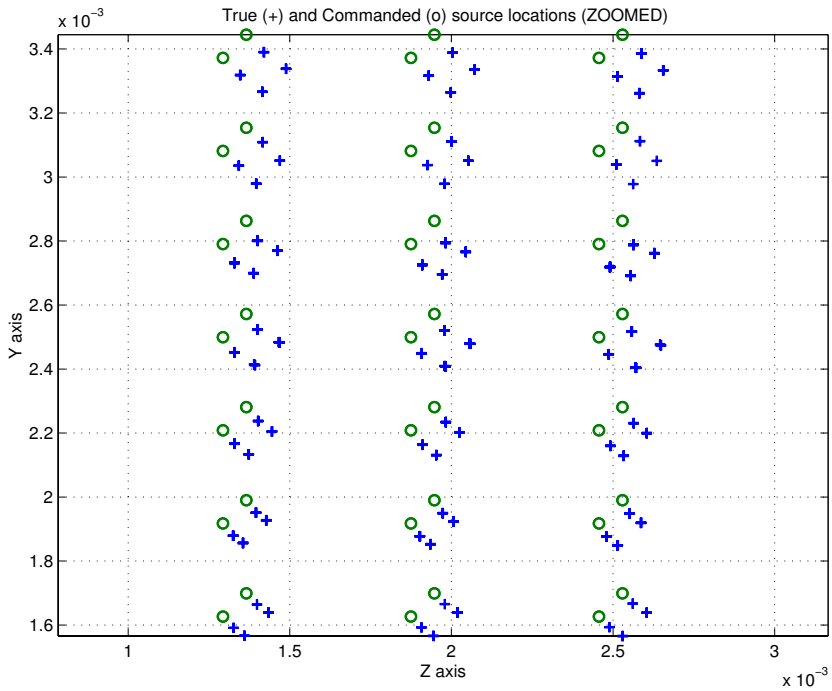

Figure 2.4: True (+) and commanded (o) source locations (ZOOMED)

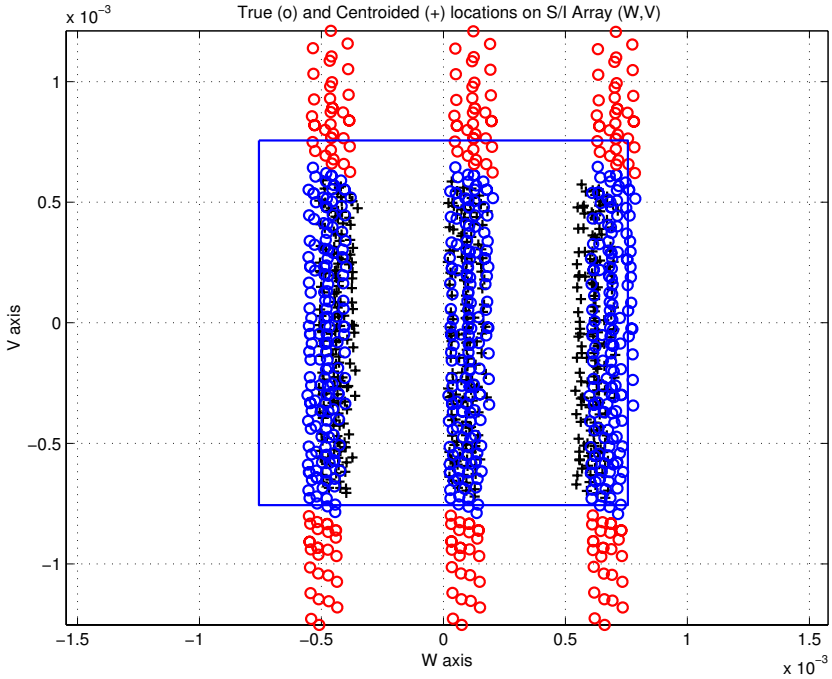

Figure 2.5: True-sampled (o) and centroided (+) locations on S/I array (W,V)

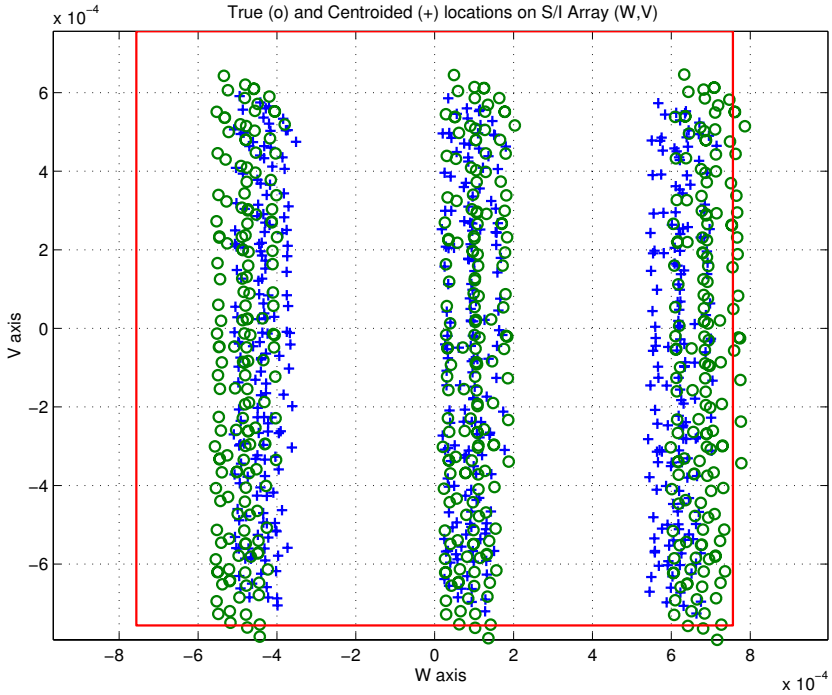

Figure 2.6: True (o) and centroided (+) locations on S/I array (W,V)

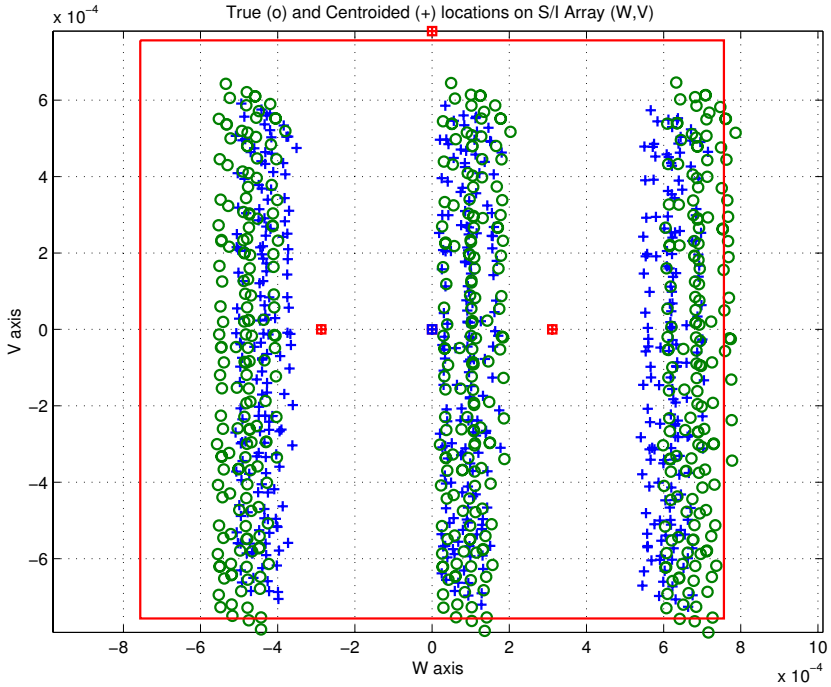

Figure 2.7: True (o) and centroided (+) locations on S/I array (W,V) showing prime and inferred frames

3 IPF EXECUTION RESULTS

3.1 IPF EXECUTION OUTPUT PLOTS

This subsection summarizes the IPF filter results. As shown in Table 3.1, the output plots are segmented to three groups: predicted performance, post-run results and IPF trending plots.

FIGURE NO.	DESCRIPTION
Predicted performance prior to IPF run	
Figure 3.1	Meas. and a-priori predicts in TPF coords
Figure 3.2	Meas. and a-priori predicts in Oriented Pixel Coords including rectangular array boundary approximation
Figure 3.3	A-priori prediction error
Figure 3.4	Oriented Pixel Coords of measurements and a-priori predicts (PCRS only)
IPF filter performance (post run results)	
Figure 3.5	IPF execution convergence, chart 1: (top) normalized residual error vs. iteration number and (bottom) norm of effective parameter corrections
Figure 3.6	IPF execution convergence, chart 2: parameter correction size vs. iteration number
Figure 3.7	Parameter uncertainty convergence: square-root of diagonal elements of covariance matrix vs. maneuver number
Figure 3.8	IPF parameter symbol table
Figure 3.9	KF parameter error sigma plot (a-priori-dashed, a-posteriori-solid). Includes true parameter errors (FLUTE runs only)
Figure 3.10	LS parameter error sigma plot. Includes true parameter errors (FLUTE runs only)
Figure 3.11	KF and LS parameter errors sigma plot (Figure 3.9 & Figure 3.10 combined)
Figure 3.12	Measurements and a-posteriori predicts in Oriented Pixel Coords including rectangular array boundaries (a-priori-dashed, a-posteriori-solid)
Figure 3.13	Attitude corrected meas. and a-posteriori predicts in Oriented Pixel Coords including rectangular array boundaries (a-priori-dashed, a-posteriori-solid)
Figure 3.14	Array plot with (solid) and w/o (dashed) optical distortion corrections
Figure 3.15	KF innovations with (o) and w/o (+) attitude corrections
Figure 3.16	W-axis KF innovations and 1-sigma bound
Figure 3.17	V-axis KF innovations and 1-sigma bound
IPF parameter trending plots	
Figure 3.18	Estimated attitude corrections (Body frame)
Figure 3.19	Estimated attitude error sigma plot (Body frame)
Figure 3.20	Systematic error attributed to thermo-mechanical boresight drift (equiv. angle in (W,V) coords)
Figure 3.21	Systematic error attributed to thermo-mechanical boresight drift (equiv. angle in Body frame)
Figure 3.22	Systematic error attributed to gyro drift bias (equiv. rate in (W,V) coords)
Figure 3.23	Systematic error attributed to gyro drift bias (equiv. angle in (W,V) coords)
Figure 3.24	Systematic error attributed to gyro drift bias (equiv. angle in Body frame)

Table 3.1: Table of figures (IPF run)

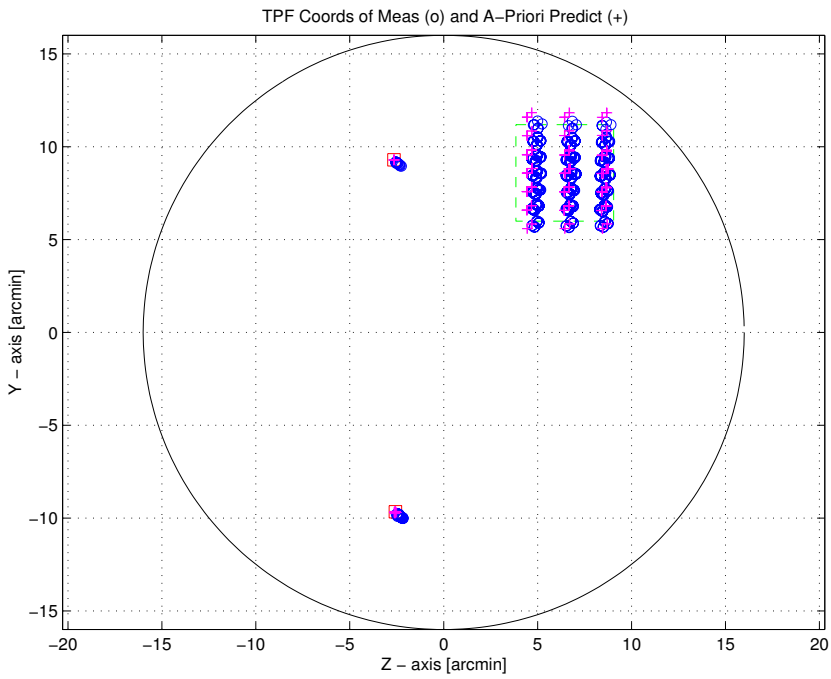

Figure 3.1: TPF coords of measurements and a-priori predicts

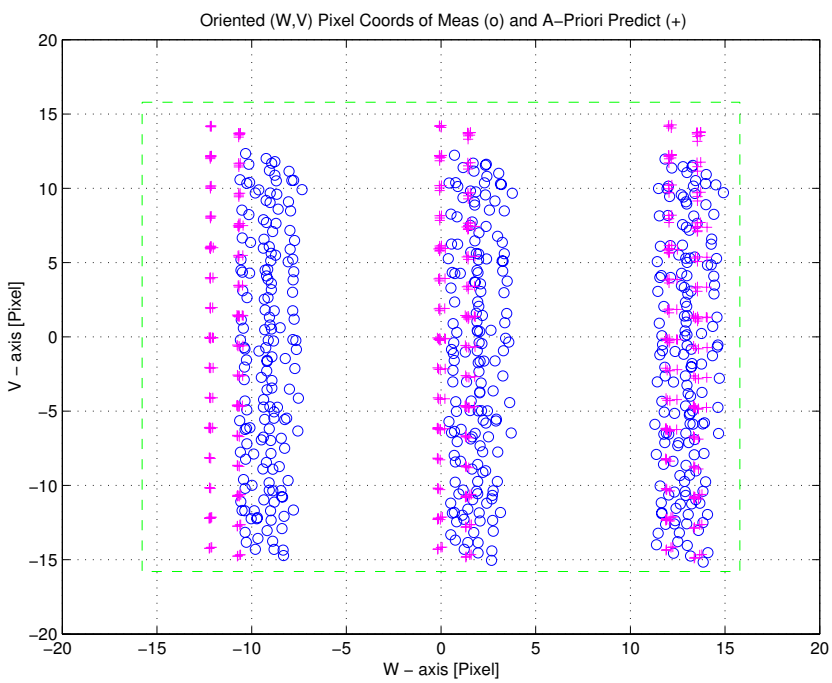

Figure 3.2: Oriented Pixel Coords of measurements and a-priori predicts

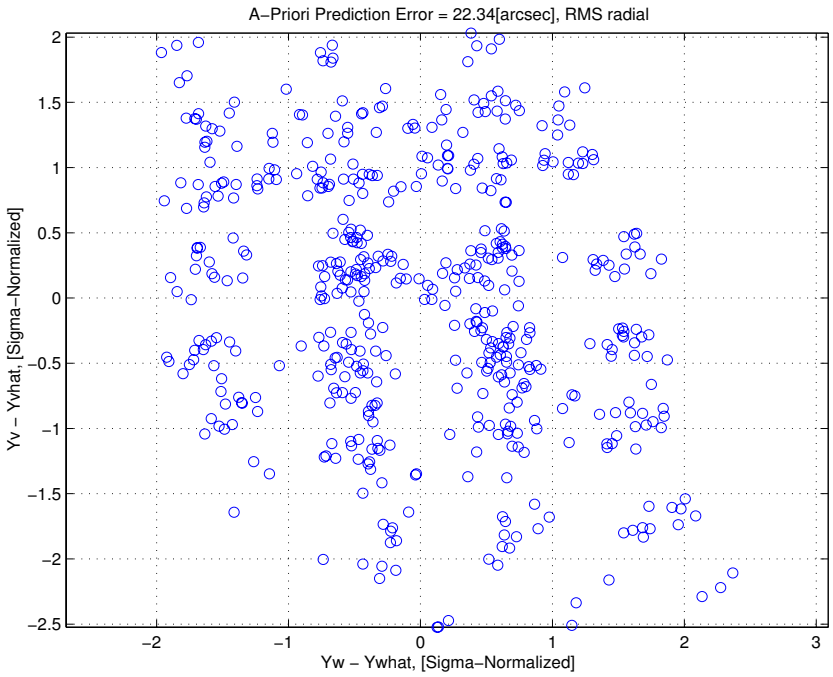

Figure 3.3: A-priori prediction error

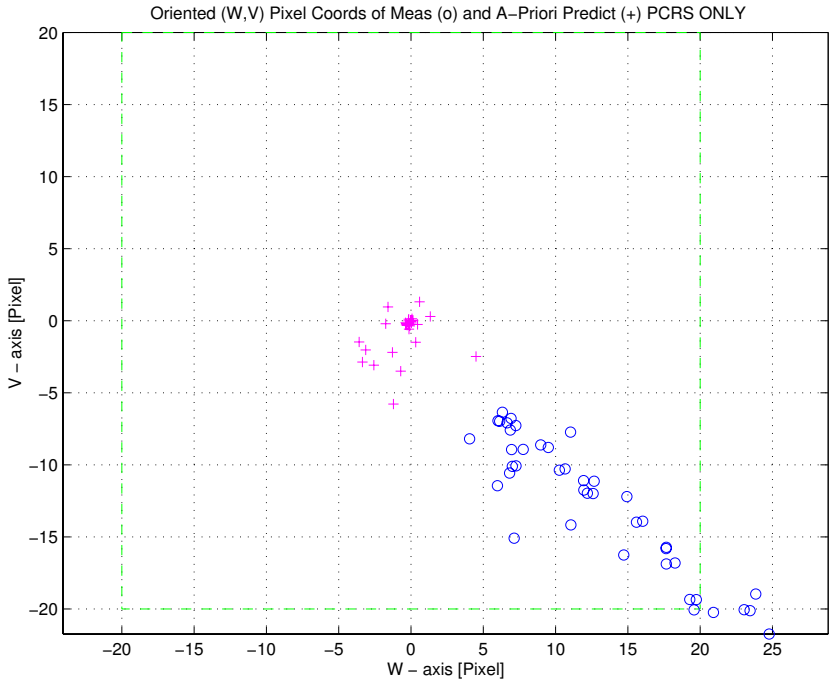

Figure 3.4: Oriented Pixel Coords of measurements and a-priori predicts (PCRS only)

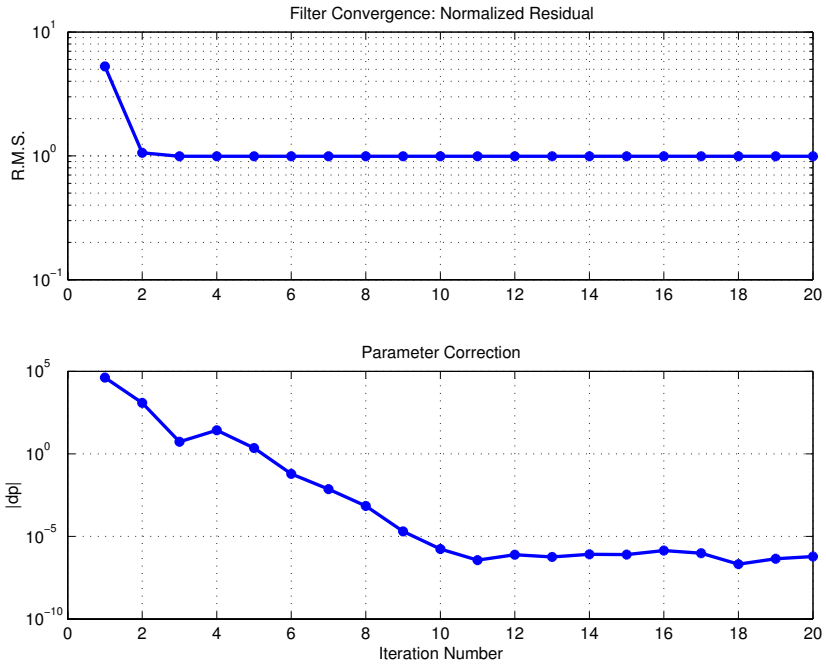

Figure 3.5: IPF execution convergence, chart 1

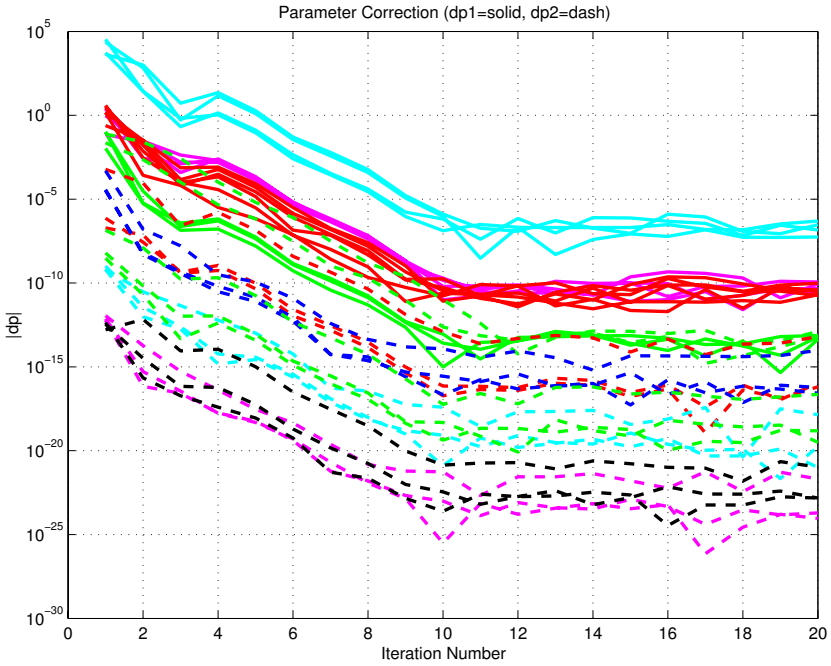

Figure 3.6: IPF execution convergence, chart 2

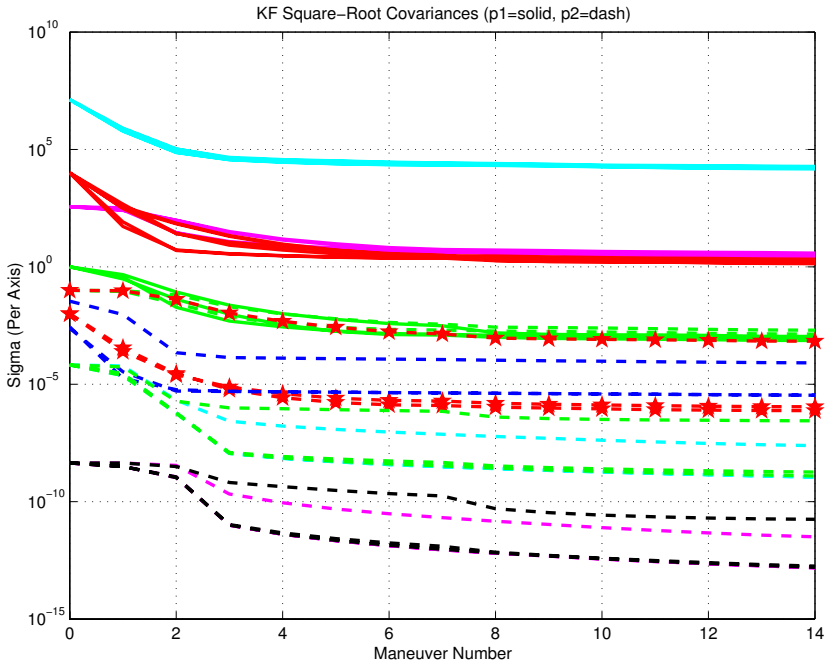

Figure 3.7: Parameter uncertainty convergence

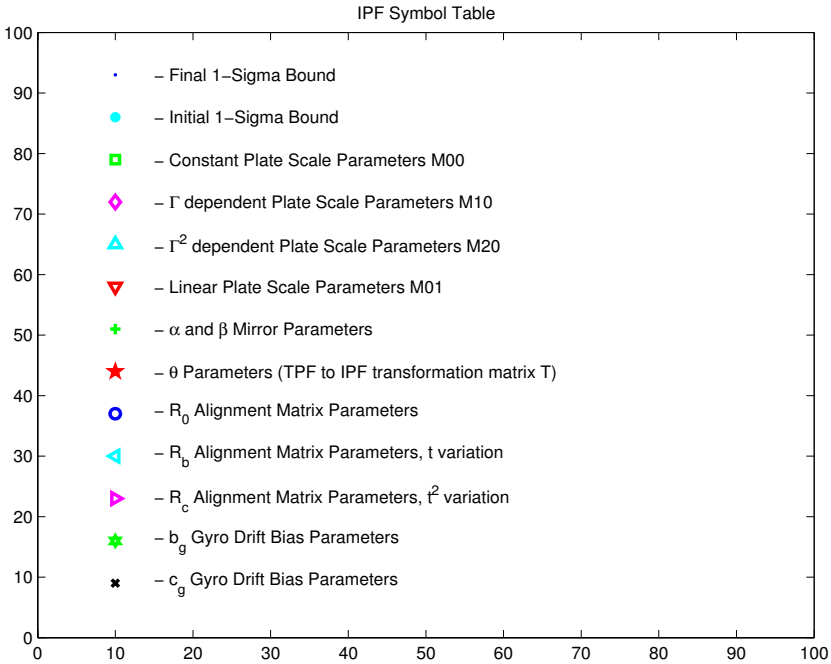

Figure 3.8: IPF parameter symbol table

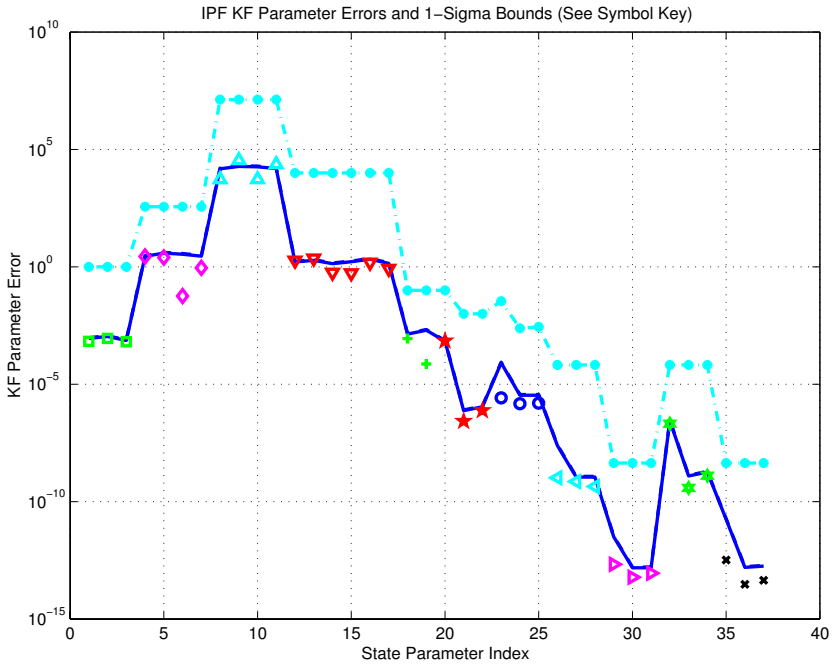

Figure 3.9: KF parameter error sigma plots

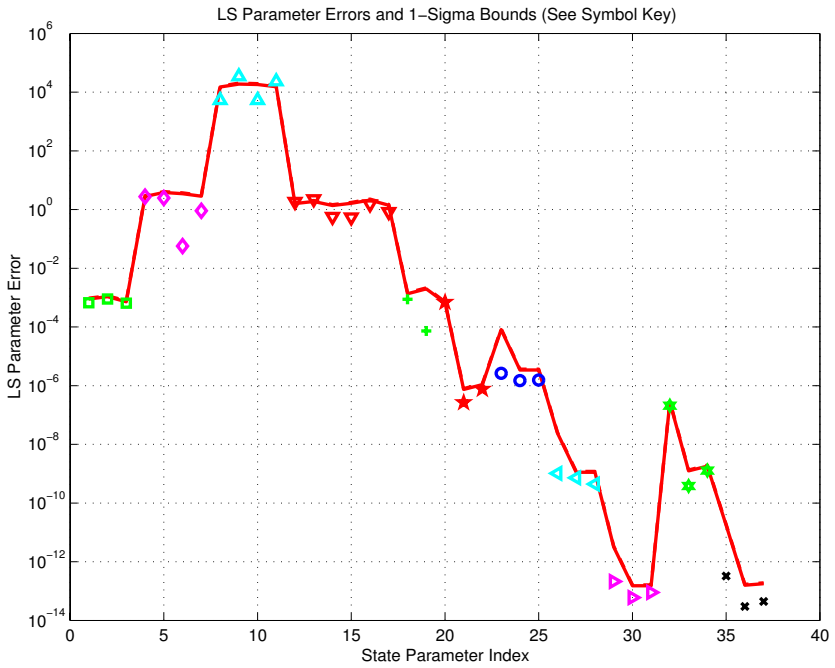

Figure 3.10: LS parameter error sigma plot

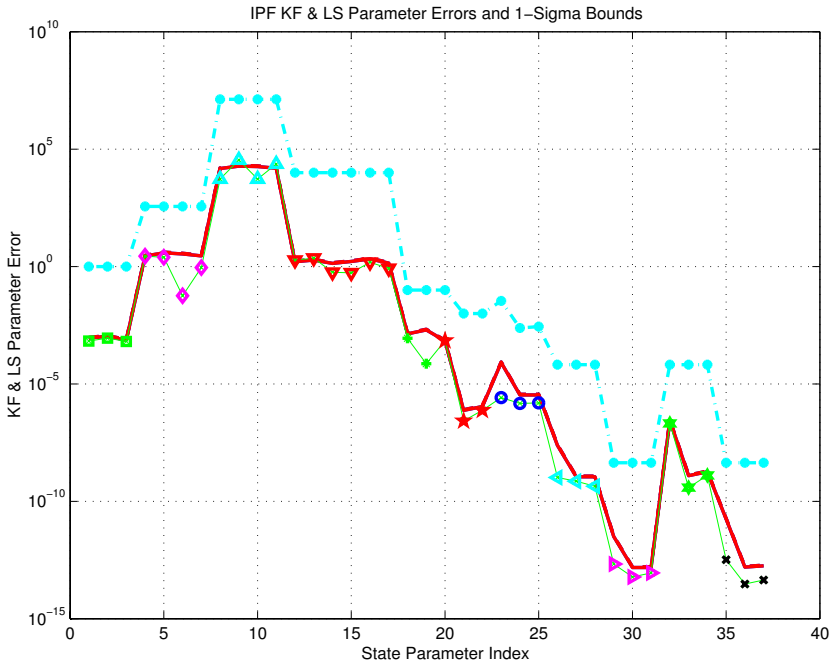

Figure 3.11: KF and LS parameter error sigma plot

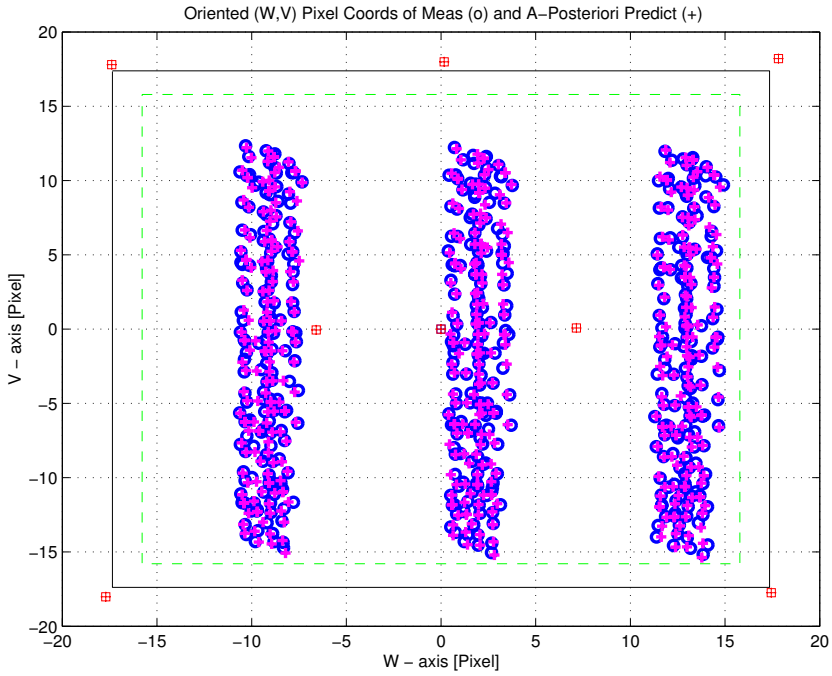

Figure 3.12: Oriented Pixel Coords of meas. and a-posteriori predicts

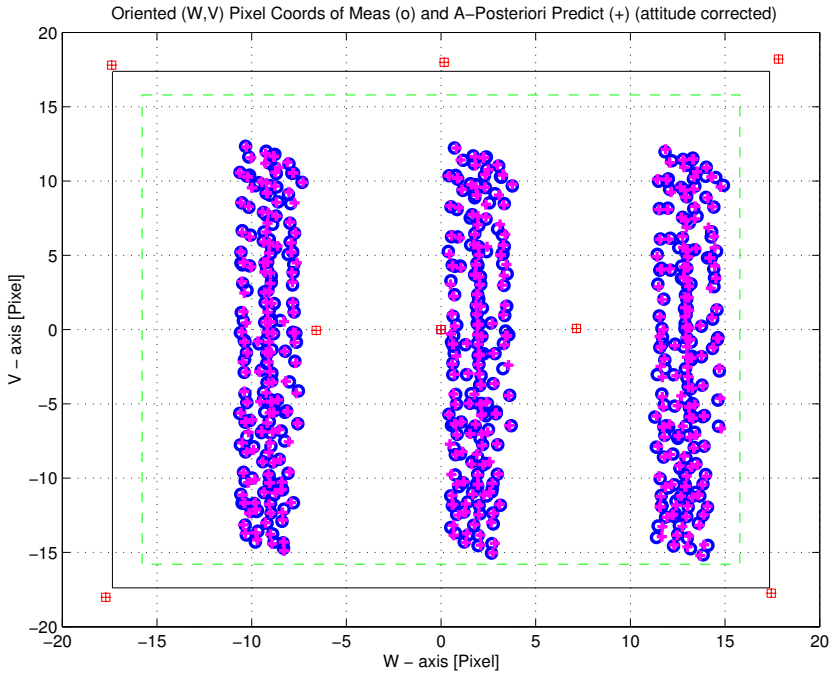

Figure 3.13: Oriented Pixel Coords of meas. and a-posteriori predicts (attitude corrected)

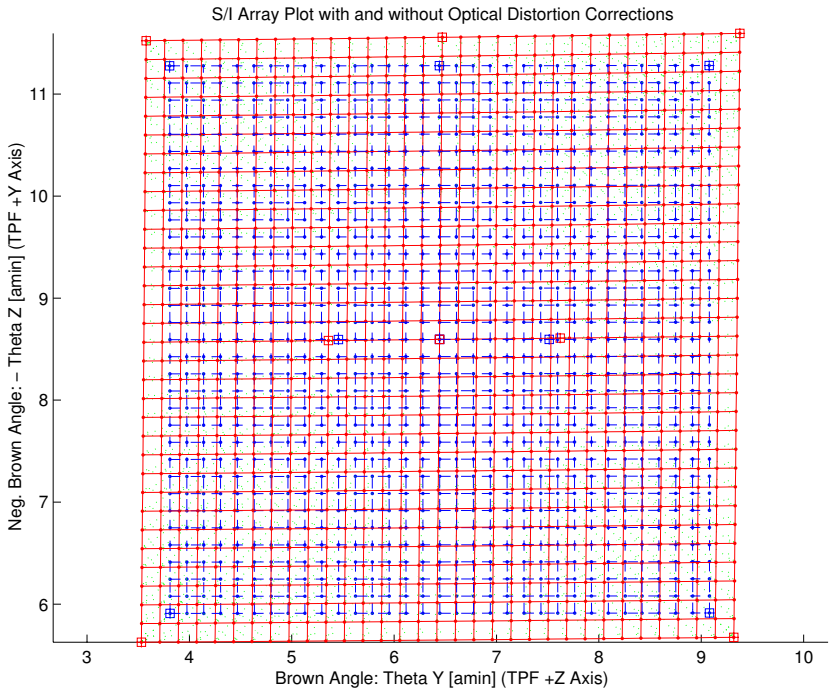

Figure 3.14: Array plot with (solid) and w/o (dashed) optical distortion corrections

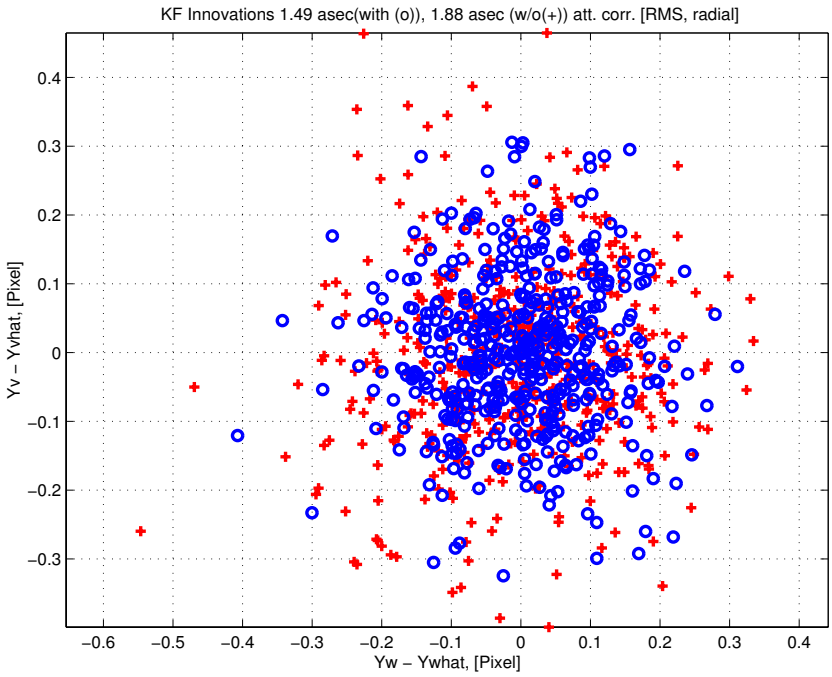

Figure 3.15: KF innovations with (o) and w/o (+) attitude corrections

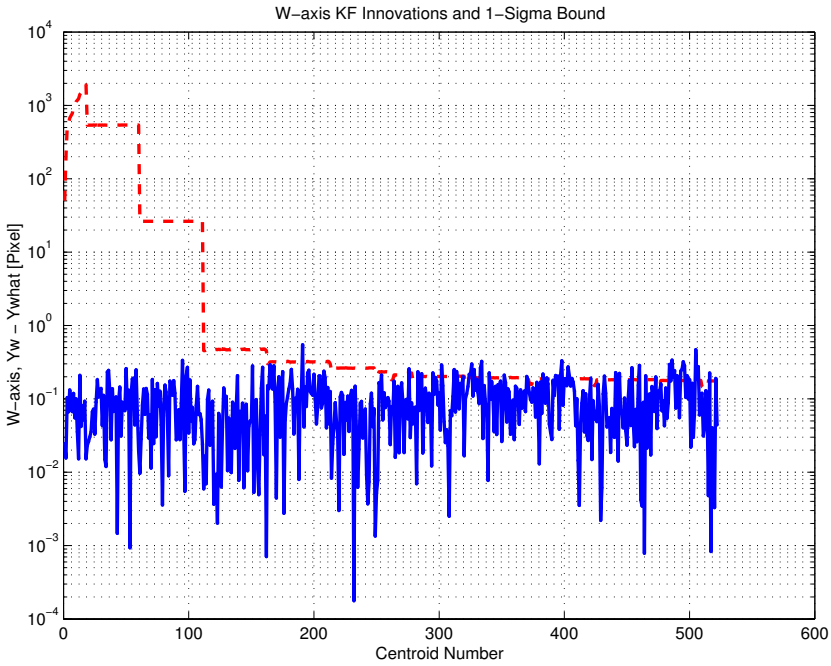

Figure 3.16: W-axis KF innovations and 1-sigma bound

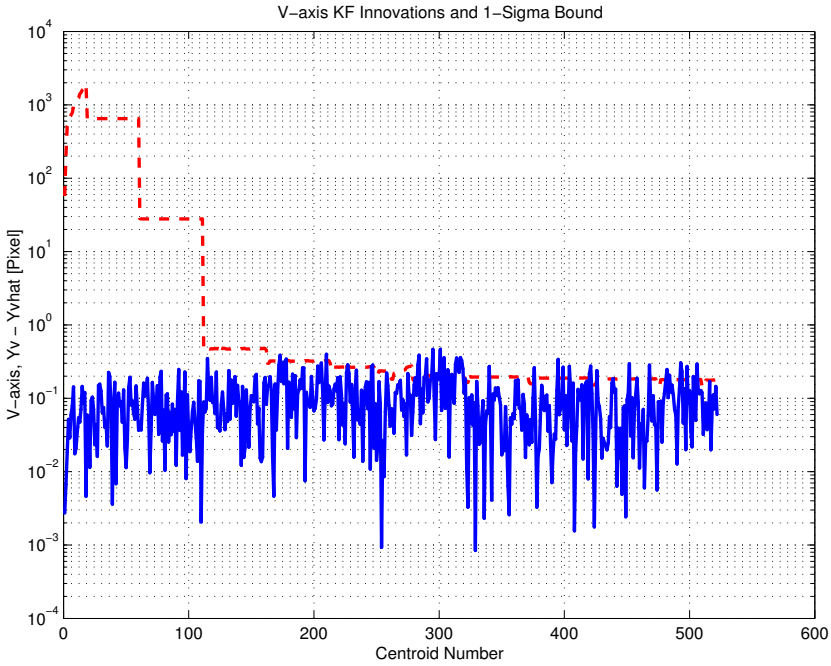

Figure 3.17: V-axis KF innovations and 1-sigma bound

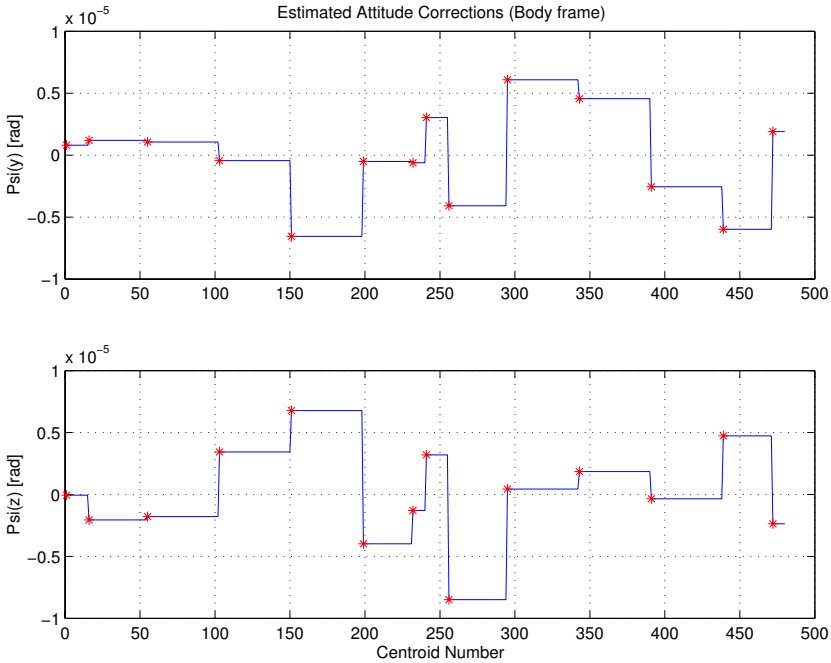

Figure 3.18: Estimated attitude corrections (Body frame)

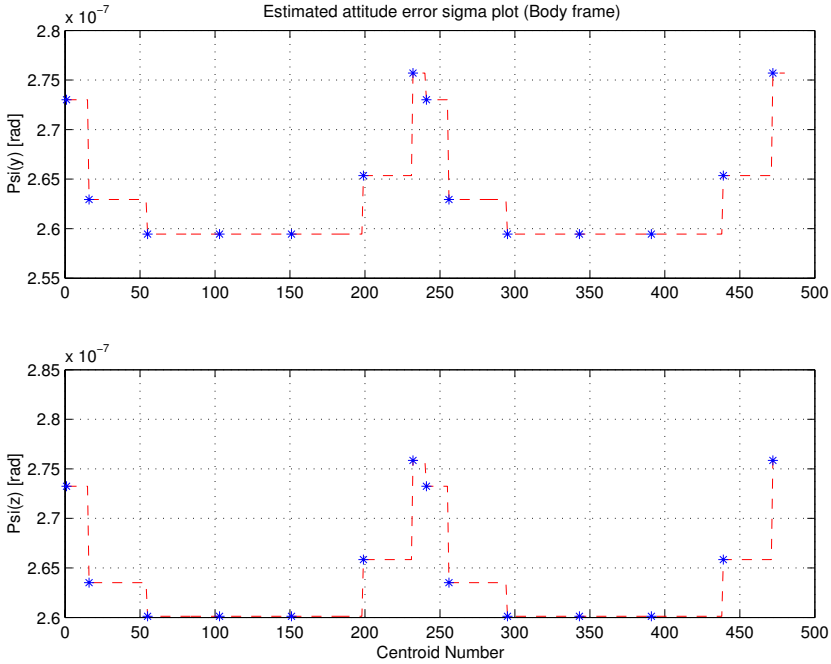

Figure 3.19: Estimated attitude error sigma plot (Body frame)

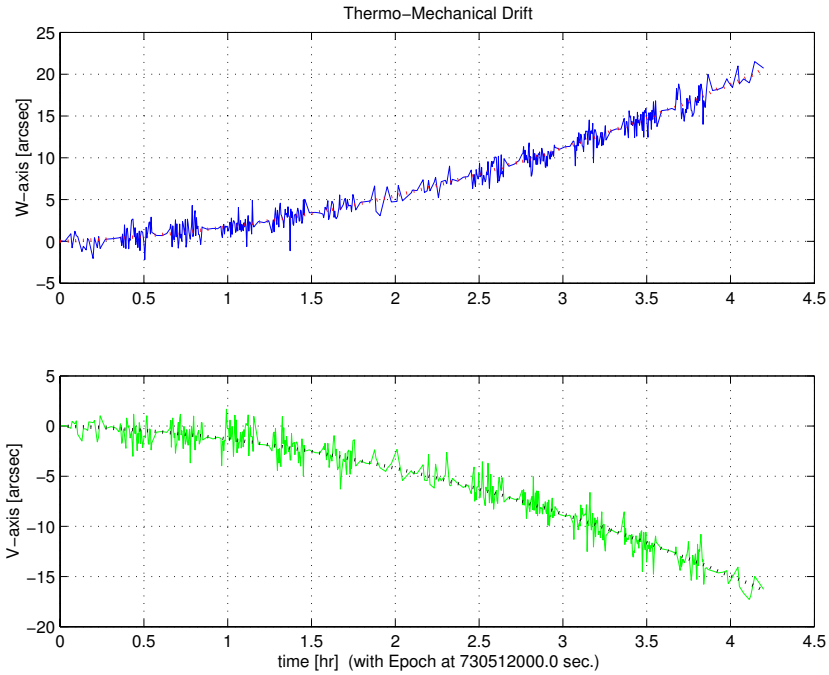

Figure 3.20: Thermo-mechanical boresight drift (equiv. angle in (W,V) coords)

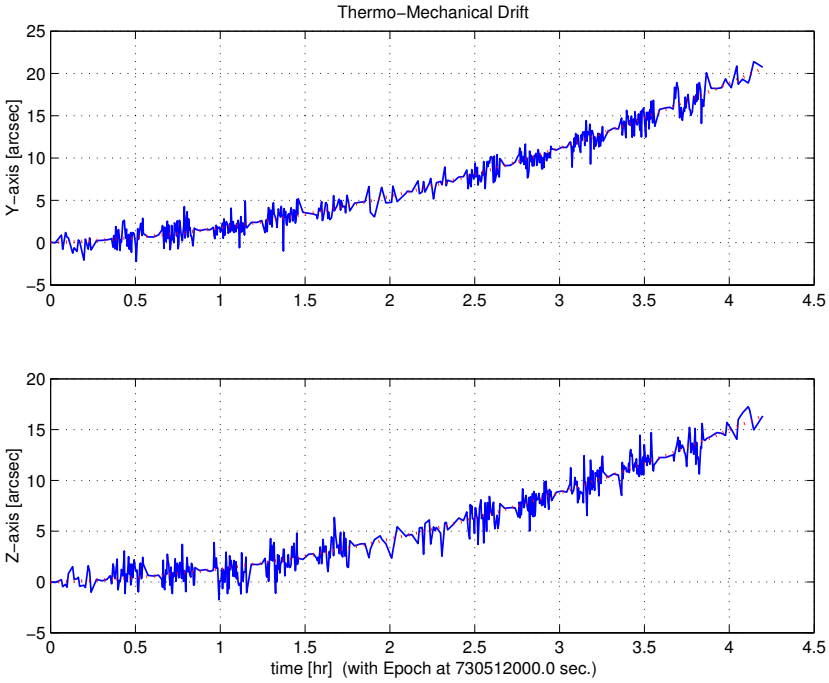

Figure 3.21: Thermo-mechanical boresight drift (equiv. angle in Body frame)

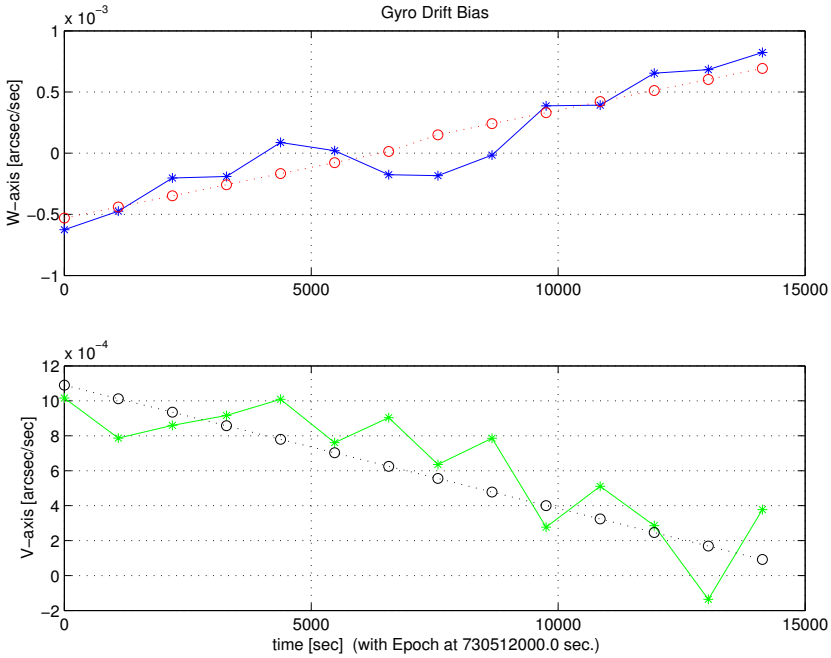

Figure 3.22: Gyro drift bias contribution (equiv. rate in (W,V) coords)

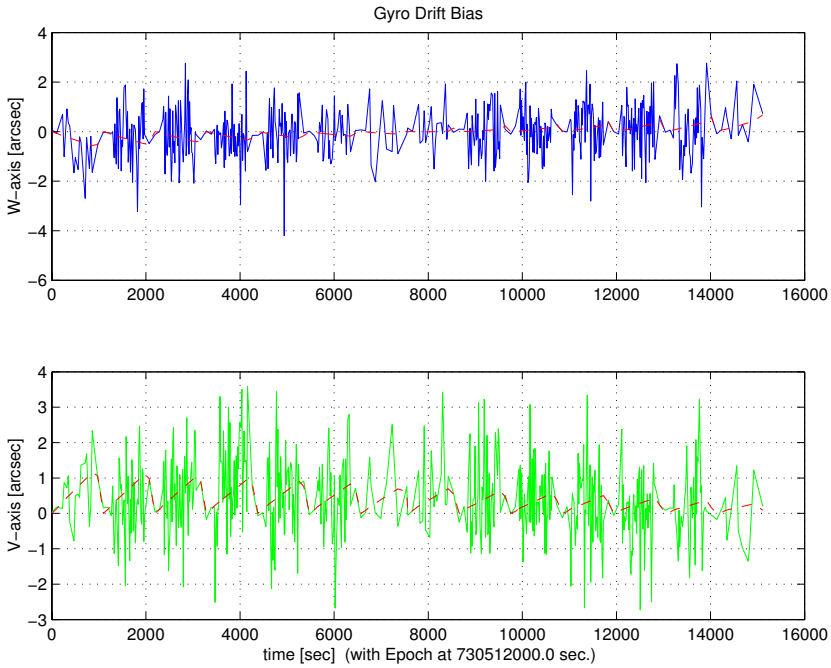

Figure 3.23: Gyro drift bias contribution (equiv. angle in (W,V) coords)

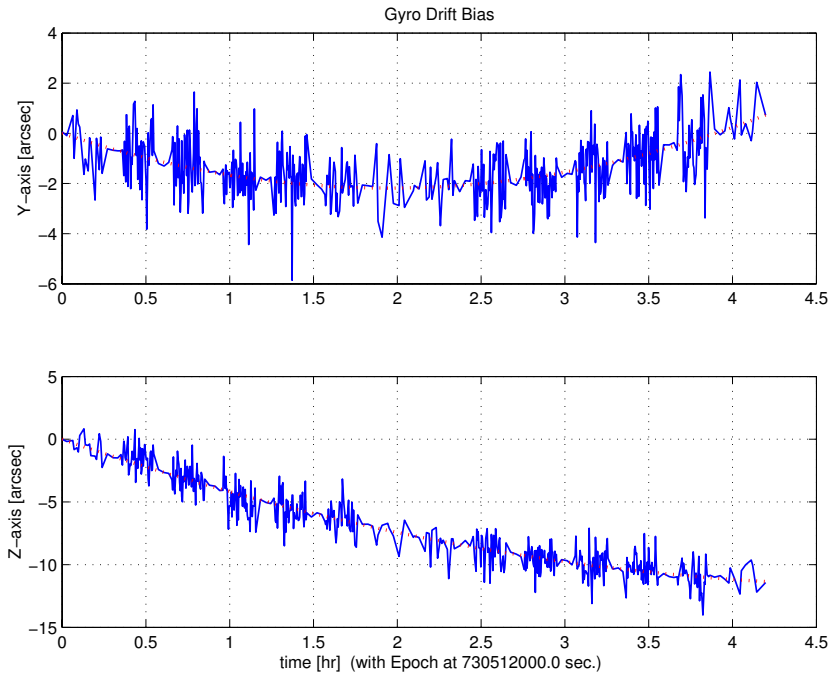

Figure 3.24: Gyro drift bias contribution (equiv. angle in Body frame)

3.2 IPF OUTPUT DATA (IF MINI FILE)

```
OUTPUT FILE NAME: IFmini992107.dat   DATE: 05-Aug-2003   TIME: 22:12
INSTRUMENT NAME:  MIPS_70um_center   NF: 107
IPF FILTER VERSION: IPF.V2.0.1Beta       SW RELEASE DATE: August 5, 2003
-------------------------------------------------------------------------------
---------------------------- IPF BROWN ANGLE SUMMARY ----------------------------
-------------------------------------------------------------------------------
         ------------ WAS ------------           ------------ IS -------------
Frame    theta_Y     theta_Z     angle           theta_Y     theta_Z     angle
Number   (arcmin)    (arcmin)    (deg)           (arcmin)    (arcmin)    (deg)
------  --------------------------------       --------------------------------
 107     +6.445000  -8.592000   +0.000000        +6.444083  -8.594608   -0.039787
 108     +6.348000 -11.259000   -0.000000        +6.470013 -11.556576   -0.039787
 111     +7.423000  -8.647000   -0.000000        +7.622128  -8.607305   -0.039787
 112     +5.385000  -8.533000   +0.000000        +5.358933  -8.583754   -0.039787
 115     +6.445000  -8.592000   +0.000000        +6.444083  -8.594608   -0.039787
 001     +0.000000  +0.000000   +0.000000        +9.377372 -11.595419   -0.039787
 001     +0.000000  +0.000000   +0.000000        +9.318468  -5.674528   -0.039787
 001     +0.000000  +0.000000   +0.000000        +3.578200 -11.523640   -0.039787
 001     +0.000000  +0.000000   +0.000000        +3.531061  -5.626091   -0.039787
-------------------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  0             107            +0.000            +0.000     pixels
OFFSET FRAME NAME: MIPS_70um_center
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
WAS(FTB)            +6.445000        -8.592000       +0.000000
IS (EST)            +6.444083        -8.594608       -0.039787
dT_EST              -0.000917        -0.002608       -0.039787
T_sSIGMA            +0.002728        +0.004009       +0.041329
dT_EST/T_sSIGMA     -0.336261        -0.650723       -0.962681
-----------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  1             108            +0.000           +16.000     pixels
OFFSET FRAME NAME: MIPS_70um_minusY_edge
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
WAS(FTB)            +6.348000       -11.259000       -0.000000
IS (EST)            +6.470013       -11.556576       -0.039787
dT_EST              +0.122013        -0.297576       -0.039787
T_sSIGMA            +0.005453        +0.006443       +0.041329
dT_EST/T_sSIGMA    +22.377059       -46.189400       -0.962682
-----------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  2             111            +6.500            +0.000     pixels
OFFSET FRAME NAME: MIPS_70um_default_small_FOV1
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
WAS(FTB)            +7.423000        -8.647000       -0.000000
IS (EST)            +7.622128        -8.607305       -0.039787
dT_EST              +0.199128        +0.039695       -0.039787
T_sSIGMA            +0.003172        +0.004851       +0.041329
dT_EST/T_sSIGMA    +62.785226        +8.182209       -0.962681
-----------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  3             112            -6.000            +0.000     pixels
OFFSET FRAME NAME: MIPS_70um_default_small_FOV2
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
WAS(FTB)            +5.385000        -8.533000       +0.000000
IS (EST)            +5.358933        -8.583754       -0.039787
dT_EST              -0.026067        -0.050754       -0.039787
T_sSIGMA            +0.002261        +0.003264       +0.041329
dT_EST/T_sSIGMA    -11.528775       -15.550038       -0.962681
-----------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  4             115            +0.000            +0.000     pixels
OFFSET FRAME NAME: MIPS_70um_default_large_FOV1
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
```

```
WAS(FTB)            +6.445000        -8.592000       +0.000000
IS (EST)            +6.444083        -8.594608       -0.039787
dT_EST              -0.000917        -0.002608       -0.039787
T_sSIGMA            +0.002728        +0.004009       +0.041329
dT_EST/T_sSIGMA     -0.336261        -0.650723       -0.962681
-------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  5               1           +16.000           +16.000     pixels
OFFSET FRAME NAME: CORNER PIXEL (DIAGNOSTICS)
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
WAS(FTB)            +0.000000        +0.000000       +0.000000
IS (EST)            +9.377372       -11.595419       -0.039787
dT_EST              +9.377372       -11.595419       -0.039787
T_sSIGMA            +0.007298        +0.008949       +0.041329
dT_EST/T_sSIGMA    +1284.980280       -1295.720819       -0.962683
-------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  6               1           +16.000           -16.000     pixels
OFFSET FRAME NAME: CORNER PIXEL (DIAGNOSTICS)
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
WAS(FTB)            +0.000000        +0.000000       +0.000000
IS (EST)            +9.318468        -5.674528       -0.039787
dT_EST              +9.318468        -5.674528       -0.039787
T_sSIGMA            +0.005872        +0.008012       +0.041329
dT_EST/T_sSIGMA    +1587.063319       -708.273875       -0.962682
-------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  7               1           -16.000           +16.000     pixels
OFFSET FRAME NAME: CORNER PIXEL (DIAGNOSTICS)
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
WAS(FTB)            +0.000000        +0.000000       +0.000000
IS (EST)            +3.578200       -11.523640       -0.039787
dT_EST              +3.578200       -11.523640       -0.039787
T_sSIGMA            +0.007105        +0.007612       +0.041329
dT_EST/T_sSIGMA    +503.641616       -1513.940588       -0.962681
-------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  8               1           -16.000           -16.000     pixels
OFFSET FRAME NAME: CORNER PIXEL (DIAGNOSTICS)
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
WAS(FTB)            +0.000000        +0.000000       +0.000000
IS (EST)            +3.531061        -5.626091       -0.039787
dT_EST              +3.531061        -5.626091       -0.039787
T_sSIGMA            +0.006167        +0.006649       +0.041329
dT_EST/T_sSIGMA    +572.547262       -846.209677       -0.962681
-------------------------------------------------------------------
-------------------------------------------------------------------------------------
-------------------------------------------------------------------------------------
VARNAME             MEAN                     SIGMA                 SCALED_SIGMA
a00        +9.9331393435925008E-002 +8.8988672280721891E-004 +9.5261963128749486E-004
b00        +1.0089492224385838E-001 +1.0764378656127384E-003 +1.1523217690102008E-003
c00        +1.0642511454470944E-002 +7.2150634224308469E-004 +7.7236921071368160E-004
a10        +2.8697959107170239E+000 +2.7882277217788904E+000 +2.9847849127219628E+000
b10        -2.3589847434252440E+000 +3.8270334970521356E+000 +4.0968217026387608E+000
c10        -4.6736159024306723E-002 +3.4546800929480392E+000 +3.6982191013915782E+000
d10        +9.1625440749140452E-001 +2.8428894432636089E+000 +3.0433000333904086E+000
a20        +5.3418930314378522E+003 +1.4970403335250938E+004 +1.6025747704678692E+004
b20        -3.4289494425527577E+004 +1.8904918372649558E+004 +2.0237627900394062E+004
c20        +5.3015423105045274E+003 +1.8150869559903240E+004 +1.9430422125140816E+004
d20        -2.3268816115515441E+004 +1.5274905570136136E+004 +1.6351715942307286E+004
a01        +3.8497446162399624E+000 +1.6000581691000559E+000 +1.7128548881797907E+000
b01        -2.7336219499385445E-001 +1.8896530204210495E+000 +2.0228648404778720E+000
c01        +1.4316646116662726E+000 +1.3670310058123916E+000 +1.4634003849472981E+000
d01        +1.4596293842278372E+000 +1.6347204130039117E+000 +1.7499606603651812E+000
e01        +3.5117660221178397E+000 +2.1091275128341556E+000 +2.2578112720641723E+000
f01        +2.8334735765066044E+000 +1.3980866259556410E+000 +1.4966452830360584E+000
del_alpha  -5.9487896379717409E-014 +1.3574103170092479E-003 +1.4531014819684209E-003
beta       +1.0999269868722792E+000 +1.9877426124413778E-003 +2.1278692962009280E-003
```

```
del_theta1 -6.3228312559629463E-014 +6.7382471874991728E-004 +7.2132625274262479E-004
del_theta2 +6.4095975735467970E-017 +7.4129388573357071E-007 +7.9355168473074324E-007
del_theta3 +1.0782845885577491E-016 +1.0892600676134831E-006 +1.1660478770969817E-006
del_arx    -9.5674268746175073E-015 +8.1191369947224631E-005 +8.6914986953465624E-005
del_ary    +2.7049573654092454E-017 +3.4068447904294408E-006 +3.6470116307327932E-006
del_arz    +5.8754863902768170E-017 +3.4014938953297655E-006 +3.6412835222148566E-006
brx        -6.2823695104638446E-010 +2.4176899014148285E-008 +2.5881258854923216E-008
bry        +1.0210250306046404E-009 +1.1144062961498102E-009 +1.1929667987334118E-009
brz        +6.4085163794596452E-010 +1.1125625204332067E-009 +1.1909930453350165E-009
crx        +1.1117085486564158E-012 +3.1580484139415510E-012 +3.3806762575204627E-012
cry        +7.3967222871962582E-013 +1.5193554692419580E-013 +1.6264630203022639E-013
crz        +6.1050587683796708E-013 +1.5168950437325366E-013 +1.6238291461455605E-013
bgx        +1.5173157211737461E-007 +2.7550953582673218E-007 +2.9493168704384379E-007
bgy        -3.0154061302756877E-009 +1.2435732513899367E-009 +1.3312394284083620E-009
bgz        -6.2422547567654051E-009 +1.8146915543824785E-009 +1.9426189369170618E-009
cgx        +8.2689604672987411E-013 +1.7519117293071505E-011 +1.8754134238076046E-011
cgy        +4.2992941527971604E-013 +1.5858327223039475E-013 +1.6976266130134193E-013
cgz        +3.4429862464899024E-013 +1.7858855075040947E-013 +1.9117821966299712E-013
-------------------------------------------------------------------------------
LSQF RESIDUAL SIGMA SCALE =         +1.0704953865165894E+000
-------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------------
                    a_mirror(1)               a_mirror(2)               a_mirror(3)
a_mirror_ipf   +0.0000000000000000E+000  +2.0872973227608321E-002  +9.9978213576190667E-001
a_mirror_tpf   -1.9279842189302569E-003  +2.1562471165244405E-002  +9.9976564389565770E-001
beta                beta_0                    beta                      beta_total
               +2.8047410000000001E-006  +1.0999269868722792E+000  +3.0850103170871433E-006
-----------------------------------------------------------------------------------------------------
qT               qT(1)                     qT(2)                     qT(3)                     qT(4)
FrmTbl:   +1.1714108883076305E-006 -9.3738638321546567E-004 +1.2496548701431507E-003 +9.9999877983330654E-001
Estim:    -3.4603147803143600E-004 -9.3768692235196105E-004 +1.2497087641214306E-003 +9.9999871961590858E-001
DelTheta        deltheta(1)               deltheta(2)               deltheta(3)
          -6.9440559435959609E-004 +2.6684071905274711E-007 +7.5877294954484819E-007       [rad]
EulAngT         theta(1)                  theta(2)                  theta(3)                  [rad]
Mean      -6.9440701688944283E-004 -1.8745076641309834E-003 +2.5000702631385076E-003
SigmaT    +6.7382471874991728E-004 +7.4129388573357071E-007 +1.0892600676134831E-006
-----------------------------------------------------------------------------------------------------
qR               qR(1)                     qR(2)                     qR(3)                     qR(4)
ASFILE:   +0.0000000000000000E+000 +0.0000000000000000E+000 +0.0000000000000000E+000 +1.0000000000000000E+000
Estim:    +2.4109643311408265E-004 +1.6226697674659611E-005 +1.8611967455692843E-005 +9.9999997063139889E-001
DelThetaR       deltheta R(1)             deltheta R(2)             deltheta R(3)
          +4.8219347502800625E-004 +3.2444419843966853E-005 +3.7231758244229587E-005       [rad]
EulAngR         angR(1)                   angR(2)                   angR(3)                   [rad]
Mean      +4.8219347502800625E-004 +3.2444419843966853E-005 +3.7231758244229587E-005
SigmaR    +8.1191369947224631E-005 +3.4068447904294408E-006 +3.4014938953297655E-006
-----------------------------------------------------------------------------------------------------
Initial Gyro Bias         Bg0(1)                    Bg0(2)                    Bg0(3)
                  +1.5108113660766746E-006 +1.9656065089985414E-007 +2.4738151977060690E-007
Gyro Bias Correction      Bg(1)                     Bg(2)                     Bg(3)
                  +1.5173157211737461E-007 -3.0154061302756877E-009 -6.2422547567654051E-009
Total Gyro Bias           BgT(1)                    BgT(2)                    BgT(3)
                  +1.6625429381940492E-006 +1.9354524476957844E-007 +2.4113926501384151E-007

Initial Gyro Bias Rate     Cg0(1)                    Cg0(2)                    Cg0(3)
                  +0.0000000000000000E+000 +0.0000000000000000E+000 +0.0000000000000000E+000
Gyro Bias Rate Correction  Cg(1)                     Cg(2)                     Cg(3)
                  +8.2689604672987411E-013 +4.2992941527971604E-013 +3.4429862464899024E-013
Total Gyro Bias Rate       CgT(1)                    CgT(2)                    CgT(3)
                  +8.2689604672987411E-013 +4.2992941527971604E-013 +3.4429862464899024E-013
-----------------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  1             108            +0.000           +16.000     pixels
OFFSET FRAME NAME: MIPS_70um_minusY_edge
qT               qT(1)                     qT(2)                     qT(3)                     qT(4)
WAS(FTB)  +1.5119196953387772E-006 -9.2327780520473960E-004 +1.6375537408473187E-003 +9.9999823298521595E-001
IS (EST)  -3.4562114934291727E-004 -9.4160733170221443E-004 +1.6805074947528883E-003 +9.9999808490627340E-001
```

```
DelTheta        deltheta(1)               deltheta(2)               deltheta(3)
Units             rad                       rad                       rad
          -6.9424717634958017E-004 -3.5492188388992128E-005 +8.6561222358759877E-005
EulAngT         theta(1)                  theta(2)                  theta(3)                  [rad]
Mean      -6.9440701688944294E-004 -1.8820505300809962E-003 +3.3616717169766934E-003
sSigmaT   +7.2132572272106440E-004 +1.5860967604063340E-006 +1.8740528146995418E-006
SigmaT    +6.7382422363189334E-004 +1.4816474506887139E-006 +1.7506407204590973E-006
-----------------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  2             111            +6.500            +0.000     pixels
OFFSET FRAME NAME: MIPS_70um_default_small_FOV1
qT               qT(1)                     qT(2)                     qT(3)                     qT(4)
WAS(FTB)  +1.3578036248737386E-006 -1.0796305229011367E-003 +1.2576541056642260E-003 +9.9999862635017700E-001
IS (EST)  -3.4581518863060140E-004 -1.1090270866440373E-003 +1.2514957251409324E-003 +9.9999854211355044E-001

DelTheta        deltheta(1)               deltheta(2)               deltheta(3)
Units             rad                       rad                       rad
          -6.9443194930376062E-004 -5.7924010959713026E-005 -1.1546703858160962E-005
EulAngT         theta(1)                  theta(2)                  theta(3)                  [rad]
Mean      -6.9440701688944283E-004 -2.2171871837414208E-003 +2.5037636081123166E-003
sSigmaT   +7.2132601023611404E-004 +9.2257389388130233E-007 +1.4111998629942162E-006
SigmaT    +6.7382449221319995E-004 +8.6181958885724283E-007 +1.3182680474563138E-006
-----------------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  3             112            -6.000            +0.000     pixels
OFFSET FRAME NAME: MIPS_70um_default_small_FOV2
qT               qT(1)                     qT(2)                     qT(3)                     qT(4)
WAS(FTB)  +9.7202971260263934E-007 -7.8321581857721488E-004 +1.2410738430199599E-003 +9.9999892315329675E-001
IS (EST)  -3.4623004741301194E-004 -7.7985799563839368E-004 +1.2481849558457609E-003 +9.9999885698963520E-001

DelTheta        deltheta(1)               deltheta(2)               deltheta(3)
Units             rad                       rad                       rad
          -6.9438389067319754E-004 +7.5824819235713360E-006 +1.4763604668175191E-005
EulAngT         theta(1)                  theta(2)                  theta(3)                  [rad]
Mean      -6.9440701688944283E-004 -1.5588505215706264E-003 +2.4969127071502611E-003
sSigmaT   +7.2132640109591852E-004 +6.5770060406413843E-007 +9.4942677411539945E-007
SigmaT    +6.7382485733369411E-004 +6.1438901311317901E-007 +8.8690412501902570E-007
-----------------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  4             115            +0.000            +0.000     pixels
OFFSET FRAME NAME: MIPS_70um_default_large_FOV1
qT               qT(1)                     qT(2)                     qT(3)                     qT(4)
WAS(FTB)  +1.1714108883076305E-006 -9.3738638321546567E-004 +1.2496548701431507E-003 +9.9999877983330654E-001
IS (EST)  -3.4603147803143600E-004 -9.3768692235196105E-004 +1.2497087641214304E-003 +9.9999871961590869E-001

DelTheta        deltheta(1)               deltheta(2)               deltheta(3)
Units             rad                       rad                       rad
          -6.9440559435959598E-004 +2.6684071905296379E-007 +7.5877294954441429E-007
EulAngT         theta(1)                  theta(2)                  theta(3)                  [rad]
Mean      -6.9440701688944294E-004 -1.8745076641309836E-003 +2.5000702631385067E-003
sSigmaT   +7.2132625274262457E-004 +7.9355168473074303E-007 +1.1660478770969813E-006
SigmaT    +6.7382471874991706E-004 +7.4129388573357050E-007 +1.0892600676134826E-006
-----------------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  5              1           +16.000           +16.000     pixels
OFFSET FRAME NAME: CORNER PIXEL (DIAGNOSTICS)
qT               qT(1)                     qT(2)                     qT(3)                     qT(4)
WAS(FTB)  +0.0000000000000000E+000 +0.0000000000000000E+000 +0.0000000000000000E+000 +1.0000000000000000E+000
IS (EST)  -3.4490251742933631E-004 -1.3644665196198631E-003 +1.6860092595726917E-003 +9.9999758832016528E-001

DelTheta        deltheta(1)               deltheta(2)               deltheta(3)
Units             rad                       rad                       rad
          -6.9440701688944294E-004 -2.7277668230040980E-003 +3.3729705470823225E-003
```

```
EulAngT         theta(1)                theta(2)                theta(3)                [rad]
Mean      -6.9440701688944283E-004 -2.7277668230040980E-003 +3.3729705470823220E-003
sSigmaT   +7.2132495848204457E-004 +2.1228083154893115E-006 +2.6031614964713344E-006
SigmaT    +6.7382350972034410E-004 +1.9830149127470477E-006 +2.4317353715479965E-006
-----------------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------------
OFFSET          NF          Delta_CW          Delta_CV
  6              1           +16.000           -16.000     pixels
OFFSET FRAME NAME: CORNER PIXEL (DIAGNOSTICS)
qT              qT(1)                   qT(2)                   qT(3)                   qT(4)
WAS(FTB)  +0.0000000000000000E+000 +0.0000000000000000E+000 +0.0000000000000000E+000 +1.0000000000000000E+000
IS (EST)  -3.4608448627179630E-004 -1.3556018948542776E-003 +8.2485513227118141E-004 +9.9999868109065115E-001

DelTheta        deltheta(1)               deltheta(2)               deltheta(3)
Units             rad                       rad                       rad
          -6.9440701688944294E-004 -2.7106325941545356E-003 +1.6506532079764813E-003
EulAngT         theta(1)                theta(2)                theta(3)                [rad]
Mean      -6.9440701688944294E-004 -2.7106325941545356E-003 +1.6506532079764813E-003
sSigmaT   +7.2132550895397790E-004 +1.7079549140213267E-006 +2.3305295666475451E-006
SigmaT    +6.7382402394202149E-004 +1.5954808731862373E-006 +2.1770570859077952E-006
-----------------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------------
OFFSET          NF          Delta_CW          Delta_CV
  7              1           -16.000           +16.000     pixels
OFFSET FRAME NAME: CORNER PIXEL (DIAGNOSTICS)
qT              qT(1)                   qT(2)                   qT(3)                   qT(4)
WAS(FTB)  +0.0000000000000000E+000 +0.0000000000000000E+000 +0.0000000000000000E+000 +1.0000000000000000E+000
IS (EST)  -3.4633070600632371E-004 -5.2100929071340258E-004 +1.6758637287037986E-003 +9.9999840004128193E-001

DelTheta        deltheta(1)               deltheta(2)               deltheta(3)
Units             rad                       rad                       rad
          -6.9440701688944294E-004 -1.0408562960442160E-003 +3.3520910712398775E-003
EulAngT         theta(1)                theta(2)                theta(3)                [rad]
Mean      -6.9440701688944294E-004 -1.0408562960442160E-003 +3.3520910712398766E-003
sSigmaT   +7.2132596948179366E-004 +2.0666606217829124E-006 +2.2141496822555500E-006
SigmaT    +6.7382445414267589E-004 +1.9305647159376017E-006 +2.0683411718946605E-006
-----------------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------------
OFFSET          NF          Delta_CW          Delta_CV
  8              1           -16.000           -16.000     pixels
OFFSET FRAME NAME: CORNER PIXEL (DIAGNOSTICS)
qT              qT(1)                   qT(2)                   qT(3)                   qT(4)
WAS(FTB)  +0.0000000000000000E+000 +0.0000000000000000E+000 +0.0000000000000000E+000 +1.0000000000000000E+000
IS (EST)  -3.4678309295644297E-004 -5.1385587143692904E-004 +8.1810316689016449E-004 +9.9999947320028038E-001

DelTheta        deltheta(1)               deltheta(2)               deltheta(3)
Units             rad                       rad                       rad
          -6.9440701688944304E-004 -1.0271439733928315E-003 +1.6365634587366137E-003
EulAngT         theta(1)                theta(2)                theta(3)                [rad]
Mean      -6.9440701688944283E-004 -1.0271439733928315E-003 +1.6365634587366133E-003
sSigmaT   +7.2132647549035282E-004 +1.7939898427380563E-006 +1.9339928436494706E-006
SigmaT    +6.7382492682902797E-004 +1.6758501394160422E-006 +1.8066335156685886E-006
-----------------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------------
              q(1)                    q(2)                    q(3)                    q(4)
PCRS1A: +5.2603126189317361E-007 +3.7451819048221893E-004 -1.4045531552277380E-003 +9.9999894348258311E-001
PCRS2A: -5.1968404336718985E-007 +3.8455385122900486E-004 +1.3513933841514693E-003 +9.9999901292650617E-001
-----------------------------------------------------------------------------------------
**********  CS-FILE PARAMETERS:  **********  **********  AS-FILE PARAMETERS:  **********
Row (01) PIX2RADX: +4.7904467948999998E-005  Row (1) TASTART:   +7.3051200000000000E+008
Row (02) PIX2RADY: +4.8792938470999998E-005  Row (2) TASTOP:    +7.3052711000000000E+008
Row (03) CX0:      +1.6500000000000000E+001  Row (3) S/C TIME:  +7.3051200000000000E+008
Row (04) CY0:      +1.6500000000000000E+001  Row (4) QR1:       +0.0000000000000000E+000
Row (05) BETA0:    +2.8047410000000001E-006  Row (5) QR2:       +0.0000000000000000E+000
Row (06) GAMMA_E0: +2.0070000000000000E+003  Row (6) QR3:       +0.0000000000000000E+000
Row (07) D11:      -1.0000000000000000E+000  Row (7) QR4:       +1.0000000000000000E+000
Row (08) D12:      +0.0000000000000000E+000
Row (09) D21:      +0.0000000000000000E+000
```

```
Row (10) D22:      -1.0000000000000000E+000
Row (11) DG:       +1.0000000000000000E+000
-------------------------------------------------------------------------------------
-------------------------------------------------------
INITIAL STA-TO-PCRS ALIGNMENT (R) KNOWLEDGE (1-SIGMA)
    SIGMA(X)        SIGMA(Y)         SIGMA(Z)
1.41421656E+002  9.90383438E+000  1.13175056E+001  [arcsec]
-------------------------------------------------------
PIX2RADX = 4.790446794900E-005[rad/pixel]
XPIXSIZE = 9.8810[arcsec]
PIX2RADY = 4.879293847100E-005[rad/pixel]
YPIXSIZE = 10.0643[arcsec]
CX0 = 16.5[pixel] = 163.04[arcsec]
CY0 = 16.5[pixel] = 166.06[arcsec]
-------------------------------------------------------
NOMINAL BETA0 = 2.804741000000E-006[rad/encoder unit]
ENCODER UNIT SIZE = 0.58[arcsec]
GAMMA_E0 = 2007.00[encoder unit] = 1161.09[arcsec]
-------------------------------------------------------
                | -1 | +0 |
FLIP MATRIX D = |----|----|   and   DG = +1
                | +0 | -1 |
-------------------------------------------------------
```

3.3 IPF EXECUTION LOG

```
*********************************************************************
IPF EXECUTION-LOG FILE NAME:  LG992107.dat
INSTRUMENT TYPE:              MIPS_70um_center
IPF FILTER EXECUTION DATE:    05-Aug-2003    TIME: 22:04
IPF FILTER VERSION USED:      IPF.V2.0.1Beta
*********************************************************************

------------------- Loading & Preparing Input Files -------------------
AAFILE:  AA992107 Loaded!        AAFILE dimension = 151101 X 21
ASFILE:  AS992107 Loaded!
CAFILE:  CA992107 Loaded!        CAFILE dimension = 480 X 15
CBFILE:  CB992107 Loaded!        CBFILE dimension = 42 X 15
CCFILE:  CC992107 Created!       CCFILE dimension = 522 X 19
CSFILE:  CS992107 Loaded!
Loading Input Files Completed!
---------------------------------------------------------------------

------------------------ Selected Mask Vectors ------------------------
index =   1  2  3  4  5  6  7  8  9 10 11 12 13 14 15 16 17 18 19 20
---------------------------------------------------------------------
mask1 = [ 1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1 ]
mask2 = [ 1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1 ]
---------------------------------------------------------------------

---------------  Selected Initial Gyro Bias Parameters  ---------------
User Entered 1 : Use AFILE database - from S/C filter
IPF Linearized Using Following Nominal Gyro Bias Estimates
bg0 = [+1.5108113660766746E-006 +1.9656065089985414E-007 +2.4738151977060690E-007 ]
cg0 = [+0.0000000000000000E+000 +0.0000000000000000E+000 +0.0000000000000000E+000 ]
---------------------------------------------------------------------

---------------  Gyro Pre-Processor Run Completed  --------------------
     AGFILE CREATED:  AG992107.m     ACFILE CREATED:  AC992107.m
---------------------------------------------------------------------
```

```
Total Gyro Preprocessor Execution Time: 81 seconds

FRAME TABLE ENTRIES FOR PCRS LOADED TO TPCRS
q_PCRS4 = [ +5.2603126189317361E-007     q_PCRS5 = [ +7.3379987833742897E-007
            +3.7451819048221893E-004                 +5.2236196154513707E-004
            -1.4045531552277380E-003                 -1.4047712280184723E-003
            +9.9999894348258311E-001 ];              +9.9999887687698918E-001 ];
q_PCRS8 = [ -5.1968404336718985E-007     q_PCRS9 = [ -7.1963421681856818E-007
            +3.8455385122900486E-004                 +5.3239763239987400E-004
            +1.3513933841514693E-003                 +1.3516841804518383E-003
            +9.9999901292650617E-001 ];              +9.9999894475050310E-001 ];
-------------------------------------------------------------------------------
------ Initial Conditions for State -----  ------   Inital Square-Root Cov (diag)   -----
p1(01)  = a00  = +0.0000000000000000E+000  Sigma_initial(01,01) = 1.0000000000000000E+000
p1(02)  = b00  = +0.0000000000000000E+000  Sigma_initial(02,02) = 1.0000000000000000E+000
p1(03)  = c00  = +0.0000000000000000E+000  Sigma_initial(03,03) = 1.0000000000000000E+000
p1(04)  = a10  = +0.0000000000000000E+000  Sigma_initial(04,04) = 3.6384517097704270E+002
p1(05)  = b10  = +0.0000000000000000E+000  Sigma_initial(05,05) = 3.6384517097704270E+002
p1(06)  = c10  = +0.0000000000000000E+000  Sigma_initial(06,06) = 3.6384517097704270E+002
p1(07)  = d10  = +0.0000000000000000E+000  Sigma_initial(07,07) = 3.6384517097704270E+002
p1(08)  = a20  = +0.0000000000000000E+000  Sigma_initial(08,08) = 1.3238330844331343E+007
p1(09)  = b20  = +0.0000000000000000E+000  Sigma_initial(09,09) = 1.3238330844331343E+007
p1(10)  = c20  = +0.0000000000000000E+000  Sigma_initial(10,10) = 1.3238330844331343E+007
p1(11)  = d20  = +0.0000000000000000E+000  Sigma_initial(11,11) = 1.3238330844331343E+007
p1(12)  = a01  = +0.0000000000000000E+000  Sigma_initial(12,12) = 1.0000000000000000E+004
p1(13)  = b01  = +0.0000000000000000E+000  Sigma_initial(13,13) = 1.0000000000000000E+004
p1(14)  = c01  = +0.0000000000000000E+000  Sigma_initial(14,14) = 1.0000000000000000E+004
p1(15)  = d01  = +0.0000000000000000E+000  Sigma_initial(15,15) = 1.0000000000000000E+004
p1(16)  = e01  = +0.0000000000000000E+000  Sigma_initial(16,16) = 1.0000000000000000E+004
p1(17)  = f01  = +0.0000000000000000E+000  Sigma_initial(17,17) = 1.0000000000000000E+004
-------------------------------------------------------------------------------------------
p2f(01) = am1  = +0.0000000000000000E+000
p2f(02) = am2  = +0.0000000000000000E+000  Sigma_initial(18,18) = 1.0000000000000001E-001
p2f(03) = am3  = +1.0000000000000000E+000
p2f(04) = beta = +1.0000000000000000E+000  Sigma_initial(19,19) = 1.0000000000000001E-001
p2f(05) = qT1  = +1.1714108883076305E-006  Sigma_initial(20,20) = 1.0000000000000001E-001
p2f(06) = qT2  = -9.3738638321546567E-004  Sigma_initial(21,21) = 1.0000000000000000E-002
p2f(07) = aT3  = +1.2496548701431507E-003  Sigma_initial(22,22) = 1.0000000000000000E-002
p2f(08) = qT4  = +9.9999877983330654E-001
p2f(09) = qR1  = +0.0000000000000000E+000  Sigma_initial(23,23) = 3.4281576788666959E-002
p2f(10) = qR2  = +0.0000000000000000E+000  Sigma_initial(24,24) = 2.4007572013584836E-003
p2f(11) = qR3  = +0.0000000000000000E+000  Sigma_initial(25,25) = 2.7434407822204804E-003
p2f(12) = qR4  = +1.0000000000000000E+000
p2f(13) = brx  = +0.0000000000000000E+000  Sigma_initial(26,26) = 6.6181336863004636E-005
p2f(14) = bry  = +0.0000000000000000E+000  Sigma_initial(27,27) = 6.6181336863004636E-005
p2f(15) = brz  = +0.0000000000000000E+000  Sigma_initial(28,28) = 6.6181336863004636E-005
p2f(16) = crx  = +0.0000000000000000E+000  Sigma_initial(29,29) = 4.3799693489744957E-009
p2f(17) = cry  = +0.0000000000000000E+000  Sigma_initial(30,30) = 4.3799693489744957E-009
p2f(18) = crz  = +0.0000000000000000E+000  Sigma_initial(31,31) = 4.3799693489744957E-009
p2f(19) = bgx  = +0.0000000000000000E+000  Sigma_initial(32,32) = 6.6181336863004636E-005
p2f(20) = bgy  = +0.0000000000000000E+000  Sigma_initial(33,33) = 6.6181336863004636E-005
p2f(21) = bgz  = +0.0000000000000000E+000  Sigma_initial(34,34) = 6.6181336863004636E-005
p2f(22) = cgx  = +0.0000000000000000E+000  Sigma_initial(35,35) = 4.3799693489744957E-009
p2f(23) = cgy  = +0.0000000000000000E+000  Sigma_initial(36,36) = 4.3799693489744957E-009
p2f(24) = cgz  = +0.0000000000000000E+000  Sigma_initial(37,37) = 4.3799693489744957E-009
-------------------------------------------------------------------------------------------

--------------------   IPF KALMAN FILTER STARTED  ---------------------
Iteration#001: |dp|= +4.161610381363E+004   RMS(|Res|)=+4.161610381363E+004
Iteration#002: |dp|= +1.214099608016E+003   RMS(|Res|)=+1.214099608016E+003
Iteration#003: |dp|= +5.383409922239E+000   RMS(|Res|)=+5.383409922239E+000
Iteration#004: |dp|= +2.680675199569E+001   RMS(|Res|)=+2.680675199569E+001
Iteration#005: |dp|= +2.268662951478E+000   RMS(|Res|)=+2.268662951478E+000
Iteration#006: |dp|= +6.162205949169E-002   RMS(|Res|)=+6.162205949169E-002
Iteration#007: |dp|= +7.213711707114E-003   RMS(|Res|)=+7.213711707114E-003
Iteration#008: |dp|= +6.972732088155E-004   RMS(|Res|)=+6.972732088155E-004
Iteration#009: |dp|= +2.016113254192E-005   RMS(|Res|)=+2.016113254192E-005
Iteration#010: |dp|= +1.721820581093E-006   RMS(|Res|)=+1.721820581093E-006
```

```
Iteration#011: |dp|= +3.629679928072E-007   RMS(|Res|)=+3.629679928072E-007
Iteration#012: |dp|= +7.759700331270E-007   RMS(|Res|)=+7.759700331270E-007
Iteration#013: |dp|= +5.743373875364E-007   RMS(|Res|)=+5.743373875364E-007
Iteration#014: |dp|= +8.282145390296E-007   RMS(|Res|)=+8.282145390296E-007
Iteration#015: |dp|= +7.931984793177E-007   RMS(|Res|)=+7.931984793177E-007
Iteration#016: |dp|= +1.390653562925E-006   RMS(|Res|)=+1.390653562925E-006
Iteration#017: |dp|= +9.630044779164E-007   RMS(|Res|)=+9.630044779164E-007
Iteration#018: |dp|= +2.100327715404E-007   RMS(|Res|)=+2.100327715404E-007
Iteration#019: |dp|= +4.467808399695E-007   RMS(|Res|)=+4.467808399695E-007
Iteration#020: |dp|= +6.026094497477E-007   RMS(|Res|)=+6.026094497477E-007
IPF Kalman Filter Completed with Error |dp1| + |dp2| = +6.0260944974773012E-007
----------------------------------------------------------------------

-----------------  IPF LEAST SQUARES FILTER STARTED  ------------------
Iteration#001   COND#=+9.669870775058E+012,   |dp|=+4.163129776127E+004
Iteration#002   COND#=+9.667477046346E+012,   |dp|=+1.145931066849E+003
Iteration#003   COND#=+9.667486718585E+012,   |dp|=+3.893843767182E+000
Iteration#004   COND#=+9.667483468936E+012,   |dp|=+1.449442166898E-002
Iteration#005   COND#=+9.667487169077E+012,   |dp|=+1.704956028699E-004
Iteration#006   COND#=+9.667487376653E+012,   |dp|=+2.856489849330E-006
Iteration#007   COND#=+9.667488604821E+012,   |dp|=+5.875619789725E-007
Iteration#008   COND#=+9.667484772449E+012,   |dp|=+5.442659043150E-007
Iteration#009   COND#=+9.667487477316E+012,   |dp|=+8.200194871028E-007
Iteration#010   COND#=+9.667482921849E+012,   |dp|=+7.582643506432E-007
Iteration#011   COND#=+9.667484738023E+012,   |dp|=+5.756225301457E-007
Iteration#012   COND#=+9.667486264286E+012,   |dp|=+5.184306877971E-007
Iteration#013   COND#=+9.667483001823E+012,   |dp|=+8.252956521997E-007
Iteration#014   COND#=+9.667481218928E+012,   |dp|=+6.601495710729E-007
Iteration#015   COND#=+9.667487327658E+012,   |dp|=+3.007994754187E-007
Iteration#016   COND#=+9.667487106094E+012,   |dp|=+4.705038368651E-007
Iteration#017   COND#=+9.667482245610E+012,   |dp|=+6.197669922475E-007
Iteration#018   COND#=+9.667485288732E+012,   |dp|=+4.740161793710E-007
Iteration#019   COND#=+9.667487110532E+012,   |dp|=+6.208013262201E-007
Iteration#020   COND#=+9.667483234924E+012,   |dp|=+1.051977767652E-006
IPF Least Squares Filter Completed with Error |dp1| + |dp2| = +1.0519777676520631E-006
----------------------------------------------------------------------
Total Execution Time: 479 seconds
```

4 USER COMMENTS

This section left blank.

IPF TEAM CONTACT INFORMATION

IPF Team email		ipf@sirtfweb.jpl.nasa.gov	
David S. Bayard	X4-8208	David.S.Bayard@jpl.nasa.gov	(TEAM LEADER)
Dhemetrio Boussalis	X4-3977	boussali@grover.jpl.nasa.gov	
Paul Brugarolas	X4-9243	Paul.Brugarolas@jpl.nasa.gov	
Bryan H. Kang	X4-0541	Bryan.H.Kang@jpl.nasa.gov	
Edward.C.Wong	X4-3053	Edward.C.Wong@jpl.nasa.gov	(TASK MANAGER)

ACKNOWLEDGEMENTS

This work was performed at the Jet Propulsion Laboratory, California Institute of Technology, under contract with the National Aeronautics and Space Administration.

References

[1] D.S. Bayard, B.H. Kang, *SIRTF Instrument Pointing Frame Kalman Filter Algorithm*, JPL D-Document D-24809, September 30, 2003.

[2] B.H. Kang, D.S. Bayard, *SIRTF Instrument Pointing Frame (IPF) Software Description Document and User's Guide*, JPL D-Document D-24808, September 30, 2003.

[3] D.S. Bayard, B.H. Kang, *SIRTF Instrument Pointing Frame (IPF) Kalman Filter Unit Test Report*, JPL D-Document D-24810, September 30, 2003.

[4] *Space Infrared Telescope Facility In-Orbit Checkout and Science Verification Mission Plan*, JPL D-Document D-22622, 674-FE-301 Version 1.4, February 8, 2002.

[5] *Space Infrared Telescope Facility Observatory Description Document*, Lockheed Martin LMMS/P458569, 674-SEIT-300 Version 1.2, November 1, 2002.

[6] *SIRTF Software Interface Specification for Science Centroid INPUT Files (CAFILE, CS-FILE)*, JPL SOS-SIS-2002, November 18, 2002.

[7] *SIRTF Software Interface Specification for Inferred Frames Offset INPUT Files (OFILE)*, JPL SOS-SIS-2003, November 18, 2002.

[8] *SIRTF Software Interface Specification for PCRS Centroid INPUT Files (CBFILE)*, JPL SIS-FES-015, November 18, 2002.

[9] *SIRTF Software Interface Specification for Attitude INPUT Files (AFILE, ASFILE)*, JPL SIS-FES-014, January 7, 2002.

[10] *SIRTF Software Interface Specification for IPF Filter Output Files (IFFILE, LGFILE, TARFILE)*, JPL SOS-SIS-2005, November 18, 2002.

[11] R.J. Brown, *Focal Surface to Object Space Field of View Conversion.* Systems Engineering Report SER No. S20447-OPT-051, Ball Aerospace & Technologies Corp., November 23, 1999.

JET PROPULSION LABORATORY **SIRTF IPF REPORT**

JPL ID91M107
August 19, 2003

SIRTF INSTRUMENT POINTING FRAME KALMAN FILTER EXECUTION SUMMARY

IPF RUN NUMBER: 91M107
REPORT TYPE: COVARIANCE ANALYSIS (MULTI-RUN)

PRIME FRAME: MIPS_70um_center (107)
INFERRED FRAMES: (108) (111) (112) (115) (1) (1) (1) (1)

IPF TEAM

Autonomy and Control Section (345)
Jet Propulsion Laboratory
California Institute of Technology
4800 Oak Grove Drive
Pasadena, CA 91109

Contents

1 IPF MULTI-RUN SUMMARY **3**

2 IPF MULTI-RUN RESULTS **7**

2.1 IPF MULTI-RUN OUTPUT PLOTS 7

2.2 IPF MULTI-RUN OUTPUT DATA (MF MINI FILE) 9

2.3 IPF MULTI-RUN EXECUTION LOG 14

3 USER COMMENTS **19**

List of Figures

1.1 A-priori and a-posteriori IPF frames 3

1.2 A-priori and a-posteriori IPF frames (ZOOMED) 6

2.1 Array plot with (solid) and w/o (dashed) optical distortion corrections 7

2.2 IPF parameter symbol table 7

2.3 KF parameter error sigma plots 8

2.4 KF parameter error 1-sigma bound 8

List of Tables

1.1 IPF filter execution configuration 4

1.2 Merge performance chart 4

1.3 IPF filter execution mask vector assignment 4

1.4 IPF calibration error summary ([arcsec], 1-sigma, radial) 5

1.5 IPF Brown angle summary 6

1 IPF MULTI-RUN SUMMARY

This report summarizes the SIRTF Instrument Pointing Frame (IPF) Kalman Filter execution. This document captures the results generated by a multi-run execution with the MR run number specified as: MR91M107. This multi-run execution merges 2 previously executed IPF runs of the instrument: MIPS_70um_center (107), for the purpose of improving estimation accuracy. The main multi-run calibration results have been documented in MF91M107 typically stored in the mission archive DOM collection IPF_MF. This report only summarizes the main aspects of the run, and does not substitute for the full information contained in the MF file.

Section 1 summarizes the multi-run merge results. The merge configurations are tabulated in Table 1.1. The overall End-to-End pointing performances are tabulated in Table 1.4. Section 2 summarizes resulting plots, a mini summary of the MF Multi-Run output file, and the execution log. Section 3 captures the user comments that are specific to this particular run.

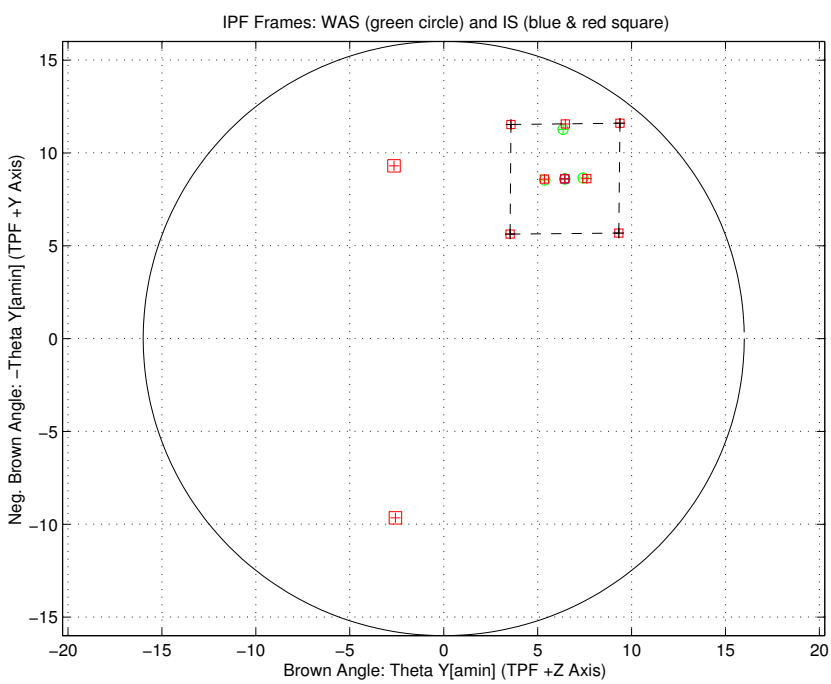

Figure 1.1: A-priori and a-posteriori IPF frames

EXECUTION CONFIGURATION ITEM	CURRENT STATUS
IPF Filter Version Used	IPF.V2.0.1Beta
Frame Table Version Used	FTVE2E1
IPF Filter Mode	NORMAL-MODE(0)
LS Residual Sigma Scale	1.07213564E+000
Merge Data Set #1	991107
Merge Data Set #2	992107

Table 1.1: IPF filter execution configuration

	BROWN ANGLES AND SIGMAS [arcmin, arcmin, deg]					
RUN#	$-\theta_y$	$-\theta_z$	θ_x	σ_y	σ_z	σ_x
991107	+6.441205	-8.595346	-0.011234	0.002683	0.004105	0.040149
992107	+6.444083	-8.594608	-0.039787	0.002728	0.004009	0.041329
91M107	+6.442664	-8.595115	-0.026317	0.001904	0.002858	0.028569

Table 1.2: Merge performance chart

Con. Plate Scale			Γ Dependent				Γ^2 Dependent				Linear Plate Scale						Mirror	
a_{00}	b_{00}	c_{00}	a_{10}	b_{10}	c_{10}	d_{10}	a_{20}	b_{20}	c_{20}	d_{20}	a_{01}	b_{01}	c_{01}	d_{01}	e_{01}	f_{01}	α	β
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
IPF (T)			Alignment R									Gyro Drift Bias						
θ_1	θ_2	θ_3	a_{rx}	a_{ry}	a_{rz}	b_{rx}	b_{ry}	b_{rz}	c_{rx}	c_{ry}	c_{rz}	b_{gx}	b_{gy}	b_{gz}	c_{gx}	c_{gy}	c_{gz}	
20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	
1	1	1																

Table 1.3: IPF filter execution mask vector assignment

FOCAL PLANE SURVEY ANALYSIS: MULTI-RUN
INSTRUMENT NAME: MIPS_70um_center NF: 107

```
PIX2RADW: 4.79044679E-005[rad/pixel] = 9.8810E+000[arcsec/pixel]
PIX2RADV: 4.79044679E-005[rad/pixel] = 9.8810E+000[arcsec/pixel]
```

FRAME	DESCRIPTION	IPF[1]	SF[2]	ARW[3]	TOTAL	REQ
107(P)	MIPS_70um_center	0.1922	0.0855	0.0708	0.2219	2.60
108(I)	MIPS_70um_minusY_edge	0.3417	0.0855	0.0708	0.3593	N/A
111(I)	MIPS_70um_default_small_FOV1	0.2451	0.0855	0.0708	0.2690	N/A
112(I)	MIPS_70um_default_small_FOV2	0.1696	0.0855	0.0708	0.2027	N/A
115(I)	MIPS_70um_default_large_FOV1	0.2060	0.0855	0.0708	0.2340	N/A
TR (C)	CORNERS OF INSTRUMENT	0.4823	0.0855	0.0708	0.4949	N/A
BR (C)	CORNERS OF INSTRUMENT	0.4318	0.0855	0.0708	0.4458	N/A
TL (C)	CORNERS OF INSTRUMENT	0.4097	0.0855	0.0708	0.4244	N/A
BL (C)	CORNERS OF INSTRUMENT	0.3866	0.0855	0.0708	0.4022	N/A

Table 1.4: IPF calibration error summary ([arcsec], 1-sigma, radial)

[1]IPF filter removes systematic pointing errors due to: thermomechanical alignment drift (Body to TPF), gyro bias and bias drift, centroiding error, attitude error, and optical distortion. IPF SIGMA presented here is "NOT Scaled" by the Least Squares Scale factor. The Least Squares Scale Factor was: 1.072136.

[2]Error due to gyro Scale Factor: assumes 95 ppm error over 0.250 degree maneuver.

[3]Error due to gyro Angle Random Walk: assumes ARW = 100 $\mu deg/\sqrt{hr}$, with 975 second Maneuver time (max), and 14 independent Maneuvers.

IPF BROWN ANGLE SUMMARY						
	WAS			IS		
Frame Number	theta_Y (arcmin)	theta_Z (arcmin)	angle (deg)	theta_Y (arcmin)	theta_Z (arcmin)	angle (deg)
107	+6.445000	-8.592000	+0.000000	+6.442664	-8.595115	-0.026317
108	+6.348000	-11.259000	-0.000000	+6.469555	-11.553347	-0.026317
111	+7.423000	-8.647000	-0.000000	+7.620616	-8.607539	-0.026317
112	+5.385000	-8.533000	+0.000000	+5.358000	-8.584935	-0.026317
115	+6.445000	-8.592000	+0.000000	+6.442664	-8.595115	-0.026317
001	+0.000000	+0.000000	+0.000000	+9.378106	-11.590628	-0.026317
001	+0.000000	+0.000000	+0.000000	+9.317755	-5.672984	-0.026317
001	+0.000000	+0.000000	+0.000000	+3.579270	-11.524854	-0.026317
001	+0.000000	+0.000000	+0.000000	+3.533149	-5.623574	-0.026317

Table 1.5: IPF Brown angle summary

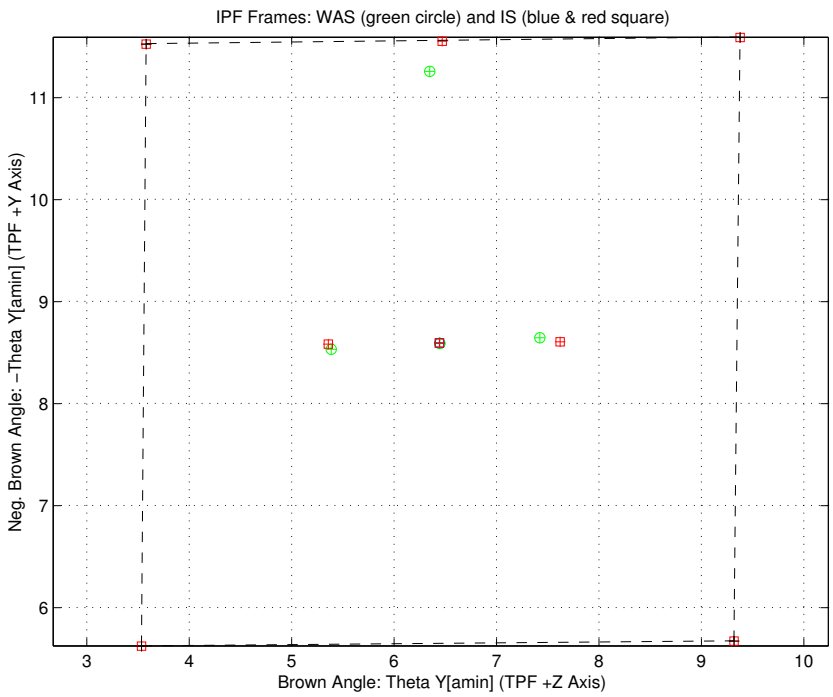

Figure 1.2: A-priori and a-posteriori IPF frames (ZOOMED)

2 IPF MULTI-RUN RESULTS

2.1 IPF MULTI-RUN OUTPUT PLOTS

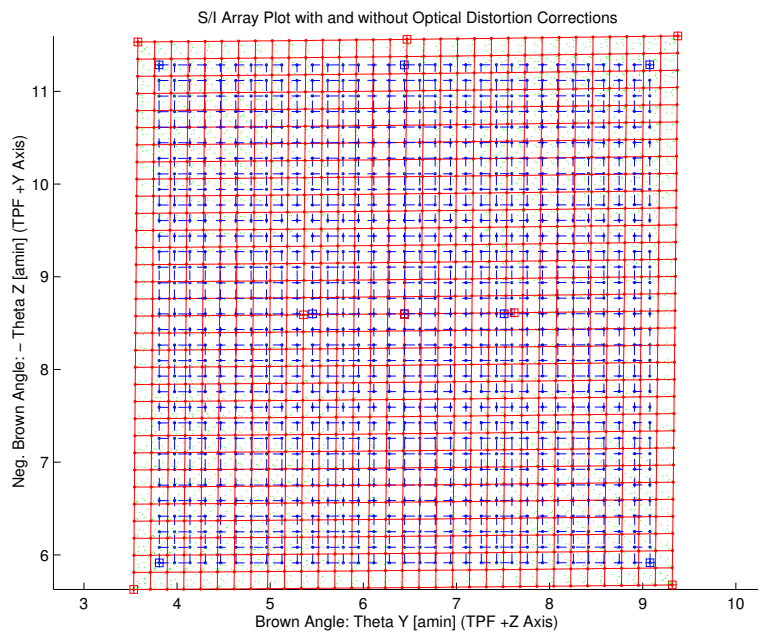

Figure 2.1: Array plot with (solid) and w/o (dashed) optical distortion corrections

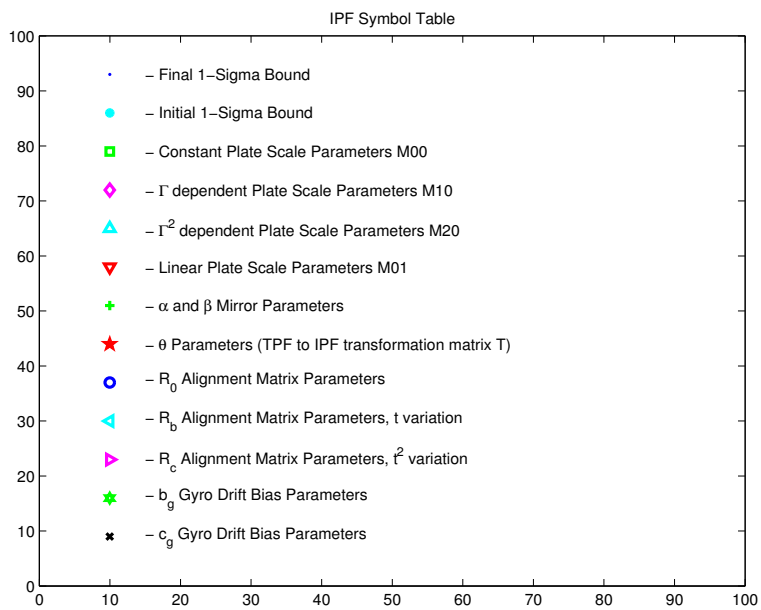

Figure 2.2: IPF parameter symbol table

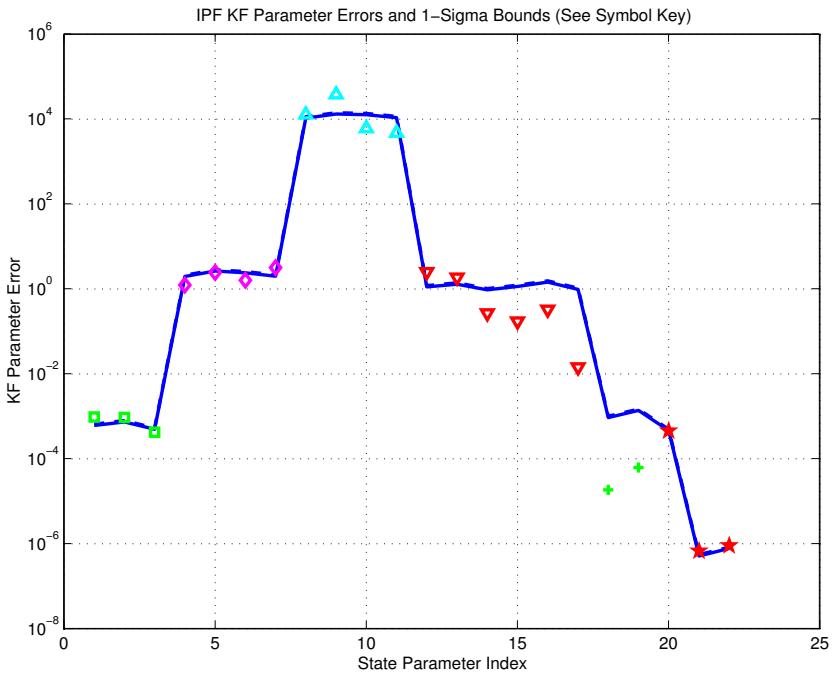

Figure 2.3: KF parameter error sigma plots

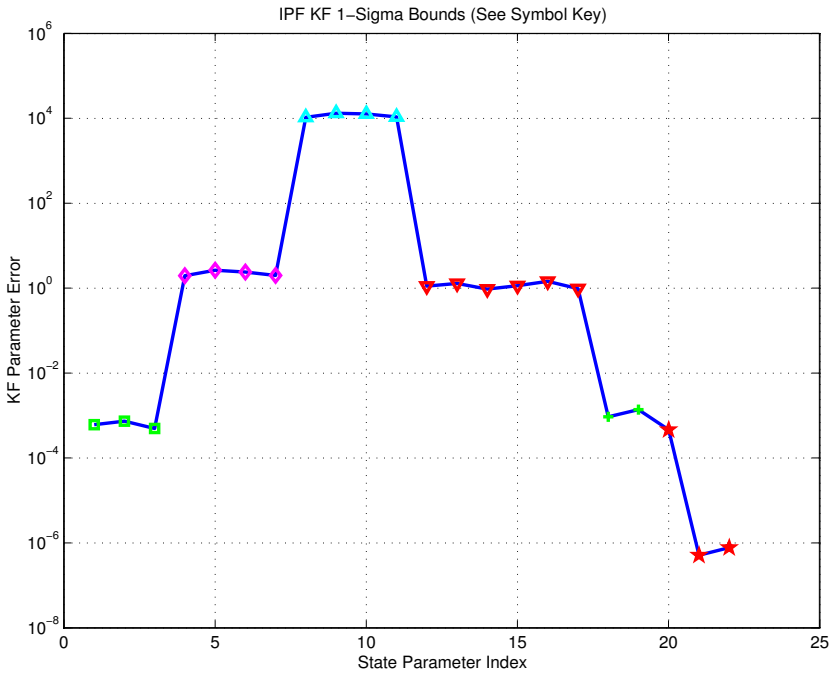

Figure 2.4: KF parameter error 1-sigma bound

2.2 IPF MULTI-RUN OUTPUT DATA (MF MINI FILE)

```
OUTPUT FILE NAME: MF91M107mini.dat   DATE: 06-Aug-2003   TIME: 20:15
INSTRUMENT NAME:  MIPS_70um_center   NF: 107
IPF FILTER VERSION: IPF.V2.0.1Beta       SW RELEASE DATE: August 5, 2003
-------------------------------------------------------------------------------
---------------------------- IPF BROWN ANGLE SUMMARY ---------------------------
-------------------------------------------------------------------------------
         ------------ WAS ------------           ------------ IS -------------
Frame    theta_Y     theta_Z     angle           theta_Y     theta_Z     angle
Number   (arcmin)    (arcmin)    (deg)           (arcmin)    (arcmin)    (deg)
------  --------------------------------       --------------------------------
 107     +6.445000  -8.592000   +0.000000        +6.442664  -8.595115   -0.026317
 108     +6.348000 -11.259000   -0.000000        +6.469555 -11.553347   -0.026317
 111     +7.423000  -8.647000   -0.000000        +7.620616  -8.607539   -0.026317
 112     +5.385000  -8.533000   +0.000000        +5.358000  -8.584935   -0.026317
 115     +6.445000  -8.592000   +0.000000        +6.442664  -8.595115   -0.026317
 001     +0.000000  +0.000000   +0.000000        +9.378106 -11.590628   -0.026317
 001     +0.000000  +0.000000   +0.000000        +9.317755  -5.672984   -0.026317
 001     +0.000000  +0.000000   +0.000000        +3.579270 -11.524854   -0.026317
 001     +0.000000  +0.000000   +0.000000        +3.533149  -5.623574   -0.026317
-------------------------------------------------------------------------------
OFFSET            NF          Delta_CW          Delta_CV
  0              107            +0.000            +0.000     pixels
OFFSET FRAME NAME: MIPS_70um_center
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
WAS(FTB)            +6.445000        -8.592000       +0.000000
IS (EST)            +6.442664        -8.595115       -0.026317
dT_EST              -0.002336        -0.003115       -0.026317
T_sSIGMA            +0.001904        +0.002858       +0.028569
dT_EST/T_sSIGMA     -1.226791        -1.090245       -0.921151
-----------------------------------------------------------------
OFFSET            NF          Delta_CW          Delta_CV
  1              108            +0.000           +16.000     pixels
OFFSET FRAME NAME: MIPS_70um_minusY_edge
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
WAS(FTB)            +6.348000       -11.259000       -0.000000
IS (EST)            +6.469555       -11.553347       -0.026317
dT_EST              +0.121555        -0.294347       -0.026317
T_sSIGMA            +0.003619        +0.004397       +0.028569
dT_EST/T_sSIGMA    +33.589513       -66.938897       -0.921152
-----------------------------------------------------------------
OFFSET            NF          Delta_CW          Delta_CV
  2              111            +6.500            +0.000     pixels
OFFSET FRAME NAME: MIPS_70um_default_small_FOV1
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
WAS(FTB)            +7.423000        -8.647000       -0.000000
IS (EST)            +7.620616        -8.607539       -0.026317
dT_EST              +0.197616        +0.039461       -0.026317
T_sSIGMA            +0.002192        +0.003446       +0.028569
dT_EST/T_sSIGMA    +90.168767       +11.450093       -0.921152
-----------------------------------------------------------------
OFFSET            NF          Delta_CW          Delta_CV
  3              112            -6.000            +0.000     pixels
OFFSET FRAME NAME: MIPS_70um_default_small_FOV2
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
WAS(FTB)            +5.385000        -8.533000       +0.000000
IS (EST)            +5.358000        -8.584935       -0.026317
dT_EST              -0.027000        -0.051935       -0.026317
T_sSIGMA            +0.001598        +0.002331       +0.028569
dT_EST/T_sSIGMA    -16.900711       -22.276018       -0.921151
-----------------------------------------------------------------
OFFSET            NF          Delta_CW          Delta_CV
  4              115            +0.000            +0.000     pixels
OFFSET FRAME NAME: MIPS_70um_default_large_FOV1
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
```

```
WAS(FTB)            +6.445000        -8.592000       +0.000000
IS (EST)            +6.442664        -8.595115       -0.026317
dT_EST              -0.002336        -0.003115       -0.026317
T_sSIGMA            +0.001904        +0.002858       +0.028569
dT_EST/T_sSIGMA     -1.226791        -1.090245       -0.921151
-------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  5               1           +16.000           +16.000     pixels
OFFSET FRAME NAME: CORNER PIXEL (DIAGNOSTICS)
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
WAS(FTB)            +0.000000        +0.000000       +0.000000
IS (EST)            +9.378106       -11.590628       -0.026317
dT_EST              +9.378106       -11.590628       -0.026317
T_sSIGMA            +0.005025        +0.006274       +0.028569
dT_EST/T_sSIGMA    +1866.160643       -1847.347544       -0.921153
-------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  6               1           +16.000           -16.000     pixels
OFFSET FRAME NAME: CORNER PIXEL (DIAGNOSTICS)
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
WAS(FTB)            +0.000000        +0.000000       +0.000000
IS (EST)            +9.317755        -5.672984       -0.026317
dT_EST              +9.317755        -5.672984       -0.026317
T_sSIGMA            +0.004265        +0.005796       +0.028569
dT_EST/T_sSIGMA    +2184.764961       -978.707842       -0.921152
-------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  7               1           -16.000           +16.000     pixels
OFFSET FRAME NAME: CORNER PIXEL (DIAGNOSTICS)
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
WAS(FTB)            +0.000000        +0.000000       +0.000000
IS (EST)            +3.579270       -11.524854       -0.026317
dT_EST              +3.579270       -11.524854       -0.026317
T_sSIGMA            +0.004642        +0.005007       +0.028569
dT_EST/T_sSIGMA    +770.999062       -2301.879030       -0.921152
-------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  8               1           -16.000           -16.000     pixels
OFFSET FRAME NAME: CORNER PIXEL (DIAGNOSTICS)
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
WAS(FTB)            +0.000000        +0.000000       +0.000000
IS (EST)            +3.533149        -5.623574       -0.026317
dT_EST              +3.533149        -5.623574       -0.026317
T_sSIGMA            +0.004384        +0.004721       +0.028569
dT_EST/T_sSIGMA    +805.834945       -1191.209112       -0.921151
-------------------------------------------------------------------
-------------------------------------------------------------------------------------
-------------------------------------------------------------------------------------
VARNAME             MEAN                      SIGMA                 SCALED_SIGMA
a00        +9.9031056619365759E-002 +6.0970449055671643E-004 +6.5368591545278540E-004
b00        +1.0094249821890104E-001 +7.4278882361634492E-004 +7.9637037232642904E-004
c00        +1.0423673506417985E-002 +4.9897235661895527E-004 +5.3496604793622422E-004
a10        +1.3436190048660217E+000 +1.9680214991371132E+000 +2.1099859935745973E+000
b10        -2.3469998816216253E+000 +2.6605352260150963E+000 +2.8524546427795756E+000
c10        +1.6130131416040800E+000 +2.4063280859025777E+000 +2.5799101073975970E+000
d10        -3.1832849533473357E+000 +2.0070202727929427E+000 +2.1517979688078279E+000
a20        +1.2830000133955544E+004 +1.0671540478418610E+004 +1.1441338902649288E+004
b20        -3.8319306214415490E+004 +1.3262547131939793E+004 +1.4219249484716256E+004
c20        -6.1035291287221480E+003 +1.2740857295394035E+004 +1.3659927216852617E+004
d20        -4.7813505542404091E+003 +1.0893057149914335E+004 +1.1678834821471402E+004
a01        +4.5231880319967175E+000 +1.1220315963377834E+000 +1.2029700659565439E+000
b01        +1.3210570490350459E-001 +1.3022567246446739E+000 +1.3961958496100537E+000
c01        +1.7305089863773626E+000 +9.5454555813535369E-001 +1.0234023148515010E+000
d01        +2.1734900343089794E+000 +1.1471548119794415E+000 +1.2299055608892442E+000
e01        +1.6707179851445231E+000 +1.4526789554860344E+000 +1.5574688846539675E+000
f01        +1.9856366858552144E+000 +9.7750226043295085E-001 +1.0480150136090245E+000
del_alpha  +7.2292097040876696E-004 +9.4093824726331832E-004 +1.0088134318729366E-003
beta       +1.1000626639384117E+000 +1.3793165609376598E-003 +1.4788144466714385E-003
```

```
del_theta1 -2.6323816320369703E-004 +4.6508012915247472E-004 +4.9862898288044455E-004
del_theta2 -4.2456892412021304E-007 +5.1657502598043364E-007 +5.5383849715414622E-007
del_theta3 -6.7317763643345871E-008 +7.7529605189984596E-007 +8.3122253039390576E-007
-------------------------------------------------------------------------------
LSQF RESIDUAL SIGMA SCALE =         +1.0721356420647483E+000
-------------------------------------------------------------------------------
-------------------------------------------------------------------------------------------------------
-------------------------------------------------------------------------------------------------------
                    a_mirror(1)               a_mirror(2)               a_mirror(3)
a_mirror_ipf   +0.0000000000000000E+000  +1.9981474681767163E-002  +9.9980035040479043E-001
a_mirror_tpf   -1.9248026790995749E-003  +2.0435945059630103E-002  +9.9978931144724981E-001
beta                beta_0                    beta                      beta_total
               +2.8047410000000001E-006  +1.1000626639384117E+000  +3.0853908561172848E-006
-------------------------------------------------------------------------------------------------------
qT               qT(1)                     qT(2)                     qT(3)                     qT(4)
FrmTbl:   +1.1714108883076305E-006 -9.3738638321546567E-004 +1.2496548701431507E-003 +9.9999877983330654E-001
Estim:    -2.2848468213283176E-004 -9.3733373170875320E-004 +1.2498927564961483E-003 +9.9999875348338441E-001
DelTheta        deltheta(1)               deltheta(2)               deltheta(3)
          -4.5931105169751173E-004 +6.7944389210329216E-007 +9.0623483343329149E-007       [rad]
EulAngT         theta(1)                  theta(2)                  theta(3)                  [rad]
Mean      -4.5931275068546124E-004 -1.8740950609577025E-003 +2.5002177252807698E-003
SigmaT    +4.6508012915247472E-004 +5.1657502598043364E-007 +7.7529605189984596E-007
-------------------------------------------------------------------------------------------------------
Initial Gyro Bias         Bg0(1)                    Bg0(2)                    Bg0(3)
                  +1.5108113660766746E-006 +1.9656065089985414E-007 +2.4738151977060690E-007
Gyro Bias Correction      Bg(1)                     Bg(2)                     Bg(3)
                  +3.6608892841697107E-007 -3.8612760686212014E-009 +8.3294187515633201E-009
Total Gyro Bias           BgT(1)                    BgT(2)                    BgT(3)
                  +1.8769002944936457E-006 +1.9269937483123295E-007 +2.5571093852217021E-007

Initial Gyro Bias Rate     Cg0(1)                    Cg0(2)                    Cg0(3)
                  +0.0000000000000000E+000 +0.0000000000000000E+000 +0.0000000000000000E+000
Gyro Bias Rate Correction  Cg(1)                     Cg(2)                     Cg(3)
                  -2.2979419526555039E-011 +3.8843107731920028E-013 +6.1185050350764278E-013
Total Gyro Bias Rate       CgT(1)                    CgT(2)                    CgT(3)
                  -2.2979419526555039E-011 +3.8843107731920028E-013 +6.1185050350764278E-013
-------------------------------------------------------------------------------------------------------
-------------------------------------------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  1             108            +0.000           +16.000     pixels
OFFSET FRAME NAME: MIPS_70um_minusY_edge
qT               qT(1)                     qT(2)                     qT(3)                     qT(4)
WAS(FTB)  +1.5119196953387772E-006 -9.2327780520473960E-004 +1.6375537408473187E-003 +9.9999823298521595E-001
IS (EST)  -2.2807479332059982E-004 -9.4134304511118538E-004 +1.6801485691842226E-003 +9.9999811947620443E-001

DelTheta        deltheta(1)               deltheta(2)               deltheta(3)
Units             rad                       rad                       rad
          -4.5915464448203802E-004 -3.5358919706511709E-005 +8.5621997057962261E-005
EulAngT         theta(1)                  theta(2)                  theta(3)                  [rad]
Mean      -4.5931275068546124E-004 -1.8819172615478278E-003 +3.3607324899919931E-003
sSigmaT   +4.9862860458254438E-004 +1.0526771507974021E-006 +1.2791090545317954E-006
SigmaT    +4.6507977630728860E-004 +9.8185071878603665E-007 +1.1930477864428161E-006
-------------------------------------------------------------------------------------------------------
-------------------------------------------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  2             111            +6.500            +0.000     pixels
OFFSET FRAME NAME: MIPS_70um_default_small_FOV1
qT               qT(1)                     qT(2)                     qT(3)                     qT(4)
WAS(FTB)  +1.3578036248737386E-006 -1.0796305229011367E-003 +1.2576541056642260E-003 +9.9999862635017700E-001
IS (EST)  -2.2826846255881282E-004 -1.1086599930949139E-003 +1.2516601097567819E-003 +9.9999857605573539E-001

DelTheta        deltheta(1)               deltheta(2)               deltheta(3)
Units             rad                       rad                       rad
          -4.5933753635839599E-004 -5.7484042512332773E-005 -1.1478744975687809E-005
EulAngT         theta(1)                  theta(2)                  theta(3)                  [rad]
Mean      -4.5931275068546124E-004 -2.2167472152957303E-003 +2.5038315671726211E-003
sSigmaT   +4.9862880765316395E-004 +6.3751612132481868E-007 +1.0025047685998250E-006
SigmaT    +4.6507996571487067E-004 +5.9462263571153419E-007 +9.3505404471879481E-007
```

```
-----------------------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  3             112            -6.000            +0.000     pixels
OFFSET FRAME NAME: MIPS_70um_default_small_FOV2
qT               qT(1)                    qT(2)                    qT(3)                    qT(4)
WAS(FTB)  +9.7202971260263934E-007 -7.8321581857721488E-004 +1.2410738430199599E-003 +9.9999892315329675E-001
IS (EST)  -2.2868308207133308E-004 -7.7957559314835022E-004 +1.2484484542706522E-003 +9.9999889067058456E-001

DelTheta        deltheta(1)               deltheta(2)               deltheta(3)
Units             rad                       rad                       rad
          -4.5928908622467436E-004 +7.8539138738583418E-006 +1.5107215991704363E-005
EulAngT         theta(1)                  theta(2)                  theta(3)                  [rad]
Mean      -4.5931275068546124E-004 -1.5585790896123000E-003 +2.4972563188848480E-003
sSigmaT   +4.9862909237130331E-004 +4.6470908235617665E-007 +6.7818378688905348E-007
SigmaT    +4.6508023127654787E-004 +4.3344243407599726E-007 +6.3255409136757037E-007
-----------------------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  4             115            +0.000            +0.000     pixels
OFFSET FRAME NAME: MIPS_70um_default_large_FOV1
qT               qT(1)                    qT(2)                    qT(3)                    qT(4)
WAS(FTB)  +1.1714108883076305E-006 -9.3738638321546567E-004 +1.2496548701431507E-003 +9.9999877983330654E-001
IS (EST)  -2.2848468213283182E-004 -9.3733373170875320E-004 +1.2498927564961483E-003 +9.9999875348338441E-001

DelTheta        deltheta(1)               deltheta(2)               deltheta(3)
Units             rad                       rad                       rad
          -4.5931105169751184E-004 +6.7944389210329216E-007 +9.0623483343329149E-007
EulAngT         theta(1)                  theta(2)                  theta(3)                  [rad]
Mean      -4.5931275068546119E-004 -1.8740950609577025E-003 +2.5002177252807694E-003
sSigmaT   +4.9862898288044444E-004 +5.5383849715414622E-007 +8.3122253039390555E-007
SigmaT    +4.6508012915247462E-004 +5.1657502598043364E-007 +7.7529605189984575E-007
-----------------------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  5               1           +16.000           +16.000     pixels
OFFSET FRAME NAME: CORNER PIXEL (DIAGNOSTICS)
qT               qT(1)                    qT(2)                    qT(3)                    qT(4)
WAS(FTB)  +0.0000000000000000E+000 +0.0000000000000000E+000 +0.0000000000000000E+000 +1.0000000000000000E+000
IS (EST)  -2.2735643611431909E-004 -1.3643750347308440E-003 +1.6854728269089072E-003 +9.9999762298275752E-001

DelTheta        deltheta(1)               deltheta(2)               deltheta(3)
Units             rad                       rad                       rad
          -4.5931275068546124E-004 -2.7279805605340012E-003 +3.3715769730607993E-003
EulAngT         theta(1)                  theta(2)                  theta(3)                  [rad]
Mean      -4.5931275068546124E-004 -2.7279805605340012E-003 +3.3715769730607997E-003
sSigmaT   +4.9862805733272406E-004 +1.4618144318691207E-006 +1.8250907813476399E-006
SigmaT    +4.6507926587763883E-004 +1.3634603444895445E-006 +1.7022946628589176E-006
-----------------------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  6               1           +16.000           -16.000     pixels
OFFSET FRAME NAME: CORNER PIXEL (DIAGNOSTICS)
qT               qT(1)                    qT(2)                    qT(3)                    qT(4)
WAS(FTB)  +0.0000000000000000E+000 +0.0000000000000000E+000 +0.0000000000000000E+000 +1.0000000000000000E+000
IS (EST)  -2.2853789614892496E-004 -1.3554010960026685E-003 +8.2478992849501572E-004 +9.9999871518911110E-001

DelTheta        deltheta(1)               deltheta(2)               deltheta(3)
Units             rad                       rad                       rad
          -4.5931275068546119E-004 -2.7104250362720637E-003 +1.6502040691132509E-003
EulAngT         theta(1)                  theta(2)                  theta(3)                  [rad]
Mean      -4.5931275068546119E-004 -2.7104250362720637E-003 +1.6502040691132511E-003
sSigmaT   +4.9862846211414479E-004 +1.2406025748145048E-006 +1.6861048801631408E-006
SigmaT    +4.6507964342447600E-004 +1.1571321073006380E-006 +1.5726600385339243E-006
-----------------------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  7               1           -16.000           +16.000     pixels
```

```
OFFSET FRAME NAME: CORNER PIXEL (DIAGNOSTICS)
qT              qT(1)                   qT(2)                   qT(3)                   qT(4)
WAS(FTB)  +0.0000000000000000E+000 +0.0000000000000000E+000 +0.0000000000000000E+000 +1.0000000000000000E+000
IS (EST)  -2.2878340620481055E-004 -5.2096783913923672E-004 +1.6761015117785346E-003 +9.9999843346596595E-001

DelTheta        deltheta(1)               deltheta(2)               deltheta(3)
Units             rad                       rad                       rad
          -4.5931275068546124E-004 -1.0411673057340637E-003 +3.3524442464984835E-003
EulAngT         theta(1)                  theta(2)                  theta(3)                  [rad]
Mean      -4.5931275068546124E-004 -1.0411673057340635E-003 +3.3524442464984839E-003
sSigmaT   +4.9862879315750916E-004 +1.3504131936635990E-006 +1.4563946247136519E-006
SigmaT    +4.6507995219451537E-004 +1.2595544263997568E-006 +1.3584051938697672E-006
-----------------------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  8               1           -16.000           -16.000     pixels
OFFSET FRAME NAME: CORNER PIXEL (DIAGNOSTICS)
qT              qT(1)                   qT(2)                   qT(3)                   qT(4)
WAS(FTB)  +0.0000000000000000E+000 +0.0000000000000000E+000 +0.0000000000000000E+000 +1.0000000000000000E+000
IS (EST)  -2.2923595924255442E-004 -5.1406338212879794E-004 +8.1779741114179605E-004 +9.9999950719843289E-001

DelTheta        deltheta(1)               deltheta(2)               deltheta(3)
Units             rad                       rad                       rad
          -4.5931275068546124E-004 -1.0277515013781397E-003 +1.6358312933921991E-003
EulAngT         theta(1)                  theta(2)                  theta(3)                  [rad]
Mean      -4.5931275068546124E-004 -1.0277515013781395E-003 +1.6358312933921991E-003
sSigmaT   +4.9862916775549786E-004 +1.2753871100915907E-006 +1.3732528376465461E-006
SigmaT    +4.6508030158872815E-004 +1.1895762626036898E-006 +1.2808573689443791E-006
-----------------------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------------------
               q(1)                    q(2)                    q(3)                    q(4)
PCRS1A: +5.2603126189317361E-007 +3.7451819048221893E-004 -1.4045531552277380E-003 +9.9999894348258311E-001
PCRS2A: -5.1968404336718985E-007 +3.8455385122900486E-004 +1.3513933841514693E-003 +9.9999901292650617E-001
-------------------------------------------------------------------------------------------
**********  CS-FILE PARAMETERS:  **********  **********  AS-FILE PARAMETERS:  **********
Row (01) PIX2RADX: +4.7904467948999998E-005  Row (1) TASTART:   +7.3051200000000000E+008
Row (02) PIX2RADY: +4.8792938470999998E-005  Row (2) TASTOP:    +7.3052711000000000E+008
Row (03) CX0:      +1.6500000000000000E+001  Row (3) S/C TIME:  +7.3051200000000000E+008
Row (04) CY0:      +1.6500000000000000E+001  Row (4) QR1:       +0.0000000000000000E+000
Row (05) BETA0:    +2.8047410000000001E-006  Row (5) QR2:       +0.0000000000000000E+000
Row (06) GAMMA_E0: +2.0070000000000000E+003  Row (6) QR3:       +0.0000000000000000E+000
Row (07) D11:      -1.0000000000000000E+000  Row (7) QR4:       +1.0000000000000000E+000
Row (08) D12:      +0.0000000000000000E+000
Row (09) D21:      +0.0000000000000000E+000
Row (10) D22:      -1.0000000000000000E+000
Row (11) DG:       +1.0000000000000000E+000
-------------------------------------------------------------------------------------------
-----------------------------------------------------------
INITIAL STA-TO-PCRS ALIGNMENT (R) KNOWLEDGE (1-SIGMA)
    SIGMA(X)        SIGMA(Y)         SIGMA(Z)
1.41421656E+002  9.90383438E+000  1.13175056E+001  [arcsec]
-----------------------------------------------------------
PIX2RADX = 4.790446794900E-005[rad/pixel]
XPIXSIZE = 9.8810[arcsec]
PIX2RADY = 4.879293847100E-005[rad/pixel]
YPIXSIZE = 10.0643[arcsec]
CX0 = 16.5[pixel] = 163.04[arcsec]
CY0 = 16.5[pixel] = 166.06[arcsec]
-----------------------------------------------------------
NOMINAL BETA0 = 2.804741000000E-006[rad/encoder unit]
ENCODER UNIT SIZE = 0.58[arcsec]
GAMMA_E0 = 2007.00[encoder unit] = 1161.09[arcsec]
-----------------------------------------------------------
                | -1 | +0 |
FLIP MATRIX D = |----|----|   and   DG = +1
                | +0 | -1 |
-----------------------------------------------------------
```

2.3 IPF MULTI-RUN EXECUTION LOG

```
************************************************
*****          MULTI_RUN LOG FILE           *****
************************************************

-------------------------------------------------
MULTI-RUN-LOG FILE NAME:  LG91M107.dat
INSTRUMENT TYPE:              MIPS_70um_center
MULTI-RUN EXECUTION DATE: 06-Aug-2003    TIME: 20:15
-------------------------------------------------


-------------------------------------------------------
MT991107 FILE LOADED!
q_T    = -9.6866059879698914E-005 -9.3695692196613665E-004 +1.2500497270103955E-003 +9.9999877505143620E-001
SigmaT = +6.5266370470858201E-004 +7.2688705076347485E-007 +1.1122240688221774E-006
Sigma Scale = +1.0736399125940050E+000

-------------------------------------------------------
MT992107 FILE LOADED!
q_T    = -3.4603147803143600E-004 -9.3768692235196105E-004 +1.2497087641214306E-003 +9.9999871961590858E-001
SigmaT = +6.7382471874991728E-004 +7.4129388573357071E-007 +1.0892600676134831E-006
Sigma Scale = +1.0704953865165894E+000

-------------------------------------------------------

----------------------------------------------------------------
Conditioning Number for LSQ Filter was:  +7.6630041702607086E+010
----------------------------------------------------------------

Merged q_T    = -2.2848468213283176E-004 -9.3733373170875320E-004 +1.2498927564961483E-003 +9.9999875348338441E-001
Merged SigmaT = +4.6508012915247472E-004 +5.1657502598043364E-007 +7.7529605189984596E-007
Merged Sigma Scale = +1.0721356420647483E+000

*********** Sigma T Ratios for Multi-Run ************
DATA#1 Expected:     1.41421 1.41421 1.41421
DATA#1 Calculated:   1.40334 1.40713 1.43458
-----------------------------------------------------
DATA#2 Expected:     1.41421 1.41421 1.41421
DATA#2 Calculated:   1.44884 1.43502 1.40496
-----------------------------------------------------


Merging LG Files!


*********************************************************************
IPF EXECUTION-LOG FILE NAME:  LG991107.dat
INSTRUMENT TYPE:              MIPS_70um_center
IPF FILTER EXECUTION DATE:    05-Aug-2003    TIME: 21:53
IPF FILTER VERSION USED:      IPF.V2.0.1Beta
*********************************************************************

------------------- Loading & Preparing Input Files -------------------
AAFILE:  AA991107 Loaded!        AAFILE dimension = 151101 X 21
ASFILE:  AS991107 Loaded!
CAFILE:  CA991107 Loaded!        CAFILE dimension = 480 X 15
CBFILE:  CB991107 Loaded!        CBFILE dimension = 42 X 15
CCFILE:  CC991107 Created!       CCFILE dimension = 522 X 19
CSFILE:  CS991107 Loaded!
Loading Input Files Completed!
---------------------------------------------------------------------

------------------------- Selected Mask Vectors -------------------------
index =   1  2  3  4  5  6  7  8  9 10 11 12 13 14 15 16 17 18 19 20
```

```
-----------------------------------------------------------------------
mask1 = [ 1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1 ]
mask2 = [ 1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1 ]
-----------------------------------------------------------------------

---------------  Selected Initial Gyro Bias Parameters  ---------------
User Entered 1 : Use AFILE database - from S/C filter
IPF Linearized Using Following Nominal Gyro Bias Estimates
bg0 = [+2.5698065383442246E-006 +2.5043076857825201E-006 +2.4899044449250012E-006 ]
cg0 = [+0.0000000000000000E+000 +0.0000000000000000E+000 +0.0000000000000000E+000 ]
-----------------------------------------------------------------------

---------------  Gyro Pre-Processor Run Completed  --------------------
     AGFILE CREATED:  AG991107.m     ACFILE CREATED:  AC991107.m
-----------------------------------------------------------------------
Total Gyro Preprocessor Execution Time: 88 seconds

FRAME TABLE ENTRIES FOR PCRS LOADED TO TPCRS
q_PCRS4 = [ +5.2603126189317361E-007     q_PCRS5 = [ +7.3379987833742897E-007
            +3.7451819048221893E-004                 +5.2236196154513707E-004
            -1.4045531552277380E-003                 -1.4047712280184723E-003
            +9.9999894348258311E-001 ];              +9.9999887687698918E-001 ];
q_PCRS8 = [ -5.1968404336718985E-007     q_PCRS9 = [ -7.1963421681856818E-007
            +3.8455385122900486E-004                 +5.3239763239987400E-004
            +1.3513933841514693E-003                 +1.3516841804518383E-003
            +9.9999901292650617E-001 ];              +9.9999894475050310E-001 ];
-------------------------------------------------------------------------------
------ Initial Conditions for State -----  ------   Inital Square-Root Cov (diag)   -----
p1(01)  = a00  = +0.0000000000000000E+000  Sigma_initial(01,01) = 1.0000000000000000E+000
p1(02)  = b00  = +0.0000000000000000E+000  Sigma_initial(02,02) = 1.0000000000000000E+000
p1(03)  = c00  = +0.0000000000000000E+000  Sigma_initial(03,03) = 1.0000000000000000E+000
p1(04)  = a10  = +0.0000000000000000E+000  Sigma_initial(04,04) = 3.6384517097704270E+002
p1(05)  = b10  = +0.0000000000000000E+000  Sigma_initial(05,05) = 3.6384517097704270E+002
p1(06)  = c10  = +0.0000000000000000E+000  Sigma_initial(06,06) = 3.6384517097704270E+002
p1(07)  = d10  = +0.0000000000000000E+000  Sigma_initial(07,07) = 3.6384517097704270E+002
p1(08)  = a20  = +0.0000000000000000E+000  Sigma_initial(08,08) = 1.3238330844331343E+007
p1(09)  = b20  = +0.0000000000000000E+000  Sigma_initial(09,09) = 1.3238330844331343E+007
p1(10)  = c20  = +0.0000000000000000E+000  Sigma_initial(10,10) = 1.3238330844331343E+007
p1(11)  = d20  = +0.0000000000000000E+000  Sigma_initial(11,11) = 1.3238330844331343E+007
p1(12)  = a01  = +0.0000000000000000E+000  Sigma_initial(12,12) = 1.0000000000000000E+004
p1(13)  = b01  = +0.0000000000000000E+000  Sigma_initial(13,13) = 1.0000000000000000E+004
p1(14)  = c01  = +0.0000000000000000E+000  Sigma_initial(14,14) = 1.0000000000000000E+004
p1(15)  = d01  = +0.0000000000000000E+000  Sigma_initial(15,15) = 1.0000000000000000E+004
p1(16)  = e01  = +0.0000000000000000E+000  Sigma_initial(16,16) = 1.0000000000000000E+004
p1(17)  = f01  = +0.0000000000000000E+000  Sigma_initial(17,17) = 1.0000000000000000E+004
-------------------------------------------------------------------------------------
p2f(01) = am1  = +0.0000000000000000E+000
p2f(02) = am2  = +0.0000000000000000E+000  Sigma_initial(18,18) = 1.0000000000000001E-001
p2f(03) = am3  = +1.0000000000000000E+000
p2f(04) = beta = +1.0000000000000000E+000  Sigma_initial(19,19) = 1.0000000000000001E-001
p2f(05) = qT1  = +1.1714108883076305E-006  Sigma_initial(20,20) = 1.0000000000000001E-001
p2f(06) = qT2  = -9.3738638321546567E-004  Sigma_initial(21,21) = 1.0000000000000000E-002
p2f(07) = aT3  = +1.2496548701431507E-003  Sigma_initial(22,22) = 1.0000000000000000E-002
p2f(08) = qT4  = +9.9999877983330654E-001
p2f(09) = qR1  = +0.0000000000000000E+000  Sigma_initial(23,23) = 3.4288868839039716E-003
p2f(10) = qR2  = +0.0000000000000000E+000  Sigma_initial(24,24) = 1.8555467699985827E-004
p2f(11) = qR3  = +0.0000000000000000E+000  Sigma_initial(25,25) = 1.8555467699985827E-004
p2f(12) = qR4  = +1.0000000000000000E+000
p2f(13) = brx  = +0.0000000000000000E+000  Sigma_initial(26,26) = 6.6181336863004636E-005
p2f(14) = bry  = +0.0000000000000000E+000  Sigma_initial(27,27) = 6.6181336863004636E-005
p2f(15) = brz  = +0.0000000000000000E+000  Sigma_initial(28,28) = 6.6181336863004636E-005
p2f(16) = crx  = +0.0000000000000000E+000  Sigma_initial(29,29) = 4.3799693489744957E-009
p2f(17) = cry  = +0.0000000000000000E+000  Sigma_initial(30,30) = 4.3799693489744957E-009
p2f(18) = crz  = +0.0000000000000000E+000  Sigma_initial(31,31) = 4.3799693489744957E-009
p2f(19) = bgx  = +0.0000000000000000E+000  Sigma_initial(32,32) = 6.6181336863004636E-005
p2f(20) = bgy  = +0.0000000000000000E+000  Sigma_initial(33,33) = 6.6181336863004636E-005
p2f(21) = bgz  = +0.0000000000000000E+000  Sigma_initial(34,34) = 6.6181336863004636E-005
p2f(22) = cgx  = +0.0000000000000000E+000  Sigma_initial(35,35) = 4.3799693489744957E-009
```

```
p2f(23) = cgy  = +0.0000000000000000E+000  Sigma_initial(36,36) = 4.3799693489744957E-009
p2f(24) = cgz  = +0.0000000000000000E+000  Sigma_initial(37,37) = 4.3799693489744957E-009
-------------------------------------------------------------------------------------

--------------------   IPF KALMAN FILTER STARTED  ---------------------
Iteration#001: |dp|= +5.096910571965E+004   RMS(|Res|)=+5.096910571965E+004
Iteration#002: |dp|= +6.489483560050E+001   RMS(|Res|)=+6.489483560050E+001
Iteration#003: |dp|= +5.045548016368E+000   RMS(|Res|)=+5.045548016368E+000
Iteration#004: |dp|= +2.345670709654E+001   RMS(|Res|)=+2.345670709654E+001
Iteration#005: |dp|= +1.929677950377E+000   RMS(|Res|)=+1.929677950377E+000
Iteration#006: |dp|= +4.840273908660E-002   RMS(|Res|)=+4.840273908660E-002
Iteration#007: |dp|= +5.985941209625E-003   RMS(|Res|)=+5.985941209625E-003
Iteration#008: |dp|= +5.516117322077E-004   RMS(|Res|)=+5.516117322077E-004
Iteration#009: |dp|= +1.331056979242E-005   RMS(|Res|)=+1.331056979242E-005
Iteration#010: |dp|= +9.248450832335E-006   RMS(|Res|)=+9.248450832335E-006
Iteration#011: |dp|= +7.501216719705E-006   RMS(|Res|)=+7.501216719705E-006
Iteration#012: |dp|= +5.081768960798E-006   RMS(|Res|)=+5.081768960798E-006
Iteration#013: |dp|= +2.491338169810E-006   RMS(|Res|)=+2.491338169810E-006
Iteration#014: |dp|= +1.205220480205E-005   RMS(|Res|)=+1.205220480205E-005
Iteration#015: |dp|= +1.562119011600E-005   RMS(|Res|)=+1.562119011600E-005
Iteration#016: |dp|= +3.119868065772E-006   RMS(|Res|)=+3.119868065772E-006
Iteration#017: |dp|= +3.879003319789E-006   RMS(|Res|)=+3.879003319789E-006
Iteration#018: |dp|= +1.331610779788E-005   RMS(|Res|)=+1.331610779788E-005
Iteration#019: |dp|= +1.178439151713E-005   RMS(|Res|)=+1.178439151713E-005
Iteration#020: |dp|= +7.084106904167E-006   RMS(|Res|)=+7.084106904167E-006
IPF Kalman Filter Completed with Error |dp1| + |dp2| = +7.0841069041665971E-006
-----------------------------------------------------------------------

-----------------  IPF LEAST SQUARES FILTER STARTED  ------------------
Iteration#001   COND#=+9.540024242997E+012,   |dp|=+5.094834567957E+004
Iteration#002   COND#=+9.539973450586E+012,   |dp|=+7.838442318469E+000
Iteration#003   COND#=+9.539973869395E+012,   |dp|=+2.106939850796E-002
Iteration#004   COND#=+9.539973230270E+012,   |dp|=+1.579070583161E-003
Iteration#005   COND#=+9.539973601515E+012,   |dp|=+5.444620061094E-005
Iteration#006   COND#=+9.539973611154E+012,   |dp|=+1.143316920668E-006
Iteration#007   COND#=+9.539974195204E+012,   |dp|=+8.864149789266E-007
Iteration#008   COND#=+9.539973775278E+012,   |dp|=+5.794827102648E-007
Iteration#009   COND#=+9.539972983912E+012,   |dp|=+3.676571144226E-007
Iteration#010   COND#=+9.539973511440E+012,   |dp|=+1.936347397819E-007
Iteration#011   COND#=+9.539973177128E+012,   |dp|=+3.758529524527E-007
Iteration#012   COND#=+9.539972881399E+012,   |dp|=+8.195333278696E-007
Iteration#013   COND#=+9.539972824435E+012,   |dp|=+8.489615678661E-007
Iteration#014   COND#=+9.539973939870E+012,   |dp|=+5.485065636936E-007
Iteration#015   COND#=+9.539973873888E+012,   |dp|=+6.361971747107E-007
Iteration#016   COND#=+9.539974001887E+012,   |dp|=+7.964711178785E-007
Iteration#017   COND#=+9.539974750374E+012,   |dp|=+3.553018654431E-007
Iteration#018   COND#=+9.539974109827E+012,   |dp|=+3.149466630615E-007
Iteration#019   COND#=+9.539974684211E+012,   |dp|=+4.286757294353E-007
Iteration#020   COND#=+9.539973996782E+012,   |dp|=+6.610618830752E-007
IPF Least Squares Filter Completed with Error |dp1| + |dp2| = +6.6106188307519166E-007
-----------------------------------------------------------------------
Total Execution Time: 370 seconds



*********************************************************************
IPF EXECUTION-LOG FILE NAME:  LG992107.dat
INSTRUMENT TYPE:              MIPS_70um_center
IPF FILTER EXECUTION DATE:    05-Aug-2003    TIME: 22:04
IPF FILTER VERSION USED:      IPF.V2.0.1Beta
*********************************************************************

------------------- Loading & Preparing Input Files -------------------
AAFILE:  AA992107 Loaded!        AAFILE dimension = 151101 X 21
ASFILE:  AS992107 Loaded!
CAFILE:  CA992107 Loaded!        CAFILE dimension = 480 X 15
CBFILE:  CB992107 Loaded!        CBFILE dimension = 42 X 15
```

```
CCFILE:  CC992107 Created!       CCFILE dimension = 522 X 19
CSFILE:  CS992107 Loaded!
Loading Input Files Completed!
-----------------------------------------------------------------------

------------------------ Selected Mask Vectors ------------------------
index =   1  2  3  4  5  6  7  8  9 10 11 12 13 14 15 16 17 18 19 20
-----------------------------------------------------------------------
mask1 = [ 1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1 ]
mask2 = [ 1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1 ]
-----------------------------------------------------------------------

---------------  Selected Initial Gyro Bias Parameters  ---------------
User Entered 1 : Use AFILE database - from S/C filter
IPF Linearized Using Following Nominal Gyro Bias Estimates
bg0 = [+1.5108113660766746E-006 +1.9656065089985414E-007 +2.4738151977060690E-007 ]
cg0 = [+0.0000000000000000E+000 +0.0000000000000000E+000 +0.0000000000000000E+000 ]
-----------------------------------------------------------------------

---------------  Gyro Pre-Processor Run Completed  --------------------
     AGFILE CREATED:  AG992107.m     ACFILE CREATED:  AC992107.m
-----------------------------------------------------------------------
Total Gyro Preprocessor Execution Time: 81 seconds

FRAME TABLE ENTRIES FOR PCRS LOADED TO TPCRS
q_PCRS4 = [ +5.2603126189317361E-007     q_PCRS5 = [ +7.3379987833742897E-007
            +3.7451819048221893E-004                 +5.2236196154513707E-004
            -1.4045531552277380E-003                 -1.4047712280184723E-003
            +9.9999894348258311E-001 ];              +9.9999887687698918E-001 ];
q_PCRS8 = [ -5.1968404336718985E-007     q_PCRS9 = [ -7.1963421681856818E-007
            +3.8455385122900486E-004                 +5.3239763239987400E-004
            +1.3513933841514693E-003                 +1.3516841804518383E-003
            +9.9999901292650617E-001 ];              +9.9999894475050310E-001 ];
-------------------------------------------------------------------------------
------ Initial Conditions for State -----  ------   Inital Square-Root Cov (diag)   -----
p1(01)  = a00  = +0.0000000000000000E+000  Sigma_initial(01,01) = 1.0000000000000000E+000
p1(02)  = b00  = +0.0000000000000000E+000  Sigma_initial(02,02) = 1.0000000000000000E+000
p1(03)  = c00  = +0.0000000000000000E+000  Sigma_initial(03,03) = 1.0000000000000000E+000
p1(04)  = a10  = +0.0000000000000000E+000  Sigma_initial(04,04) = 3.6384517097704270E+002
p1(05)  = b10  = +0.0000000000000000E+000  Sigma_initial(05,05) = 3.6384517097704270E+002
p1(06)  = c10  = +0.0000000000000000E+000  Sigma_initial(06,06) = 3.6384517097704270E+002
p1(07)  = d10  = +0.0000000000000000E+000  Sigma_initial(07,07) = 3.6384517097704270E+002
p1(08)  = a20  = +0.0000000000000000E+000  Sigma_initial(08,08) = 1.3238330844331343E+007
p1(09)  = b20  = +0.0000000000000000E+000  Sigma_initial(09,09) = 1.3238330844331343E+007
p1(10)  = c20  = +0.0000000000000000E+000  Sigma_initial(10,10) = 1.3238330844331343E+007
p1(11)  = d20  = +0.0000000000000000E+000  Sigma_initial(11,11) = 1.3238330844331343E+007
p1(12)  = a01  = +0.0000000000000000E+000  Sigma_initial(12,12) = 1.0000000000000000E+004
p1(13)  = b01  = +0.0000000000000000E+000  Sigma_initial(13,13) = 1.0000000000000000E+004
p1(14)  = c01  = +0.0000000000000000E+000  Sigma_initial(14,14) = 1.0000000000000000E+004
p1(15)  = d01  = +0.0000000000000000E+000  Sigma_initial(15,15) = 1.0000000000000000E+004
p1(16)  = e01  = +0.0000000000000000E+000  Sigma_initial(16,16) = 1.0000000000000000E+004
p1(17)  = f01  = +0.0000000000000000E+000  Sigma_initial(17,17) = 1.0000000000000000E+004
-------------------------------------------------------------------------------------------
p2f(01) = am1  = +0.0000000000000000E+000
p2f(02) = am2  = +0.0000000000000000E+000  Sigma_initial(18,18) = 1.0000000000000001E-001
p2f(03) = am3  = +1.0000000000000000E+000
p2f(04) = beta = +1.0000000000000000E+000  Sigma_initial(19,19) = 1.0000000000000001E-001
p2f(05) = qT1  = +1.1714108883076305E-006  Sigma_initial(20,20) = 1.0000000000000001E-001
p2f(06) = qT2  = -9.3738638321546567E-004  Sigma_initial(21,21) = 1.0000000000000000E-002
p2f(07) = aT3  = +1.2496548701431507E-003  Sigma_initial(22,22) = 1.0000000000000000E-002
p2f(08) = qT4  = +9.9999877983330654E-001
p2f(09) = qR1  = +0.0000000000000000E+000  Sigma_initial(23,23) = 3.4281576788666959E-002
p2f(10) = qR2  = +0.0000000000000000E+000  Sigma_initial(24,24) = 2.4007572013584836E-003
p2f(11) = qR3  = +0.0000000000000000E+000  Sigma_initial(25,25) = 2.7434407822204804E-003
p2f(12) = qR4  = +1.0000000000000000E+000
p2f(13) = brx  = +0.0000000000000000E+000  Sigma_initial(26,26) = 6.6181336863004636E-005
p2f(14) = bry  = +0.0000000000000000E+000  Sigma_initial(27,27) = 6.6181336863004636E-005
p2f(15) = brz  = +0.0000000000000000E+000  Sigma_initial(28,28) = 6.6181336863004636E-005
```

```
p2f(16) = crx  = +0.0000000000000000E+000  Sigma_initial(29,29) = 4.3799693489744957E-009
p2f(17) = cry  = +0.0000000000000000E+000  Sigma_initial(30,30) = 4.3799693489744957E-009
p2f(18) = crz  = +0.0000000000000000E+000  Sigma_initial(31,31) = 4.3799693489744957E-009
p2f(19) = bgx  = +0.0000000000000000E+000  Sigma_initial(32,32) = 6.6181336863004636E-005
p2f(20) = bgy  = +0.0000000000000000E+000  Sigma_initial(33,33) = 6.6181336863004636E-005
p2f(21) = bgz  = +0.0000000000000000E+000  Sigma_initial(34,34) = 6.6181336863004636E-005
p2f(22) = cgx  = +0.0000000000000000E+000  Sigma_initial(35,35) = 4.3799693489744957E-009
p2f(23) = cgy  = +0.0000000000000000E+000  Sigma_initial(36,36) = 4.3799693489744957E-009
p2f(24) = cgz  = +0.0000000000000000E+000  Sigma_initial(37,37) = 4.3799693489744957E-009
--------------------------------------------------------------------------------------

--------------------   IPF KALMAN FILTER STARTED  ---------------------
Iteration#001: |dp|= +4.161610381363E+004   RMS(|Res|)=+4.161610381363E+004
Iteration#002: |dp|= +1.214099608016E+003   RMS(|Res|)=+1.214099608016E+003
Iteration#003: |dp|= +5.383409922239E+000   RMS(|Res|)=+5.383409922239E+000
Iteration#004: |dp|= +2.680675199569E+001   RMS(|Res|)=+2.680675199569E+001
Iteration#005: |dp|= +2.268662951478E+000   RMS(|Res|)=+2.268662951478E+000
Iteration#006: |dp|= +6.162205949169E-002   RMS(|Res|)=+6.162205949169E-002
Iteration#007: |dp|= +7.213711707114E-003   RMS(|Res|)=+7.213711707114E-003
Iteration#008: |dp|= +6.972732088155E-004   RMS(|Res|)=+6.972732088155E-004
Iteration#009: |dp|= +2.016113254192E-005   RMS(|Res|)=+2.016113254192E-005
Iteration#010: |dp|= +1.721820581093E-006   RMS(|Res|)=+1.721820581093E-006
Iteration#011: |dp|= +3.629679928072E-007   RMS(|Res|)=+3.629679928072E-007
Iteration#012: |dp|= +7.759700331270E-007   RMS(|Res|)=+7.759700331270E-007
Iteration#013: |dp|= +5.743373875364E-007   RMS(|Res|)=+5.743373875364E-007
Iteration#014: |dp|= +8.282145390296E-007   RMS(|Res|)=+8.282145390296E-007
Iteration#015: |dp|= +7.931984793177E-007   RMS(|Res|)=+7.931984793177E-007
Iteration#016: |dp|= +1.390653562925E-006   RMS(|Res|)=+1.390653562925E-006
Iteration#017: |dp|= +9.630044779164E-007   RMS(|Res|)=+9.630044779164E-007
Iteration#018: |dp|= +2.100327715404E-007   RMS(|Res|)=+2.100327715404E-007
Iteration#019: |dp|= +4.467808399695E-007   RMS(|Res|)=+4.467808399695E-007
Iteration#020: |dp|= +6.026094497477E-007   RMS(|Res|)=+6.026094497477E-007
IPF Kalman Filter Completed with Error |dp1| + |dp2| = +6.0260944974773012E-007
-----------------------------------------------------------------------

-----------------  IPF LEAST SQUARES FILTER STARTED  ------------------
Iteration#001   COND#=+9.669870775058E+012,   |dp|=+4.163129776127E+004
Iteration#002   COND#=+9.667477046346E+012,   |dp|=+1.145931066849E+003
Iteration#003   COND#=+9.667486718585E+012,   |dp|=+3.893843767182E+000
Iteration#004   COND#=+9.667483468936E+012,   |dp|=+1.449442166898E-002
Iteration#005   COND#=+9.667487169077E+012,   |dp|=+1.704956028699E-004
Iteration#006   COND#=+9.667487376653E+012,   |dp|=+2.856489849330E-006
Iteration#007   COND#=+9.667488604821E+012,   |dp|=+5.875619789725E-007
Iteration#008   COND#=+9.667484772449E+012,   |dp|=+5.442659043150E-007
Iteration#009   COND#=+9.667487477316E+012,   |dp|=+8.200194871028E-007
Iteration#010   COND#=+9.667482921849E+012,   |dp|=+7.582643506432E-007
Iteration#011   COND#=+9.667484738023E+012,   |dp|=+5.756225301457E-007
Iteration#012   COND#=+9.667486264286E+012,   |dp|=+5.184306877971E-007
Iteration#013   COND#=+9.667483001823E+012,   |dp|=+8.252956521997E-007
Iteration#014   COND#=+9.667481218928E+012,   |dp|=+6.601495710729E-007
Iteration#015   COND#=+9.667487327658E+012,   |dp|=+3.007994754187E-007
Iteration#016   COND#=+9.667487106094E+012,   |dp|=+4.705038368651E-007
Iteration#017   COND#=+9.667482245610E+012,   |dp|=+6.197669922475E-007
Iteration#018   COND#=+9.667485288732E+012,   |dp|=+4.740161793710E-007
Iteration#019   COND#=+9.667487110532E+012,   |dp|=+6.208013262201E-007
Iteration#020   COND#=+9.667483234924E+012,   |dp|=+1.051977767652E-006
IPF Least Squares Filter Completed with Error |dp1| + |dp2| = +1.0519777676520631E-006
-----------------------------------------------------------------------
Total Execution Time: 479 seconds
```

3 USER COMMENTS

This section left blank.

IPF TEAM CONTACT INFORMATION

IPF Team email		ipf@sirtfweb.jpl.nasa.gov	
David S. Bayard	X4-8208	David.S.Bayard@jpl.nasa.gov	(TEAM LEADER)
Dhemetrio Boussalis	X4-3977	boussali@grover.jpl.nasa.gov	
Paul Brugarolas	X4-9243	Paul.Brugarolas@jpl.nasa.gov	
Bryan H. Kang	X4-0541	Bryan.H.Kang@jpl.nasa.gov	
Edward.C.Wong	X4-3053	Edward.C.Wong@jpl.nasa.gov	(TASK MANAGER)

ACKNOWLEDGEMENTS

This work was performed at the Jet Propulsion Laboratory, California Institute of Technology, under contract with the National Aeronautics and Space Administration.

References

[1] D.S. Bayard, B.H. Kang, *SIRTF Instrument Pointing Frame Kalman Filter Algorithm*, JPL D-Document D-24809, September 30, 2003.

[2] B.H. Kang, D.S. Bayard, *SIRTF Instrument Pointing Frame (IPF) Software Description Document and User's Guide*, JPL D-Document D-24808, September 30, 2003.

[3] D.S. Bayard, B.H. Kang, *SIRTF Instrument Pointing Frame (IPF) Kalman Filter Unit Test Report*, JPL D-Document D-24810, September 30, 2003.

[4] *Space Infrared Telescope Facility In-Orbit Checkout and Science Verification Mission Plan*, JPL D-Document D-22622, 674-FE-301 Version 1.4, February 8, 2002.

[5] *Space Infrared Telescope Facility Observatory Description Document*, Lockheed Martin LMMS/P458569, 674-SEIT-300 Version 1.2, November 1, 2002.

[6] *SIRTF Software Interface Specification for Science Centroid INPUT Files (CAFILE, CS-FILE)*, JPL SOS-SIS-2002, November 18, 2002.

[7] *SIRTF Software Interface Specification for Inferred Frames Offset INPUT Files (OFILE)*, JPL SOS-SIS-2003, November 18, 2002.

[8] *SIRTF Software Interface Specification for PCRS Centroid INPUT Files (CBFILE)*, JPL SIS-FES-015, November 18, 2002.

[9] *SIRTF Software Interface Specification for Attitude INPUT Files (AFILE, ASFILE)*, JPL SIS-FES-014, January 7, 2002.

[10] *SIRTF Software Interface Specification for IPF Filter Output Files (IFFILE, LGFILE, TARFILE)*, JPL SOS-SIS-2005, November 18, 2002.

[11] R.J. Brown, *Focal Surface to Object Space Field of View Conversion.* Systems Engineering Report SER No. S20447-OPT-051, Ball Aerospace & Technologies Corp., November 23, 1999.

JET PROPULSION LABORATORY **SIRTF IPF REPORT**
JPL ID991118
August 5, 2003

SIRTF INSTRUMENT POINTING FRAME KALMAN FILTER EXECUTION SUMMARY

IPF RUN NUMBER: 991118
REPORT TYPE: COVARIANCE ANALYSIS

PRIME FRAME: MIPS_70um_fine_center (118)
INFERRED FRAMES: (119) (120) (124) (127) (1) (1) (1) (1)

IPF TEAM

Autonomy and Control Section (345)
Jet Propulsion Laboratory
California Institute of Technology
4800 Oak Grove Drive
Pasadena, CA 91109

Contents

1 IPF EXECUTION SUMMARY **4**

2 FLUTE DATA SUMMARY **8**

2.1 FLUTE CONFIGURATION PARAMETERS 8

2.2 FLUTE GENERATED UNIT TEST DATA 11

3 IPF EXECUTION RESULTS **15**

3.1 IPF EXECUTION OUTPUT PLOTS 15

3.2 IPF OUTPUT DATA (IF MINI FILE) 29

3.3 IPF EXECUTION LOG 34

4 USER COMMENTS **37**

List of Figures

1.1 A-priori and a-posteriori IPF frames 4

1.2 A-priori and a-posteriori IPF frames (ZOOMED) 7

2.1 Focal plane survey scenario plot (See key in [3]) 11

2.2 Commanded-only source locations 12

2.3 True (+) and commanded (o) source locations 12

2.4 True (+) and commanded (o) source locations (ZOOMED) 13

2.5 True-sampled (o) and centroided (+) locations on S/I array (W,V) 13

2.6 True (o) and centroided (+) locations on S/I array (W,V) 14

2.7 True (o) and centroided (+) locations on S/I array (W,V) showing prime and inferred frames 14

3.1 TPF coords of measurements and a-priori predicts 16

3.2 Oriented Pixel Coords of measurements and a-priori predicts 16

3.3 A-priori prediction error 17

3.4 Oriented Pixel Coords of measurements and a-priori predicts (PCRS only) 17

3.5 IPF execution convergence, chart 1 18

3.6 IPF execution convergence, chart 2 18

3.7 Parameter uncertainty convergence 19

3.8 IPF parameter symbol table 19

3.9 KF parameter error sigma plots . . . 20
3.10 LS parameter error sigma plot . . . 20
3.11 KF and LS parameter error sigma plot . . . 21
3.12 Oriented Pixel Coords of meas. and a-posteriori predicts . . . 22
3.13 Oriented Pixel Coords of meas. and a-posteriori predicts (attitude corrected) . . . 22
3.14 Array plot with (solid) and w/o (dashed) optical distortion corrections . . . 23
3.15 KF innovations with (o) and w/o (+) attitude corrections . . . 23
3.16 W-axis KF innovations and 1-sigma bound . . . 24
3.17 V-axis KF innovations and 1-sigma bound . . . 24
3.18 Estimated attitude corrections (Body frame) . . . 25
3.19 Estimated attitude error sigma plot (Body frame) . . . 25
3.20 Thermo-mechanical boresight drift (equiv. angle in (W,V) coords) . . . 26
3.21 Thermo-mechanical boresight drift (equiv. angle in Body frame) . . . 26
3.22 Gyro drift bias contribution (equiv. rate in (W,V) coords) . . . 27
3.23 Gyro drift bias contribution (equiv. angle in (W,V) coords) . . . 27
3.24 Gyro drift bias contribution (equiv. angle in Body frame) . . . 28

List of Tables

1.1 IPF filter input files . . . 5
1.2 IPF filter execution configuration . . . 5
1.3 IPF filter execution mask vector assignment . . . 5
1.4 IPF calibration error summary ([arcsec], 1-sigma, radial) . . . 6
1.5 Measurement prediction error summary (1-sigma) . . . 6
1.6 IPF Brown angle summary . . . 7
2.1 FLUTE Parameter Table (1) . . . 8
2.2 FLUTE Parameter Table (2) . . . 9
2.3 FLUTE Parameter Table (3) . . . 10
2.4 Table of figures (FLUTE) . . . 11
3.1 Table of figures (IPF run) . . . 15

1 IPF EXECUTION SUMMARY

This report summarizes the SIRTF Instrument Pointing Frame (IPF) Kalman Filter execution associated with run file: RN991118. In particular, this Focal Point Survey calibrates the instrument: MIPS_70um_fine_center (118), as part of the Covariance Analysis. The main calibration results from the IPF filter execution have been documented in IF991118 typically stored in the mission archive DOM collection IPF_IF. This report only summarizes the main aspects of the run, and does not substitute for the full information contained in the IF file.

Section 1 summarizes the filter execution results. The filter configurations are tabulated in Table 1.2 and the mask vector assignments are tabulated in Table 1.3. A total of 37 state parameters are estimated in this run. The overall End-to-End pointing performances are tabulated in Table 1.4. The prediction residuals throughout the estimation processes are tabulated in Table 1.6. Section 2 documents the FLUTE generated input file data. Section 3 summarizes resulting plots, a mini summary of the IF IPF output file, and the execution log. Section 4 captures the user comments that are specific to this particular run.

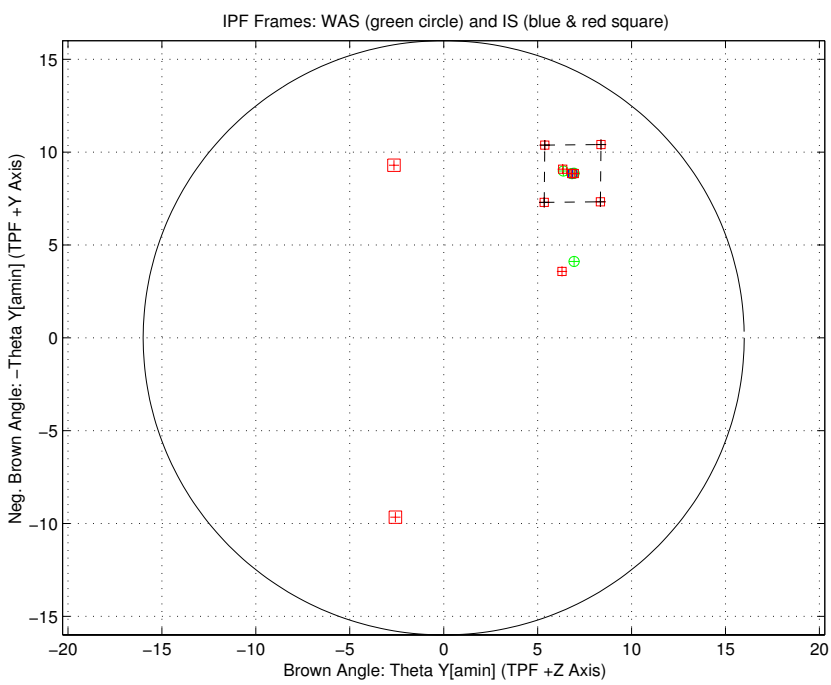

Figure 1.1: A-priori and a-posteriori IPF frames

RAW	FINAL (After Editing)
AA991118	AA991118
AS991118	AS991118
CA991118	CA991118
CB991118	CB991118
CS991118	CS991118

Table 1.1: IPF filter input files

EXECUTION CONFIGURATION ITEM	CURRENT STATUS
IPF Filter Version Used	IPF.V2.0.1Beta
Frame Table Version Used	FTVE2E1
Scan-Mirror Employed?	YES
IPF Filter Mode	NORMAL-MODE(0)
SLIT-MODE Operation	DISABLED
Kalman Filter Operation	ENABLED
Least-Squares Data Analysis	ENABLED
IBAD Screening	ENABLED
User-Specified Data Editing	DISABLED
Total Number of Iterations	20
LS Residual Sigma Scale	1.08606281E+000
Total Number of Maneuvers	22

Table 1.2: IPF filter execution configuration

Con. Plate Scale			Γ Dependent				Γ^2 Dependent				Linear Plate Scale						Mirror	
a_{00}	b_{00}	c_{00}	a_{10}	b_{10}	c_{10}	d_{10}	a_{20}	b_{20}	c_{20}	d_{20}	a_{01}	b_{01}	c_{01}	d_{01}	e_{01}	f_{01}	α	β
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
IPF (T)			Alignment R									Gyro Drift Bias						
θ_1	θ_2	θ_3	a_{rx}	a_{ry}	a_{rz}	b_{rx}	b_{ry}	b_{rz}	c_{rx}	c_{ry}	c_{rz}	b_{gx}	b_{gy}	b_{gz}	c_{gx}	c_{gy}	c_{gz}	
20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	

Table 1.3: IPF filter execution mask vector assignment

FOCAL PLANE SURVEY ANALYSIS: Covariance Analysis.
INSTRUMENT NAME: MIPS_70um_fine_center NF: 118

```
PIX2RADW: 2.47365083E-005[rad/pixel] = 5.1023E+000[arcsec/pixel]
PIX2RADV: 2.47365083E-005[rad/pixel] = 5.1023E+000[arcsec/pixel]
```

FRAME	DESCRIPTION	IPF[1]	SF[2]	ARW[3]	TOTAL	REQ
118(P)	MIPS_70um_fine_center	0.1852	0.0855	0.0565	0.2117	1.10
119(I)	MIPS_70um_fine_FOV1	0.1930	0.0855	0.0565	0.2185	N/A
120(I)	MIPS_70um_fine_FOV2	1.6859	0.0855	0.0565	1.6890	N/A
124(I)	MIPS_70um_fine_FOV3	0.1426	0.0855	0.0565	0.1756	N/A
127(I)	MIPS_70um_fine_FOV4	0.1813	0.0855	0.0565	0.2082	N/A
TR (C)	CORNERS OF INSTRUMENT	0.4063	0.0855	0.0565	0.4190	N/A
BR (C)	CORNERS OF INSTRUMENT	0.3893	0.0855	0.0565	0.4026	N/A
TL (C)	CORNERS OF INSTRUMENT	0.2974	0.0855	0.0565	0.3146	N/A
BL (C)	CORNERS OF INSTRUMENT	0.2893	0.0855	0.0565	0.3069	N/A

Table 1.4: IPF calibration error summary ([arcsec], 1-sigma, radial)

RMS METRIC	A PRIORI[4]	A POSTERIORI[4]	ATT. CORRECTED[5]	UNITS
Radial	7.6358	1.5671	0.7963	arcsec
Radial	1.4966	0.3071	0.1561	pixels
W-Axis	0.8157	0.1901	0.1082	pixels
V-Axis	1.2547	0.2412	0.1125	pixels

Table 1.5: Measurement prediction error summary (1-sigma)

[1]IPF filter removes systematic pointing errors due to: thermomechanical alignment drift (Body to TPF), gyro bias and bias drift, centroiding error, attitude error, and optical distortion. IPF SIGMA presented here is "NOT Scaled" by the Least Squares Scale factor. The Least Squares Scale Factor was: 1.086063.

[2]Error due to gyro Scale Factor: assumes 95 ppm error over 0.250 degree maneuver.

[3]Error due to gyro Angle Random Walk: assumes ARW = 100 $\mu deg/\sqrt{hr}$, with 975 second Maneuver time (max), and 22 independent Maneuvers.

[4]This can be interpreted as estimate of "pixel to sky" pointing reconstruction error if no science data is used.

[5]This can be interpreted as estimate of achieved S/I centroiding error

IPF BROWN ANGLE SUMMARY						
	WAS			IS		
Frame Number	theta_Y (arcmin)	theta_Z (arcmin)	angle (deg)	theta_Y (arcmin)	theta_Z (arcmin)	angle (deg)
118	+6.859000	-8.847000	-0.000000	+6.857763	-8.846235	-0.040586
119	+6.942000	-8.861000	-0.000000	+6.951192	-8.847207	-0.040586
120	+6.941000	-4.117000	+0.000000	+6.302093	-3.578516	-0.040586
124	+6.372000	-8.981000	-0.000000	+6.337374	-9.082097	-0.040586
127	+6.818000	-8.840000	+0.000000	+6.811061	-8.845759	-0.040586
001	+0.000000	+0.000000	+0.000000	+8.370836	-10.410809	-0.040586
001	+0.000000	+0.000000	+0.000000	+8.344954	-7.325037	-0.040586
001	+0.000000	+0.000000	+0.000000	+5.382960	-10.376793	-0.040586
001	+0.000000	+0.000000	+0.000000	+5.354457	-7.297747	-0.040586

Table 1.6: IPF Brown angle summary

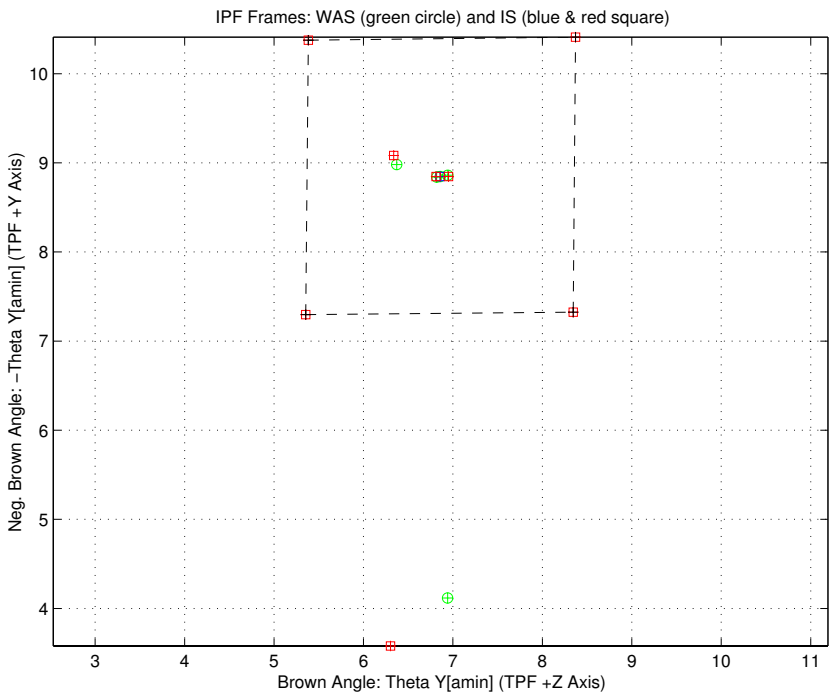

Figure 1.2: A-priori and a-posteriori IPF frames (ZOOMED)

2 FLUTE DATA SUMMARY

2.1 FLUTE CONFIGURATION PARAMETERS

The covariance analysis was performed using the FLUTE generated input data files. The internal configuration parameters, used to produce the data are tabulated in Table 2.1, Table 2.2 and Table 2.3.

NAME	DESCRIPTION	VALUE	UNIT
d2003	days into YEAR2003	+6.0000000000000000E+001	day
tstart	start time	+7.3051200000000000E+008	sec
tdel	data rate	+1.0000000000000001E-001	sec
tshelf	Inertial Hold duration pad	+5.0000000000000000E+000	sec
ipro	slew profile(1-linear, 2-S-curve)	1	int flag
sig_gcf [1]	gcf sigma(1)	+4.8481368110953601E-008	rad/sec
sig_gcf [2]	gcf sigma(2)	+9.6962736221907205E-009	rad/sec
sig_gcf [3]	gcf sigma(3)	+9.6962736221907205E-009	rad/sec
igcf	gcf bias correction flag	1	int flag
SigA [1][1]	Sigma A(1,1)	+9.4017722156391537E-009	rad^2
SigA [2][2]	Sigma A(2,2)	+2.3504430539097885E-011	rad^2
SigA [3][3]	Sigma A(3,3)	+2.3504430539097885E-011	rad^2
NFprime	Prime Frame NF	118	int
ftable [name]	Frame Table row number	118	int
ftable [q0]	Frametable quaternion q0	+1.2836566686785979E-006	N/A
ftable [q1]	Frametable quaternion q1	-9.9760012028013629E-004	N/A
ftable [q2]	Frametable quaternion q2	+1.2867429956649658E-003	N/A
ftable [q3]	Frametable quaternion q3	+9.9999867454152913E-001	N/A
ft_cmd [name]	Command row number	118	int
ft_cmd [q0]	Command quaternion q0	+1.2836566686785979E-006	N/A
ft_cmd [q1]	Command quaternion q1	-9.9760012028013629E-004	N/A
ft_cmd [q2]	Command quaternion q2	+1.2867429956649658E-003	N/A
ft_cmd [q3]	Command quaternion q3	+9.9999867454152913E-001	N/A
ft_true [name]	Truth row number	118	int
ft_true [q0]	Truth quaternion q0	+1.2836566686785979E-006	N/A
ft_true [q1]	Truth quaternion q1	-9.9760012028013629E-004	N/A
ft_true [q2]	Truth quaternion q2	+1.2867429956649658E-003	N/A
ft_true [q3]	Truth quaternion q3	+9.9999867454152913E-001	N/A
ft_prior [name]	Prior row number	118	int
ft_prior [q0]	FTprior quaternion q0	+1.2836566686785979E-006	N/A
ft_prior [q1]	FTprior quaternion q1	-9.9760012028013629E-004	N/A
ft_prior [q2]	FTprior quaternion q2	+1.2867429956649658E-003	N/A
ft_prior [q3]	FTprior quaternion q3	+9.9999867454152913E-001	N/A
ntable [NF]	ntable row number	118	int
ntable [iprime]	Prime frame indication flag	1	int
ntable [SIG_CX]	CX Sigma	+1.0000000000000001E-001	pixel
ntable [SIG_CY]	CY Sigma	+1.0000000000000001E-001	pixel
ntable [PIX2RADX]	Nom. angular pixelsize X-dir	+2.4736508339999999E-005	rad/pixel
ntable [PIX2RADY]	Nom. angular pixelsize Y-dir	+2.5464808057000000E-005	rad/pixel
ntable [CX0]	Center pixel along X-axis	+1.6500000000000000E+001	pixel
ntable [CY0]	Center pixel along Y-axis	+1.6500000000000000E+001	pixel
ntable [BETA0]	Nominal mirror scale factor	+2.8047410000000001E-006	rad/(e.u.)
ntable [GAMMA_E0]	Reference Mirror position	+8.7500000000000000E+002	(e.u.[6])

Table 2.1: FLUTE Parameter Table (1)

[6] encoder units

NAME	DESCRIPTION	VALUE	UNIT
ntable [D11]	x-to-w frame flip parameter	-1	int
ntable [D12]	y-to-w frame flip parameter	0	int
ntable [D21]	x-to-v frame flip parameter	0	int
ntable [D22]	y-to-v frame flip parameter	-1	int
ntable [DG]	Mirror flip parameter	1	int
ntable [sisizew]	Array size (w-direction)	+7.8539816339744833E-004	pixel
ntable [sisizev]	Array size (v-direction)	+7.8539816339744833E-004	pixel
ntable [p2i_w]	w-offset from prime	+0.0000000000000000E+000	pixel
ntable [p2i_v]	v-offset from prime	+0.0000000000000000E+000	pixel
p1true [a00]	True Constant Plate Scales	+1.0000000000000001E-001	N/A
p1true [b00]	True Constant Plate Scales	+1.0000000000000001E-001	N/A
p1true [c00]	True Constant Plate Scales	+1.0000000000000000E-002	N/A
p1true [a10]	True Γ Dependent Plate Scales	+1.0000000000000001E-001	1/rad
p1true [b10]	True Γ Dependent Plate Scales	+1.0000000000000001E-001	1/rad
p1true [c10]	True Γ Dependent Plate Scales	+1.0000000000000000E-002	1/rad
p1true [d10]	True Γ Dependent Plate Scales	+1.0000000000000000E-002	1/rad
p1true [a20]	True Γ^2 Dependent Plate Scales	+1.0000000000000001E-001	$1/\mathrm{rad}^2$
p1true [b20]	True Γ^2 Dependent Plate Scales	+1.0000000000000001E-001	$1/\mathrm{rad}^2$
p1true [c20]	True Γ^2 Dependent Plate Scales	+1.0000000000000000E-002	$1/\mathrm{rad}^2$
p1true [d20]	True Γ^2 Dependent Plate Scales	+1.0000000000000000E-002	$1/\mathrm{rad}^2$
p1true [a01]	True Linear Plate Scales	+2.0000000000000000E+000	N/A
p1true [b01]	True Linear Plate Scales	+2.0000000000000000E+000	N/A
p1true [c01]	True Linear Plate Scales	+2.0000000000000000E+000	N/A
p1true [d01]	True Linear Plate Scales	+2.0000000000000000E+000	N/A
p1true [e01]	True Linear Plate Scales	+2.0000000000000000E+000	N/A
p1true [f01]	True Linear Plate Scales	+2.0000000000000000E+000	N/A
p2true [am1]	True Scan mirror alignment Ux	+0.0000000000000000E+000	N/A
p2true [am2]	True Scan mirror alignment Uy	+2.0000000000000000E-002	N/A
p2true [am3]	True Scan mirror alignment Uz	+9.9979997999599901E-001	N/A
p2true [beta]	True Scan mirror scale factor	+1.1000000000000001E+000	N/A
p2true [qT1]	True IPF q1	+1.2836566686785979E-006	N/A
p2true [qT2]	True IPF q2	-9.9760012028013629E-004	N/A
p2true [qT3]	True IPF q3	+1.2867429956649658E-003	N/A
p2true [qT4]	True IPF q4	+9.9999867454152913E-001	N/A
p2true [qR01]	True Boresight Alignment q1	+2.4240684048319150E-005	N/A
p2true [qR02]	True Boresight Alignment q2	+1.2120342024159575E-006	N/A
p2true [qR03]	True Boresight Alignment q3	+1.2120342024159575E-006	N/A
p2true [qR04]	True Boresight Alignment q4	+9.9999999970472575E-001	N/A
p2true [brx]	True B. Alignment drift rate X	+5.6000000000000000E-011	rad/sec
p2true [bry]	True B. Alignment drift rate Y	+5.6000000000000000E-011	rad/sec
p2true [brz]	True B. Alignment drift rate Z	+5.6000000000000000E-011	rad/sec
p2true [crx]	True B. Alignment drift accel. X	+5.0000000000000002E-014	$\mathrm{rad/sec}^2$
p2true [cry]	True B. Alignment drift accel. Y	+5.0000000000000002E-014	$\mathrm{rad/sec}^2$
p2true [crz]	True B. Alignment drift accel. Z	+5.0000000000000002E-014	$\mathrm{rad/sec}^2$
p2true [bgx]	True Gyro bias correction X	+2.5000000000000002E-006	rad/sec
p2true [bgy]	True Gyro bias correction Y	+2.5000000000000002E-006	rad/sec
p2true [bgz]	True Gyro bias correction Z	+2.5000000000000002E-006	rad/sec
p2true [cgx]	True Gyro bias-rate correction X	+4.9999999999999999E-013	$\mathrm{rad/sec}^2$
p2true [cgy]	True Gyro bias-rate correction Y	+4.9999999999999999E-013	$\mathrm{rad/sec}^2$
p2true [cgz]	True Gyro bias-rate correction Z	+4.9999999999999999E-013	$\mathrm{rad/sec}^2$

Table 2.2: FLUTE Parameter Table (2)

NAME	DESCRIPTION	VALUE	UNIT
p2cmd [am1]	CMD Scan mirror alignment Ux	+0.0000000000000000E+000	N/A
p2cmd [am2]	CMD Scan mirror alignment Uy	+0.0000000000000000E+000	N/A
p2cmd [am3]	CMD Scan mirror alignment Uz	+1.0000000000000000E+000	N/A
p2cmd [beta]	CMD Scan mirror rotation SF	+1.0000000000000000E+000	N/A
p2cmd [qT1]	CMD IPF q1	+1.2836566686785979E-006	N/A
p2cmd [qT2]	CMD IPF q2	-9.9760012028013629E-004	N/A
p2cmd [qT3]	CMD IPF q3	+1.2867429956649658E-003	N/A
p2cmd [qT4]	CMD IPF q4	+9.9999867454152913E-001	N/A
p2cmd [qR01]	CMD Boresight Alignment q1	+0.0000000000000000E+000	N/A
p2cmd [qR02]	CMD Boresight Alignment q2	+0.0000000000000000E+000	N/A
p2cmd [qR03]	CMD Boresight Alignment q3	+0.0000000000000000E+000	N/A
p2cmd [qR04]	CMD Boresight Alignment q4	+1.0000000000000000E+000	N/A
p2cmd [brx]	CMD B. Alignment drift rate X	+0.0000000000000000E+000	rad/sec
p2cmd [bry]	CMD B. Alignment drift rate Y	+0.0000000000000000E+000	rad/sec
p2cmd [brz]	CMD B. Alignment drift rate Z	+0.0000000000000000E+000	rad/sec
p2cmd [crx]	CMD B. Alignment drift accel. X	+0.0000000000000000E+000	rad/sec^2
p2cmd [cry]	CMD B. Alignment drift accel. Y	+0.0000000000000000E+000	rad/sec^2
p2cmd [crz]	CMD B. Alignment drift accel. Z	+0.0000000000000000E+000	rad/sec^2
p2cmd [bgx]	CMD Gyro bias correction X	+0.0000000000000000E+000	rad/sec
p2cmd [bgy]	CMD Gyro bias correction Y	+0.0000000000000000E+000	rad/sec
p2cmd [bgz]	CMD Gyro bias correction Z	+0.0000000000000000E+000	rad/sec
p2cmd [cgx]	CMD Gyro bias-rate correction X	+0.0000000000000000E+000	rad/sec^2
p2cmd [cgy]	CMD Gyro bias-rate correction Y	+0.0000000000000000E+000	rad/sec^2
p2cmd [cgz]	CMD Gyro bias-rate correction Z	+0.0000000000000000E+000	rad/sec^2
a1	Semi-Major Axis of SIRTF (HCO [7])	+1.4960000000000000E+011	m
a2	Semi-Major Axis of Earth (HCO)	+1.4960000000000000E+011	m
e1	Eccentricity (SIRTF in HCO)	+1.6722000000000001E-002	N/A
e2	Eccentricity (Earth in HCO)	+1.6722000000000001E-002	N/A
inc1	inclination (SIRTF in HCO)	+4.0142572795869580E-001	rad
inc2	inclination (Earth in HCO)	+4.0142572795869580E-001	rad
Omega1	Ascending Node Long.(SIRTF in HCO)	+0.0000000000000000E+000	rad
Omega2	Ascending Node Long.(Earth in HCO)	+0.0000000000000000E+000	rad
omega1	Argument of Perigee(SIRTF in HCO)	+1.7627825445142729E+000	rad
omega2	Argument of Perigee(Earth in HCO)	+1.7627825445142729E+000	rad
nu0_1	True Anomaly of SIRTF(HCO)	+8.6071031605199810E-001	rad
nu0_2	True Anomaly of Earth(HCO)	+1.0328523792623976E+000	rad
inav	Velocity Report Flag	+0.0000000000000000E+000	rad
wsize	Array size W-dir	+7.8539816339744833E-004	rad
vsize	Array size V-dir	+7.8539816339744833E-004	rad

Table 2.3: FLUTE Parameter Table (3)

[7] Heliocentric Orbit

2.2 FLUTE GENERATED UNIT TEST DATA

This subsection plots the FLUTE generated IPF filter input files. Seven figures, as tabulated in Table 2.4, show the campaign maneuver senario, the true sampled locations on the array and the actual centroided data superimposed the array plane. All angles shown in FLUTE plots have units of radians.

FIGURE NO.	DESCRIPTION
Figure 2.1	Focal Plane Survey Scenario Plot
Figure 2.2	Commanded-only source locations in TPF
Figure 2.3	True and commanded source locations in TPF
Figure 2.4	True and commanded source locations (ZOOMED) in TPF
Figure 2.5	True-sampled and centroided locations in Focal Plane (W,V) including rectangular array boundary approximation
Figure 2.6	True and centroided locations on S/I Array (W,V) including rectangular array boundary approximation
Figure 2.7	True and centroided locations on S/I Array (W,V) showing Prime and Inferred Frames including rectangular array boundary approximation

Table 2.4: Table of figures (FLUTE)

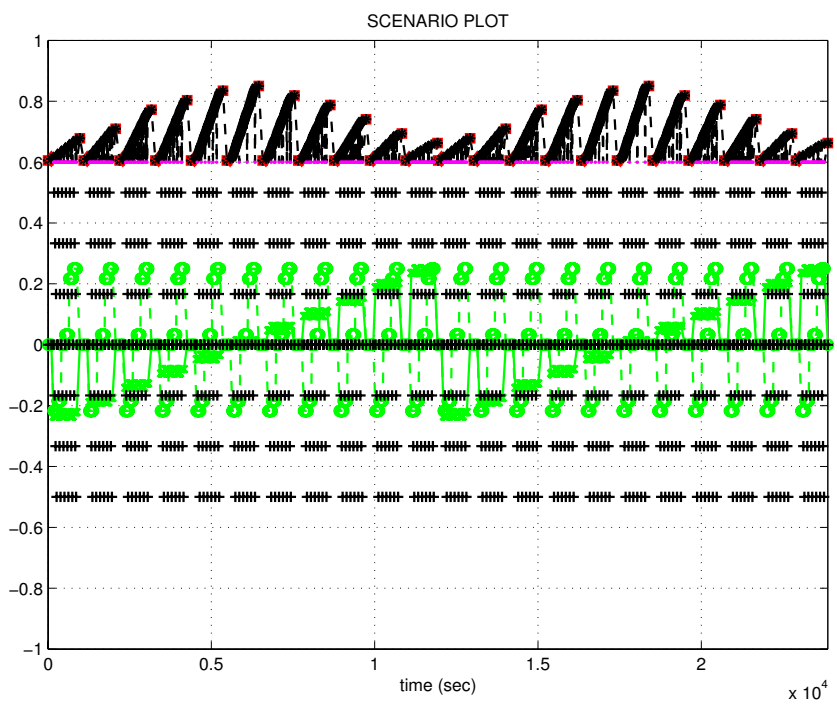

Figure 2.1: Focal plane survey scenario plot (See key in [3])

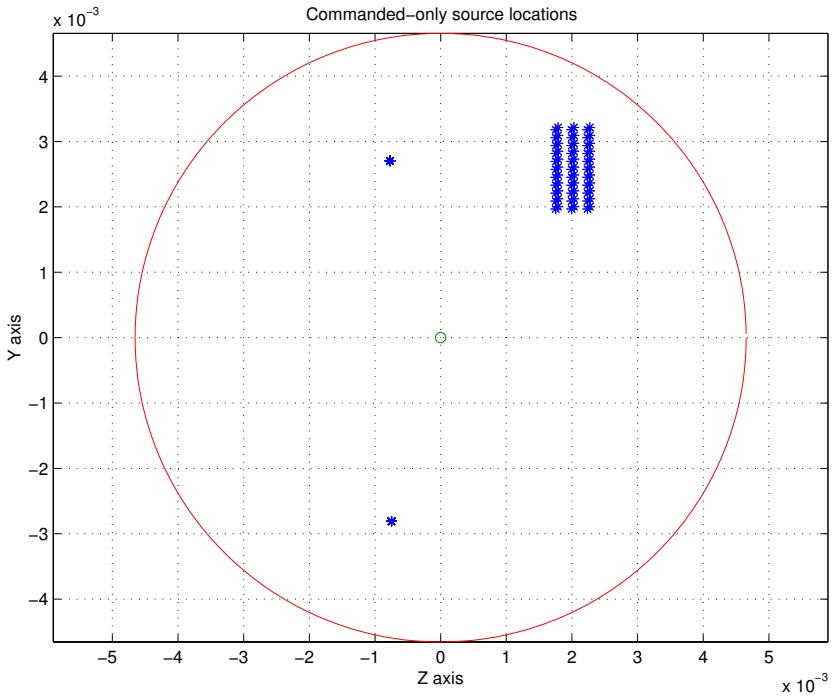

Figure 2.2: Commanded-only source locations

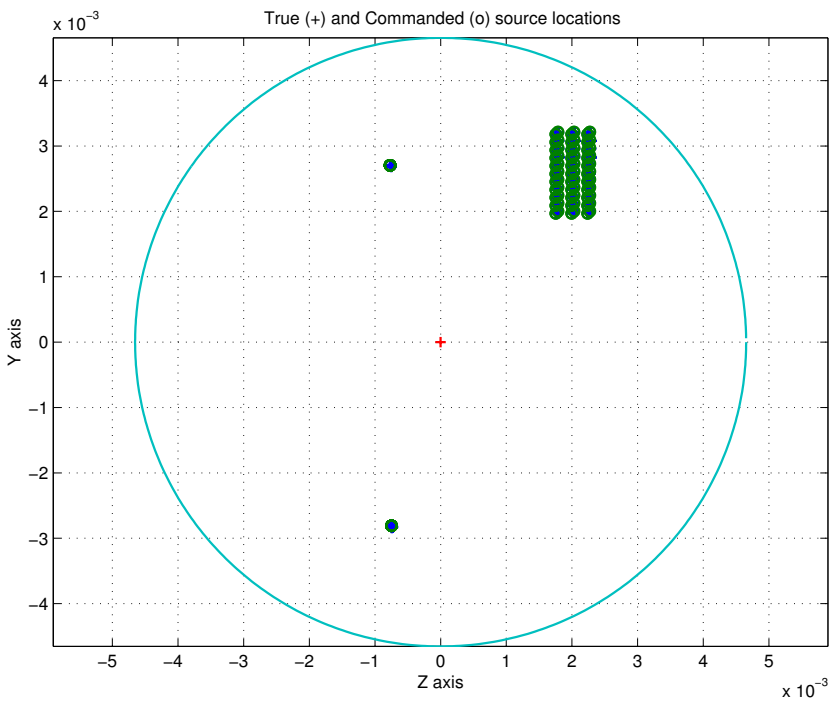

Figure 2.3: True (+) and commanded (o) source locations

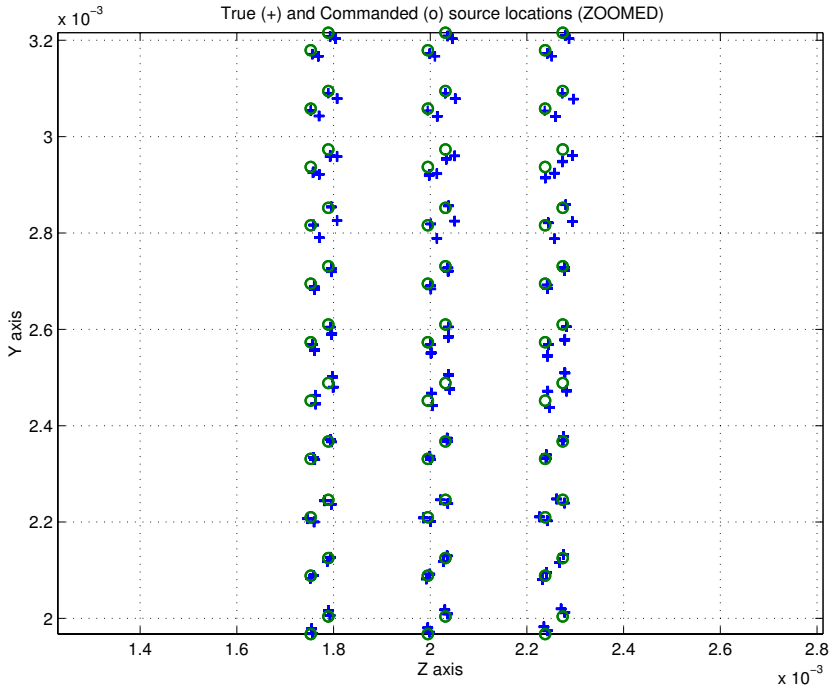

Figure 2.4: True (+) and commanded (o) source locations (ZOOMED)

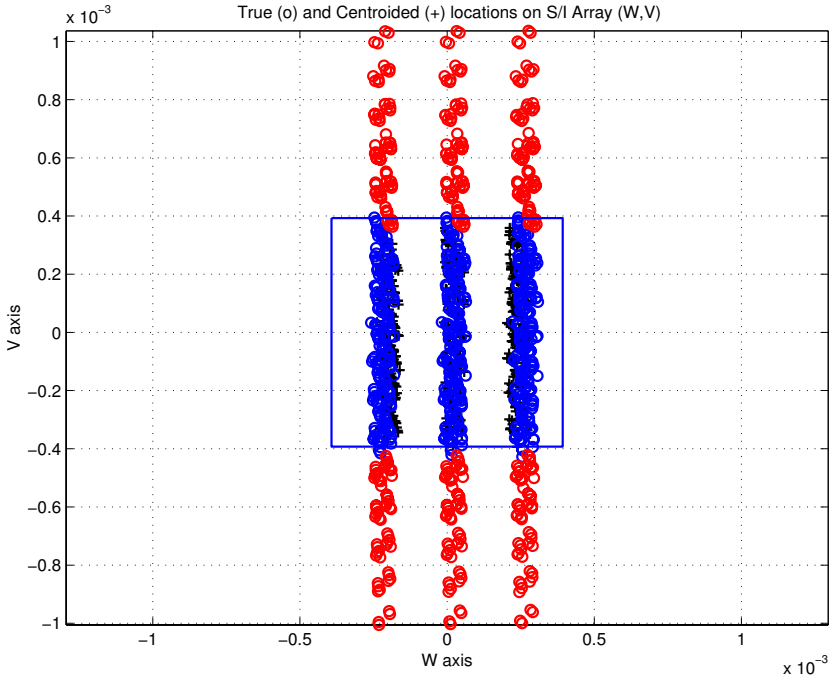

Figure 2.5: True-sampled (o) and centroided (+) locations on S/I array (W,V)

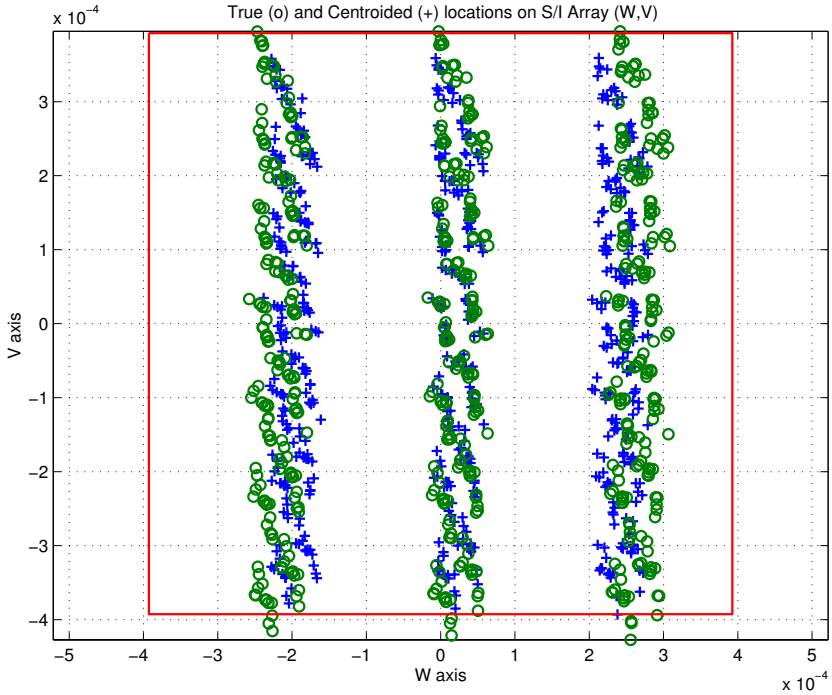

Figure 2.6: True (o) and centroided (+) locations on S/I array (W,V)

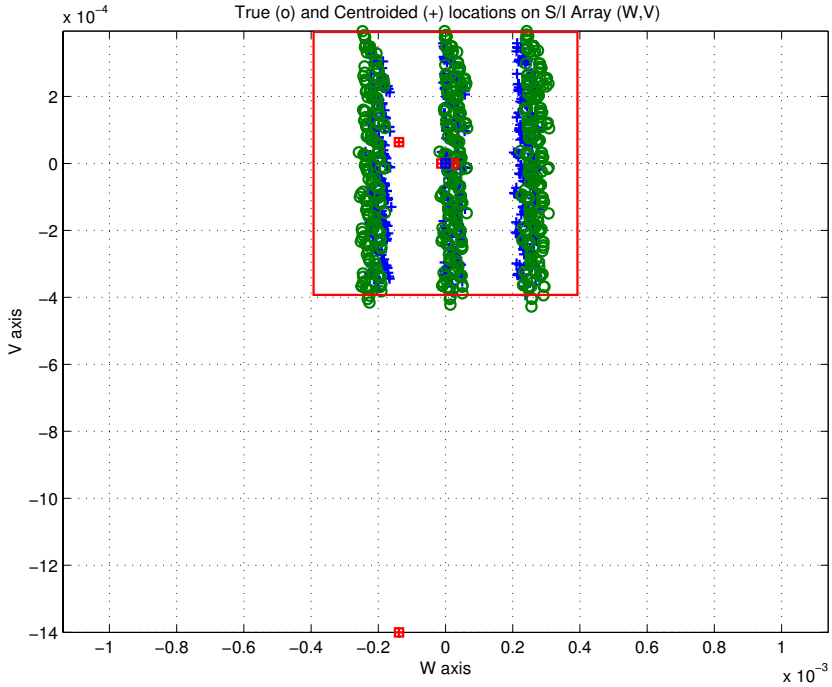

Figure 2.7: True (o) and centroided (+) locations on S/I array (W,V) showing prime and inferred frames

3 IPF EXECUTION RESULTS

3.1 IPF EXECUTION OUTPUT PLOTS

This subsection summarizes the IPF filter results. As shown in Table 3.1, the output plots are segmented to three groups: predicted performance, post-run results and IPF trending plots.

FIGURE NO.	DESCRIPTION
Predicted performance prior to IPF run	
Figure 3.1	Meas. and a-priori predicts in TPF coords
Figure 3.2	Meas. and a-priori predicts in Oriented Pixel Coords including rectangular array boundary approximation
Figure 3.3	A-priori prediction error
Figure 3.4	Oriented Pixel Coords of measurements and a-priori predicts (PCRS only)
IPF filter performance (post run results)	
Figure 3.5	IPF execution convergence, chart 1: (top) normalized residual error vs. iteration number and (bottom) norm of effective parameter corrections
Figure 3.6	IPF execution convergence, chart 2: parameter correction size vs. iteration number
Figure 3.7	Parameter uncertainty convergence: square-root of diagonal elements of covariance matrix vs. maneuver number
Figure 3.8	IPF parameter symbol table
Figure 3.9	KF parameter error sigma plot (a-priori-dashed, a-posteriori-solid). Includes true parameter errors (FLUTE runs only)
Figure 3.10	LS parameter error sigma plot. Includes true parameter errors (FLUTE runs only)
Figure 3.11	KF and LS parameter errors sigma plot (Figure 3.9 & Figure 3.10 combined)
Figure 3.12	Measurements and a-posteriori predicts in Oriented Pixel Coords including rectangular array boundaries (a-priori-dashed, a-posteriori-solid)
Figure 3.13	Attitude corrected meas. and a-posteriori predicts in Oriented Pixel Coords including rectangular array boundaries (a-priori-dashed, a-posteriori-solid)
Figure 3.14	Array plot with (solid) and w/o (dashed) optical distortion corrections
Figure 3.15	KF innovations with (o) and w/o (+) attitude corrections
Figure 3.16	W-axis KF innovations and 1-sigma bound
Figure 3.17	V-axis KF innovations and 1-sigma bound
IPF parameter trending plots	
Figure 3.18	Estimated attitude corrections (Body frame)
Figure 3.19	Estimated attitude error sigma plot (Body frame)
Figure 3.20	Systematic error attributed to thermo-mechanical boresight drift (equiv. angle in (W,V) coords)
Figure 3.21	Systematic error attributed to thermo-mechanical boresight drift (equiv. angle in Body frame)
Figure 3.22	Systematic error attributed to gyro drift bias (equiv. rate in (W,V) coords)
Figure 3.23	Systematic error attributed to gyro drift bias (equiv. angle in (W,V) coords)
Figure 3.24	Systematic error attributed to gyro drift bias (equiv. angle in Body frame)

Table 3.1: Table of figures (IPF run)

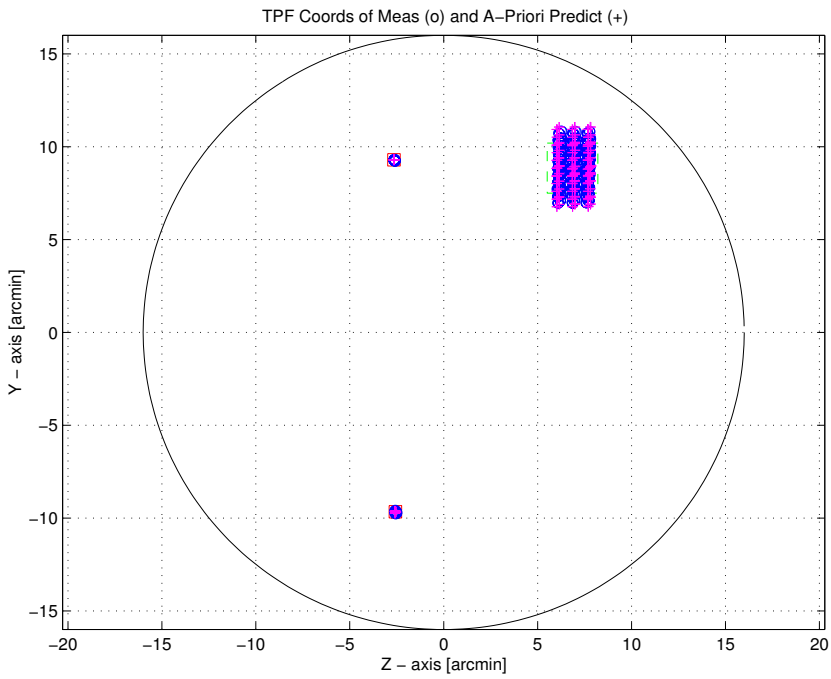

Figure 3.1: TPF coords of measurements and a-priori predicts

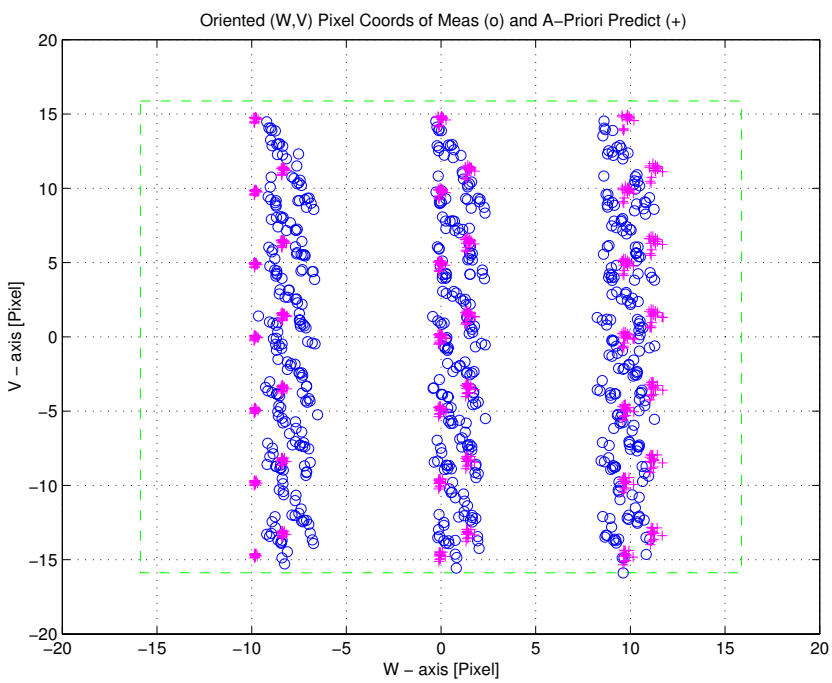

Figure 3.2: Oriented Pixel Coords of measurements and a-priori predicts

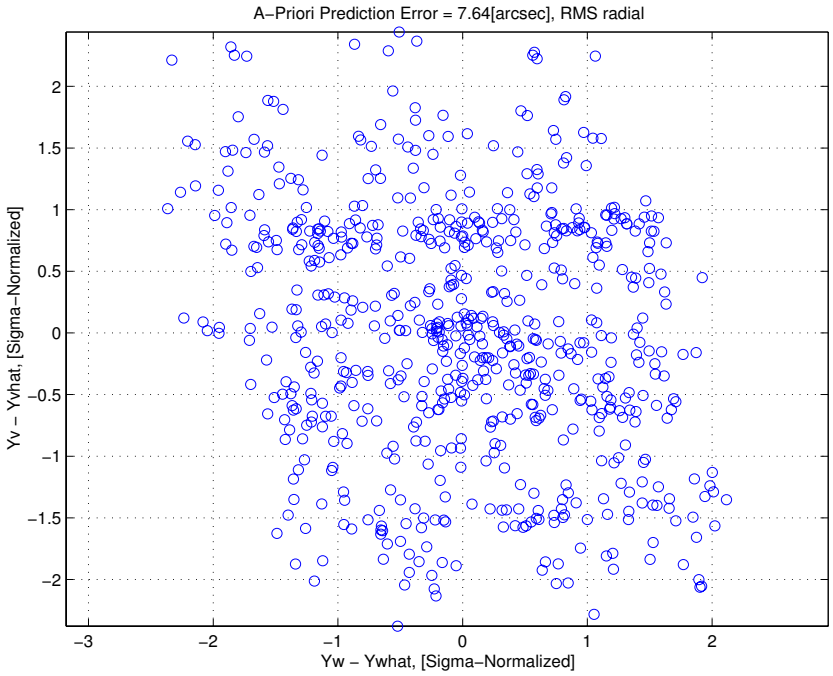

Figure 3.3: A-priori prediction error

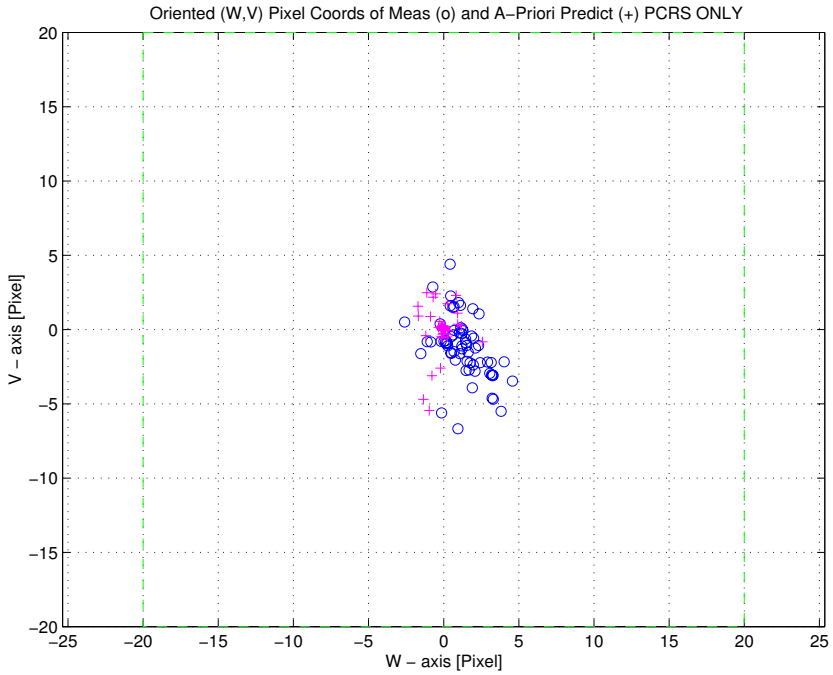

Figure 3.4: Oriented Pixel Coords of measurements and a-priori predicts (PCRS only)

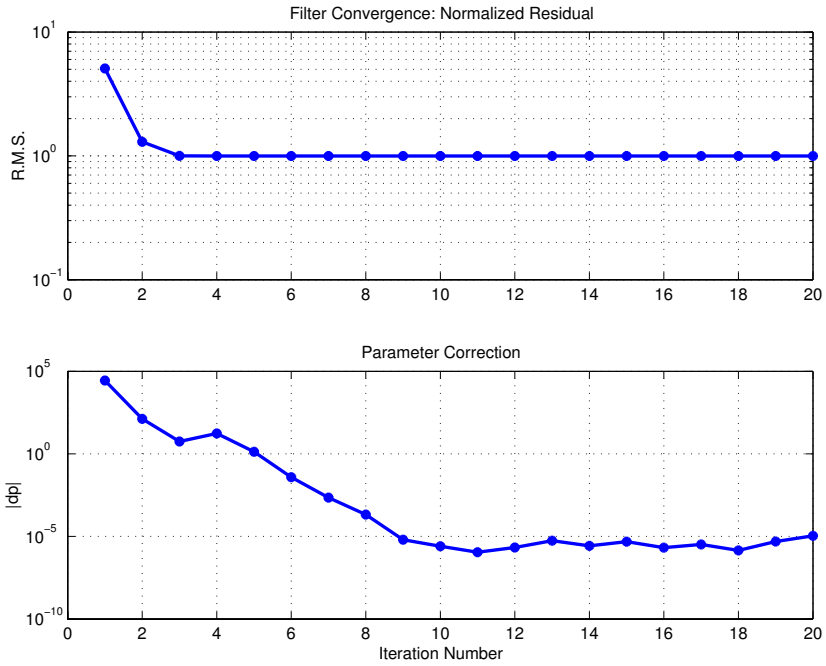

Figure 3.5: IPF execution convergence, chart 1

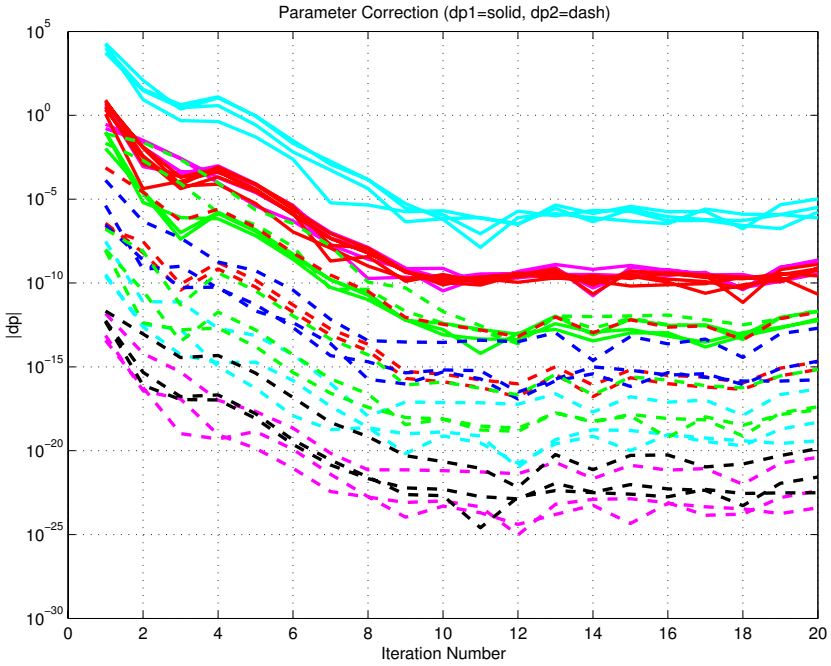

Figure 3.6: IPF execution convergence, chart 2

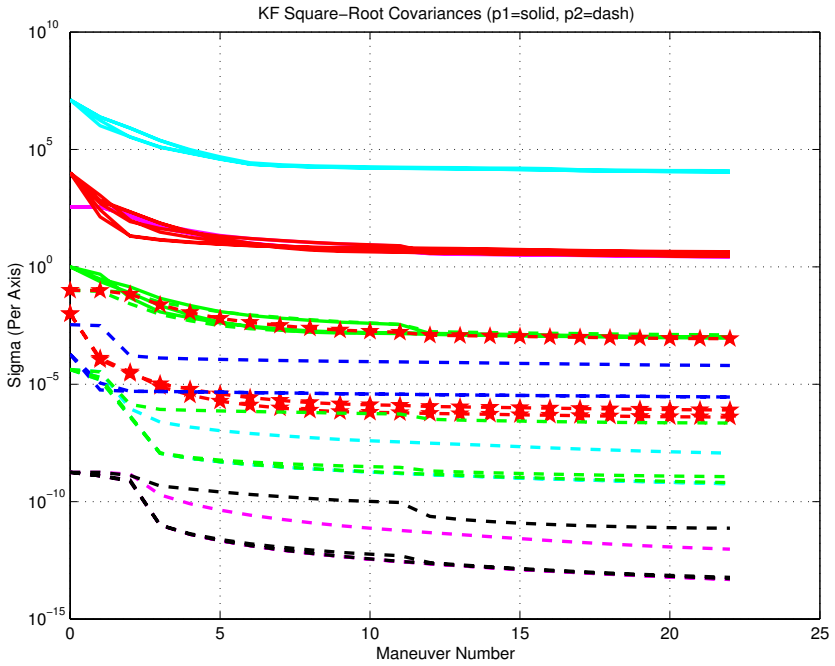

Figure 3.7: Parameter uncertainty convergence

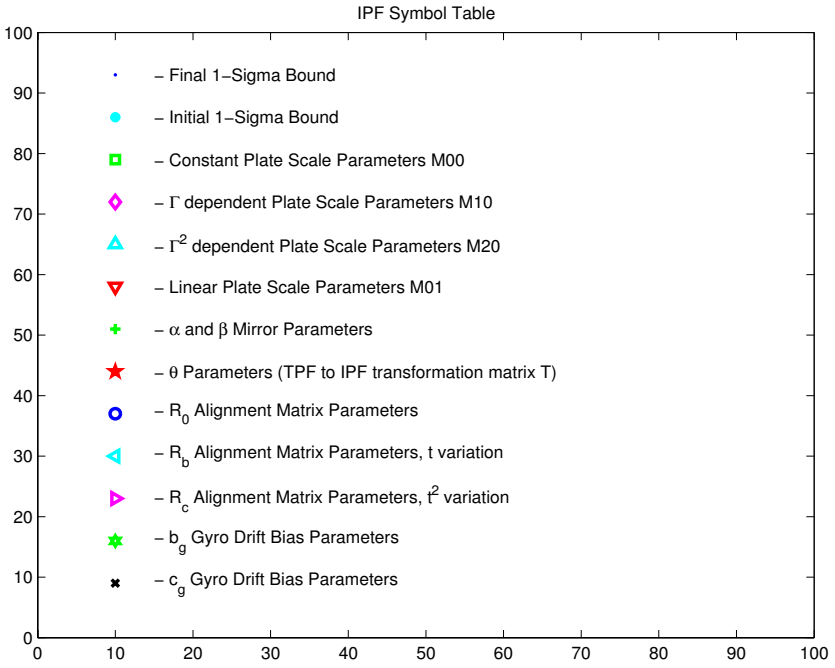

Figure 3.8: IPF parameter symbol table

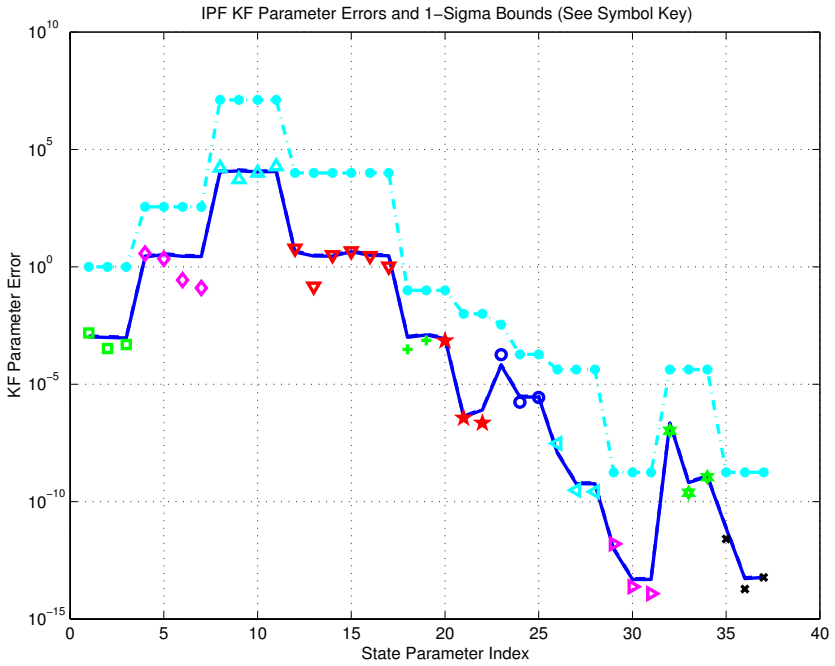

Figure 3.9: KF parameter error sigma plots

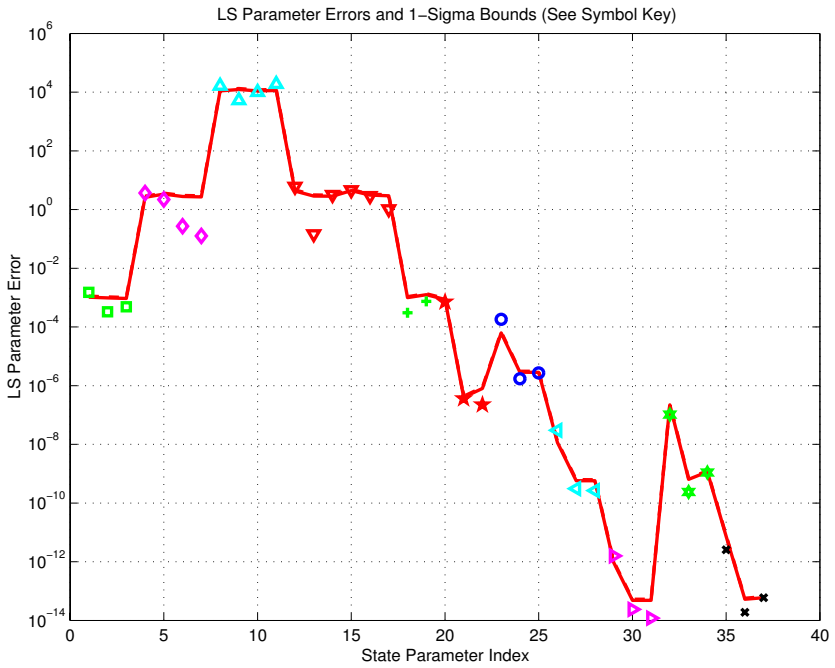

Figure 3.10: LS parameter error sigma plot

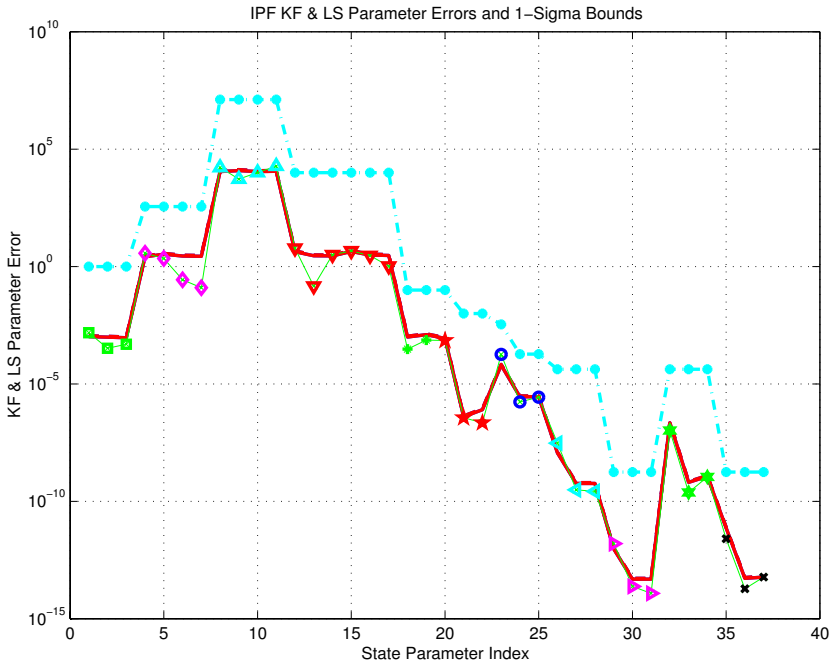

Figure 3.11: KF and LS parameter error sigma plot

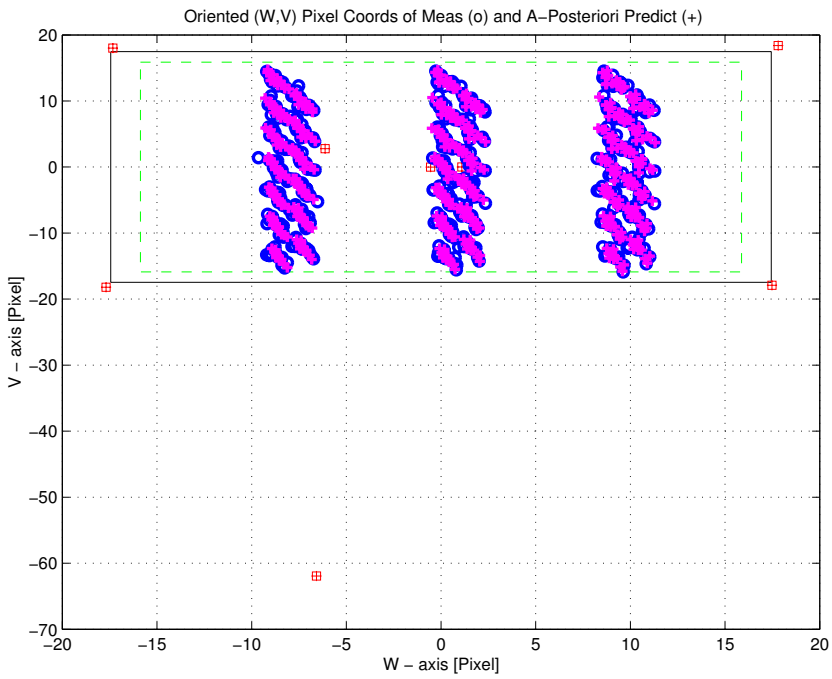

Figure 3.12: Oriented Pixel Coords of meas. and a-posteriori predicts

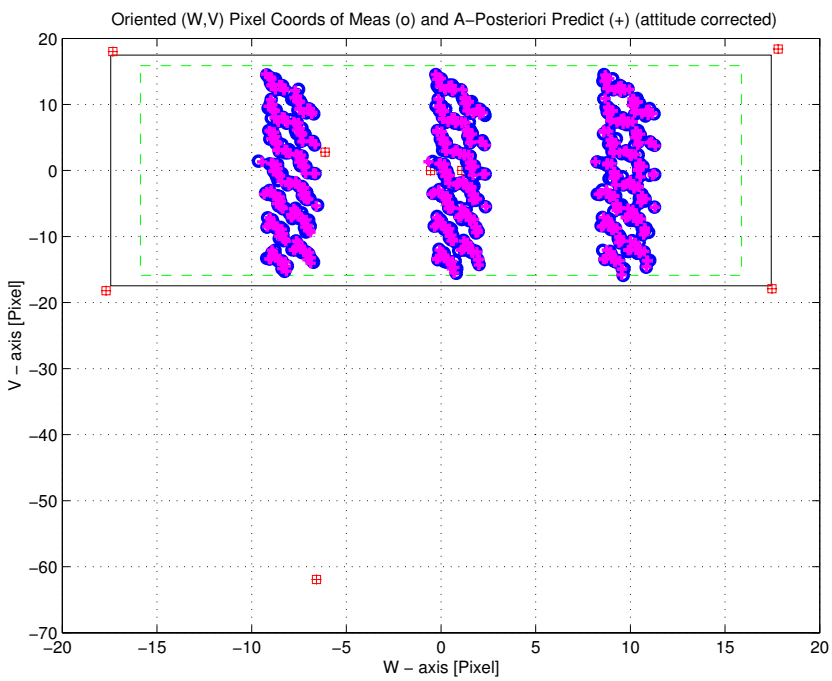

Figure 3.13: Oriented Pixel Coords of meas. and a-posteriori predicts (attitude corrected)

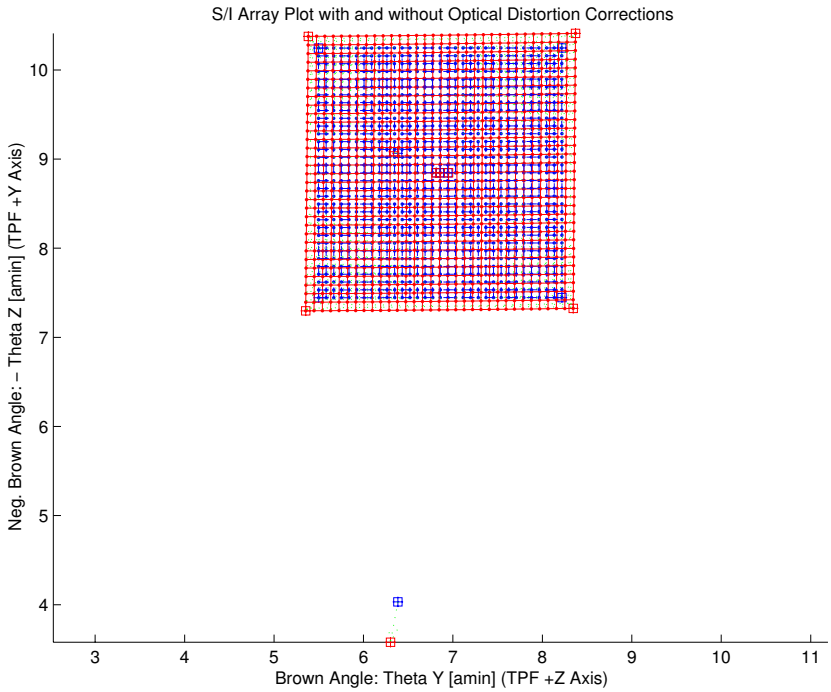

Figure 3.14: Array plot with (solid) and w/o (dashed) optical distortion corrections

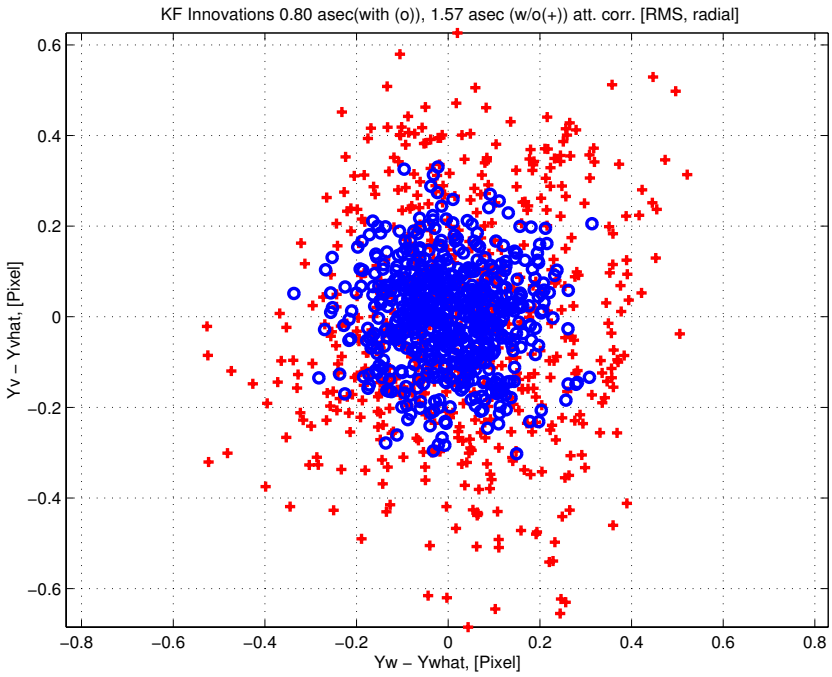

Figure 3.15: KF innovations with (o) and w/o (+) attitude corrections

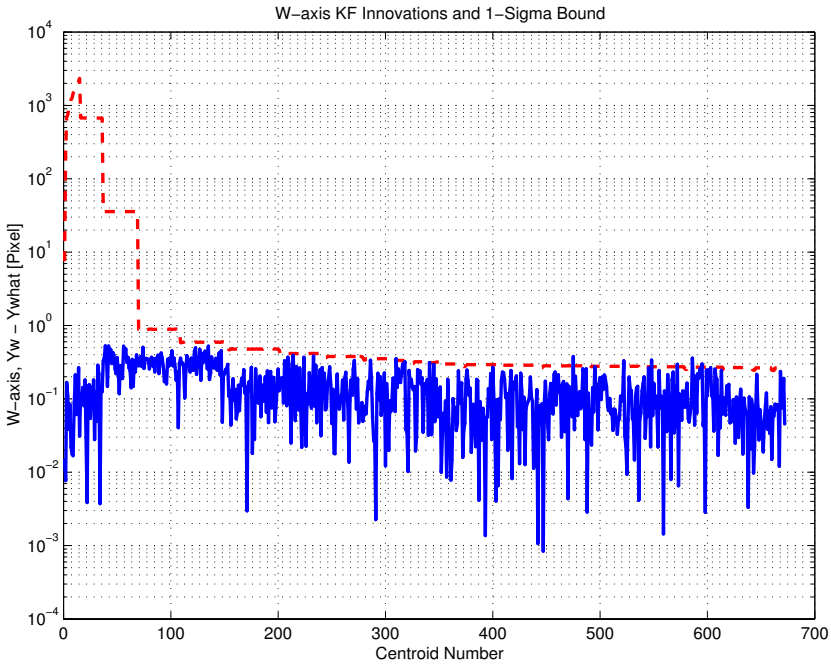

Figure 3.16: W-axis KF innovations and 1-sigma bound

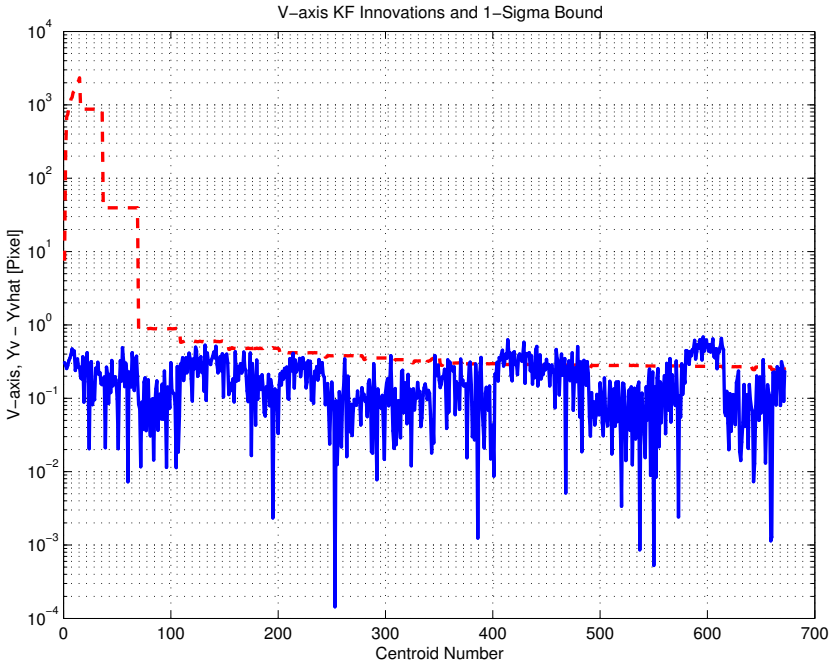

Figure 3.17: V-axis KF innovations and 1-sigma bound

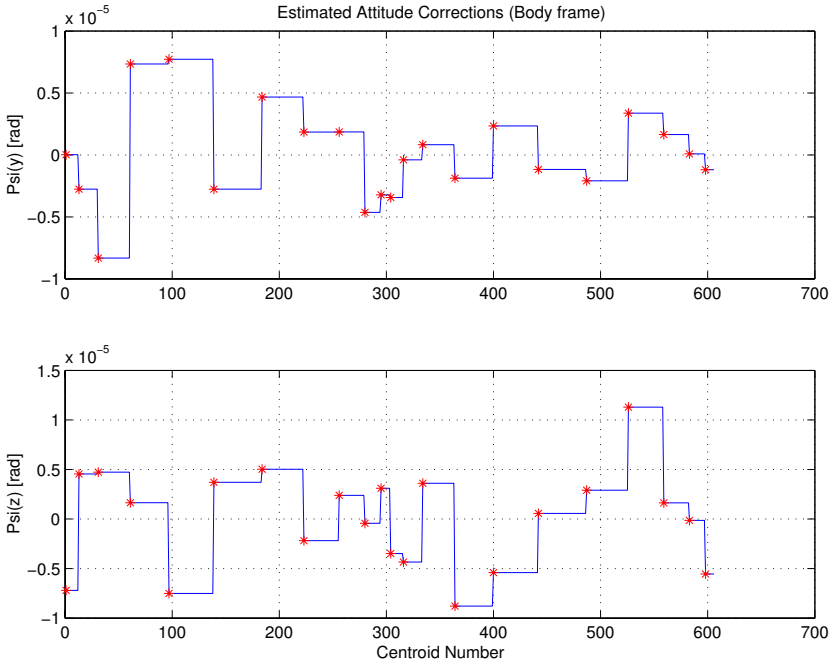

Figure 3.18: Estimated attitude corrections (Body frame)

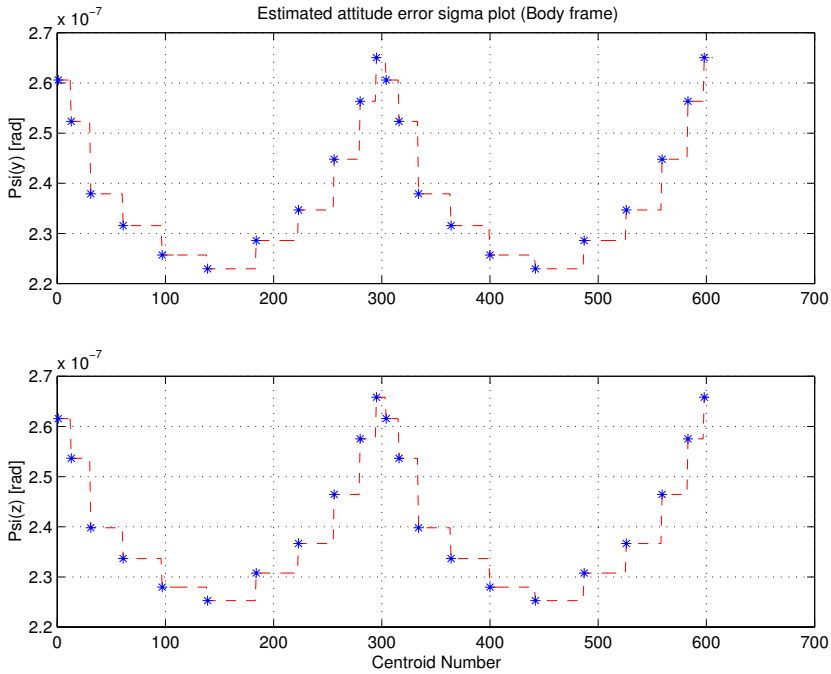

Figure 3.19: Estimated attitude error sigma plot (Body frame)

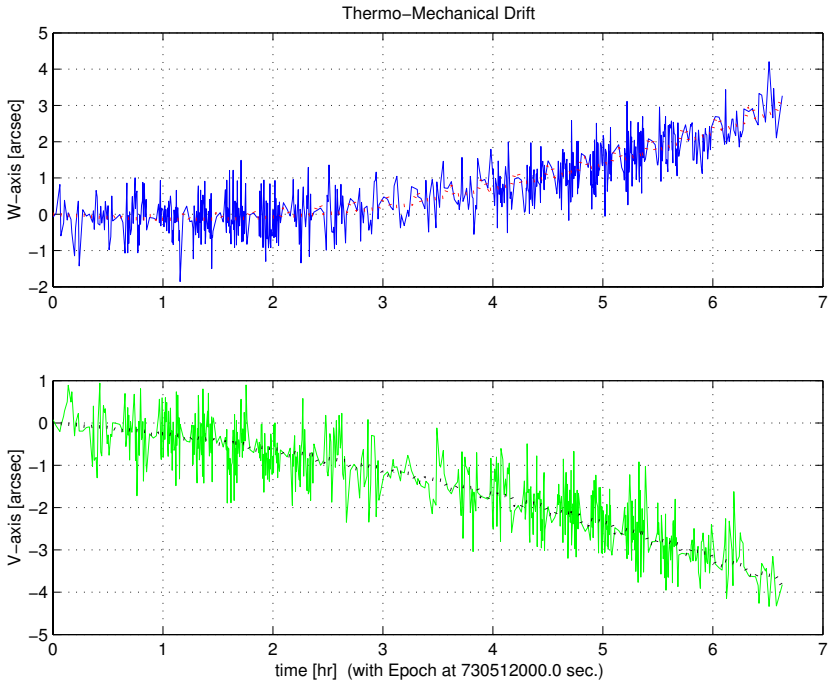

Figure 3.20: Thermo-mechanical boresight drift (equiv. angle in (W,V) coords)

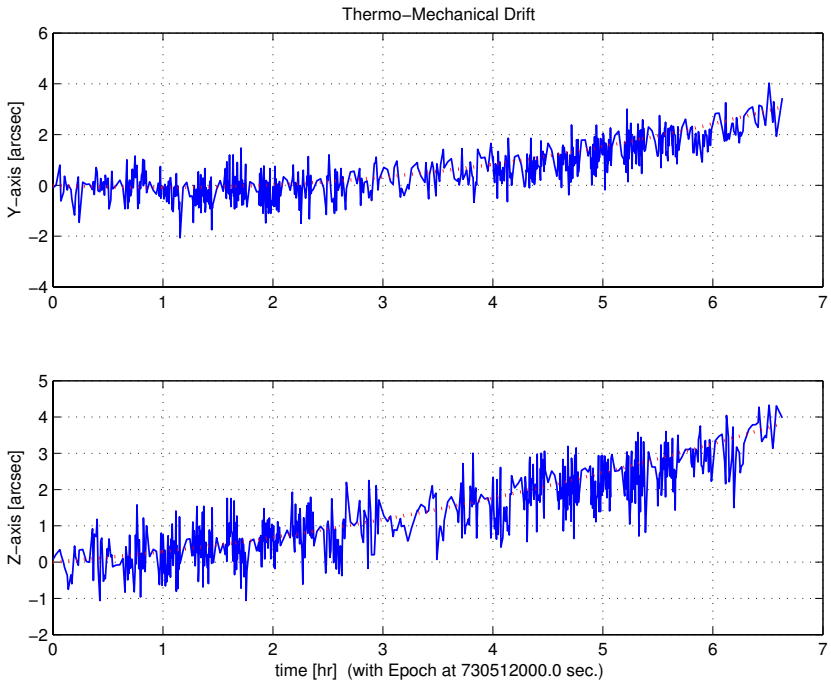

Figure 3.21: Thermo-mechanical boresight drift (equiv. angle in Body frame)

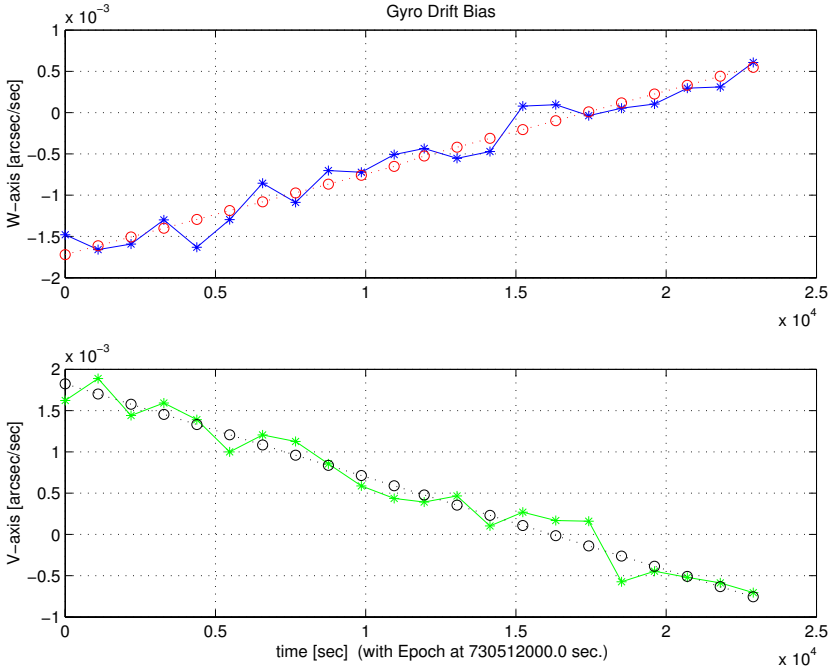

Figure 3.22: Gyro drift bias contribution (equiv. rate in (W,V) coords)

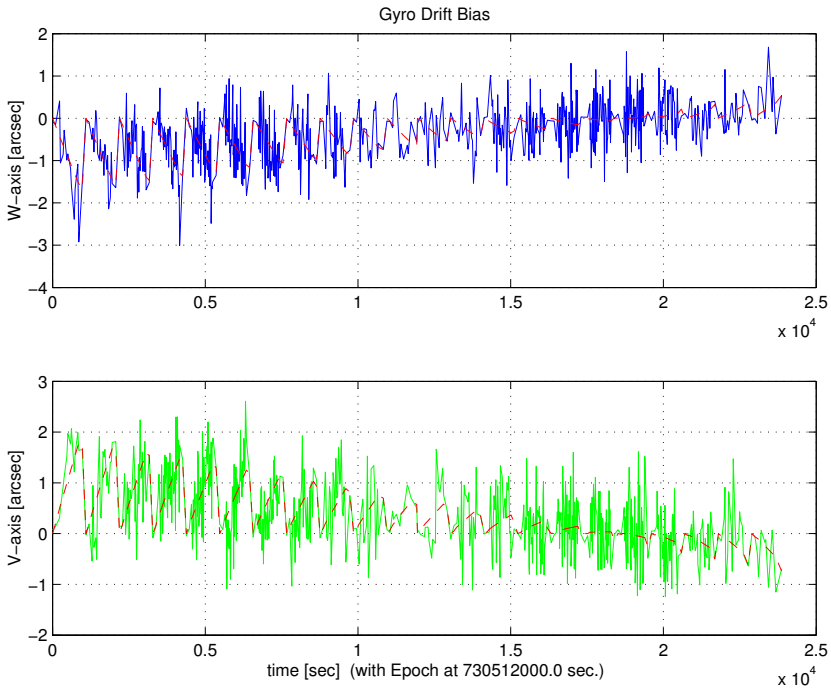

Figure 3.23: Gyro drift bias contribution (equiv. angle in (W,V) coords)

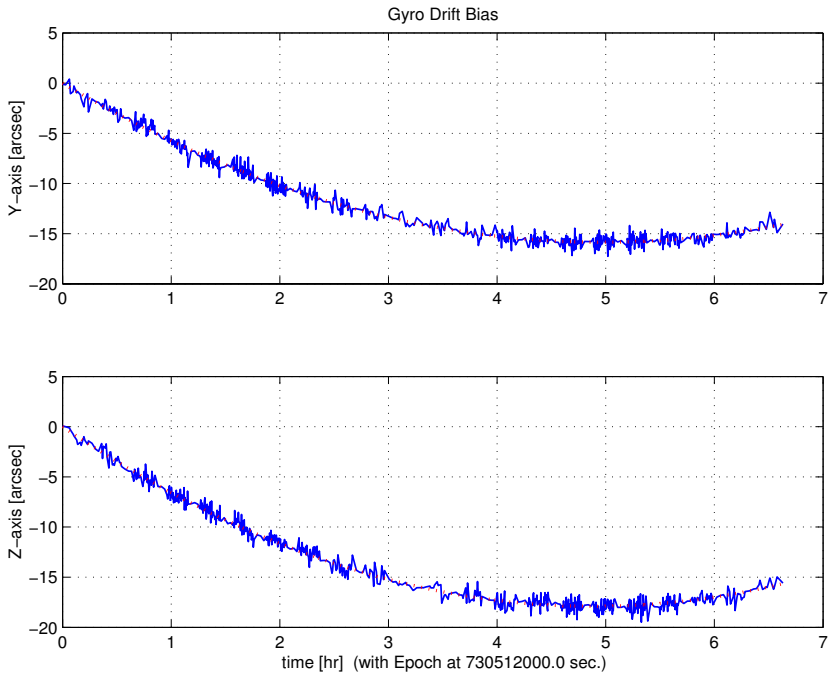

Figure 3.24: Gyro drift bias contribution (equiv. angle in Body frame)

3.2 IPF OUTPUT DATA (IF MINI FILE)

```
OUTPUT FILE NAME: IFmini991118.dat   DATE: 05-Aug-2003   TIME: 22:22
INSTRUMENT NAME:  MIPS_70um_fine_center   NF: 118
IPF FILTER VERSION: IPF.V2.0.1Beta       SW RELEASE DATE: August 5, 2003
--------------------------------------------------------------------------------
---------------------------- IPF BROWN ANGLE SUMMARY ---------------------------
--------------------------------------------------------------------------------
         ------------ WAS ------------           ------------ IS -------------
Frame    theta_Y     theta_Z     angle           theta_Y     theta_Z     angle
Number   (arcmin)    (arcmin)    (deg)           (arcmin)    (arcmin)    (deg)
------  --------------------------------       --------------------------------
 118     +6.859000  -8.847000   -0.000000        +6.857763  -8.846235   -0.040586
 119     +6.942000  -8.861000   -0.000000        +6.951192  -8.847207   -0.040586
 120     +6.941000  -4.117000   +0.000000        +6.302093  -3.578516   -0.040586
 124     +6.372000  -8.981000   -0.000000        +6.337374  -9.082097   -0.040586
 127     +6.818000  -8.840000   +0.000000        +6.811061  -8.845759   -0.040586
 001     +0.000000  +0.000000   +0.000000        +8.370836 -10.410809   -0.040586
 001     +0.000000  +0.000000   +0.000000        +8.344954  -7.325037   -0.040586
 001     +0.000000  +0.000000   +0.000000        +5.382960 -10.376793   -0.040586
 001     +0.000000  +0.000000   +0.000000        +5.354457  -7.297747   -0.040586
--------------------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  0             118            +0.000            +0.000     pixels
OFFSET FRAME NAME: MIPS_70um_fine_center
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
WAS(FTB)            +6.859000        -8.847000       -0.000000
IS (EST)            +6.857763        -8.846235       -0.040586
dT_EST              -0.001237        +0.000765       -0.040586
T_sSIGMA            +0.001494        +0.003001       +0.053751
dT_EST/T_sSIGMA     -0.827904        +0.254952       -0.755080
-------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  1             119            +1.000            +0.000     pixels
OFFSET FRAME NAME: MIPS_70um_fine_FOV1
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
WAS(FTB)            +6.942000        -8.861000       -0.000000
IS (EST)            +6.951192        -8.847207       -0.040586
dT_EST              +0.009192        +0.013793       -0.040586
T_sSIGMA            +0.001547        +0.003132       +0.053751
dT_EST/T_sSIGMA     +5.941596        +4.403318       -0.755080
-------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  2             120            -5.600           -55.000     pixels
OFFSET FRAME NAME: MIPS_70um_fine_FOV2
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
WAS(FTB)            +6.941000        -4.117000       +0.000000
IS (EST)            +6.302093        -3.578516       -0.040586
dT_EST              -0.638907        +0.538484       -0.040586
T_sSIGMA            +0.020749        +0.022378       +0.053751
dT_EST/T_sSIGMA    -30.792775       +24.063093       -0.755081
-------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  3             124            -5.600            +2.500     pixels
OFFSET FRAME NAME: MIPS_70um_fine_FOV3
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
WAS(FTB)            +6.372000        -8.981000       -0.000000
IS (EST)            +6.337374        -9.082097       -0.040586
dT_EST              -0.034626        -0.101097       -0.040586
T_sSIGMA            +0.001206        +0.002282       +0.053751
dT_EST/T_sSIGMA    -28.711656       -44.308812       -0.755080
-------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  4             127            -0.500            +0.000     pixels
OFFSET FRAME NAME: MIPS_70um_fine_FOV4
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
```

```
WAS(FTB)            +6.818000        -8.840000       +0.000000
IS (EST)            +6.811061        -8.845759       -0.040586
dT_EST              -0.006939        -0.005759       -0.040586
T_sSIGMA            +0.001467        +0.002935       +0.053751
dT_EST/T_sSIGMA     -4.729354        -1.962150       -0.755080
-------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  5               1           +16.000           +16.000     pixels
OFFSET FRAME NAME: CORNER PIXEL (DIAGNOSTICS)
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
WAS(FTB)            +0.000000        +0.000000       +0.000000
IS (EST)            +8.370836       -10.410809       -0.040586
dT_EST              +8.370836       -10.410809       -0.040586
T_sSIGMA            +0.004070        +0.006125       +0.053751
dT_EST/T_sSIGMA    +2056.591169       -1699.828735       -0.755081
-------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  6               1           +16.000           -16.000     pixels
OFFSET FRAME NAME: CORNER PIXEL (DIAGNOSTICS)
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
WAS(FTB)            +0.000000        +0.000000       +0.000000
IS (EST)            +8.344954        -7.325037       -0.040586
dT_EST              +8.344954        -7.325037       -0.040586
T_sSIGMA            +0.003681        +0.006009       +0.053751
dT_EST/T_sSIGMA    +2267.189575       -1219.034867       -0.755080
-------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  7               1           -16.000           +16.000     pixels
OFFSET FRAME NAME: CORNER PIXEL (DIAGNOSTICS)
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
WAS(FTB)            +0.000000        +0.000000       +0.000000
IS (EST)            +5.382960       -10.376793       -0.040586
dT_EST              +5.382960       -10.376793       -0.040586
T_sSIGMA            +0.003675        +0.003934       +0.053751
dT_EST/T_sSIGMA    +1464.698764       -2637.832134       -0.755080
-------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  8               1           -16.000           -16.000     pixels
OFFSET FRAME NAME: CORNER PIXEL (DIAGNOSTICS)
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
WAS(FTB)            +0.000000        +0.000000       +0.000000
IS (EST)            +5.354457        -7.297747       -0.040586
dT_EST              +5.354457        -7.297747       -0.040586
T_sSIGMA            +0.003567        +0.003834       +0.053751
dT_EST/T_sSIGMA    +1501.133518       -1903.219354       -0.755080
-------------------------------------------------------------------
-------------------------------------------------------------------------------------
-------------------------------------------------------------------------------------
VARNAME              MEAN                      SIGMA                 SCALED_SIGMA
a00        +9.8484374971113495E-002 +1.0304451020317642E-003 +1.1191281018461932E-003
b00        +1.0032826458804231E-001 +9.7375091566652297E-004 +1.0575546545586627E-003
c00        +1.0486348420695266E-002 +9.3065213866850747E-004 +1.0107466757555430E-003
a10        -3.5755016792057646E+000 +2.6090545262446168E+000 +2.8335970871346334E+000
b10        +2.2890934952141007E+000 +3.3420030497454967E+000 +3.6296252192875915E+000
c10        -2.6148568380883663E-001 +2.7828109459911872E+000 +3.0223074724148922E+000
d10        +1.3557999848711261E-001 +2.7098663579031785E+000 +2.9430850681878988E+000
a20        +1.6362297484089258E+004 +1.1059181597790510E+004 +1.2010965829333551E+004
b20        -5.2717371015603912E+003 +1.2261763738713908E+004 +1.3317045567140143E+004
c20        +1.0044661877978500E+004 +1.1020889832425077E+004 +1.1969378567086138E+004
d20        -1.8893633265754033E+004 +1.1403521719380124E+004 +1.2384940828976174E+004
a01        +8.0221006311683389E+000 +4.2708588480069558E+000 +4.6384209565350609E+000
b01        +2.1450351232379070E+000 +2.8767520910180702E+000 +3.1243334562464429E+000
c01        -1.1802805131333061E+000 +2.8337554374985490E+000 +3.0776363899552228E+000
d01        +6.6105128475249701E+000 +4.4014835684665758E+000 +4.7802876073386065E+000
e01        +4.9028195305325868E+000 +3.0968304392534534E+000 +3.3633523652911652E+000
f01        +3.0317127752450972E+000 +2.9367796862483364E+000 +3.1895271949288637E+000
del_alpha  +2.0381697631716156E-012 +9.9232960617948065E-004 +1.0777322793613408E-003
beta       +1.1007408850509208E+000 +1.2520931541672433E-003 +1.3598518079176677E-003
```

```
del_theta1 +1.7476811759397325E-012 +8.6378443156739384E-004 +9.3812414596203470E-004
del_theta2 -6.8970393590054332E-016 +4.0027608342798019E-007 +4.3472496747078068E-007
del_theta3 -1.9951962120958674E-015 +8.0380289049877423E-007 +8.7298042499176947E-007
del_arx    -1.9852749747416819E-013 +6.2633803210623441E-005 +6.8024244241933696E-005
del_ary    -2.1802803556964450E-015 +2.8492641048676122E-006 +3.0944797767991041E-006
del_arz    -1.6795191624306921E-016 +2.8452686494088910E-006 +3.0901404612210951E-006
brx        +2.9961257588237785E-008 +1.1581673110511443E-008 +1.2578424429223232E-008
bry        -2.5195426357389608E-010 +5.7500055745415582E-010 +6.2448672050103648E-010
brz        +3.2245227589584737E-010 +5.7423587491327187E-010 +6.2365622723282944E-010
crx        -1.5239834178705579E-012 +9.4050771330962997E-013 +1.0214504488328038E-012
cry        +7.3680543327635951E-014 +4.8484834416091014E-014 +5.2657575451054252E-014
crz        +3.7987867991399993E-014 +4.8421427675276338E-014 +5.2588711748027021E-014
bgx        +1.5444483210627148E-007 +2.2140424863531337E-007 +2.4045892015728451E-007
bgy        -8.6004049923586703E-009 +6.4109972234861886E-010 +6.9627456518689410E-010
bgz        -9.8547697589928841E-009 +1.1534579614647283E-009 +1.2527277934827906E-009
cgx        -2.0560455024822193E-012 +7.3297495170691107E-012 +7.9605683484463247E-012
cgy        +4.8116385608096076E-013 +5.2617005456402296E-014 +5.7145372737614432E-014
cgz        +5.5941920345982538E-013 +5.9568847982714768E-014 +6.4695510358207341E-014
-------------------------------------------------------------------------------
LSQF RESIDUAL SIGMA SCALE =         +1.0860628088188005E+000
-------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------------
                    a_mirror(1)               a_mirror(2)               a_mirror(3)
a_mirror_ipf   +0.0000000000000000E+000  +1.9696510618037757E-002  +9.9980600491769067E-001
a_mirror_tpf   -2.0469257846705544E-003  +2.0399527368347430E-002  +9.9978981259961841E-001
beta                beta_0                    beta                      beta_total
               +2.8047410000000001E-006  +1.1007408850509208E+000  +3.0872930906786049E-006
-----------------------------------------------------------------------------------------------------
qT               qT(1)                     qT(2)                     qT(3)                     qT(4)
FrmTbl:   +1.2836566686785979E-006 -9.9760012028013629E-004 +1.2867429956649658E-003 +9.9999867454152913E-001
Estim:    -3.5289566277023056E-004 -9.9787580123327250E-004 +1.2862783657053146E-003 +9.9999861259728884E-001
DelTheta        deltheta(1)               deltheta(2)               deltheta(3)
          -7.0835935115959173E-004 +3.5991075124588246E-007 -2.2256739089685521E-007       [rad]
EulAngT         theta(1)                  theta(2)                  theta(3)                  [rad]
Mean      -7.0835890709204945E-004 -1.9948423124868898E-003 +2.5732654142318987E-003
SigmaT    +8.6378443156739384E-004 +4.0027608342798019E-007 +8.0380289049877423E-007
-----------------------------------------------------------------------------------------------------
qR               qR(1)                     qR(2)                     qR(3)                     qR(4)
ASFILE:   +0.0000000000000000E+000 +0.0000000000000000E+000 +0.0000000000000000E+000 +1.0000000000000000E+000
Estim:    -6.6326829383486587E-005 +2.0693147472085607E-006 -1.4515747200131663E-007 +9.9999999779822435E-001
DelThetaR       deltheta R(1)             deltheta R(2)             deltheta R(3)
          -1.3265365946583951E-004 +4.1386102296468437E-006 -2.9058944553827521E-007       [rad]
EulAngR         angR(1)                   angR(2)                   angR(3)                   [rad]
Mean      -1.3265365946583951E-004 +4.1386102296468437E-006 -2.9058944553827521E-007
SigmaR    +6.2633803210623441E-005 +2.8492641048676122E-006 +2.8452686494088910E-006
-----------------------------------------------------------------------------------------------------
Initial Gyro Bias         Bg0(1)                    Bg0(2)                    Bg0(3)
                  +2.4485408342998006E-006 +2.5088395420218739E-006 +2.5087559469960914E-006
Gyro Bias Correction      Bg(1)                     Bg(2)                     Bg(3)
                  +1.5444483210627148E-007 -8.6004049923586703E-009 -9.8547697589928841E-009
Total Gyro Bias           BgT(1)                    BgT(2)                    BgT(3)
                  +2.6029856664060720E-006 +2.5002391370295151E-006 +2.4989011772370983E-006

Initial Gyro Bias Rate     Cg0(1)                    Cg0(2)                    Cg0(3)
                  +0.0000000000000000E+000 +0.0000000000000000E+000 +0.0000000000000000E+000
Gyro Bias Rate Correction  Cg(1)                     Cg(2)                     Cg(3)
                  -2.0560455024822193E-012 +4.8116385608096076E-013 +5.5941920345982538E-013
Total Gyro Bias Rate       CgT(1)                    CgT(2)                    CgT(3)
                  -2.0560455024822193E-012 +4.8116385608096076E-013 +5.5941920345982538E-013
-----------------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  1             119            +1.000            +0.000     pixels
OFFSET FRAME NAME: MIPS_70um_fine_FOV1
qT               qT(1)                     qT(2)                     qT(3)                     qT(4)
WAS(FTB)  +1.3012459624148111E-006 -1.0096719622185043E-003 +1.2887791948094824E-003 +9.9999865980361324E-001
IS (EST)  -3.5287803133007047E-004 -1.0114645237279617E-003 +1.2864148814072964E-003 +9.9999859877570085E-001
```

```
DelTheta        deltheta(1)               deltheta(2)               deltheta(3)
Units             rad                       rad                       rad
          -7.0836700932883859E-004 -2.6737510948415772E-006 -4.0123019803432750E-006
EulAngT         theta(1)                  theta(2)                  theta(3)                  [rad]
Mean      -7.0835890709204934E-004 -2.0220196956360257E-003 +2.5735481068043390E-003
sSigmaT   +9.3812412753440050E-004 +4.5000557027449115E-007 +9.1120150422890939E-007
SigmaT    +8.6378441460001950E-004 +4.1434580635710770E-007 +8.3899521908859960E-007
-----------------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  2             120            -5.600           -55.000     pixels
OFFSET FRAME NAME: MIPS_70um_fine_FOV2
qT               qT(1)                     qT(2)                     qT(3)                     qT(4)
WAS(FTB)  +6.0449825951069261E-007 -1.0095271757136512E-003 +5.9879303662630152E-004 +9.9999931115047058E-001
IS (EST)  -3.5370218177946909E-004 -9.1678623639281781E-004 +5.2014920118437203E-004 +9.9999938192109494E-001

DelTheta        deltheta(1)               deltheta(2)               deltheta(3)
Units             rad                       rad                       rad
          -7.0867516867715577E-004 +1.8585062111153852E-004 -1.5663825949788898E-004
EulAngT         theta(1)                  theta(2)                  theta(3)                  [rad]
Mean      -7.0835890709204945E-004 -1.8332044104679033E-003 +1.0409482350814234E-003
sSigmaT   +9.3812355960910137E-004 +6.0355277688546427E-006 +6.5094924701277471E-006
SigmaT    +8.6378389167879018E-004 +5.5572548105379552E-006 +5.9936611559394592E-006
-----------------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  3             124            -5.600            +2.500     pixels
OFFSET FRAME NAME: MIPS_70um_fine_FOV3
qT               qT(1)                     qT(2)                     qT(3)                     qT(4)
WAS(FTB)  +1.2105772857918672E-006 -9.2676890949311853E-004 +1.3062325685908875E-003 +9.9999871742637714E-001
IS (EST)  -3.5296143480172679E-004 -9.2220053184929266E-004 +1.3206099169078595E-003 +9.9999864047600195E-001

DelTheta        deltheta(1)               deltheta(2)               deltheta(3)
Units             rad                       rad                       rad
          -7.0830439858906354E-004 +1.0072313236495452E-005 +2.9407755656021820E-005
EulAngT         theta(1)                  theta(2)                  theta(3)                  [rad]
Mean      -7.0835890709204945E-004 -1.8434673515799963E-003 +2.6418748076506918E-003
sSigmaT   +9.3812421447048969E-004 +3.5080923231259128E-007 +6.6370106845366106E-007
SigmaT    +8.6378449464703756E-004 +3.2301007774507135E-007 +6.1110744522731693E-007
-----------------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  4             127            -0.500            +0.000     pixels
OFFSET FRAME NAME: MIPS_70um_fine_FOV4
qT               qT(1)                     qT(2)                     qT(3)                     qT(4)
WAS(FTB)  +1.2749739579667491E-006 -9.9163692118734836E-004 +1.2857248959092255E-003 +9.9999868178217266E-001
IS (EST)  -3.5290447315320799E-004 -9.9108328012757416E-004 +1.2862116252720756E-003 +9.9999861943505686E-001

DelTheta        deltheta(1)               deltheta(2)               deltheta(3)
Units             rad                       rad                       rad
          -7.0835558443359356E-004 +2.0185064087120462E-006 +1.6753363811054865E-006
EulAngT         theta(1)                  theta(2)                  theta(3)                  [rad]
Mean      -7.0835890709204945E-004 -1.9812573002713938E-003 +2.5731271042742530E-003
sSigmaT   +9.3812415491276082E-004 +4.2680379446690466E-007 +8.5382842326459569E-007
SigmaT    +8.6378443980883815E-004 +3.9298260745259802E-007 +7.8616854967459719E-007
-----------------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  5               1           +16.000           +16.000     pixels
OFFSET FRAME NAME: CORNER PIXEL (DIAGNOSTICS)
qT               qT(1)                     qT(2)                     qT(3)                     qT(4)
WAS(FTB)  +0.0000000000000000E+000 +0.0000000000000000E+000 +0.0000000000000000E+000 +1.0000000000000000E+000
IS (EST)  -3.5233526876987014E-004 -1.2180231967790240E-003 +1.5137577735126972E-003 +9.9999805040647616E-001

DelTheta        deltheta(1)               deltheta(2)               deltheta(3)
Units             rad                       rad                       rad
          -7.0835890709204934E-004 -2.4349773499630937E-003 +3.0283815563810976E-003
```

```
EulAngT         theta(1)                theta(2)                theta(3)                [rad]
Mean      -7.0835890709204945E-004 -2.4349773499630946E-003 +3.0283815563810980E-003
sSigmaT   +9.3812354157444839E-004 +1.1839870688933628E-006 +1.7815803987696633E-006
SigmaT    +8.6378387507325617E-004 +1.0901644539150222E-006 +1.6404027320549779E-006
-----------------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------------
OFFSET          NF          Delta_CW          Delta_CV
  6              1           +16.000           -16.000     pixels
OFFSET FRAME NAME: CORNER PIXEL (DIAGNOSTICS)
qT              qT(1)                   qT(2)                   qT(3)                   qT(4)
WAS(FTB)  +0.0000000000000000E+000 +0.0000000000000000E+000 +0.0000000000000000E+000 +1.0000000000000000E+000
IS (EST)  -3.5288590296483788E-004 -1.2141006743751845E-003 +1.0649525625426031E-003 +9.9999863365263231E-001

DelTheta        deltheta(1)               deltheta(2)               deltheta(3)
Units             rad                       rad                       rad
          -7.0835890709204945E-004 -2.4274488014499693E-003 +2.1307669830326792E-003
EulAngT         theta(1)                theta(2)                theta(3)                [rad]
Mean      -7.0835890709204945E-004 -2.4274488014499693E-003 +2.1307669830326792E-003
sSigmaT   +9.3812380109173366E-004 +1.0706862930643750E-006 +1.7479130749890455E-006
SigmaT    +8.6378411402562904E-004 +9.8584196454425247E-007 +1.6094033059561922E-006
-----------------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------------
OFFSET          NF          Delta_CW          Delta_CV
  7              1           -16.000           +16.000     pixels
OFFSET FRAME NAME: CORNER PIXEL (DIAGNOSTICS)
qT              qT(1)                   qT(2)                   qT(3)                   qT(4)
WAS(FTB)  +0.0000000000000000E+000 +0.0000000000000000E+000 +0.0000000000000000E+000 +1.0000000000000000E+000
IS (EST)  -3.5299731838796315E-004 -7.8345331007414023E-004 +1.5089649076536497E-003 +9.9999849230821936E-001

DelTheta        deltheta(1)               deltheta(2)               deltheta(3)
Units             rad                       rad                       rad
          -7.0835890709204955E-004 -1.5658395764723118E-003 +3.0184866631732719E-003
EulAngT         theta(1)                theta(2)                theta(3)                [rad]
Mean      -7.0835890709204945E-004 -1.5658395764723112E-003 +3.0184866631732719E-003
sSigmaT   +9.3812412876373831E-004 +1.0690522961846581E-006 +1.1443058200415632E-006
SigmaT    +8.6378441573194099E-004 +9.8433745037946478E-007 +1.0536276638421196E-006
-----------------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------------
OFFSET          NF          Delta_CW          Delta_CV
  8              1           -16.000           -16.000     pixels
OFFSET FRAME NAME: CORNER PIXEL (DIAGNOSTICS)
qT              qT(1)                   qT(2)                   qT(3)                   qT(4)
WAS(FTB)  +0.0000000000000000E+000 +0.0000000000000000E+000 +0.0000000000000000E+000 +1.0000000000000000E+000
IS (EST)  -3.5335253747490462E-004 -7.7914952039774099E-004 +1.0611379113577204E-003 +9.9999907102673957E-001

DelTheta        deltheta(1)               deltheta(2)               deltheta(3)
Units             rad                       rad                       rad
          -7.0835890709204955E-004 -1.5575483113875578E-003 +2.1228286494269434E-003
EulAngT         theta(1)                theta(2)                theta(3)                [rad]
Mean      -7.0835890709204955E-004 -1.5575483113875578E-003 +2.1228286494269430E-003
sSigmaT   +9.3812437429557525E-004 +1.0375814630393121E-006 +1.1153883259852806E-006
SigmaT    +8.6378464180711357E-004 +9.5536045854270938E-007 +1.0270016770009596E-006
-----------------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------------
               q(1)                    q(2)                    q(3)                    q(4)
PCRS1A: +5.2603126189317361E-007 +3.7451819048221893E-004 -1.4045531552277380E-003 +9.9999894348258311E-001
PCRS2A: -5.1968404336718985E-007 +3.8455385122900486E-004 +1.3513933841514693E-003 +9.9999901292650617E-001
-----------------------------------------------------------------------------------------------
**********  CS-FILE PARAMETERS:  **********  **********  AS-FILE PARAMETERS:  **********
Row (01) PIX2RADX: +2.4736508339999999E-005  Row (1) TASTART:   +7.3051200000000000E+008
Row (02) PIX2RADY: +2.5464808057000000E-005  Row (2) TASTOP:    +7.3053587000000000E+008
Row (03) CX0:      +1.6500000000000000E+001  Row (3) S/C TIME:  +7.3051200000000000E+008
Row (04) CY0:      +1.6500000000000000E+001  Row (4) QR1:       +0.0000000000000000E+000
Row (05) BETA0:    +2.8047410000000001E-006  Row (5) QR2:       +0.0000000000000000E+000
Row (06) GAMMA_E0: +8.7500000000000000E+002  Row (6) QR3:       +0.0000000000000000E+000
Row (07) D11:      -1.0000000000000000E+000  Row (7) QR4:       +1.0000000000000000E+000
Row (08) D12:      +0.0000000000000000E+000
Row (09) D21:      +0.0000000000000000E+000
```

```
Row (10) D22:      -1.0000000000000000E+000
Row (11) DG:       +1.0000000000000000E+000
-------------------------------------------------------------------------------------
-------------------------------------------------------
INITIAL STA-TO-PCRS ALIGNMENT (R) KNOWLEDGE (1-SIGMA)
    SIGMA(X)        SIGMA(Y)         SIGMA(Z)
1.41451738E+001  7.65467990E-001  7.65467990E-001  [arcsec]
-------------------------------------------------------
PIX2RADX = 2.473650834000E-005[rad/pixel]
XPIXSIZE = 5.1023[arcsec]
PIX2RADY = 2.546480805700E-005[rad/pixel]
YPIXSIZE = 5.2525[arcsec]
CX0 = 16.5[pixel] = 84.19[arcsec]
CY0 = 16.5[pixel] = 86.67[arcsec]
-------------------------------------------------------
NOMINAL BETA0 = 2.804741000000E-006[rad/encoder unit]
ENCODER UNIT SIZE = 0.58[arcsec]
GAMMA_E0 = 875.00[encoder unit] = 506.20[arcsec]
-------------------------------------------------------
                | -1 | +0 |
FLIP MATRIX D = |----|----|   and   DG = +1
                | +0 | -1 |
-------------------------------------------------------
```

3.3 IPF EXECUTION LOG

```
*********************************************************************
IPF EXECUTION-LOG FILE NAME:  LG991118.dat
INSTRUMENT TYPE:              MIPS_70um_fine_center
IPF FILTER EXECUTION DATE:    05-Aug-2003    TIME: 22:15
IPF FILTER VERSION USED:      IPF.V2.0.1Beta
*********************************************************************

------------------- Loading & Preparing Input Files -------------------
AAFILE:  AA991118 Loaded!        AAFILE dimension = 238701 X 21
ASFILE:  AS991118 Loaded!
CAFILE:  CA991118 Loaded!        CAFILE dimension = 606 X 15
CBFILE:  CB991118 Loaded!        CBFILE dimension = 66 X 15
CCFILE:  CC991118 Created!       CCFILE dimension = 672 X 19
CSFILE:  CS991118 Loaded!
Loading Input Files Completed!
-----------------------------------------------------------------------

------------------------ Selected Mask Vectors ------------------------
index =   1  2  3  4  5  6  7  8  9 10 11 12 13 14 15 16 17 18 19 20
-----------------------------------------------------------------------
mask1 = [ 1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1 ]
mask2 = [ 1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1 ]
-----------------------------------------------------------------------

---------------  Selected Initial Gyro Bias Parameters  ---------------
User Entered 1 : Use AFILE database - from S/C filter
IPF Linearized Using Following Nominal Gyro Bias Estimates
bg0 = [+2.4485408342998006E-006 +2.5088395420218739E-006 +2.5087559469960914E-006 ]
cg0 = [+0.0000000000000000E+000 +0.0000000000000000E+000 +0.0000000000000000E+000 ]
-----------------------------------------------------------------------

---------------  Gyro Pre-Processor Run Completed  --------------------
     AGFILE CREATED:  AG991118.m     ACFILE CREATED:  AC991118.m
-----------------------------------------------------------------------
```

```
Total Gyro Preprocessor Execution Time: 128 seconds

FRAME TABLE ENTRIES FOR PCRS LOADED TO TPCRS
q_PCRS4 = [ +5.2603126189317361E-007     q_PCRS5 = [ +7.3379987833742897E-007
            +3.7451819048221893E-004                 +5.2236196154513707E-004
            -1.4045531552277380E-003                 -1.4047712280184723E-003
            +9.9999894348258311E-001 ];              +9.9999887687698918E-001 ];
q_PCRS8 = [ -5.1968404336718985E-007     q_PCRS9 = [ -7.1963421681856818E-007
            +3.8455385122900486E-004                 +5.3239763239987400E-004
            +1.3513933841514693E-003                 +1.3516841804518383E-003
            +9.9999901292650617E-001 ];              +9.9999894475050310E-001 ];
-------------------------------------------------------------------------------
------ Initial Conditions for State -----  ------   Inital Square-Root Cov (diag)   -----
p1(01)  = a00  = +0.0000000000000000E+000  Sigma_initial(01,01) = 1.0000000000000000E+000
p1(02)  = b00  = +0.0000000000000000E+000  Sigma_initial(02,02) = 1.0000000000000000E+000
p1(03)  = c00  = +0.0000000000000000E+000  Sigma_initial(03,03) = 1.0000000000000000E+000
p1(04)  = a10  = +0.0000000000000000E+000  Sigma_initial(04,04) = 3.5969004473570845E+002
p1(05)  = b10  = +0.0000000000000000E+000  Sigma_initial(05,05) = 3.5969004473570845E+002
p1(06)  = c10  = +0.0000000000000000E+000  Sigma_initial(06,06) = 3.5969004473570845E+002
p1(07)  = d10  = +0.0000000000000000E+000  Sigma_initial(07,07) = 3.5969004473570845E+002
p1(08)  = a20  = +0.0000000000000000E+000  Sigma_initial(08,08) = 1.2937692828197595E+007
p1(09)  = b20  = +0.0000000000000000E+000  Sigma_initial(09,09) = 1.2937692828197595E+007
p1(10)  = c20  = +0.0000000000000000E+000  Sigma_initial(10,10) = 1.2937692828197595E+007
p1(11)  = d20  = +0.0000000000000000E+000  Sigma_initial(11,11) = 1.2937692828197595E+007
p1(12)  = a01  = +0.0000000000000000E+000  Sigma_initial(12,12) = 1.0000000000000000E+004
p1(13)  = b01  = +0.0000000000000000E+000  Sigma_initial(13,13) = 1.0000000000000000E+004
p1(14)  = c01  = +0.0000000000000000E+000  Sigma_initial(14,14) = 1.0000000000000000E+004
p1(15)  = d01  = +0.0000000000000000E+000  Sigma_initial(15,15) = 1.0000000000000000E+004
p1(16)  = e01  = +0.0000000000000000E+000  Sigma_initial(16,16) = 1.0000000000000000E+004
p1(17)  = f01  = +0.0000000000000000E+000  Sigma_initial(17,17) = 1.0000000000000000E+004
-------------------------------------------------------------------------------------------
p2f(01) = am1  = +0.0000000000000000E+000
p2f(02) = am2  = +0.0000000000000000E+000  Sigma_initial(18,18) = 1.0000000000000001E-001
p2f(03) = am3  = +1.0000000000000000E+000
p2f(04) = beta = +1.0000000000000000E+000  Sigma_initial(19,19) = 1.0000000000000001E-001
p2f(05) = qT1  = +1.2836566686785981E-006  Sigma_initial(20,20) = 1.0000000000000001E-001
p2f(06) = qT2  = -9.9760012028013651E-004  Sigma_initial(21,21) = 1.0000000000000000E-002
p2f(07) = aT3  = +1.2867429956649661E-003  Sigma_initial(22,22) = 1.0000000000000000E-002
p2f(08) = qT4  = +9.9999867454152924E-001
p2f(09) = qR1  = +0.0000000000000000E+000  Sigma_initial(23,23) = 3.4288868839039716E-003
p2f(10) = qR2  = +0.0000000000000000E+000  Sigma_initial(24,24) = 1.8555467699985827E-004
p2f(11) = qR3  = +0.0000000000000000E+000  Sigma_initial(25,25) = 1.8555467699985827E-004
p2f(12) = qR4  = +1.0000000000000000E+000
p2f(13) = brx  = +0.0000000000000000E+000  Sigma_initial(26,26) = 4.1893590280687055E-005
p2f(14) = bry  = +0.0000000000000000E+000  Sigma_initial(27,27) = 4.1893590280687055E-005
p2f(15) = brz  = +0.0000000000000000E+000  Sigma_initial(28,28) = 4.1893590280687055E-005
p2f(16) = crx  = +0.0000000000000000E+000  Sigma_initial(29,29) = 1.7550729066060769E-009
p2f(17) = cry  = +0.0000000000000000E+000  Sigma_initial(30,30) = 1.7550729066060769E-009
p2f(18) = crz  = +0.0000000000000000E+000  Sigma_initial(31,31) = 1.7550729066060769E-009
p2f(19) = bgx  = +0.0000000000000000E+000  Sigma_initial(32,32) = 4.1893590280687055E-005
p2f(20) = bgy  = +0.0000000000000000E+000  Sigma_initial(33,33) = 4.1893590280687055E-005
p2f(21) = bgz  = +0.0000000000000000E+000  Sigma_initial(34,34) = 4.1893590280687055E-005
p2f(22) = cgx  = +0.0000000000000000E+000  Sigma_initial(35,35) = 1.7550729066060769E-009
p2f(23) = cgy  = +0.0000000000000000E+000  Sigma_initial(36,36) = 1.7550729066060769E-009
p2f(24) = cgz  = +0.0000000000000000E+000  Sigma_initial(37,37) = 1.7550729066060769E-009
-------------------------------------------------------------------------------------------

--------------------   IPF KALMAN FILTER STARTED  ---------------------
Iteration#001: |dp|= +2.756937349017E+004   RMS(|Res|)=+2.756937349017E+004
Iteration#002: |dp|= +1.318871013134E+002   RMS(|Res|)=+1.318871013134E+002
Iteration#003: |dp|= +5.639308899096E+000   RMS(|Res|)=+5.639308899096E+000
Iteration#004: |dp|= +1.719556978334E+001   RMS(|Res|)=+1.719556978334E+001
Iteration#005: |dp|= +1.320048038732E+000   RMS(|Res|)=+1.320048038732E+000
Iteration#006: |dp|= +3.816936806602E-002   RMS(|Res|)=+3.816936806602E-002
Iteration#007: |dp|= +2.232063087663E-003   RMS(|Res|)=+2.232063087663E-003
Iteration#008: |dp|= +2.105858592665E-004   RMS(|Res|)=+2.105858592665E-004
Iteration#009: |dp|= +6.344598444370E-006   RMS(|Res|)=+6.344598444370E-006
Iteration#010: |dp|= +2.534682489056E-006   RMS(|Res|)=+2.534682489056E-006
```

```
Iteration#011: |dp|= +1.096084224054E-006   RMS(|Res|)=+1.096084224054E-006
Iteration#012: |dp|= +2.142181312521E-006   RMS(|Res|)=+2.142181312521E-006
Iteration#013: |dp|= +5.515663816861E-006   RMS(|Res|)=+5.515663816861E-006
Iteration#014: |dp|= +2.706820166699E-006   RMS(|Res|)=+2.706820166699E-006
Iteration#015: |dp|= +4.840933564709E-006   RMS(|Res|)=+4.840933564709E-006
Iteration#016: |dp|= +2.093854423671E-006   RMS(|Res|)=+2.093854423671E-006
Iteration#017: |dp|= +3.278111834557E-006   RMS(|Res|)=+3.278111834557E-006
Iteration#018: |dp|= +1.412184507779E-006   RMS(|Res|)=+1.412184507779E-006
Iteration#019: |dp|= +4.896950641001E-006   RMS(|Res|)=+4.896950641001E-006
Iteration#020: |dp|= +1.091219876730E-005   RMS(|Res|)=+1.091219876730E-005
IPF Kalman Filter Completed with Error |dp1| + |dp2| = +1.0912198767295368E-005
----------------------------------------------------------------------

-----------------  IPF LEAST SQUARES FILTER STARTED  ------------------
Iteration#001   COND#=+8.354825824772E+012,   |dp|=+2.759026829644E+004
Iteration#002   COND#=+8.354644624300E+012,   |dp|=+1.741611144011E+002
Iteration#003   COND#=+8.354640687393E+012,   |dp|=+2.360695554299E+000
Iteration#004   COND#=+8.354640412261E+012,   |dp|=+7.443236340573E-003
Iteration#005   COND#=+8.354640505473E+012,   |dp|=+3.488405372926E-005
Iteration#006   COND#=+8.354640366781E+012,   |dp|=+1.021156817091E-006
Iteration#007   COND#=+8.354640242053E+012,   |dp|=+8.796863222805E-007
Iteration#008   COND#=+8.354640599939E+012,   |dp|=+4.104249577843E-007
Iteration#009   COND#=+8.354640996715E+012,   |dp|=+8.282304370088E-007
Iteration#010   COND#=+8.354640590230E+012,   |dp|=+5.382720557982E-007
Iteration#011   COND#=+8.354640784591E+012,   |dp|=+8.792989598991E-007
Iteration#012   COND#=+8.354640570859E+012,   |dp|=+5.018847206464E-007
Iteration#013   COND#=+8.354640910156E+012,   |dp|=+4.676814822468E-007
Iteration#014   COND#=+8.354640964261E+012,   |dp|=+6.390310460405E-007
Iteration#015   COND#=+8.354639779455E+012,   |dp|=+3.752103063203E-007
Iteration#016   COND#=+8.354640990166E+012,   |dp|=+6.719267573513E-007
Iteration#017   COND#=+8.354640335089E+012,   |dp|=+5.695348512736E-007
Iteration#018   COND#=+8.354640468019E+012,   |dp|=+2.850074495109E-007
Iteration#019   COND#=+8.354640441950E+012,   |dp|=+3.118157401291E-007
Iteration#020   COND#=+8.354640449528E+012,   |dp|=+6.225101985486E-007
IPF Least Squares Filter Completed with Error |dp1| + |dp2| = +6.2251019854857963E-007
----------------------------------------------------------------------
Total Execution Time: 410 seconds
```

4 USER COMMENTS

This section left blank.

IPF TEAM CONTACT INFORMATION

IPF Team email		ipf@sirtfweb.jpl.nasa.gov	
David S. Bayard	X4-8208	David.S.Bayard@jpl.nasa.gov	(TEAM LEADER)
Dhemetrio Boussalis	X4-3977	boussali@grover.jpl.nasa.gov	
Paul Brugarolas	X4-9243	Paul.Brugarolas@jpl.nasa.gov	
Bryan H. Kang	X4-0541	Bryan.H.Kang@jpl.nasa.gov	
Edward.C.Wong	X4-3053	Edward.C.Wong@jpl.nasa.gov	(TASK MANAGER)

ACKNOWLEDGEMENTS

This work was performed at the Jet Propulsion Laboratory, California Institute of Technology, under contract with the National Aeronautics and Space Administration.

References

[1] D.S. Bayard, B.H. Kang, *SIRTF Instrument Pointing Frame Kalman Filter Algorithm*, JPL D-Document D-24809, September 30, 2003.

[2] B.H. Kang, D.S. Bayard, *SIRTF Instrument Pointing Frame (IPF) Software Description Document and User's Guide*, JPL D-Document D-24808, September 30, 2003.

[3] D.S. Bayard, B.H. Kang, *SIRTF Instrument Pointing Frame (IPF) Kalman Filter Unit Test Report*, JPL D-Document D-24810, September 30, 2003.

[4] *Space Infrared Telescope Facility In-Orbit Checkout and Science Verification Mission Plan*, JPL D-Document D-22622, 674-FE-301 Version 1.4, February 8, 2002.

[5] *Space Infrared Telescope Facility Observatory Description Document*, Lockheed Martin LMMS/P458569, 674-SEIT-300 Version 1.2, November 1, 2002.

[6] *SIRTF Software Interface Specification for Science Centroid INPUT Files (CAFILE, CS-FILE)*, JPL SOS-SIS-2002, November 18, 2002.

[7] *SIRTF Software Interface Specification for Inferred Frames Offset INPUT Files (OFILE)*, JPL SOS-SIS-2003, November 18, 2002.

[8] *SIRTF Software Interface Specification for PCRS Centroid INPUT Files (CBFILE)*, JPL SIS-FES-015, November 18, 2002.

[9] *SIRTF Software Interface Specification for Attitude INPUT Files (AFILE, ASFILE)*, JPL SIS-FES-014, January 7, 2002.

[10] *SIRTF Software Interface Specification for IPF Filter Output Files (IFFILE, LGFILE, TARFILE)*, JPL SOS-SIS-2005, November 18, 2002.

[11] R.J. Brown, *Focal Surface to Object Space Field of View Conversion.* Systems Engineering Report SER No. S20447-OPT-051, Ball Aerospace & Technologies Corp., November 23, 1999.

JET PROPULSION LABORATORY **SIRTF IPF REPORT**
JPL ID992118
August 5, 2003

SIRTF INSTRUMENT POINTING FRAME KALMAN FILTER EXECUTION SUMMARY

IPF RUN NUMBER: 992118
REPORT TYPE: COVARIANCE ANALYSIS

PRIME FRAME: MIPS_70um_fine_center (118)
INFERRED FRAMES: (119) (120) (124) (127) (1) (1) (1) (1)

IPF TEAM

Autonomy and Control Section (345)
Jet Propulsion Laboratory
California Institute of Technology
4800 Oak Grove Drive
Pasadena, CA 91109

Contents

1 IPF EXECUTION SUMMARY **4**

2 FLUTE DATA SUMMARY **8**

2.1 FLUTE CONFIGURATION PARAMETERS 8

2.2 FLUTE GENERATED UNIT TEST DATA 11

3 IPF EXECUTION RESULTS **15**

3.1 IPF EXECUTION OUTPUT PLOTS 15

3.2 IPF OUTPUT DATA (IF MINI FILE) 29

3.3 IPF EXECUTION LOG 34

4 USER COMMENTS **37**

List of Figures

1.1 A-priori and a-posteriori IPF frames 4

1.2 A-priori and a-posteriori IPF frames (ZOOMED) 7

2.1 Focal plane survey scenario plot (See key in [3]) 11

2.2 Commanded-only source locations 12

2.3 True (+) and commanded (o) source locations 12

2.4 True (+) and commanded (o) source locations (ZOOMED) 13

2.5 True-sampled (o) and centroided (+) locations on S/I array (W,V) 13

2.6 True (o) and centroided (+) locations on S/I array (W,V) 14

2.7 True (o) and centroided (+) locations on S/I array (W,V) showing prime and inferred frames 14

3.1 TPF coords of measurements and a-priori predicts 16

3.2 Oriented Pixel Coords of measurements and a-priori predicts 16

3.3 A-priori prediction error 17

3.4 Oriented Pixel Coords of measurements and a-priori predicts (PCRS only) 17

3.5 IPF execution convergence, chart 1 18

3.6 IPF execution convergence, chart 2 18

3.7 Parameter uncertainty convergence 19

3.8 IPF parameter symbol table 19

3.9 KF parameter error sigma plots . . . 20
3.10 LS parameter error sigma plot . . . 20
3.11 KF and LS parameter error sigma plot . . . 21
3.12 Oriented Pixel Coords of meas. and a-posteriori predicts . . . 22
3.13 Oriented Pixel Coords of meas. and a-posteriori predicts (attitude corrected) . . . 22
3.14 Array plot with (solid) and w/o (dashed) optical distortion corrections . . . 23
3.15 KF innovations with (o) and w/o (+) attitude corrections . . . 23
3.16 W-axis KF innovations and 1-sigma bound . . . 24
3.17 V-axis KF innovations and 1-sigma bound . . . 24
3.18 Estimated attitude corrections (Body frame) . . . 25
3.19 Estimated attitude error sigma plot (Body frame) . . . 25
3.20 Thermo-mechanical boresight drift (equiv. angle in (W,V) coords) . . . 26
3.21 Thermo-mechanical boresight drift (equiv. angle in Body frame) . . . 26
3.22 Gyro drift bias contribution (equiv. rate in (W,V) coords) . . . 27
3.23 Gyro drift bias contribution (equiv. angle in (W,V) coords) . . . 27
3.24 Gyro drift bias contribution (equiv. angle in Body frame) . . . 28

List of Tables

1.1 IPF filter input files . . . 5
1.2 IPF filter execution configuration . . . 5
1.3 IPF filter execution mask vector assignment . . . 5
1.4 IPF calibration error summary ([arcsec], 1-sigma, radial) . . . 6
1.5 Measurement prediction error summary (1-sigma) . . . 6
1.6 IPF Brown angle summary . . . 7
2.1 FLUTE Parameter Table (1) . . . 8
2.2 FLUTE Parameter Table (2) . . . 9
2.3 FLUTE Parameter Table (3) . . . 10
2.4 Table of figures (FLUTE) . . . 11
3.1 Table of figures (IPF run) . . . 15

1 IPF EXECUTION SUMMARY

This report summarizes the SIRTF Instrument Pointing Frame (IPF) Kalman Filter execution associated with run file: RN992118. In particular, this Focal Point Survey calibrates the instrument: MIPS_70um_fine_center (118), as part of the Covariance Analysis. The main calibration results from the IPF filter execution have been documented in IF992118 typically stored in the mission archive DOM collection IPF_IF. This report only summarizes the main aspects of the run, and does not substitute for the full information contained in the IF file.

Section 1 summarizes the filter execution results. The filter configurations are tabulated in Table 1.2 and the mask vector assignments are tabulated in Table 1.3. A total of 37 state parameters are estimated in this run. The overall End-to-End pointing performances are tabulated in Table 1.4. The prediction residuals throughout the estimation processes are tabulated in Table 1.6. Section 2 documents the FLUTE generated input file data. Section 3 summarizes resulting plots, a mini summary of the IF IPF output file, and the execution log. Section 4 captures the user comments that are specific to this particular run.

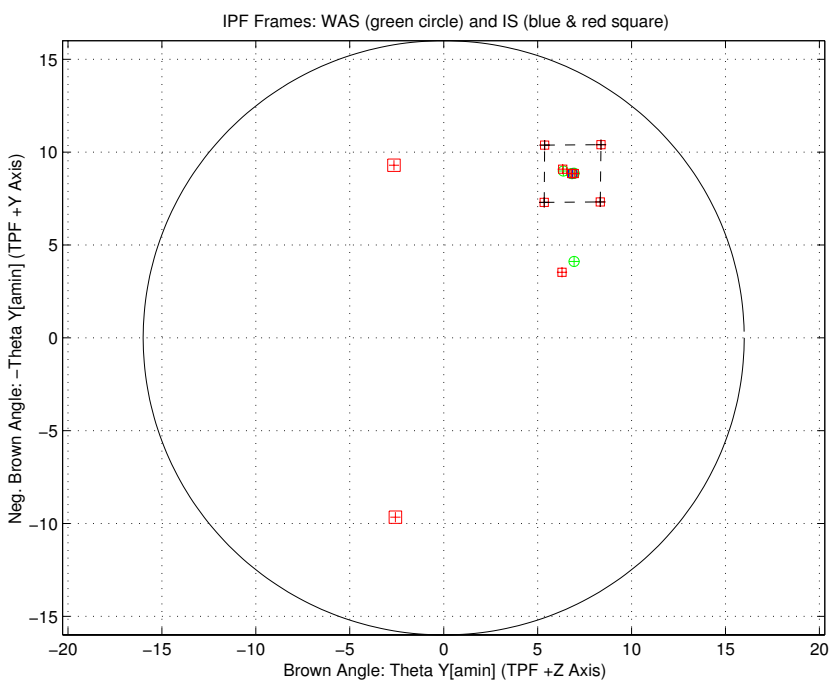

Figure 1.1: A-priori and a-posteriori IPF frames

RAW	FINAL (After Editing)
AA992118	AA992118
AS992118	AS992118
CA992118	CA992118
CB992118	CB992118
CS992118	CS992118

Table 1.1: IPF filter input files

EXECUTION CONFIGURATION ITEM	CURRENT STATUS
IPF Filter Version Used	IPF.V2.0.1Beta
Frame Table Version Used	FTVE2E1
Scan-Mirror Employed?	YES
IPF Filter Mode	NORMAL-MODE(0)
SLIT-MODE Operation	DISABLED
Kalman Filter Operation	ENABLED
Least-Squares Data Analysis	ENABLED
IBAD Screening	ENABLED
User-Specified Data Editing	DISABLED
Total Number of Iterations	20
LS Residual Sigma Scale	1.10045201E+000
Total Number of Maneuvers	22

Table 1.2: IPF filter execution configuration

Con. Plate Scale			Γ Dependent				Γ^2 Dependent				Linear Plate Scale						Mirror	
a_{00}	b_{00}	c_{00}	a_{10}	b_{10}	c_{10}	d_{10}	a_{20}	b_{20}	c_{20}	d_{20}	a_{01}	b_{01}	c_{01}	d_{01}	e_{01}	f_{01}	α	β
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
IPF (T)			Alignment R									Gyro Drift Bias						
θ_1	θ_2	θ_3	a_{rx}	a_{ry}	a_{rz}	b_{rx}	b_{ry}	b_{rz}	c_{rx}	c_{ry}	c_{rz}	b_{gx}	b_{gy}	b_{gz}	c_{gx}	c_{gy}	c_{gz}	
20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	

Table 1.3: IPF filter execution mask vector assignment

FOCAL PLANE SURVEY ANALYSIS: Covariance Analysis.
INSTRUMENT NAME: MIPS_70um_fine_center NF: 118

```
PIX2RADW: 2.47365083E-005[rad/pixel] = 5.1023E+000[arcsec/pixel]
PIX2RADV: 2.47365083E-005[rad/pixel] = 5.1023E+000[arcsec/pixel]
```

FRAME	DESCRIPTION	IPF[1]	SF[2]	ARW[3]	TOTAL	REQ
118(P)	MIPS_70um_fine_center	0.1845	0.0855	0.0565	0.2110	1.10
119(I)	MIPS_70um_fine_FOV1	0.1922	0.0855	0.0565	0.2178	N/A
120(I)	MIPS_70um_fine_FOV2	1.6669	0.0855	0.0565	1.6700	N/A
124(I)	MIPS_70um_fine_FOV3	0.1420	0.0855	0.0565	0.1751	N/A
127(I)	MIPS_70um_fine_FOV4	0.1806	0.0855	0.0565	0.2076	N/A
TR (C)	CORNERS OF INSTRUMENT	0.4095	0.0855	0.0565	0.4221	N/A
BR (C)	CORNERS OF INSTRUMENT	0.3807	0.0855	0.0565	0.3943	N/A
TL (C)	CORNERS OF INSTRUMENT	0.2936	0.0855	0.0565	0.3110	N/A
BL (C)	CORNERS OF INSTRUMENT	0.2897	0.0855	0.0565	0.3073	N/A

Table 1.4: IPF calibration error summary ([arcsec], 1-sigma, radial)

RMS METRIC	A PRIORI[4]	A POSTERIORI[4]	ATT. CORRECTED[5]	UNITS
Radial	8.1081	1.5610	0.8121	arcsec
Radial	1.5891	0.3059	0.1592	pixels
W-Axis	0.9117	0.2289	0.1133	pixels
V-Axis	1.3016	0.2030	0.1118	pixels

Table 1.5: Measurement prediction error summary (1-sigma)

[1]IPF filter removes systematic pointing errors due to: thermomechanical alignment drift (Body to TPF), gyro bias and bias drift, centroiding error, attitude error, and optical distortion. IPF SIGMA presented here is "NOT Scaled" by the Least Squares Scale factor. The Least Squares Scale Factor was: 1.100452.

[2]Error due to gyro Scale Factor: assumes 95 ppm error over 0.250 degree maneuver.

[3]Error due to gyro Angle Random Walk: assumes ARW = 100 $\mu deg/\sqrt{hr}$, with 975 second Maneuver time (max), and 22 independent Maneuvers.

[4]This can be interpreted as estimate of "pixel to sky" pointing reconstruction error if no science data is used.

[5]This can be interpreted as estimate of achieved S/I centroiding error

IPF BROWN ANGLE SUMMARY						
	WAS			IS		
Frame Number	theta_Y (arcmin)	theta_Z (arcmin)	angle (deg)	theta_Y (arcmin)	theta_Z (arcmin)	angle (deg)
118	+6.859000	-8.847000	-0.000000	+6.859782	-8.847774	+0.038167
119	+6.942000	-8.861000	-0.000000	+6.953357	-8.848622	+0.038167
120	+6.941000	-4.117000	+0.000000	+6.298534	-3.528239	+0.038167
124	+6.372000	-8.981000	-0.000000	+6.337955	-9.084072	+0.038167
127	+6.818000	-8.840000	+0.000000	+6.812991	-8.847355	+0.038167
001	+0.000000	+0.000000	+0.000000	+8.376380	-10.402420	+0.038167
001	+0.000000	+0.000000	+0.000000	+8.338023	-7.320601	+0.038167
001	+0.000000	+0.000000	+0.000000	+5.375330	-10.376182	+0.038167
001	+0.000000	+0.000000	+0.000000	+5.350033	-7.292985	+0.038167

Table 1.6: IPF Brown angle summary

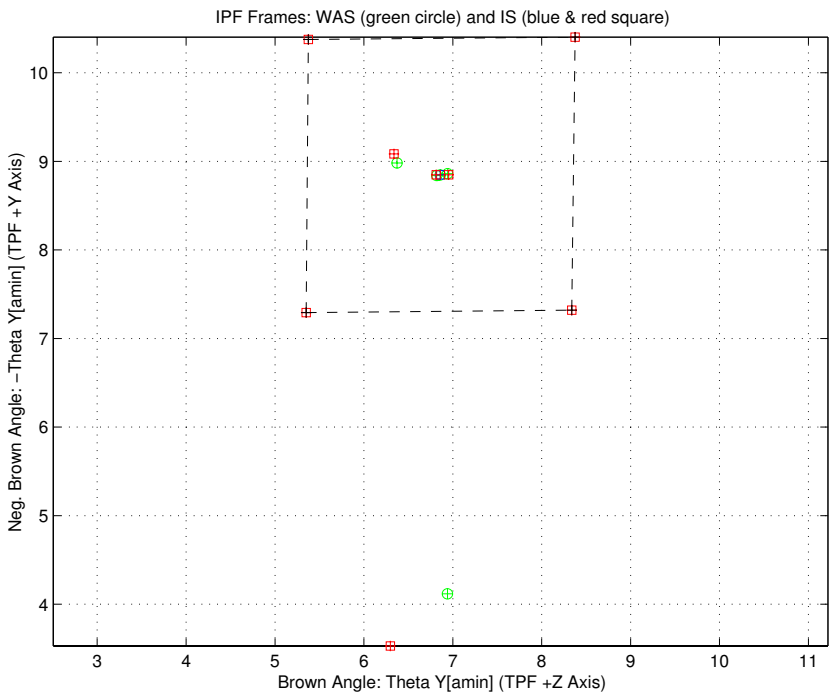

Figure 1.2: A-priori and a-posteriori IPF frames (ZOOMED)

2 FLUTE DATA SUMMARY

2.1 FLUTE CONFIGURATION PARAMETERS

The covariance analysis was performed using the FLUTE generated input data files. The internal configuration parameters, used to produce the data are tabulated in Table 2.1, Table 2.2 and Table 2.3.

NAME	DESCRIPTION	VALUE	UNIT
d2003	days into YEAR2003	+6.0000000000000000E+001	day
tstart	start time	+7.3051200000000000E+008	sec
tdel	data rate	+1.0000000000000001E-001	sec
tshelf	Inertial Hold duration pad	+5.0000000000000000E+000	sec
ipro	slew profile(1-linear, 2-S-curve)	1	int flag
sig_gcf [1]	gcf sigma(1)	+4.8481368110953601E-008	rad/sec
sig_gcf [2]	gcf sigma(2)	+9.6962736221907205E-009	rad/sec
sig_gcf [3]	gcf sigma(3)	+9.6962736221907205E-009	rad/sec
igcf	gcf bias correction flag	1	int flag
SigA [1][1]	Sigma A(1,1)	+9.4017722156391537E-009	rad^2
SigA [2][2]	Sigma A(2,2)	+2.3504430539097885E-011	rad^2
SigA [3][3]	Sigma A(3,3)	+2.3504430539097885E-011	rad^2
NFprime	Prime Frame NF	118	int
ftable [name]	Frame Table row number	118	int
ftable [q0]	Frametable quaternion q0	+1.2836566686785979E-006	N/A
ftable [q1]	Frametable quaternion q1	-9.9760012028013629E-004	N/A
ftable [q2]	Frametable quaternion q2	+1.2867429956649658E-003	N/A
ftable [q3]	Frametable quaternion q3	+9.9999867454152913E-001	N/A
ft_cmd [name]	Command row number	118	int
ft_cmd [q0]	Command quaternion q0	+1.2836566686785979E-006	N/A
ft_cmd [q1]	Command quaternion q1	-9.9760012028013629E-004	N/A
ft_cmd [q2]	Command quaternion q2	+1.2867429956649658E-003	N/A
ft_cmd [q3]	Command quaternion q3	+9.9999867454152913E-001	N/A
ft_true [name]	Truth row number	118	int
ft_true [q0]	Truth quaternion q0	+1.2836566686785979E-006	N/A
ft_true [q1]	Truth quaternion q1	-9.9760012028013629E-004	N/A
ft_true [q2]	Truth quaternion q2	+1.2867429956649658E-003	N/A
ft_true [q3]	Truth quaternion q3	+9.9999867454152913E-001	N/A
ft_prior [name]	Prior row number	118	int
ft_prior [q0]	FTprior quaternion q0	+1.2836566686785979E-006	N/A
ft_prior [q1]	FTprior quaternion q1	-9.9760012028013629E-004	N/A
ft_prior [q2]	FTprior quaternion q2	+1.2867429956649658E-003	N/A
ft_prior [q3]	FTprior quaternion q3	+9.9999867454152913E-001	N/A
ntable [NF]	ntable row number	118	int
ntable [iprime]	Prime frame indication flag	1	int
ntable [SIG_CX]	CX Sigma	+1.0000000000000001E-001	pixel
ntable [SIG_CY]	CY Sigma	+1.0000000000000001E-001	pixel
ntable [PIX2RADX]	Nom. angular pixelsize X-dir	+2.4736508339999999E-005	rad/pixel
ntable [PIX2RADY]	Nom. angular pixelsize Y-dir	+2.5464808057000000E-005	rad/pixel
ntable [CX0]	Center pixel along X-axis	+1.6500000000000000E+001	pixel
ntable [CY0]	Center pixel along Y-axis	+1.6500000000000000E+001	pixel
ntable [BETA0]	Nominal mirror scale factor	+2.8047410000000001E-006	rad/(e.u.)
ntable [GAMMA_E0]	Reference Mirror position	+8.7500000000000000E+002	(e.u.[6])

Table 2.1: FLUTE Parameter Table (1)

[6] encoder units

NAME	DESCRIPTION	VALUE	UNIT
ntable [D11]	x-to-w frame flip parameter	-1	int
ntable [D12]	y-to-w frame flip parameter	0	int
ntable [D21]	x-to-v frame flip parameter	0	int
ntable [D22]	y-to-v frame flip parameter	-1	int
ntable [DG]	Mirror flip parameter	1	int
ntable [sisizew]	Array size (w-direction)	+7.8539816339744833E-004	pixel
ntable [sisizev]	Array size (v-direction)	+7.8539816339744833E-004	pixel
ntable [p2i_w]	w-offset from prime	+0.0000000000000000E+000	pixel
ntable [p2i_v]	v-offset from prime	+0.0000000000000000E+000	pixel
p1true [a00]	True Constant Plate Scales	+1.0000000000000001E-001	N/A
p1true [b00]	True Constant Plate Scales	+1.0000000000000001E-001	N/A
p1true [c00]	True Constant Plate Scales	+1.0000000000000000E-002	N/A
p1true [a10]	True Γ Dependent Plate Scales	+1.0000000000000001E-001	1/rad
p1true [b10]	True Γ Dependent Plate Scales	+1.0000000000000001E-001	1/rad
p1true [c10]	True Γ Dependent Plate Scales	+1.0000000000000000E-002	1/rad
p1true [d10]	True Γ Dependent Plate Scales	+1.0000000000000000E-002	1/rad
p1true [a20]	True Γ^2 Dependent Plate Scales	+1.0000000000000001E-001	$1/\mathrm{rad}^2$
p1true [b20]	True Γ^2 Dependent Plate Scales	+1.0000000000000001E-001	$1/\mathrm{rad}^2$
p1true [c20]	True Γ^2 Dependent Plate Scales	+1.0000000000000000E-002	$1/\mathrm{rad}^2$
p1true [d20]	True Γ^2 Dependent Plate Scales	+1.0000000000000000E-002	$1/\mathrm{rad}^2$
p1true [a01]	True Linear Plate Scales	+2.0000000000000000E+000	N/A
p1true [b01]	True Linear Plate Scales	+2.0000000000000000E+000	N/A
p1true [c01]	True Linear Plate Scales	+2.0000000000000000E+000	N/A
p1true [d01]	True Linear Plate Scales	+2.0000000000000000E+000	N/A
p1true [e01]	True Linear Plate Scales	+2.0000000000000000E+000	N/A
p1true [f01]	True Linear Plate Scales	+2.0000000000000000E+000	N/A
p2true [am1]	True Scan mirror alignment Ux	+0.0000000000000000E+000	N/A
p2true [am2]	True Scan mirror alignment Uy	+2.0000000000000000E-002	N/A
p2true [am3]	True Scan mirror alignment Uz	+9.9979997999599901E-001	N/A
p2true [beta]	True Scan mirror scale factor	+1.1000000000000001E+000	N/A
p2true [qT1]	True IPF q1	+1.2836566686785979E-006	N/A
p2true [qT2]	True IPF q2	-9.9760012028013629E-004	N/A
p2true [qT3]	True IPF q3	+1.2867429956649658E-003	N/A
p2true [qT4]	True IPF q4	+9.9999867454152913E-001	N/A
p2true [qR01]	True Boresight Alignment q1	+4.8481368053692367E-005	N/A
p2true [qR02]	True Boresight Alignment q2	+2.4240684026846184E-006	N/A
p2true [qR03]	True Boresight Alignment q3	+2.4240684026846184E-006	N/A
p2true [qR04]	True Boresight Alignment q4	+9.9999999881890234E-001	N/A
p2true [brx]	True B. Alignment drift rate X	+5.6000000000000000E-011	rad/sec
p2true [bry]	True B. Alignment drift rate Y	+5.6000000000000000E-011	rad/sec
p2true [brz]	True B. Alignment drift rate Z	+5.6000000000000000E-011	rad/sec
p2true [crx]	True B. Alignment drift accel. X	+5.0000000000000002E-014	$\mathrm{rad/sec}^2$
p2true [cry]	True B. Alignment drift accel. Y	+5.0000000000000002E-014	$\mathrm{rad/sec}^2$
p2true [crz]	True B. Alignment drift accel. Z	+5.0000000000000002E-014	$\mathrm{rad/sec}^2$
p2true [bgx]	True Gyro bias correction X	+2.5000000000000002E-006	rad/sec
p2true [bgy]	True Gyro bias correction Y	+2.5000000000000002E-006	rad/sec
p2true [bgz]	True Gyro bias correction Z	+2.5000000000000002E-006	rad/sec
p2true [cgx]	True Gyro bias-rate correction X	+9.9999999999999998E-013	$\mathrm{rad/sec}^2$
p2true [cgy]	True Gyro bias-rate correction Y	+9.9999999999999998E-013	$\mathrm{rad/sec}^2$
p2true [cgz]	True Gyro bias-rate correction Z	+9.9999999999999998E-013	$\mathrm{rad/sec}^2$

Table 2.2: FLUTE Parameter Table (2)

NAME	DESCRIPTION	VALUE	UNIT
p2cmd [am1]	CMD Scan mirror alignment Ux	+0.0000000000000000E+000	N/A
p2cmd [am2]	CMD Scan mirror alignment Uy	+0.0000000000000000E+000	N/A
p2cmd [am3]	CMD Scan mirror alignment Uz	+1.0000000000000000E+000	N/A
p2cmd [beta]	CMD Scan mirror rotation SF	+1.0000000000000000E+000	N/A
p2cmd [qT1]	CMD IPF q1	+1.2836566686785979E-006	N/A
p2cmd [qT2]	CMD IPF q2	-9.9760012028013629E-004	N/A
p2cmd [qT3]	CMD IPF q3	+1.2867429956649658E-003	N/A
p2cmd [qT4]	CMD IPF q4	+9.9999867454152913E-001	N/A
p2cmd [qR01]	CMD Boresight Alignment q1	+0.0000000000000000E+000	N/A
p2cmd [qR02]	CMD Boresight Alignment q2	+0.0000000000000000E+000	N/A
p2cmd [qR03]	CMD Boresight Alignment q3	+0.0000000000000000E+000	N/A
p2cmd [qR04]	CMD Boresight Alignment q4	+1.0000000000000000E+000	N/A
p2cmd [brx]	CMD B. Alignment drift rate X	+0.0000000000000000E+000	rad/sec
p2cmd [bry]	CMD B. Alignment drift rate Y	+0.0000000000000000E+000	rad/sec
p2cmd [brz]	CMD B. Alignment drift rate Z	+0.0000000000000000E+000	rad/sec
p2cmd [crx]	CMD B. Alignment drift accel. X	+0.0000000000000000E+000	rad/sec^2
p2cmd [cry]	CMD B. Alignment drift accel. Y	+0.0000000000000000E+000	rad/sec^2
p2cmd [crz]	CMD B. Alignment drift accel. Z	+0.0000000000000000E+000	rad/sec^2
p2cmd [bgx]	CMD Gyro bias correction X	+0.0000000000000000E+000	rad/sec
p2cmd [bgy]	CMD Gyro bias correction Y	+0.0000000000000000E+000	rad/sec
p2cmd [bgz]	CMD Gyro bias correction Z	+0.0000000000000000E+000	rad/sec
p2cmd [cgx]	CMD Gyro bias-rate correction X	+0.0000000000000000E+000	rad/sec^2
p2cmd [cgy]	CMD Gyro bias-rate correction Y	+0.0000000000000000E+000	rad/sec^2
p2cmd [cgz]	CMD Gyro bias-rate correction Z	+0.0000000000000000E+000	rad/sec^2
a1	Semi-Major Axis of SIRTF (HCO [7])	+1.4960000000000000E+011	m
a2	Semi-Major Axis of Earth (HCO)	+1.4960000000000000E+011	m
e1	Eccentricity (SIRTF in HCO)	+1.6722000000000001E-002	N/A
e2	Eccentricity (Earth in HCO)	+1.6722000000000001E-002	N/A
inc1	inclination (SIRTF in HCO)	+4.0142572795869580E-001	rad
inc2	inclination (Earth in HCO)	+4.0142572795869580E-001	rad
Omega1	Ascending Node Long.(SIRTF in HCO)	+0.0000000000000000E+000	rad
Omega2	Ascending Node Long.(Earth in HCO)	+0.0000000000000000E+000	rad
omega1	Argument of Perigee(SIRTF in HCO)	+1.7627825445142729E+000	rad
omega2	Argument of Perigee(Earth in HCO)	+1.7627825445142729E+000	rad
nu0_1	True Anomaly of SIRTF(HCO)	+8.6071031605199810E-001	rad
nu0_2	True Anomaly of Earth(HCO)	+1.0328523792623976E+000	rad
inav	Velocity Report Flag	+0.0000000000000000E+000	rad
wsize	Array size W-dir	+7.8539816339744833E-004	rad
vsize	Array size V-dir	+7.8539816339744833E-004	rad

Table 2.3: FLUTE Parameter Table (3)

[7] Heliocentric Orbit

2.2 FLUTE GENERATED UNIT TEST DATA

This subsection plots the FLUTE generated IPF filter input files. Seven figures, as tabulated in Table 2.4, show the campaign maneuver senario, the true sampled locations on the array and the actual centroided data superimposed the array plane. All angles shown in FLUTE plots have units of radians.

FIGURE NO.	DESCRIPTION
Figure 2.1	Focal Plane Survey Scenario Plot
Figure 2.2	Commanded-only source locations in TPF
Figure 2.3	True and commanded source locations in TPF
Figure 2.4	True and commanded source locations (ZOOMED) in TPF
Figure 2.5	True-sampled and centroided locations in Focal Plane (W,V) including rectangular array boundary approximation
Figure 2.6	True and centroided locations on S/I Array (W,V) including rectangular array boundary approximation
Figure 2.7	True and centroided locations on S/I Array (W,V) showing Prime and Inferred Frames including rectangular array boundary approximation

Table 2.4: Table of figures (FLUTE)

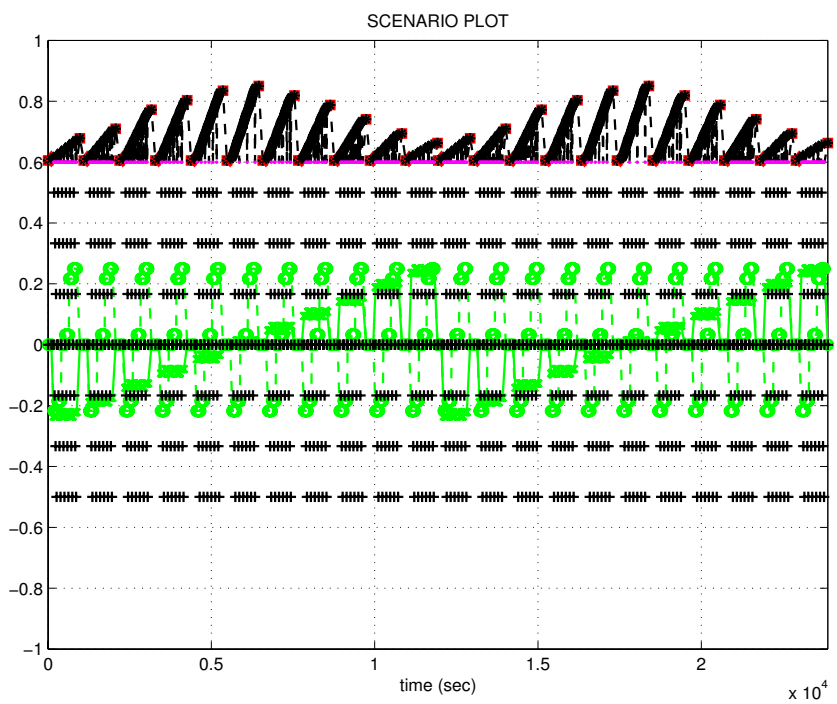

Figure 2.1: Focal plane survey scenario plot (See key in [3])

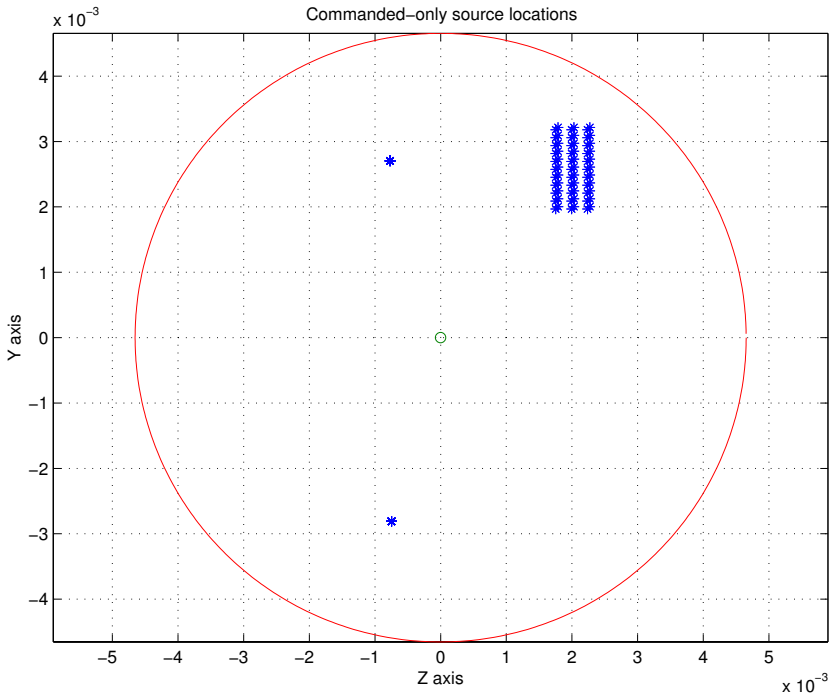

Figure 2.2: Commanded-only source locations

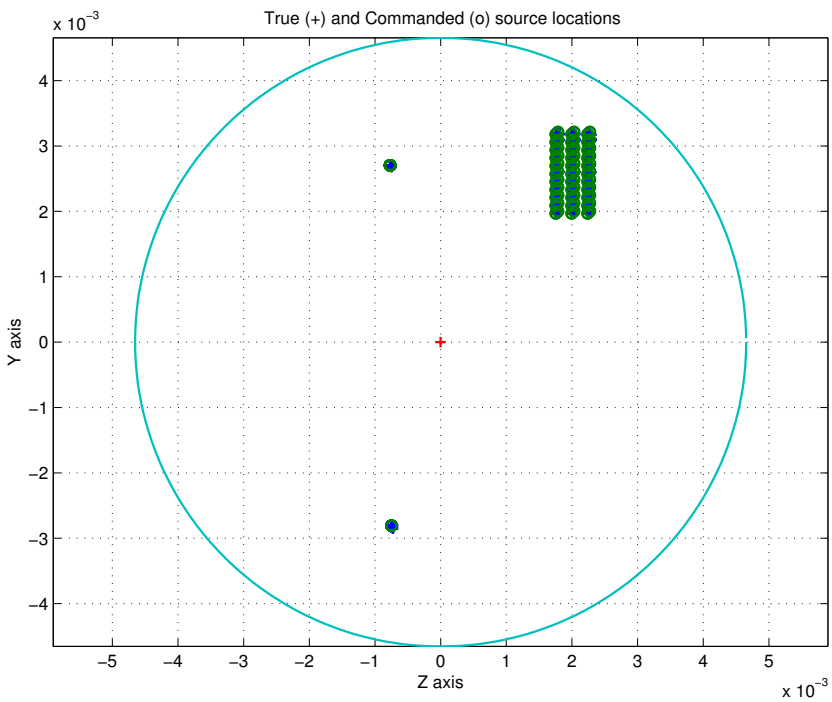

Figure 2.3: True (+) and commanded (o) source locations

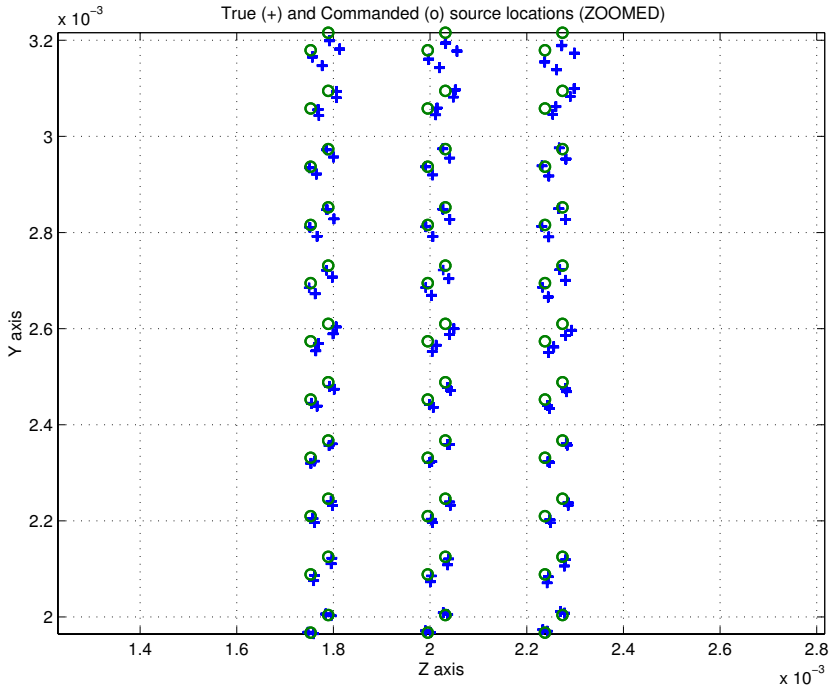

Figure 2.4: True (+) and commanded (o) source locations (ZOOMED)

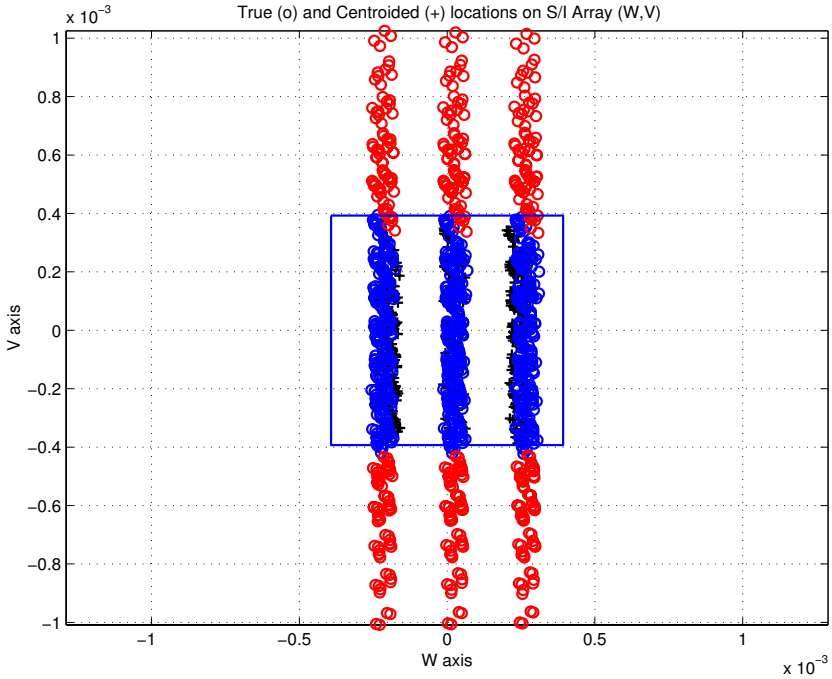

Figure 2.5: True-sampled (o) and centroided (+) locations on S/I array (W,V)

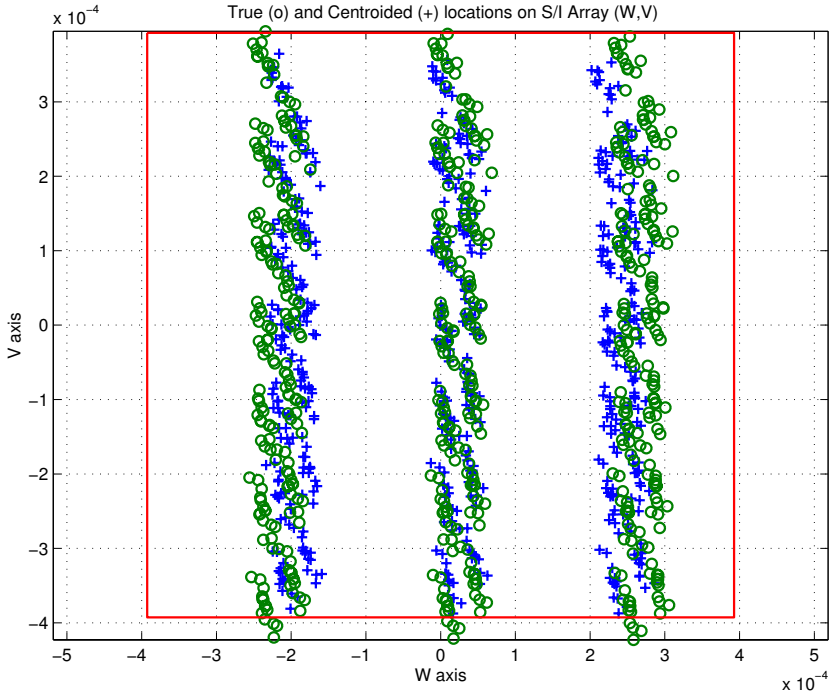

Figure 2.6: True (o) and centroided (+) locations on S/I array (W,V)

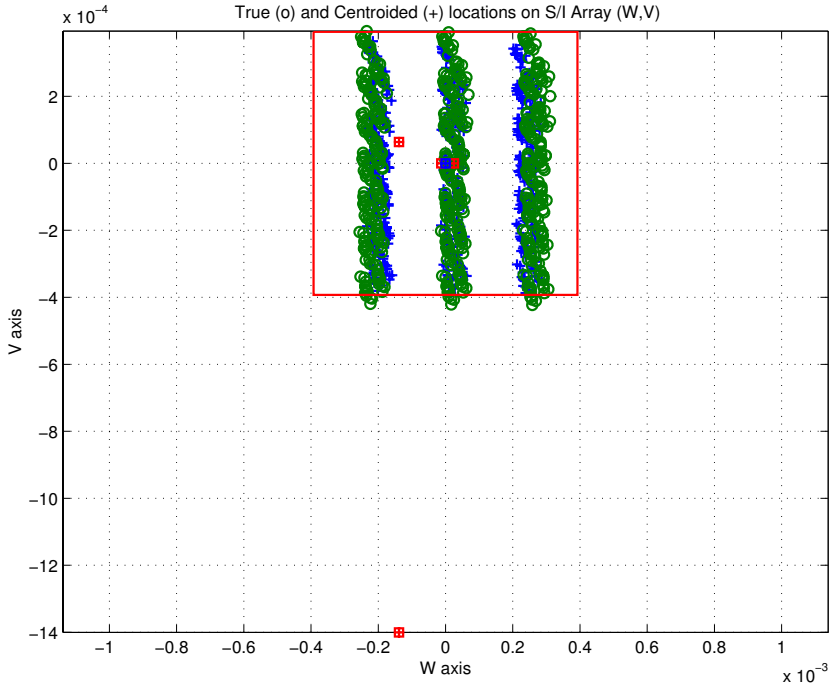

Figure 2.7: True (o) and centroided (+) locations on S/I array (W,V) showing prime and inferred frames

3 IPF EXECUTION RESULTS

3.1 IPF EXECUTION OUTPUT PLOTS

This subsection summarizes the IPF filter results. As shown in Table 3.1, the output plots are segmented to three groups: predicted performance, post-run results and IPF trending plots.

FIGURE NO.	DESCRIPTION
Predicted performance prior to IPF run	
Figure 3.1	Meas. and a-priori predicts in TPF coords
Figure 3.2	Meas. and a-priori predicts in Oriented Pixel Coords including rectangular array boundary approximation
Figure 3.3	A-priori prediction error
Figure 3.4	Oriented Pixel Coords of measurements and a-priori predicts (PCRS only)
IPF filter performance (post run results)	
Figure 3.5	IPF execution convergence, chart 1: (top) normalized residual error vs. iteration number and (bottom) norm of effective parameter corrections
Figure 3.6	IPF execution convergence, chart 2: parameter correction size vs. iteration number
Figure 3.7	Parameter uncertainty convergence: square-root of diagonal elements of covariance matrix vs. maneuver number
Figure 3.8	IPF parameter symbol table
Figure 3.9	KF parameter error sigma plot (a-priori-dashed, a-posteriori-solid). Includes true parameter errors (FLUTE runs only)
Figure 3.10	LS parameter error sigma plot. Includes true parameter errors (FLUTE runs only)
Figure 3.11	KF and LS parameter errors sigma plot (Figure 3.9 & Figure 3.10 combined)
Figure 3.12	Measurements and a-posteriori predicts in Oriented Pixel Coords including rectangular array boundaries (a-priori-dashed, a-posteriori-solid)
Figure 3.13	Attitude corrected meas. and a-posteriori predicts in Oriented Pixel Coords including rectangular array boundaries (a-priori-dashed, a-posteriori-solid)
Figure 3.14	Array plot with (solid) and w/o (dashed) optical distortion corrections
Figure 3.15	KF innovations with (o) and w/o (+) attitude corrections
Figure 3.16	W-axis KF innovations and 1-sigma bound
Figure 3.17	V-axis KF innovations and 1-sigma bound
IPF parameter trending plots	
Figure 3.18	Estimated attitude corrections (Body frame)
Figure 3.19	Estimated attitude error sigma plot (Body frame)
Figure 3.20	Systematic error attributed to thermo-mechanical boresight drift (equiv. angle in (W,V) coords)
Figure 3.21	Systematic error attributed to thermo-mechanical boresight drift (equiv. angle in Body frame)
Figure 3.22	Systematic error attributed to gyro drift bias (equiv. rate in (W,V) coords)
Figure 3.23	Systematic error attributed to gyro drift bias (equiv. angle in (W,V) coords)
Figure 3.24	Systematic error attributed to gyro drift bias (equiv. angle in Body frame)

Table 3.1: Table of figures (IPF run)

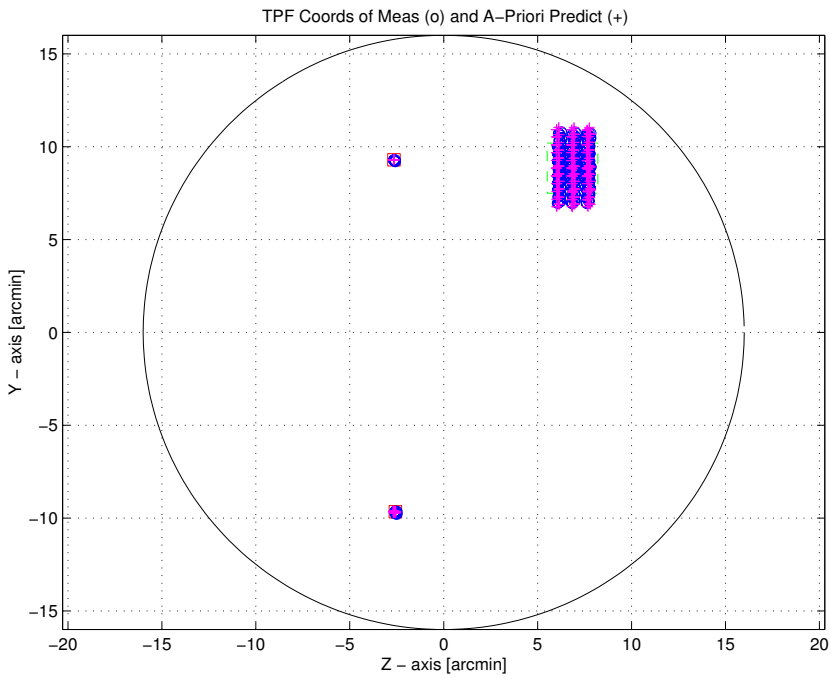

Figure 3.1: TPF coords of measurements and a-priori predicts

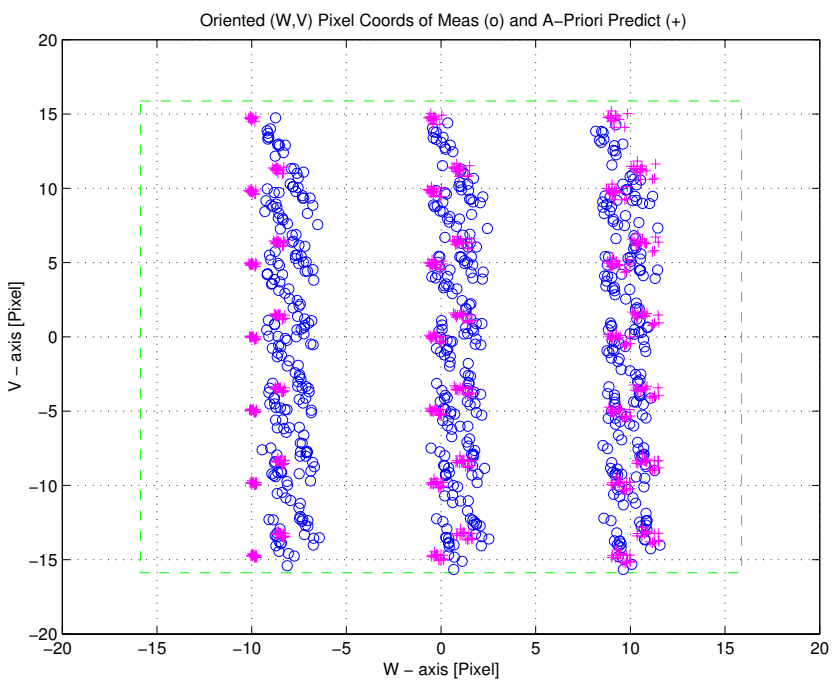

Figure 3.2: Oriented Pixel Coords of measurements and a-priori predicts

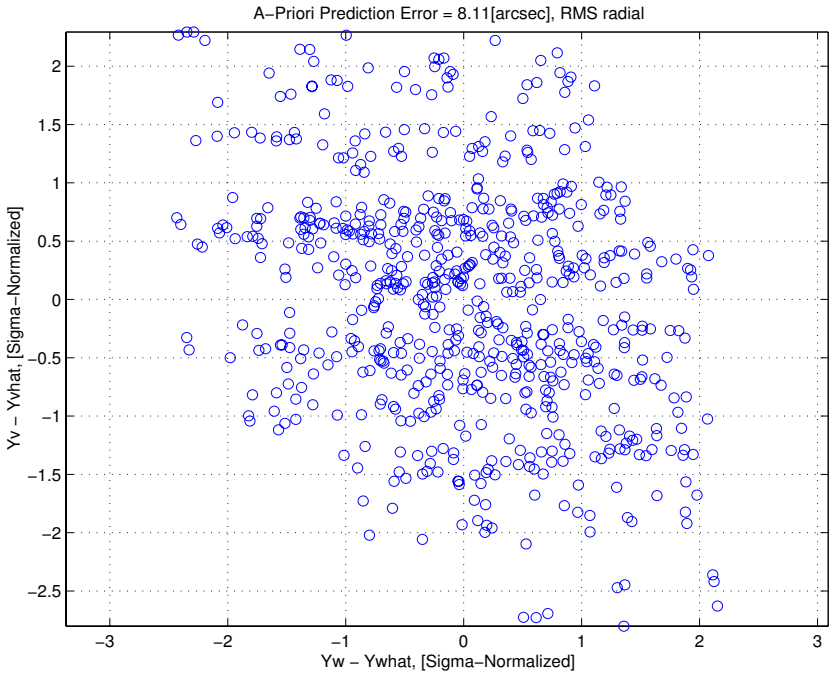

Figure 3.3: A-priori prediction error

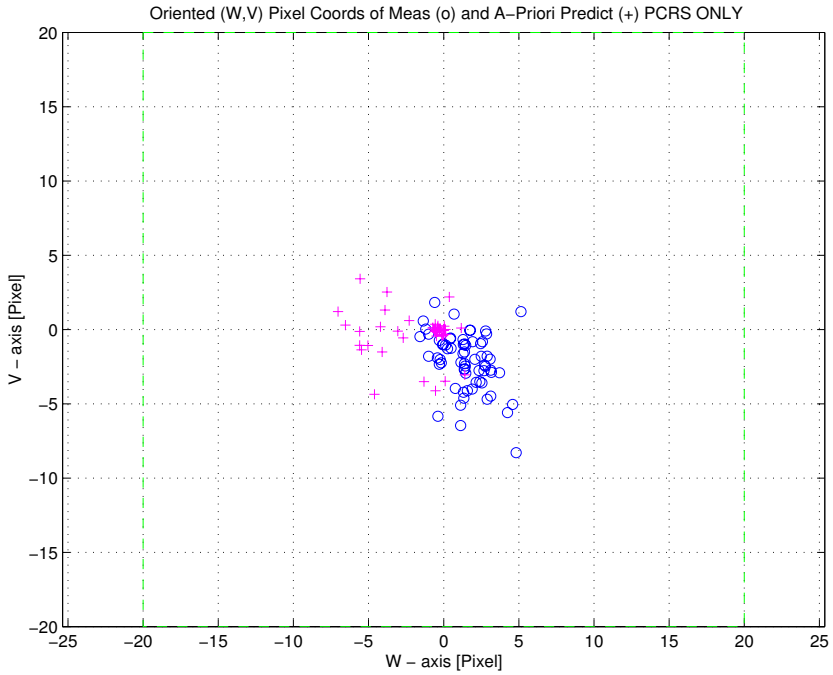

Figure 3.4: Oriented Pixel Coords of measurements and a-priori predicts (PCRS only)

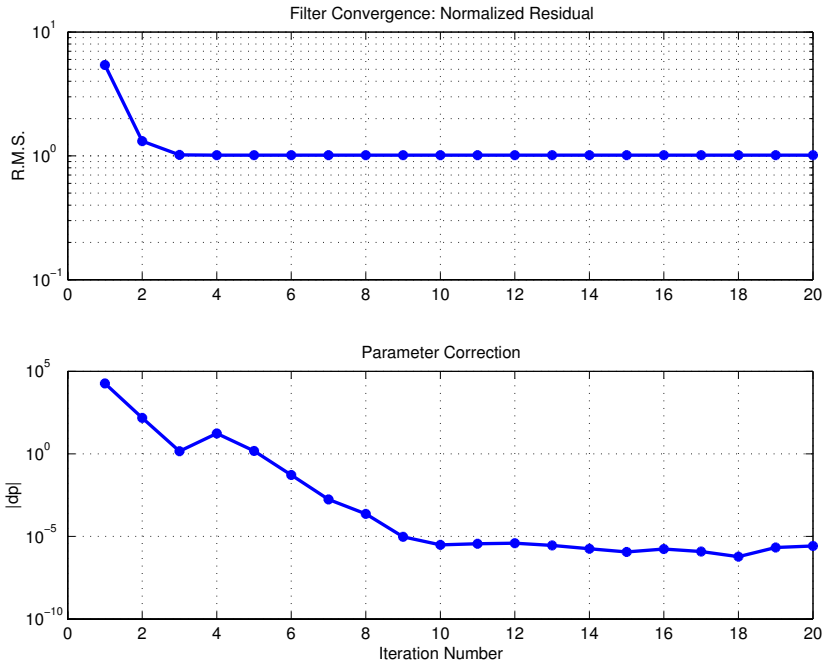

Figure 3.5: IPF execution convergence, chart 1

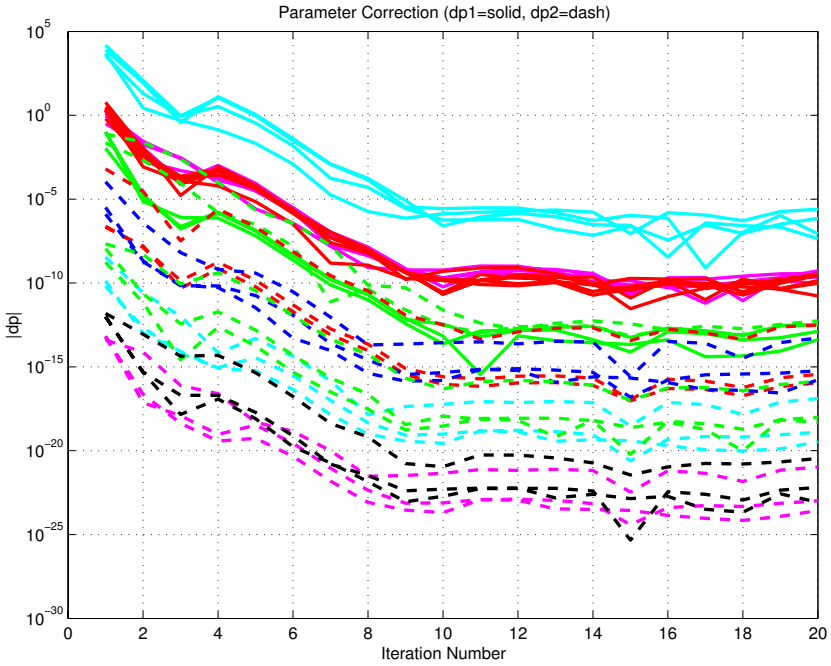

Figure 3.6: IPF execution convergence, chart 2

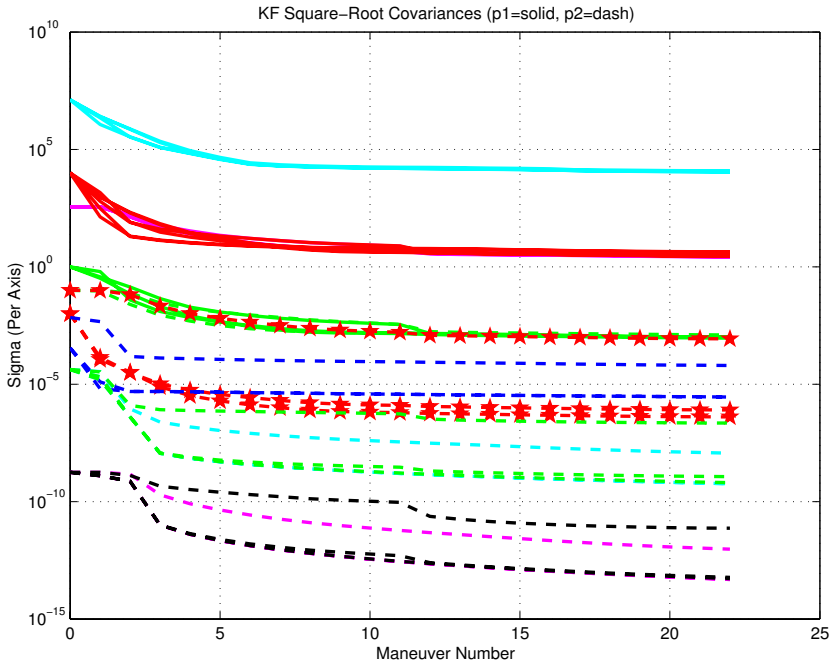

Figure 3.7: Parameter uncertainty convergence

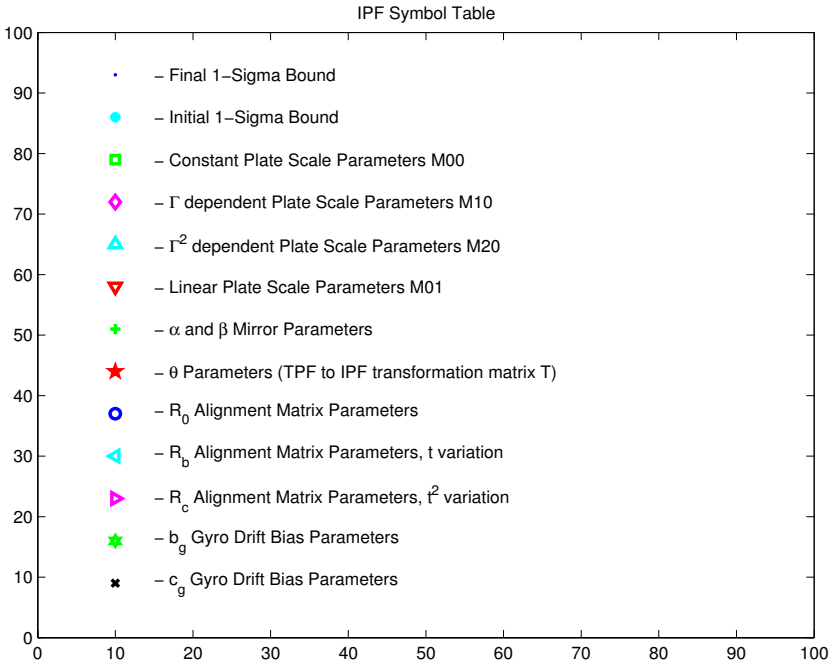

Figure 3.8: IPF parameter symbol table

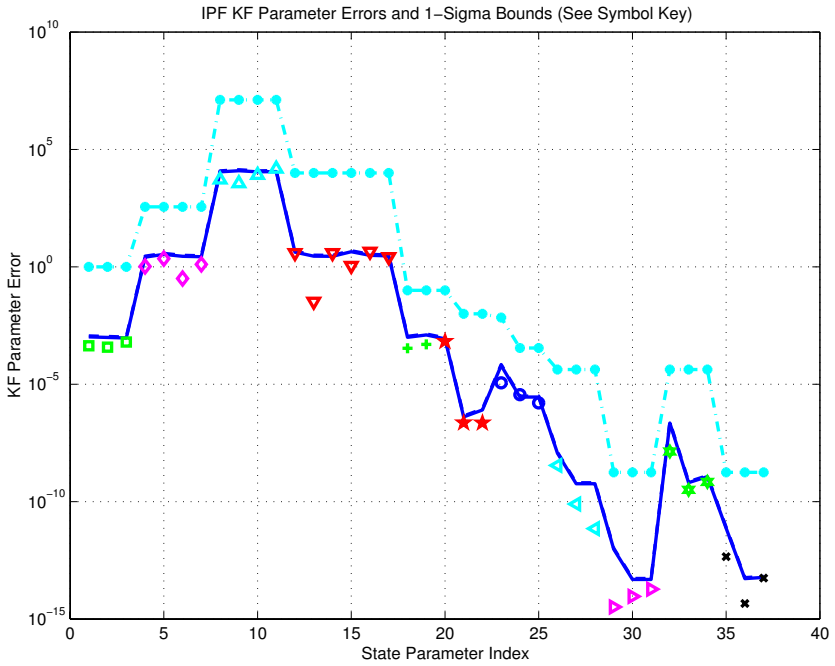

Figure 3.9: KF parameter error sigma plots

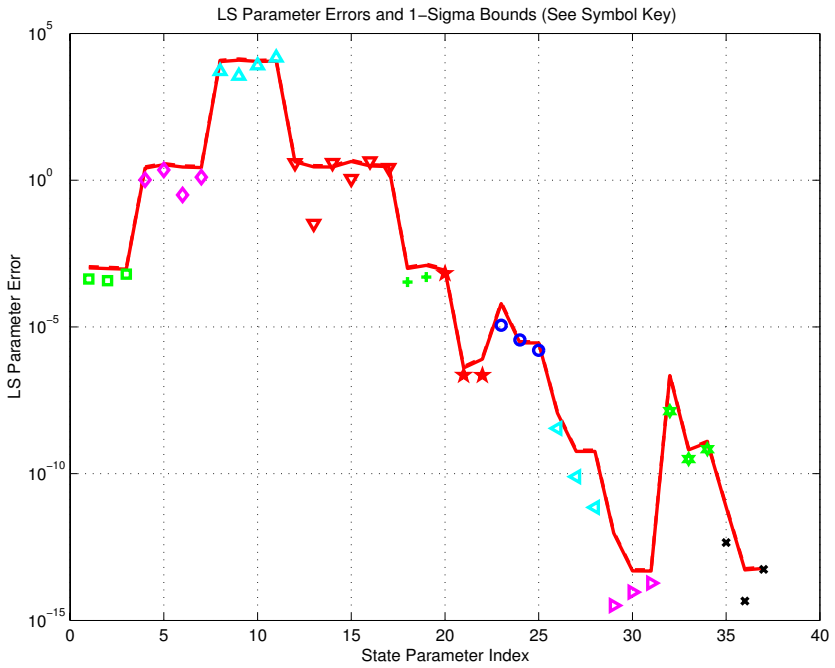

Figure 3.10: LS parameter error sigma plot

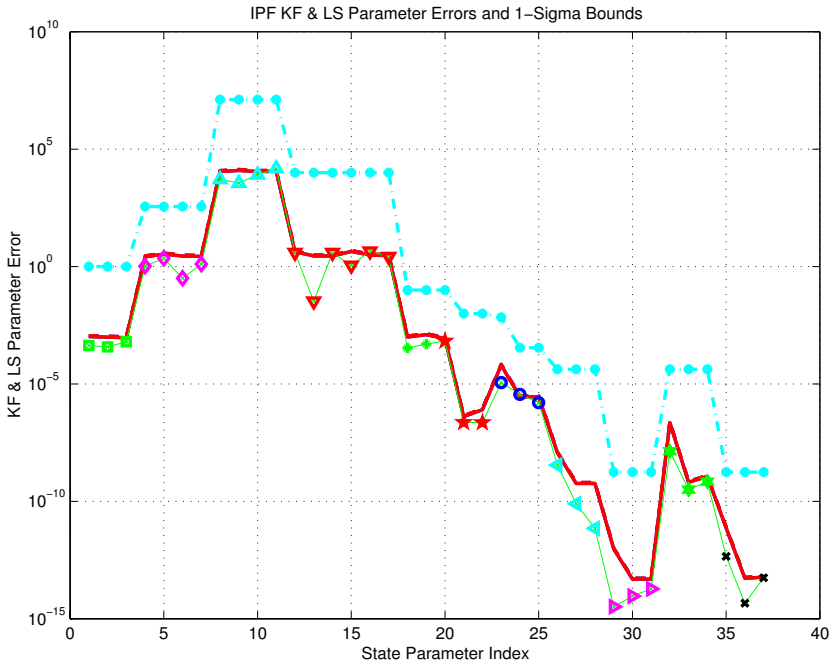

Figure 3.11: KF and LS parameter error sigma plot

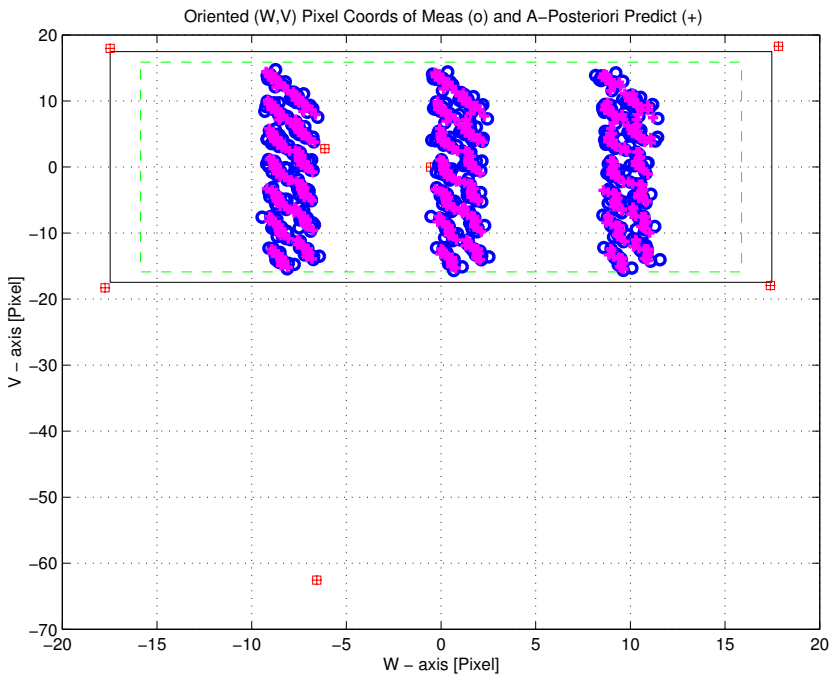

Figure 3.12: Oriented Pixel Coords of meas. and a-posteriori predicts

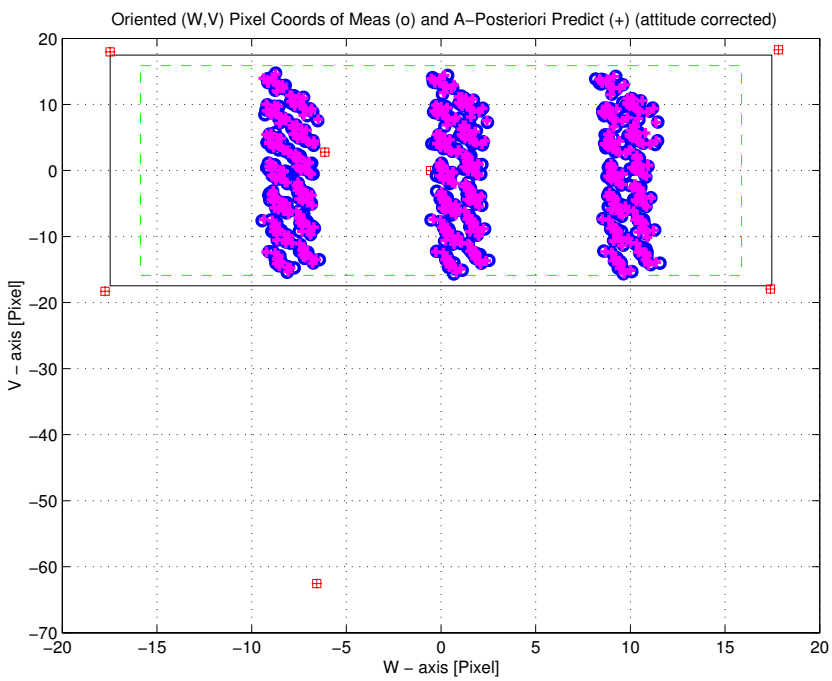

Figure 3.13: Oriented Pixel Coords of meas. and a-posteriori predicts (attitude corrected)

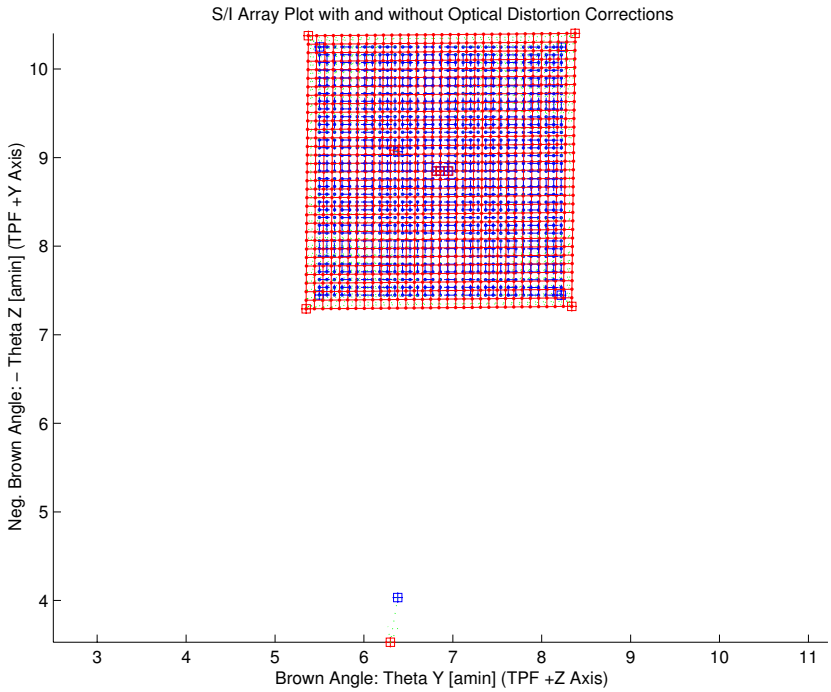

Figure 3.14: Array plot with (solid) and w/o (dashed) optical distortion corrections

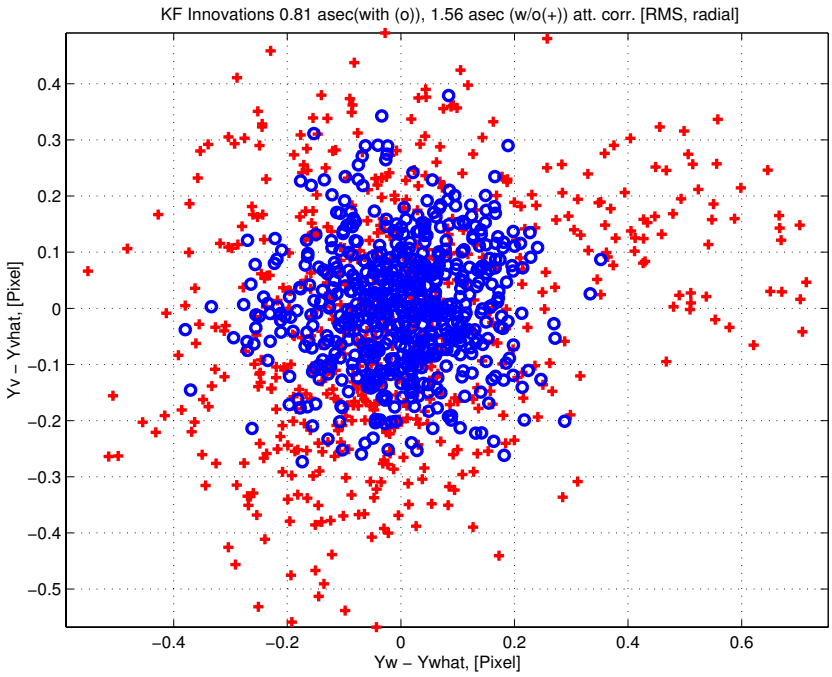

Figure 3.15: KF innovations with (o) and w/o (+) attitude corrections

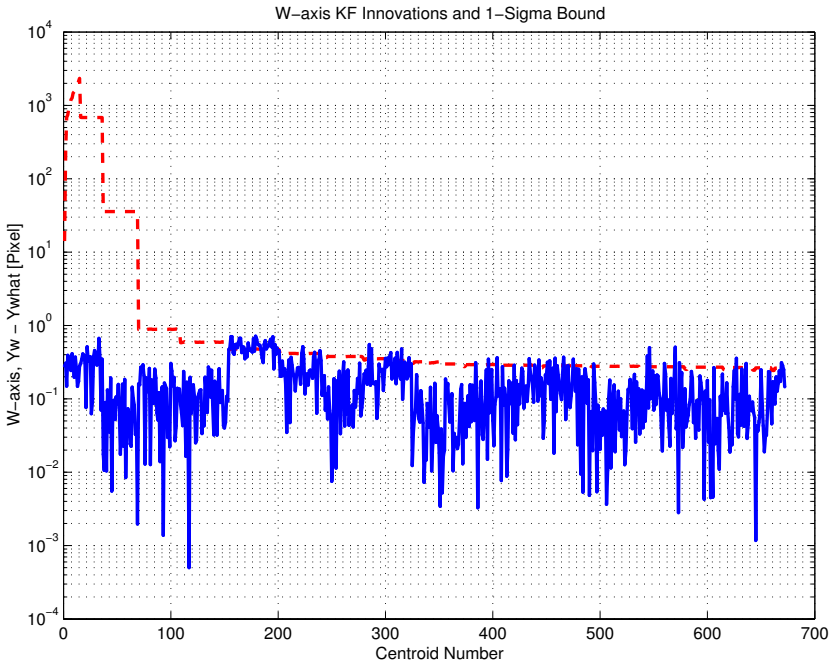

Figure 3.16: W-axis KF innovations and 1-sigma bound

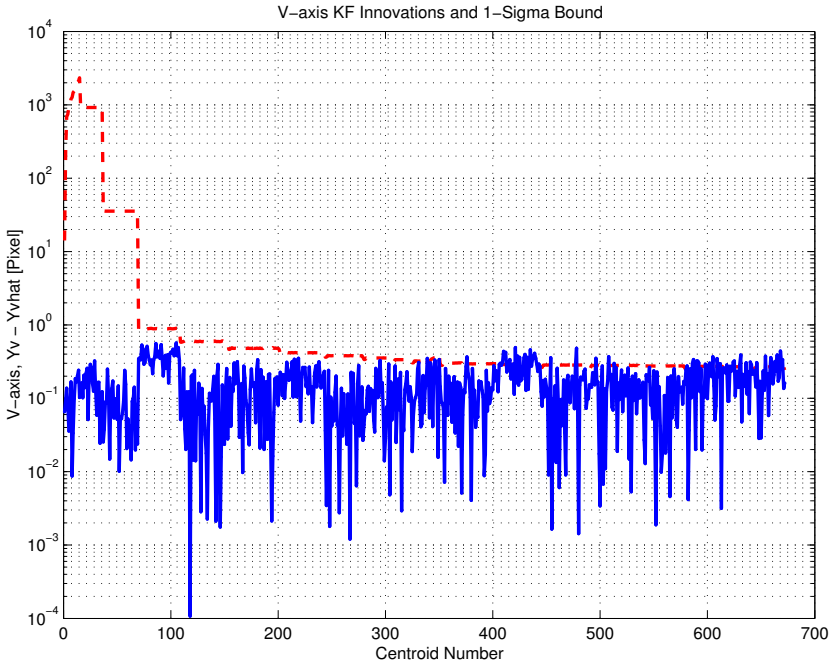

Figure 3.17: V-axis KF innovations and 1-sigma bound

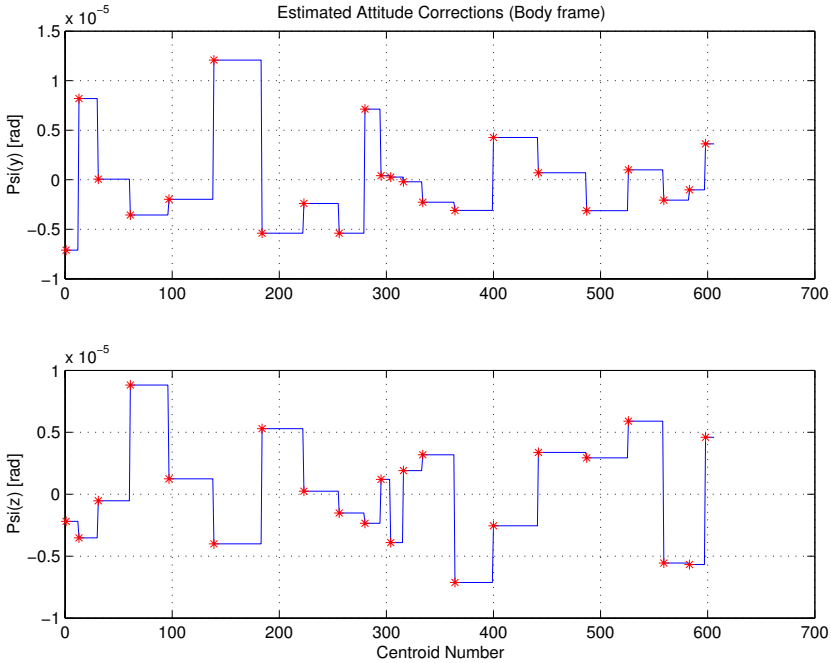

Figure 3.18: Estimated attitude corrections (Body frame)

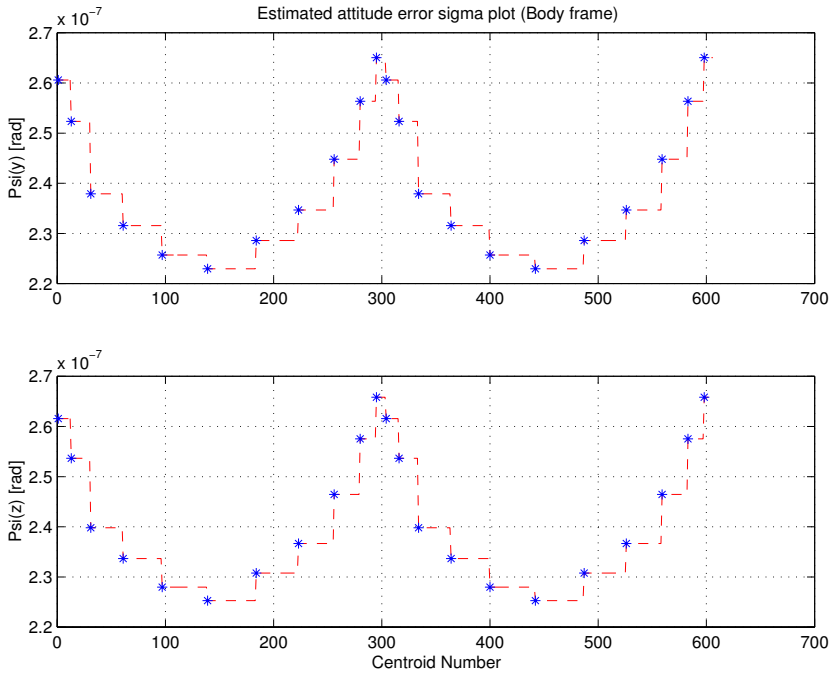

Figure 3.19: Estimated attitude error sigma plot (Body frame)

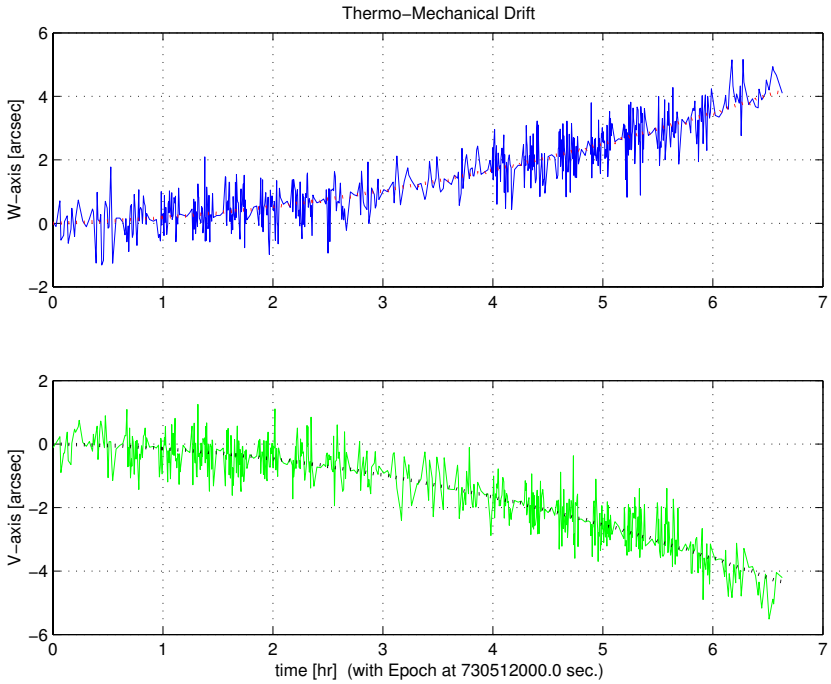

Figure 3.20: Thermo-mechanical boresight drift (equiv. angle in (W,V) coords)

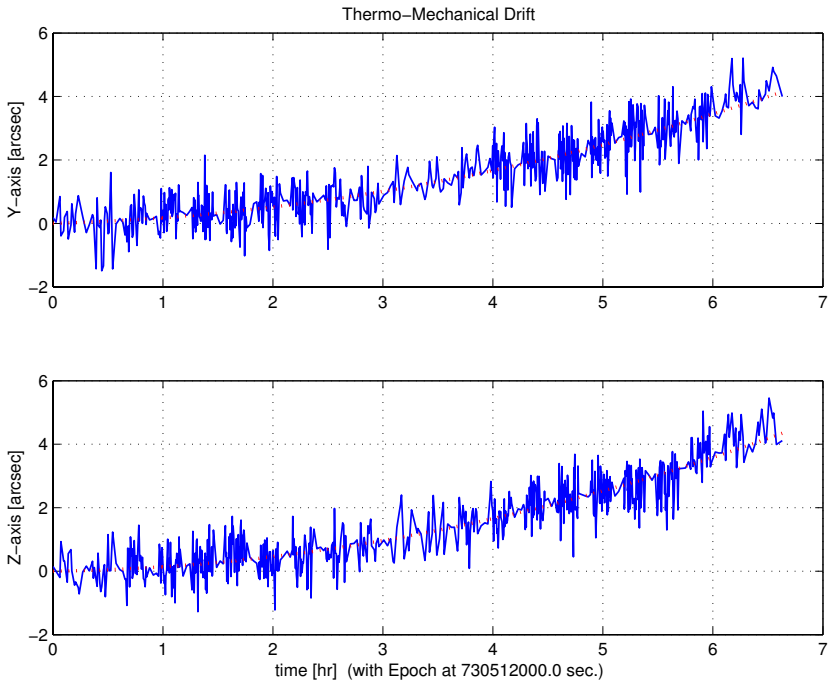

Figure 3.21: Thermo-mechanical boresight drift (equiv. angle in Body frame)

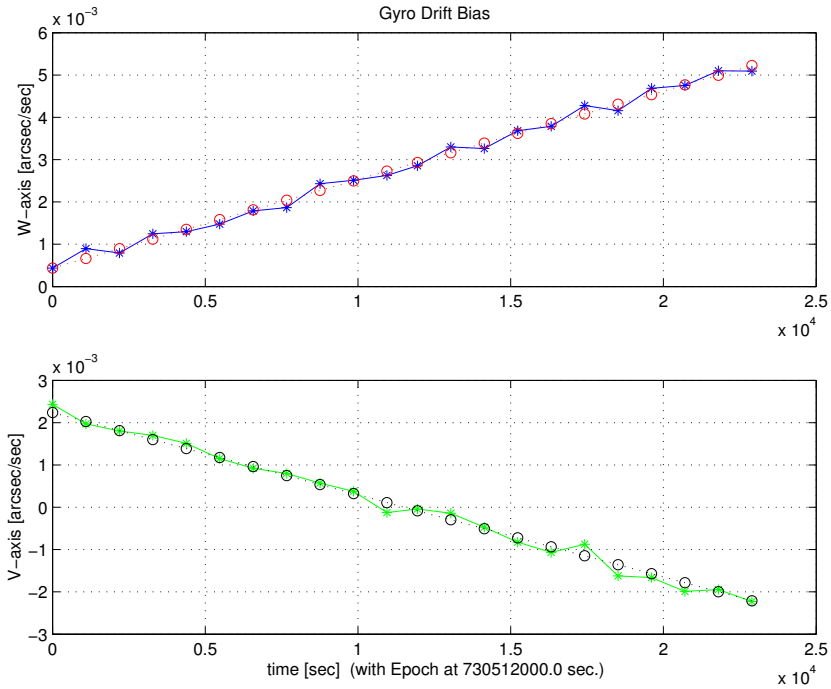

Figure 3.22: Gyro drift bias contribution (equiv. rate in (W,V) coords)

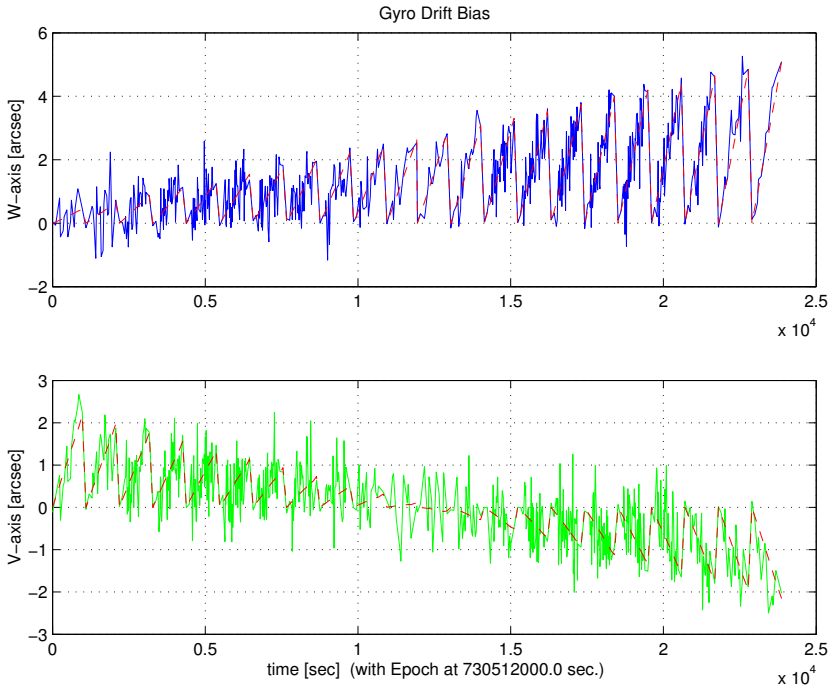

Figure 3.23: Gyro drift bias contribution (equiv. angle in (W,V) coords)

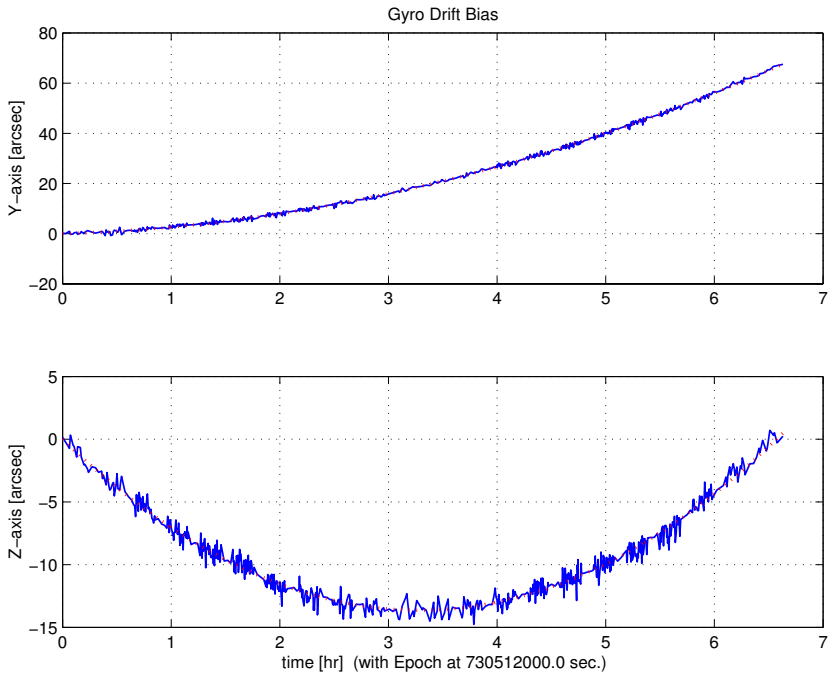

Figure 3.24: Gyro drift bias contribution (equiv. angle in Body frame)

3.2 IPF OUTPUT DATA (IF MINI FILE)

```
OUTPUT FILE NAME: IFmini992118.dat   DATE: 05-Aug-2003   TIME: 22:31
INSTRUMENT NAME:  MIPS_70um_fine_center   NF: 118
IPF FILTER VERSION: IPF.V2.0.1Beta       SW RELEASE DATE: August 5, 2003
-------------------------------------------------------------------------------
---------------------------- IPF BROWN ANGLE SUMMARY ----------------------------
-------------------------------------------------------------------------------
         ------------ WAS ------------           ------------ IS -------------
Frame    theta_Y     theta_Z     angle           theta_Y     theta_Z     angle
Number   (arcmin)    (arcmin)    (deg)           (arcmin)    (arcmin)    (deg)
------  --------------------------------       --------------------------------
 118     +6.859000  -8.847000   -0.000000        +6.859782  -8.847774   +0.038167
 119     +6.942000  -8.861000   -0.000000        +6.953357  -8.848622   +0.038167
 120     +6.941000  -4.117000   +0.000000        +6.298534  -3.528239   +0.038167
 124     +6.372000  -8.981000   -0.000000        +6.337955  -9.084072   +0.038167
 127     +6.818000  -8.840000   +0.000000        +6.812991  -8.847355   +0.038167
 001     +0.000000  +0.000000   +0.000000        +8.376380 -10.402420   +0.038167
 001     +0.000000  +0.000000   +0.000000        +8.338023  -7.320601   +0.038167
 001     +0.000000  +0.000000   +0.000000        +5.375330 -10.376182   +0.038167
 001     +0.000000  +0.000000   +0.000000        +5.350033  -7.292985   +0.038167
-------------------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  0             118            +0.000            +0.000     pixels
OFFSET FRAME NAME: MIPS_70um_fine_center
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
WAS(FTB)            +6.859000        -8.847000       -0.000000
IS (EST)            +6.859782        -8.847774       +0.038167
dT_EST              +0.000782        -0.000774       +0.038167
T_sSIGMA            +0.001526        +0.003020       +0.054111
dT_EST/T_sSIGMA     +0.512495        -0.256211       +0.705357
-----------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  1             119            +1.000            +0.000     pixels
OFFSET FRAME NAME: MIPS_70um_fine_FOV1
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
WAS(FTB)            +6.942000        -8.861000       -0.000000
IS (EST)            +6.953357        -8.848622       +0.038167
dT_EST              +0.011357        +0.012378       +0.038167
T_sSIGMA            +0.001579        +0.003152       +0.054111
dT_EST/T_sSIGMA     +7.191007        +3.926840       +0.705357
-----------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  2             120            -5.600           -55.000     pixels
OFFSET FRAME NAME: MIPS_70um_fine_FOV2
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
WAS(FTB)            +6.941000        -4.117000       +0.000000
IS (EST)            +6.298534        -3.528239       +0.038167
dT_EST              -0.642466        +0.588761       +0.038167
T_sSIGMA            +0.020790        +0.022415       +0.054111
dT_EST/T_sSIGMA    -30.903132       +26.266213       +0.705357
-----------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  3             124            -5.600            +2.500     pixels
OFFSET FRAME NAME: MIPS_70um_fine_FOV3
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
WAS(FTB)            +6.372000        -8.981000       -0.000000
IS (EST)            +6.337955        -9.084072       +0.038167
dT_EST              -0.034045        -0.103072       +0.038167
T_sSIGMA            +0.001230        +0.002296       +0.054111
dT_EST/T_sSIGMA    -27.673750       -44.886797       +0.705357
-----------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  4             127            -0.500            +0.000     pixels
OFFSET FRAME NAME: MIPS_70um_fine_FOV4
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
```

```
WAS(FTB)            +6.818000        -8.840000       +0.000000
IS (EST)            +6.812991        -8.847355       +0.038167
dT_EST              -0.005009        -0.007355       +0.038167
T_sSIGMA            +0.001498        +0.002954       +0.054111
dT_EST/T_sSIGMA     -3.344014        -2.489849       +0.705357
-------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  5               1           +16.000           +16.000     pixels
OFFSET FRAME NAME: CORNER PIXEL (DIAGNOSTICS)
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
WAS(FTB)            +0.000000        +0.000000       +0.000000
IS (EST)            +8.376380       -10.402420       +0.038167
dT_EST              +8.376380       -10.402420       +0.038167
T_sSIGMA            +0.004187        +0.006234       +0.054111
dT_EST/T_sSIGMA    +2000.361307       -1668.674439       +0.705357
-------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  6               1           +16.000           -16.000     pixels
OFFSET FRAME NAME: CORNER PIXEL (DIAGNOSTICS)
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
WAS(FTB)            +0.000000        +0.000000       +0.000000
IS (EST)            +8.338023        -7.320601       +0.038167
dT_EST              +8.338023        -7.320601       +0.038167
T_sSIGMA            +0.003627        +0.005966       +0.054111
dT_EST/T_sSIGMA    +2298.655629       -1226.954481       +0.705357
-------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  7               1           -16.000           +16.000     pixels
OFFSET FRAME NAME: CORNER PIXEL (DIAGNOSTICS)
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
WAS(FTB)            +0.000000        +0.000000       +0.000000
IS (EST)            +5.375330       -10.376182       +0.038167
dT_EST              +5.375330       -10.376182       +0.038167
T_sSIGMA            +0.003676        +0.003935       +0.054111
dT_EST/T_sSIGMA    +1462.248516       -2636.630776       +0.705357
-------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  8               1           -16.000           -16.000     pixels
OFFSET FRAME NAME: CORNER PIXEL (DIAGNOSTICS)
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
WAS(FTB)            +0.000000        +0.000000       +0.000000
IS (EST)            +5.350033        -7.292985       +0.038167
dT_EST              +5.350033        -7.292985       +0.038167
T_sSIGMA            +0.003617        +0.003892       +0.054111
dT_EST/T_sSIGMA    +1479.208566       -1873.959794       +0.705357
-------------------------------------------------------------------
-------------------------------------------------------------------------------------
-------------------------------------------------------------------------------------
VARNAME             MEAN                     SIGMA                 SCALED_SIGMA
a00        +1.0042990610874317E-001 +1.0318902335093164E-003 +1.1355456840433757E-003
b00        +1.0037832724292352E-001 +9.7465390752688732E-004 +1.0725598539335103E-003
c00        +1.0628326297253217E-002 +9.2662899568862604E-004 +1.0197107430556633E-003
a10        -9.2786149730212208E-001 +2.5877121788994999E+000 +2.8476530747873161E+000
b10        +2.3305883682897202E+000 +3.3675588311248545E+000 +3.7058368925937297E+000
c10        +3.2542942193737656E-001 +2.7978182704392465E+000 +3.0788647460401650E+000
d10        +1.2715052390170605E+000 +2.6881616262476054E+000 +2.9581928712662151E+000
a20        -5.1646905271882406E+003 +1.1004123325735005E+004 +1.2109509658525714E+004
b20        +3.5790039889383311E+003 +1.2301202357360658E+004 +1.3536882889122700E+004
c20        -8.0981827293812748E+003 +1.1071507507214135E+004 +1.2183662716638490E+004
d20        -1.4951732367952891E+004 +1.1348379895575728E+004 +1.2488347493589574E+004
a01        -1.8573683173040128E+000 +4.2341296207769767E+000 +4.6594564619552639E+000
b01        +2.0328781888498377E+000 +2.8515417971588324E+000 +3.1379849091320704E+000
c01        +5.8898829337476712E+000 +2.8089269309842031E+000 +3.0910892938919541E+000
d01        +3.1075496597808403E+000 +4.3617484962065625E+000 +4.7998949102422417E+000
e01        -2.4539088904298105E+000 +3.0688108089260333E+000 +3.3770790303638969E+000
f01        -6.1953293027622491E-001 +2.9111485510688628E+000 +3.2035792814251187E+000
del_alpha  -3.2552389603313081E-013 +9.8800525797116063E-004 +1.0872523743981962E-003
beta       +1.1004989781519086E+000 +1.2496543068897040E-003 +1.3751845968236966E-003
```

```
del_theta1 -3.0402195450268503E-013 +8.5819964338120815E-004 +9.4440752460159467E-004
del_theta2 +1.1340149889734478E-016 +4.0326154741339424E-007 +4.4376998137544496E-007
del_theta3 +3.5368055265483383E-016 +7.9831366853028855E-007 +8.7850588306224008E-007
del_arx    +5.2723201577676605E-014 +6.2625927406018996E-005 +6.8916827842499943E-005
del_ary    +5.8930289720100456E-016 +2.8495463617359691E-006 +3.1357890282053620E-006
del_arz    +1.6949616318503221E-016 +2.8455015688682252E-006 +3.1313379277543036E-006
brx        -3.4301646802951126E-009 +1.1573678145978829E-008 +1.2736277406636334E-008
bry        +1.3502833372434191E-010 +5.7504046374479914E-010 +6.3280443554058738E-010
brz        +6.3080738711118749E-011 +5.7426192382651292E-010 +6.3194768972077394E-010
crx        +4.6766404684581044E-014 +9.3957346946583858E-013 +1.0339555152732827E-012
cry        +5.9175269030631980E-014 +4.8487300405797317E-014 +5.3357947307503664E-014
crz        +6.8649240954709975E-014 +4.8422837379835015E-014 +5.3287008840857922E-014
bgx        -2.6626809669129181E-008 +2.2079157898122360E-007 +2.4297053741131946E-007
bgy        +1.7345159042854423E-009 +6.4309855397008006E-010 +7.0769909788923988E-010
bgz        -1.1177827271145691E-008 +1.1568793060542724E-009 +1.2730901604537415E-009
cgx        +1.4504940486221317E-012 +7.3326151949915567E-012 +8.0691911474985018E-012
cgy        +1.0045848769931987E-012 +5.2659114668157281E-014 +5.7948828707885373E-014
cgz        +9.4495259842924219E-013 +5.9557144080221282E-014 +6.5539779055999910E-014
-------------------------------------------------------------------------------
LSQF RESIDUAL SIGMA SCALE =         +1.1004520124020762E+000
-------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------------
                    a_mirror(1)               a_mirror(2)               a_mirror(3)
a_mirror_ipf   +0.0000000000000000E+000  +2.0338141606515921E-002  +9.9979315860631568E-001
a_mirror_tpf   -2.0456659393033542E-003  +1.9666930721155315E-002  +9.9980449443222352E-001
beta                beta_0                    beta                      beta_total
               +2.8047410000000001E-006  +1.1004989781519086E+000  +3.0866146044807622E-006
-----------------------------------------------------------------------------------------------------
qT               qT(1)                     qT(2)                     qT(3)                     qT(4)
FrmTbl:   +1.2836566686785979E-006 -9.9760012028013629E-004 +1.2867429956649658E-003 +9.9999867454152913E-001
Estim:    +3.3435566440088527E-004 -9.9728516378089173E-004 +1.2871877760104412E-003 +9.9999861838715609E-001
DelTheta        deltheta(1)               deltheta(2)               deltheta(3)
          +6.6614484291546683E-004 -2.2742986102824505E-007 +2.2508212769598316E-007       [rad]
EulAngT         theta(1)                  theta(2)                  theta(3)                 [rad]
Mean      +6.6614439383050924E-004 -1.9954296530991624E-003 +2.5737130646414455E-003
SigmaT    +8.5819964338120815E-004 +4.0326154741339424E-007 +7.9831366853028855E-007
-----------------------------------------------------------------------------------------------------
qR               qR(1)                     qR(2)                     qR(3)                     qR(4)
ASFILE:   +0.0000000000000000E+000 +0.0000000000000000E+000 +0.0000000000000000E+000 +1.0000000000000000E+000
Estim:    +5.4199032429980156E-005 +6.3469998277566023E-007 +1.6244769294057753E-006 +9.9999999852971166E-001
DelThetaR       deltheta R(1)             deltheta R(2)             deltheta R(3)
          +1.0839806697506424E-004 +1.2692238735297200E-006 +3.2490226542928836E-006       [rad]
EulAngR         angR(1)                   angR(2)                   angR(3)                  [rad]
Mean      +1.0839806697506424E-004 +1.2692238735297200E-006 +3.2490226542928836E-006
SigmaR    +6.2625927406018996E-005 +2.8495463617359691E-006 +2.8455015688682252E-006
-----------------------------------------------------------------------------------------------------
Initial Gyro Bias         Bg0(1)                    Bg0(2)                    Bg0(3)
                  +2.5130689902097530E-006 +2.4979504330423607E-006 +2.5118618914581101E-006
Gyro Bias Correction      Bg(1)                     Bg(2)                     Bg(3)
                  -2.6626809669129181E-008 +1.7345159042854423E-009 -1.1177827271145691E-008
Total Gyro Bias           BgT(1)                    BgT(2)                    BgT(3)
                  +2.4864421805406236E-006 +2.4996849489466461E-006 +2.5006840641869646E-006

Initial Gyro Bias Rate     Cg0(1)                    Cg0(2)                    Cg0(3)
                  +0.0000000000000000E+000 +0.0000000000000000E+000 +0.0000000000000000E+000
Gyro Bias Rate Correction  Cg(1)                     Cg(2)                     Cg(3)
                  +1.4504940486221317E-012 +1.0045848769931987E-012 +9.4495259842924219E-013
Total Gyro Bias Rate       CgT(1)                    CgT(2)                    CgT(3)
                  +1.4504940486221317E-012 +1.0045848769931987E-012 +9.4495259842924219E-013
-----------------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  1             119            +1.000            +0.000     pixels
OFFSET FRAME NAME: MIPS_70um_fine_FOV1
qT               qT(1)                     qT(2)                     qT(3)                     qT(4)
WAS(FTB)  +1.3012459624148111E-006 -1.0096719622185043E-003 +1.2887791948094824E-003 +9.9999865980361324E-001
IS (EST)  +3.3437329852149935E-004 -1.0108950173504359E-003 +1.2873156300233417E-003 +9.9999860455114131E-001
```

```
DelTheta        deltheta(1)               deltheta(2)               deltheta(3)
Units             rad                       rad                       rad
          +6.6613712282710376E-004 -3.3035359457722921E-006 -3.6006675792952426E-006
EulAngT         theta(1)                  theta(2)                  theta(3)                  [rad]
Mean      +6.6614439383050924E-004 -2.0226494804901208E-003 +2.5739597420423054E-003
sSigmaT   +9.4440750608995832E-004 +4.5939821726431847E-007 +9.1693948239680617E-007
SigmaT    +8.5819962655936030E-004 +4.1746319883730328E-007 +8.3323895277841573E-007
-----------------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  2             120            -5.600           -55.000     pixels
OFFSET FRAME NAME: MIPS_70um_fine_FOV2
qT               qT(1)                     qT(2)                     qT(3)                     qT(4)
WAS(FTB)  +6.0449825951069261E-007 -1.0095271757136512E-003 +5.9879303662630152E-004 +9.9999931115047058E-001
IS (EST)  +3.3354210638780074E-004 -9.1591341312871697E-004 +5.1346634814874309E-004 +9.9999939310211206E-001

DelTheta        deltheta(1)               deltheta(2)               deltheta(3)
Units             rad                       rad                       rad
          +6.6579860307906108E-004 +1.8688576186690517E-004 -1.7126348615867842E-004
EulAngT         theta(1)                  theta(2)                  theta(3)                  [rad]
Mean      +6.6614439383050935E-004 -1.8321692648712040E-003 +1.0263229844560753E-003
sSigmaT   +9.4440692096591709E-004 +6.0474708294936314E-006 +6.5203070203638867E-006
SigmaT    +8.5819909484690521E-004 +5.4954425648176695E-006 +5.9251170854159316E-006
-----------------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  3             124            -5.600            +2.500     pixels
OFFSET FRAME NAME: MIPS_70um_fine_FOV3
qT               qT(1)                     qT(2)                     qT(3)                     qT(4)
WAS(FTB)  +1.2105772857918672E-006 -9.2676890949311853E-004 +1.3062325685908875E-003 +9.9999871742637714E-001
IS (EST)  +3.3428968684465405E-004 -9.2137706976549234E-004 +1.3215307553112725E-003 +9.9999864643466563E-001

DelTheta        deltheta(1)               deltheta(2)               deltheta(3)
Units             rad                       rad                       rad
          +6.6619996752081002E-004 +9.9034269192169749E-006 +2.9982432377415466E-005
EulAngT         theta(1)                  theta(2)                  theta(3)                  [rad]
Mean      +6.6614439383050924E-004 -1.8436362378656439E-003 +2.6424494853579256E-003
sSigmaT   +9.4440759323854008E-004 +3.5786359182452935E-007 +6.6795773471150248E-007
SigmaT    +8.5819970575280150E-004 +3.2519690799000092E-007 +6.0698488183367351E-007
-----------------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  4             127            -0.500            +0.000     pixels
OFFSET FRAME NAME: MIPS_70um_fine_FOV4
qT               qT(1)                     qT(2)                     qT(3)                     qT(4)
WAS(FTB)  +1.2749739579667491E-006 -9.9163692118734836E-004 +1.2857248959092255E-003 +9.9999868178217266E-001
IS (EST)  +3.3434684873520854E-004 -9.9047981096816833E-004 +1.2871245621213598E-003 +9.9999862523520022E-001

DelTheta        deltheta(1)               deltheta(2)               deltheta(3)
Units             rad                       rad                       rad
          +6.6614863682426181E-004 +1.4569187126170979E-006 +2.1393838352613077E-006
EulAngT         theta(1)                  theta(2)                  theta(3)                  [rad]
Mean      +6.6614439383050924E-004 -1.9818188879657341E-003 +2.5735911526415735E-003
sSigmaT   +9.4440753359515035E-004 +4.3567967237822511E-007 +8.5924422578637203E-007
SigmaT    +8.5819965155380952E-004 +3.9590974205882884E-007 +7.8081026351236003E-007
-----------------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  5               1           +16.000           +16.000     pixels
OFFSET FRAME NAME: CORNER PIXEL (DIAGNOSTICS)
qT               qT(1)                     qT(2)                     qT(3)                     qT(4)
WAS(FTB)  +0.0000000000000000E+000 +0.0000000000000000E+000 +0.0000000000000000E+000 +1.0000000000000000E+000
IS (EST)  +3.3491480579047147E-004 -1.2177893569791018E-003 +1.5133746769796722E-003 +9.9999805725723379E-001

DelTheta        deltheta(1)               deltheta(2)               deltheta(3)
Units             rad                       rad                       rad
          +6.6614439383050935E-004 -2.4365900964208624E-003 +3.0259413625836761E-003
```

```
EulAngT         theta(1)                theta(2)                theta(3)                [rad]
Mean      +6.6614439383050924E-004 -2.4365900964208624E-003 +3.0259413625836752E-003
sSigmaT   +9.4440691690638899E-004 +1.2180749988124824E-006 +1.8133803048363311E-006
SigmaT    +8.5819909115794092E-004 +1.1068860659845201E-006 +1.6478504145565318E-006
-----------------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  6               1           +16.000           -16.000     pixels
OFFSET FRAME NAME: CORNER PIXEL (DIAGNOSTICS)
qT               qT(1)                   qT(2)                   qT(3)                   qT(4)
WAS(FTB)  +0.0000000000000000E+000 +0.0000000000000000E+000 +0.0000000000000000E+000 +1.0000000000000000E+000
IS (EST)  +3.3436298176672146E-004 -1.2123606220544821E-003 +1.0651410624503395E-003 +9.9999864192789578E-001

DelTheta        deltheta(1)               deltheta(2)               deltheta(3)
Units             rad                       rad                       rad
          +6.6614439383050914E-004 -2.4254326166701285E-003 +2.1294763677628119E-003
EulAngT         theta(1)                theta(2)                theta(3)                [rad]
Mean      +6.6614439383050924E-004 -2.4254326166701277E-003 +2.1294763677628119E-003
sSigmaT   +9.4440718203743881E-004 +1.0551526667161019E-006 +1.7355789478213150E-006
SigmaT    +8.5819933208716530E-004 +9.5883569190164456E-007 +1.5771509600249431E-006
-----------------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  7               1           -16.000           +16.000     pixels
OFFSET FRAME NAME: CORNER PIXEL (DIAGNOSTICS)
qT               qT(1)                   qT(2)                   qT(3)                   qT(4)
WAS(FTB)  +0.0000000000000000E+000 +0.0000000000000000E+000 +0.0000000000000000E+000 +1.0000000000000000E+000
IS (EST)  +3.3425158106410643E-004 -7.8130633207451768E-004 +1.5094137073285207E-003 +9.9999849975215249E-001

DelTheta        deltheta(1)               deltheta(2)               deltheta(3)
Units             rad                       rad                       rad
          +6.6614439383050914E-004 -1.5636200048300319E-003 +3.0183088525423730E-003
EulAngT         theta(1)                theta(2)                theta(3)                [rad]
Mean      +6.6614439383050924E-004 -1.5636200048300326E-003 +3.0183088525423726E-003
sSigmaT   +9.4440750638236472E-004 +1.0693257596042431E-006 +1.1447597744810546E-006
SigmaT    +8.5819962682507505E-004 +9.7171502941787475E-007 +1.0402632387233887E-006
-----------------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  8               1           -16.000           -16.000     pixels
OFFSET FRAME NAME: CORNER PIXEL (DIAGNOSTICS)
qT               qT(1)                   qT(2)                   qT(3)                   qT(4)
WAS(FTB)  +0.0000000000000000E+000 +0.0000000000000000E+000 +0.0000000000000000E+000 +1.0000000000000000E+000
IS (EST)  +3.3389728232216450E-004 -7.7777683583758847E-004 +1.0609802290222424E-003 +9.9999907894795192E-001

DelTheta        deltheta(1)               deltheta(2)               deltheta(3)
Units             rad                       rad                       rad
          +6.6614439383050903E-004 -1.5562613839570872E-003 +2.1214432687432587E-003
EulAngT         theta(1)                theta(2)                theta(3)                [rad]
Mean      +6.6614439383050924E-004 -1.5562613839570872E-003 +2.1214432687432587E-003
sSigmaT   +9.4440775485128507E-004 +1.0520905702144602E-006 +1.1320644525758271E-006
SigmaT    +8.5819985261313084E-004 +9.5605311122831042E-007 +1.0287267775582026E-006
-----------------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------------
              q(1)                    q(2)                    q(3)                    q(4)
PCRS1A: +5.2603126189317361E-007 +3.7451819048221893E-004 -1.4045531552277380E-003 +9.9999894348258311E-001
PCRS2A: -5.1968404336718985E-007 +3.8455385122900486E-004 +1.3513933841514693E-003 +9.9999901292650617E-001
-----------------------------------------------------------------------------------------
**********  CS-FILE PARAMETERS:  **********  **********  AS-FILE PARAMETERS:  **********
Row (01) PIX2RADX: +2.4736508339999999E-005  Row (1) TASTART:   +7.3051200000000000E+008
Row (02) PIX2RADY: +2.5464808057000000E-005  Row (2) TASTOP:    +7.3053587000000000E+008
Row (03) CX0:      +1.6500000000000000E+001  Row (3) S/C TIME:  +7.3051200000000000E+008
Row (04) CY0:      +1.6500000000000000E+001  Row (4) QR1:       +0.0000000000000000E+000
Row (05) BETA0:    +2.8047410000000001E-006  Row (5) QR2:       +0.0000000000000000E+000
Row (06) GAMMA_E0: +8.7500000000000000E+002  Row (6) QR3:       +0.0000000000000000E+000
Row (07) D11:      -1.0000000000000000E+000  Row (7) QR4:       +1.0000000000000000E+000
Row (08) D12:      +0.0000000000000000E+000
Row (09) D21:      +0.0000000000000000E+000
```

```
Row (10) D22:      -1.0000000000000000E+000
Row (11) DG:       +1.0000000000000000E+000
-------------------------------------------------------------------------------------
-------------------------------------------------------
INITIAL STA-TO-PCRS ALIGNMENT (R) KNOWLEDGE (1-SIGMA)
    SIGMA(X)        SIGMA(Y)         SIGMA(Z)
2.82857904E+001  1.44427880E+000  1.44427880E+000  [arcsec]
-------------------------------------------------------
PIX2RADX = 2.473650834000E-005[rad/pixel]
XPIXSIZE = 5.1023[arcsec]
PIX2RADY = 2.546480805700E-005[rad/pixel]
YPIXSIZE = 5.2525[arcsec]
CX0 = 16.5[pixel] = 84.19[arcsec]
CY0 = 16.5[pixel] = 86.67[arcsec]
-------------------------------------------------------
NOMINAL BETA0 = 2.804741000000E-006[rad/encoder unit]
ENCODER UNIT SIZE = 0.58[arcsec]
GAMMA_E0 = 875.00[encoder unit] = 506.20[arcsec]
-------------------------------------------------------
                | -1 | +0 |
FLIP MATRIX D = |----|----|   and   DG = +1
                | +0 | -1 |
-------------------------------------------------------
```

3.3 IPF EXECUTION LOG

```
*********************************************************************
IPF EXECUTION-LOG FILE NAME:  LG992118.dat
INSTRUMENT TYPE:              MIPS_70um_fine_center
IPF FILTER EXECUTION DATE:    05-Aug-2003    TIME: 22:26
IPF FILTER VERSION USED:      IPF.V2.0.1Beta
*********************************************************************

------------------- Loading & Preparing Input Files -------------------
AAFILE:  AA992118 Loaded!        AAFILE dimension = 238701 X 21
ASFILE:  AS992118 Loaded!
CAFILE:  CA992118 Loaded!        CAFILE dimension = 606 X 15
CBFILE:  CB992118 Loaded!        CBFILE dimension = 66 X 15
CCFILE:  CC992118 Created!       CCFILE dimension = 672 X 19
CSFILE:  CS992118 Loaded!
Loading Input Files Completed!
-----------------------------------------------------------------------

------------------------ Selected Mask Vectors ------------------------
index =   1  2  3  4  5  6  7  8  9 10 11 12 13 14 15 16 17 18 19 20
-----------------------------------------------------------------------
mask1 = [ 1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1 ]
mask2 = [ 1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1 ]
-----------------------------------------------------------------------

---------------  Selected Initial Gyro Bias Parameters  ---------------
User Entered 1 : Use AFILE database - from S/C filter
IPF Linearized Using Following Nominal Gyro Bias Estimates
bg0 = [+2.5130689902097530E-006 +2.4979504330423607E-006 +2.5118618914581101E-006 ]
cg0 = [+0.0000000000000000E+000 +0.0000000000000000E+000 +0.0000000000000000E+000 ]
-----------------------------------------------------------------------

---------------  Gyro Pre-Processor Run Completed  --------------------
     AGFILE CREATED:  AG992118.m     ACFILE CREATED:  AC992118.m
-----------------------------------------------------------------------
```

```
Total Gyro Preprocessor Execution Time: 123 seconds

FRAME TABLE ENTRIES FOR PCRS LOADED TO TPCRS
q_PCRS4 = [ +5.2603126189317361E-007     q_PCRS5 = [ +7.3379987833742897E-007
            +3.7451819048221893E-004                 +5.2236196154513707E-004
            -1.4045531552277380E-003                 -1.4047712280184723E-003
            +9.9999894348258311E-001 ];              +9.9999887687698918E-001 ];
q_PCRS8 = [ -5.1968404336718985E-007     q_PCRS9 = [ -7.1963421681856818E-007
            +3.8455385122900486E-004                 +5.3239763239987400E-004
            +1.3513933841514693E-003                 +1.3516841804518383E-003
            +9.9999901292650617E-001 ];              +9.9999894475050310E-001 ];
-------------------------------------------------------------------------------
------ Initial Conditions for State -----  ------   Inital Square-Root Cov (diag)   -----
p1(01)  = a00  = +0.0000000000000000E+000  Sigma_initial(01,01) = 1.0000000000000000E+000
p1(02)  = b00  = +0.0000000000000000E+000  Sigma_initial(02,02) = 1.0000000000000000E+000
p1(03)  = c00  = +0.0000000000000000E+000  Sigma_initial(03,03) = 1.0000000000000000E+000
p1(04)  = a10  = +0.0000000000000000E+000  Sigma_initial(04,04) = 3.5969004473570845E+002
p1(05)  = b10  = +0.0000000000000000E+000  Sigma_initial(05,05) = 3.5969004473570845E+002
p1(06)  = c10  = +0.0000000000000000E+000  Sigma_initial(06,06) = 3.5969004473570845E+002
p1(07)  = d10  = +0.0000000000000000E+000  Sigma_initial(07,07) = 3.5969004473570845E+002
p1(08)  = a20  = +0.0000000000000000E+000  Sigma_initial(08,08) = 1.2937692828197595E+007
p1(09)  = b20  = +0.0000000000000000E+000  Sigma_initial(09,09) = 1.2937692828197595E+007
p1(10)  = c20  = +0.0000000000000000E+000  Sigma_initial(10,10) = 1.2937692828197595E+007
p1(11)  = d20  = +0.0000000000000000E+000  Sigma_initial(11,11) = 1.2937692828197595E+007
p1(12)  = a01  = +0.0000000000000000E+000  Sigma_initial(12,12) = 1.0000000000000000E+004
p1(13)  = b01  = +0.0000000000000000E+000  Sigma_initial(13,13) = 1.0000000000000000E+004
p1(14)  = c01  = +0.0000000000000000E+000  Sigma_initial(14,14) = 1.0000000000000000E+004
p1(15)  = d01  = +0.0000000000000000E+000  Sigma_initial(15,15) = 1.0000000000000000E+004
p1(16)  = e01  = +0.0000000000000000E+000  Sigma_initial(16,16) = 1.0000000000000000E+004
p1(17)  = f01  = +0.0000000000000000E+000  Sigma_initial(17,17) = 1.0000000000000000E+004
-------------------------------------------------------------------------------------------
p2f(01) = am1  = +0.0000000000000000E+000
p2f(02) = am2  = +0.0000000000000000E+000  Sigma_initial(18,18) = 1.0000000000000001E-001
p2f(03) = am3  = +1.0000000000000000E+000
p2f(04) = beta = +1.0000000000000000E+000  Sigma_initial(19,19) = 1.0000000000000001E-001
p2f(05) = qT1  = +1.2836566686785981E-006  Sigma_initial(20,20) = 1.0000000000000001E-001
p2f(06) = qT2  = -9.9760012028013651E-004  Sigma_initial(21,21) = 1.0000000000000000E-002
p2f(07) = aT3  = +1.2867429956649661E-003  Sigma_initial(22,22) = 1.0000000000000000E-002
p2f(08) = qT4  = +9.9999867454152924E-001
p2f(09) = qR1  = +0.0000000000000000E+000  Sigma_initial(23,23) = 6.8566690868928238E-003
p2f(10) = qR2  = +0.0000000000000000E+000  Sigma_initial(24,24) = 3.5010305970939351E-004
p2f(11) = qR3  = +0.0000000000000000E+000  Sigma_initial(25,25) = 3.5010305970939351E-004
p2f(12) = qR4  = +1.0000000000000000E+000
p2f(13) = brx  = +0.0000000000000000E+000  Sigma_initial(26,26) = 4.1893590280687055E-005
p2f(14) = bry  = +0.0000000000000000E+000  Sigma_initial(27,27) = 4.1893590280687055E-005
p2f(15) = brz  = +0.0000000000000000E+000  Sigma_initial(28,28) = 4.1893590280687055E-005
p2f(16) = crx  = +0.0000000000000000E+000  Sigma_initial(29,29) = 1.7550729066060769E-009
p2f(17) = cry  = +0.0000000000000000E+000  Sigma_initial(30,30) = 1.7550729066060769E-009
p2f(18) = crz  = +0.0000000000000000E+000  Sigma_initial(31,31) = 1.7550729066060769E-009
p2f(19) = bgx  = +0.0000000000000000E+000  Sigma_initial(32,32) = 4.1893590280687055E-005
p2f(20) = bgy  = +0.0000000000000000E+000  Sigma_initial(33,33) = 4.1893590280687055E-005
p2f(21) = bgz  = +0.0000000000000000E+000  Sigma_initial(34,34) = 4.1893590280687055E-005
p2f(22) = cgx  = +0.0000000000000000E+000  Sigma_initial(35,35) = 1.7550729066060769E-009
p2f(23) = cgy  = +0.0000000000000000E+000  Sigma_initial(36,36) = 1.7550729066060769E-009
p2f(24) = cgz  = +0.0000000000000000E+000  Sigma_initial(37,37) = 1.7550729066060769E-009
-------------------------------------------------------------------------------------------

--------------------   IPF KALMAN FILTER STARTED  ---------------------
Iteration#001: |dp|= +1.819034157647E+004   RMS(|Res|)=+1.819034157647E+004
Iteration#002: |dp|= +1.499986188111E+002   RMS(|Res|)=+1.499986188111E+002
Iteration#003: |dp|= +1.427186591956E+000   RMS(|Res|)=+1.427186591956E+000
Iteration#004: |dp|= +1.733460118839E+001   RMS(|Res|)=+1.733460118839E+001
Iteration#005: |dp|= +1.498755134211E+000   RMS(|Res|)=+1.498755134211E+000
Iteration#006: |dp|= +5.282910567756E-002   RMS(|Res|)=+5.282910567756E-002
Iteration#007: |dp|= +1.743232598764E-003   RMS(|Res|)=+1.743232598764E-003
Iteration#008: |dp|= +2.307926349451E-004   RMS(|Res|)=+2.307926349451E-004
Iteration#009: |dp|= +9.432807458715E-006   RMS(|Res|)=+9.432807458715E-006
Iteration#010: |dp|= +3.093209700804E-006   RMS(|Res|)=+3.093209700804E-006
```

```
Iteration#011: |dp|= +3.601082066866E-006   RMS(|Res|)=+3.601082066866E-006
Iteration#012: |dp|= +3.880847526014E-006   RMS(|Res|)=+3.880847526014E-006
Iteration#013: |dp|= +2.870561634132E-006   RMS(|Res|)=+2.870561634132E-006
Iteration#014: |dp|= +1.784263025686E-006   RMS(|Res|)=+1.784263025686E-006
Iteration#015: |dp|= +1.146194838070E-006   RMS(|Res|)=+1.146194838070E-006
Iteration#016: |dp|= +1.730879419298E-006   RMS(|Res|)=+1.730879419298E-006
Iteration#017: |dp|= +1.217225571841E-006   RMS(|Res|)=+1.217225571841E-006
Iteration#018: |dp|= +5.984428985343E-007   RMS(|Res|)=+5.984428985343E-007
Iteration#019: |dp|= +2.132640349363E-006   RMS(|Res|)=+2.132640349363E-006
Iteration#020: |dp|= +2.628217579688E-006   RMS(|Res|)=+2.628217579688E-006
IPF Kalman Filter Completed with Error |dp1| + |dp2| = +2.6282175796884451E-006
----------------------------------------------------------------------

-----------------  IPF LEAST SQUARES FILTER STARTED  ------------------
Iteration#001   COND#=+8.389726056271E+012,   |dp|=+1.819826381687E+004
Iteration#002   COND#=+8.389415048951E+012,   |dp|=+1.944257764664E+002
Iteration#003   COND#=+8.389411214214E+012,   |dp|=+9.552840124427E-001
Iteration#004   COND#=+8.389411407572E+012,   |dp|=+6.888210178772E-003
Iteration#005   COND#=+8.389411130372E+012,   |dp|=+4.409478909488E-004
Iteration#006   COND#=+8.389410696729E+012,   |dp|=+8.329025658438E-006
Iteration#007   COND#=+8.389411086177E+012,   |dp|=+1.086414005516E-006
Iteration#008   COND#=+8.389410903492E+012,   |dp|=+4.924823018969E-007
Iteration#009   COND#=+8.389411442562E+012,   |dp|=+4.513286382391E-007
Iteration#010   COND#=+8.389411220728E+012,   |dp|=+7.202951675333E-007
Iteration#011   COND#=+8.389410819159E+012,   |dp|=+7.844279976311E-007
Iteration#012   COND#=+8.389410842729E+012,   |dp|=+7.749195551851E-007
Iteration#013   COND#=+8.389411094512E+012,   |dp|=+5.858844236984E-007
Iteration#014   COND#=+8.389411644130E+012,   |dp|=+4.602456648284E-007
Iteration#015   COND#=+8.389410968645E+012,   |dp|=+2.935340188036E-007
Iteration#016   COND#=+8.389411535018E+012,   |dp|=+5.957123392655E-007
Iteration#017   COND#=+8.389411301391E+012,   |dp|=+5.896685997622E-007
Iteration#018   COND#=+8.389411760859E+012,   |dp|=+3.853703540043E-007
Iteration#019   COND#=+8.389411328730E+012,   |dp|=+4.074082936544E-007
Iteration#020   COND#=+8.389411352248E+012,   |dp|=+7.206468871356E-007
IPF Least Squares Filter Completed with Error |dp1| + |dp2| = +7.2064688713559279E-007
----------------------------------------------------------------------
Total Execution Time: 343 seconds
```

4 USER COMMENTS

This section left blank.

IPF TEAM CONTACT INFORMATION

IPF Team email		ipf@sirtfweb.jpl.nasa.gov	
David S. Bayard	X4-8208	David.S.Bayard@jpl.nasa.gov	(TEAM LEADER)
Dhemetrio Boussalis	X4-3977	boussali@grover.jpl.nasa.gov	
Paul Brugarolas	X4-9243	Paul.Brugarolas@jpl.nasa.gov	
Bryan H. Kang	X4-0541	Bryan.H.Kang@jpl.nasa.gov	
Edward.C.Wong	X4-3053	Edward.C.Wong@jpl.nasa.gov	(TASK MANAGER)

ACKNOWLEDGEMENTS

This work was performed at the Jet Propulsion Laboratory, California Institute of Technology, under contract with the National Aeronautics and Space Administration.

References

[1] D.S. Bayard, B.H. Kang, *SIRTF Instrument Pointing Frame Kalman Filter Algorithm*, JPL D-Document D-24809, September 30, 2003.

[2] B.H. Kang, D.S. Bayard, *SIRTF Instrument Pointing Frame (IPF) Software Description Document and User's Guide*, JPL D-Document D-24808, September 30, 2003.

[3] D.S. Bayard, B.H. Kang, *SIRTF Instrument Pointing Frame (IPF) Kalman Filter Unit Test Report*, JPL D-Document D-24810, September 30, 2003.

[4] *Space Infrared Telescope Facility In-Orbit Checkout and Science Verification Mission Plan*, JPL D-Document D-22622, 674-FE-301 Version 1.4, February 8, 2002.

[5] *Space Infrared Telescope Facility Observatory Description Document*, Lockheed Martin LMMS/P458569, 674-SEIT-300 Version 1.2, November 1, 2002.

[6] *SIRTF Software Interface Specification for Science Centroid INPUT Files (CAFILE, CS-FILE)*, JPL SOS-SIS-2002, November 18, 2002.

[7] *SIRTF Software Interface Specification for Inferred Frames Offset INPUT Files (OFILE)*, JPL SOS-SIS-2003, November 18, 2002.

[8] *SIRTF Software Interface Specification for PCRS Centroid INPUT Files (CBFILE)*, JPL SIS-FES-015, November 18, 2002.

[9] *SIRTF Software Interface Specification for Attitude INPUT Files (AFILE, ASFILE)*, JPL SIS-FES-014, January 7, 2002.

[10] *SIRTF Software Interface Specification for IPF Filter Output Files (IFFILE, LGFILE, TARFILE)*, JPL SOS-SIS-2005, November 18, 2002.

[11] R.J. Brown, *Focal Surface to Object Space Field of View Conversion.* Systems Engineering Report SER No. S20447-OPT-051, Ball Aerospace & Technologies Corp., November 23, 1999.

SIRTF INSTRUMENT POINTING FRAME KALMAN FILTER EXECUTION SUMMARY

IPF RUN NUMBER: 91M118
REPORT TYPE: COVARIANCE ANALYSIS (MULTI-RUN)

PRIME FRAME: MIPS_70um_fine_center (118)
INFERRED FRAMES: (119) (120) (124) (127) (1) (1) (1) (1)

IPF TEAM

Autonomy and Control Section (345)
Jet Propulsion Laboratory
California Institute of Technology
4800 Oak Grove Drive
Pasadena, CA 91109

Contents

1 IPF MULTI-RUN SUMMARY **3**

2 IPF MULTI-RUN RESULTS **7**

2.1 IPF MULTI-RUN OUTPUT PLOTS 7

2.2 IPF MULTI-RUN OUTPUT DATA (MF MINI FILE) 9

2.3 IPF MULTI-RUN EXECUTION LOG 14

3 USER COMMENTS **19**

List of Figures

1.1 A-priori and a-posteriori IPF frames 3

1.2 A-priori and a-posteriori IPF frames (ZOOMED) 6

2.1 Array plot with (solid) and w/o (dashed) optical distortion corrections 7

2.2 IPF parameter symbol table 7

2.3 KF parameter error sigma plots 8

2.4 KF parameter error 1-sigma bound 8

List of Tables

1.1 IPF filter execution configuration 4

1.2 Merge performance chart 4

1.3 IPF filter execution mask vector assignment 4

1.4 IPF calibration error summary ([arcsec], 1-sigma, radial) 5

1.5 IPF Brown angle summary 6

1 IPF MULTI-RUN SUMMARY

This report summarizes the SIRTF Instrument Pointing Frame (IPF) Kalman Filter execution. This document captures the results generated by a multi-run execution with the MR run number specified as: MR91M118. This multi-run execution merges 2 previously executed IPF runs of the instrument: MIPS_70um_fine_center (118), for the purpose of improving estimation accuracy. The main multi-run calibration results have been documented in MF91M118 typically stored in the mission archive DOM collection IPF_MF. This report only summarizes the main aspects of the run, and does not substitute for the full information contained in the MF file.

Section 1 summarizes the multi-run merge results. The merge configurations are tabulated in Table 1.1. The overall End-to-End pointing performances are tabulated in Table 1.4. Section 2 summarizes resulting plots, a mini summary of the MF Multi-Run output file, and the execution log. Section 3 captures the user comments that are specific to this particular run.

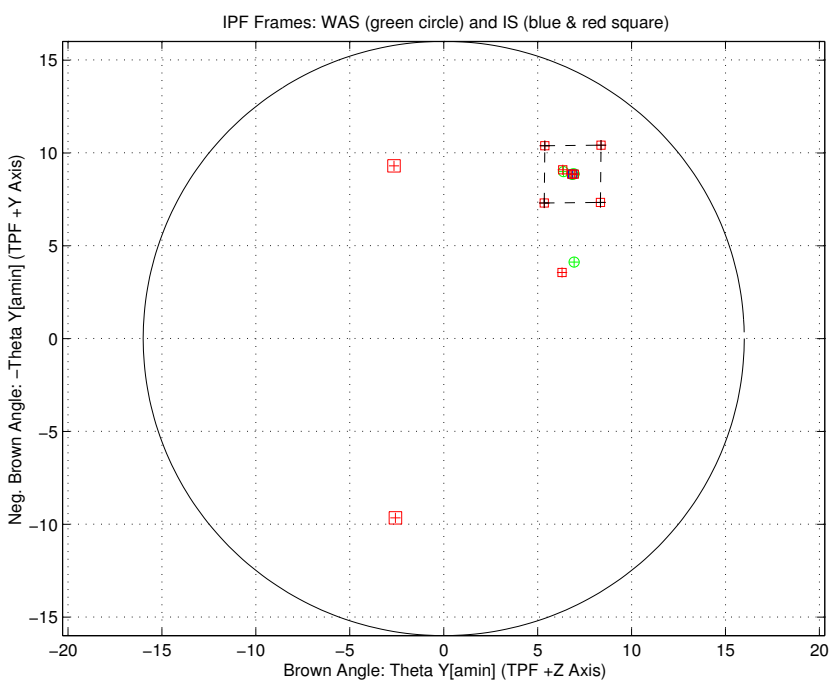

Figure 1.1: A-priori and a-posteriori IPF frames

EXECUTION CONFIGURATION ITEM	CURRENT STATUS
IPF Filter Version Used	IPF.V2.0.1Beta
Frame Table Version Used	FTVE2E1
IPF Filter Mode	NORMAL-MODE(0)
LS Residual Sigma Scale	1.09325178E+000
Merge Data Set #1	991118
Merge Data Set #2	992118

Table 1.1: IPF filter execution configuration

	BROWN ANGLES AND SIGMAS [arcmin, arcmin, deg]					
RUN#	$-\theta_y$	$-\theta_z$	θ_x	σ_y	σ_z	σ_x
991118	+6.857763	-8.846235	-0.040586	0.001494	0.003001	0.053751
992118	+6.859782	-8.847774	+0.038167	0.001526	0.003020	0.054111
91M118	+6.858775	-8.847045	-0.001850	0.001067	0.002128	0.038123

Table 1.2: Merge performance chart

Con. Plate Scale			Γ Dependent				Γ^2 Dependent				Linear Plate Scale						Mirror	
a_{00}	b_{00}	c_{00}	a_{10}	b_{10}	c_{10}	d_{10}	a_{20}	b_{20}	c_{20}	d_{20}	a_{01}	b_{01}	c_{01}	d_{01}	e_{01}	f_{01}	α	β
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
IPF (T)			Alignment R									Gyro Drift Bias						
θ_1	θ_2	θ_3	a_{rx}	a_{ry}	a_{rz}	b_{rx}	b_{ry}	b_{rz}	c_{rx}	c_{ry}	c_{rz}	b_{gx}	b_{gy}	b_{gz}	c_{gx}	c_{gy}	c_{gz}	
20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	
1	1	1																

Table 1.3: IPF filter execution mask vector assignment

FOCAL PLANE SURVEY ANALYSIS: MULTI-RUN
INSTRUMENT NAME: MIPS_70um_fine_center NF: 118

```
PIX2RADW: 2.47365083E-005[rad/pixel] = 5.1023E+000[arcsec/pixel]
PIX2RADV: 2.47365083E-005[rad/pixel] = 5.1023E+000[arcsec/pixel]
```

FRAME	DESCRIPTION	IPF[1]	SF[2]	ARW[3]	TOTAL	REQ
118(P)	MIPS_70um_fine_center	0.1307	0.0855	0.0565	0.1661	1.10
119(I)	MIPS_70um_fine_FOV1	0.1489	0.0855	0.0565	0.1807	N/A
120(I)	MIPS_70um_fine_FOV2	1.2953	0.0855	0.0565	1.2994	N/A
124(I)	MIPS_70um_fine_FOV3	0.1100	0.0855	0.0565	0.1503	N/A
127(I)	MIPS_70um_fine_FOV4	0.1398	0.0855	0.0565	0.1734	N/A
TR (C)	CORNERS OF INSTRUMENT	0.3152	0.0855	0.0565	0.3314	N/A
BR (C)	CORNERS OF INSTRUMENT	0.2974	0.0855	0.0565	0.3146	N/A
TL (C)	CORNERS OF INSTRUMENT	0.2284	0.0855	0.0565	0.2503	N/A
BL (C)	CORNERS OF INSTRUMENT	0.2238	0.0855	0.0565	0.2461	N/A

Table 1.4: IPF calibration error summary ([arcsec], 1-sigma, radial)

[1]IPF filter removes systematic pointing errors due to: thermomechanical alignment drift (Body to TPF), gyro bias and bias drift, centroiding error, attitude error, and optical distortion. IPF SIGMA presented here is "NOT Scaled" by the Least Squares Scale factor. The Least Squares Scale Factor was: 1.093252.

[2]Error due to gyro Scale Factor: assumes 95 ppm error over 0.250 degree maneuver.

[3]Error due to gyro Angle Random Walk: assumes ARW = 100 $\mu deg/\sqrt{hr}$, with 975 second Maneuver time (max), and 22 independent Maneuvers.

IPF BROWN ANGLE SUMMARY						
	WAS			IS		
Frame Number	theta_Y (arcmin)	theta_Z (arcmin)	angle (deg)	theta_Y (arcmin)	theta_Z (arcmin)	angle (deg)
118	+6.859000	-8.847000	-0.000000	+6.858775	-8.847045	-0.001850
119	+6.942000	-8.861000	-0.000000	+6.952274	-8.847958	-0.001850
120	+6.941000	-4.117000	+0.000000	+6.300005	-3.553015	-0.001850
124	+6.372000	-8.981000	-0.000000	+6.337661	-9.083111	-0.001850
127	+6.818000	-8.840000	+0.000000	+6.812030	-8.846597	-0.001850
001	+0.000000	+0.000000	+0.000000	+8.373491	-10.406743	-0.001850
001	+0.000000	+0.000000	+0.000000	+8.341267	-7.322781	-0.001850
001	+0.000000	+0.000000	+0.000000	+5.378995	-10.376424	-0.001850
001	+0.000000	+0.000000	+0.000000	+5.352173	-7.295356	-0.001850

Table 1.5: IPF Brown angle summary

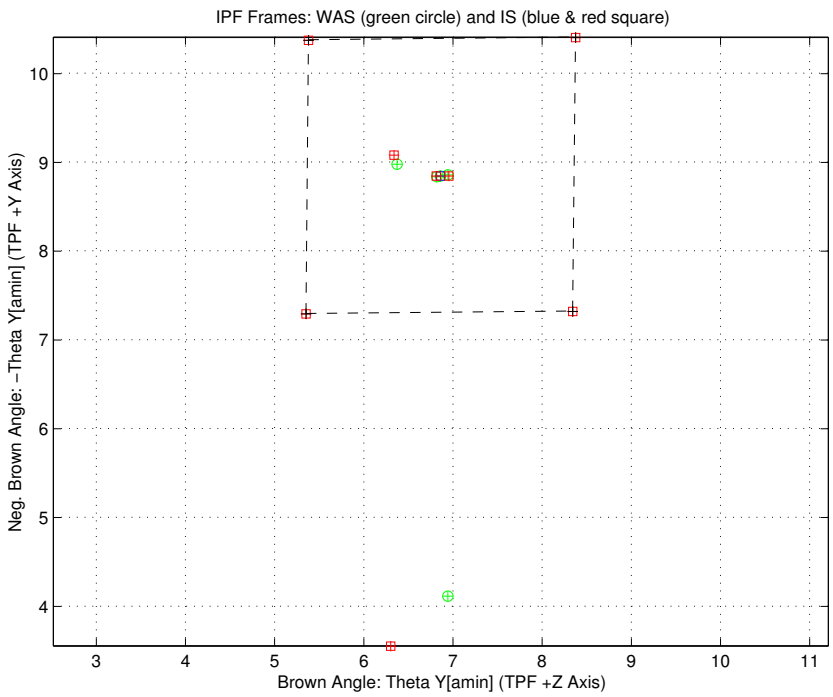

Figure 1.2: A-priori and a-posteriori IPF frames (ZOOMED)

2 IPF MULTI-RUN RESULTS

2.1 IPF MULTI-RUN OUTPUT PLOTS

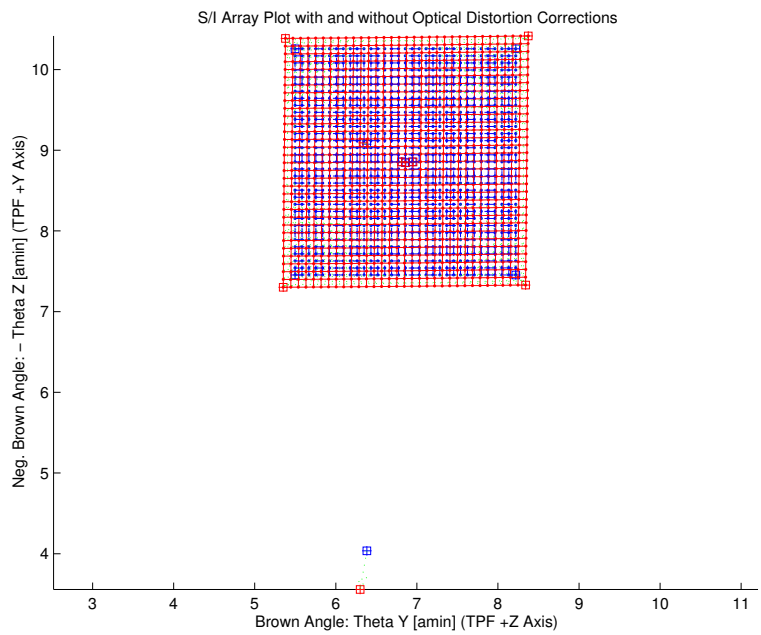

Figure 2.1: Array plot with (solid) and w/o (dashed) optical distortion corrections

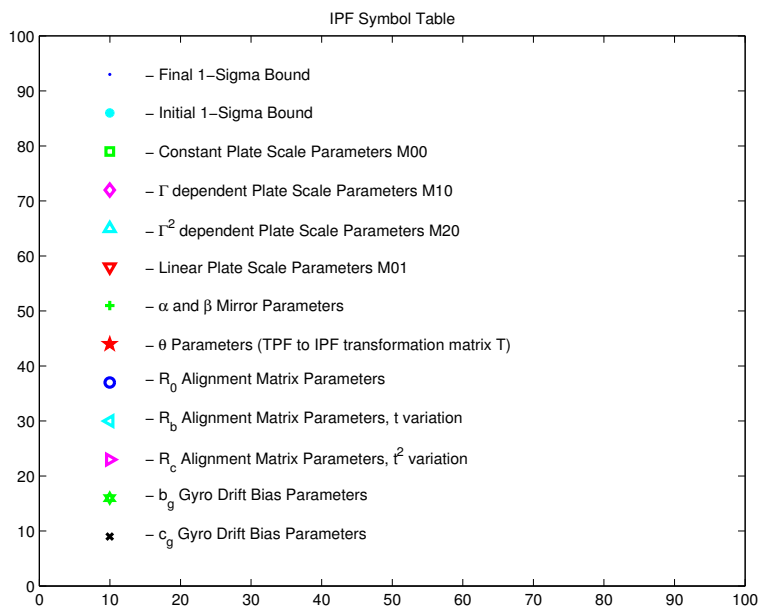

Figure 2.2: IPF parameter symbol table

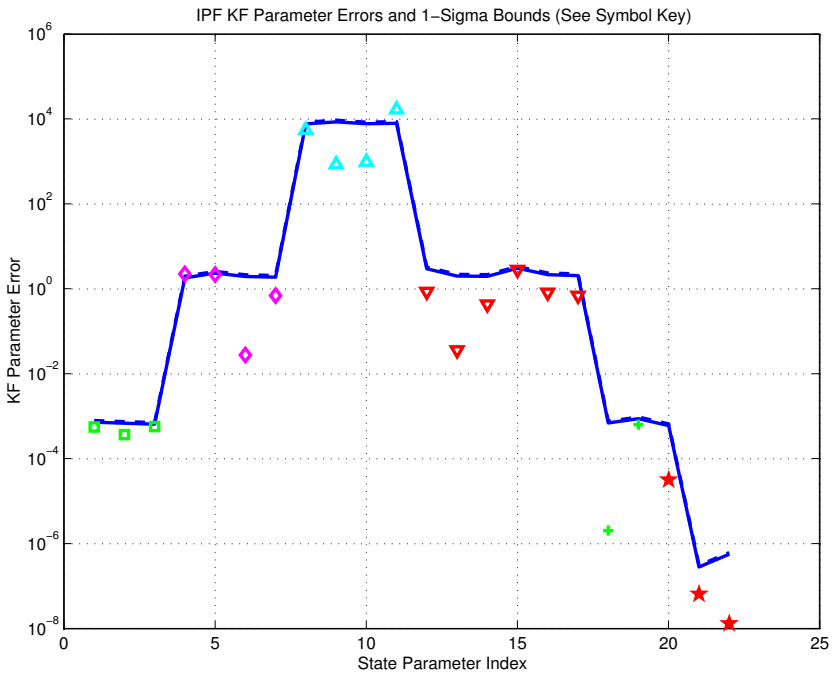

Figure 2.3: KF parameter error sigma plots

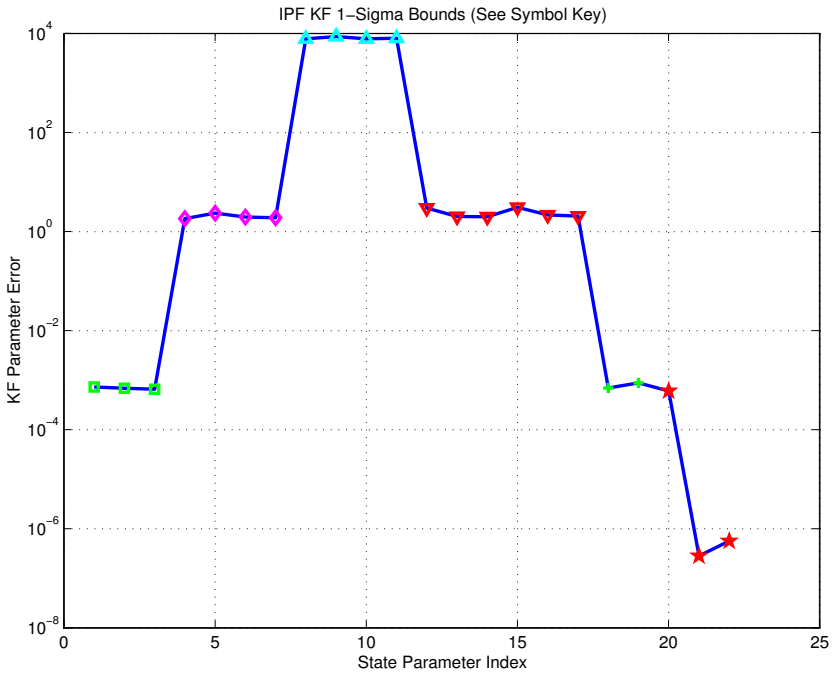

Figure 2.4: KF parameter error 1-sigma bound

2.2 IPF MULTI-RUN OUTPUT DATA (MF MINI FILE)

```
OUTPUT FILE NAME: MF91M118mini.dat   DATE: 06-Aug-2003   TIME: 21:10
INSTRUMENT NAME:  MIPS_70um_fine_center   NF: 118
IPF FILTER VERSION: IPF.V2.0.1Beta       SW RELEASE DATE: August 5, 2003
--------------------------------------------------------------------------------
---------------------------- IPF BROWN ANGLE SUMMARY ---------------------------
--------------------------------------------------------------------------------
         ------------ WAS ------------           ------------ IS -------------
Frame    theta_Y     theta_Z     angle           theta_Y     theta_Z     angle
Number   (arcmin)    (arcmin)    (deg)           (arcmin)    (arcmin)    (deg)
------  --------------------------------       --------------------------------
 118     +6.859000  -8.847000   -0.000000        +6.858775  -8.847045   -0.001850
 119     +6.942000  -8.861000   -0.000000        +6.952274  -8.847958   -0.001850
 120     +6.941000  -4.117000   +0.000000        +6.300005  -3.553015   -0.001850
 124     +6.372000  -8.981000   -0.000000        +6.337661  -9.083111   -0.001850
 127     +6.818000  -8.840000   +0.000000        +6.812030  -8.846597   -0.001850
 001     +0.000000  +0.000000   +0.000000        +8.373491 -10.406743   -0.001850
 001     +0.000000  +0.000000   +0.000000        +8.341267  -7.322781   -0.001850
 001     +0.000000  +0.000000   +0.000000        +5.378995 -10.376424   -0.001850
 001     +0.000000  +0.000000   +0.000000        +5.352173  -7.295356   -0.001850
--------------------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  0             118            +0.000            +0.000     pixels
OFFSET FRAME NAME: MIPS_70um_fine_center
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
WAS(FTB)            +6.859000        -8.847000       -0.000000
IS (EST)            +6.858775        -8.847045       -0.001850
dT_EST              -0.000225        -0.000045       -0.001850
T_sSIGMA            +0.001067        +0.002128       +0.038123
dT_EST/T_sSIGMA     -0.210970        -0.021334       -0.048532
-------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  1             119            +1.000            +0.000     pixels
OFFSET FRAME NAME: MIPS_70um_fine_FOV1
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
WAS(FTB)            +6.942000        -8.861000       -0.000000
IS (EST)            +6.952274        -8.847958       -0.001850
dT_EST              +0.010274        +0.013042       -0.001850
T_sSIGMA            +0.001105        +0.002221       +0.038123
dT_EST/T_sSIGMA     +9.298794        +5.871011       -0.048532
-------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  2             120            -5.600           -55.000     pixels
OFFSET FRAME NAME: MIPS_70um_fine_FOV2
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
WAS(FTB)            +6.941000        -4.117000       +0.000000
IS (EST)            +6.300005        -3.553015       -0.001850
dT_EST              -0.640995        +0.563985       -0.001850
T_sSIGMA            +0.014679        +0.015831       +0.038123
dT_EST/T_sSIGMA    -43.666674       +35.626187       -0.048532
-------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  3             124            -5.600            +2.500     pixels
OFFSET FRAME NAME: MIPS_70um_fine_FOV3
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
WAS(FTB)            +6.372000        -8.981000       -0.000000
IS (EST)            +6.337661        -9.083111       -0.001850
dT_EST              -0.034339        -0.102111       -0.001850
T_sSIGMA            +0.000861        +0.001618       +0.038123
dT_EST/T_sSIGMA    -39.878021       -63.102008       -0.048532
-------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  4             127            -0.500            +0.000     pixels
OFFSET FRAME NAME: MIPS_70um_fine_FOV4
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
```

```
WAS(FTB)            +6.818000        -8.840000       +0.000000
IS (EST)            +6.812030        -8.846597       -0.001850
dT_EST              -0.005970        -0.006597       -0.001850
T_sSIGMA            +0.001048        +0.002082       +0.038123
dT_EST/T_sSIGMA     -5.697504        -3.169055       -0.048532
-------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  5               1           +16.000           +16.000     pixels
OFFSET FRAME NAME: CORNER PIXEL (DIAGNOSTICS)
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
WAS(FTB)            +0.000000        +0.000000       +0.000000
IS (EST)            +8.373491       -10.406743       -0.001850
dT_EST              +8.373491       -10.406743       -0.001850
T_sSIGMA            +0.002919        +0.004368       +0.038123
dT_EST/T_sSIGMA    +2868.902013       -2382.571818       -0.048532
-------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  6               1           +16.000           -16.000     pixels
OFFSET FRAME NAME: CORNER PIXEL (DIAGNOSTICS)
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
WAS(FTB)            +0.000000        +0.000000       +0.000000
IS (EST)            +8.341267        -7.322781       -0.001850
dT_EST              +8.341267        -7.322781       -0.001850
T_sSIGMA            +0.002582        +0.004232       +0.038123
dT_EST/T_sSIGMA    +3230.194903       -1730.409172       -0.048532
-------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  7               1           -16.000           +16.000     pixels
OFFSET FRAME NAME: CORNER PIXEL (DIAGNOSTICS)
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
WAS(FTB)            +0.000000        +0.000000       +0.000000
IS (EST)            +5.378995       -10.376424       -0.001850
dT_EST              +5.378995       -10.376424       -0.001850
T_sSIGMA            +0.002598        +0.002781       +0.038123
dT_EST/T_sSIGMA    +2070.499396       -3730.677477       -0.048532
-------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  8               1           -16.000           -16.000     pixels
OFFSET FRAME NAME: CORNER PIXEL (DIAGNOSTICS)
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
WAS(FTB)            +0.000000        +0.000000       +0.000000
IS (EST)            +5.352173        -7.295356       -0.001850
dT_EST              +5.352173        -7.295356       -0.001850
T_sSIGMA            +0.002540        +0.002731       +0.038123
dT_EST/T_sSIGMA    +2107.550820       -2670.936299       -0.048532
-------------------------------------------------------------------
-------------------------------------------------------------------------------------
-------------------------------------------------------------------------------------
VARNAME              MEAN                      SIGMA                 SCALED_SIGMA
a00        +9.9435613157951561E-002 +7.2897686992313190E-004 +7.9695525785460845E-004
b00        +1.0037317738141592E-001 +6.8877433408493253E-004 +7.5300376414161893E-004
c00        +1.0574567252111431E-002 +6.5646106128785934E-004 +7.1767722126127591E-004
a10        -2.1626567252726501E+000 +1.8368897714403685E+000 +2.0081830053169134E+000
b10        +2.2903162609516867E+000 +2.3718318394795510E+000 +2.5930093713666329E+000
c10        -1.7963162528633475E-002 +1.9727358502130619E+000 +2.1566969722254181E+000
d10        +7.0721039048792700E-001 +1.9081150289670026E+000 +2.0860501446184458E+000
a20        +5.5589938448388802E+003 +7.7998579968393806E+003 +8.5272086091784076E+003
b20        -8.6619253288628261E+002 +8.6831610643461954E+003 +9.4928812566560828E+003
c20        +9.9001134689060746E+002 +7.8099208357339558E+003 +8.5382098256735499E+003
d20        -1.6997291811278832E+004 +8.0432132723645955E+003 +8.7932571963947994E+003
a01        +2.8696272345713352E+000 +3.0058293985191038E+000 +3.2861283288952001E+000
b01        +2.0362541670403176E+000 +2.0242096449027338E+000 +2.2129707896978275E+000
c01        +2.4363981360674476E+000 +1.9939372701312561E+000 +2.1798754622090164E+000
d01        +4.8496833896263958E+000 +3.0973180726255438E+000 +3.3861484843645533E+000
e01        +1.1715419518655539E+000 +2.1789313139946276E+000 +2.3821205292496845E+000
f01        +1.3027911037944484E+000 +2.0666696825860154E+000 +2.2593903013127354E+000
del_alpha  +3.0559934574487732E-004 +6.9999170656251928E-004 +7.6526717652707500E-004
beta       +1.1006386004038260E+000 +8.8432292219196428E-004 +9.6678760542368491E-004
```

```
del_theta1 +6.7606755949586265E-004 +6.0862147709969032E-004 +6.6537651087473137E-004
del_theta2 -2.9449520394255567E-007 +2.8400074125999686E-007 +3.1048431482555419E-007
del_theta3 +2.3566639238640942E-007 +5.6629279115815575E-007 +6.1910059978479570E-007
-------------------------------------------------------------------------------
LSQF RESIDUAL SIGMA SCALE =         +1.0932517762033309E+000
-------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------------------
                    a_mirror(1)               a_mirror(2)               a_mirror(3)
a_mirror_ipf   +0.0000000000000000E+000  +2.0002049745007112E-002  +9.9979993899079544E-001
a_mirror_tpf   -2.0462866810800643E-003  +2.0029135302336541E-002  +9.9979730268182854E-001
beta                beta_0                    beta                      beta_total
               +2.8047410000000001E-006  +1.1006386004038260E+000  +3.0870062087352275E-006
-----------------------------------------------------------------------------------------------------------
qT               qT(1)                     qT(2)                     qT(3)                     qT(4)
FrmTbl:   +1.2836566686785979E-006 -9.9760012028013629E-004 +1.2867429956649658E-003 +9.9999867454152913E-001
Estim:    -1.4862266468299934E-005 -9.9758814450376528E-004 +1.2867334929317050E-003 +9.9999867445608415E-001
DelTheta        deltheta(1)               deltheta(2)               deltheta(3)
          -3.2291791613569935E-005 +6.5502846393784451E-008 +1.3208039941917253E-008       [rad]
EulAngT         theta(1)                  theta(2)                  theta(3)                  [rad]
Mean      -3.2291817966315557E-005 -1.9951367203917916E-003 +2.5735011901318683E-003
SigmaT    +6.0862147709969032E-004 +2.8400074125999686E-007 +5.6629279115815575E-007
-----------------------------------------------------------------------------------------------------------
Initial Gyro Bias         Bg0(1)                    Bg0(2)                    Bg0(3)
                  +2.5130689902097530E-006 +2.4979504330423607E-006 +2.5118618914581101E-006
Gyro Bias Correction      Bg(1)                     Bg(2)                     Bg(3)
                  +1.5444483210627148E-007 -8.6004049923586703E-009 -9.8547697589928841E-009
Total Gyro Bias           BgT(1)                    BgT(2)                    BgT(3)
                  +2.6675138223160244E-006 +2.4893500280500019E-006 +2.5020071216991171E-006

Initial Gyro Bias Rate     Cg0(1)                    Cg0(2)                    Cg0(3)
                  +0.0000000000000000E+000 +0.0000000000000000E+000 +0.0000000000000000E+000
Gyro Bias Rate Correction  Cg(1)                     Cg(2)                     Cg(3)
                  -2.0560455024822193E-012 +4.8116385608096076E-013 +5.5941920345982538E-013
Total Gyro Bias Rate       CgT(1)                    CgT(2)                    CgT(3)
                  -2.0560455024822193E-012 +4.8116385608096076E-013 +5.5941920345982538E-013
-----------------------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  1             119            +1.000            +0.000     pixels
OFFSET FRAME NAME: MIPS_70um_fine_FOV1
qT               qT(1)                     qT(2)                     qT(3)                     qT(4)
WAS(FTB)  +1.3012459624148111E-006 -1.0096719622185043E-003 +1.2887791948094824E-003 +9.9999865980361324E-001
IS (EST)  -1.4844633578358937E-005 -1.0111871011349138E-003 +1.2868659677021759E-003 +9.9999866062723530E-001

DelTheta        deltheta(1)               deltheta(2)               deltheta(3)
Units             rad                       rad                       rad
          -3.2299478961152915E-005 -2.9887214095610957E-006 -3.7937949158837187E-006
EulAngT         theta(1)                  theta(2)                  theta(3)                  [rad]
Mean      -3.2291817966315557E-005 -2.0223346659524683E-003 +2.5737666143130769E-003
sSigmaT   +6.6537649781877087E-004 +3.2140956753138044E-007 +6.4619236014907936E-007
SigmaT    +6.0862146515737220E-004 +2.9399409589580429E-007 +5.9107368880130301E-007
-----------------------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  2             120            -5.600           -55.000     pixels
OFFSET FRAME NAME: MIPS_70um_fine_FOV2
qT               qT(1)                     qT(2)                     qT(3)                     qT(4)
WAS(FTB)  +6.0449825951069261E-007 -1.0095271757136512E-003 +5.9879303662630152E-004 +9.9999931115047058E-001
IS (EST)  -1.5672389033121244E-005 -9.1630671198935536E-004 +5.1675001674745321E-004 +9.9999944655274986E-001

DelTheta        deltheta(1)               deltheta(2)               deltheta(3)
Units             rad                       rad                       rad
          -3.2623057159552796E-005 +1.8645779109911412E-004 -1.6405637999642537E-004
EulAngT         theta(1)                  theta(2)                  theta(3)                  [rad]
Mean      -3.2291817966315550E-005 -1.8325972380787081E-003 +1.0335301024472911E-003
sSigmaT   +6.6537609017250138E-004 +4.2700256568081657E-006 +4.6049455456826095E-006
SigmaT    +6.0862109228235998E-004 +3.9058026245676045E-006 +4.2121546435303011E-006
```

```
-----------------------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  3             124            -5.600            +2.500     pixels
OFFSET FRAME NAME: MIPS_70um_fine_FOV3
qT               qT(1)                    qT(2)                    qT(3)                    qT(4)
WAS(FTB)  +1.2105772857918672E-006 -9.2676890949311853E-004 +1.3062325685908875E-003 +9.9999871742637714E-001
IS (EST)  -1.4928144951002412E-005 -9.2179580508213420E-004 +1.3210691084587138E-003 +9.9999870242218569E-001

DelTheta        deltheta(1)               deltheta(2)               deltheta(3)
Units             rad                       rad                       rad
          -3.2236762546332902E-005 +9.9888447889893576E-006 +2.9702821568344044E-005
EulAngT         theta(1)                  theta(2)                  theta(3)                  [rad]
Mean      -3.2291817966315557E-005 -1.8435508200113379E-003 +2.6421698740689658E-003
sSigmaT   +6.6537655935355866E-004 +2.5048498624810134E-007 +4.7071199539778790E-007
SigmaT    +6.0862152144338896E-004 +2.2911921270138810E-007 +4.3056138178205117E-007
-----------------------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  4             127            -0.500            +0.000     pixels
OFFSET FRAME NAME: MIPS_70um_fine_FOV4
qT               qT(1)                    qT(2)                    qT(3)                    qT(4)
WAS(FTB)  +1.2749739579667491E-006 -9.9163692118734836E-004 +1.2857248959092255E-003 +9.9999868178217266E-001
IS (EST)  -1.4871079608890427E-005 -9.9078932456185737E-004 +1.2866683682828822E-003 +9.9999868129906822E-001

DelTheta        deltheta(1)               deltheta(2)               deltheta(3)
Units             rad                       rad                       rad
          -3.2288012183286870E-005 +1.7367422096399738E-006 +1.9189353488319251E-006
EulAngT         theta(1)                  theta(2)                  theta(3)                  [rad]
Mean      -3.2291817966315564E-005 -1.9815390644695985E-003 +2.5733707037211614E-003
sSigmaT   +6.6537651721707957E-004 +3.0482507232421459E-007 +6.0552399063886439E-007
SigmaT    +6.0862148290105134E-004 +2.7882421868347460E-007 +5.5387423448031483E-007
-----------------------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  5              1            +16.000           +16.000     pixels
OFFSET FRAME NAME: CORNER PIXEL (DIAGNOSTICS)
qT               qT(1)                    qT(2)                    qT(3)                    qT(4)
WAS(FTB)  +0.0000000000000000E+000 +0.0000000000000000E+000 +0.0000000000000000E+000 +1.0000000000000000E+000
IS (EST)  -1.4302504881467478E-005 -1.2178976715541128E-003 +1.5135780598084820E-003 +9.9999811279929762E-001

DelTheta        deltheta(1)               deltheta(2)               deltheta(3)
Units             rad                       rad                       rad
          -3.2291817966315557E-005 -2.4357498588585226E-003 +3.0271988482279350E-003
EulAngT         theta(1)                  theta(2)                  theta(3)                  [rad]
Mean      -3.2291817966315557E-005 -2.4357498588585221E-003 +3.0271988482279345E-003
sSigmaT   +6.6537608249908425E-004 +8.4901814274430955E-007 +1.2705593282235871E-006
SigmaT    +6.0862108526346702E-004 +7.7659891456366865E-007 +1.1621836395601513E-006
-----------------------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  6              1            +16.000           -16.000     pixels
OFFSET FRAME NAME: CORNER PIXEL (DIAGNOSTICS)
qT               qT(1)                    qT(2)                    qT(3)                    qT(4)
WAS(FTB)  +0.0000000000000000E+000 +0.0000000000000000E+000 +0.0000000000000000E+000 +1.0000000000000000E+000
IS (EST)  -1.4853776165378185E-005 -1.2132042754653223E-003 +1.0650346941146497E-003 +9.9999869680707676E-001

DelTheta        deltheta(1)               deltheta(2)               deltheta(3)
Units             rad                       rad                       rad
          -3.2291817966315557E-005 -2.4263761300787352E-003 +2.1301105348105931E-003
EulAngT         theta(1)                  theta(2)                  theta(3)                  [rad]
Mean      -3.2291817966315557E-005 -2.4263761300787343E-003 +2.1301105348105927E-003
sSigmaT   +6.6537626792641746E-004 +7.5115471450653200E-007 +1.2309866179089515E-006
SigmaT    +6.0862125487428980E-004 +6.8708300398574129E-007 +1.1259863873113923E-006
-----------------------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  7              1            -16.000           +16.000     pixels
```

```
OFFSET FRAME NAME: CORNER PIXEL (DIAGNOSTICS)
qT              qT(1)                   qT(2)                   qT(3)                   qT(4)
WAS(FTB)  +0.0000000000000000E+000 +0.0000000000000000E+000 +0.0000000000000000E+000 +1.0000000000000000E+000
IS (EST)  -1.4965182144276111E-005 -7.8236648556802215E-004 +1.5091759648608054E-003 +9.9999855503227242E-001

DelTheta        deltheta(1)               deltheta(2)               deltheta(3)
Units             rad                       rad                       rad
          -3.2291817966315557E-005 -1.5646861784162048E-003 +3.0183792628830685E-003
EulAngT         theta(1)                  theta(2)                  theta(3)                  [rad]
Mean      -3.2291817966315557E-005 -1.5646861784162048E-003 +3.0183792628830689E-003
sSigmaT   +6.6537649840104273E-004 +7.5570472590317748E-007 +8.0907000984161751E-007
SigmaT    +6.0862146568997774E-004 +6.9124491023248610E-007 +7.4005826238066933E-007
-----------------------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  8               1           -16.000           -16.000     pixels
OFFSET FRAME NAME: CORNER PIXEL (DIAGNOSTICS)
qT              qT(1)                   qT(2)                   qT(3)                   qT(4)
WAS(FTB)  +0.0000000000000000E+000 +0.0000000000000000E+000 +0.0000000000000000E+000 +1.0000000000000000E+000
IS (EST)  -1.5319916577578789E-005 -7.7845859092894271E-004 +1.0610533585622038E-003 +9.9999913396627116E-001

DelTheta        deltheta(1)               deltheta(2)               deltheta(3)
Units             rad                       rad                       rad
          -3.2291817966315557E-005 -1.5568839519691027E-003 +2.1221328958719999E-003
EulAngT         theta(1)                  theta(2)                  theta(3)                  [rad]
Mean      -3.2291817966315557E-005 -1.5568839519691034E-003 +2.1221328958719999E-003
sSigmaT   +6.6537667294202173E-004 +7.3871715796113633E-007 +7.9452770812144568E-007
SigmaT    +6.0862162534302633E-004 +6.7570634143085471E-007 +7.2675638440826431E-007
-----------------------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------------------
               q(1)                    q(2)                    q(3)                    q(4)
PCRS1A: +5.2603126189317361E-007 +3.7451819048221893E-004 -1.4045531552277380E-003 +9.9999894348258311E-001
PCRS2A: -5.1968404336718985E-007 +3.8455385122900486E-004 +1.3513933841514693E-003 +9.9999901292650617E-001
-------------------------------------------------------------------------------------------
**********  CS-FILE PARAMETERS:  **********  **********  AS-FILE PARAMETERS:  **********
Row (01) PIX2RADX: +2.4736508339999999E-005  Row (1) TASTART:   +7.3051200000000000E+008
Row (02) PIX2RADY: +2.5464808057000000E-005  Row (2) TASTOP:    +7.3053587000000000E+008
Row (03) CX0:      +1.6500000000000000E+001  Row (3) S/C TIME:  +7.3051200000000000E+008
Row (04) CY0:      +1.6500000000000000E+001  Row (4) QR1:       +0.0000000000000000E+000
Row (05) BETA0:    +2.8047410000000001E-006  Row (5) QR2:       +0.0000000000000000E+000
Row (06) GAMMA_E0: +8.7500000000000000E+002  Row (6) QR3:       +0.0000000000000000E+000
Row (07) D11:      -1.0000000000000000E+000  Row (7) QR4:       +1.0000000000000000E+000
Row (08) D12:      +0.0000000000000000E+000
Row (09) D21:      +0.0000000000000000E+000
Row (10) D22:      -1.0000000000000000E+000
Row (11) DG:       +1.0000000000000000E+000
-------------------------------------------------------------------------------------------
-------------------------------------------------------------
INITIAL STA-TO-PCRS ALIGNMENT (R) KNOWLEDGE (1-SIGMA)
    SIGMA(X)        SIGMA(Y)         SIGMA(Z)
2.82857904E+001  1.44427880E+000  1.44427880E+000  [arcsec]
-------------------------------------------------------------
PIX2RADX = 2.473650834000E-005[rad/pixel]
XPIXSIZE = 5.1023[arcsec]
PIX2RADY = 2.546480805700E-005[rad/pixel]
YPIXSIZE = 5.2525[arcsec]
CX0 = 16.5[pixel] = 84.19[arcsec]
CY0 = 16.5[pixel] = 86.67[arcsec]
-------------------------------------------------------------
NOMINAL BETA0 = 2.804741000000E-006[rad/encoder unit]
ENCODER UNIT SIZE = 0.58[arcsec]
GAMMA_E0 = 875.00[encoder unit] = 506.20[arcsec]
-------------------------------------------------------------
                | -1 | +0 |
FLIP MATRIX D = |----|----|   and   DG = +1
                | +0 | -1 |
-------------------------------------------------------------
```

2.3 IPF MULTI-RUN EXECUTION LOG

```
************************************************
*****          MULTI_RUN LOG FILE           *****
************************************************

-------------------------------------------------
MULTI-RUN-LOG FILE NAME:  LG91M118.dat
INSTRUMENT TYPE:              MIPS_70um_fine_center
MULTI-RUN EXECUTION DATE: 06-Aug-2003    TIME: 21:10
-------------------------------------------------


-------------------------------------------------------
MT991118 FILE LOADED!
q_T    = -3.5289566277023056E-004 -9.9787580123327250E-004 +1.2862783657053146E-003 +9.9999861259728884E-001
SigmaT = +8.6378443156739384E-004 +4.0027608342798019E-007 +8.0380289049877423E-007
Sigma Scale = +1.0860628088188005E+000

-------------------------------------------------------
MT992118 FILE LOADED!
q_T    = +3.3435566440088527E-004 -9.9728516378089173E-004 +1.2871877760104412E-003 +9.9999861838715609E-001
SigmaT = +8.5819964338120815E-004 +4.0326154741339424E-007 +7.9831366853028855E-007
Sigma Scale = +1.1004520124020762E+000

-------------------------------------------------------

----------------------------------------------------------------
Conditioning Number for LSQ Filter was:  +9.0573311274546753E+010
----------------------------------------------------------------

Merged q_T    = -1.4862266468299934E-005 -9.9758814450376528E-004 +1.2867334929317050E-003 +9.9999867445608415E-001
Merged SigmaT = +6.0862147709969032E-004 +2.8400074125999681E-007 +5.6629279115815575E-007
Merged Sigma Scale = +1.0932517762033309E+000

*********** Sigma T Ratios for Multi-Run ************
DATA#1 Expected:     1.41421 1.41421 1.41421
DATA#1 Calculated:   1.41925 1.40942 1.41941
-----------------------------------------------------
DATA#2 Expected:     1.41421 1.41421 1.41421
DATA#2 Calculated:   1.41007 1.41993 1.40972
-----------------------------------------------------


Merging LG Files!


*********************************************************************
IPF EXECUTION-LOG FILE NAME:  LG991118.dat
INSTRUMENT TYPE:              MIPS_70um_fine_center
IPF FILTER EXECUTION DATE:    18-Jul-2003    TIME: 16:03
IPF FILTER VERSION USED:      IPF.V1.6.5
*********************************************************************

------------------- Loading & Preparing Input Files -------------------
AAFILE:  AA991118 Loaded!        AAFILE dimension = 238701 X 21
ASFILE:  AS991118 Loaded!
CAFILE:  CA991118 Loaded!        CAFILE dimension = 606 X 15
CBFILE:  CB991118 Loaded!        CBFILE dimension = 66 X 15
CCFILE:  CC991118 Created!       CCFILE dimension = 672 X 19
CSFILE:  CS991118 Loaded!
Loading Input Files Completed!
-----------------------------------------------------------------------

------------------------- Selected Mask Vectors -------------------------
index =   1  2  3  4  5  6  7  8  9 10 11 12 13 14 15 16 17 18 19 20
```

```
-----------------------------------------------------------------------
mask1 = [ 1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1 ]
mask2 = [ 1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1 ]
-----------------------------------------------------------------------

---------------  Selected Initial Gyro Bias Parameters  ---------------
User Entered 1 : Use AFILE database - from S/C filter
IPF Linearized Using Following Nominal Gyro Bias Estimates
bg0 = [+2.4485408342998006E-006 +2.5088395420218739E-006 +2.5087559469960914E-006 ]
cg0 = [+0.0000000000000000E+000 +0.0000000000000000E+000 +0.0000000000000000E+000 ]
-----------------------------------------------------------------------

---------------  Gyro Pre-Processor Run Completed  --------------------
     AGFILE CREATED:  AG991118.m     ACFILE CREATED:  AC991118.m
-----------------------------------------------------------------------
Total Gyro Preprocessor Execution Time: 112 seconds

FRAME TABLE ENTRIES FOR PCRS LOADED TO TPCRS
q_PCRS4 = [ +5.2603126189317361E-007     q_PCRS5 = [ +7.3379987833742897E-007
            +3.7451819048221893E-004                 +5.2236196154513707E-004
            -1.4045531552277380E-003                 -1.4047712280184723E-003
            +9.9999894348258311E-001 ];              +9.9999887687698918E-001 ];
q_PCRS8 = [ -5.1968404336718985E-007     q_PCRS9 = [ -7.1963421681856818E-007
            +3.8455385122900486E-004                 +5.3239763239987400E-004
            +1.3513933841514693E-003                 +1.3516841804518383E-003
            +9.9999901292650617E-001 ];              +9.9999894475050310E-001 ];
-------------------------------------------------------------------------------
------ Initial Conditions for State -----  ------   Inital Square-Root Cov (diag)   -----
p1(01)  = a00  = +0.0000000000000000E+000  Sigma_initial(01,01) = 1.0000000000000000E+000
p1(02)  = b00  = +0.0000000000000000E+000  Sigma_initial(02,02) = 1.0000000000000000E+000
p1(03)  = c00  = +0.0000000000000000E+000  Sigma_initial(03,03) = 1.0000000000000000E+000
p1(04)  = a10  = +0.0000000000000000E+000  Sigma_initial(04,04) = 3.5969004473570845E+002
p1(05)  = b10  = +0.0000000000000000E+000  Sigma_initial(05,05) = 3.5969004473570845E+002
p1(06)  = c10  = +0.0000000000000000E+000  Sigma_initial(06,06) = 3.5969004473570845E+002
p1(07)  = d10  = +0.0000000000000000E+000  Sigma_initial(07,07) = 3.5969004473570845E+002
p1(08)  = a20  = +0.0000000000000000E+000  Sigma_initial(08,08) = 1.2937692828197595E+007
p1(09)  = b20  = +0.0000000000000000E+000  Sigma_initial(09,09) = 1.2937692828197595E+007
p1(10)  = c20  = +0.0000000000000000E+000  Sigma_initial(10,10) = 1.2937692828197595E+007
p1(11)  = d20  = +0.0000000000000000E+000  Sigma_initial(11,11) = 1.2937692828197595E+007
p1(12)  = a01  = +0.0000000000000000E+000  Sigma_initial(12,12) = 1.0000000000000000E+004
p1(13)  = b01  = +0.0000000000000000E+000  Sigma_initial(13,13) = 1.0000000000000000E+004
p1(14)  = c01  = +0.0000000000000000E+000  Sigma_initial(14,14) = 1.0000000000000000E+004
p1(15)  = d01  = +0.0000000000000000E+000  Sigma_initial(15,15) = 1.0000000000000000E+004
p1(16)  = e01  = +0.0000000000000000E+000  Sigma_initial(16,16) = 1.0000000000000000E+004
p1(17)  = f01  = +0.0000000000000000E+000  Sigma_initial(17,17) = 1.0000000000000000E+004
-------------------------------------------------------------------------------------
p2f(01) = am1  = +0.0000000000000000E+000
p2f(02) = am2  = +0.0000000000000000E+000  Sigma_initial(18,18) = 1.0000000000000001E-001
p2f(03) = am3  = +1.0000000000000000E+000
p2f(04) = beta = +1.0000000000000000E+000  Sigma_initial(19,19) = 1.0000000000000001E-001
p2f(05) = qT1  = +1.2836566686785981E-006  Sigma_initial(20,20) = 1.0000000000000001E-001
p2f(06) = qT2  = -9.9760012028013651E-004  Sigma_initial(21,21) = 1.0000000000000000E-002
p2f(07) = aT3  = +1.2867429956649661E-003  Sigma_initial(22,22) = 1.0000000000000000E-002
p2f(08) = qT4  = +9.9999867454152924E-001
p2f(09) = qR1  = +0.0000000000000000E+000  Sigma_initial(23,23) = 3.4288868839039716E-003
p2f(10) = qR2  = +0.0000000000000000E+000  Sigma_initial(24,24) = 1.8555467699985827E-004
p2f(11) = qR3  = +0.0000000000000000E+000  Sigma_initial(25,25) = 1.8555467699985827E-004
p2f(12) = qR4  = +1.0000000000000000E+000
p2f(13) = brx  = +0.0000000000000000E+000  Sigma_initial(26,26) = 4.1893590280687055E-005
p2f(14) = bry  = +0.0000000000000000E+000  Sigma_initial(27,27) = 4.1893590280687055E-005
p2f(15) = brz  = +0.0000000000000000E+000  Sigma_initial(28,28) = 4.1893590280687055E-005
p2f(16) = crx  = +0.0000000000000000E+000  Sigma_initial(29,29) = 1.7550729066060769E-009
p2f(17) = cry  = +0.0000000000000000E+000  Sigma_initial(30,30) = 1.7550729066060769E-009
p2f(18) = crz  = +0.0000000000000000E+000  Sigma_initial(31,31) = 1.7550729066060769E-009
p2f(19) = bgx  = +0.0000000000000000E+000  Sigma_initial(32,32) = 4.1893590280687055E-005
p2f(20) = bgy  = +0.0000000000000000E+000  Sigma_initial(33,33) = 4.1893590280687055E-005
p2f(21) = bgz  = +0.0000000000000000E+000  Sigma_initial(34,34) = 4.1893590280687055E-005
p2f(22) = cgx  = +0.0000000000000000E+000  Sigma_initial(35,35) = 1.7550729066060769E-009
```

```
p2f(23) = cgy  = +0.0000000000000000E+000  Sigma_initial(36,36) = 1.7550729066060769E-009
p2f(24) = cgz  = +0.0000000000000000E+000  Sigma_initial(37,37) = 1.7550729066060769E-009
-------------------------------------------------------------------------------------

--------------------   IPF KALMAN FILTER STARTED  ---------------------
Iteration#001: |dp|= +2.756937349017E+004   RMS(|Res|)=+2.756937349017E+004
Iteration#002: |dp|= +1.318871013134E+002   RMS(|Res|)=+1.318871013134E+002
Iteration#003: |dp|= +5.639308899096E+000   RMS(|Res|)=+5.639308899096E+000
Iteration#004: |dp|= +1.719556978334E+001   RMS(|Res|)=+1.719556978334E+001
Iteration#005: |dp|= +1.320048038732E+000   RMS(|Res|)=+1.320048038732E+000
Iteration#006: |dp|= +3.816936806602E-002   RMS(|Res|)=+3.816936806602E-002
Iteration#007: |dp|= +2.232063087663E-003   RMS(|Res|)=+2.232063087663E-003
Iteration#008: |dp|= +2.105858592665E-004   RMS(|Res|)=+2.105858592665E-004
Iteration#009: |dp|= +6.344598444370E-006   RMS(|Res|)=+6.344598444370E-006
Iteration#010: |dp|= +2.534682489056E-006   RMS(|Res|)=+2.534682489056E-006
Iteration#011: |dp|= +1.096084224054E-006   RMS(|Res|)=+1.096084224054E-006
Iteration#012: |dp|= +2.142181312521E-006   RMS(|Res|)=+2.142181312521E-006
Iteration#013: |dp|= +5.515663816861E-006   RMS(|Res|)=+5.515663816861E-006
Iteration#014: |dp|= +2.706820166699E-006   RMS(|Res|)=+2.706820166699E-006
Iteration#015: |dp|= +4.840933564709E-006   RMS(|Res|)=+4.840933564709E-006
Iteration#016: |dp|= +2.093854423671E-006   RMS(|Res|)=+2.093854423671E-006
Iteration#017: |dp|= +3.278111834557E-006   RMS(|Res|)=+3.278111834557E-006
Iteration#018: |dp|= +1.412184507779E-006   RMS(|Res|)=+1.412184507779E-006
Iteration#019: |dp|= +4.896950641001E-006   RMS(|Res|)=+4.896950641001E-006
Iteration#020: |dp|= +1.091219876730E-005   RMS(|Res|)=+1.091219876730E-005
IPF Kalman Filter Completed with Error |dp1| + |dp2| = +1.0912198767295368E-005
-----------------------------------------------------------------------

-----------------  IPF LEAST SQUARES FILTER STARTED  ------------------
Iteration#001   COND#=+8.354825824772E+012,   |dp|=+2.759026829644E+004
Iteration#002   COND#=+8.354644624300E+012,   |dp|=+1.741611144011E+002
Iteration#003   COND#=+8.354640687393E+012,   |dp|=+2.360695554299E+000
Iteration#004   COND#=+8.354640412261E+012,   |dp|=+7.443236340573E-003
Iteration#005   COND#=+8.354640505473E+012,   |dp|=+3.488405372926E-005
Iteration#006   COND#=+8.354640366781E+012,   |dp|=+1.021156817091E-006
Iteration#007   COND#=+8.354640242053E+012,   |dp|=+8.796863222805E-007
Iteration#008   COND#=+8.354640599939E+012,   |dp|=+4.104249577843E-007
Iteration#009   COND#=+8.354640996715E+012,   |dp|=+8.282304370088E-007
Iteration#010   COND#=+8.354640590230E+012,   |dp|=+5.382720557982E-007
Iteration#011   COND#=+8.354640784591E+012,   |dp|=+8.792989598991E-007
Iteration#012   COND#=+8.354640570859E+012,   |dp|=+5.018847206464E-007
Iteration#013   COND#=+8.354640910156E+012,   |dp|=+4.676814822468E-007
Iteration#014   COND#=+8.354640964261E+012,   |dp|=+6.390310460405E-007
Iteration#015   COND#=+8.354639779455E+012,   |dp|=+3.752103063203E-007
Iteration#016   COND#=+8.354640990166E+012,   |dp|=+6.719267573513E-007
Iteration#017   COND#=+8.354640335089E+012,   |dp|=+5.695348512736E-007
Iteration#018   COND#=+8.354640468019E+012,   |dp|=+2.850074495109E-007
Iteration#019   COND#=+8.354640441950E+012,   |dp|=+3.118157401291E-007
Iteration#020   COND#=+8.354640449528E+012,   |dp|=+6.225101985486E-007
IPF Least Squares Filter Completed with Error |dp1| + |dp2| = +6.2251019854857963E-007
-----------------------------------------------------------------------
Total Execution Time: 308 seconds



*********************************************************************
IPF EXECUTION-LOG FILE NAME:  LG992118.dat
INSTRUMENT TYPE:              MIPS_70um_fine_center
IPF FILTER EXECUTION DATE:    05-Aug-2003    TIME: 22:26
IPF FILTER VERSION USED:      IPF.V2.0.1Beta
*********************************************************************

------------------- Loading & Preparing Input Files -------------------
AAFILE:  AA992118 Loaded!        AAFILE dimension = 238701 X 21
ASFILE:  AS992118 Loaded!
CAFILE:  CA992118 Loaded!        CAFILE dimension = 606 X 15
CBFILE:  CB992118 Loaded!        CBFILE dimension = 66 X 15
```

```
CCFILE:  CC992118 Created!       CCFILE dimension = 672 X 19
CSFILE:  CS992118 Loaded!
Loading Input Files Completed!
-----------------------------------------------------------------------

------------------------ Selected Mask Vectors ------------------------
index =   1  2  3  4  5  6  7  8  9 10 11 12 13 14 15 16 17 18 19 20
-----------------------------------------------------------------------
mask1 = [ 1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1 ]
mask2 = [ 1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1 ]
-----------------------------------------------------------------------

---------------  Selected Initial Gyro Bias Parameters  ---------------
User Entered 1 : Use AFILE database - from S/C filter
IPF Linearized Using Following Nominal Gyro Bias Estimates
bg0 = [+2.5130689902097530E-006 +2.4979504330423607E-006 +2.5118618914581101E-006 ]
cg0 = [+0.0000000000000000E+000 +0.0000000000000000E+000 +0.0000000000000000E+000 ]
-----------------------------------------------------------------------

---------------  Gyro Pre-Processor Run Completed  --------------------
     AGFILE CREATED:  AG992118.m     ACFILE CREATED:  AC992118.m
-----------------------------------------------------------------------
Total Gyro Preprocessor Execution Time: 123 seconds

FRAME TABLE ENTRIES FOR PCRS LOADED TO TPCRS
q_PCRS4 = [ +5.2603126189317361E-007     q_PCRS5 = [ +7.3379987833742897E-007
            +3.7451819048221893E-004                 +5.2236196154513707E-004
            -1.4045531552277380E-003                 -1.4047712280184723E-003
            +9.9999894348258311E-001 ];              +9.9999887687698918E-001 ];
q_PCRS8 = [ -5.1968404336718985E-007     q_PCRS9 = [ -7.1963421681856818E-007
            +3.8455385122900486E-004                 +5.3239763239987400E-004
            +1.3513933841514693E-003                 +1.3516841804518383E-003
            +9.9999901292650617E-001 ];              +9.9999894475050310E-001 ];
-------------------------------------------------------------------------------
------ Initial Conditions for State -----  ------   Inital Square-Root Cov (diag)   -----
p1(01)  = a00  = +0.0000000000000000E+000  Sigma_initial(01,01) = 1.0000000000000000E+000
p1(02)  = b00  = +0.0000000000000000E+000  Sigma_initial(02,02) = 1.0000000000000000E+000
p1(03)  = c00  = +0.0000000000000000E+000  Sigma_initial(03,03) = 1.0000000000000000E+000
p1(04)  = a10  = +0.0000000000000000E+000  Sigma_initial(04,04) = 3.5969004473570845E+002
p1(05)  = b10  = +0.0000000000000000E+000  Sigma_initial(05,05) = 3.5969004473570845E+002
p1(06)  = c10  = +0.0000000000000000E+000  Sigma_initial(06,06) = 3.5969004473570845E+002
p1(07)  = d10  = +0.0000000000000000E+000  Sigma_initial(07,07) = 3.5969004473570845E+002
p1(08)  = a20  = +0.0000000000000000E+000  Sigma_initial(08,08) = 1.2937692828197595E+007
p1(09)  = b20  = +0.0000000000000000E+000  Sigma_initial(09,09) = 1.2937692828197595E+007
p1(10)  = c20  = +0.0000000000000000E+000  Sigma_initial(10,10) = 1.2937692828197595E+007
p1(11)  = d20  = +0.0000000000000000E+000  Sigma_initial(11,11) = 1.2937692828197595E+007
p1(12)  = a01  = +0.0000000000000000E+000  Sigma_initial(12,12) = 1.0000000000000000E+004
p1(13)  = b01  = +0.0000000000000000E+000  Sigma_initial(13,13) = 1.0000000000000000E+004
p1(14)  = c01  = +0.0000000000000000E+000  Sigma_initial(14,14) = 1.0000000000000000E+004
p1(15)  = d01  = +0.0000000000000000E+000  Sigma_initial(15,15) = 1.0000000000000000E+004
p1(16)  = e01  = +0.0000000000000000E+000  Sigma_initial(16,16) = 1.0000000000000000E+004
p1(17)  = f01  = +0.0000000000000000E+000  Sigma_initial(17,17) = 1.0000000000000000E+004
-------------------------------------------------------------------------------------------
p2f(01) = am1  = +0.0000000000000000E+000
p2f(02) = am2  = +0.0000000000000000E+000  Sigma_initial(18,18) = 1.0000000000000001E-001
p2f(03) = am3  = +1.0000000000000000E+000
p2f(04) = beta = +1.0000000000000000E+000  Sigma_initial(19,19) = 1.0000000000000001E-001
p2f(05) = qT1  = +1.2836566686785981E-006  Sigma_initial(20,20) = 1.0000000000000001E-001
p2f(06) = qT2  = -9.9760012028013651E-004  Sigma_initial(21,21) = 1.0000000000000000E-002
p2f(07) = aT3  = +1.2867429956649661E-003  Sigma_initial(22,22) = 1.0000000000000000E-002
p2f(08) = qT4  = +9.9999867454152924E-001
p2f(09) = qR1  = +0.0000000000000000E+000  Sigma_initial(23,23) = 6.8566690868928238E-003
p2f(10) = qR2  = +0.0000000000000000E+000  Sigma_initial(24,24) = 3.5010305970939351E-004
p2f(11) = qR3  = +0.0000000000000000E+000  Sigma_initial(25,25) = 3.5010305970939351E-004
p2f(12) = qR4  = +1.0000000000000000E+000
p2f(13) = brx  = +0.0000000000000000E+000  Sigma_initial(26,26) = 4.1893590280687055E-005
p2f(14) = bry  = +0.0000000000000000E+000  Sigma_initial(27,27) = 4.1893590280687055E-005
p2f(15) = brz  = +0.0000000000000000E+000  Sigma_initial(28,28) = 4.1893590280687055E-005
```

```
p2f(16) = crx  = +0.0000000000000000E+000  Sigma_initial(29,29) = 1.7550729066060769E-009
p2f(17) = cry  = +0.0000000000000000E+000  Sigma_initial(30,30) = 1.7550729066060769E-009
p2f(18) = crz  = +0.0000000000000000E+000  Sigma_initial(31,31) = 1.7550729066060769E-009
p2f(19) = bgx  = +0.0000000000000000E+000  Sigma_initial(32,32) = 4.1893590280687055E-005
p2f(20) = bgy  = +0.0000000000000000E+000  Sigma_initial(33,33) = 4.1893590280687055E-005
p2f(21) = bgz  = +0.0000000000000000E+000  Sigma_initial(34,34) = 4.1893590280687055E-005
p2f(22) = cgx  = +0.0000000000000000E+000  Sigma_initial(35,35) = 1.7550729066060769E-009
p2f(23) = cgy  = +0.0000000000000000E+000  Sigma_initial(36,36) = 1.7550729066060769E-009
p2f(24) = cgz  = +0.0000000000000000E+000  Sigma_initial(37,37) = 1.7550729066060769E-009
--------------------------------------------------------------------------------------

--------------------   IPF KALMAN FILTER STARTED  ---------------------
Iteration#001: |dp|= +1.819034157647E+004   RMS(|Res|)=+1.819034157647E+004
Iteration#002: |dp|= +1.499986188111E+002   RMS(|Res|)=+1.499986188111E+002
Iteration#003: |dp|= +1.427186591956E+000   RMS(|Res|)=+1.427186591956E+000
Iteration#004: |dp|= +1.733460118839E+001   RMS(|Res|)=+1.733460118839E+001
Iteration#005: |dp|= +1.498755134211E+000   RMS(|Res|)=+1.498755134211E+000
Iteration#006: |dp|= +5.282910567756E-002   RMS(|Res|)=+5.282910567756E-002
Iteration#007: |dp|= +1.743232598764E-003   RMS(|Res|)=+1.743232598764E-003
Iteration#008: |dp|= +2.307926349451E-004   RMS(|Res|)=+2.307926349451E-004
Iteration#009: |dp|= +9.432807458715E-006   RMS(|Res|)=+9.432807458715E-006
Iteration#010: |dp|= +3.093209700804E-006   RMS(|Res|)=+3.093209700804E-006
Iteration#011: |dp|= +3.601082066866E-006   RMS(|Res|)=+3.601082066866E-006
Iteration#012: |dp|= +3.880847526014E-006   RMS(|Res|)=+3.880847526014E-006
Iteration#013: |dp|= +2.870561634132E-006   RMS(|Res|)=+2.870561634132E-006
Iteration#014: |dp|= +1.784263025686E-006   RMS(|Res|)=+1.784263025686E-006
Iteration#015: |dp|= +1.146194838070E-006   RMS(|Res|)=+1.146194838070E-006
Iteration#016: |dp|= +1.730879419298E-006   RMS(|Res|)=+1.730879419298E-006
Iteration#017: |dp|= +1.217225571841E-006   RMS(|Res|)=+1.217225571841E-006
Iteration#018: |dp|= +5.984428985343E-007   RMS(|Res|)=+5.984428985343E-007
Iteration#019: |dp|= +2.132640349363E-006   RMS(|Res|)=+2.132640349363E-006
Iteration#020: |dp|= +2.628217579688E-006   RMS(|Res|)=+2.628217579688E-006
IPF Kalman Filter Completed with Error |dp1| + |dp2| = +2.6282175796884451E-006
-----------------------------------------------------------------------

-----------------  IPF LEAST SQUARES FILTER STARTED  ------------------
Iteration#001   COND#=+8.389726056271E+012,   |dp|=+1.819826381687E+004
Iteration#002   COND#=+8.389415048951E+012,   |dp|=+1.944257764664E+002
Iteration#003   COND#=+8.389411214214E+012,   |dp|=+9.552840124427E-001
Iteration#004   COND#=+8.389411407572E+012,   |dp|=+6.888210178772E-003
Iteration#005   COND#=+8.389411130372E+012,   |dp|=+4.409478909488E-004
Iteration#006   COND#=+8.389410696729E+012,   |dp|=+8.329025658438E-006
Iteration#007   COND#=+8.389411086177E+012,   |dp|=+1.086414005516E-006
Iteration#008   COND#=+8.389410903492E+012,   |dp|=+4.924823018969E-007
Iteration#009   COND#=+8.389411442562E+012,   |dp|=+4.513286382391E-007
Iteration#010   COND#=+8.389411220728E+012,   |dp|=+7.202951675333E-007
Iteration#011   COND#=+8.389410819159E+012,   |dp|=+7.844279976311E-007
Iteration#012   COND#=+8.389410842729E+012,   |dp|=+7.749195551851E-007
Iteration#013   COND#=+8.389411094512E+012,   |dp|=+5.858844236984E-007
Iteration#014   COND#=+8.389411644130E+012,   |dp|=+4.602456648284E-007
Iteration#015   COND#=+8.389410968645E+012,   |dp|=+2.935340188036E-007
Iteration#016   COND#=+8.389411535018E+012,   |dp|=+5.957123392655E-007
Iteration#017   COND#=+8.389411301391E+012,   |dp|=+5.896685997622E-007
Iteration#018   COND#=+8.389411760859E+012,   |dp|=+3.853703540043E-007
Iteration#019   COND#=+8.389411328730E+012,   |dp|=+4.074082936544E-007
Iteration#020   COND#=+8.389411352248E+012,   |dp|=+7.206468871356E-007
IPF Least Squares Filter Completed with Error |dp1| + |dp2| = +7.2064688713559279E-007
-----------------------------------------------------------------------
Total Execution Time: 343 seconds
```

3 USER COMMENTS

This section left blank.

IPF TEAM CONTACT INFORMATION

IPF Team email		ipf@sirtfweb.jpl.nasa.gov	
David S. Bayard	X4-8208	David.S.Bayard@jpl.nasa.gov	(TEAM LEADER)
Dhemetrio Boussalis	X4-3977	boussali@grover.jpl.nasa.gov	
Paul Brugarolas	X4-9243	Paul.Brugarolas@jpl.nasa.gov	
Bryan H. Kang	X4-0541	Bryan.H.Kang@jpl.nasa.gov	
Edward.C.Wong	X4-3053	Edward.C.Wong@jpl.nasa.gov	(TASK MANAGER)

ACKNOWLEDGEMENTS

This work was performed at the Jet Propulsion Laboratory, California Institute of Technology, under contract with the National Aeronautics and Space Administration.

References

[1] D.S. Bayard, B.H. Kang, *SIRTF Instrument Pointing Frame Kalman Filter Algorithm*, JPL D-Document D-24809, September 30, 2003.

[2] B.H. Kang, D.S. Bayard, *SIRTF Instrument Pointing Frame (IPF) Software Description Document and User's Guide*, JPL D-Document D-24808, September 30, 2003.

[3] D.S. Bayard, B.H. Kang, *SIRTF Instrument Pointing Frame (IPF) Kalman Filter Unit Test Report*, JPL D-Document D-24810, September 30, 2003.

[4] *Space Infrared Telescope Facility In-Orbit Checkout and Science Verification Mission Plan*, JPL D-Document D-22622, 674-FE-301 Version 1.4, February 8, 2002.

[5] *Space Infrared Telescope Facility Observatory Description Document*, Lockheed Martin LMMS/P458569, 674-SEIT-300 Version 1.2, November 1, 2002.

[6] *SIRTF Software Interface Specification for Science Centroid INPUT Files (CAFILE, CS-FILE)*, JPL SOS-SIS-2002, November 18, 2002.

[7] *SIRTF Software Interface Specification for Inferred Frames Offset INPUT Files (OFILE)*, JPL SOS-SIS-2003, November 18, 2002.

[8] *SIRTF Software Interface Specification for PCRS Centroid INPUT Files (CBFILE)*, JPL SIS-FES-015, November 18, 2002.

[9] *SIRTF Software Interface Specification for Attitude INPUT Files (AFILE, ASFILE)*, JPL SIS-FES-014, January 7, 2002.

[10] *SIRTF Software Interface Specification for IPF Filter Output Files (IFFILE, LGFILE, TARFILE)*, JPL SOS-SIS-2005, November 18, 2002.

[11] R.J. Brown, *Focal Surface to Object Space Field of View Conversion.* Systems Engineering Report SER No. S20447-OPT-051, Ball Aerospace & Technologies Corp., November 23, 1999.

JET PROPULSION LABORATORY **SIRTF IPF REPORT**
JPL ID995121
August 27, 2003

SIRTF INSTRUMENT POINTING FRAME KALMAN FILTER EXECUTION SUMMARY

IPF RUN NUMBER: 995121
REPORT TYPE: COVARIANCE ANALYSIS

PRIME FRAME: MIPS_SED_center (121)
INFERRED FRAMES: (113) (114) (116) (117) (1) (1) (1) (1)

IPF TEAM

Autonomy and Control Section (345)
Jet Propulsion Laboratory
California Institute of Technology
4800 Oak Grove Drive
Pasadena, CA 91109

Contents

1 IPF EXECUTION SUMMARY **4**

2 FLUTE DATA SUMMARY **8**

2.1 FLUTE CONFIGURATION PARAMETERS 8

2.2 FLUTE GENERATED UNIT TEST DATA 11

3 IPF EXECUTION RESULTS **16**

3.1 IPF EXECUTION OUTPUT PLOTS 16

3.2 IPF OUTPUT DATA (IF MINI FILE) 30

3.3 IPF EXECUTION LOG 35

4 USER COMMENTS **39**

List of Figures

1.1 A-priori and a-posteriori IPF frames 4

1.2 A-priori and a-posteriori IPF frames (ZOOMED) 7

2.1 Focal plane survey scenario plot (See key in [3]) 12

2.2 Commanded-only source locations 13

2.3 True (+) and commanded (o) source locations 13

2.4 True (+) and commanded (o) source locations (ZOOMED) 14

2.5 True-sampled (o) and centroided (+) locations on S/I array (W,V) 14

2.6 True (o) and centroided (+) locations on S/I array (W,V) 15

2.7 True (o) and centroided (+) locations on S/I array (W,V) showing prime and inferred frames 15

3.1 TPF coords of measurements and a-priori predicts 17

3.2 Oriented Pixel Coords of measurements and a-priori predicts 17

3.3 A-priori prediction error 18

3.4 Oriented Pixel Coords of measurements and a-priori predicts (PCRS only) 18

3.5 IPF execution convergence, chart 1 19

3.6 IPF execution convergence, chart 2 19

3.7 Parameter uncertainty convergence 20

3.8 IPF parameter symbol table 20
3.9 KF parameter error sigma plots 21
3.10 LS parameter error sigma plot 21
3.11 KF and LS parameter error sigma plot 22
3.12 Oriented Pixel Coords of meas. and a-posteriori predicts 23
3.13 Oriented Pixel Coords of meas. and a-posteriori predicts (attitude corrected) 23
3.14 Array plot with (solid) and w/o (dashed) optical distortion corrections 24
3.15 KF innovations with (o) and w/o (+) attitude corrections 24
3.16 W-axis KF innovations and 1-sigma bound 25
3.17 V-axis KF innovations and 1-sigma bound 25
3.18 Estimated attitude corrections (Body frame) 26
3.19 Estimated attitude error sigma plot (Body frame) 26
3.20 Thermo-mechanical boresight drift (equiv. angle in (W,V) coords) 27
3.21 Thermo-mechanical boresight drift (equiv. angle in Body frame) 27
3.22 Gyro drift bias contribution (equiv. rate in (W,V) coords) 28
3.23 Gyro drift bias contribution (equiv. angle in (W,V) coords) 28
3.24 Gyro drift bias contribution (equiv. angle in Body frame) 29

List of Tables

1.1 IPF filter input files 5
1.2 IPF filter execution configuration 5
1.3 IPF filter execution mask vector assignment 5
1.4 IPF calibration error summary ([arcsec], 1-sigma, radial) 6
1.5 Measurement prediction error summary (1-sigma) 6
1.6 IPF Brown angle summary 7
2.1 FLUTE Parameter Table (1) 8
2.2 FLUTE Parameter Table (2) 9
2.3 FLUTE Parameter Table (3) 10
2.4 Table of figures (FLUTE) 11
3.1 Table of figures (IPF run) 16

1 IPF EXECUTION SUMMARY

This report summarizes the SIRTF Instrument Pointing Frame (IPF) Kalman Filter execution associated with run file: RN995121. In particular, this Focal Point Survey calibrates the instrument: MIPS_SED_center (121), as part of the Covariance Analysis. The main calibration results from the IPF filter execution have been documented in IF995121 typically stored in the mission archive DOM collection IPF_IF. This report only summarizes the main aspects of the run, and does not substitute for the full information contained in the IF file.

Section 1 summarizes the filter execution results. The filter configurations are tabulated in Table 1.2 and the mask vector assignments are tabulated in Table 1.3. A total of 23 state parameters are estimated in this run. The overall End-to-End pointing performances are tabulated in Table 1.4. The prediction residuals throughout the estimation processes are tabulated in Table 1.6. Section 2 documents the FLUTE generated input file data. Section 3 summarizes resulting plots, a mini summary of the IF IPF output file, and the execution log. Section 4 captures the user comments that are specific to this particular run.

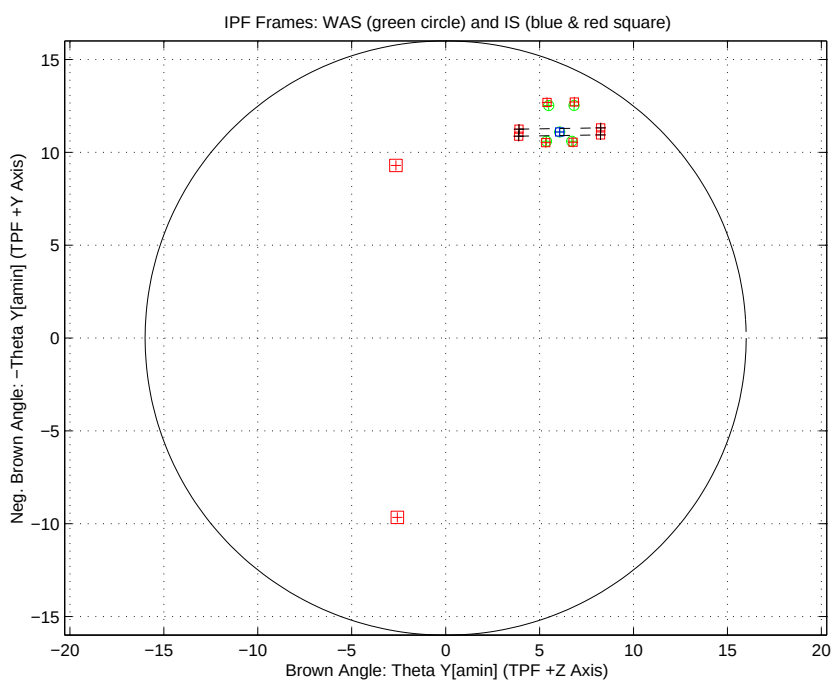

Figure 1.1: A-priori and a-posteriori IPF frames

RAW	FINAL (After Editing)
AA995121	AA995121
AS995121	AS995121
CA995121	CA995121
CB995121	CB995121
CS995121	CS995121

Table 1.1: IPF filter input files

EXECUTION CONFIGURATION ITEM	CURRENT STATUS
IPF Filter Version Used	IPF.V2.0.1Beta
Frame Table Version Used	FTVE2E1
Scan-Mirror Employed?	YES
IPF Filter Mode	NORMAL-MODE(0)
SLIT-MODE Operation	ENABLED
Kalman Filter Operation	ENABLED
Least-Squares Data Analysis	ENABLED
IBAD Screening	ENABLED
User-Specified Data Editing	DISABLED
Total Number of Iterations	30
LS Residual Sigma Scale	9.20167450E-001
Total Number of Maneuvers	6

Table 1.2: IPF filter execution configuration

Con. Plate Scale			Γ Dependent				Γ^2 Dependent				Linear Plate Scale						Mirror	
a_{00}	b_{00}	c_{00}	a_{10}	b_{10}	c_{10}	d_{10}	a_{20}	b_{20}	c_{20}	d_{20}	a_{01}	b_{01}	c_{01}	d_{01}	e_{01}	f_{01}	α	β
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
IPF (T)			Alignment R									Gyro Drift Bias						
θ_1	θ_2	θ_3	a_{rx}	a_{ry}	a_{rz}	b_{rx}	b_{ry}	b_{rz}	c_{rx}	c_{ry}	c_{rz}	b_{gx}	b_{gy}	b_{gz}	c_{gx}	c_{gy}	c_{gz}	
20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	

Table 1.3: IPF filter execution mask vector assignment

FOCAL PLANE SURVEY ANALYSIS: Covariance Analysis.
INSTRUMENT NAME: MIPS_SED_center NF: 121

```
PIX2RADW: 4.79222664E-005[rad/pixel] = 9.8847E+000[arcsec/pixel]
PIX2RADV: 4.79222664E-005[rad/pixel] = 9.8847E+000[arcsec/pixel]
```

FRAME	DESCRIPTION	IPF[1]	SF[2]	ARW[3]	TOTAL	REQ
121(P)	MIPS_SED_center	0.6427	0.0855	0.0936	0.6551	1.10
113(I)	MIPS_SED_5	2.7548	0.0855	0.0936	2.7577	N/A
114(I)	MIPS_SED_6	2.7034	0.0855	0.0936	2.7064	N/A
116(I)	MIPS_SED_7	1.1166	0.0855	0.0936	1.1238	N/A
117(I)	MIPS_SED_8	1.0862	0.0855	0.0936	1.0935	N/A
TR (C)	CORNERS OF INSTRUMENT	1.2580	0.0855	0.0936	1.2644	N/A
BR (C)	CORNERS OF INSTRUMENT	1.2068	0.0855	0.0936	1.2135	N/A
TL (C)	CORNERS OF INSTRUMENT	1.0768	0.0855	0.0936	1.0842	N/A
BL (C)	CORNERS OF INSTRUMENT	1.0703	0.0855	0.0936	1.0777	N/A

Table 1.4: IPF calibration error summary ([arcsec], 1-sigma, radial)

RMS METRIC	A PRIORI[4]	A POSTERIORI[4]	ATT. CORRECTED[5]	UNITS
Radial	5.3188	1.2310	1.2197	arcsec
Radial	0.5381	0.1245	0.1234	pixels
W-Axis	0.4816	0.0970	0.0913	pixels
V-Axis	0.2399	0.0781	0.0830	pixels

Table 1.5: Measurement prediction error summary (1-sigma)

[1]IPF filter removes systematic pointing errors due to: thermomechanical alignment drift (Body to TPF), gyro bias and bias drift, centroiding error, attitude error, and optical distortion. IPF SIGMA presented here is "NOT Scaled" by the Least Squares Scale factor. The Least Squares Scale Factor was: 0.920167.

[2]Error due to gyro Scale Factor: assumes 95 ppm error over 0.250 degree maneuver.

[3]Error due to gyro Angle Random Walk: assumes ARW = 100 $\mu deg/\sqrt{hr}$, with 730 second Maneuver time (max), and 6 independent Maneuvers.

[4]This can be interpreted as estimate of "pixel to sky" pointing reconstruction error if no science data is used.

[5]This can be interpreted as estimate of achieved S/I centroiding error

IPF BROWN ANGLE SUMMARY						
	WAS			IS		
Frame Number	theta_Y (arcmin)	theta_Z (arcmin)	angle (deg)	theta_Y (arcmin)	theta_Z (arcmin)	angle (deg)
121	+6.073000	-11.098000	-0.000000	+6.072481	-11.094429	+0.444676
113	+6.838000	-12.531000	+0.000000	+6.848464	-12.710132	+0.444676
114	+5.487000	-12.525000	+0.000000	+5.397888	-12.685922	+0.444676
116	+6.717000	-10.601000	-0.000000	+6.780053	-10.546127	+0.444676
117	+5.366000	-10.595000	+0.000000	+5.329476	-10.521918	+0.444676
001	+0.000000	+0.000000	+0.000000	+8.254331	-11.320070	+0.444676
001	+0.000000	+0.000000	+0.000000	+8.242361	-10.941416	+0.444676
001	+0.000000	+0.000000	+0.000000	+3.902601	-11.247442	+0.444676
001	+0.000000	+0.000000	+0.000000	+3.890630	-10.868789	+0.444676

Table 1.6: IPF Brown angle summary

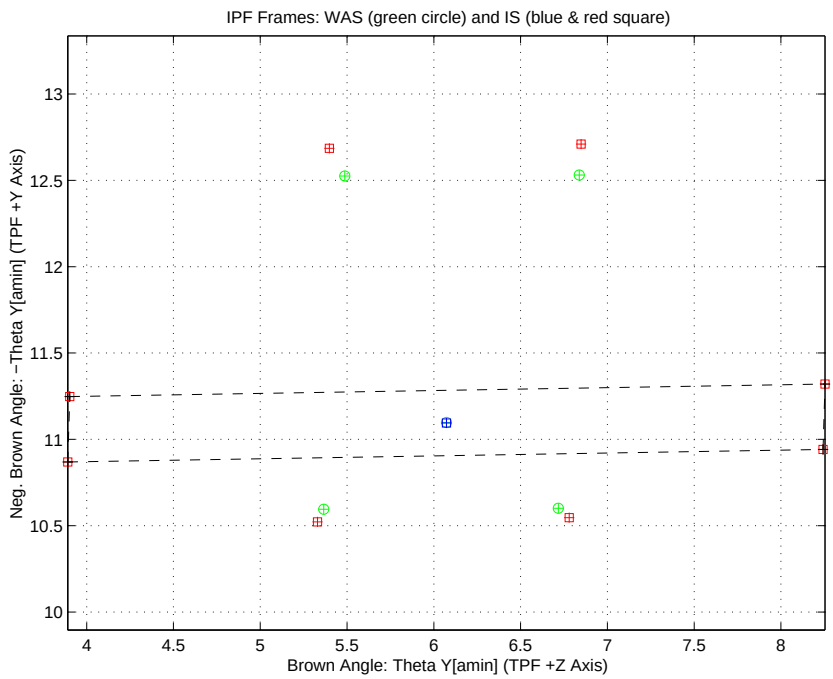

Figure 1.2: A-priori and a-posteriori IPF frames (ZOOMED)

2 FLUTE DATA SUMMARY

2.1 FLUTE CONFIGURATION PARAMETERS

The covariance analysis was performed using the FLUTE generated input data files. The internal configuration parameters, used to produce the data are tabulated in Table 2.1, Table 2.2 and Table 2.3.

NAME	DESCRIPTION	VALUE	UNIT
d2003	days into YEAR2003	+6.0000000000000000E+001	day
tstart	start time	+7.3051200000000000E+008	sec
tdel	data rate	+1.0000000000000001E-001	sec
tshelf	Inertial Hold duration pad	+5.0000000000000000E+000	sec
ipro	slew profile(1-linear, 2-S-curve)	1	int flag
sig_gcf [1]	gcf sigma(1)	+4.8481368110953601E-008	rad/sec
sig_gcf [2]	gcf sigma(2)	+9.6962736221907205E-009	rad/sec
sig_gcf [3]	gcf sigma(3)	+9.6962736221907205E-009	rad/sec
igcf	gcf bias correction flag	1	int flag
SigA [1][1]	Sigma A(1,1)	+9.4017722156391537E-009	rad^2
SigA [2][2]	Sigma A(2,2)	+2.3504430539097885E-011	rad^2
SigA [3][3]	Sigma A(3,3)	+2.3504430539097885E-011	rad^2
NFprime	Prime Frame NF	121	int
ftable [name]	Frame Table row number	121	int
ftable [q0]	Frametable quaternion q0	+1.4257389017362338E-006	N/A
ftable [q1]	Frametable quaternion q1	-8.8328078008885079E-004	N/A
ftable [q2]	Frametable quaternion q2	+1.6141373392967960E-003	N/A
ftable [q3]	Frametable quaternion q3	+9.9999830718540750E-001	N/A
ft_cmd [name]	Command row number	121	int
ft_cmd [q0]	Command quaternion q0	+1.4257389017362338E-006	N/A
ft_cmd [q1]	Command quaternion q1	-8.8328078008885079E-004	N/A
ft_cmd [q2]	Command quaternion q2	+1.6141373392967960E-003	N/A
ft_cmd [q3]	Command quaternion q3	+9.9999830718540750E-001	N/A
ft_true [name]	Truth row number	121	int
ft_true [q0]	Truth quaternion q0	+1.4257389017362338E-006	N/A
ft_true [q1]	Truth quaternion q1	-8.8328078008885079E-004	N/A
ft_true [q2]	Truth quaternion q2	+1.6141373392967960E-003	N/A
ft_true [q3]	Truth quaternion q3	+9.9999830718540750E-001	N/A
ft_prior [name]	Prior row number	121	int
ft_prior [q0]	FTprior quaternion q0	+1.4257389017362338E-006	N/A
ft_prior [q1]	FTprior quaternion q1	-8.8328078008885079E-004	N/A
ft_prior [q2]	FTprior quaternion q2	+1.6141373392967960E-003	N/A
ft_prior [q3]	FTprior quaternion q3	+9.9999830718540750E-001	N/A
ntable [NF]	ntable row number	121	int
ntable [iprime]	Prime frame indication flag	1	int
ntable [SIG_CX]	CX Sigma	+1.0000000000000001E-001	pixel
ntable [SIG_CY]	CY Sigma	+1.0000000000000001E-001	pixel
ntable [PIX2RADX]	Nom. angular pixelsize X-dir	+4.7922266400000000E-005	rad/pixel
ntable [PIX2RADY]	Nom. angular pixelsize Y-dir	+4.8814231500000000E-005	rad/pixel
ntable [CX0]	Center pixel along X-axis	+1.2500000000000000E+001	pixel
ntable [CY0]	Center pixel along Y-axis	+1.6500000000000000E+001	pixel
ntable [BETA0]	Nominal mirror scale factor	+2.8047410000000001E-006	rad/(e.u.)
ntable [GAMMA_E0]	Reference Mirror position	+3.2200000000000000E+003	(e.u.[6])

Table 2.1: FLUTE Parameter Table (1)

[6] encoder units

NAME	DESCRIPTION	VALUE	UNIT
ntable [D11]	x-to-w frame flip parameter	-1	int
ntable [D12]	y-to-w frame flip parameter	0	int
ntable [D21]	x-to-v frame flip parameter	0	int
ntable [D22]	y-to-v frame flip parameter	-1	int
ntable [DG]	Mirror flip parameter	1	int
ntable [sisizew]	Array size (w-direction)	+1.1635528346628863E-003	pixel
ntable [sisizev]	Array size (v-direction)	+9.5993108859688124E-005	pixel
ntable [p2i_w]	w-offset from prime	+0.0000000000000000E+000	pixel
ntable [p2i_v]	v-offset from prime	+0.0000000000000000E+000	pixel
p1true [a00]	True Constant Plate Scales	+1.0000000000000001E-001	N/A
p1true [b00]	True Constant Plate Scales	+1.0000000000000001E-001	N/A
p1true [c00]	True Constant Plate Scales	+1.0000000000000000E-002	N/A
p1true [a10]	True Γ Dependent Plate Scales	+1.0000000000000001E-001	1/rad
p1true [b10]	True Γ Dependent Plate Scales	+1.0000000000000001E-001	1/rad
p1true [c10]	True Γ Dependent Plate Scales	+1.0000000000000000E-002	1/rad
p1true [d10]	True Γ Dependent Plate Scales	+1.0000000000000000E-002	1/rad
p1true [a20]	True Γ^2 Dependent Plate Scales	+1.0000000000000001E-001	$1/\mathrm{rad}^2$
p1true [b20]	True Γ^2 Dependent Plate Scales	+1.0000000000000001E-001	$1/\mathrm{rad}^2$
p1true [c20]	True Γ^2 Dependent Plate Scales	+1.0000000000000000E-002	$1/\mathrm{rad}^2$
p1true [d20]	True Γ^2 Dependent Plate Scales	+1.0000000000000000E-002	$1/\mathrm{rad}^2$
p1true [a01]	True Linear Plate Scales	+2.0000000000000000E+000	N/A
p1true [b01]	True Linear Plate Scales	+2.0000000000000000E+000	N/A
p1true [c01]	True Linear Plate Scales	+2.0000000000000000E+000	N/A
p1true [d01]	True Linear Plate Scales	+2.0000000000000000E+000	N/A
p1true [e01]	True Linear Plate Scales	+2.0000000000000000E+000	N/A
p1true [f01]	True Linear Plate Scales	+2.0000000000000000E+000	N/A
p2true [am1]	True Scan mirror alignment Ux	+0.0000000000000000E+000	N/A
p2true [am2]	True Scan mirror alignment Uy	+2.0000000000000000E-002	N/A
p2true [am3]	True Scan mirror alignment Uz	+9.9979997999599901E-001	N/A
p2true [beta]	True Scan mirror scale factor	+1.1000000000000001E+000	N/A
p2true [qT1]	True IPF q1	+1.4257389017362338E-006	N/A
p2true [qT2]	True IPF q2	-8.8328078008885079E-004	N/A
p2true [qT3]	True IPF q3	+1.6141373392967960E-003	N/A
p2true [qT4]	True IPF q4	+9.9999830718540750E-001	N/A
p2true [qR01]	True Boresight Alignment q1	+2.4240684048319150E-005	N/A
p2true [qR02]	True Boresight Alignment q2	+1.2120342024159575E-006	N/A
p2true [qR03]	True Boresight Alignment q3	+1.2120342024159575E-006	N/A
p2true [qR04]	True Boresight Alignment q4	+9.9999999970472575E-001	N/A
p2true [brx]	True B. Alignment drift rate X	+5.6000000000000000E-011	rad/sec
p2true [bry]	True B. Alignment drift rate Y	+5.6000000000000000E-011	rad/sec
p2true [brz]	True B. Alignment drift rate Z	+5.6000000000000000E-011	rad/sec
p2true [crx]	True B. Alignment drift accel. X	+5.0000000000000002E-014	$\mathrm{rad/sec}^2$
p2true [cry]	True B. Alignment drift accel. Y	+5.0000000000000002E-014	$\mathrm{rad/sec}^2$
p2true [crz]	True B. Alignment drift accel. Z	+5.0000000000000002E-014	$\mathrm{rad/sec}^2$
p2true [bgx]	True Gyro bias correction X	+2.5000000000000002E-006	rad/sec
p2true [bgy]	True Gyro bias correction Y	+2.5000000000000002E-006	rad/sec
p2true [bgz]	True Gyro bias correction Z	+2.5000000000000002E-006	rad/sec
p2true [cgx]	True Gyro bias-rate correction X	+4.9999999999999999E-013	$\mathrm{rad/sec}^2$
p2true [cgy]	True Gyro bias-rate correction Y	+4.9999999999999999E-013	$\mathrm{rad/sec}^2$
p2true [cgz]	True Gyro bias-rate correction Z	+4.9999999999999999E-013	$\mathrm{rad/sec}^2$

Table 2.2: FLUTE Parameter Table (2)

NAME	DESCRIPTION	VALUE	UNIT
p2cmd [am1]	CMD Scan mirror alignment Ux	+0.0000000000000000E+000	N/A
p2cmd [am2]	CMD Scan mirror alignment Uy	+0.0000000000000000E+000	N/A
p2cmd [am3]	CMD Scan mirror alignment Uz	+1.0000000000000000E+000	N/A
p2cmd [beta]	CMD Scan mirror rotation SF	+1.0000000000000000E+000	N/A
p2cmd [qT1]	CMD IPF q1	+1.4257389017362338E-006	N/A
p2cmd [qT2]	CMD IPF q2	-8.8328078008885079E-004	N/A
p2cmd [qT3]	CMD IPF q3	+1.6141373392967960E-003	N/A
p2cmd [qT4]	CMD IPF q4	+9.9999830718540750E-001	N/A
p2cmd [qR01]	CMD Boresight Alignment q1	+0.0000000000000000E+000	N/A
p2cmd [qR02]	CMD Boresight Alignment q2	+0.0000000000000000E+000	N/A
p2cmd [qR03]	CMD Boresight Alignment q3	+0.0000000000000000E+000	N/A
p2cmd [qR04]	CMD Boresight Alignment q4	+1.0000000000000000E+000	N/A
p2cmd [brx]	CMD B. Alignment drift rate X	+0.0000000000000000E+000	rad/sec
p2cmd [bry]	CMD B. Alignment drift rate Y	+0.0000000000000000E+000	rad/sec
p2cmd [brz]	CMD B. Alignment drift rate Z	+0.0000000000000000E+000	rad/sec
p2cmd [crx]	CMD B. Alignment drift accel. X	+0.0000000000000000E+000	rad/sec^2
p2cmd [cry]	CMD B. Alignment drift accel. Y	+0.0000000000000000E+000	rad/sec^2
p2cmd [crz]	CMD B. Alignment drift accel. Z	+0.0000000000000000E+000	rad/sec^2
p2cmd [bgx]	CMD Gyro bias correction X	+0.0000000000000000E+000	rad/sec
p2cmd [bgy]	CMD Gyro bias correction Y	+0.0000000000000000E+000	rad/sec
p2cmd [bgz]	CMD Gyro bias correction Z	+0.0000000000000000E+000	rad/sec
p2cmd [cgx]	CMD Gyro bias-rate correction X	+0.0000000000000000E+000	rad/sec^2
p2cmd [cgy]	CMD Gyro bias-rate correction Y	+0.0000000000000000E+000	rad/sec^2
p2cmd [cgz]	CMD Gyro bias-rate correction Z	+0.0000000000000000E+000	rad/sec^2
a1	Semi-Major Axis of SIRTF (HCO [7])	+1.4960000000000000E+011	m
a2	Semi-Major Axis of Earth (HCO)	+1.4960000000000000E+011	m
e1	Eccentricity (SIRTF in HCO)	+1.6722000000000001E-002	N/A
e2	Eccentricity (Earth in HCO)	+1.6722000000000001E-002	N/A
inc1	inclination (SIRTF in HCO)	+4.0142572795869580E-001	rad
inc2	inclination (Earth in HCO)	+4.0142572795869580E-001	rad
Omega1	Ascending Node Long.(SIRTF in HCO)	+0.0000000000000000E+000	rad
Omega2	Ascending Node Long.(Earth in HCO)	+0.0000000000000000E+000	rad
omega1	Argument of Perigee(SIRTF in HCO)	+1.7627825445142729E+000	rad
omega2	Argument of Perigee(Earth in HCO)	+1.7627825445142729E+000	rad
nu0_1	True Anomaly of SIRTF(HCO)	+8.6071031605199810E-001	rad
nu0_2	True Anomaly of Earth(HCO)	+1.0328523792623976E+000	rad
inav	Velocity Report Flag	+0.0000000000000000E+000	rad
wsize	Array size W-dir	+1.1635528346628863E-003	rad
vsize	Array size V-dir	+9.5993108859688124E-005	rad
SigwDisp	CW Sigma, dispersion Xing	N/A	arcsec
SigvDisp	CV-Sigma, dispersion Xing	N/A	arcsec
SigwCross	CW-Sigma, cross-dispersion Xing	N/A	arcsec
SigvCross	CV-Sigma, cross-dispersion Xing	N/A	arcsec

Table 2.3: FLUTE Parameter Table (3)

[7] Heliocentric Orbit

2.2 FLUTE GENERATED UNIT TEST DATA

This subsection plots the FLUTE generated IPF filter input files. Seven figures, as tabulated in Table 2.4, show the campaign maneuver senario, the true sampled locations on the array and the actual centroided data superimposed the array plane. All angles shown in FLUTE plots have units of radians.

FIGURE NO.	DESCRIPTION
Figure 2.1	Focal Plane Survey Scenario Plot
Figure 2.2	Commanded-only source locations in TPF
Figure 2.3	True and commanded source locations in TPF
Figure 2.4	True and commanded source locations (ZOOMED) in TPF
Figure 2.5	True-sampled and centroided locations in Focal Plane (W,V) including rectangular array boundary approximation
Figure 2.6	True and centroided locations on S/I Array (W,V) including rectangular array boundary approximation
Figure 2.7	True and centroided locations on S/I Array (W,V) showing Prime and Inferred Frames including rectangular array boundary approximation

Table 2.4: Table of figures (FLUTE)

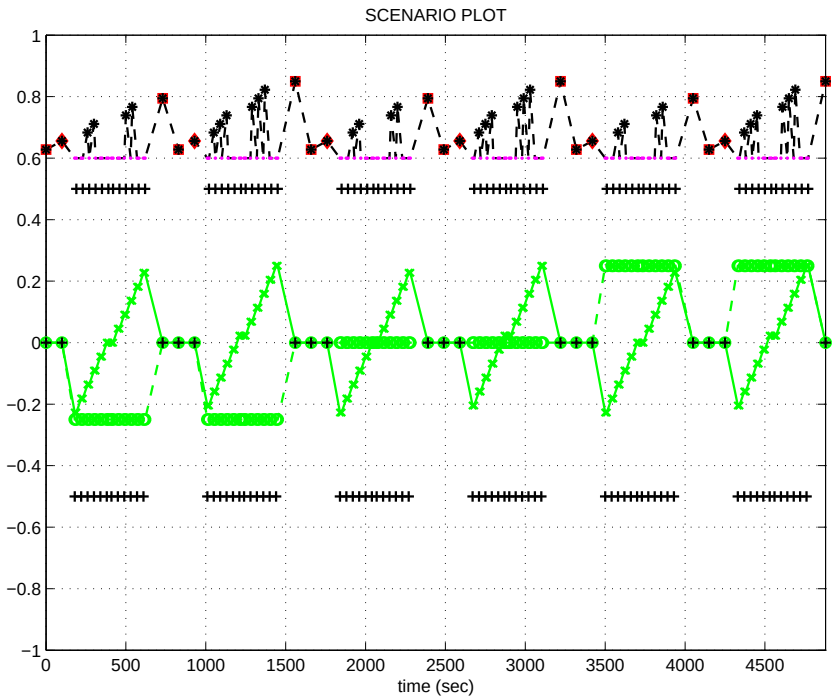

Figure 2.1: Focal plane survey scenario plot (See key in [3])

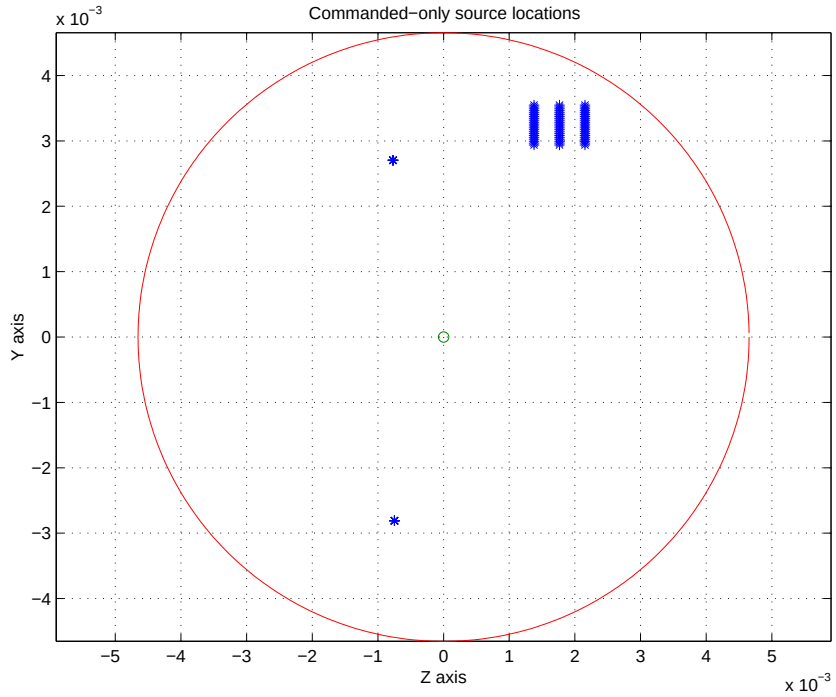

Figure 2.2: Commanded-only source locations

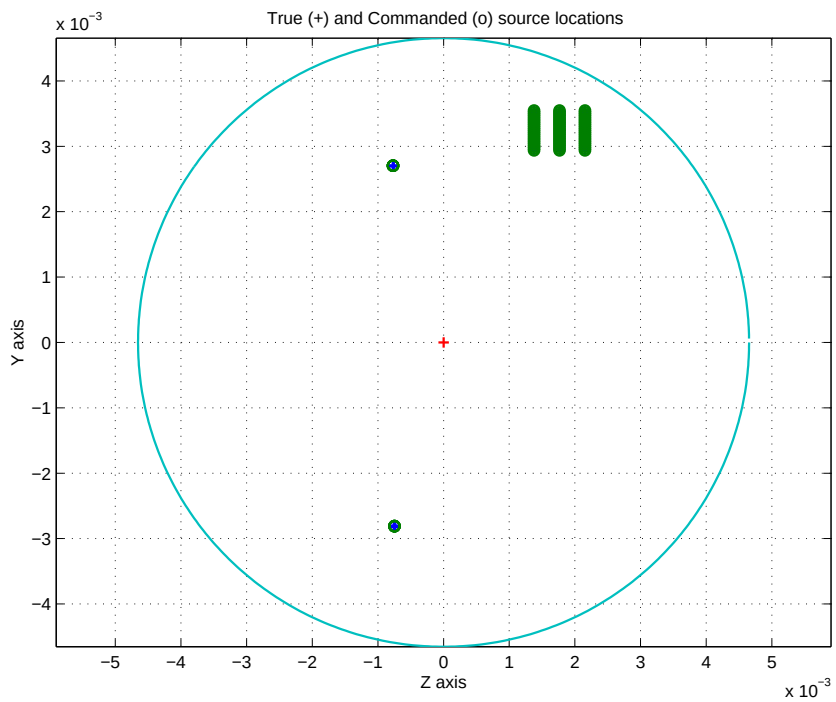

Figure 2.3: True (+) and commanded (o) source locations

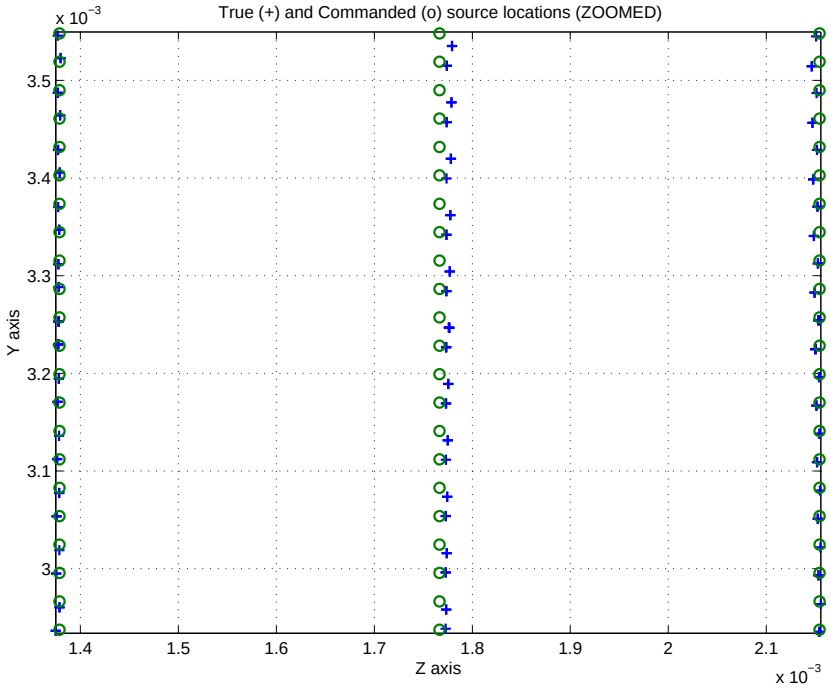

Figure 2.4: True (+) and commanded (o) source locations (ZOOMED)

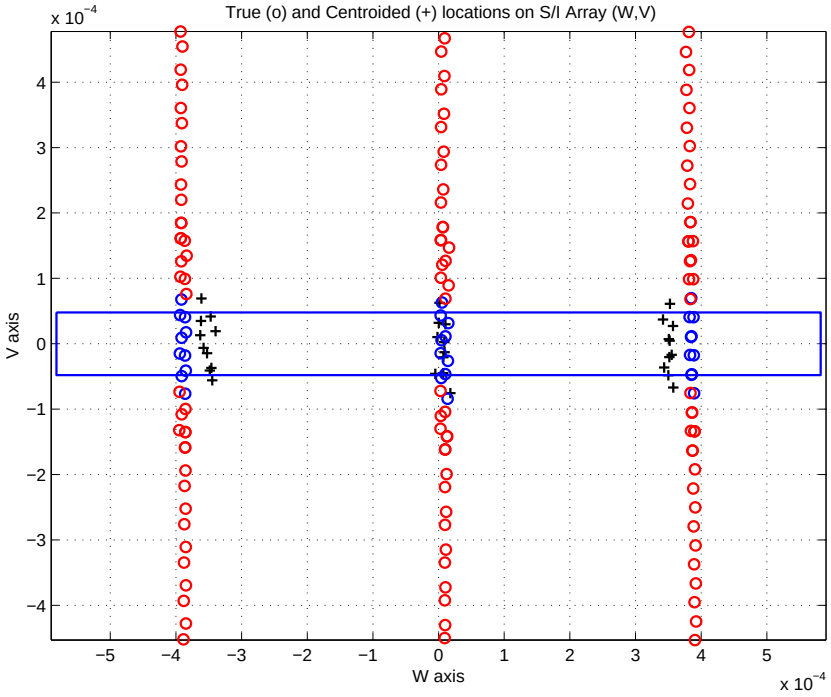

Figure 2.5: True-sampled (o) and centroided (+) locations on S/I array (W,V)

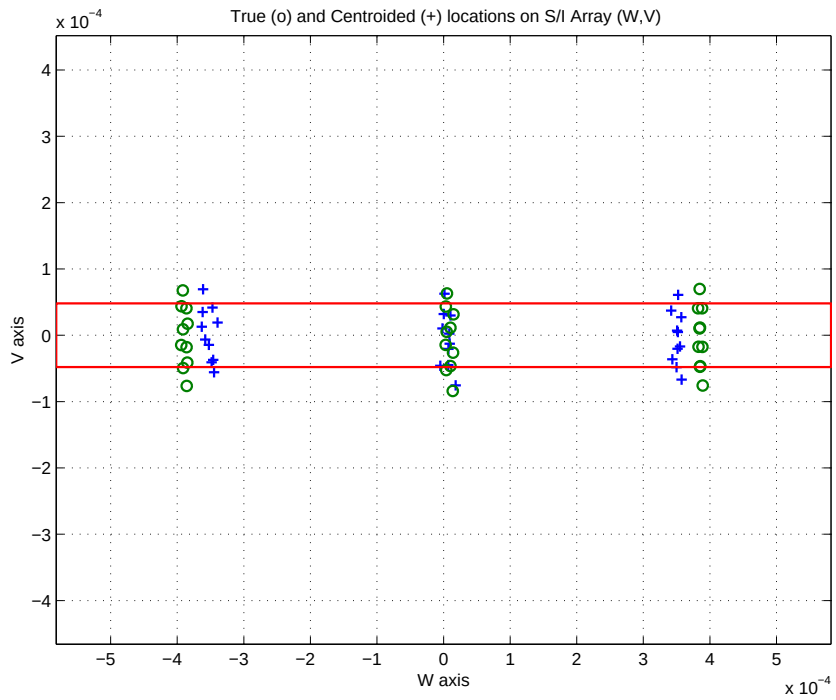

Figure 2.6: True (o) and centroided (+) locations on S/I array (W,V)

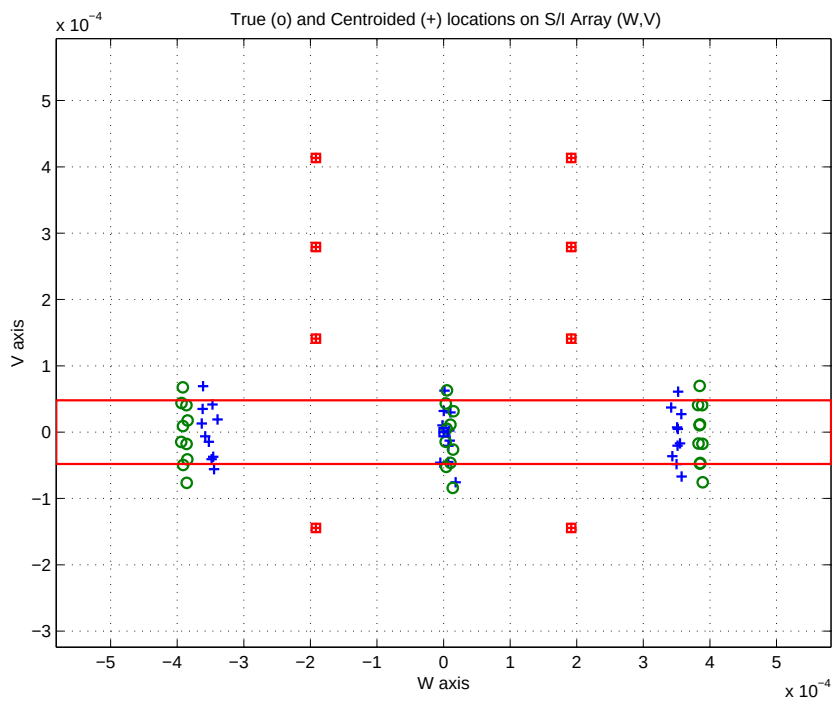

Figure 2.7: True (o) and centroided (+) locations on S/I array (W,V) showing prime and inferred frames

3 IPF EXECUTION RESULTS

3.1 IPF EXECUTION OUTPUT PLOTS

This subsection summarizes the IPF filter results. As shown in Table 3.1, the output plots are segmented to three groups: predicted performance, post-run results and IPF trending plots.

FIGURE NO.	DESCRIPTION
Predicted performance prior to IPF run	
Figure 3.1	Meas. and a-priori predicts in TPF coords
Figure 3.2	Meas. and a-priori predicts in Oriented Pixel Coords including rectangular array boundary approximation
Figure 3.3	A-priori prediction error
Figure 3.4	Oriented Pixel Coords of measurements and a-priori predicts (PCRS only)
IPF filter performance (post run results)	
Figure 3.5	IPF execution convergence, chart 1: (top) normalized residual error vs. iteration number and (bottom) norm of effective parameter corrections
Figure 3.6	IPF execution convergence, chart 2: parameter correction size vs. iteration number
Figure 3.7	Parameter uncertainty convergence: square-root of diagonal elements of covariance matrix vs. maneuver number
Figure 3.8	IPF parameter symbol table
Figure 3.9	KF parameter error sigma plot (a-priori-dashed, a-posteriori-solid). Includes true parameter errors (FLUTE runs only)
Figure 3.10	LS parameter error sigma plot. Includes true parameter errors (FLUTE runs only)
Figure 3.11	KF and LS parameter errors sigma plot (Figure 3.9 & Figure 3.10 combined)
Figure 3.12	Measurements and a-posteriori predicts in Oriented Pixel Coords including rectangular array boundaries (a-priori-dashed, a-posteriori-solid)
Figure 3.13	Attitude corrected meas. and a-posteriori predicts in Oriented Pixel Coords including rectangular array boundaries (a-priori-dashed, a-posteriori-solid)
Figure 3.14	Array plot with (solid) and w/o (dashed) optical distortion corrections
Figure 3.15	KF innovations with (o) and w/o (+) attitude corrections
Figure 3.16	W-axis KF innovations and 1-sigma bound
Figure 3.17	V-axis KF innovations and 1-sigma bound
IPF parameter trending plots	
Figure 3.18	Estimated attitude corrections (Body frame)
Figure 3.19	Estimated attitude error sigma plot (Body frame)
Figure 3.20	Systematic error attributed to thermo-mechanical boresight drift (equiv. angle in (W,V) coords)
Figure 3.21	Systematic error attributed to thermo-mechanical boresight drift (equiv. angle in Body frame)
Figure 3.22	Systematic error attributed to gyro drift bias (equiv. rate in (W,V) coords)
Figure 3.23	Systematic error attributed to gyro drift bias (equiv. angle in (W,V) coords)
Figure 3.24	Systematic error attributed to gyro drift bias (equiv. angle in Body frame)

Table 3.1: Table of figures (IPF run)

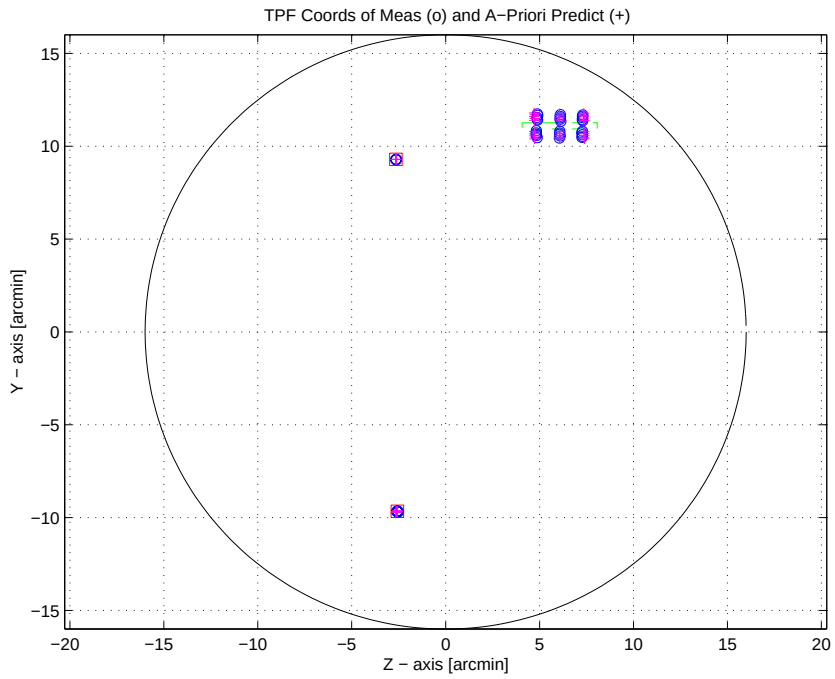

Figure 3.1: TPF coords of measurements and a-priori predicts

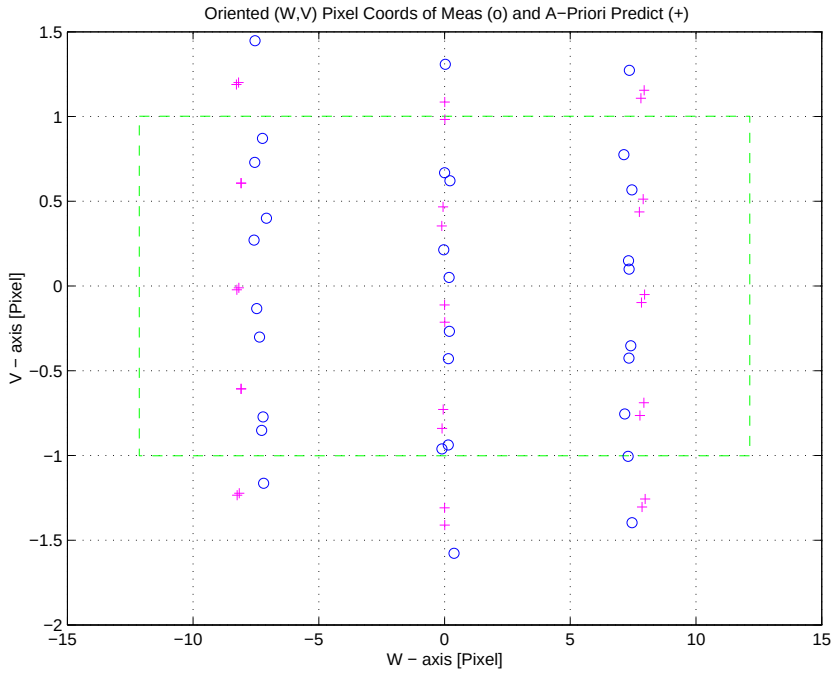

Figure 3.2: Oriented Pixel Coords of measurements and a-priori predicts

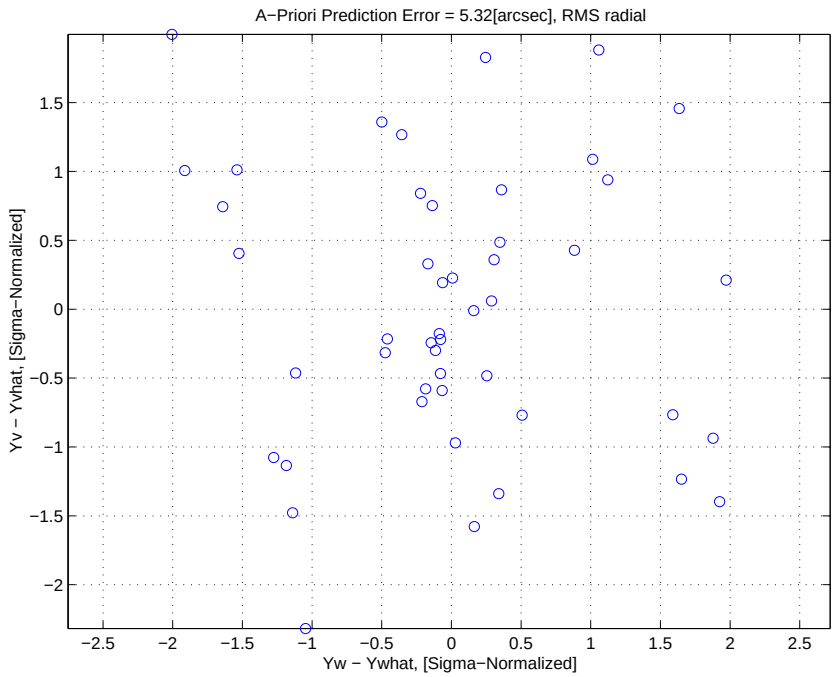

Figure 3.3: A-priori prediction error

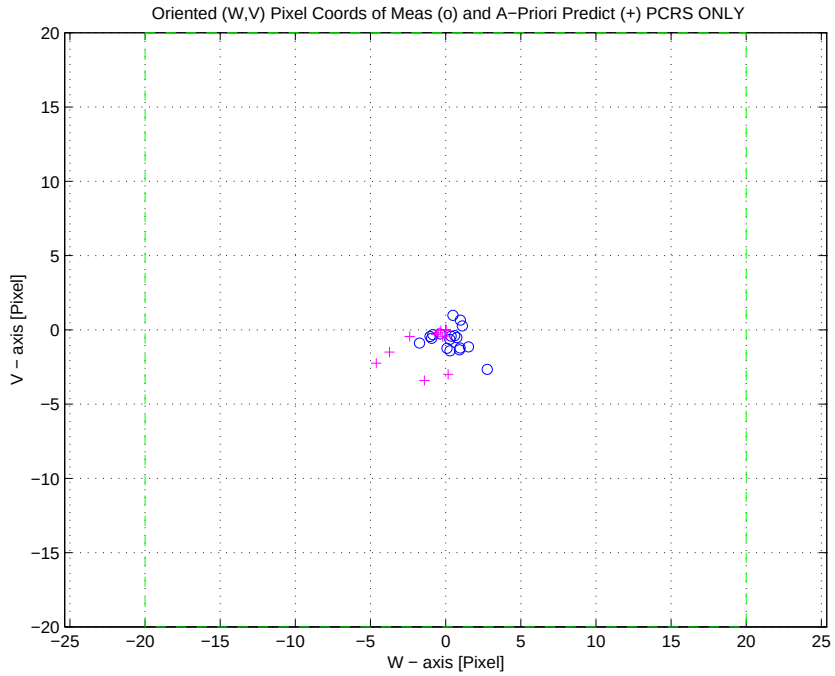

Figure 3.4: Oriented Pixel Coords of measurements and a-priori predicts (PCRS only)

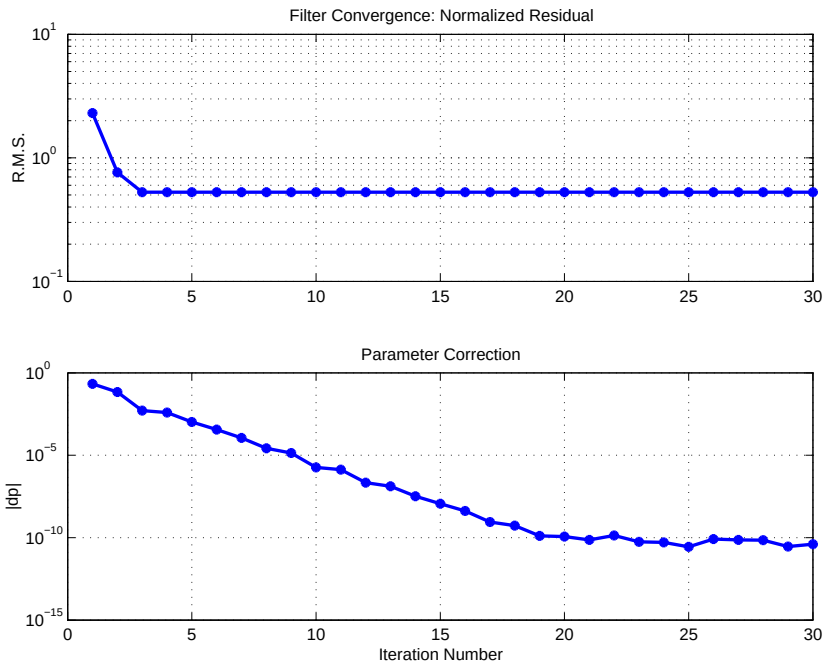

Figure 3.5: IPF execution convergence, chart 1

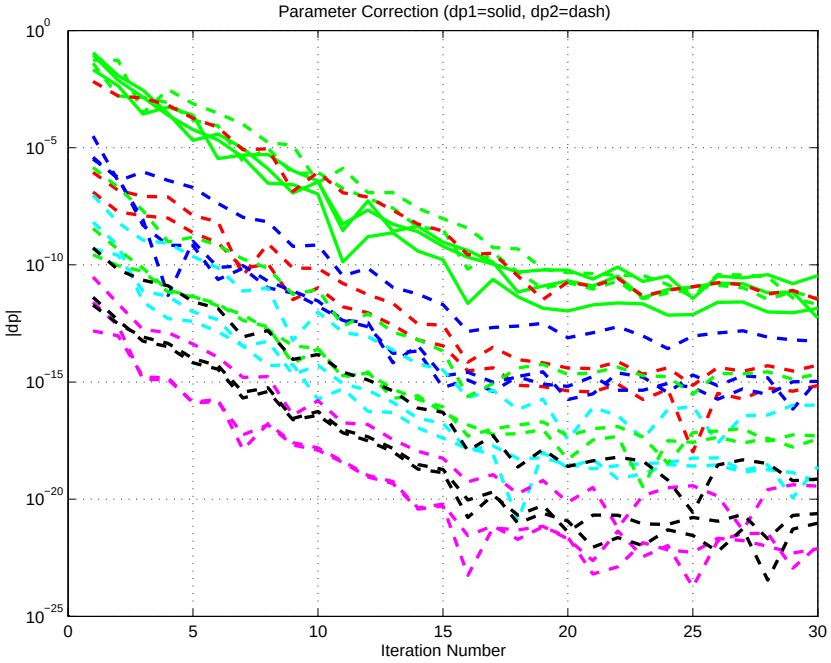

Figure 3.6: IPF execution convergence, chart 2

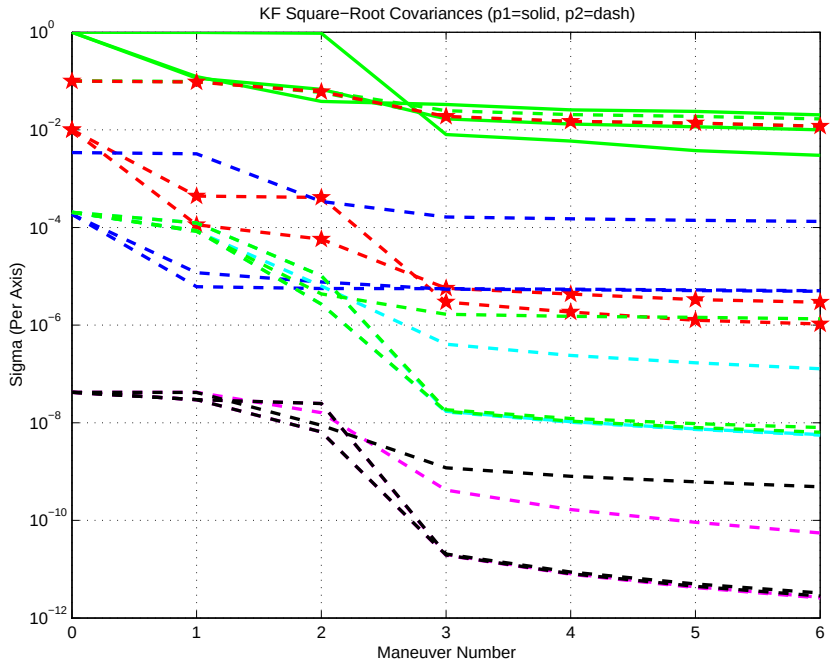

Figure 3.7: Parameter uncertainty convergence

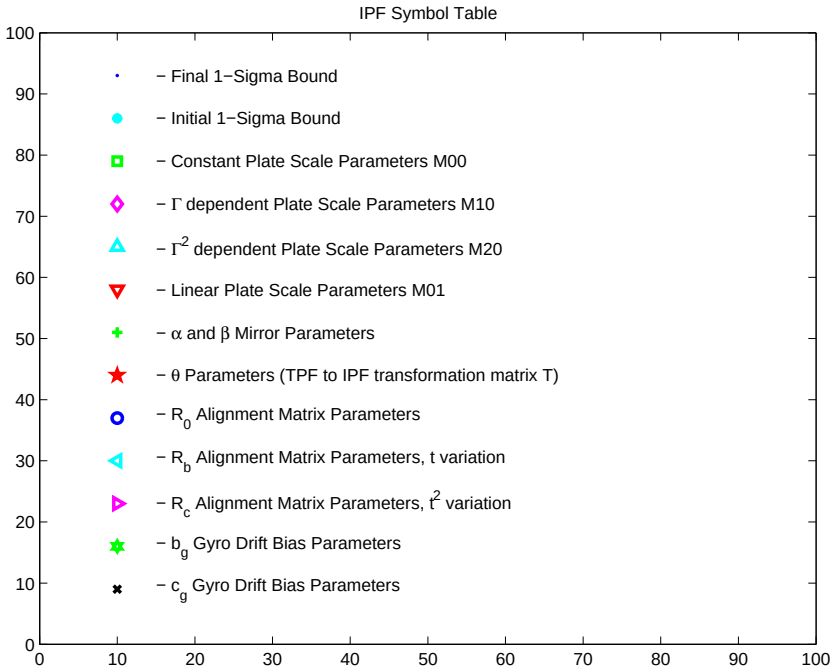

Figure 3.8: IPF parameter symbol table

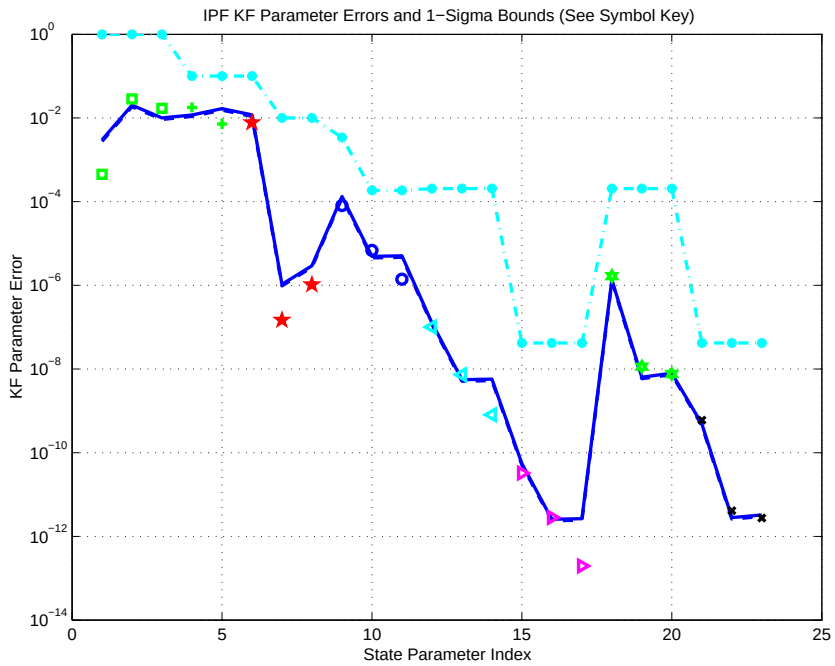

Figure 3.9: KF parameter error sigma plots

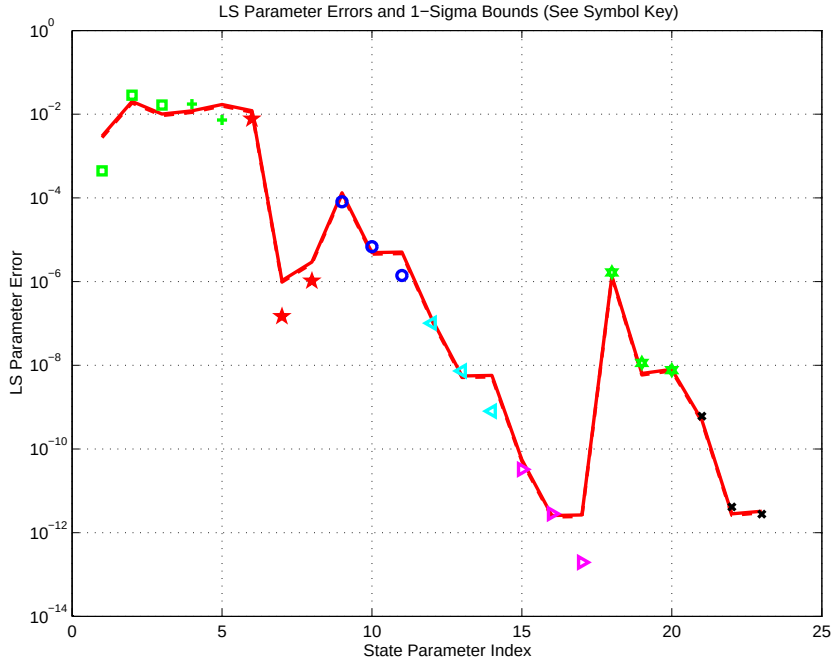

Figure 3.10: LS parameter error sigma plot

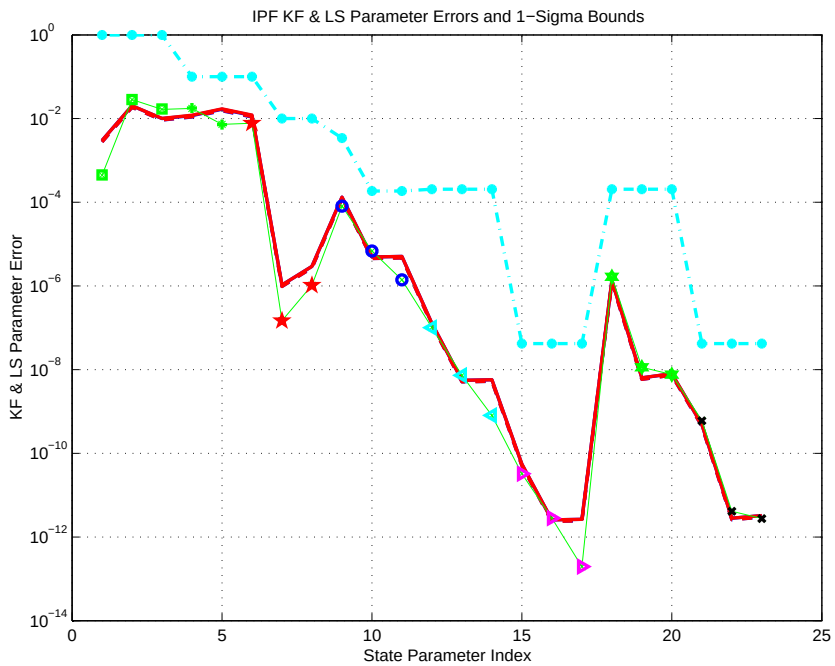

Figure 3.11: KF and LS parameter error sigma plot

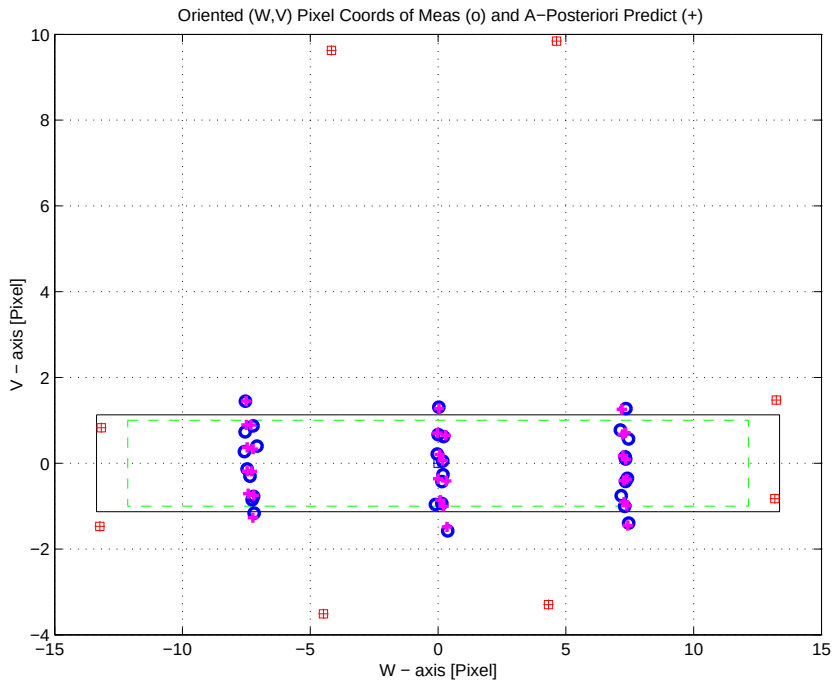

Figure 3.12: Oriented Pixel Coords of meas. and a-posteriori predicts

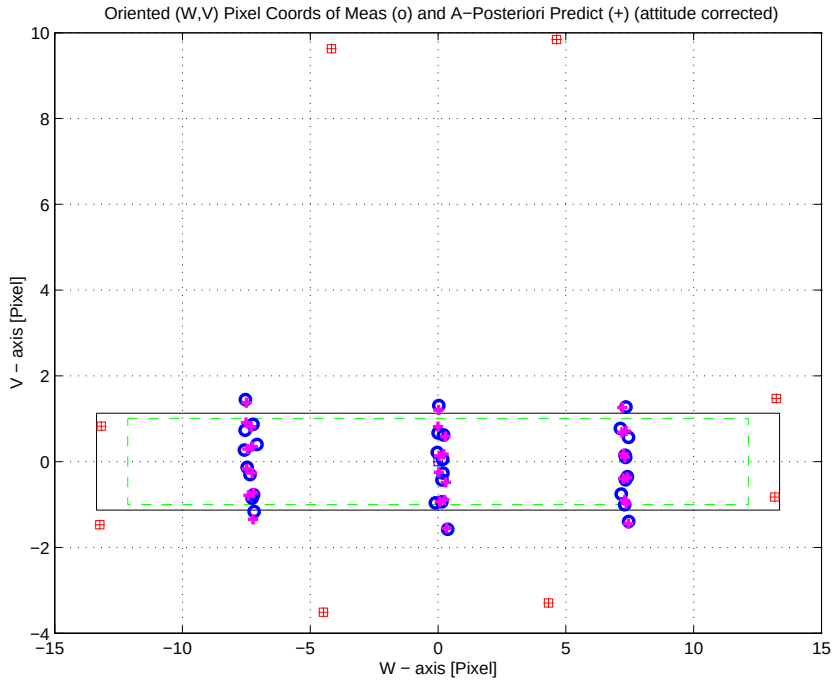

Figure 3.13: Oriented Pixel Coords of meas. and a-posteriori predicts (attitude corrected)

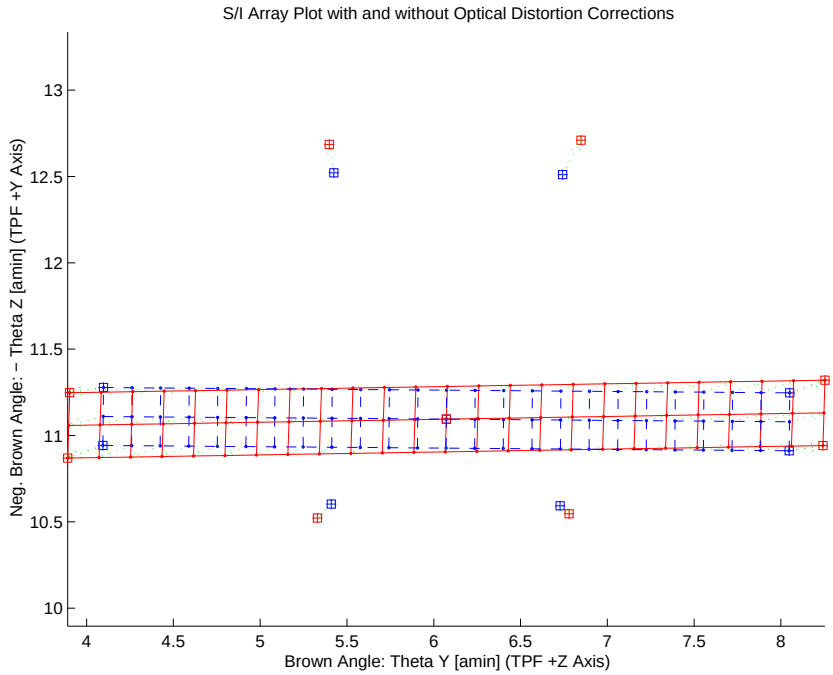

Figure 3.14: Array plot with (solid) and w/o (dashed) optical distortion corrections

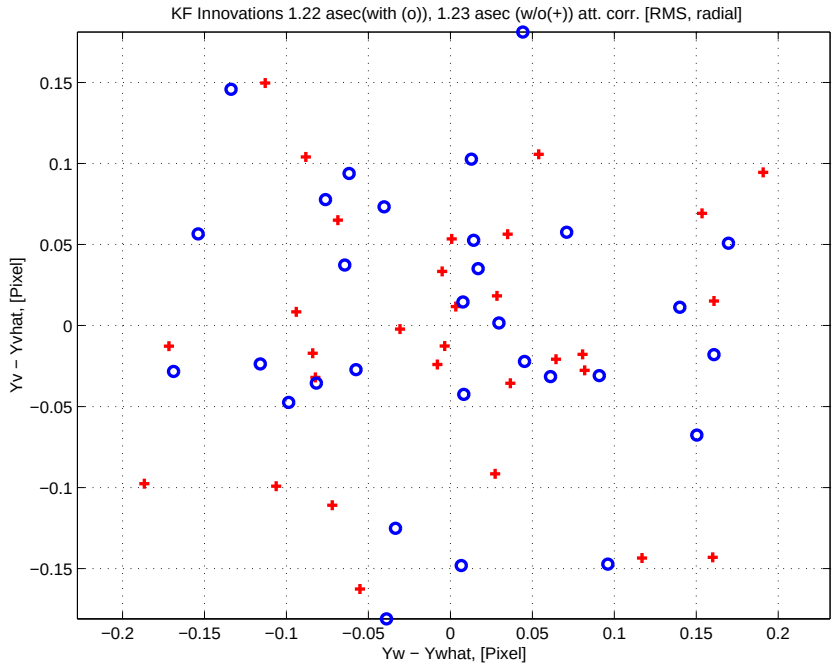

Figure 3.15: KF innovations with (o) and w/o (+) attitude corrections

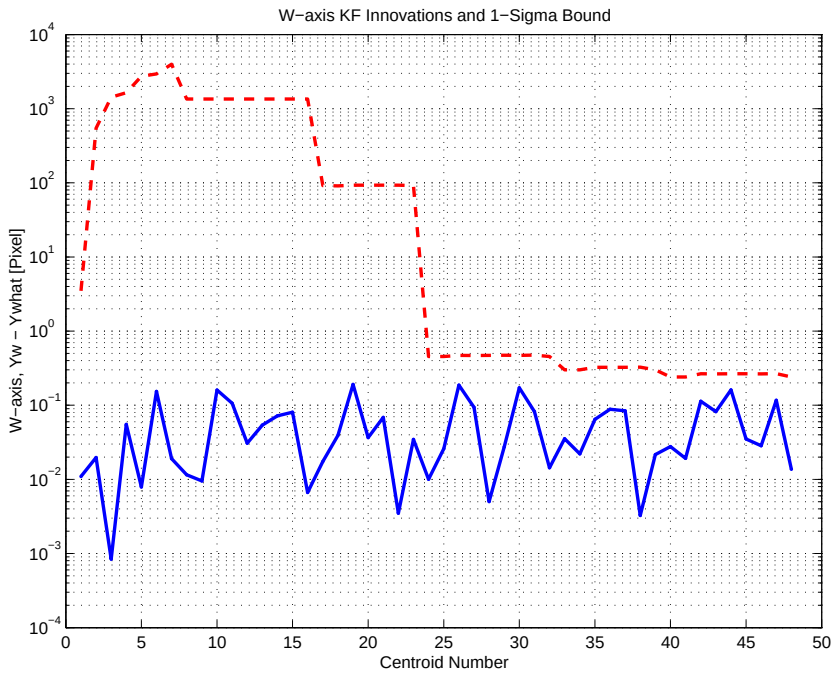

Figure 3.16: W-axis KF innovations and 1-sigma bound

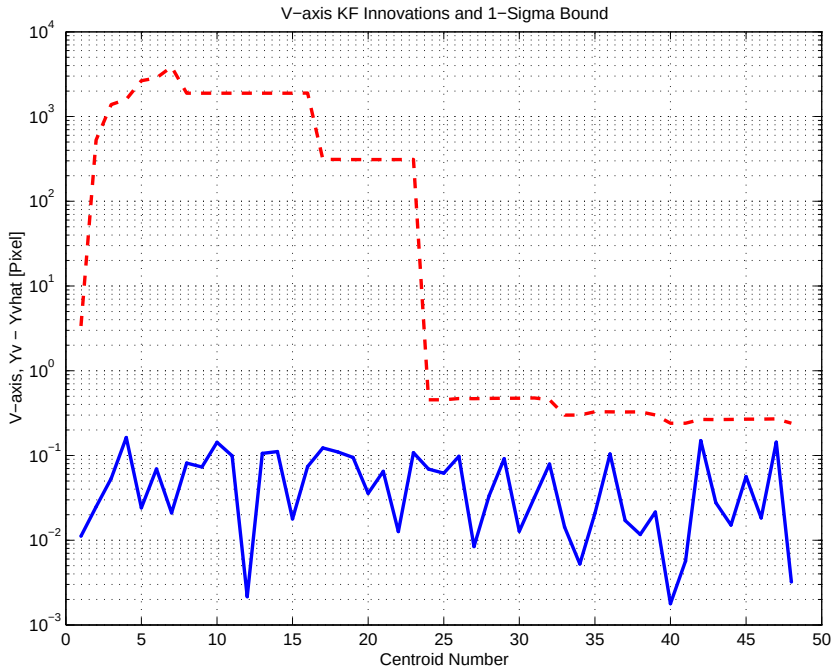

Figure 3.17: V-axis KF innovations and 1-sigma bound

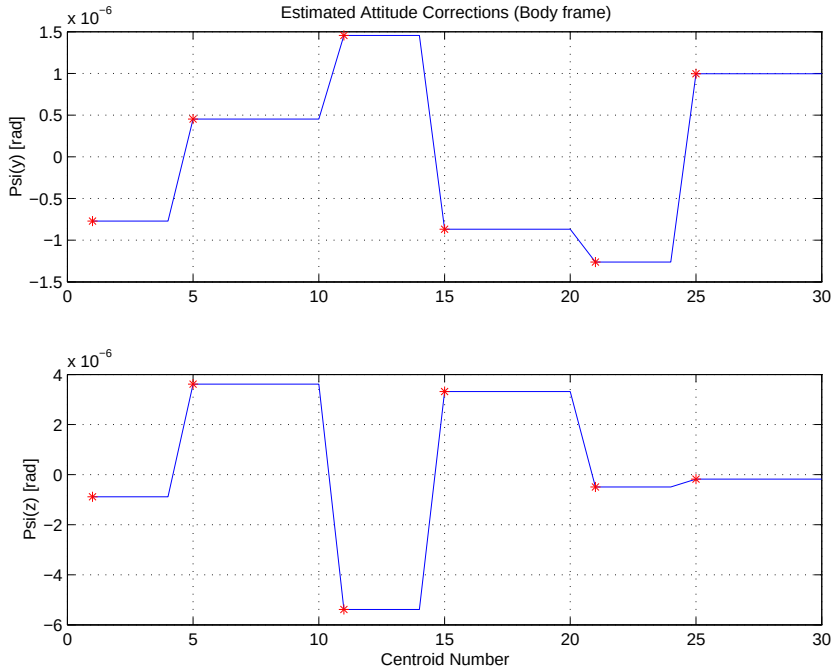

Figure 3.18: Estimated attitude corrections (Body frame)

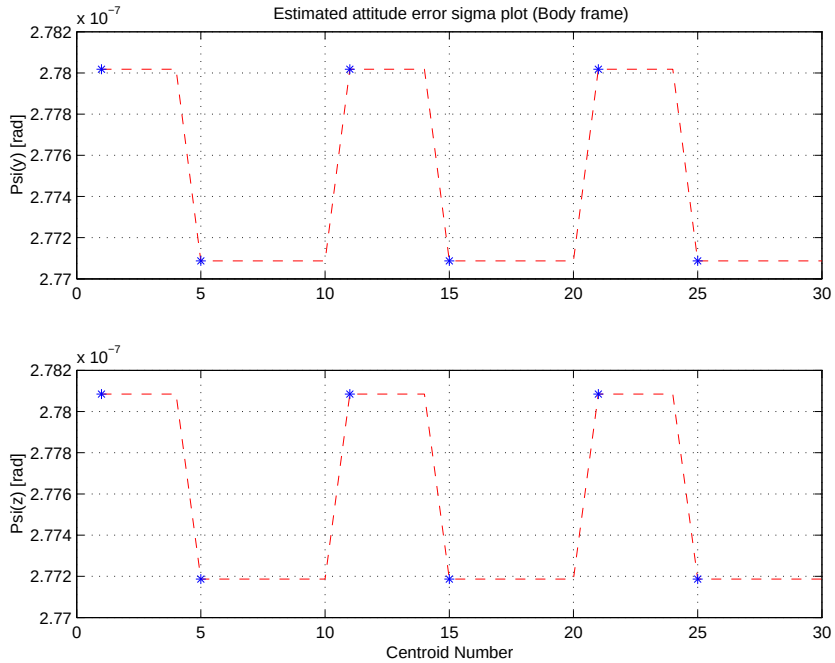

Figure 3.19: Estimated attitude error sigma plot (Body frame)

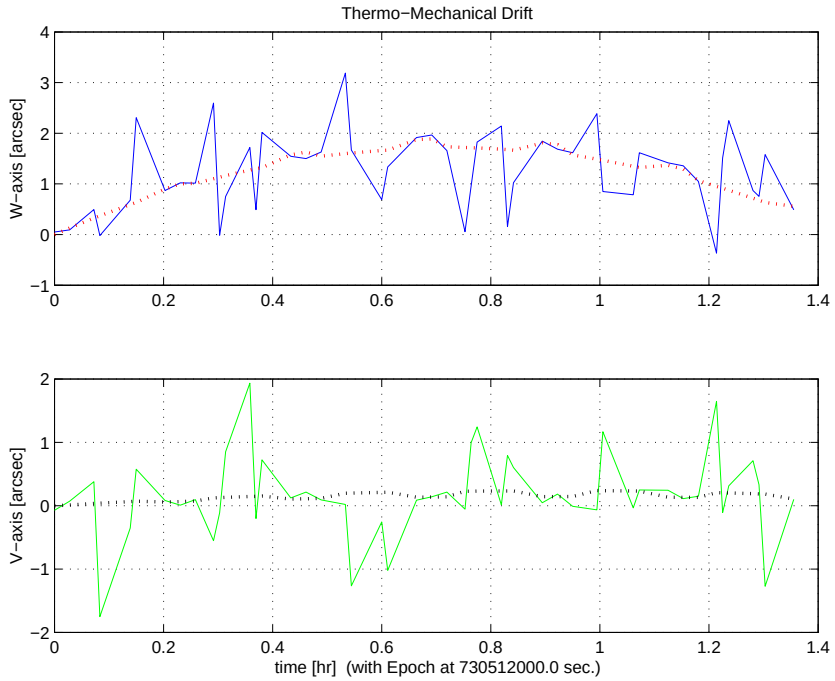

Figure 3.20: Thermo-mechanical boresight drift (equiv. angle in (W,V) coords)

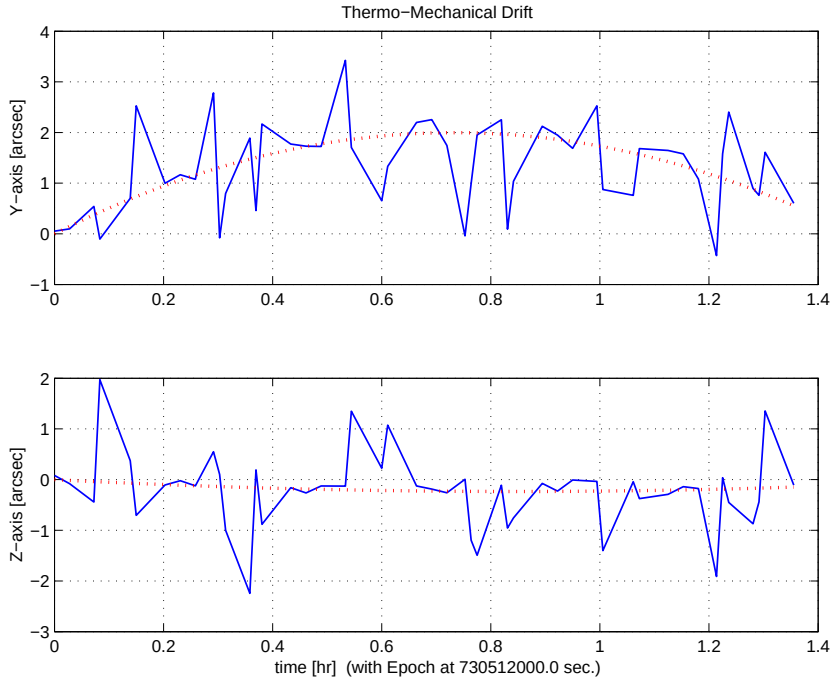

Figure 3.21: Thermo-mechanical boresight drift (equiv. angle in Body frame)

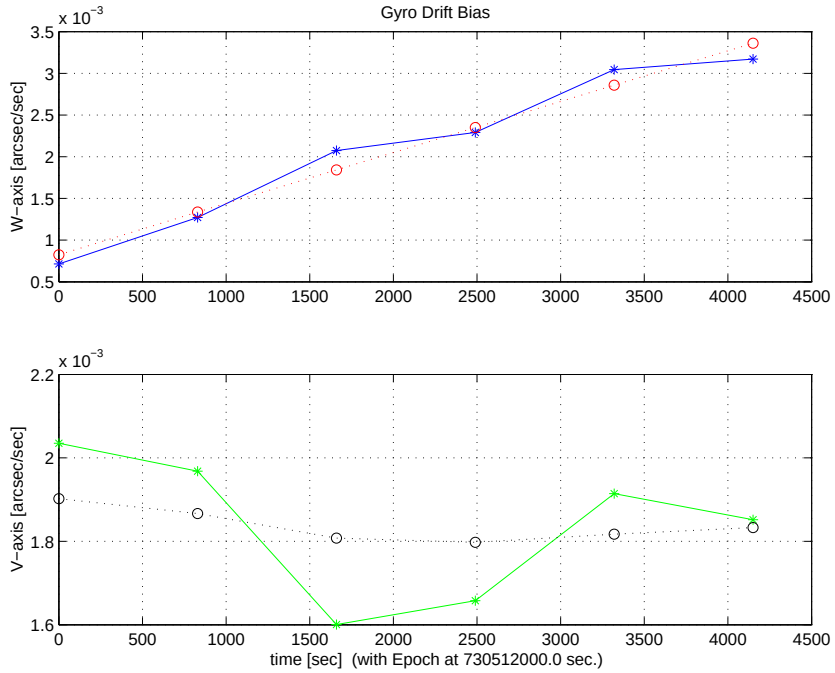

Figure 3.22: Gyro drift bias contribution (equiv. rate in (W,V) coords)

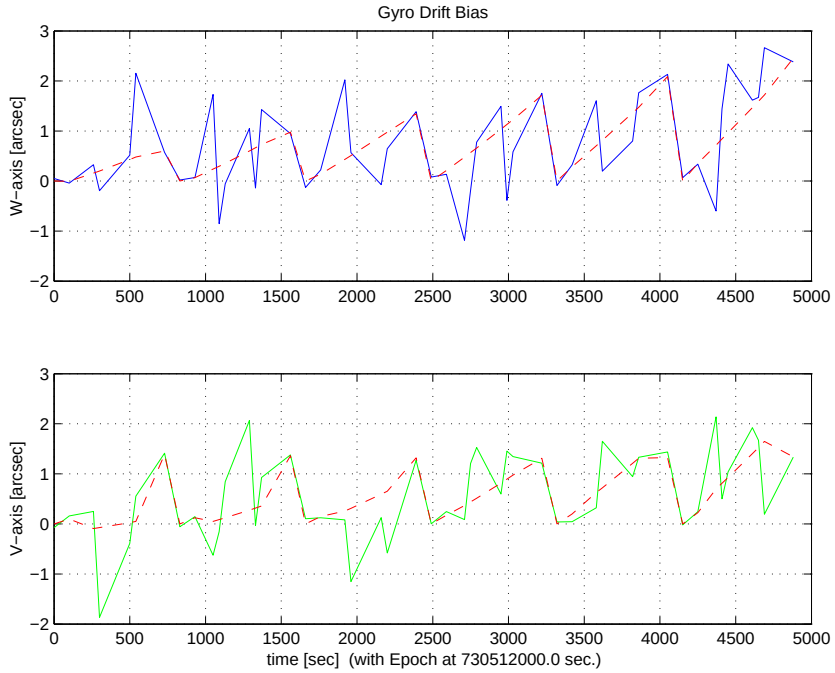

Figure 3.23: Gyro drift bias contribution (equiv. angle in (W,V) coords)

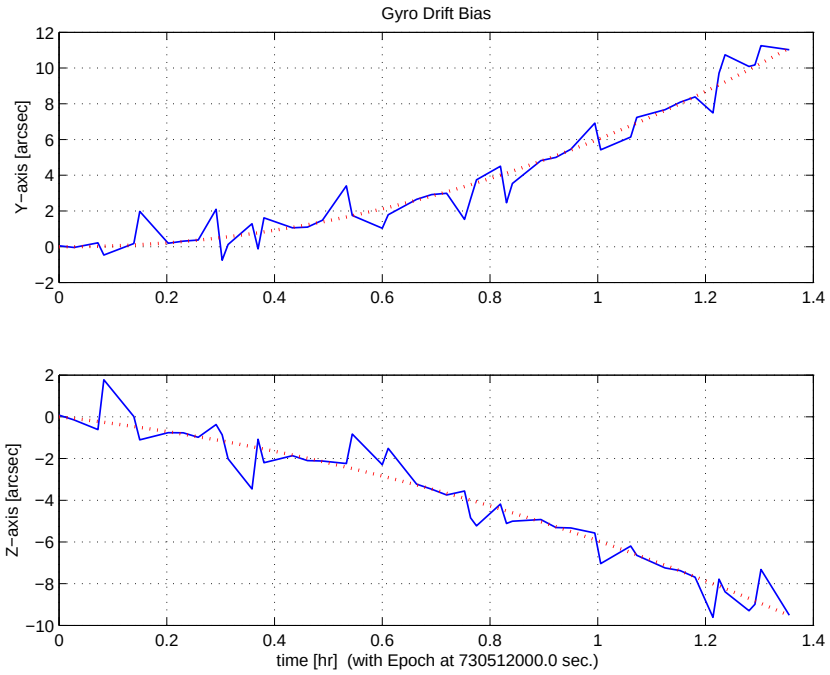

Figure 3.24: Gyro drift bias contribution (equiv. angle in Body frame)

3.2 IPF OUTPUT DATA (IF MINI FILE)

```
OUTPUT FILE NAME: IFmini995121.dat   DATE: 27-Aug-2003   TIME: 10:53
INSTRUMENT NAME:  MIPS_SED_center   NF: 121
IPF FILTER VERSION: IPF.V2.0.1Beta       SW RELEASE DATE: August 5, 2003
-------------------------------------------------------------------------------
---------------------------- IPF BROWN ANGLE SUMMARY ---------------------------
-------------------------------------------------------------------------------
         ------------ WAS ------------           ------------ IS -------------
Frame    theta_Y     theta_Z     angle           theta_Y     theta_Z     angle
Number   (arcmin)    (arcmin)    (deg)           (arcmin)    (arcmin)    (deg)
------  --------------------------------       --------------------------------
 121     +6.073000 -11.098000   -0.000000        +6.072481 -11.094429   +0.444676
 113     +6.838000 -12.531000   +0.000000        +6.848464 -12.710132   +0.444676
 114     +5.487000 -12.525000   +0.000000        +5.397888 -12.685922   +0.444676
 116     +6.717000 -10.601000   -0.000000        +6.780053 -10.546127   +0.444676
 117     +5.366000 -10.595000   +0.000000        +5.329476 -10.521918   +0.444676
 001     +0.000000  +0.000000   +0.000000        +8.254331 -11.320070   +0.444676
 001     +0.000000  +0.000000   +0.000000        +8.242361 -10.941416   +0.444676
 001     +0.000000  +0.000000   +0.000000        +3.902601 -11.247442   +0.444676
 001     +0.000000  +0.000000   +0.000000        +3.890630 -10.868789   +0.444676
-------------------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  0             121            +0.000            +0.000     pixels
OFFSET FRAME NAME: MIPS_SED_center
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
WAS(FTB)            +6.073000       -11.098000       -0.000000
IS (EST)            +6.072481       -11.094429       +0.444676
dT_EST              -0.000519        +0.003571       +0.444676
T_sSIGMA            +0.003343        +0.009273       +0.625347
dT_EST/T_sSIGMA     -0.155328        +0.385066       +0.711087
-------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  1             113            +4.000            +8.470     pixels
OFFSET FRAME NAME: MIPS_SED_5
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
WAS(FTB)            +6.838000       -12.531000       +0.000000
IS (EST)            +6.848464       -12.710132       +0.444676
dT_EST              +0.010464        -0.179132       +0.444676
T_sSIGMA            +0.029715        +0.030032       +0.625347
dT_EST/T_sSIGMA     +0.352158        -5.964737       +0.711087
-------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  2             114            -4.000            +8.470     pixels
OFFSET FRAME NAME: MIPS_SED_6
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
WAS(FTB)            +5.487000       -12.525000       +0.000000
IS (EST)            +5.397888       -12.685922       +0.444676
dT_EST              -0.089112        -0.160922       +0.444676
T_sSIGMA            +0.029900        +0.028721       +0.625347
dT_EST/T_sSIGMA     -2.980378        -5.602931       +0.711087
-------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  3             116            +4.000            -2.960     pixels
OFFSET FRAME NAME: MIPS_SED_7
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
WAS(FTB)            +6.717000       -10.601000       -0.000000
IS (EST)            +6.780053       -10.546127       +0.444676
dT_EST              +0.063053        +0.054873       +0.444676
T_sSIGMA            +0.010909        +0.013200       +0.625347
dT_EST/T_sSIGMA     +5.779895        +4.157117       +0.711087
-------------------------------------------------------------------
```

```
OFFSET           NF          Delta_CW          Delta_CV
  4             117            -4.000            -2.960     pixels
OFFSET FRAME NAME: MIPS_SED_8
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
WAS(FTB)            +5.366000       -10.595000       +0.000000
IS (EST)            +5.329476       -10.521918       +0.444676
dT_EST              -0.036524        +0.073082       +0.444676
T_sSIGMA            +0.010672        +0.012790       +0.625347
dT_EST/T_sSIGMA     -3.422398        +5.714015       +0.711087
-------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  5               1           +12.000            +1.000     pixels
OFFSET FRAME NAME: CORNER PIXEL (DIAGNOSTICS)
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
WAS(FTB)            +0.000000        +0.000000       +0.000000
IS (EST)            +8.254331       -11.320070       +0.444676
dT_EST              +8.254331       -11.320070       +0.444676
T_sSIGMA            +0.007281        +0.017866       +0.625347
dT_EST/T_sSIGMA    +1133.615196       -633.603796       +0.711087
-------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  6               1           +12.000            -1.000     pixels
OFFSET FRAME NAME: CORNER PIXEL (DIAGNOSTICS)
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
WAS(FTB)            +0.000000        +0.000000       +0.000000
IS (EST)            +8.242361       -10.941416       +0.444676
dT_EST              +8.242361       -10.941416       +0.444676
T_sSIGMA            +0.007408        +0.016961       +0.625347
dT_EST/T_sSIGMA    +1112.590361       -645.110022       +0.711087
-------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  7               1           -12.000            +1.000     pixels
OFFSET FRAME NAME: CORNER PIXEL (DIAGNOSTICS)
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
WAS(FTB)            +0.000000        +0.000000       +0.000000
IS (EST)            +3.902601       -11.247442       +0.444676
dT_EST              +3.902601       -11.247442       +0.444676
T_sSIGMA            +0.007379        +0.014774       +0.625347
dT_EST/T_sSIGMA    +528.886831       -761.312141       +0.711087
-------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  8               1           -12.000            -1.000     pixels
OFFSET FRAME NAME: CORNER PIXEL (DIAGNOSTICS)
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
WAS(FTB)            +0.000000        +0.000000       +0.000000
IS (EST)            +3.890630       -10.868789       +0.444676
dT_EST              +3.890630       -10.868789       +0.444676
T_sSIGMA            +0.006917        +0.014885       +0.625347
dT_EST/T_sSIGMA    +562.456955       -730.187563       +0.711087
-------------------------------------------------------------------
-------------------------------------------------------------------------------------
-------------------------------------------------------------------------------------
VARNAME             MEAN                      SIGMA                 SCALED_SIGMA
a00        +1.0044977967299309E-001 +2.9957367160089858E-003 +2.7565794162400506E-003
b00        +1.2845571249378396E-001 +2.0216604242816790E-002 +1.8602661183210894E-002
c00        +2.6910077835446092E-002 +1.0002922775766294E-002 +9.2043639477940864E-003
del_alpha  -3.7335828872997467E-012 +1.1812982466731937E-002 +1.0869921958822833E-002
beta       +1.1071514322322014E+000 +1.6744072358232984E-002 +1.5407350372308419E-002
del_theta1 -3.3923454323403490E-012 +1.1861278699491216E-002 +1.0914362580188094E-002
del_theta2 -7.0954806497013946E-016 +1.0567822103373089E-006 +9.7241659218484932E-007
del_theta3 -5.2800588890017922E-015 +2.9313165771346470E-006 +2.6973021012933274E-006
del_arx    +5.5533363823266624E-014 +1.3269975255431746E-004 +1.2210599298549384E-004
del_ary    +1.0676835477063879E-015 +4.9140038396487916E-006 +4.5217063847141510E-006
del_arz    +1.2447572544026673E-015 +5.0605802119495872E-006 +4.6565811915128603E-006
```

```
brx        +1.0112748724633166E-007 +1.2737506018205967E-007 +1.1720638438079289E-007
bry        +7.3435681551057921E-009 +5.5604535369466661E-009 +5.1165483545318301E-009
brz        -7.5047456435182392E-010 +5.7300633312982952E-009 +5.2726177665745828E-009
crx        -3.2515555809035625E-011 +5.5281538618778866E-011 +5.0868272448728828E-011
cry        -2.7833173617052729E-012 +2.5716453688439523E-012 +2.3663443625541317E-012
crz        +2.4644325972540254E-013 +2.6506654748347766E-012 +2.4390560920193325E-012
bgx        -1.6652729809552012E-006 +1.3446937951018553E-006 +1.2373434610975246E-006
bgy        -2.2244106964725247E-010 +6.3707984611111002E-009 +5.8622013773990057E-009
bgz        -3.9368271738864212E-009 +7.9807330531045848E-009 +7.3436107863321079E-009
cgx        +6.0064362024182139E-010 +4.8503459123288489E-010 +4.4631304320301521E-010
cgy        +4.6067265110686990E-012 +2.8143497085128144E-012 +2.5896729960044797E-012
cgz        -2.2474005630045247E-012 +3.2482948238449340E-012 +2.9889751664221977E-012
-------------------------------------------------------------------------------
LSQF RESIDUAL SIGMA SCALE =         +9.2016745046689286E-001
-------------------------------------------------------------------------------
-------------------------------------------------------------------------------------------------
-------------------------------------------------------------------------------------------------
                    a_mirror(1)               a_mirror(2)               a_mirror(3)
a_mirror_ipf   +0.0000000000000000E+000  +3.7905525207445133E-002  +9.9928132733417352E-001
a_mirror_tpf   -1.8628977378610178E-003  +3.0143124824586080E-002  +9.9954385678559765E-001
beta                beta_0                    beta                      beta_total
               +2.8047410000000001E-006  +1.1071514322322014E+000  +3.1052730151903768E-006
-------------------------------------------------------------------------------------------------
qT              qT(1)                     qT(2)                     qT(3)                     qT(4)
FrmTbl:   +1.4257389017362338E-006 -8.8328078008885079E-004 +1.6141373392967960E-003 +9.9999830718540750E-001
Estim:    +3.8819384786349886E-003 -8.7693693242941800E-004 +1.6170331672440527E-003 +9.9999077332693453E-001
DelTheta        deltheta(1)               deltheta(2)               deltheta(3)
          +7.7610574365389691E-003 +1.5104364362598918E-007 -1.0386369667027728E-006       [rad]
EulAngT         theta(1)                  theta(2)                  theta(3)                [rad]
Mean      +7.7610592713596473E-003 -1.7664130475823483E-003 +3.2272387011850882E-003
SigmaT    +1.1861278699491216E-002 +1.0567822103373089E-006 +2.9313165771346470E-006
-------------------------------------------------------------------------------------------------
qR              qR(1)                     qR(2)                     qR(3)                     qR(4)
ASFILE:   +0.0000000000000000E+000 +0.0000000000000000E+000 +0.0000000000000000E+000 +1.0000000000000000E+000
Estim:    -1.6116668666420651E-005 -2.1969901619510317E-006 +1.9092399466079203E-006 +9.9999999986589061E-001
DelThetaR       deltheta(1)               deltheta(2)               deltheta(3)
          -3.2233345723574092E-005 -4.3939187821516792E-006 +3.8185507090748938E-006       [rad]
EulAngR         angR(1)                   angR(2)                   angR(3)                 [rad]
Mean      -3.2233345723574092E-005 -4.3939187821516792E-006 +3.8185507090748938E-006
SigmaR    +1.3269975255431746E-004 +4.9140038396487916E-006 +5.0605802119495872E-006
-------------------------------------------------------------------------------------------------
Initial Gyro Bias         Bg0(1)                    Bg0(2)                    Bg0(3)
                  +2.5139469464322443E-006 +2.4888835000837901E-006 +2.5115474422157735E-006
Gyro Bias Correction      Bg(1)                     Bg(2)                     Bg(3)
                  -1.6652729809552012E-006 -2.2244106964725247E-010 -3.9368271738864212E-009
Total Gyro Bias           BgT(1)                    BgT(2)                    BgT(3)
                  +8.4867396547704316E-007 +2.4886610590141428E-006 +2.5076106150418870E-006

Initial Gyro Bias Rate     Cg0(1)                    Cg0(2)                    Cg0(3)
                  +0.0000000000000000E+000 +0.0000000000000000E+000 +0.0000000000000000E+000
Gyro Bias Rate Correction  Cg(1)                     Cg(2)                     Cg(3)
                  +6.0064362024182139E-010 +4.6067265110686990E-012 -2.2474005630045247E-012
Total Gyro Bias Rate       CgT(1)                    CgT(2)                    CgT(3)
                  +6.0064362024182139E-010 +4.6067265110686990E-012 -2.2474005630045247E-012
-------------------------------------------------------------------------------------------------
-------------------------------------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  1             113            +4.000            +8.470     pixels
OFFSET FRAME NAME: MIPS_SED_5
qT              qT(1)                     qT(2)                     qT(3)                     qT(4)
WAS(FTB)  +1.8126199579333211E-006 -9.9454496966837184E-004 +1.8225581610202054E-003 +9.9999784457706087E-001
IS (EST)  +3.8823526721753392E-003 -9.8888582269605310E-004 +1.8524631985917454E-003 +9.9999025886388337E-001

DelTheta        deltheta(1)               deltheta(2)               deltheta(3)
```

```
Units            rad                      rad                      rad
         +7.7611629180178721E-003 -3.0439600616604187E-006 +5.2107413381790354E-005
EulAngT        theta(1)                 theta(2)                 theta(3)                 [rad]
Mean     +7.7610592713596481E-003 -1.9921375282174847E-003 +3.6972276595689281E-003
sSigmaT  +1.0914361001939916E-002 +8.6437347272137702E-006 +8.7359292606905592E-006
SigmaT   +1.1861276984316247E-002 +9.3936540820129423E-006 +9.4938472951395425E-006
-----------------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------------
OFFSET          NF          Delta_CW          Delta_CV
  2            114            -4.000            +8.470     pixels
OFFSET FRAME NAME: MIPS_SED_6
qT              qT(1)                    qT(2)                    qT(3)                    qT(4)
WAS(FTB)  +1.4537999564721429E-006 -7.9805039157808107E-004 +1.8216858191067733E-003 +9.9999802228516210E-001
IS (EST)  +3.8819606488074564E-003 -7.7792368182228475E-004 +1.8481236205092860E-003 +9.9999045478211923E-001

DelTheta        deltheta(1)              deltheta(2)              deltheta(3)
Units            rad                      rad                      rad
         +7.7611339854672650E-003 +2.5921754913502141E-005 +4.6810274232269794E-005
EulAngT        theta(1)                 theta(2)                 theta(3)                 [rad]
Mean     +7.7610592713596481E-003 -1.5701818442866188E-003 +3.6901851454594525E-003
sSigmaT  +1.0914361224070079E-002 +8.6974740883425801E-006 +8.3546144999739649E-006
SigmaT   +1.1861277225718139E-002 +9.4520558012886491E-006 +9.0794501541375263E-006
-----------------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------------
OFFSET          NF          Delta_CW          Delta_CV
  3            116            +4.000            -2.960     pixels
OFFSET FRAME NAME: MIPS_SED_7
qT              qT(1)                    qT(2)                    qT(3)                    qT(4)
WAS(FTB)  +1.5063093946384967E-006 -9.7694673214546602E-004 +1.5418516033291201E-003 +9.9999833413183592E-001
IS (EST)  +3.8820260122984581E-003 -9.8015770695262855E-004 +1.5376856788473948E-003 +9.9999080230153237E-001

DelTheta        deltheta(1)              deltheta(2)              deltheta(3)
Units            rad                      rad                      rad
         +7.7610280832000281E-003 -1.8341236339439057E-005 -1.5962014994875706E-005
EulAngT        theta(1)                 theta(2)                 theta(3)                 [rad]
Mean     +7.7610592713596490E-003 -1.9722373336981784E-003 +3.0677438540291885E-003
sSigmaT  +1.0914362163433951E-002 +3.1732818852796445E-006 +3.8396909886605593E-006
SigmaT   +1.1861278246580016E-002 +3.4485917575866457E-006 +4.1728176612988219E-006
-----------------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------------
OFFSET          NF          Delta_CW          Delta_CV
  4            117            -4.000            -2.960     pixels
OFFSET FRAME NAME: MIPS_SED_8
qT              qT(1)                    qT(2)                    qT(3)                    qT(4)
WAS(FTB)  +1.2026621870087705E-006 -7.8045205798068791E-004 +1.5409792062221856E-003 +9.9999850813699964E-001
IS (EST)  +3.8817004146052174E-003 -7.6919542620645779E-004 +1.5333462700093973E-003 +9.9999099475420472E-001

DelTheta        deltheta(1)              deltheta(2)              deltheta(3)
Units            rad                      rad                      rad
         +7.7610260884399922E-003 +1.0624525834236595E-005 -2.1258737261228991E-005
EulAngT        theta(1)                 theta(2)                 theta(3)                 [rad]
Mean     +7.7610592713596481E-003 -1.5502816015133115E-003 +3.0607018080069282E-003
sSigmaT  +1.0914362245532926E-002 +3.1044094642786534E-006 +3.7204599341903435E-006
SigmaT   +1.1861278335801794E-002 +3.3737440535453372E-006 +4.0432422732434000E-006
-----------------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------------
OFFSET          NF          Delta_CW          Delta_CV
  5             1           +12.000            +1.000     pixels
OFFSET FRAME NAME: CORNER PIXEL (DIAGNOSTICS)
qT              qT(1)                    qT(2)                    qT(3)                    qT(4)
WAS(FTB)  +0.0000000000000000E+000 +0.0000000000000000E+000 +0.0000000000000000E+000 +1.0000000000000000E+000
IS (EST)  +3.8824884445341360E-003 -1.1941438377321436E-003 +1.6510818784078968E-003 +9.9999038707009757E-001

DelTheta        deltheta(1)              deltheta(2)              deltheta(3)
```

```
Units            rad                      rad                      rad
         +7.7610592713596490E-003 -2.4010876367832213E-003 +3.2928749568850715E-003
EulAngT        theta(1)                 theta(2)                 theta(3)                 [rad]
Mean     +7.7610592713596473E-003 -2.4010876367832213E-003 +3.2928749568850715E-003
sSigmaT  +1.0914360176715987E-002 +2.1180799668867661E-006 +5.1970568616748225E-006
SigmaT   +1.1861276087496946E-002 +2.3018418721636510E-006 +5.6479468590611808E-006
-----------------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------------
OFFSET          NF          Delta_CW          Delta_CV
  6              1           +12.000            -1.000     pixels
OFFSET FRAME NAME: CORNER PIXEL (DIAGNOSTICS)
qT              qT(1)                    qT(2)                    qT(3)                    qT(4)
WAS(FTB)  +0.0000000000000000E+000 +0.0000000000000000E+000 +0.0000000000000000E+000 +1.0000000000000000E+000
IS (EST)  +3.8824199110333688E-003 -1.1926166083008568E-003 +1.5960026603595683E-003 +9.9999047858305545E-001

DelTheta        deltheta(1)              deltheta(2)              deltheta(3)
Units            rad                      rad                      rad
         +7.7610592713596481E-003 -2.3976055079251131E-003 +3.1827289727106439E-003
EulAngT        theta(1)                 theta(2)                 theta(3)                 [rad]
Mean     +7.7610592713596481E-003 -2.3976055079251127E-003 +3.1827289727106431E-003
sSigmaT  +1.0914360221872109E-002 +2.1549759844110958E-006 +4.9336219639616770E-006
SigmaT   +1.1861276136570755E-002 +2.3419389409152227E-006 +5.3616566870066509E-006
-----------------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------------
OFFSET          NF          Delta_CW          Delta_CV
  7              1           -12.000            +1.000     pixels
OFFSET FRAME NAME: CORNER PIXEL (DIAGNOSTICS)
qT              qT(1)                    qT(2)                    qT(3)                    qT(4)
WAS(FTB)  +0.0000000000000000E+000 +0.0000000000000000E+000 +0.0000000000000000E+000 +1.0000000000000000E+000
IS (EST)  +3.8814426106655556E-003 -5.6125718984112569E-004 +1.6380634751315933E-003 +9.9999096803005094E-001

DelTheta        deltheta(1)              deltheta(2)              deltheta(3)
Units            rad                      rad                      rad
         +7.7610592713596473E-003 -1.1352205837401297E-003 +3.2717483304075864E-003
EulAngT        theta(1)                 theta(2)                 theta(3)                 [rad]
Mean     +7.7610592713596481E-003 -1.1352205837401297E-003 +3.2717483304075868E-003
sSigmaT  +1.0914360568557102E-002 +2.1464338237761950E-006 +4.2975123507827474E-006
SigmaT   +1.1861276513333695E-002 +2.3326556733636848E-006 +4.6703590184614665E-006
-----------------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------------
OFFSET          NF          Delta_CW          Delta_CV
  8              1           -12.000            -1.000     pixels
OFFSET FRAME NAME: CORNER PIXEL (DIAGNOSTICS)
qT              qT(1)                    qT(2)                    qT(3)                    qT(4)
WAS(FTB)  +0.0000000000000000E+000 +0.0000000000000000E+000 +0.0000000000000000E+000 +1.0000000000000000E+000
IS (EST)  +3.8814089463068838E-003 -5.5972990024340491E-004 +1.5829843465414006E-003 +9.9999105772381236E-001

DelTheta        deltheta(1)              deltheta(2)              deltheta(3)
Units            rad                      rad                      rad
         +7.7610592713596499E-003 -1.1317384507715921E-003 +3.1616025926543951E-003
EulAngT        theta(1)                 theta(2)                 theta(3)                 [rad]
Mean     +7.7610592713596481E-003 -1.1317384507715919E-003 +3.1616025926543942E-003
sSigmaT  +1.0914360540206055E-002 +2.0121334452369768E-006 +4.3298499625465033E-006
SigmaT   +1.1861276482522947E-002 +2.1867035659824963E-006 +4.7055022000066810E-006
-----------------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------------
              q(1)                     q(2)                     q(3)                     q(4)
PCRS1A: +5.2603126189317361E-007 +3.7451819048221893E-004 -1.4045531552277380E-003 +9.9999894348258311E-001
PCRS2A: -5.1968404336718985E-007 +3.8455385122900486E-004 +1.3513933841514693E-003 +9.9999901292650617E-001
-------------------------------------------------------------------------------------
**********  CS-FILE PARAMETERS:  **********  **********  AS-FILE PARAMETERS:  **********
Row (01) PIX2RADX: +4.7922266400000000E-005  Row (1) TASTART:   +7.3051200000000000E+008
Row (02) PIX2RADY: +4.8814231500000000E-005  Row (2) TASTOP:    +7.3051688000000000E+008
Row (03) CX0:      +1.2500000000000000E+001  Row (3) S/C TIME:  +7.3051200000000000E+008
```

```
Row (04) CY0:      +1.6500000000000000E+001  Row (4) QR1:       +0.0000000000000000E+000
Row (05) BETA0:    +2.8047410000000001E-006  Row (5) QR2:       +0.0000000000000000E+000
Row (06) GAMMA_E0: +3.2200000000000000E+003  Row (6) QR3:       +0.0000000000000000E+000
Row (07) D11:      -1.0000000000000000E+000  Row (7) QR4:       +1.0000000000000000E+000
Row (08) D12:      +0.0000000000000000E+000
Row (09) D21:      +0.0000000000000000E+000
Row (10) D22:      -1.0000000000000000E+000
Row (11) DG:       +1.0000000000000000E+000
-------------------------------------------------------------------------------------------
-------------------------------------------------------------
INITIAL STA-TO-PCRS ALIGNMENT (R) KNOWLEDGE (1-SIGMA)
    SIGMA(X)        SIGMA(Y)         SIGMA(Z)
1.41451738E+001  7.65467990E-001  7.65467990E-001  [arcsec]
-------------------------------------------------------------
PIX2RADX = 4.792226640000E-005[rad/pixel]
XPIXSIZE = 9.8847[arcsec]
PIX2RADY = 4.881423150000E-005[rad/pixel]
YPIXSIZE = 10.0687[arcsec]
CX0 = 12.5[pixel] = 123.56[arcsec]
CY0 = 16.5[pixel] = 166.13[arcsec]
-------------------------------------------------------------
NOMINAL BETA0 = 2.804741000000E-006[rad/encoder unit]
ENCODER UNIT SIZE = 0.58[arcsec]
GAMMA_E0 = 3220.00[encoder unit] = 1862.83[arcsec]
-------------------------------------------------------------
                | -1 | +0 |
FLIP MATRIX D = |----|----|   and   DG = +1
                | +0 | -1 |
-------------------------------------------------------------
```

3.3 IPF EXECUTION LOG

```
*********************************************************************
IPF EXECUTION-LOG FILE NAME:  LG995121.dat
INSTRUMENT TYPE:              MIPS_SED_center
IPF FILTER EXECUTION DATE:    27-Aug-2003    TIME: 10:51
IPF FILTER VERSION USED:      IPF.V2.0.1Beta
*********************************************************************

**************************************
SLIT FLAG ENABLED! ENTERING SLIT MODE.
**************************************


------------------- Loading & Preparing Input Files -------------------
AAFILE:  AA995121 Loaded!        AAFILE dimension = 48801 X 21
ASFILE:  AS995121 Loaded!
CAFILE:  CA995121 Loaded!        CAFILE dimension = 30 X 15
CBFILE:  CB995121 Loaded!        CBFILE dimension = 18 X 15
CCFILE:  CC995121 Created!       CCFILE dimension = 48 X 19
CSFILE:  CS995121 Loaded!
Loading Input Files Completed!
-----------------------------------------------------------------------

------------------------- Selected Mask Vectors -------------------------
index =   1  2  3  4  5  6  7  8  9 10 11 12 13 14 15 16 17 18 19 20
-----------------------------------------------------------------------
```

```
mask1 = [ 1  1  1  0  0  0  0  0  0  0  0  0  0  0  0  0  0 ]
mask2 = [ 1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1 ]
----------------------------------------------------------------------

---------------  Selected Initial Gyro Bias Parameters  ---------------
User Entered 1 : Use AFILE database - from S/C filter
IPF Linearized Using Following Nominal Gyro Bias Estimates
bg0 = [+2.5139469464322443E-006 +2.4888835000837901E-006 +2.5115474422157735E-006 ]
cg0 = [+0.0000000000000000E+000 +0.0000000000000000E+000 +0.0000000000000000E+000 ]
----------------------------------------------------------------------

---------------  Gyro Pre-Processor Run Completed  --------------------
     AGFILE CREATED:  AG995121.m     ACFILE CREATED:  AC995121.m
----------------------------------------------------------------------
Total Gyro Preprocessor Execution Time: 23 seconds

FRAME TABLE ENTRIES FOR PCRS LOADED TO TPCRS
q_PCRS4 = [ +5.2603126189317361E-007     q_PCRS5 = [ +7.3379987833742897E-007
            +3.7451819048221893E-004                 +5.2236196154513707E-004
            -1.4045531552277380E-003                 -1.4047712280184723E-003
            +9.9999894348258311E-001 ];              +9.9999887687698918E-001 ];
q_PCRS8 = [ -5.1968404336718985E-007     q_PCRS9 = [ -7.1963421681856818E-007
            +3.8455385122900486E-004                 +5.3239763239987400E-004
            +1.3513933841514693E-003                 +1.3516841804518383E-003
            +9.9999901292650617E-001 ];              +9.9999894475050310E-001 ];
-------------------------------------------------------------------------------
------ Initial Conditions for State -----  ------   Inital Square-Root Cov (diag)   -----
p1(01)  = a00  = +0.0000000000000000E+000  Sigma_initial(01,01) = 1.0000000000000000E+000
p1(02)  = b00  = +0.0000000000000000E+000  Sigma_initial(02,02) = 1.0000000000000000E+000
p1(03)  = c00  = +0.0000000000000000E+000  Sigma_initial(03,03) = 1.0000000000000000E+000
p1(04)  = a10  = +0.0000000000000000E+000  Sigma_initial(04,04) = 9.9999000000000000E+004
p1(05)  = b10  = +0.0000000000000000E+000  Sigma_initial(05,05) = 9.9999000000000000E+004
p1(06)  = c10  = +0.0000000000000000E+000  Sigma_initial(06,06) = 9.9999000000000000E+004
p1(07)  = d10  = +0.0000000000000000E+000  Sigma_initial(07,07) = 9.9999000000000000E+004
p1(08)  = a20  = +0.0000000000000000E+000  Sigma_initial(08,08) = 9.9999000000000000E+004
p1(09)  = b20  = +0.0000000000000000E+000  Sigma_initial(09,09) = 9.9999000000000000E+004
p1(10)  = c20  = +0.0000000000000000E+000  Sigma_initial(10,10) = 9.9999000000000000E+004
p1(11)  = d20  = +0.0000000000000000E+000  Sigma_initial(11,11) = 9.9999000000000000E+004
p1(12)  = a01  = +0.0000000000000000E+000  Sigma_initial(12,12) = 9.9999000000000000E+004
p1(13)  = b01  = +0.0000000000000000E+000  Sigma_initial(13,13) = 9.9999000000000000E+004
p1(14)  = c01  = +0.0000000000000000E+000  Sigma_initial(14,14) = 9.9999000000000000E+004
p1(15)  = d01  = +0.0000000000000000E+000  Sigma_initial(15,15) = 9.9999000000000000E+004
p1(16)  = e01  = +0.0000000000000000E+000  Sigma_initial(16,16) = 9.9999000000000000E+004
p1(17)  = f01  = +0.0000000000000000E+000  Sigma_initial(17,17) = 9.9999000000000000E+004
-------------------------------------------------------------------------------------
p2f(01) = am1  = +0.0000000000000000E+000
p2f(02) = am2  = +0.0000000000000000E+000  Sigma_initial(18,18) = 1.0000000000000001E-001
p2f(03) = am3  = +1.0000000000000000E+000
p2f(04) = beta = +1.0000000000000000E+000  Sigma_initial(19,19) = 1.0000000000000001E-001
p2f(05) = qT1  = +1.4257389017362338E-006  Sigma_initial(20,20) = 1.0000000000000001E-001
p2f(06) = qT2  = -8.8328078008885079E-004  Sigma_initial(21,21) = 1.0000000000000000E-002
p2f(07) = aT3  = +1.6141373392967960E-003  Sigma_initial(22,22) = 1.0000000000000000E-002
p2f(08) = qT4  = +9.9999830718540750E-001
p2f(09) = qR1  = +0.0000000000000000E+000  Sigma_initial(23,23) = 3.4288868839039716E-003
p2f(10) = qR2  = +0.0000000000000000E+000  Sigma_initial(24,24) = 1.8555467699985827E-004
p2f(11) = qR3  = +0.0000000000000000E+000  Sigma_initial(25,25) = 1.8555467699985827E-004
p2f(12) = qR4  = +1.0000000000000000E+000
p2f(13) = brx  = +0.0000000000000000E+000  Sigma_initial(26,26) = 2.0491803278688525E-004
p2f(14) = bry  = +0.0000000000000000E+000  Sigma_initial(27,27) = 2.0491803278688525E-004
p2f(15) = brz  = +0.0000000000000000E+000  Sigma_initial(28,28) = 2.0491803278688525E-004
p2f(16) = crx  = +0.0000000000000000E+000  Sigma_initial(29,29) = 4.1991400161246979E-008
p2f(17) = cry  = +0.0000000000000000E+000  Sigma_initial(30,30) = 4.1991400161246979E-008
p2f(18) = crz  = +0.0000000000000000E+000  Sigma_initial(31,31) = 4.1991400161246979E-008
p2f(19) = bgx  = +0.0000000000000000E+000  Sigma_initial(32,32) = 2.0491803278688525E-004
```

```
p2f(20) = bgy  = +0.0000000000000000E+000  Sigma_initial(33,33) = 2.0491803278688525E-004
p2f(21) = bgz  = +0.0000000000000000E+000  Sigma_initial(34,34) = 2.0491803278688525E-004
p2f(22) = cgx  = +0.0000000000000000E+000  Sigma_initial(35,35) = 4.1991400161246979E-008
p2f(23) = cgy  = +0.0000000000000000E+000  Sigma_initial(36,36) = 4.1991400161246979E-008
p2f(24) = cgz  = +0.0000000000000000E+000  Sigma_initial(37,37) = 4.1991400161246979E-008
-------------------------------------------------------------------------------------

--------------------   IPF KALMAN FILTER STARTED  ---------------------
Iteration#001: |dp|= +2.152617941261E-001   RMS(|Res|)=+2.152617941261E-001
Iteration#002: |dp|= +6.890075204103E-002   RMS(|Res|)=+6.890075204103E-002
Iteration#003: |dp|= +5.126908185359E-003   RMS(|Res|)=+5.126908185359E-003
Iteration#004: |dp|= +3.870710297731E-003   RMS(|Res|)=+3.870710297731E-003
Iteration#005: |dp|= +1.052218899134E-003   RMS(|Res|)=+1.052218899134E-003
Iteration#006: |dp|= +3.632804475193E-004   RMS(|Res|)=+3.632804475193E-004
Iteration#007: |dp|= +1.119767041633E-004   RMS(|Res|)=+1.119767041633E-004
Iteration#008: |dp|= +2.655721189473E-005   RMS(|Res|)=+2.655721189473E-005
Iteration#009: |dp|= +1.368720364650E-005   RMS(|Res|)=+1.368720364650E-005
Iteration#010: |dp|= +1.819489406124E-006   RMS(|Res|)=+1.819489406124E-006
Iteration#011: |dp|= +1.339709560795E-006   RMS(|Res|)=+1.339709560795E-006
Iteration#012: |dp|= +2.172135195707E-007   RMS(|Res|)=+2.172135195707E-007
Iteration#013: |dp|= +1.322137426337E-007   RMS(|Res|)=+1.322137426337E-007
Iteration#014: |dp|= +3.232464106401E-008   RMS(|Res|)=+3.232464106401E-008
Iteration#015: |dp|= +1.138595518856E-008   RMS(|Res|)=+1.138595518856E-008
Iteration#016: |dp|= +4.177762809282E-009   RMS(|Res|)=+4.177762809282E-009
Iteration#017: |dp|= +8.867266186279E-010   RMS(|Res|)=+8.867266186279E-010
Iteration#018: |dp|= +5.337330125461E-010   RMS(|Res|)=+5.337330125461E-010
Iteration#019: |dp|= +1.288544735077E-010   RMS(|Res|)=+1.288544735077E-010
Iteration#020: |dp|= +1.163891059612E-010   RMS(|Res|)=+1.163891059612E-010
Iteration#021: |dp|= +7.300532872347E-011   RMS(|Res|)=+7.300532872347E-011
Iteration#022: |dp|= +1.362347845356E-010   RMS(|Res|)=+1.362347845356E-010
Iteration#023: |dp|= +5.629526884258E-011   RMS(|Res|)=+5.629526884258E-011
Iteration#024: |dp|= +5.209032257369E-011   RMS(|Res|)=+5.209032257369E-011
Iteration#025: |dp|= +2.757777862724E-011   RMS(|Res|)=+2.757777862724E-011
Iteration#026: |dp|= +8.137421913109E-011   RMS(|Res|)=+8.137421913109E-011
Iteration#027: |dp|= +7.348771625803E-011   RMS(|Res|)=+7.348771625803E-011
Iteration#028: |dp|= +7.009064157721E-011   RMS(|Res|)=+7.009064157721E-011
Iteration#029: |dp|= +2.873259199426E-011   RMS(|Res|)=+2.873259199426E-011
Iteration#030: |dp|= +4.013244945443E-011   RMS(|Res|)=+4.013244945443E-011
IPF Kalman Filter Completed with Error |dp1| + |dp2| = +4.0132449454430236E-011
----------------------------------------------------------------------

-----------------  IPF LEAST SQUARES FILTER STARTED  ------------------
Iteration#001   COND#=+7.088852893665E+007,   |dp|=+2.156114203553E-001
Iteration#002   COND#=+7.216215474063E+007,   |dp|=+6.940180517085E-002
Iteration#003   COND#=+7.044074072746E+007,   |dp|=+6.245606066742E-003
Iteration#004   COND#=+7.062197550120E+007,   |dp|=+1.071257553443E-003
Iteration#005   COND#=+7.063208975263E+007,   |dp|=+2.086620891471E-004
Iteration#006   COND#=+7.063916279740E+007,   |dp|=+4.168044665517E-005
Iteration#007   COND#=+7.064040026491E+007,   |dp|=+9.876877148970E-006
Iteration#008   COND#=+7.064076491811E+007,   |dp|=+2.126028804037E-006
Iteration#009   COND#=+7.064084476980E+007,   |dp|=+5.243989820643E-007
Iteration#010   COND#=+7.064086480133E+007,   |dp|=+1.204666781923E-007
Iteration#011   COND#=+7.064086939640E+007,   |dp|=+2.888402451845E-008
Iteration#012   COND#=+7.064087052773E+007,   |dp|=+6.772024509287E-009
Iteration#013   COND#=+7.064087083207E+007,   |dp|=+1.606949553438E-009
Iteration#014   COND#=+7.064087089304E+007,   |dp|=+3.792640856221E-010
Iteration#015   COND#=+7.064087086843E+007,   |dp|=+8.955087329071E-011
Iteration#016   COND#=+7.064087088632E+007,   |dp|=+2.122690099365E-011
Iteration#017   COND#=+7.064087092413E+007,   |dp|=+5.002159052738E-012
Iteration#018   COND#=+7.064087090962E+007,   |dp|=+1.447908350104E-012
Iteration#019   COND#=+7.064087085826E+007,   |dp|=+6.153345236105E-013
Iteration#020   COND#=+7.064087085732E+007,   |dp|=+6.937504917003E-013
Iteration#021   COND#=+7.064087091323E+007,   |dp|=+5.430049838921E-013
Iteration#022   COND#=+7.064087091445E+007,   |dp|=+2.722523516887E-013
```

```
Iteration#023   COND#=+7.064087088106E+007,   |dp|=+3.764667365058E-013
Iteration#024   COND#=+7.064087087428E+007,   |dp|=+7.202177042578E-013
Iteration#025   COND#=+7.064087090413E+007,   |dp|=+7.736982081102E-013
Iteration#026   COND#=+7.064087086075E+007,   |dp|=+7.540348270433E-013
Iteration#027   COND#=+7.064087088034E+007,   |dp|=+6.032709322815E-013
Iteration#028   COND#=+7.064087090919E+007,   |dp|=+2.798256095500E-013
Iteration#029   COND#=+7.064087090466E+007,   |dp|=+1.531677689047E-013
Iteration#030   COND#=+7.064087089087E+007,   |dp|=+2.225180367167E-013
IPF Least Squares Filter Completed with Error |dp1| + |dp2| = +2.2251803671668311E-013
----------------------------------------------------------------------
Total Execution Time: 141 seconds
```

4 USER COMMENTS

This section left blank.

IPF TEAM CONTACT INFORMATION

IPF Team email		ipf@sirtfweb.jpl.nasa.gov	
David S. Bayard	X4-8208	David.S.Bayard@jpl.nasa.gov	(TEAM LEADER)
Dhemetrio Boussalis	X4-3977	boussali@grover.jpl.nasa.gov	
Paul Brugarolas	X4-9243	Paul.Brugarolas@jpl.nasa.gov	
Bryan H. Kang	X4-0541	Bryan.H.Kang@jpl.nasa.gov	
Edward.C.Wong	X4-3053	Edward.C.Wong@jpl.nasa.gov	(TASK MANAGER)

ACKNOWLEDGEMENTS

This work was performed at the Jet Propulsion Laboratory, California Institute of Technology, under contract with the National Aeronautics and Space Administration.

References

[1] D.S. Bayard, B.H. Kang, *SIRTF Instrument Pointing Frame Kalman Filter Algorithm*, JPL D-Document D-24809, September 30, 2003.

[2] B.H. Kang, D.S. Bayard, *SIRTF Instrument Pointing Frame (IPF) Software Description Document and User's Guide*, JPL D-Document D-24808, September 30, 2003.

[3] D.S. Bayard, B.H. Kang, *SIRTF Instrument Pointing Frame (IPF) Kalman Filter Unit Test Report*, JPL D-Document D-24810, September 30, 2003.

[4] *Space Infrared Telescope Facility In-Orbit Checkout and Science Verification Mission Plan*, JPL D-Document D-22622, 674-FE-301 Version 1.4, February 8, 2002.

[5] *Space Infrared Telescope Facility Observatory Description Document*, Lockheed Martin LMMS/P458569, 674-SEIT-300 Version 1.2, November 1, 2002.

[6] *SIRTF Software Interface Specification for Science Centroid INPUT Files (CAFILE, CSFILE)*, JPL SOS-SIS-2002, November 18, 2002.

[7] *SIRTF Software Interface Specification for Inferred Frames Offset INPUT Files (OFILE)*, JPL SOS-SIS-2003, November 18, 2002.

[8] *SIRTF Software Interface Specification for PCRS Centroid INPUT Files (CBFILE)*, JPL SIS-FES-015, November 18, 2002.

[9] *SIRTF Software Interface Specification for Attitude INPUT Files (AFILE, ASFILE)*, JPL SIS-FES-014, January 7, 2002.

[10] *SIRTF Software Interface Specification for IPF Filter Output Files (IFFILE, LGFILE, TARFILE)*, JPL SOS-SIS-2005, November 18, 2002.

[11] R.J. Brown, *Focal Surface to Object Space Field of View Conversion.* Systems Engineering Report SER No. S20447-OPT-051, Ball Aerospace & Technologies Corp., November 23, 1999.

SIRTF INSTRUMENT POINTING FRAME KALMAN FILTER EXECUTION SUMMARY

IPF RUN NUMBER: 996121
REPORT TYPE: COVARIANCE ANALYSIS

PRIME FRAME: MIPS_SED_center (121)
INFERRED FRAMES: (113) (114) (116) (117) (1) (1) (1) (1)

IPF TEAM

Autonomy and Control Section (345)
Jet Propulsion Laboratory
California Institute of Technology
4800 Oak Grove Drive
Pasadena, CA 91109

Contents

1 IPF EXECUTION SUMMARY **4**

2 FLUTE DATA SUMMARY **8**

2.1 FLUTE CONFIGURATION PARAMETERS 8

2.2 FLUTE GENERATED UNIT TEST DATA 11

3 IPF EXECUTION RESULTS **16**

3.1 IPF EXECUTION OUTPUT PLOTS 16

3.2 IPF OUTPUT DATA (IF MINI FILE) 30

3.3 IPF EXECUTION LOG 35

4 USER COMMENTS **39**

List of Figures

1.1 A-priori and a-posteriori IPF frames 4

1.2 A-priori and a-posteriori IPF frames (ZOOMED) 7

2.1 Focal plane survey scenario plot (See key in [3]) 12

2.2 Commanded-only source locations 13

2.3 True (+) and commanded (o) source locations 13

2.4 True (+) and commanded (o) source locations (ZOOMED) 14

2.5 True-sampled (o) and centroided (+) locations on S/I array (W,V) 14

2.6 True (o) and centroided (+) locations on S/I array (W,V) 15

2.7 True (o) and centroided (+) locations on S/I array (W,V) showing prime and inferred frames 15

3.1 TPF coords of measurements and a-priori predicts 17

3.2 Oriented Pixel Coords of measurements and a-priori predicts 17

3.3 A-priori prediction error 18

3.4 Oriented Pixel Coords of measurements and a-priori predicts (PCRS only) 18

3.5 IPF execution convergence, chart 1 19

3.6 IPF execution convergence, chart 2 19

3.7 Parameter uncertainty convergence 20

3.8 IPF parameter symbol table 20
3.9 KF parameter error sigma plots 21
3.10 LS parameter error sigma plot 21
3.11 KF and LS parameter error sigma plot 22
3.12 Oriented Pixel Coords of meas. and a-posteriori predicts 23
3.13 Oriented Pixel Coords of meas. and a-posteriori predicts (attitude corrected) 23
3.14 Array plot with (solid) and w/o (dashed) optical distortion corrections 24
3.15 KF innovations with (o) and w/o (+) attitude corrections 24
3.16 W-axis KF innovations and 1-sigma bound 25
3.17 V-axis KF innovations and 1-sigma bound 25
3.18 Estimated attitude corrections (Body frame) 26
3.19 Estimated attitude error sigma plot (Body frame) 26
3.20 Thermo-mechanical boresight drift (equiv. angle in (W,V) coords) 27
3.21 Thermo-mechanical boresight drift (equiv. angle in Body frame) 27
3.22 Gyro drift bias contribution (equiv. rate in (W,V) coords) 28
3.23 Gyro drift bias contribution (equiv. angle in (W,V) coords) 28
3.24 Gyro drift bias contribution (equiv. angle in Body frame) 29

List of Tables

1.1 IPF filter input files 5
1.2 IPF filter execution configuration 5
1.3 IPF filter execution mask vector assignment 5
1.4 IPF calibration error summary ([arcsec], 1-sigma, radial) 6
1.5 Measurement prediction error summary (1-sigma) 6
1.6 IPF Brown angle summary 7
2.1 FLUTE Parameter Table (1) 8
2.2 FLUTE Parameter Table (2) 9
2.3 FLUTE Parameter Table (3) 10
2.4 Table of figures (FLUTE) 11
3.1 Table of figures (IPF run) 16

1 IPF EXECUTION SUMMARY

This report summarizes the SIRTF Instrument Pointing Frame (IPF) Kalman Filter execution associated with run file: RN996121. In particular, this Focal Point Survey calibrates the instrument: MIPS_SED_center (121), as part of the Covariance Analysis. The main calibration results from the IPF filter execution have been documented in IF996121 typically stored in the mission archive DOM collection IPF_IF. This report only summarizes the main aspects of the run, and does not substitute for the full information contained in the IF file.

Section 1 summarizes the filter execution results. The filter configurations are tabulated in Table 1.2 and the mask vector assignments are tabulated in Table 1.3. A total of 23 state parameters are estimated in this run. The overall End-to-End pointing performances are tabulated in Table 1.4. The prediction residuals throughout the estimation processes are tabulated in Table 1.6. Section 2 documents the FLUTE generated input file data. Section 3 summarizes resulting plots, a mini summary of the IF IPF output file, and the execution log. Section 4 captures the user comments that are specific to this particular run.

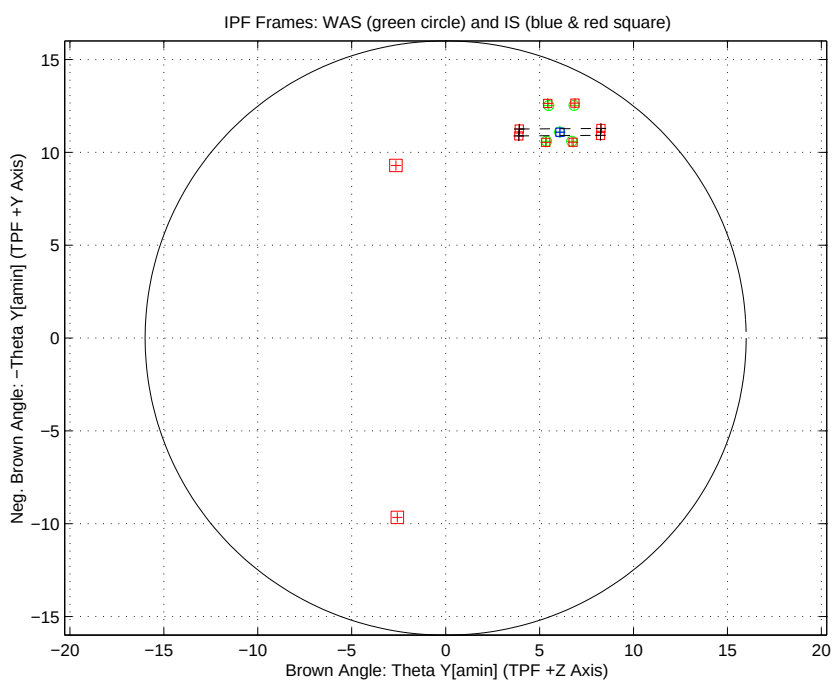

Figure 1.1: A-priori and a-posteriori IPF frames

RAW	FINAL (After Editing)
AA996121	AA996121
AS996121	AS996121
CA996121	CA996121
CB996121	CB996121
CS996121	CS996121

Table 1.1: IPF filter input files

EXECUTION CONFIGURATION ITEM	CURRENT STATUS
IPF Filter Version Used	IPF.V2.0.1Beta
Frame Table Version Used	FTVE2E1
Scan-Mirror Employed?	YES
IPF Filter Mode	NORMAL-MODE(0)
SLIT-MODE Operation	ENABLED
Kalman Filter Operation	ENABLED
Least-Squares Data Analysis	ENABLED
IBAD Screening	ENABLED
User-Specified Data Editing	DISABLED
Total Number of Iterations	30
LS Residual Sigma Scale	1.00553009E+000
Total Number of Maneuvers	6

Table 1.2: IPF filter execution configuration

Con. Plate Scale			Γ Dependent				Γ^2 Dependent				Linear Plate Scale						Mirror	
a_{00}	b_{00}	c_{00}	a_{10}	b_{10}	c_{10}	d_{10}	a_{20}	b_{20}	c_{20}	d_{20}	a_{01}	b_{01}	c_{01}	d_{01}	e_{01}	f_{01}	α	β
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
IPF (T)			Alignment R									Gyro Drift Bias						
θ_1	θ_2	θ_3	a_{rx}	a_{ry}	a_{rz}	b_{rx}	b_{ry}	b_{rz}	c_{rx}	c_{ry}	c_{rz}	b_{gx}	b_{gy}	b_{gz}	c_{gx}	c_{gy}	c_{gz}	
20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	

Table 1.3: IPF filter execution mask vector assignment

FOCAL PLANE SURVEY ANALYSIS: Covariance Analysis.
INSTRUMENT NAME: MIPS_SED_center NF: 121

```
PIX2RADW: 4.79222664E-005[rad/pixel] = 9.8847E+000[arcsec/pixel]
PIX2RADV: 4.79222664E-005[rad/pixel] = 9.8847E+000[arcsec/pixel]
```

FRAME	DESCRIPTION	IPF[1]	SF[2]	ARW[3]	TOTAL	REQ
121(P)	MIPS_SED_center	0.6376	0.0855	0.0936	0.6501	1.10
113(I)	MIPS_SED_5	2.5158	0.0855	0.0936	2.5190	N/A
114(I)	MIPS_SED_6	2.5750	0.0855	0.0936	2.5781	N/A
116(I)	MIPS_SED_7	1.0866	0.0855	0.0936	1.0940	N/A
117(I)	MIPS_SED_8	1.0714	0.0855	0.0936	1.0788	N/A
TR (C)	CORNERS OF INSTRUMENT	1.0801	0.0855	0.0936	1.0875	N/A
BR (C)	CORNERS OF INSTRUMENT	1.1063	0.0855	0.0936	1.1135	N/A
TL (C)	CORNERS OF INSTRUMENT	1.1898	0.0855	0.0936	1.1965	N/A
BL (C)	CORNERS OF INSTRUMENT	1.1390	0.0855	0.0936	1.1460	N/A

Table 1.4: IPF calibration error summary ([arcsec], 1-sigma, radial)

RMS METRIC	A PRIORI[4]	A POSTERIORI[4]	ATT. CORRECTED[5]	UNITS
Radial	12.7976	1.8705	1.3913	arcsec
Radial	1.2947	0.1892	0.1408	pixels
W-Axis	0.9117	0.1326	0.0844	pixels
V-Axis	0.9192	0.1350	0.1126	pixels

Table 1.5: Measurement prediction error summary (1-sigma)

[1]IPF filter removes systematic pointing errors due to: thermomechanical alignment drift (Body to TPF), gyro bias and bias drift, centroiding error, attitude error, and optical distortion. IPF SIGMA presented here is "NOT Scaled" by the Least Squares Scale factor. The Least Squares Scale Factor was: 1.005530.

[2]Error due to gyro Scale Factor: assumes 95 ppm error over 0.250 degree maneuver.

[3]Error due to gyro Angle Random Walk: assumes ARW = 100 $\mu deg/\sqrt{hr}$, with 730 second Maneuver time (max), and 6 independent Maneuvers.

[4]This can be interpreted as estimate of "pixel to sky" pointing reconstruction error if no science data is used.

[5]This can be interpreted as estimate of achieved S/I centroiding error

IPF BROWN ANGLE SUMMARY						
	WAS			IS		
Frame Number	theta_Y (arcmin)	theta_Z (arcmin)	angle (deg)	theta_Y (arcmin)	theta_Z (arcmin)	angle (deg)
121	+6.073000	-11.098000	-0.000000	+6.083644	-11.086016	+1.181230
113	+6.838000	-12.531000	+0.000000	+6.883550	-12.648880	+1.181230
114	+5.487000	-12.525000	+0.000000	+5.434301	-12.638740	+1.181230
116	+6.717000	-10.601000	-0.000000	+6.781960	-10.546685	+1.181230
117	+5.366000	-10.595000	+0.000000	+5.332711	-10.536547	+1.181230
001	+0.000000	+0.000000	+0.000000	+8.266406	-11.285144	+1.181230
001	+0.000000	+0.000000	+0.000000	+8.248630	-10.917305	+1.181230
001	+0.000000	+0.000000	+0.000000	+3.918659	-11.254727	+1.181230
001	+0.000000	+0.000000	+0.000000	+3.900883	-10.886889	+1.181230

Table 1.6: IPF Brown angle summary

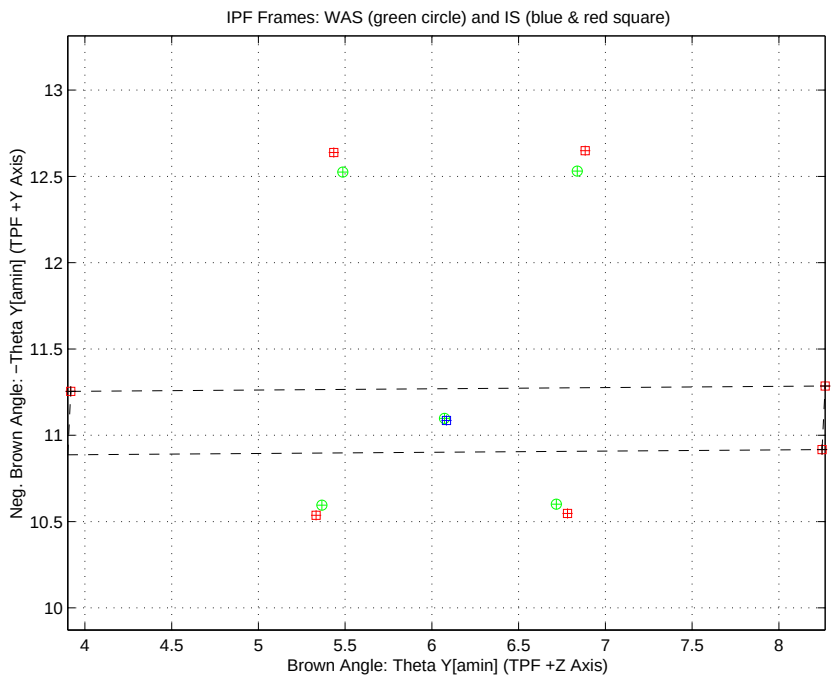

Figure 1.2: A-priori and a-posteriori IPF frames (ZOOMED)

2 FLUTE DATA SUMMARY

2.1 FLUTE CONFIGURATION PARAMETERS

The covariance analysis was performed using the FLUTE generated input data files. The internal configuration parameters, used to produce the data are tabulated in Table 2.1, Table 2.2 and Table 2.3.

NAME	DESCRIPTION	VALUE	UNIT
d2003	days into YEAR2003	+6.0000000000000000E+001	day
tstart	start time	+7.3051200000000000E+008	sec
tdel	data rate	+1.0000000000000001E-001	sec
tshelf	Inertial Hold duration pad	+5.0000000000000000E+000	sec
ipro	slew profile(1-linear, 2-S-curve)	1	int flag
sig_gcf [1]	gcf sigma(1)	+4.8481368110953601E-008	rad/sec
sig_gcf [2]	gcf sigma(2)	+9.6962736221907205E-009	rad/sec
sig_gcf [3]	gcf sigma(3)	+9.6962736221907205E-009	rad/sec
igcf	gcf bias correction flag	1	int flag
SigA [1][1]	Sigma A(1,1)	+9.4017722156391537E-009	rad^2
SigA [2][2]	Sigma A(2,2)	+2.3504430539097885E-011	rad^2
SigA [3][3]	Sigma A(3,3)	+2.3504430539097885E-011	rad^2
NFprime	Prime Frame NF	121	int
ftable [name]	Frame Table row number	121	int
ftable [q0]	Frametable quaternion q0	+1.4257389017362338E-006	N/A
ftable [q1]	Frametable quaternion q1	-8.8328078008885079E-004	N/A
ftable [q2]	Frametable quaternion q2	+1.6141373392967960E-003	N/A
ftable [q3]	Frametable quaternion q3	+9.9999830718540750E-001	N/A
ft_cmd [name]	Command row number	121	int
ft_cmd [q0]	Command quaternion q0	+1.4257389017362338E-006	N/A
ft_cmd [q1]	Command quaternion q1	-8.8328078008885079E-004	N/A
ft_cmd [q2]	Command quaternion q2	+1.6141373392967960E-003	N/A
ft_cmd [q3]	Command quaternion q3	+9.9999830718540750E-001	N/A
ft_true [name]	Truth row number	121	int
ft_true [q0]	Truth quaternion q0	+1.4257389017362338E-006	N/A
ft_true [q1]	Truth quaternion q1	-8.8328078008885079E-004	N/A
ft_true [q2]	Truth quaternion q2	+1.6141373392967960E-003	N/A
ft_true [q3]	Truth quaternion q3	+9.9999830718540750E-001	N/A
ft_prior [name]	Prior row number	121	int
ft_prior [q0]	FTprior quaternion q0	+1.4257389017362338E-006	N/A
ft_prior [q1]	FTprior quaternion q1	-8.8328078008885079E-004	N/A
ft_prior [q2]	FTprior quaternion q2	+1.6141373392967960E-003	N/A
ft_prior [q3]	FTprior quaternion q3	+9.9999830718540750E-001	N/A
ntable [NF]	ntable row number	121	int
ntable [iprime]	Prime frame indication flag	1	int
ntable [SIG_CX]	CX Sigma	+1.0000000000000001E-001	pixel
ntable [SIG_CY]	CY Sigma	+1.0000000000000001E-001	pixel
ntable [PIX2RADX]	Nom. angular pixelsize X-dir	+4.7922266400000000E-005	rad/pixel
ntable [PIX2RADY]	Nom. angular pixelsize Y-dir	+4.8814231500000000E-005	rad/pixel
ntable [CX0]	Center pixel along X-axis	+1.2500000000000000E+001	pixel
ntable [CY0]	Center pixel along Y-axis	+1.6500000000000000E+001	pixel
ntable [BETA0]	Nominal mirror scale factor	+2.8047410000000001E-006	rad/(e.u.)
ntable [GAMMA_E0]	Reference Mirror position	+3.2200000000000000E+003	(e.u.[6])

Table 2.1: FLUTE Parameter Table (1)

[6] encoder units

NAME	DESCRIPTION	VALUE	UNIT
ntable [D11]	x-to-w frame flip parameter	-1	int
ntable [D12]	y-to-w frame flip parameter	0	int
ntable [D21]	x-to-v frame flip parameter	0	int
ntable [D22]	y-to-v frame flip parameter	-1	int
ntable [DG]	Mirror flip parameter	1	int
ntable [sisizew]	Array size (w-direction)	+1.1635528346628863E-003	pixel
ntable [sisizev]	Array size (v-direction)	+9.5993108859688124E-005	pixel
ntable [p2i_w]	w-offset from prime	+0.0000000000000000E+000	pixel
ntable [p2i_v]	v-offset from prime	+0.0000000000000000E+000	pixel
p1true [a00]	True Constant Plate Scales	+1.0000000000000001E-001	N/A
p1true [b00]	True Constant Plate Scales	+1.0000000000000001E-001	N/A
p1true [c00]	True Constant Plate Scales	+1.0000000000000000E-002	N/A
p1true [a10]	True Γ Dependent Plate Scales	+1.0000000000000001E-001	1/rad
p1true [b10]	True Γ Dependent Plate Scales	+1.0000000000000001E-001	1/rad
p1true [c10]	True Γ Dependent Plate Scales	+1.0000000000000000E-002	1/rad
p1true [d10]	True Γ Dependent Plate Scales	+1.0000000000000000E-002	1/rad
p1true [a20]	True Γ^2 Dependent Plate Scales	+1.0000000000000001E-001	$1/\mathrm{rad}^2$
p1true [b20]	True Γ^2 Dependent Plate Scales	+1.0000000000000001E-001	$1/\mathrm{rad}^2$
p1true [c20]	True Γ^2 Dependent Plate Scales	+1.0000000000000000E-002	$1/\mathrm{rad}^2$
p1true [d20]	True Γ^2 Dependent Plate Scales	+1.0000000000000000E-002	$1/\mathrm{rad}^2$
p1true [a01]	True Linear Plate Scales	+2.0000000000000000E+000	N/A
p1true [b01]	True Linear Plate Scales	+2.0000000000000000E+000	N/A
p1true [c01]	True Linear Plate Scales	+2.0000000000000000E+000	N/A
p1true [d01]	True Linear Plate Scales	+2.0000000000000000E+000	N/A
p1true [e01]	True Linear Plate Scales	+2.0000000000000000E+000	N/A
p1true [f01]	True Linear Plate Scales	+2.0000000000000000E+000	N/A
p2true [am1]	True Scan mirror alignment Ux	+0.0000000000000000E+000	N/A
p2true [am2]	True Scan mirror alignment Uy	+2.0000000000000000E-002	N/A
p2true [am3]	True Scan mirror alignment Uz	+9.9979997999599901E-001	N/A
p2true [beta]	True Scan mirror scale factor	+1.1000000000000001E+000	N/A
p2true [qT1]	True IPF q1	+1.4257389017362338E-006	N/A
p2true [qT2]	True IPF q2	-8.8328078008885079E-004	N/A
p2true [qT3]	True IPF q3	+1.6141373392967960E-003	N/A
p2true [qT4]	True IPF q4	+9.9999830718540750E-001	N/A
p2true [qR01]	True Boresight Alignment q1	+2.4240683335224579E-004	N/A
p2true [qR02]	True Boresight Alignment q2	+1.6968478334657203E-005	N/A
p2true [qR03]	True Boresight Alignment q3	+1.9392546668179664E-005	N/A
p2true [qR04]	True Boresight Alignment q4	+9.9999997028746312E-001	N/A
p2true [brx]	True B. Alignment drift rate X	+4.0000000000000001E-010	rad/sec
p2true [bry]	True B. Alignment drift rate Y	+3.0000000000000000E-010	rad/sec
p2true [brz]	True B. Alignment drift rate Z	+2.0000000000000001E-010	rad/sec
p2true [crx]	True B. Alignment drift accel. X	+9.0000000000000000E-013	$\mathrm{rad/sec}^2$
p2true [cry]	True B. Alignment drift accel. Y	+8.0000000000000002E-013	$\mathrm{rad/sec}^2$
p2true [crz]	True B. Alignment drift accel. Z	+7.0000000000000005E-013	$\mathrm{rad/sec}^2$
p2true [bgx]	True Gyro bias correction X	+1.4544410433286078E-006	rad/sec
p2true [bgy]	True Gyro bias correction Y	+1.9392547244381440E-007	rad/sec
p2true [bgz]	True Gyro bias correction Z	+2.4240684055476802E-007	rad/sec
p2true [cgx]	True Gyro bias-rate correction X	+4.9999999999999999E-013	$\mathrm{rad/sec}^2$
p2true [cgy]	True Gyro bias-rate correction Y	+4.0000000000000001E-013	$\mathrm{rad/sec}^2$
p2true [cgz]	True Gyro bias-rate correction Z	+2.9999999999999998E-013	$\mathrm{rad/sec}^2$

Table 2.2: FLUTE Parameter Table (2)

NAME	DESCRIPTION	VALUE	UNIT
p2cmd [am1]	CMD Scan mirror alignment Ux	+0.0000000000000000E+000	N/A
p2cmd [am2]	CMD Scan mirror alignment Uy	+0.0000000000000000E+000	N/A
p2cmd [am3]	CMD Scan mirror alignment Uz	+1.0000000000000000E+000	N/A
p2cmd [beta]	CMD Scan mirror rotation SF	+1.0000000000000000E+000	N/A
p2cmd [qT1]	CMD IPF q1	+1.4257389017362338E-006	N/A
p2cmd [qT2]	CMD IPF q2	-8.8328078008885079E-004	N/A
p2cmd [qT3]	CMD IPF q3	+1.6141373392967960E-003	N/A
p2cmd [qT4]	CMD IPF q4	+9.9999830718540750E-001	N/A
p2cmd [qR01]	CMD Boresight Alignment q1	+0.0000000000000000E+000	N/A
p2cmd [qR02]	CMD Boresight Alignment q2	+0.0000000000000000E+000	N/A
p2cmd [qR03]	CMD Boresight Alignment q3	+0.0000000000000000E+000	N/A
p2cmd [qR04]	CMD Boresight Alignment q4	+1.0000000000000000E+000	N/A
p2cmd [brx]	CMD B. Alignment drift rate X	+0.0000000000000000E+000	rad/sec
p2cmd [bry]	CMD B. Alignment drift rate Y	+0.0000000000000000E+000	rad/sec
p2cmd [brz]	CMD B. Alignment drift rate Z	+0.0000000000000000E+000	rad/sec
p2cmd [crx]	CMD B. Alignment drift accel. X	+0.0000000000000000E+000	rad/sec^2
p2cmd [cry]	CMD B. Alignment drift accel. Y	+0.0000000000000000E+000	rad/sec^2
p2cmd [crz]	CMD B. Alignment drift accel. Z	+0.0000000000000000E+000	rad/sec^2
p2cmd [bgx]	CMD Gyro bias correction X	+0.0000000000000000E+000	rad/sec
p2cmd [bgy]	CMD Gyro bias correction Y	+0.0000000000000000E+000	rad/sec
p2cmd [bgz]	CMD Gyro bias correction Z	+0.0000000000000000E+000	rad/sec
p2cmd [cgx]	CMD Gyro bias-rate correction X	+0.0000000000000000E+000	rad/sec^2
p2cmd [cgy]	CMD Gyro bias-rate correction Y	+0.0000000000000000E+000	rad/sec^2
p2cmd [cgz]	CMD Gyro bias-rate correction Z	+0.0000000000000000E+000	rad/sec^2
a1	Semi-Major Axis of SIRTF (HCO [7])	+1.4960000000000000E+011	m
a2	Semi-Major Axis of Earth (HCO)	+1.4960000000000000E+011	m
e1	Eccentricity (SIRTF in HCO)	+1.6722000000000001E-002	N/A
e2	Eccentricity (Earth in HCO)	+1.6722000000000001E-002	N/A
inc1	inclination (SIRTF in HCO)	+4.0142572795869580E-001	rad
inc2	inclination (Earth in HCO)	+4.0142572795869580E-001	rad
Omega1	Ascending Node Long.(SIRTF in HCO)	+0.0000000000000000E+000	rad
Omega2	Ascending Node Long.(Earth in HCO)	+0.0000000000000000E+000	rad
omega1	Argument of Perigee(SIRTF in HCO)	+1.7627825445142729E+000	rad
omega2	Argument of Perigee(Earth in HCO)	+1.7627825445142729E+000	rad
nu0_1	True Anomaly of SIRTF(HCO)	+8.6071031605199810E-001	rad
nu0_2	True Anomaly of Earth(HCO)	+1.0328523792623976E+000	rad
inav	Velocity Report Flag	+0.0000000000000000E+000	rad
wsize	Array size W-dir	+1.1635528346628863E-003	rad
vsize	Array size V-dir	+9.5993108859688124E-005	rad
SigwDisp	CW Sigma, dispersion Xing	N/A	arcsec
SigvDisp	CV-Sigma, dispersion Xing	N/A	arcsec
SigwCross	CW-Sigma, cross-dispersion Xing	N/A	arcsec
SigvCross	CV-Sigma, cross-dispersion Xing	N/A	arcsec

Table 2.3: FLUTE Parameter Table (3)

[7] Heliocentric Orbit

2.2 FLUTE GENERATED UNIT TEST DATA

This subsection plots the FLUTE generated IPF filter input files. Seven figures, as tabulated in Table 2.4, show the campaign maneuver senario, the true sampled locations on the array and the actual centroided data superimposed the array plane. All angles shown in FLUTE plots have units of radians.

FIGURE NO.	DESCRIPTION
Figure 2.1	Focal Plane Survey Scenario Plot
Figure 2.2	Commanded-only source locations in TPF
Figure 2.3	True and commanded source locations in TPF
Figure 2.4	True and commanded source locations (ZOOMED) in TPF
Figure 2.5	True-sampled and centroided locations in Focal Plane (W,V) including rectangular array boundary approximation
Figure 2.6	True and centroided locations on S/I Array (W,V) including rectangular array boundary approximation
Figure 2.7	True and centroided locations on S/I Array (W,V) showing Prime and Inferred Frames including rectangular array boundary approximation

Table 2.4: Table of figures (FLUTE)

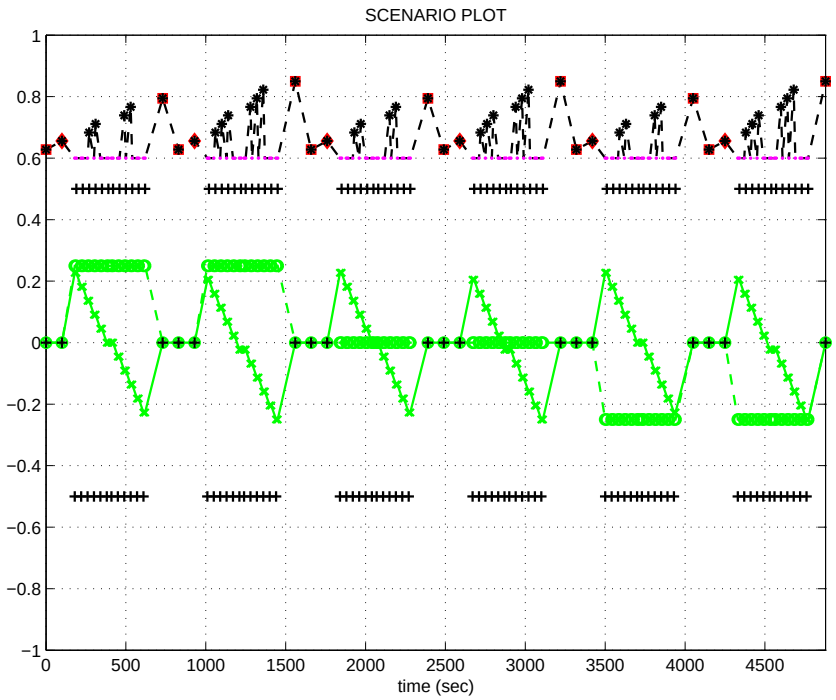

Figure 2.1: Focal plane survey scenario plot (See key in [3])

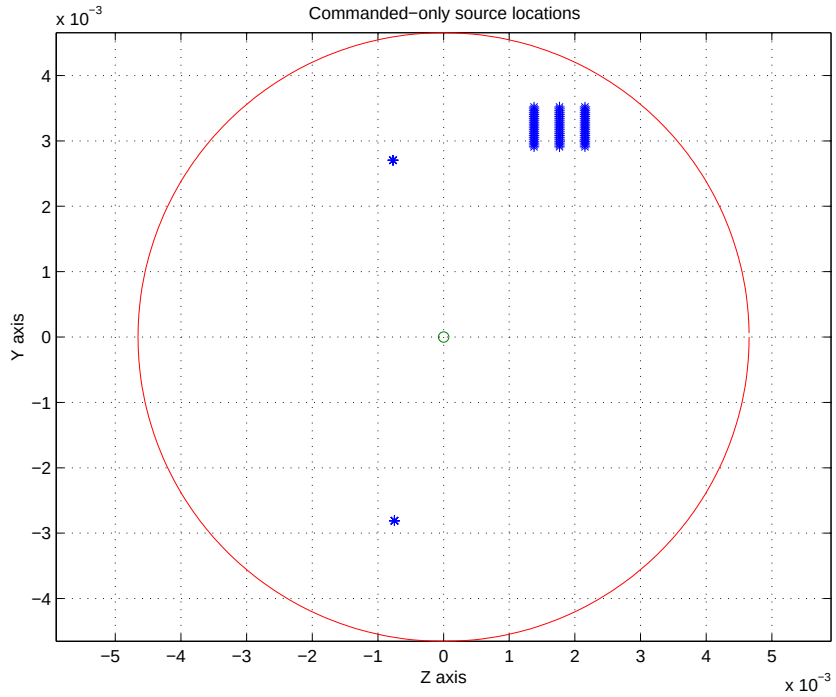

Figure 2.2: Commanded-only source locations

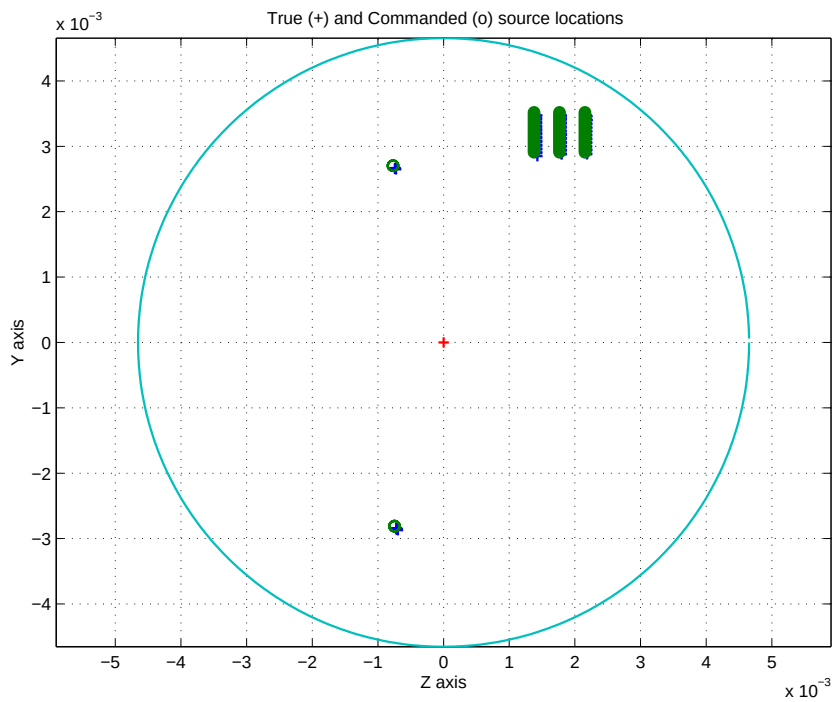

Figure 2.3: True (+) and commanded (o) source locations

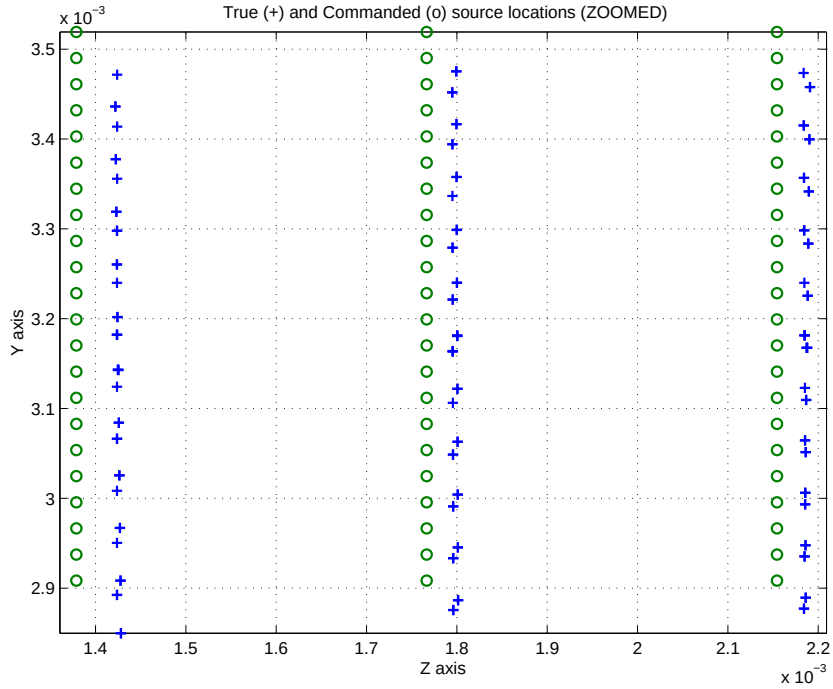

Figure 2.4: True (+) and commanded (o) source locations (ZOOMED)

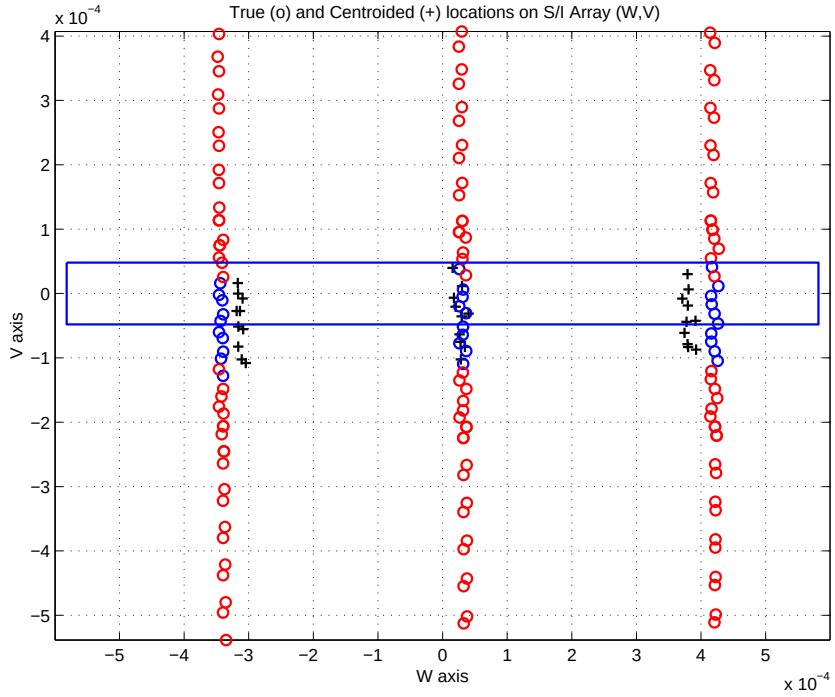

Figure 2.5: True-sampled (o) and centroided (+) locations on S/I array (W,V)

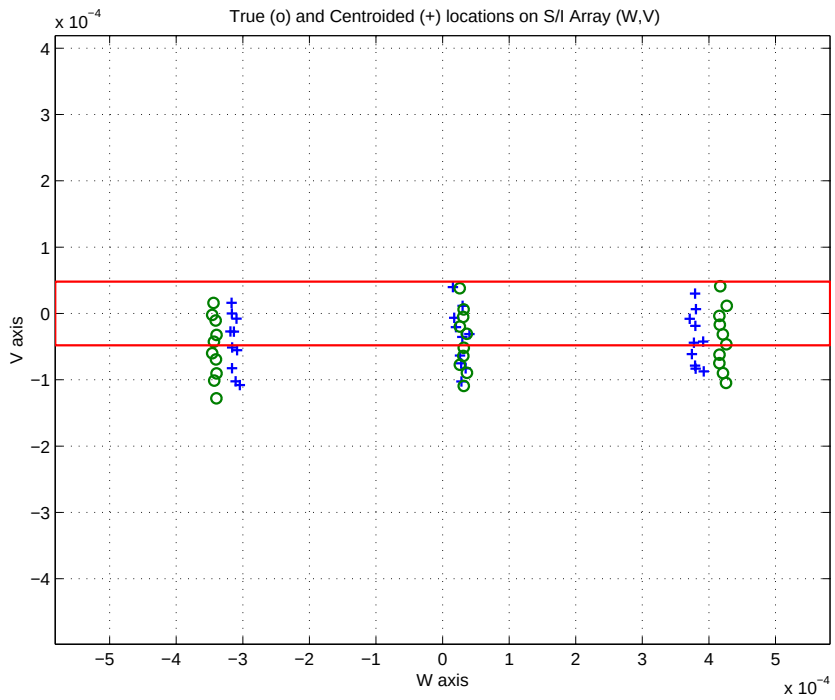

Figure 2.6: True (o) and centroided (+) locations on S/I array (W,V)

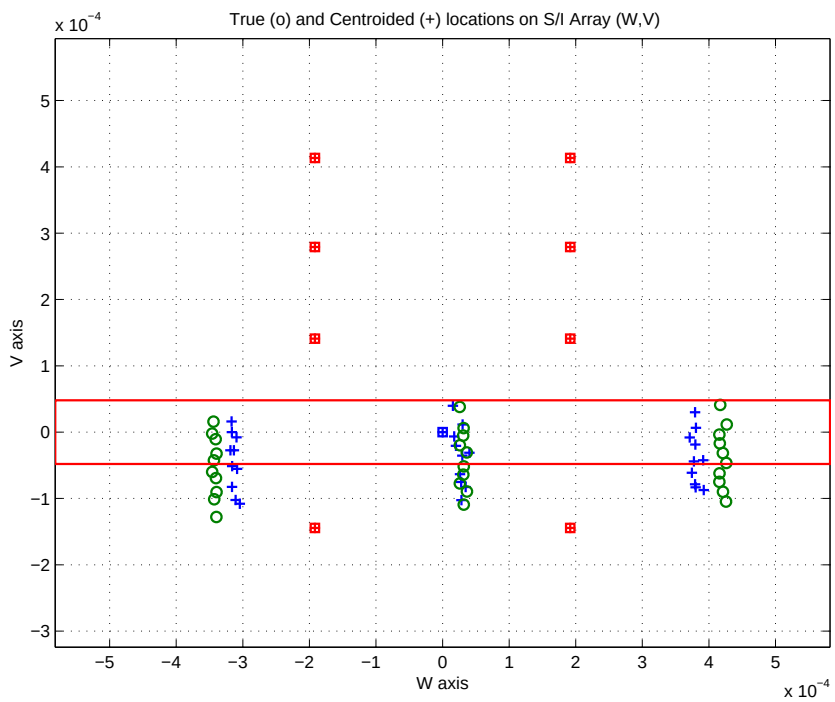

Figure 2.7: True (o) and centroided (+) locations on S/I array (W,V) showing prime and inferred frames

3 IPF EXECUTION RESULTS

3.1 IPF EXECUTION OUTPUT PLOTS

This subsection summarizes the IPF filter results. As shown in Table 3.1, the output plots are segmented to three groups: predicted performance, post-run results and IPF trending plots.

FIGURE NO.	DESCRIPTION
Predicted performance prior to IPF run	
Figure 3.1	Meas. and a-priori predicts in TPF coords
Figure 3.2	Meas. and a-priori predicts in Oriented Pixel Coords including rectangular array boundary approximation
Figure 3.3	A-priori prediction error
Figure 3.4	Oriented Pixel Coords of measurements and a-priori predicts (PCRS only)
IPF filter performance (post run results)	
Figure 3.5	IPF execution convergence, chart 1: (top) normalized residual error vs. iteration number and (bottom) norm of effective parameter corrections
Figure 3.6	IPF execution convergence, chart 2: parameter correction size vs. iteration number
Figure 3.7	Parameter uncertainty convergence: square-root of diagonal elements of covariance matrix vs. maneuver number
Figure 3.8	IPF parameter symbol table
Figure 3.9	KF parameter error sigma plot (a-priori-dashed, a-posteriori-solid). Includes true parameter errors (FLUTE runs only)
Figure 3.10	LS parameter error sigma plot. Includes true parameter errors (FLUTE runs only)
Figure 3.11	KF and LS parameter errors sigma plot (Figure 3.9 & Figure 3.10 combined)
Figure 3.12	Measurements and a-posteriori predicts in Oriented Pixel Coords including rectangular array boundaries (a-priori-dashed, a-posteriori-solid)
Figure 3.13	Attitude corrected meas. and a-posteriori predicts in Oriented Pixel Coords including rectangular array boundaries (a-priori-dashed, a-posteriori-solid)
Figure 3.14	Array plot with (solid) and w/o (dashed) optical distortion corrections
Figure 3.15	KF innovations with (o) and w/o (+) attitude corrections
Figure 3.16	W-axis KF innovations and 1-sigma bound
Figure 3.17	V-axis KF innovations and 1-sigma bound
IPF parameter trending plots	
Figure 3.18	Estimated attitude corrections (Body frame)
Figure 3.19	Estimated attitude error sigma plot (Body frame)
Figure 3.20	Systematic error attributed to thermo-mechanical boresight drift (equiv. angle in (W,V) coords)
Figure 3.21	Systematic error attributed to thermo-mechanical boresight drift (equiv. angle in Body frame)
Figure 3.22	Systematic error attributed to gyro drift bias (equiv. rate in (W,V) coords)
Figure 3.23	Systematic error attributed to gyro drift bias (equiv. angle in (W,V) coords)
Figure 3.24	Systematic error attributed to gyro drift bias (equiv. angle in Body frame)

Table 3.1: Table of figures (IPF run)

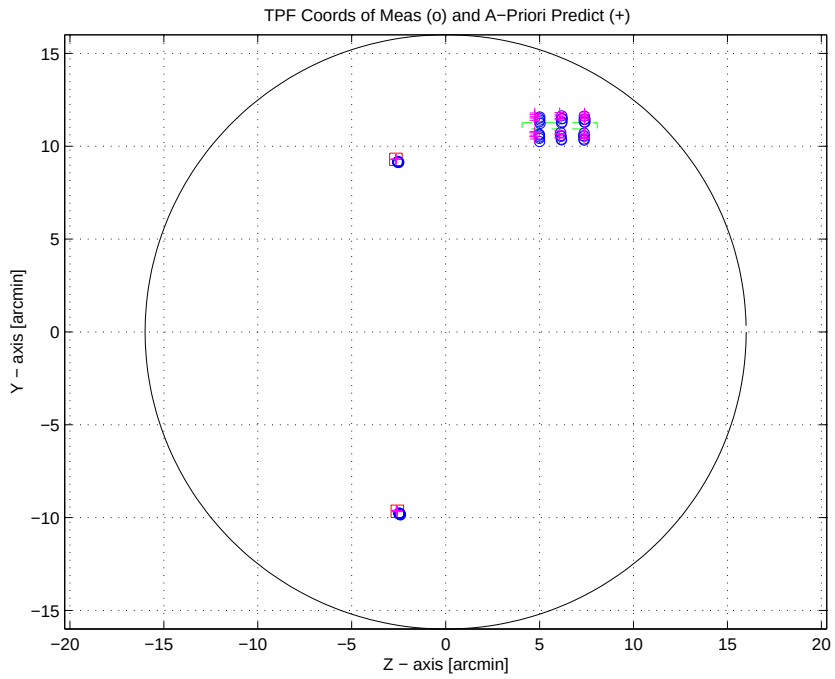

Figure 3.1: TPF coords of measurements and a-priori predicts

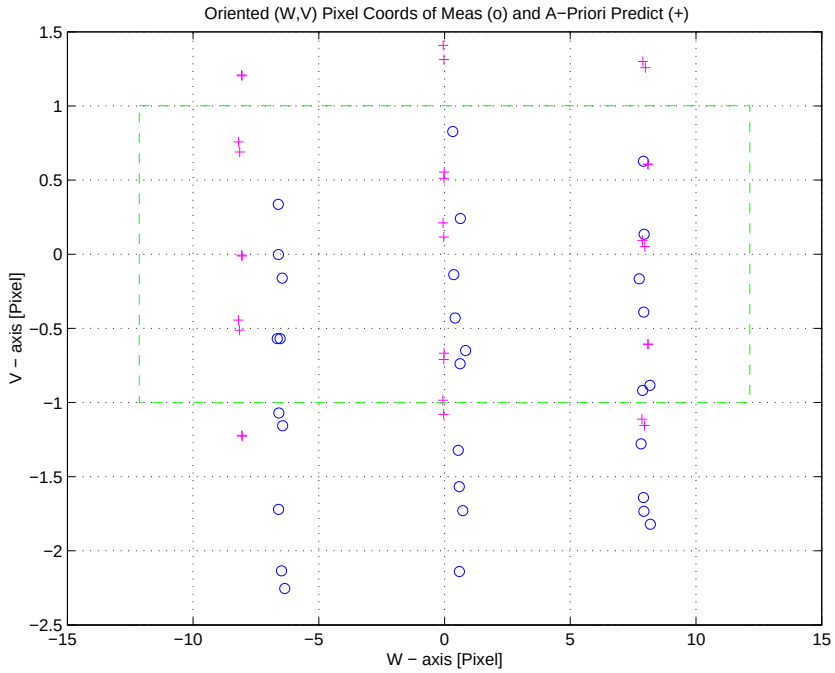

Figure 3.2: Oriented Pixel Coords of measurements and a-priori predicts

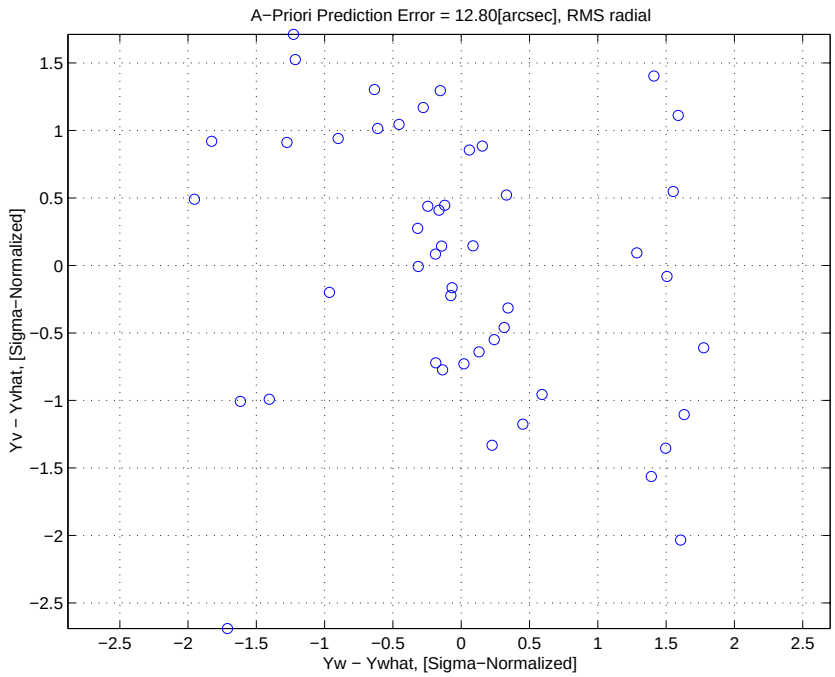

Figure 3.3: A-priori prediction error

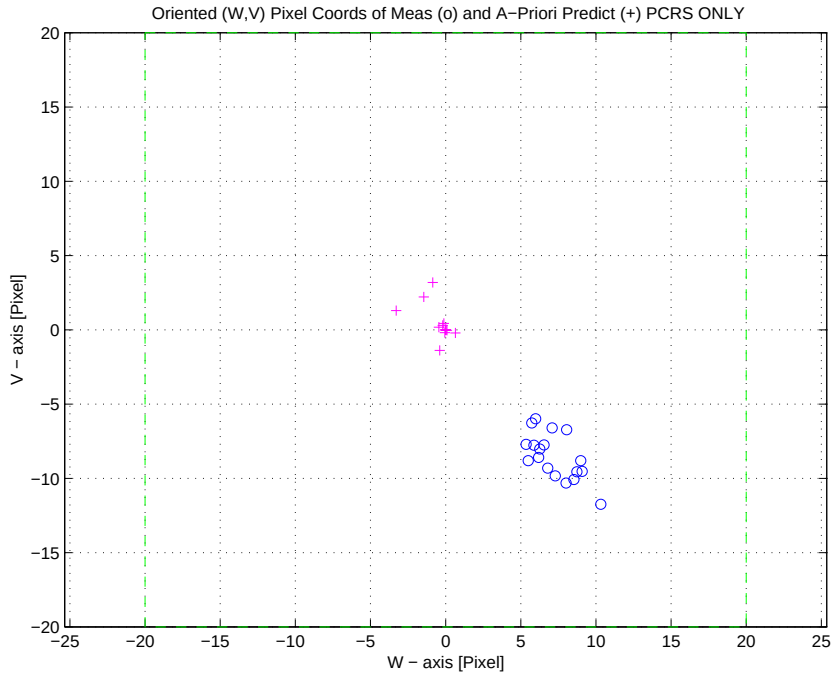

Figure 3.4: Oriented Pixel Coords of measurements and a-priori predicts (PCRS only)

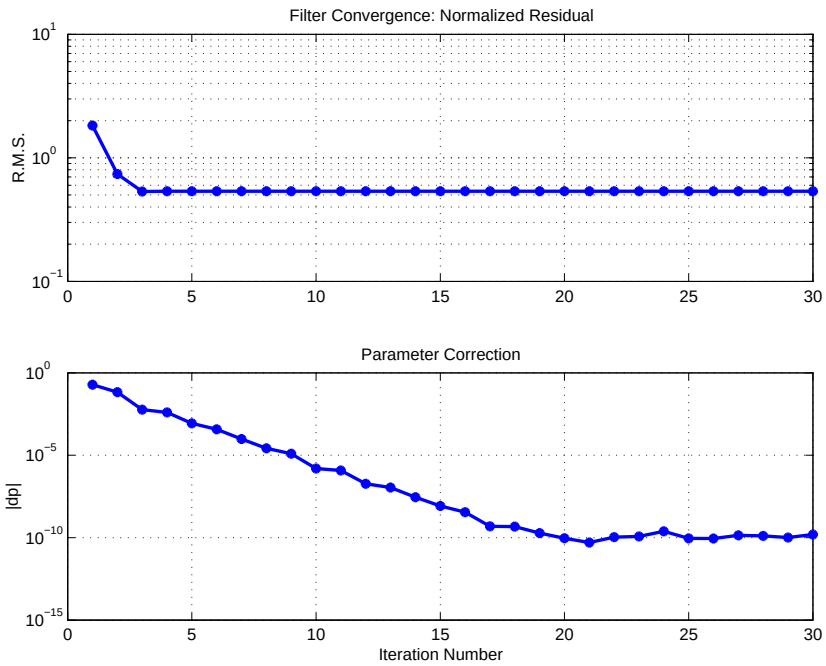

Figure 3.5: IPF execution convergence, chart 1

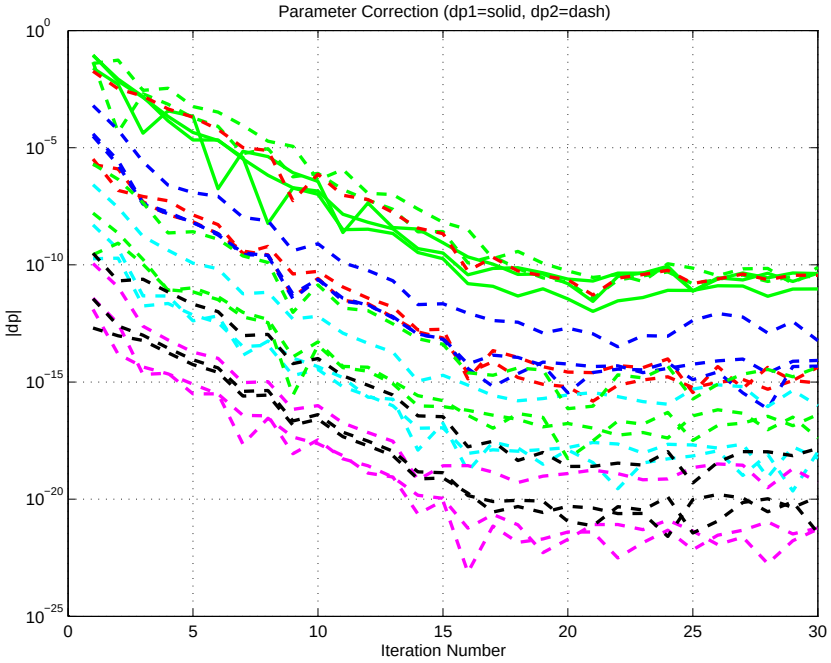

Figure 3.6: IPF execution convergence, chart 2

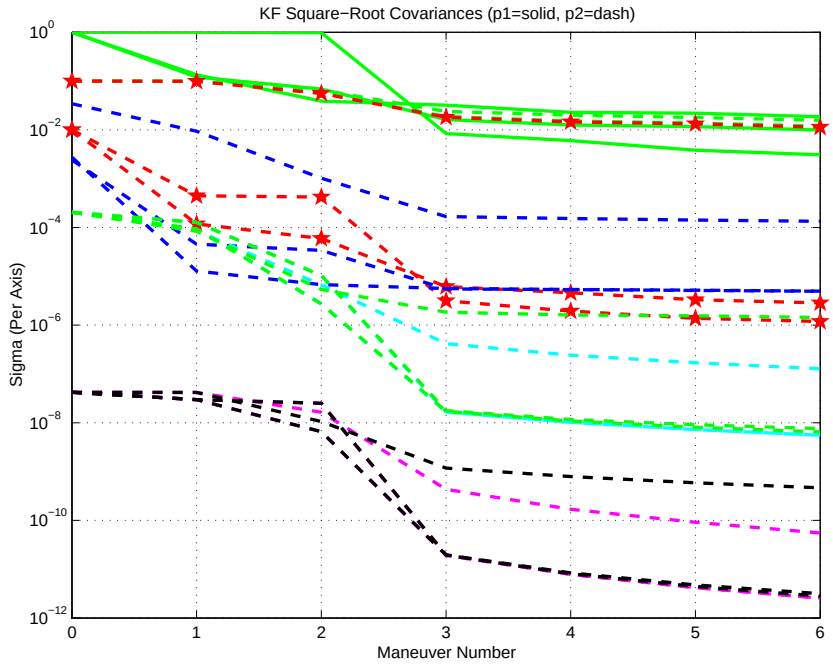

Figure 3.7: Parameter uncertainty convergence

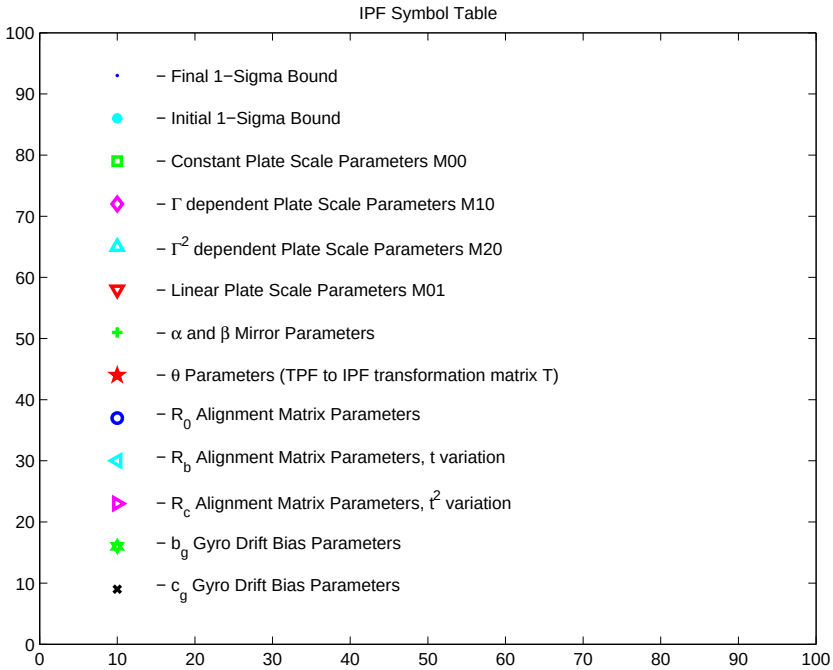

Figure 3.8: IPF parameter symbol table

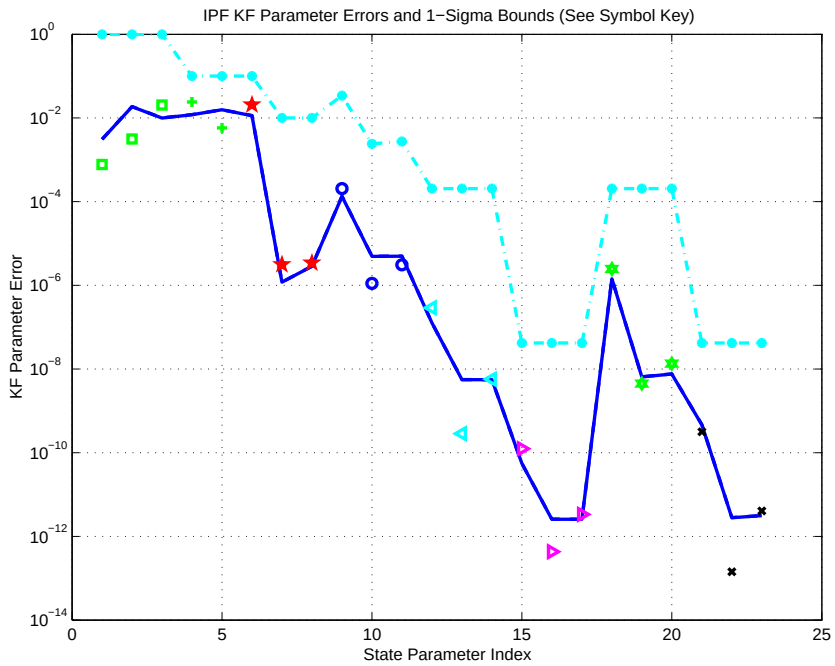

Figure 3.9: KF parameter error sigma plots

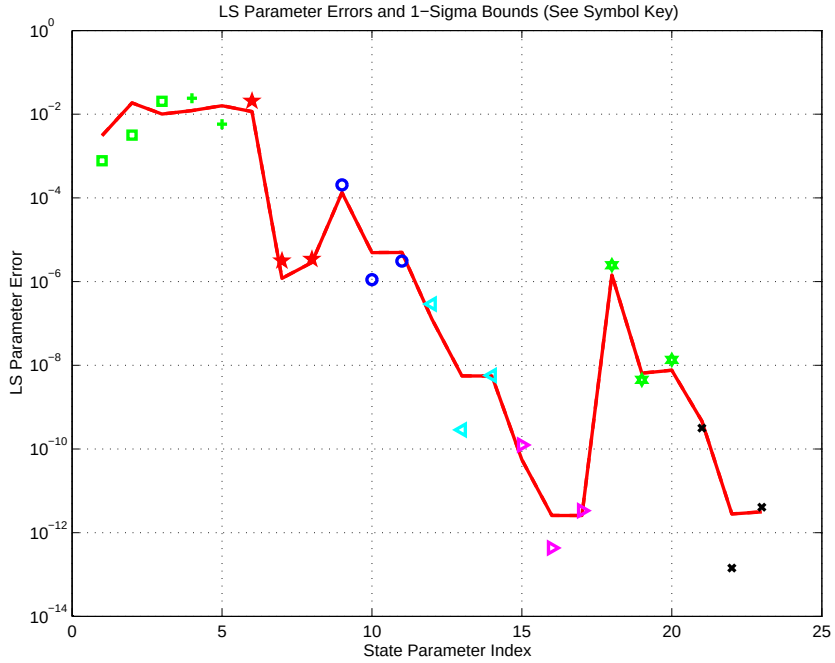

Figure 3.10: LS parameter error sigma plot

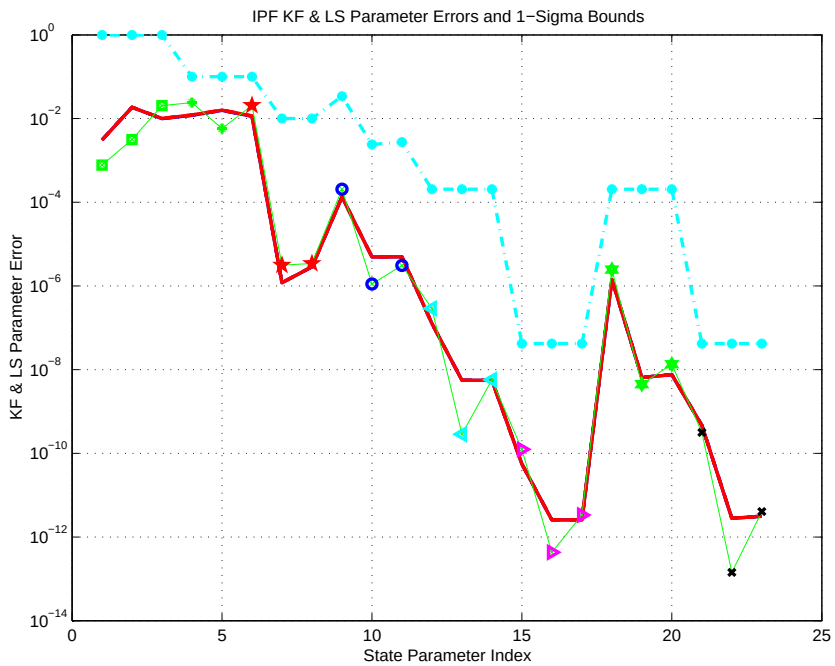

Figure 3.11: KF and LS parameter error sigma plot

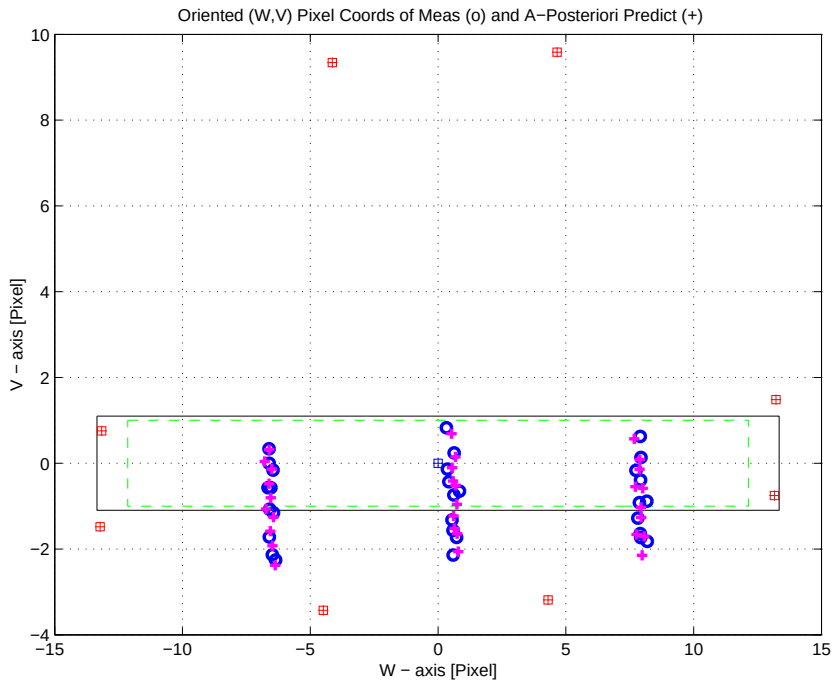

Figure 3.12: Oriented Pixel Coords of meas. and a-posteriori predicts

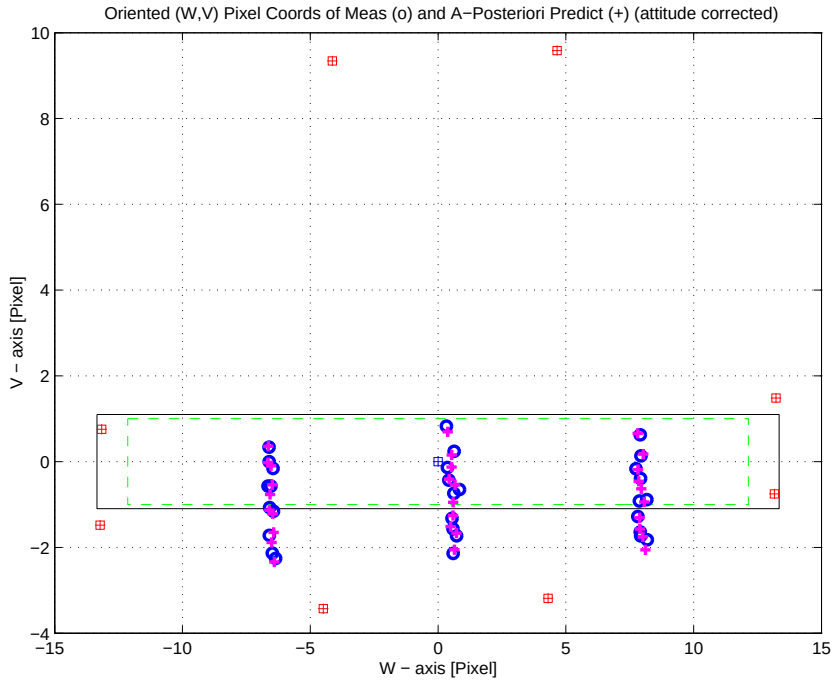

Figure 3.13: Oriented Pixel Coords of meas. and a-posteriori predicts (attitude corrected)

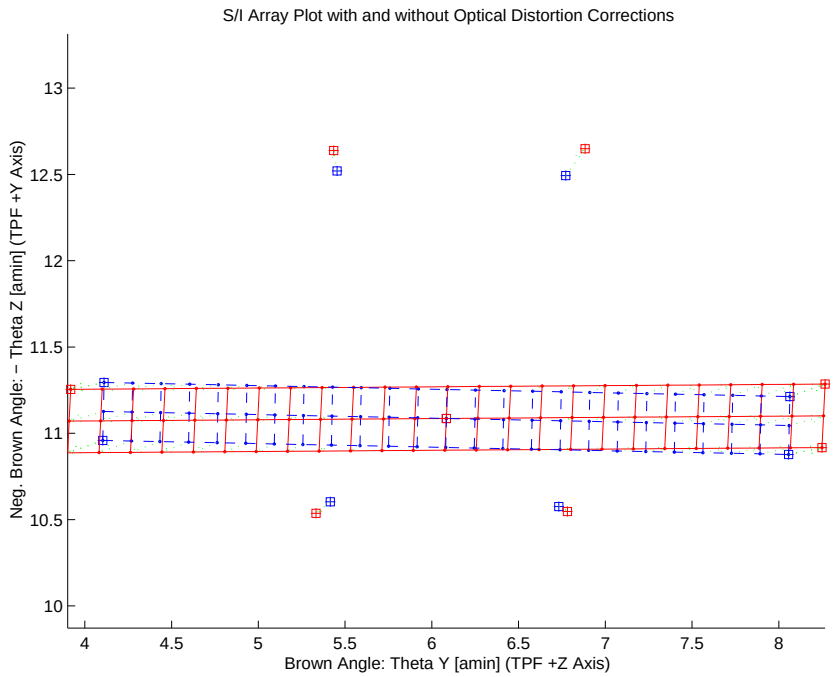

Figure 3.14: Array plot with (solid) and w/o (dashed) optical distortion corrections

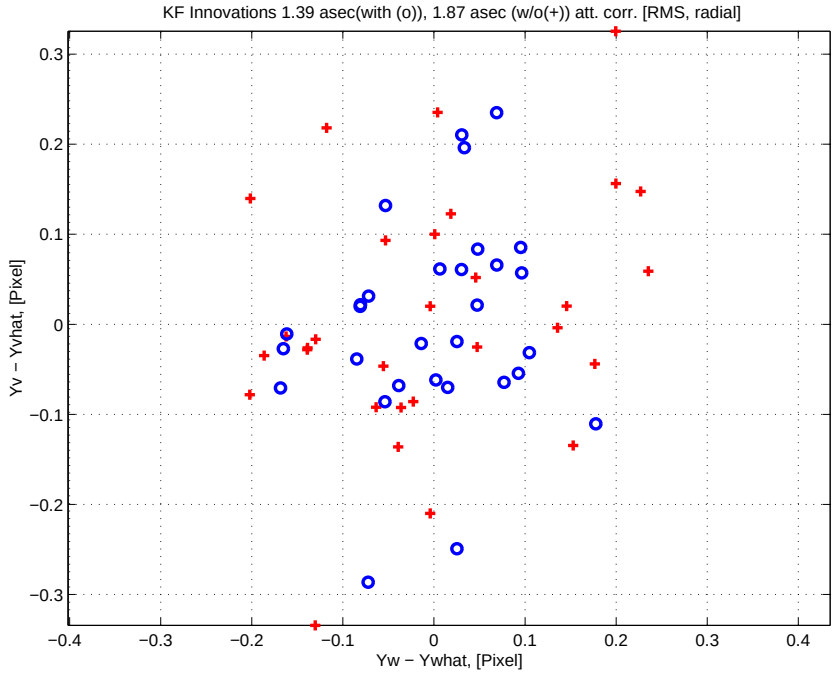

Figure 3.15: KF innovations with (o) and w/o (+) attitude corrections

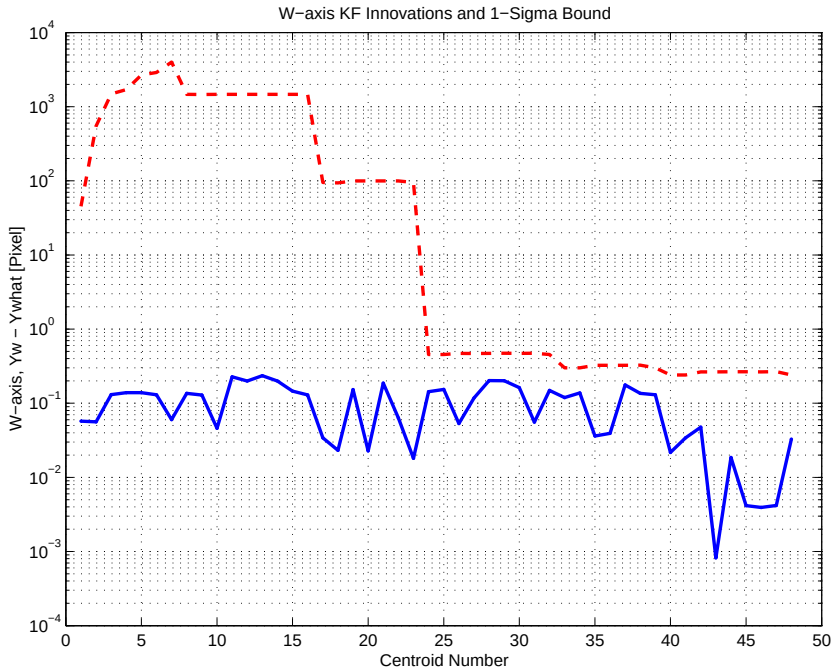

Figure 3.16: W-axis KF innovations and 1-sigma bound

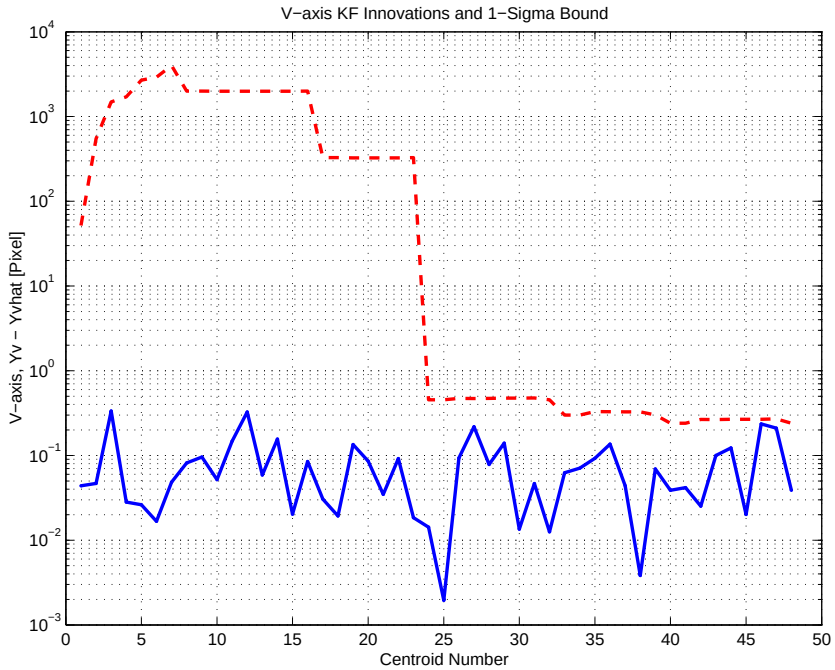

Figure 3.17: V-axis KF innovations and 1-sigma bound

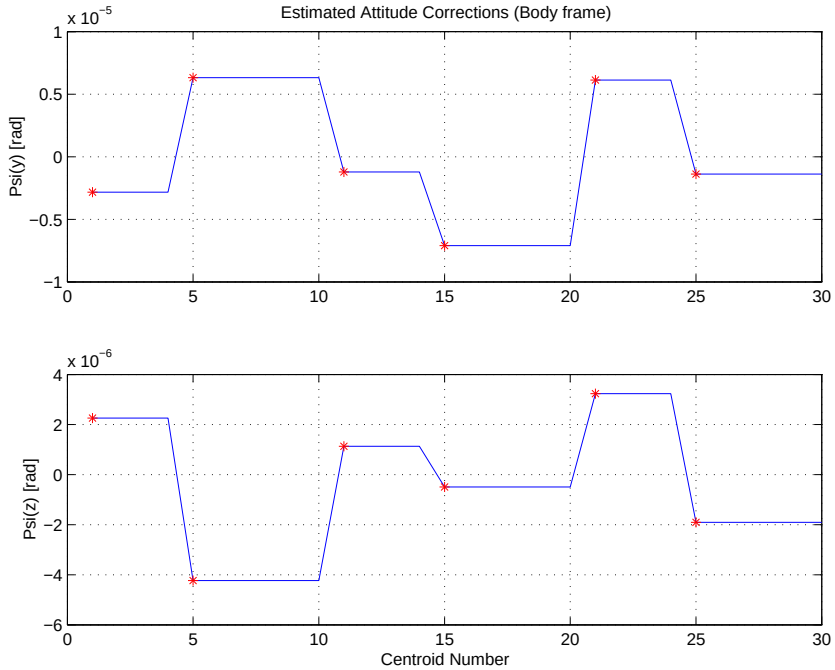

Figure 3.18: Estimated attitude corrections (Body frame)

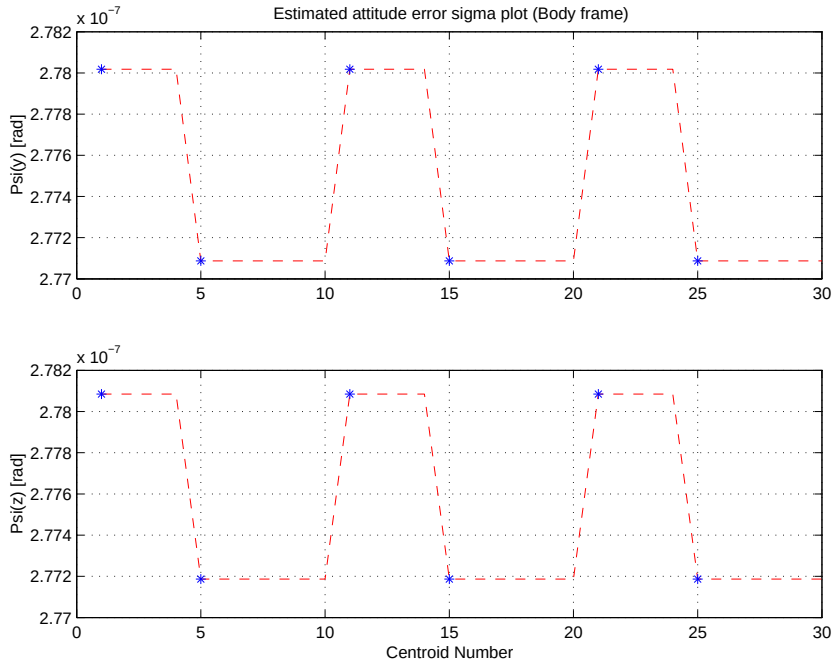

Figure 3.19: Estimated attitude error sigma plot (Body frame)

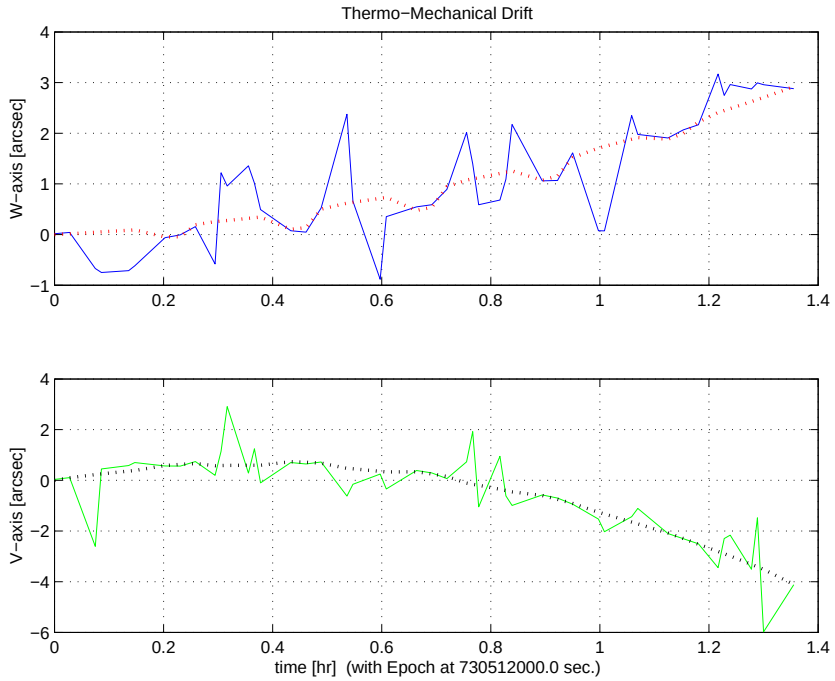

Figure 3.20: Thermo-mechanical boresight drift (equiv. angle in (W,V) coords)

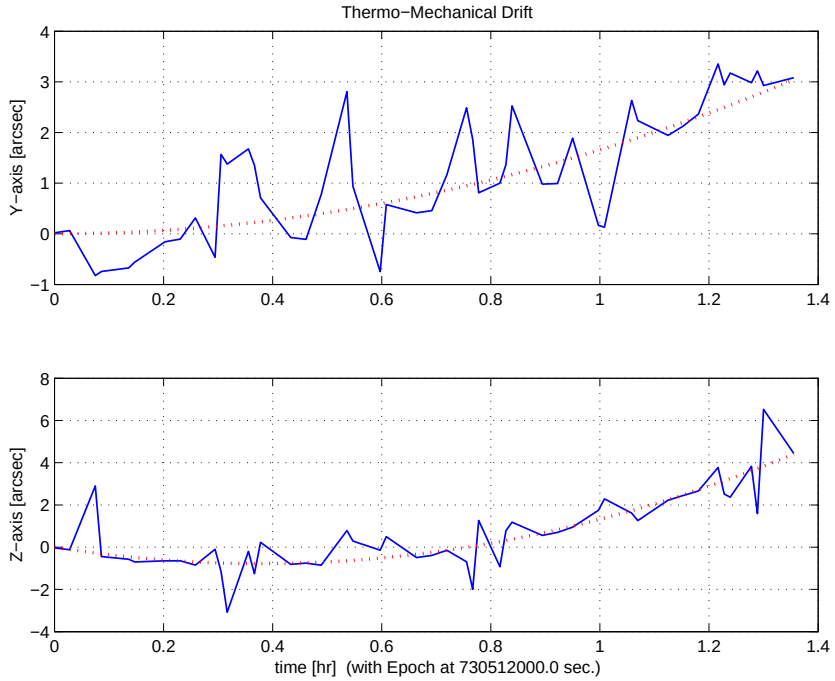

Figure 3.21: Thermo-mechanical boresight drift (equiv. angle in Body frame)

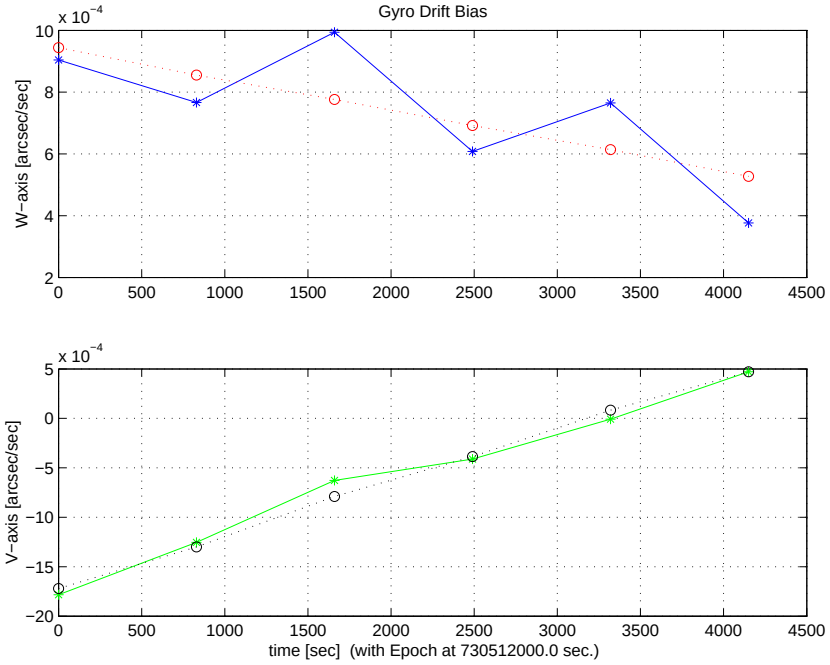

Figure 3.22: Gyro drift bias contribution (equiv. rate in (W,V) coords)

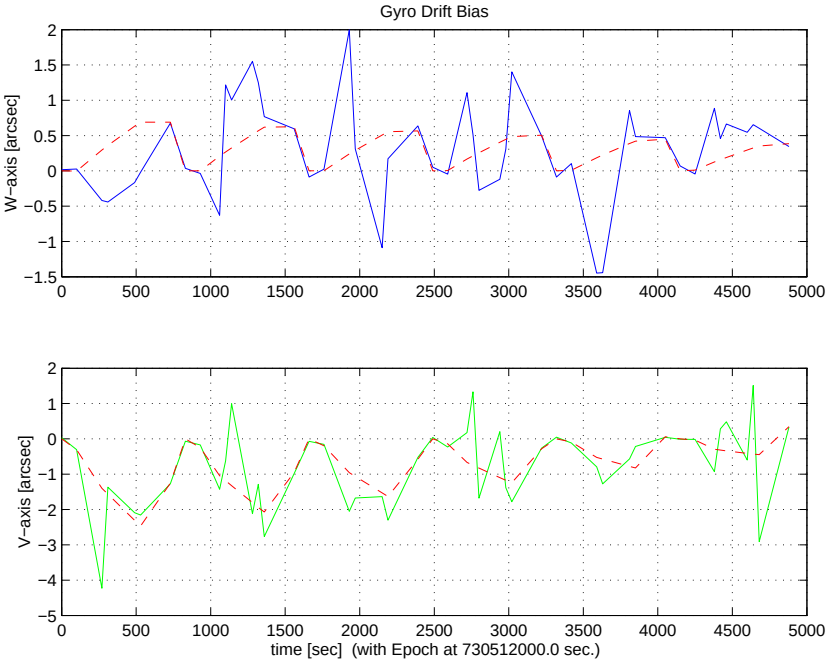

Figure 3.23: Gyro drift bias contribution (equiv. angle in (W,V) coords)

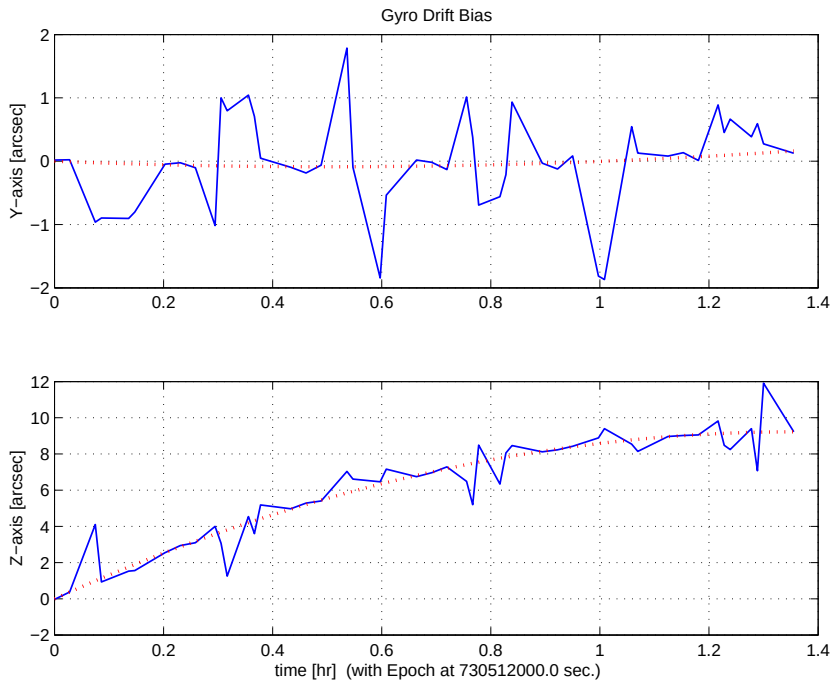

Figure 3.24: Gyro drift bias contribution (equiv. angle in Body frame)

3.2 IPF OUTPUT DATA (IF MINI FILE)

```
OUTPUT FILE NAME: IFmini996121.dat   DATE: 27-Aug-2003   TIME: 11:56
INSTRUMENT NAME:  MIPS_SED_center   NF: 121
IPF FILTER VERSION: IPF.V2.0.1Beta       SW RELEASE DATE: August 5, 2003
--------------------------------------------------------------------------------
---------------------------- IPF BROWN ANGLE SUMMARY ---------------------------
--------------------------------------------------------------------------------
         ------------ WAS ------------           ------------ IS -------------
Frame    theta_Y     theta_Z     angle           theta_Y     theta_Z     angle
Number   (arcmin)    (arcmin)    (deg)           (arcmin)    (arcmin)    (deg)
------  ---------------------------------       ---------------------------------
 121     +6.073000 -11.098000   -0.000000        +6.083644 -11.086016   +1.181230
 113     +6.838000 -12.531000   +0.000000        +6.883550 -12.648880   +1.181230
 114     +5.487000 -12.525000   +0.000000        +5.434301 -12.638740   +1.181230
 116     +6.717000 -10.601000   -0.000000        +6.781960 -10.546685   +1.181230
 117     +5.366000 -10.595000   +0.000000        +5.332711 -10.536547   +1.181230
 001     +0.000000  +0.000000   +0.000000        +8.266406 -11.285144   +1.181230
 001     +0.000000  +0.000000   +0.000000        +8.248630 -10.917305   +1.181230
 001     +0.000000  +0.000000   +0.000000        +3.918659 -11.254727   +1.181230
 001     +0.000000  +0.000000   +0.000000        +3.900883 -10.886889   +1.181230
--------------------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  0             121            +0.000            +0.000     pixels
OFFSET FRAME NAME: MIPS_SED_center
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
WAS(FTB)            +6.073000       -11.098000       -0.000000
IS (EST)            +6.083644       -11.086016       +1.181230
dT_EST              +0.010644        +0.011984       +1.181230
T_sSIGMA            +0.004109        +0.009864       +0.653648
dT_EST/T_sSIGMA     +2.590663        +1.214918       +1.807135
-------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  1             113            +4.000            +8.470     pixels
OFFSET FRAME NAME: MIPS_SED_5
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
WAS(FTB)            +6.838000       -12.531000       +0.000000
IS (EST)            +6.883550       -12.648880       +1.181230
dT_EST              +0.045550        -0.117880       +1.181230
T_sSIGMA            +0.032387        +0.026994       +0.653648
dT_EST/T_sSIGMA     +1.406421        -4.366951       +1.807135
-------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  2             114            -4.000            +8.470     pixels
OFFSET FRAME NAME: MIPS_SED_6
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
WAS(FTB)            +5.487000       -12.525000       +0.000000
IS (EST)            +5.434301       -12.638740       +1.181230
dT_EST              -0.052699        -0.113740       +1.181230
T_sSIGMA            +0.032937        +0.027883       +0.653648
dT_EST/T_sSIGMA     -1.599990        -4.079249       +1.807135
-------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  3             116            +4.000            -2.960     pixels
OFFSET FRAME NAME: MIPS_SED_7
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
WAS(FTB)            +6.717000       -10.601000       -0.000000
IS (EST)            +6.781960       -10.546685       +1.181230
dT_EST              +0.064960        +0.054315       +1.181230
T_sSIGMA            +0.010244        +0.015056       +0.653648
dT_EST/T_sSIGMA     +6.341374        +3.607557       +1.807135
-------------------------------------------------------------------
```

```
OFFSET           NF          Delta_CW          Delta_CV
  4             117            -4.000            -2.960     pixels
OFFSET FRAME NAME: MIPS_SED_8
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
WAS(FTB)            +5.366000       -10.595000       +0.000000
IS (EST)            +5.332711       -10.536547       +1.181230
dT_EST              -0.033289        +0.058453       +1.181230
T_sSIGMA            +0.009736        +0.015086       +0.653648
dT_EST/T_sSIGMA     -3.419289        +3.874563       +1.807135
-------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  5               1           +12.000            +1.000     pixels
OFFSET FRAME NAME: CORNER PIXEL (DIAGNOSTICS)
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
WAS(FTB)            +0.000000        +0.000000       +0.000000
IS (EST)            +8.266406       -11.285144       +1.181230
dT_EST              +8.266406       -11.285144       +1.181230
T_sSIGMA            +0.008363        +0.016053       +0.653648
dT_EST/T_sSIGMA    +988.502956       -702.996097       +1.807136
-------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  6               1           +12.000            -1.000     pixels
OFFSET FRAME NAME: CORNER PIXEL (DIAGNOSTICS)
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
WAS(FTB)            +0.000000        +0.000000       +0.000000
IS (EST)            +8.248630       -10.917305       +1.181230
dT_EST              +8.248630       -10.917305       +1.181230
T_sSIGMA            +0.007589        +0.016916       +0.653648
dT_EST/T_sSIGMA    +1086.959478       -645.388624       +1.807136
-------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  7               1           -12.000            +1.000     pixels
OFFSET FRAME NAME: CORNER PIXEL (DIAGNOSTICS)
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
WAS(FTB)            +0.000000        +0.000000       +0.000000
IS (EST)            +3.918659       -11.254727       +1.181230
dT_EST              +3.918659       -11.254727       +1.181230
T_sSIGMA            +0.009347        +0.017613       +0.653648
dT_EST/T_sSIGMA    +419.249928       -639.015464       +1.807136
-------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  8               1           -12.000            -1.000     pixels
OFFSET FRAME NAME: CORNER PIXEL (DIAGNOSTICS)
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
WAS(FTB)            +0.000000        +0.000000       +0.000000
IS (EST)            +3.900883       -10.886889       +1.181230
dT_EST              +3.900883       -10.886889       +1.181230
T_sSIGMA            +0.007129        +0.017707       +0.653648
dT_EST/T_sSIGMA    +547.150518       -614.843500       +1.807136
-------------------------------------------------------------------
-------------------------------------------------------------------------------------
-------------------------------------------------------------------------------------
VARNAME             MEAN                      SIGMA                SCALED_SIGMA
a00        +9.9225822642731831E-002 +3.0801727284216237E-003 +3.0972063576890797E-003
b00        +9.6846553999735671E-002 +1.8576462874338902E-002 +1.8679192367000923E-002
c00        +3.0359626866288535E-002 +9.9551819034316112E-003 +1.0010234945187498E-002
del_alpha  +3.1097808356195245E-011 +1.1946604318599986E-002 +1.2012670103512086E-002
beta       +1.0942118720328031E+000 +1.5669156902169287E-002 +1.5755808734107920E-002
del_theta1 +3.5498382445348087E-011 +1.1345567490680209E-002 +1.1408309488452579E-002
del_theta2 -9.0585705610050655E-016 +1.1886190421207325E-006 +1.1951922111891105E-006
del_theta3 +4.2770082697449825E-015 +2.8534826780955359E-006 +2.8692626912134020E-006
del_arx    -5.8411866381107014E-014 +1.3366647174846072E-004 +1.3440565923111169E-004
del_ary    -8.3280725125131302E-015 +4.9419739387139153E-006 +4.9693034943406929E-006
del_arz    -4.7420019350959261E-015 +4.9751954328620819E-006 +5.0027087063076064E-006
```

```
brx        -2.9077209366851612E-007 +1.2716404099485060E-007 +1.2786726945683617E-007
bry        +1.3570297518083117E-011 +5.5564872664382915E-009 +5.5872151354478811E-009
brz        -5.5401524883811350E-009 +5.5349610709966229E-009 +5.5655698982299801E-009
crx        +1.2529661204505803E-010 +5.5312664398636394E-011 +5.5618548354580766E-011
cry        +1.2325099017868280E-012 +2.5700855660940968E-012 +2.5842983679654122E-012
crz        +4.0647363850620566E-012 +2.5608513613532642E-012 +2.5750130972506868E-012
bgx        -2.4173465030535760E-006 +1.4366138371702977E-006 +1.4445584395223208E-006
bgy        -4.6992960689723639E-010 +6.4645450656079106E-009 +6.5002945750475161E-009
bgz        +1.8319732370225384E-008 +7.5842756249678202E-009 +7.6262173440363162E-009
cgx        +3.1518116432590091E-010 +4.6317788920480693E-010 +4.6573930414650738E-010
cgy        +2.5763128499164014E-013 +2.7914419387064526E-012 +2.8068788610150008E-012
cgz        -3.7508719702042605E-012 +3.1391320926746090E-012 +3.1564917724726937E-012
-------------------------------------------------------------------------------
LSQF RESIDUAL SIGMA SCALE =         +1.0055300889817904E+000
-------------------------------------------------------------------------------
-------------------------------------------------------------------------------------------------
-------------------------------------------------------------------------------------------------
                    a_mirror(1)               a_mirror(2)               a_mirror(3)
a_mirror_ipf   +0.0000000000000000E+000  +4.4059141015360397E-002  +9.9902892455273207E-001
a_mirror_tpf   -1.8448004946443851E-003  +2.3449072130729123E-002  +9.9972333059069041E-001
beta                beta_0                    beta                      beta_total
               +2.8047410000000001E-006  +1.0942118720328031E+000  +3.0689809001771564E-006
-------------------------------------------------------------------------------------------------
qT              qT(1)                     qT(2)                     qT(3)                     qT(4)
FrmTbl:   +1.4257389017362338E-006 -8.8328078008885079E-004 +1.6141373392967960E-003 +9.9999830718540750E-001
Estim:    +1.0309405514735120E-002 -8.6816138452836618E-004 +1.6214295288632368E-003 +9.9994516520658583E-001
DelTheta        deltheta(1)               deltheta(2)               deltheta(3)
          +2.0616351609772262E-002 -3.0963396669700649E-006 -3.4859148496415710E-006       [rad]
EulAngT         theta(1)                  theta(2)                  theta(3)                  [rad]
Mean      +2.0616357767870699E-002 -1.7696604308831644E-003 +3.2247914194641308E-003
SigmaT    +1.1345567490680209E-002 +1.1886190421207325E-006 +2.8534826780955359E-006
-------------------------------------------------------------------------------------------------
qR              qR(1)                     qR(2)                     qR(3)                     qR(4)
ASFILE:   +0.0000000000000000E+000 +0.0000000000000000E+000 +0.0000000000000000E+000 +1.0000000000000000E+000
Estim:    +3.4462193783806137E-004 +1.6412686013225255E-005 +2.0939664412731508E-005 +9.9999994026393535E-001
DelThetaR       deltheta(1)               deltheta(2)               deltheta(3)
          +6.8924457679855314E-004 +3.2810937536023919E-005 +4.1890638701875372E-005       [rad]
EulAngR         angR(1)                   angR(2)                   angR(3)                   [rad]
Mean      +6.8924457679855314E-004 +3.2810937536023919E-005 +4.1890638701875372E-005
SigmaR    +1.3366647174846072E-004 +4.9419739387139153E-006 +4.9751954328620819E-006
-------------------------------------------------------------------------------------------------
Initial Gyro Bias         Bg0(1)                    Bg0(2)                    Bg0(3)
                  +1.4103596909709606E-006 +1.8992229094009036E-007 +2.3749894380924006E-007
Gyro Bias Correction      Bg(1)                     Bg(2)                     Bg(3)
                  -2.4173465030535760E-006 -4.6992960689723639E-010 +1.8319732370225384E-008
Total Gyro Bias           BgT(1)                    BgT(2)                    BgT(3)
                  -1.0069868120826154E-006 +1.8945236133319312E-007 +2.5581867617946546E-007

Initial Gyro Bias Rate     Cg0(1)                    Cg0(2)                    Cg0(3)
                  +0.0000000000000000E+000 +0.0000000000000000E+000 +0.0000000000000000E+000
Gyro Bias Rate Correction  Cg(1)                     Cg(2)                     Cg(3)
                  +3.1518116432590091E-010 +2.5763128499164014E-013 -3.7508719702042605E-012
Total Gyro Bias Rate       CgT(1)                    CgT(2)                    CgT(3)
                  +3.1518116432590091E-010 +2.5763128499164014E-013 -3.7508719702042605E-012
-------------------------------------------------------------------------------------------------
-------------------------------------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  1             113            +4.000            +8.470     pixels
OFFSET FRAME NAME: MIPS_SED_5
qT              qT(1)                     qT(2)                     qT(3)                     qT(4)
WAS(FTB)  +1.8126199579333211E-006 -9.9454496966837184E-004 +1.8225581610202054E-003 +9.9999784457706087E-001
IS (EST)  +1.0309815481260334E-002 -9.8215305701716089E-004 +1.8499254276357715E-003 +9.9994465889669448E-001

DelTheta        deltheta(1)               deltheta(2)               deltheta(3)
```

```
Units            rad                      rad                      rad
         +2.0616425973850491E-002 -1.3249955131569750E-005 +3.4289934393999271E-005
EulAngT        theta(1)                 theta(2)                 theta(3)                 [rad]
Mean     +2.0616357767870699E-002 -2.0023435248183842E-003 +3.6794101459219431E-003
sSigmaT  +1.1408307814628293E-002 +9.4210437712909623E-006 +7.8521617151994916E-006
SigmaT   +1.1345565826061414E-002 +9.3692310896741074E-006 +7.8089773754564287E-006
-----------------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------------
OFFSET          NF          Delta_CW          Delta_CV
  2            114            -4.000            +8.470     pixels
OFFSET FRAME NAME: MIPS_SED_6
qT              qT(1)                    qT(2)                    qT(3)                    qT(4)
WAS(FTB)  +1.4537999564721429E-006 -7.9805039157808107E-004 +1.8216858191067733E-003 +9.9999802228516210E-001
IS (EST)  +1.0309428529172082E-002 -7.7139516042964572E-004 +1.8462783058620818E-003 +9.9994485442414538E-001

DelTheta       deltheta(1)              deltheta(2)              deltheta(3)
Units            rad                      rad                      rad
         +2.0616410576147323E-002 +1.5329550446204034E-005 +3.3085717643450368E-005
EulAngT        theta(1)                 theta(2)                 theta(3)                 [rad]
Mean     +2.0616357767870703E-002 -1.5807740496290113E-003 +3.6764605725158354E-003
sSigmaT  +1.1408307861943105E-002 +9.5810285830328575E-006 +8.1107469803765526E-006
SigmaT   +1.1345565873116008E-002 +9.5283360369003975E-006 +8.0661405056407360E-006
-----------------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------------
OFFSET          NF          Delta_CW          Delta_CV
  3            116            +4.000            -2.960     pixels
OFFSET FRAME NAME: MIPS_SED_7
qT              qT(1)                    qT(2)                    qT(3)                    qT(4)
WAS(FTB)  +1.5063093946384967E-006 -9.7694673214546602E-004 +1.5418516033291201E-003 +9.9999833413183592E-001
IS (EST)  +1.0309492191696499E-002 -9.7053045996057532E-004 +1.5440380836416992E-003 +9.9994519269196558E-001

DelTheta       deltheta(1)              deltheta(2)              deltheta(3)
Units            rad                      rad                      rad
         +2.0616326897207774E-002 -1.8896215022199685E-005 -1.5799521037762095E-005
EulAngT        theta(1)                 theta(2)                 theta(3)                 [rad]
Mean     +2.0616357767870699E-002 -1.9727923123859809E-003 +3.0679063482851707E-003
sSigmaT  +1.1408309227140305E-002 +2.9798296143505487E-006 +4.3795710013352409E-006
SigmaT   +1.1345567230805067E-002 +2.9634415190578268E-006 +4.3554847829268219E-006
-----------------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------------
OFFSET          NF          Delta_CW          Delta_CV
  4            117            -4.000            -2.960     pixels
OFFSET FRAME NAME: MIPS_SED_8
qT              qT(1)                    qT(2)                    qT(3)                    qT(4)
WAS(FTB)  +1.2026621870087705E-006 -7.8045205798068791E-004 +1.5409792062221856E-003 +9.9999850813699964E-001
IS (EST)  +1.0309169669075531E-002 -7.5977242911828054E-004 +1.5403911251197450E-003 +9.9994538398943167E-001

DelTheta       deltheta(1)              deltheta(2)              deltheta(3)
Units            rad                      rad                      rad
         +2.0616331227263713E-002 +9.6833316691020240E-006 -1.7003319651505240E-005
EulAngT        theta(1)                 theta(2)                 theta(3)                 [rad]
Mean     +2.0616357767870699E-002 -1.5512227958055205E-003 +3.0649572307051148E-003
sSigmaT  +1.1408309111756368E-002 +2.8319725500159271E-006 +4.3884538159830252E-006
SigmaT   +1.1345567116055704E-002 +2.8163976205660938E-006 +4.3643187449783985E-006
-----------------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------------
OFFSET          NF          Delta_CW          Delta_CV
  5             1           +12.000            +1.000     pixels
OFFSET FRAME NAME: CORNER PIXEL (DIAGNOSTICS)
qT              qT(1)                    qT(2)                    qT(3)                    qT(4)
WAS(FTB)  +0.0000000000000000E+000 +0.0000000000000000E+000 +0.0000000000000000E+000 +1.0000000000000000E+000
IS (EST)  +1.0309948292262200E-002 -1.1853151540347187E-003 +1.6536617653282683E-003 +9.9994478117392183E-001

DelTheta       deltheta(1)              deltheta(2)              deltheta(3)
```

```
Units            rad                      rad                      rad
         +2.0616357767870703E-002 -2.4046000565065128E-003 +3.2827152145852665E-003
EulAngT        theta(1)                 theta(2)                 theta(3)                 [rad]
Mean     +2.0616357767870699E-002 -2.4046000565065128E-003 +3.2827152145852665E-003
sSigmaT  +1.1408307253276781E-002 +2.4325673904006579E-006 +4.6696066033037101E-006
SigmaT   +1.1345565267797153E-002 +2.4191890596370910E-006 +4.6439252832624820E-006
-----------------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------------
OFFSET          NF          Delta_CW          Delta_CV
  6              1           +12.000            -1.000     pixels
OFFSET FRAME NAME: CORNER PIXEL (DIAGNOSTICS)
qT              qT(1)                    qT(2)                    qT(3)                    qT(4)
WAS(FTB)  +0.0000000000000000E+000 +0.0000000000000000E+000 +0.0000000000000000E+000 +1.0000000000000000E+000
IS (EST)  +1.0309880790169762E-002 -1.1832814539391753E-003 +1.6001381354645331E-003 +9.9994487136093702E-001

DelTheta        deltheta(1)              deltheta(2)              deltheta(3)
Units            rad                      rad                      rad
         +2.0616357767870706E-002 -2.3994292116907281E-003 +3.1757153422159227E-003
EulAngT        theta(1)                 theta(2)                 theta(3)                 [rad]
Mean     +2.0616357767870703E-002 -2.3994292116907272E-003 +3.1757153422159218E-003
sSigmaT  +1.1408307348565029E-002 +2.2074688717018251E-006 +4.9206249102190943E-006
SigmaT   +1.1345565362561346E-002 +2.1953285096989288E-006 +4.8935630709984690E-006
-----------------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------------
OFFSET          NF          Delta_CW          Delta_CV
  7              1           -12.000            +1.000     pixels
OFFSET FRAME NAME: CORNER PIXEL (DIAGNOSTICS)
qT              qT(1)                    qT(2)                    qT(3)                    qT(4)
WAS(FTB)  +0.0000000000000000E+000 +0.0000000000000000E+000 +0.0000000000000000E+000 +1.0000000000000000E+000
IS (EST)  +1.0308913758415800E-002 -5.5304125172214356E-004 +1.6427207197338845E-003 +9.9994535946277208E-001

DelTheta        deltheta(1)              deltheta(2)              deltheta(3)
Units            rad                      rad                      rad
         +2.0616357767870699E-002 -1.1398916458134612E-003 +3.2738673873240255E-003
EulAngT        theta(1)                 theta(2)                 theta(3)                 [rad]
Mean     +2.0616357767870703E-002 -1.1398916458134612E-003 +3.2738673873240255E-003
sSigmaT  +1.1408307076229217E-002 +2.7188833420796502E-006 +5.1232991581497540E-006
SigmaT   +1.1345565091723292E-002 +2.7039303665520523E-006 +5.0951226763762548E-006
-----------------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------------
OFFSET          NF          Delta_CW          Delta_CV
  8              1           -12.000            -1.000     pixels
OFFSET FRAME NAME: CORNER PIXEL (DIAGNOSTICS)
qT              qT(1)                    qT(2)                    qT(3)                    qT(4)
WAS(FTB)  +0.0000000000000000E+000 +0.0000000000000000E+000 +0.0000000000000000E+000 +1.0000000000000000E+000
IS (EST)  +1.0308880077585150E-002 -5.5100749367371438E-004 +1.5891971760936994E-003 +9.9994544742932034E-001

DelTheta        deltheta(1)              deltheta(2)              deltheta(3)
Units            rad                      rad                      rad
         +2.0616357767870699E-002 -1.1347207993223363E-003 +3.1668677545125447E-003
EulAngT        theta(1)                 theta(2)                 theta(3)                 [rad]
Mean     +2.0616357767870703E-002 -1.1347207993223361E-003 +3.1668677545125456E-003
sSigmaT  +1.1408307086111329E-002 +2.0738732076900782E-006 +5.1506891687844459E-006
SigmaT   +1.1345565101551056E-002 +2.0624675784591415E-006 +5.1223620508463194E-006
-----------------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------------
              q(1)                     q(2)                     q(3)                     q(4)
PCRS1A: +5.2603126189317361E-007 +3.7451819048221893E-004 -1.4045531552277380E-003 +9.9999894348258311E-001
PCRS2A: -5.1968404336718985E-007 +3.8455385122900486E-004 +1.3513933841514693E-003 +9.9999901292650617E-001
-------------------------------------------------------------------------------------
**********  CS-FILE PARAMETERS:  **********  **********  AS-FILE PARAMETERS:  **********
Row (01) PIX2RADX: +4.7922266400000000E-005  Row (1) TASTART:   +7.3051200000000000E+008
Row (02) PIX2RADY: +4.8814231500000000E-005  Row (2) TASTOP:    +7.3051688000000000E+008
Row (03) CX0:      +1.2500000000000000E+001  Row (3) S/C TIME:  +7.3051200000000000E+008
```

```
Row (04) CY0:      +1.6500000000000000E+001  Row (4) QR1:       +0.0000000000000000E+000
Row (05) BETA0:    +2.8047410000000001E-006  Row (5) QR2:       +0.0000000000000000E+000
Row (06) GAMMA_E0: +3.2200000000000000E+003  Row (6) QR3:       +0.0000000000000000E+000
Row (07) D11:      -1.0000000000000000E+000  Row (7) QR4:       +1.0000000000000000E+000
Row (08) D12:      +0.0000000000000000E+000
Row (09) D21:      +0.0000000000000000E+000
Row (10) D22:      -1.0000000000000000E+000
Row (11) DG:       +1.0000000000000000E+000
-------------------------------------------------------------------------------------
-------------------------------------------------------------
INITIAL STA-TO-PCRS ALIGNMENT (R) KNOWLEDGE (1-SIGMA)
    SIGMA(X)        SIGMA(Y)         SIGMA(Z)
1.41421656E+002  9.90383438E+000  1.13175056E+001  [arcsec]
-------------------------------------------------------------
PIX2RADX = 4.792226640000E-005[rad/pixel]
XPIXSIZE = 9.8847[arcsec]
PIX2RADY = 4.881423150000E-005[rad/pixel]
YPIXSIZE = 10.0687[arcsec]
CX0 = 12.5[pixel] = 123.56[arcsec]
CY0 = 16.5[pixel] = 166.13[arcsec]
-------------------------------------------------------------
NOMINAL BETA0 = 2.804741000000E-006[rad/encoder unit]
ENCODER UNIT SIZE = 0.58[arcsec]
GAMMA_E0 = 3220.00[encoder unit] = 1862.83[arcsec]
-------------------------------------------------------------
                | -1 | +0 |
FLIP MATRIX D = |----|----|   and   DG = +1
                | +0 | -1 |
-------------------------------------------------------------
```

3.3 IPF EXECUTION LOG

```
*********************************************************************
IPF EXECUTION-LOG FILE NAME:  LG996121.dat
INSTRUMENT TYPE:              MIPS_SED_center
IPF FILTER EXECUTION DATE:    27-Aug-2003    TIME: 11:06
IPF FILTER VERSION USED:      IPF.V2.0.1Beta
*********************************************************************

**************************************
SLIT FLAG ENABLED! ENTERING SLIT MODE.
**************************************


------------------- Loading & Preparing Input Files -------------------
AAFILE:  AA996121 Loaded!        AAFILE dimension = 48801 X 21
ASFILE:  AS996121 Loaded!
CAFILE:  CA996121 Loaded!        CAFILE dimension = 30 X 15
CBFILE:  CB996121 Loaded!        CBFILE dimension = 18 X 15
CCFILE:  CC996121 Created!       CCFILE dimension = 48 X 19
CSFILE:  CS996121 Loaded!
Loading Input Files Completed!
-----------------------------------------------------------------------

------------------------- Selected Mask Vectors -------------------------
index =   1  2  3  4  5  6  7  8  9 10 11 12 13 14 15 16 17 18 19 20
-----------------------------------------------------------------------
```

```
mask1 = [ 1  1  1  0  0  0  0  0  0  0  0  0  0  0  0  0  0 ]
mask2 = [ 1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1 ]
----------------------------------------------------------------------

---------------  Selected Initial Gyro Bias Parameters  ---------------
User Entered 1 : Use AFILE database - from S/C filter
IPF Linearized Using Following Nominal Gyro Bias Estimates
bg0 = [+1.4103596909709606E-006 +1.8992229094009036E-007 +2.3749894380924006E-007 ]
cg0 = [+0.0000000000000000E+000 +0.0000000000000000E+000 +0.0000000000000000E+000 ]
----------------------------------------------------------------------

---------------  Gyro Pre-Processor Run Completed  --------------------
     AGFILE CREATED:  AG996121.m     ACFILE CREATED:  AC996121.m
----------------------------------------------------------------------
Total Gyro Preprocessor Execution Time: 19 seconds

FRAME TABLE ENTRIES FOR PCRS LOADED TO TPCRS
q_PCRS4 = [ +5.2603126189317361E-007     q_PCRS5 = [ +7.3379987833742897E-007
            +3.7451819048221893E-004                 +5.2236196154513707E-004
            -1.4045531552277380E-003                 -1.4047712280184723E-003
            +9.9999894348258311E-001 ];              +9.9999887687698918E-001 ];
q_PCRS8 = [ -5.1968404336718985E-007     q_PCRS9 = [ -7.1963421681856818E-007
            +3.8455385122900486E-004                 +5.3239763239987400E-004
            +1.3513933841514693E-003                 +1.3516841804518383E-003
            +9.9999901292650617E-001 ];              +9.9999894475050310E-001 ];
-------------------------------------------------------------------------------
------ Initial Conditions for State -----  ------   Inital Square-Root Cov (diag)   -----
p1(01)  = a00  = +0.0000000000000000E+000  Sigma_initial(01,01) = 1.0000000000000000E+000
p1(02)  = b00  = +0.0000000000000000E+000  Sigma_initial(02,02) = 1.0000000000000000E+000
p1(03)  = c00  = +0.0000000000000000E+000  Sigma_initial(03,03) = 1.0000000000000000E+000
p1(04)  = a10  = +0.0000000000000000E+000  Sigma_initial(04,04) = 9.9999000000000000E+004
p1(05)  = b10  = +0.0000000000000000E+000  Sigma_initial(05,05) = 9.9999000000000000E+004
p1(06)  = c10  = +0.0000000000000000E+000  Sigma_initial(06,06) = 9.9999000000000000E+004
p1(07)  = d10  = +0.0000000000000000E+000  Sigma_initial(07,07) = 9.9999000000000000E+004
p1(08)  = a20  = +0.0000000000000000E+000  Sigma_initial(08,08) = 9.9999000000000000E+004
p1(09)  = b20  = +0.0000000000000000E+000  Sigma_initial(09,09) = 9.9999000000000000E+004
p1(10)  = c20  = +0.0000000000000000E+000  Sigma_initial(10,10) = 9.9999000000000000E+004
p1(11)  = d20  = +0.0000000000000000E+000  Sigma_initial(11,11) = 9.9999000000000000E+004
p1(12)  = a01  = +0.0000000000000000E+000  Sigma_initial(12,12) = 9.9999000000000000E+004
p1(13)  = b01  = +0.0000000000000000E+000  Sigma_initial(13,13) = 9.9999000000000000E+004
p1(14)  = c01  = +0.0000000000000000E+000  Sigma_initial(14,14) = 9.9999000000000000E+004
p1(15)  = d01  = +0.0000000000000000E+000  Sigma_initial(15,15) = 9.9999000000000000E+004
p1(16)  = e01  = +0.0000000000000000E+000  Sigma_initial(16,16) = 9.9999000000000000E+004
p1(17)  = f01  = +0.0000000000000000E+000  Sigma_initial(17,17) = 9.9999000000000000E+004
-------------------------------------------------------------------------------------
p2f(01) = am1  = +0.0000000000000000E+000
p2f(02) = am2  = +0.0000000000000000E+000  Sigma_initial(18,18) = 1.0000000000000001E-001
p2f(03) = am3  = +1.0000000000000000E+000
p2f(04) = beta = +1.0000000000000000E+000  Sigma_initial(19,19) = 1.0000000000000001E-001
p2f(05) = qT1  = +1.4257389017362338E-006  Sigma_initial(20,20) = 1.0000000000000001E-001
p2f(06) = qT2  = -8.8328078008885079E-004  Sigma_initial(21,21) = 1.0000000000000000E-002
p2f(07) = aT3  = +1.6141373392967960E-003  Sigma_initial(22,22) = 1.0000000000000000E-002
p2f(08) = qT4  = +9.9999830718540750E-001
p2f(09) = qR1  = +0.0000000000000000E+000  Sigma_initial(23,23) = 3.4281576788666959E-002
p2f(10) = qR2  = +0.0000000000000000E+000  Sigma_initial(24,24) = 2.4007572013584836E-003
p2f(11) = qR3  = +0.0000000000000000E+000  Sigma_initial(25,25) = 2.7434407822204804E-003
p2f(12) = qR4  = +1.0000000000000000E+000
p2f(13) = brx  = +0.0000000000000000E+000  Sigma_initial(26,26) = 2.0491803278688525E-004
p2f(14) = bry  = +0.0000000000000000E+000  Sigma_initial(27,27) = 2.0491803278688525E-004
p2f(15) = brz  = +0.0000000000000000E+000  Sigma_initial(28,28) = 2.0491803278688525E-004
p2f(16) = crx  = +0.0000000000000000E+000  Sigma_initial(29,29) = 4.1991400161246979E-008
p2f(17) = cry  = +0.0000000000000000E+000  Sigma_initial(30,30) = 4.1991400161246979E-008
p2f(18) = crz  = +0.0000000000000000E+000  Sigma_initial(31,31) = 4.1991400161246979E-008
p2f(19) = bgx  = +0.0000000000000000E+000  Sigma_initial(32,32) = 2.0491803278688525E-004
```

```
p2f(20) = bgy  = +0.0000000000000000E+000  Sigma_initial(33,33) = 2.0491803278688525E-004
p2f(21) = bgz  = +0.0000000000000000E+000  Sigma_initial(34,34) = 2.0491803278688525E-004
p2f(22) = cgx  = +0.0000000000000000E+000  Sigma_initial(35,35) = 4.1991400161246979E-008
p2f(23) = cgy  = +0.0000000000000000E+000  Sigma_initial(36,36) = 4.1991400161246979E-008
p2f(24) = cgz  = +0.0000000000000000E+000  Sigma_initial(37,37) = 4.1991400161246979E-008
-------------------------------------------------------------------------------------

--------------------   IPF KALMAN FILTER STARTED  ---------------------
Iteration#001: |dp|= +1.905784448253E-001   RMS(|Res|)=+1.905784448253E-001
Iteration#002: |dp|= +6.667902502433E-002   RMS(|Res|)=+6.667902502433E-002
Iteration#003: |dp|= +5.869659470241E-003   RMS(|Res|)=+5.869659470241E-003
Iteration#004: |dp|= +3.989704442852E-003   RMS(|Res|)=+3.989704442852E-003
Iteration#005: |dp|= +8.566554077126E-004   RMS(|Res|)=+8.566554077126E-004
Iteration#006: |dp|= +3.743648135142E-004   RMS(|Res|)=+3.743648135142E-004
Iteration#007: |dp|= +9.741946074431E-005   RMS(|Res|)=+9.741946074431E-005
Iteration#008: |dp|= +2.656447499957E-005   RMS(|Res|)=+2.656447499957E-005
Iteration#009: |dp|= +1.236738002659E-005   RMS(|Res|)=+1.236738002659E-005
Iteration#010: |dp|= +1.578344765378E-006   RMS(|Res|)=+1.578344765378E-006
Iteration#011: |dp|= +1.200412919415E-006   RMS(|Res|)=+1.200412919415E-006
Iteration#012: |dp|= +1.856838693729E-007   RMS(|Res|)=+1.856838693729E-007
Iteration#013: |dp|= +1.101691104891E-007   RMS(|Res|)=+1.101691104891E-007
Iteration#014: |dp|= +2.818317998841E-008   RMS(|Res|)=+2.818317998841E-008
Iteration#015: |dp|= +8.378311951682E-009   RMS(|Res|)=+8.378311951682E-009
Iteration#016: |dp|= +3.481613996513E-009   RMS(|Res|)=+3.481613996513E-009
Iteration#017: |dp|= +4.914307944178E-010   RMS(|Res|)=+4.914307944178E-010
Iteration#018: |dp|= +4.693785373864E-010   RMS(|Res|)=+4.693785373864E-010
Iteration#019: |dp|= +1.871261264500E-010   RMS(|Res|)=+1.871261264500E-010
Iteration#020: |dp|= +9.217809625973E-011   RMS(|Res|)=+9.217809625973E-011
Iteration#021: |dp|= +5.029694762398E-011   RMS(|Res|)=+5.029694762398E-011
Iteration#022: |dp|= +1.068253133604E-010   RMS(|Res|)=+1.068253133604E-010
Iteration#023: |dp|= +1.185424180431E-010   RMS(|Res|)=+1.185424180431E-010
Iteration#024: |dp|= +2.438667822928E-010   RMS(|Res|)=+2.438667822928E-010
Iteration#025: |dp|= +8.970683003531E-011   RMS(|Res|)=+8.970683003531E-011
Iteration#026: |dp|= +8.852776973482E-011   RMS(|Res|)=+8.852776973482E-011
Iteration#027: |dp|= +1.390075520672E-010   RMS(|Res|)=+1.390075520672E-010
Iteration#028: |dp|= +1.286448913739E-010   RMS(|Res|)=+1.286448913739E-010
Iteration#029: |dp|= +1.009065245535E-010   RMS(|Res|)=+1.009065245535E-010
Iteration#030: |dp|= +1.544761947010E-010   RMS(|Res|)=+1.544761947010E-010
IPF Kalman Filter Completed with Error |dp1| + |dp2| = +1.5447619470104271E-010
-----------------------------------------------------------------------

-----------------  IPF LEAST SQUARES FILTER STARTED  ------------------
Iteration#001   COND#=+6.915041441993E+007,   |dp|=+1.909193414469E-001
Iteration#002   COND#=+7.123807622832E+007,   |dp|=+6.805095321280E-002
Iteration#003   COND#=+6.843130452604E+007,   |dp|=+4.086433207292E-003
Iteration#004   COND#=+6.861019092019E+007,   |dp|=+6.933277044119E-004
Iteration#005   COND#=+6.861550122814E+007,   |dp|=+1.245542905162E-004
Iteration#006   COND#=+6.862107033544E+007,   |dp|=+2.400562686089E-005
Iteration#007   COND#=+6.862183308363E+007,   |dp|=+5.048512015803E-006
Iteration#008   COND#=+6.862206284757E+007,   |dp|=+1.024914794502E-006
Iteration#009   COND#=+6.862210591249E+007,   |dp|=+2.257106689156E-007
Iteration#010   COND#=+6.862211625645E+007,   |dp|=+4.725407899822E-008
Iteration#011   COND#=+6.862211839178E+007,   |dp|=+1.048590341207E-008
Iteration#012   COND#=+6.862211885360E+007,   |dp|=+2.251147454053E-009
Iteration#013   COND#=+6.862211897169E+007,   |dp|=+4.943420218336E-010
Iteration#014   COND#=+6.862211899802E+007,   |dp|=+1.066370034182E-010
Iteration#015   COND#=+6.862211900730E+007,   |dp|=+2.322603579988E-011
Iteration#016   COND#=+6.862211899827E+007,   |dp|=+5.568819457292E-012
Iteration#017   COND#=+6.862211899955E+007,   |dp|=+1.452337824185E-012
Iteration#018   COND#=+6.862211901097E+007,   |dp|=+4.539509828504E-013
Iteration#019   COND#=+6.862211898040E+007,   |dp|=+1.247237039058E-012
Iteration#020   COND#=+6.862211900884E+007,   |dp|=+8.622678601735E-013
Iteration#021   COND#=+6.862211898719E+007,   |dp|=+3.902541718044E-013
Iteration#022   COND#=+6.862211901463E+007,   |dp|=+1.526071098657E-012
```

```
Iteration#023   COND#=+6.862211901773E+007,   |dp|=+9.642515194979E-013
Iteration#024   COND#=+6.862211897934E+007,   |dp|=+3.530034613449E-013
Iteration#025   COND#=+6.862211899750E+007,   |dp|=+7.960335285001E-013
Iteration#026   COND#=+6.862211898504E+007,   |dp|=+4.735739368358E-013
Iteration#027   COND#=+6.862211898631E+007,   |dp|=+4.784673573935E-013
Iteration#028   COND#=+6.862211901945E+007,   |dp|=+6.586674071933E-013
Iteration#029   COND#=+6.862211901062E+007,   |dp|=+3.170785373578E-013
Iteration#030   COND#=+6.862211901039E+007,   |dp|=+1.381425453024E-013
IPF Least Squares Filter Completed with Error |dp1| + |dp2| = +1.3814254530235044E-013
----------------------------------------------------------------------
Total Execution Time: 3008 seconds
```

4 USER COMMENTS

This section left blank.

IPF TEAM CONTACT INFORMATION

IPF Team email		ipf@sirtfweb.jpl.nasa.gov	
David S. Bayard	X4-8208	David.S.Bayard@jpl.nasa.gov	(TEAM LEADER)
Dhemetrio Boussalis	X4-3977	boussali@grover.jpl.nasa.gov	
Paul Brugarolas	X4-9243	Paul.Brugarolas@jpl.nasa.gov	
Bryan H. Kang	X4-0541	Bryan.H.Kang@jpl.nasa.gov	
Edward.C.Wong	X4-3053	Edward.C.Wong@jpl.nasa.gov	(TASK MANAGER)

ACKNOWLEDGEMENTS

This work was performed at the Jet Propulsion Laboratory, California Institute of Technology, under contract with the National Aeronautics and Space Administration.

References

[1] D.S. Bayard, B.H. Kang, *SIRTF Instrument Pointing Frame Kalman Filter Algorithm*, JPL D-Document D-24809, September 30, 2003.

[2] B.H. Kang, D.S. Bayard, *SIRTF Instrument Pointing Frame (IPF) Software Description Document and User's Guide*, JPL D-Document D-24808, September 30, 2003.

[3] D.S. Bayard, B.H. Kang, *SIRTF Instrument Pointing Frame (IPF) Kalman Filter Unit Test Report*, JPL D-Document D-24810, September 30, 2003.

[4] *Space Infrared Telescope Facility In-Orbit Checkout and Science Verification Mission Plan*, JPL D-Document D-22622, 674-FE-301 Version 1.4, February 8, 2002.

[5] *Space Infrared Telescope Facility Observatory Description Document*, Lockheed Martin LMMS/P458569, 674-SEIT-300 Version 1.2, November 1, 2002.

[6] *SIRTF Software Interface Specification for Science Centroid INPUT Files (CAFILE, CSFILE)*, JPL SOS-SIS-2002, November 18, 2002.

[7] *SIRTF Software Interface Specification for Inferred Frames Offset INPUT Files (OFILE)*, JPL SOS-SIS-2003, November 18, 2002.

[8] *SIRTF Software Interface Specification for PCRS Centroid INPUT Files (CBFILE)*, JPL SIS-FES-015, November 18, 2002.

[9] *SIRTF Software Interface Specification for Attitude INPUT Files (AFILE, ASFILE)*, JPL SIS-FES-014, January 7, 2002.

[10] *SIRTF Software Interface Specification for IPF Filter Output Files (IFFILE, LGFILE, TARFILE)*, JPL SOS-SIS-2005, November 18, 2002.

[11] R.J. Brown, *Focal Surface to Object Space Field of View Conversion.* Systems Engineering Report SER No. S20447-OPT-051, Ball Aerospace & Technologies Corp., November 23, 1999.

JET PROPULSION LABORATORY **SIRTF IPF REPORT**
JPL ID93M121
August 27, 2003

SIRTF INSTRUMENT POINTING FRAME KALMAN FILTER EXECUTION SUMMARY

IPF RUN NUMBER: 93M121
REPORT TYPE: COVARIANCE ANALYSIS (MULTI-RUN)

PRIME FRAME: MIPS_SED_center (121)
INFERRED FRAMES: (113) (114) (116) (117) (1) (1) (1) (1)

IPF TEAM

Autonomy and Control Section (345)
Jet Propulsion Laboratory
California Institute of Technology
4800 Oak Grove Drive
Pasadena, CA 91109

Contents

1 IPF MULTI-RUN SUMMARY **3**

2 IPF MULTI-RUN RESULTS **7**

2.1 IPF MULTI-RUN OUTPUT PLOTS 7

2.2 IPF MULTI-RUN OUTPUT DATA (MF MINI FILE) 9

2.3 IPF MULTI-RUN EXECUTION LOG 14

3 USER COMMENTS **21**

List of Figures

1.1 A-priori and a-posteriori IPF frames 3

1.2 A-priori and a-posteriori IPF frames (ZOOMED) 6

2.1 Array plot with (solid) and w/o (dashed) optical distortion corrections 7

2.2 IPF parameter symbol table 7

2.3 KF parameter error sigma plots 8

2.4 KF parameter error 1-sigma bound 8

List of Tables

1.1 IPF filter execution configuration 4

1.2 Merge performance chart 4

1.3 IPF filter execution mask vector assignment 4

1.4 IPF calibration error summary ([arcsec], 1-sigma, radial) 5

1.5 IPF Brown angle summary 6

1 IPF MULTI-RUN SUMMARY

This report summarizes the SIRTF Instrument Pointing Frame (IPF) Kalman Filter execution. This document captures the results generated by a multi-run execution with the MR run number specified as: MR93M121. This multi-run execution merges 2 previously executed IPF runs of the instrument: MIPS_SED_center (121), for the purpose of improving estimation accuracy. The main multi-run calibration results have been documented in MF93M121 typically stored in the mission archive DOM collection IPF_MF. This report only summarizes the main aspects of the run, and does not substitute for the full information contained in the MF file.

Section 1 summarizes the multi-run merge results. The merge configurations are tabulated in Table 1.1. The overall End-to-End pointing performances are tabulated in Table 1.4. Section 2 summarizes resulting plots, a mini summary of the MF Multi-Run output file, and the execution log. Section 3 captures the user comments that are specific to this particular run.

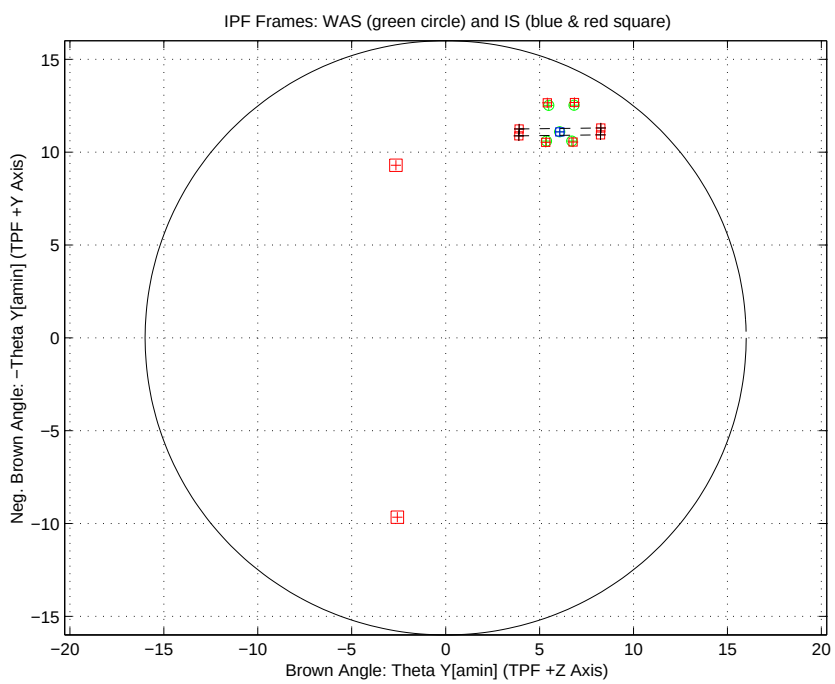

Figure 1.1: A-priori and a-posteriori IPF frames

EXECUTION CONFIGURATION ITEM	CURRENT STATUS
IPF Filter Version Used	IPF.V2.0.1Beta
Frame Table Version Used	FTVE2E1
IPF Filter Mode	NORMAL-MODE(0)
LS Residual Sigma Scale	9.63395895E-001
Merge Data Set #1	995121
Merge Data Set #2	996121

Table 1.1: IPF filter execution configuration

	BROWN ANGLES AND SIGMAS [arcmin, arcmin, deg]					
RUN#	$-\theta_y$	$-\theta_z$	θ_x	σ_y	σ_z	σ_x
995121	+6.072481	-11.094429	+0.444676	0.003343	0.009273	0.625347
996121	+6.083644	-11.086016	+1.181230	0.004109	0.009864	0.653648
93M121	+6.077676	-11.088153	+0.693046	0.002535	0.005755	0.437676

Table 1.2: Merge performance chart

Con. Plate Scale			Γ Dependent				Γ^2 Dependent				Linear Plate Scale						Mirror	
a_{00}	b_{00}	c_{00}	a_{10}	b_{10}	c_{10}	d_{10}	a_{20}	b_{20}	c_{20}	d_{20}	a_{01}	b_{01}	c_{01}	d_{01}	e_{01}	f_{01}	α	β
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1

IPF (T)			Alignment R									Gyro Drift Bias						
θ_1	θ_2	θ_3	a_{rx}	a_{ry}	a_{rz}	b_{rx}	b_{ry}	b_{rz}	c_{rx}	c_{ry}	c_{rz}	b_{gx}	b_{gy}	b_{gz}	c_{gx}	c_{gy}	c_{gz}	
20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	
1	1	1																

Table 1.3: IPF filter execution mask vector assignment

FOCAL PLANE SURVEY ANALYSIS: MULTI-RUN
INSTRUMENT NAME: MIPS_SED_center NF: 121

```
PIX2RADW: 4.79222664E-005[rad/pixel] = 9.8847E+000[arcsec/pixel]
PIX2RADV: 4.79222664E-005[rad/pixel] = 9.8847E+000[arcsec/pixel]
```

FRAME	DESCRIPTION	IPF[1]	SF[2]	ARW[3]	TOTAL	REQ
121(P)	MIPS_SED_center	0.3916	0.0855	0.0936	0.4116	1.10
113(I)	MIPS_SED_5	1.7251	0.0855	0.0936	1.7297	N/A
114(I)	MIPS_SED_6	1.7368	0.0855	0.0936	1.7414	N/A
116(I)	MIPS_SED_7	0.7112	0.0855	0.0936	0.7224	N/A
117(I)	MIPS_SED_8	0.6996	0.0855	0.0936	0.7110	N/A
TR (C)	CORNERS OF INSTRUMENT	0.7381	0.0855	0.0936	0.7489	N/A
BR (C)	CORNERS OF INSTRUMENT	0.7385	0.0855	0.0936	0.7493	N/A
TL (C)	CORNERS OF INSTRUMENT	0.7449	0.0855	0.0936	0.7556	N/A
BL (C)	CORNERS OF INSTRUMENT	0.7250	0.0855	0.0936	0.7360	N/A

Table 1.4: IPF calibration error summary ([arcsec], 1-sigma, radial)

[1]IPF filter removes systematic pointing errors due to: thermomechanical alignment drift (Body to TPF), gyro bias and bias drift, centroiding error, attitude error, and optical distortion. IPF SIGMA presented here is "NOT Scaled" by the Least Squares Scale factor. The Least Squares Scale Factor was: 0.963396.

[2]Error due to gyro Scale Factor: assumes 95 ppm error over 0.250 degree maneuver.

[3]Error due to gyro Angle Random Walk: assumes ARW = 100 $\mu deg/\sqrt{hr}$, with 730 second Maneuver time (max), and 6 independent Maneuvers.

IPF BROWN ANGLE SUMMARY						
	WAS			IS		
Frame Number	theta_Y (arcmin)	theta_Z (arcmin)	angle (deg)	theta_Y (arcmin)	theta_Z (arcmin)	angle (deg)
121	+6.073000	-11.098000	-0.000000	+6.077676	-11.088153	+0.693046
113	+6.838000	-12.531000	+0.000000	+6.859144	-12.671377	+0.693046
114	+5.487000	-12.525000	+0.000000	+5.408885	-12.654341	+0.693046
116	+6.717000	-10.601000	-0.000000	+6.783117	-10.546359	+0.693046
117	+5.366000	-10.595000	+0.000000	+5.332858	-10.529325	+0.693046
001	+0.000000	+0.000000	+0.000000	+8.259716	-11.299621	+0.693046
001	+0.000000	+0.000000	+0.000000	+8.246413	-10.927789	+0.693046
001	+0.000000	+0.000000	+0.000000	+3.908939	-11.248516	+0.693046
001	+0.000000	+0.000000	+0.000000	+3.895636	-10.876685	+0.693046

Table 1.5: IPF Brown angle summary

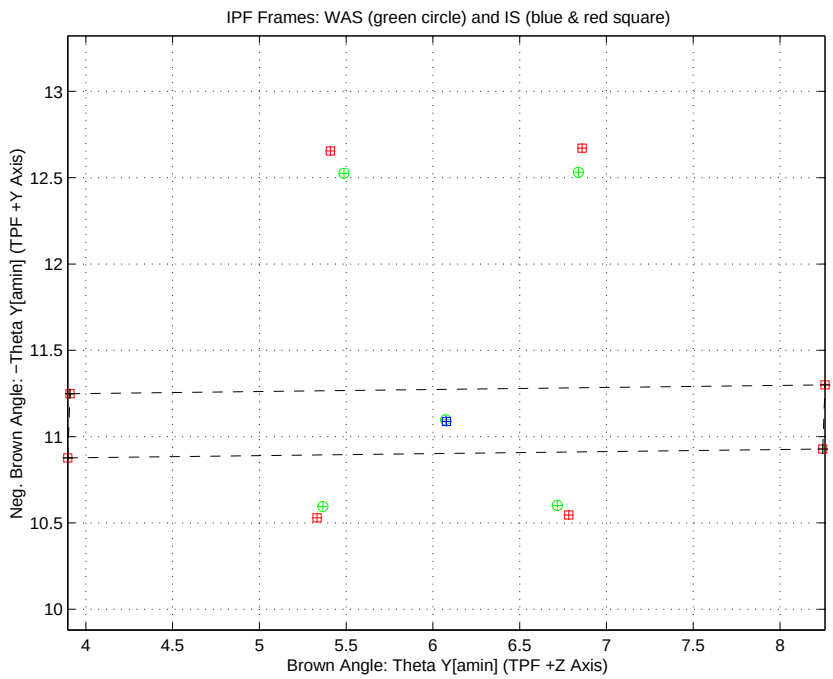

Figure 1.2: A-priori and a-posteriori IPF frames (ZOOMED)

2 IPF MULTI-RUN RESULTS

2.1 IPF MULTI-RUN OUTPUT PLOTS

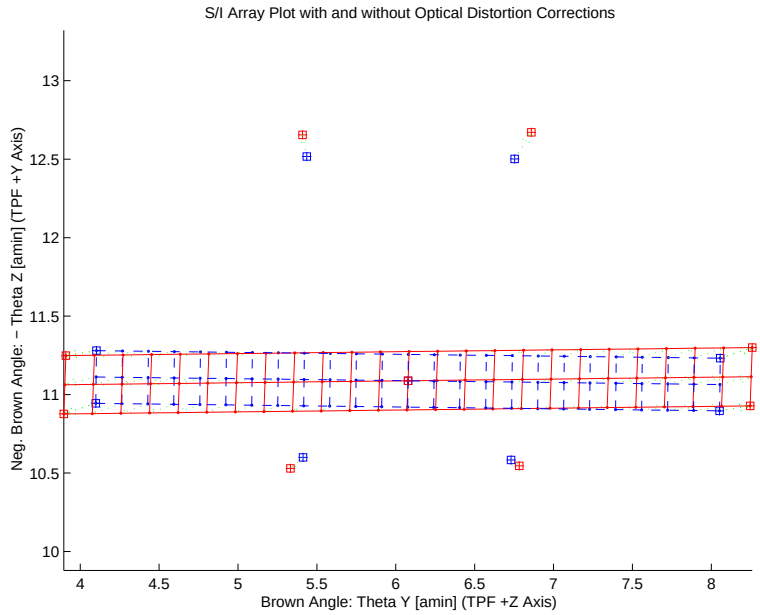

Figure 2.1: Array plot with (solid) and w/o (dashed) optical distortion corrections

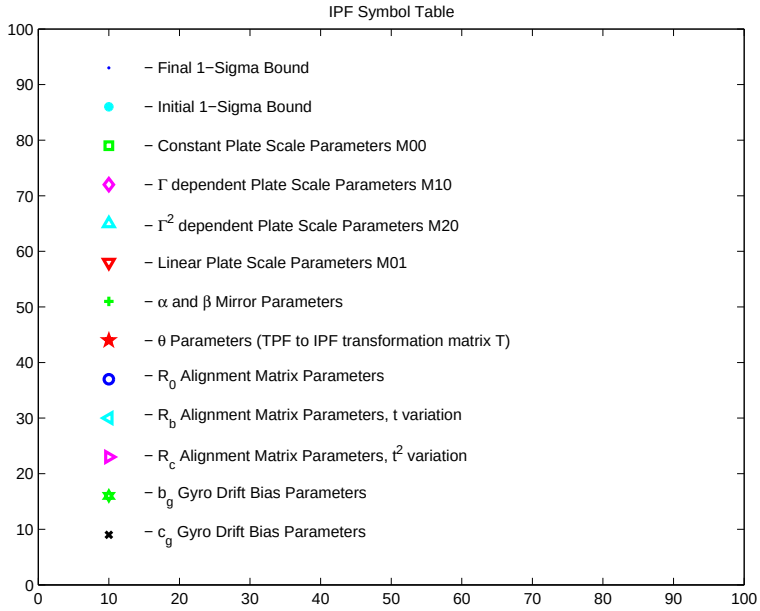

Figure 2.2: IPF parameter symbol table

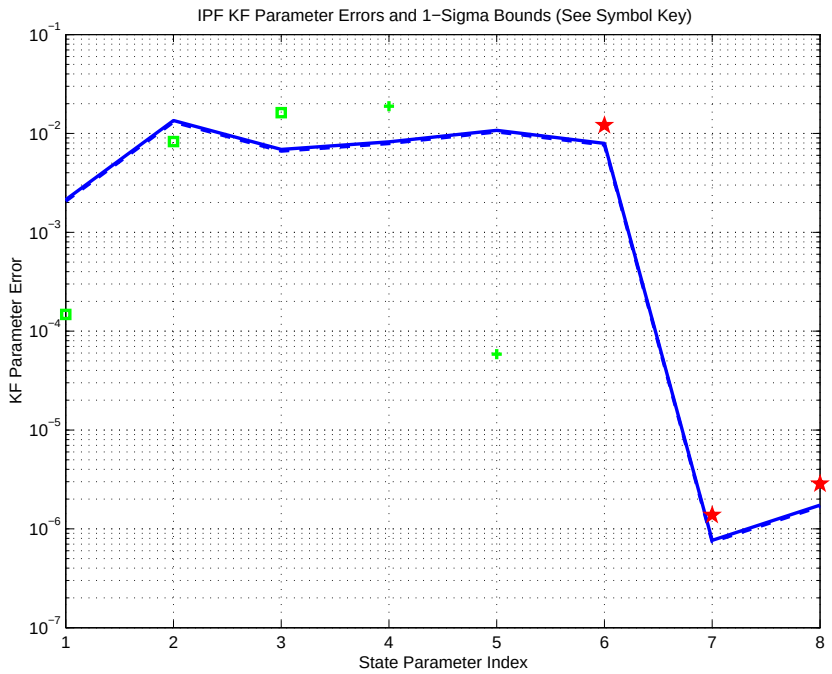

Figure 2.3: KF parameter error sigma plots

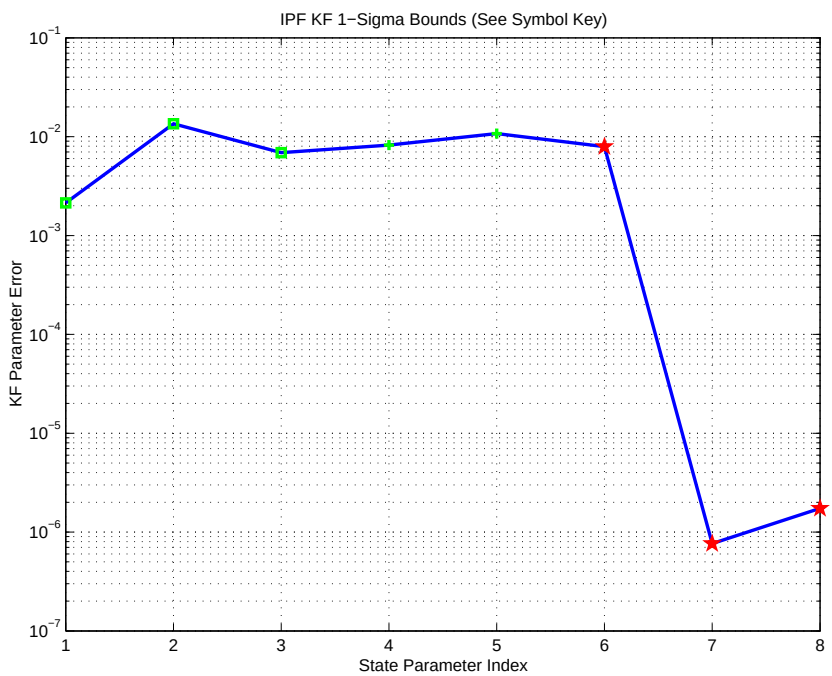

Figure 2.4: KF parameter error 1-sigma bound

2.2 IPF MULTI-RUN OUTPUT DATA (MF MINI FILE)

```
OUTPUT FILE NAME: MF93M121mini.dat   DATE: 27-Aug-2003   TIME: 12:05
INSTRUMENT NAME:  MIPS_SED_center   NF: 121
IPF FILTER VERSION: IPF.V2.0.1Beta       SW RELEASE DATE: August 5, 2003
-------------------------------------------------------------------------------
---------------------------- IPF BROWN ANGLE SUMMARY ----------------------------
-------------------------------------------------------------------------------
         ------------ WAS ------------           ------------ IS -------------
Frame    theta_Y     theta_Z     angle           theta_Y     theta_Z     angle
Number   (arcmin)    (arcmin)    (deg)           (arcmin)    (arcmin)    (deg)
------  --------------------------------       --------------------------------
 121     +6.073000 -11.098000   -0.000000        +6.077676 -11.088153   +0.693046
 113     +6.838000 -12.531000   +0.000000        +6.859144 -12.671377   +0.693046
 114     +5.487000 -12.525000   +0.000000        +5.408885 -12.654341   +0.693046
 116     +6.717000 -10.601000   -0.000000        +6.783117 -10.546359   +0.693046
 117     +5.366000 -10.595000   +0.000000        +5.332858 -10.529325   +0.693046
 001     +0.000000  +0.000000   +0.000000        +8.259716 -11.299621   +0.693046
 001     +0.000000  +0.000000   +0.000000        +8.246413 -10.927789   +0.693046
 001     +0.000000  +0.000000   +0.000000        +3.908939 -11.248516   +0.693046
 001     +0.000000  +0.000000   +0.000000        +3.895636 -10.876685   +0.693046
-------------------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  0             121            +0.000            +0.000     pixels
OFFSET FRAME NAME: MIPS_SED_center
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
WAS(FTB)            +6.073000       -11.098000       -0.000000
IS (EST)            +6.077676       -11.088153       +0.693046
dT_EST              +0.004676        +0.009847       +0.693046
T_sSIGMA            +0.002535        +0.005755       +0.437676
dT_EST/T_sSIGMA     +1.844730        +1.711187       +1.583468
-------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  1             113            +4.000            +8.470     pixels
OFFSET FRAME NAME: MIPS_SED_5
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
WAS(FTB)            +6.838000       -12.531000       +0.000000
IS (EST)            +6.859144       -12.671377       +0.693046
dT_EST              +0.021144        -0.140377       +0.693046
T_sSIGMA            +0.021208        +0.019413       +0.437676
dT_EST/T_sSIGMA     +0.997008        -7.231202       +1.583468
-------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  2             114            -4.000            +8.470     pixels
OFFSET FRAME NAME: MIPS_SED_6
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
WAS(FTB)            +5.487000       -12.525000       +0.000000
IS (EST)            +5.408885       -12.654341       +0.693046
dT_EST              -0.078115        -0.129341       +0.693046
T_sSIGMA            +0.021478        +0.019406       +0.437676
dT_EST/T_sSIGMA     -3.636987        -6.665192       +1.583468
-------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  3             116            +4.000            -2.960     pixels
OFFSET FRAME NAME: MIPS_SED_7
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
WAS(FTB)            +6.717000       -10.601000       -0.000000
IS (EST)            +6.783117       -10.546359       +0.693046
dT_EST              +0.066117        +0.054641       +0.693046
T_sSIGMA            +0.007305        +0.009334       +0.437676
dT_EST/T_sSIGMA     +9.050644        +5.853871       +1.583468
-------------------------------------------------------------------
```

```
OFFSET           NF          Delta_CW          Delta_CV
  4             117            -4.000            -2.960     pixels
OFFSET FRAME NAME: MIPS_SED_8
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
WAS(FTB)            +5.366000       -10.595000       +0.000000
IS (EST)            +5.332858       -10.529325       +0.693046
dT_EST              -0.033142        +0.065675       +0.693046
T_sSIGMA            +0.007029        +0.009303       +0.437676
dT_EST/T_sSIGMA     -4.714824        +7.059722       +1.583468
-------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  5               1           +12.000            +1.000     pixels
OFFSET FRAME NAME: CORNER PIXEL (DIAGNOSTICS)
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
WAS(FTB)            +0.000000        +0.000000       +0.000000
IS (EST)            +8.259716       -11.299621       +0.693046
dT_EST              +8.259716       -11.299621       +0.693046
T_sSIGMA            +0.005422        +0.011042       +0.437676
dT_EST/T_sSIGMA    +1523.292554       -1023.311561       +1.583468
-------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  6               1           +12.000            -1.000     pixels
OFFSET FRAME NAME: CORNER PIXEL (DIAGNOSTICS)
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
WAS(FTB)            +0.000000        +0.000000       +0.000000
IS (EST)            +8.246413       -10.927789       +0.693046
dT_EST              +8.246413       -10.927789       +0.693046
T_sSIGMA            +0.005265        +0.011126       +0.437676
dT_EST/T_sSIGMA    +1566.235290       -982.205509       +1.583468
-------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  7               1           -12.000            +1.000     pixels
OFFSET FRAME NAME: CORNER PIXEL (DIAGNOSTICS)
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
WAS(FTB)            +0.000000        +0.000000       +0.000000
IS (EST)            +3.908939       -11.248516       +0.693046
dT_EST              +3.908939       -11.248516       +0.693046
T_sSIGMA            +0.005800        +0.010977       +0.437676
dT_EST/T_sSIGMA    +673.903567       -1024.737350       +1.583468
-------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  8               1           -12.000            -1.000     pixels
OFFSET FRAME NAME: CORNER PIXEL (DIAGNOSTICS)
Brown Angle       theta_Y(arcmin)  theta_Z(arcmin)  angle(deg)
WAS(FTB)            +0.000000        +0.000000       +0.000000
IS (EST)            +3.895636       -10.876685       +0.693046
dT_EST              +3.895636       -10.876685       +0.693046
T_sSIGMA            +0.004882        +0.011054       +0.437676
dT_EST/T_sSIGMA    +798.003173       -983.974964       +1.583468
-------------------------------------------------------------------
-----------------------------------------------------------------------------------
-----------------------------------------------------------------------------------
VARNAME             MEAN                      SIGMA                SCALED_SIGMA
a00        +1.0014748990755103E-001 +2.1412921928877196E-003 +2.0629121096655862E-003
b00        +1.0828478232150171E-001 +1.3511945364979169E-002 +1.3017352704660475E-002
c00        +2.6234016912282179E-002 +6.8820161538288025E-003 +6.6301061152713265E-003
del_alpha  +9.1444715878763244E-004 +8.2075743058529875E-003 +7.9071433981602636E-003
beta       +1.1000585247687671E+000 +1.0762012133144913E-002 +1.0368078316249080E-002
del_theta1 +4.3348674352828463E-003 +7.9291248951115275E-003 +7.6388863787512709E-003
del_theta2 -1.5293243815646111E-006 +7.6537397361078269E-007 +7.3735814468891744E-007
del_theta3 -1.8106935854225634E-006 +1.7375435968055722E-006 +1.6739423693915575E-006
-----------------------------------------------------------------------------------
LSQF RESIDUAL SIGMA SCALE =         +9.6339589548662619E-001
-----------------------------------------------------------------------------------
```

```
-----------------------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------------------
                    a_mirror(1)               a_mirror(2)               a_mirror(3)
a_mirror_ipf   +0.0000000000000000E+000  +3.8819298947445818E-002  +9.9924624694277875E-001
a_mirror_tpf   -1.8534974582636030E-003  +2.6724102000496575E-002  +9.9964112906554581E-001
beta                beta_0                    beta                      beta_total
               +2.8047410000000001E-006  +1.1000585247687671E+000  +3.0853792468184765E-006
-----------------------------------------------------------------------------------------------------------
qT               qT(1)                     qT(2)                     qT(3)                     qT(4)
FrmTbl:   +1.4257389017362338E-006 -8.8328078008885079E-004 +1.6141373392967960E-003 +9.9999830718540750E-001
Estim:    +6.0493434132629816E-003 -8.7419120317997867E-004 +1.6180217641079569E-003 +9.9998001142001813E-001
DelTheta        deltheta(1)               deltheta(2)               deltheta(3)
          +1.2095924872927700E-002 -1.3602270188701589E-006 -2.8644235129723191E-006       [rad]
EulAngT         theta(1)                  theta(2)                  theta(3)                  [rad]
Mean      +1.2095929933120699E-002 -1.7679243182385498E-003 +3.2254129117827448E-003
SigmaT    +7.9291248951115275E-003 +7.6537397361078269E-007 +1.7375435968055722E-006
-----------------------------------------------------------------------------------------------------------
Initial Gyro Bias         Bg0(1)                    Bg0(2)                    Bg0(3)
                  +1.4103596909709606E-006 +1.8992229094009036E-007 +2.3749894380924006E-007
Gyro Bias Correction      Bg(1)                     Bg(2)                     Bg(3)
                  -1.6652729809552012E-006 -2.2244106964725247E-010 -3.9368271738864212E-009
Total Gyro Bias           BgT(1)                    BgT(2)                    BgT(3)
                  -2.5491328998424055E-007 +1.8969984987044310E-007 +2.3356211663535365E-007

Initial Gyro Bias Rate     Cg0(1)                    Cg0(2)                    Cg0(3)
                  +0.0000000000000000E+000 +0.0000000000000000E+000 +0.0000000000000000E+000
Gyro Bias Rate Correction  Cg(1)                     Cg(2)                     Cg(3)
                  +6.0064362024182139E-010 +4.6067265110686990E-012 -2.2474005630045247E-012
Total Gyro Bias Rate       CgT(1)                    CgT(2)                    CgT(3)
                  +6.0064362024182139E-010 +4.6067265110686990E-012 -2.2474005630045247E-012
-----------------------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  1             113            +4.000            +8.470     pixels
OFFSET FRAME NAME: MIPS_SED_5
qT               qT(1)                     qT(2)                     qT(3)                     qT(4)
WAS(FTB)  +1.8126199579333211E-006 -9.9454496966837184E-004 +1.8225581610202054E-003 +9.9999784457706087E-001
IS (EST)  +6.0497533753382810E-003 -9.8645577962566309E-004 +1.8489749995196734E-003 +9.9997950413023151E-001

DelTheta        deltheta(1)               deltheta(2)               deltheta(3)
Units             rad                       rad                       rad
          +1.2096011155949573E-002 -6.1505628475216914E-006 +4.0834037157040393E-005
EulAngT         theta(1)                  theta(2)                  theta(3)                  [rad]
Mean      +1.2095929933120701E-002 -1.9952441320453974E-003 +3.6859542612266935E-003
sSigmaT   +7.6388852989968271E-003 +6.1690176427252787E-006 +5.6469339968462674E-006
SigmaT    +7.9291237743319507E-003 +6.4034086834148410E-006 +5.8614885358151889E-006
-----------------------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  2             114            -4.000            +8.470     pixels
OFFSET FRAME NAME: MIPS_SED_6
qT               qT(1)                     qT(2)                     qT(3)                     qT(4)
WAS(FTB)  +1.4537999564721429E-006 -7.9805039157808107E-004 +1.8216858191067733E-003 +9.9999802228516210E-001
IS (EST)  +6.0493638571946515E-003 -7.7554345087670420E-004 +1.8452219225507393E-003 +9.9997969923660734E-001

DelTheta        deltheta(1)               deltheta(2)               deltheta(3)
Units             rad                       rad                       rad
          +1.2095989984725747E-002 +2.2722699542494546E-005 +3.7623846092831074E-005
EulAngT         theta(1)                  theta(2)                  theta(3)                  [rad]
Mean      +1.2095929933120699E-002 -1.5733809002766337E-003 +3.6809987061907608E-003
sSigmaT   +7.6388853489832848E-003 +6.2476709133701612E-006 +5.6448324223133131E-006
SigmaT    +7.9291238262176374E-003 +6.4850503750738588E-006 +5.8593071122251569E-006
-----------------------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------------------
```

```
OFFSET           NF          Delta_CW          Delta_CV
  3             116            +4.000            -2.960     pixels
OFFSET FRAME NAME: MIPS_SED_7
qT               qT(1)                    qT(2)                    qT(3)                    qT(4)
WAS(FTB)  +1.5063093946384967E-006 -9.7694673214546602E-004 +1.5418516033291201E-003 +9.9999833413183592E-001
IS (EST)  +6.0494313063587414E-003 -9.7726804539629642E-004 +1.5398430457979546E-003 +9.9998003890649312E-001

DelTheta        deltheta(1)               deltheta(2)               deltheta(3)
Units             rad                       rad                       rad
          +1.2095898877270620E-002 -1.9232608519661172E-005 -1.5894299304587802E-005
EulAngT         theta(1)                  theta(2)                  theta(3)                  [rad]
Mean      +1.2095929933120701E-002 -1.9731287058805083E-003 +3.0678115698234811E-003
sSigmaT   +7.6388861619212552E-003 +2.1249989481847726E-006 +2.7151830028567376E-006
SigmaT    +7.9291246700430827E-003 +2.2057380129395329E-006 +2.8183460357024427E-006
-----------------------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  4             117            -4.000            -2.960     pixels
OFFSET FRAME NAME: MIPS_SED_8
qT               qT(1)                    qT(2)                    qT(3)                    qT(4)
WAS(FTB)  +1.2026621870087705E-006 -7.8045205798068791E-004 +1.5409792062221856E-003 +9.9999850813699964E-001
IS (EST)  +6.0491069886209831E-003 -7.6635558065205934E-004 +1.5360901351088494E-003 +9.9998023052001439E-001

DelTheta        deltheta(1)               deltheta(2)               deltheta(3)
Units             rad                       rad                       rad
          +1.2095900113432733E-002 +9.6406977039570012E-006 -1.9104072734465371E-005
EulAngT         theta(1)                  theta(2)                  theta(3)                  [rad]
Mean      +1.2095929933120699E-002 -1.5512654297114663E-003 +3.0628564750934668E-003
sSigmaT   +7.6388861172406791E-003 +2.0447631838334570E-006 +2.7060692919920275E-006
SigmaT    +7.9291246236648742E-003 +2.1224537009269854E-006 +2.8088860505526131E-006
-----------------------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  5              1           +12.000            +1.000     pixels
OFFSET FRAME NAME: CORNER PIXEL (DIAGNOSTICS)
qT               qT(1)                    qT(2)                    qT(3)                    qT(4)
WAS(FTB)  +0.0000000000000000E+000 +0.0000000000000000E+000 +0.0000000000000000E+000 +1.0000000000000000E+000
IS (EST)  +6.0498898638973410E-003 -1.1913635980845747E-003 +1.6506967997220192E-003 +9.9997962713521693E-001

DelTheta        deltheta(1)               deltheta(2)               deltheta(3)
Units             rad                       rad                       rad
          +1.2095929933120699E-002 -2.4026540325155815E-003 +3.2869265093543290E-003
EulAngT         theta(1)                  theta(2)                  theta(3)                  [rad]
Mean      +1.2095929933120701E-002 -2.4026540325155802E-003 +3.2869265093543295E-003
sSigmaT   +7.6388848460365762E-003 +1.5772768179448244E-006 +3.2120486414636858E-006
SigmaT    +7.9291233041615325E-003 +1.6372052500266440E-006 +3.3340900210512422E-006
-----------------------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  6              1           +12.000            -1.000     pixels
OFFSET FRAME NAME: CORNER PIXEL (DIAGNOSTICS)
qT               qT(1)                    qT(2)                    qT(3)                    qT(4)
WAS(FTB)  +0.0000000000000000E+000 +0.0000000000000000E+000 +0.0000000000000000E+000 +1.0000000000000000E+000
IS (EST)  +6.0498223640458983E-003 -1.1897559455839916E-003 +1.5966054332119930E-003 +9.9997971728492785E-001

DelTheta        deltheta(1)               deltheta(2)               deltheta(3)
Units             rad                       rad                       rad
          +1.2095929933120701E-002 -2.3987842872189484E-003 +3.1787649740612680E-003
EulAngT         theta(1)                  theta(2)                  theta(3)                  [rad]
Mean      +1.2095929933120699E-002 -2.3987842872189476E-003 +3.1787649740612680E-003
sSigmaT   +7.6388848903346110E-003 +1.5315606168883797E-006 +3.2363542501118476E-006
SigmaT    +7.9291233501426663E-003 +1.5897520677257659E-006 +3.3593191182085275E-006
-----------------------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------------------
```

```
OFFSET           NF          Delta_CW          Delta_CV
  7               1           -12.000            +1.000     pixels
OFFSET FRAME NAME: CORNER PIXEL (DIAGNOSTICS)
qT               qT(1)                    qT(2)                    qT(3)                    qT(4)
WAS(FTB)  +0.0000000000000000E+000 +0.0000000000000000E+000 +0.0000000000000000E+000 +1.0000000000000000E+000
IS (EST)  +6.0488491434068899E-003 -5.5862639536352892E-004 +1.6394378942492687E-003 +9.9998020560608192E-001

DelTheta        deltheta(1)               deltheta(2)               deltheta(3)
Units             rad                       rad                       rad
          +1.2095929933120704E-002 -1.1370643454111128E-003 +3.2720607454501441E-003
EulAngT         theta(1)                  theta(2)                  theta(3)                  [rad]
Mean      +1.2095929933120699E-002 -1.1370643454111124E-003 +3.2720607454501433E-003
sSigmaT   +7.6388848103889490E-003 +1.6872804962186909E-006 +3.1930725906706145E-006
SigmaT    +7.9291232671594783E-003 +1.7513885040650078E-006 +3.3143929776218778E-006
-------------------------------------------------------------------------------------------------------------
-------------------------------------------------------------------------------------------------------------
OFFSET           NF          Delta_CW          Delta_CV
  8               1           -12.000            -1.000     pixels
OFFSET FRAME NAME: CORNER PIXEL (DIAGNOSTICS)
qT               qT(1)                    qT(2)                    qT(3)                    qT(4)
WAS(FTB)  +0.0000000000000000E+000 +0.0000000000000000E+000 +0.0000000000000000E+000 +1.0000000000000000E+000
IS (EST)  +6.0488158695105208E-003 -5.5701868425848803E-004 +1.5853466155545440E-003 +9.9998029392227061E-001

DelTheta        deltheta(1)               deltheta(2)               deltheta(3)
Units             rad                       rad                       rad
          +1.2095929933120699E-002 -1.1331945972718608E-003 +3.1638994522666390E-003
EulAngT         theta(1)                  theta(2)                  theta(3)                  [rad]
Mean      +1.2095929933120699E-002 -1.1331945972718606E-003 +3.1638994522666390E-003
sSigmaT   +7.6388848049930179E-003 +1.4200377087340603E-006 +3.2154267833661508E-006
SigmaT    +7.9291232615585298E-003 +1.4739918608608740E-006 +3.3375965150256208E-006
-------------------------------------------------------------------------------------------------------------
-------------------------------------------------------------------------------------------------------------
               q(1)                     q(2)                     q(3)                     q(4)
PCRS1A: +5.2603126189317361E-007 +3.7451819048221893E-004 -1.4045531552277380E-003 +9.9999894348258311E-001
PCRS2A: -5.1968404336718985E-007 +3.8455385122900486E-004 +1.3513933841514693E-003 +9.9999901292650617E-001
-----------------------------------------------------------------------------------------
**********  CS-FILE PARAMETERS:  **********  **********  AS-FILE PARAMETERS:  **********
Row (01) PIX2RADX: +4.7922266400000000E-005  Row (1) TASTART:   +7.3051200000000000E+008
Row (02) PIX2RADY: +4.8814231500000000E-005  Row (2) TASTOP:    +7.3051688000000000E+008
Row (03) CX0:      +1.2500000000000000E+001  Row (3) S/C TIME:  +7.3051200000000000E+008
Row (04) CY0:      +1.6500000000000000E+001  Row (4) QR1:       +0.0000000000000000E+000
Row (05) BETA0:    +2.8047410000000001E-006  Row (5) QR2:       +0.0000000000000000E+000
Row (06) GAMMA_E0: +3.2200000000000000E+003  Row (6) QR3:       +0.0000000000000000E+000
Row (07) D11:      -1.0000000000000000E+000  Row (7) QR4:       +1.0000000000000000E+000
Row (08) D12:      +0.0000000000000000E+000
Row (09) D21:      +0.0000000000000000E+000
Row (10) D22:      -1.0000000000000000E+000
Row (11) DG:       +1.0000000000000000E+000
-----------------------------------------------------------------------------------------
-------------------------------------------------------------
INITIAL STA-TO-PCRS ALIGNMENT (R) KNOWLEDGE (1-SIGMA)
    SIGMA(X)        SIGMA(Y)         SIGMA(Z)
1.41421656E+002  9.90383438E+000  1.13175056E+001  [arcsec]
-------------------------------------------------------------
PIX2RADX = 4.792226640000E-005[rad/pixel]
XPIXSIZE = 9.8847[arcsec]
PIX2RADY = 4.881423150000E-005[rad/pixel]
YPIXSIZE = 10.0687[arcsec]
CX0 = 12.5[pixel] = 123.56[arcsec]
CY0 = 16.5[pixel] = 166.13[arcsec]
-------------------------------------------------------------
NOMINAL BETA0 = 2.804741000000E-006[rad/encoder unit]
ENCODER UNIT SIZE = 0.58[arcsec]
GAMMA_E0 = 3220.00[encoder unit] = 1862.83[arcsec]
```

```
-------------------------------------------------------
                | -1 | +0 |
FLIP MATRIX D = |----|----|   and   DG = +1
                | +0 | -1 |
-------------------------------------------------------
```

2.3 IPF MULTI-RUN EXECUTION LOG

```
************************************************
*****          MULTI_RUN LOG FILE          *****
************************************************

-------------------------------------------------
MULTI-RUN-LOG FILE NAME:  LG93M121.dat
INSTRUMENT TYPE:              MIPS_SED_center
MULTI-RUN EXECUTION DATE: 27-Aug-2003    TIME: 12:05
-------------------------------------------------


-------------------------------------------------------
MT995121 FILE LOADED!
q_T    = +3.8819384786349886E-003 -8.7693693242941800E-004 +1.6170331672440527E-003 +9.9999077332693453E-001
SigmaT = +1.1861278699491216E-002 +1.0567822103373089E-006 +2.9313165771346470E-006
Sigma Scale = +9.2016745046689286E-001

-------------------------------------------------------
MT996121 FILE LOADED!
q_T    = +1.0309405514735120E-002 -8.6816138452836618E-004 +1.6214295288632368E-003 +9.9994516520658583E-001
SigmaT = +1.1345567490680209E-002 +1.1886190421207325E-006 +2.8534826780955359E-006
Sigma Scale = +1.0055300889817904E+000

-------------------------------------------------------

-----------------------------------------------------------------
Conditioning Number for LSQ Filter was:  +2.1583540211650492E+004
-----------------------------------------------------------------

Merged q_T    = +6.0493434132629816E-003 -8.7419120317997867E-004 +1.6180217641079569E-003 +9.9998001142001813E-001
Merged SigmaT = +7.9291248951115275E-003 +7.6537397361078269E-007 +1.7375435968055722E-006
Merged Sigma Scale = +9.6339589548662619E-001

*********** Sigma T Ratios for Multi-Run ************
DATA#1 Expected:     1.41421 1.41421 1.41421
DATA#1 Calculated:   1.49591 1.38074 1.68705
-------------------------------------------------------
DATA#2 Expected:     1.41421 1.41421 1.41421
DATA#2 Calculated:   1.43087 1.55299 1.64225
-------------------------------------------------------


Merging LG Files!


*********************************************************************
IPF EXECUTION-LOG FILE NAME:  LG995121.dat
INSTRUMENT TYPE:              MIPS_SED_center
IPF FILTER EXECUTION DATE:    27-Aug-2003    TIME: 10:51
```

```
IPF FILTER VERSION USED:      IPF.V2.0.1Beta
**********************************************************************

**************************************
SLIT FLAG ENABLED! ENTERING SLIT MODE.
**************************************


------------------- Loading & Preparing Input Files -------------------
AAFILE:  AA995121 Loaded!        AAFILE dimension = 48801 X 21
ASFILE:  AS995121 Loaded!
CAFILE:  CA995121 Loaded!        CAFILE dimension = 30 X 15
CBFILE:  CB995121 Loaded!        CBFILE dimension = 18 X 15
CCFILE:  CC995121 Created!       CCFILE dimension = 48 X 19
CSFILE:  CS995121 Loaded!
Loading Input Files Completed!
----------------------------------------------------------------------

------------------------ Selected Mask Vectors ------------------------
index =   1  2  3  4  5  6  7  8  9 10 11 12 13 14 15 16 17 18 19 20
----------------------------------------------------------------------
mask1 = [ 1  1  1  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0 ]
mask2 = [ 1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1 ]
----------------------------------------------------------------------

---------------  Selected Initial Gyro Bias Parameters  ---------------
User Entered 1 : Use AFILE database - from S/C filter
IPF Linearized Using Following Nominal Gyro Bias Estimates
bg0 = [+2.5139469464322443E-006 +2.4888835000837901E-006 +2.5115474422157735E-006 ]
cg0 = [+0.0000000000000000E+000 +0.0000000000000000E+000 +0.0000000000000000E+000 ]
----------------------------------------------------------------------

---------------  Gyro Pre-Processor Run Completed  --------------------
     AGFILE CREATED:  AG995121.m     ACFILE CREATED:  AC995121.m
----------------------------------------------------------------------
Total Gyro Preprocessor Execution Time: 23 seconds

FRAME TABLE ENTRIES FOR PCRS LOADED TO TPCRS
q_PCRS4 = [ +5.2603126189317361E-007     q_PCRS5 = [ +7.3379987833742897E-007
            +3.7451819048221893E-004                 +5.2236196154513707E-004
            -1.4045531552277380E-003                 -1.4047712280184723E-003
            +9.9999894348258311E-001 ];              +9.9999887687698918E-001 ];
q_PCRS8 = [ -5.1968404336718985E-007     q_PCRS9 = [ -7.1963421681856818E-007
            +3.8455385122900486E-004                 +5.3239763239987400E-004
            +1.3513933841514693E-003                 +1.3516841804518383E-003
            +9.9999901292650617E-001 ];              +9.9999894475050310E-001 ];
--------------------------------------------------------------------------------
------ Initial Conditions for State -----  ------   Inital Square-Root Cov (diag)   -----
p1(01)  = a00  = +0.0000000000000000E+000  Sigma_initial(01,01) = 1.0000000000000000E+000
p1(02)  = b00  = +0.0000000000000000E+000  Sigma_initial(02,02) = 1.0000000000000000E+000
p1(03)  = c00  = +0.0000000000000000E+000  Sigma_initial(03,03) = 1.0000000000000000E+000
p1(04)  = a10  = +0.0000000000000000E+000  Sigma_initial(04,04) = 9.9999000000000000E+004
p1(05)  = b10  = +0.0000000000000000E+000  Sigma_initial(05,05) = 9.9999000000000000E+004
p1(06)  = c10  = +0.0000000000000000E+000  Sigma_initial(06,06) = 9.9999000000000000E+004
p1(07)  = d10  = +0.0000000000000000E+000  Sigma_initial(07,07) = 9.9999000000000000E+004
p1(08)  = a20  = +0.0000000000000000E+000  Sigma_initial(08,08) = 9.9999000000000000E+004
p1(09)  = b20  = +0.0000000000000000E+000  Sigma_initial(09,09) = 9.9999000000000000E+004
p1(10)  = c20  = +0.0000000000000000E+000  Sigma_initial(10,10) = 9.9999000000000000E+004
p1(11)  = d20  = +0.0000000000000000E+000  Sigma_initial(11,11) = 9.9999000000000000E+004
p1(12)  = a01  = +0.0000000000000000E+000  Sigma_initial(12,12) = 9.9999000000000000E+004
p1(13)  = b01  = +0.0000000000000000E+000  Sigma_initial(13,13) = 9.9999000000000000E+004
p1(14)  = c01  = +0.0000000000000000E+000  Sigma_initial(14,14) = 9.9999000000000000E+004
p1(15)  = d01  = +0.0000000000000000E+000  Sigma_initial(15,15) = 9.9999000000000000E+004
p1(16)  = e01  = +0.0000000000000000E+000  Sigma_initial(16,16) = 9.9999000000000000E+004
```

```
p1(17)  = f01  = +0.0000000000000000E+000  Sigma_initial(17,17) = 9.9999000000000000E+004
-------------------------------------------------------------------------------------------
p2f(01) = am1  = +0.0000000000000000E+000
p2f(02) = am2  = +0.0000000000000000E+000  Sigma_initial(18,18) = 1.0000000000000001E-001
p2f(03) = am3  = +1.0000000000000000E+000
p2f(04) = beta = +1.0000000000000000E+000  Sigma_initial(19,19) = 1.0000000000000001E-001
p2f(05) = qT1  = +1.4257389017362338E-006  Sigma_initial(20,20) = 1.0000000000000001E-001
p2f(06) = qT2  = -8.8328078008885079E-004  Sigma_initial(21,21) = 1.0000000000000000E-002
p2f(07) = aT3  = +1.6141373392967960E-003  Sigma_initial(22,22) = 1.0000000000000000E-002
p2f(08) = qT4  = +9.9999830718540750E-001
p2f(09) = qR1  = +0.0000000000000000E+000  Sigma_initial(23,23) = 3.4288868839039716E-003
p2f(10) = qR2  = +0.0000000000000000E+000  Sigma_initial(24,24) = 1.8555467699985827E-004
p2f(11) = qR3  = +0.0000000000000000E+000  Sigma_initial(25,25) = 1.8555467699985827E-004
p2f(12) = qR4  = +1.0000000000000000E+000
p2f(13) = brx  = +0.0000000000000000E+000  Sigma_initial(26,26) = 2.0491803278688525E-004
p2f(14) = bry  = +0.0000000000000000E+000  Sigma_initial(27,27) = 2.0491803278688525E-004
p2f(15) = brz  = +0.0000000000000000E+000  Sigma_initial(28,28) = 2.0491803278688525E-004
p2f(16) = crx  = +0.0000000000000000E+000  Sigma_initial(29,29) = 4.1991400161246979E-008
p2f(17) = cry  = +0.0000000000000000E+000  Sigma_initial(30,30) = 4.1991400161246979E-008
p2f(18) = crz  = +0.0000000000000000E+000  Sigma_initial(31,31) = 4.1991400161246979E-008
p2f(19) = bgx  = +0.0000000000000000E+000  Sigma_initial(32,32) = 2.0491803278688525E-004
p2f(20) = bgy  = +0.0000000000000000E+000  Sigma_initial(33,33) = 2.0491803278688525E-004
p2f(21) = bgz  = +0.0000000000000000E+000  Sigma_initial(34,34) = 2.0491803278688525E-004
p2f(22) = cgx  = +0.0000000000000000E+000  Sigma_initial(35,35) = 4.1991400161246979E-008
p2f(23) = cgy  = +0.0000000000000000E+000  Sigma_initial(36,36) = 4.1991400161246979E-008
p2f(24) = cgz  = +0.0000000000000000E+000  Sigma_initial(37,37) = 4.1991400161246979E-008
-------------------------------------------------------------------------------------------

--------------------   IPF KALMAN FILTER STARTED  ---------------------
Iteration#001: |dp|= +2.152617941261E-001   RMS(|Res|)=+2.152617941261E-001
Iteration#002: |dp|= +6.890075204103E-002   RMS(|Res|)=+6.890075204103E-002
Iteration#003: |dp|= +5.126908185359E-003   RMS(|Res|)=+5.126908185359E-003
Iteration#004: |dp|= +3.870710297731E-003   RMS(|Res|)=+3.870710297731E-003
Iteration#005: |dp|= +1.052218899134E-003   RMS(|Res|)=+1.052218899134E-003
Iteration#006: |dp|= +3.632804475193E-004   RMS(|Res|)=+3.632804475193E-004
Iteration#007: |dp|= +1.119767041633E-004   RMS(|Res|)=+1.119767041633E-004
Iteration#008: |dp|= +2.655721189473E-005   RMS(|Res|)=+2.655721189473E-005
Iteration#009: |dp|= +1.368720364650E-005   RMS(|Res|)=+1.368720364650E-005
Iteration#010: |dp|= +1.819489406124E-006   RMS(|Res|)=+1.819489406124E-006
Iteration#011: |dp|= +1.339709560795E-006   RMS(|Res|)=+1.339709560795E-006
Iteration#012: |dp|= +2.172135195707E-007   RMS(|Res|)=+2.172135195707E-007
Iteration#013: |dp|= +1.322137426337E-007   RMS(|Res|)=+1.322137426337E-007
Iteration#014: |dp|= +3.232464106401E-008   RMS(|Res|)=+3.232464106401E-008
Iteration#015: |dp|= +1.138595518856E-008   RMS(|Res|)=+1.138595518856E-008
Iteration#016: |dp|= +4.177762809282E-009   RMS(|Res|)=+4.177762809282E-009
Iteration#017: |dp|= +8.867266186279E-010   RMS(|Res|)=+8.867266186279E-010
Iteration#018: |dp|= +5.337330125461E-010   RMS(|Res|)=+5.337330125461E-010
Iteration#019: |dp|= +1.288544735077E-010   RMS(|Res|)=+1.288544735077E-010
Iteration#020: |dp|= +1.163891059612E-010   RMS(|Res|)=+1.163891059612E-010
Iteration#021: |dp|= +7.300532872347E-011   RMS(|Res|)=+7.300532872347E-011
Iteration#022: |dp|= +1.362347845356E-010   RMS(|Res|)=+1.362347845356E-010
Iteration#023: |dp|= +5.629526884258E-011   RMS(|Res|)=+5.629526884258E-011
Iteration#024: |dp|= +5.209032257369E-011   RMS(|Res|)=+5.209032257369E-011
Iteration#025: |dp|= +2.757777862724E-011   RMS(|Res|)=+2.757777862724E-011
Iteration#026: |dp|= +8.137421913109E-011   RMS(|Res|)=+8.137421913109E-011
Iteration#027: |dp|= +7.348771625803E-011   RMS(|Res|)=+7.348771625803E-011
Iteration#028: |dp|= +7.009064157721E-011   RMS(|Res|)=+7.009064157721E-011
Iteration#029: |dp|= +2.873259199426E-011   RMS(|Res|)=+2.873259199426E-011
Iteration#030: |dp|= +4.013244945443E-011   RMS(|Res|)=+4.013244945443E-011
IPF Kalman Filter Completed with Error |dp1| + |dp2| = +4.0132449454430236E-011
-----------------------------------------------------------------------

-----------------  IPF LEAST SQUARES FILTER STARTED  ------------------
Iteration#001   COND#=+7.088852893665E+007,   |dp|=+2.156114203553E-001
```

```
Iteration#002   COND#=+7.216215474063E+007,   |dp|=+6.940180517085E-002
Iteration#003   COND#=+7.044074072746E+007,   |dp|=+6.245606066742E-003
Iteration#004   COND#=+7.062197550120E+007,   |dp|=+1.071257553443E-003
Iteration#005   COND#=+7.063208975263E+007,   |dp|=+2.086620891471E-004
Iteration#006   COND#=+7.063916279740E+007,   |dp|=+4.168044665517E-005
Iteration#007   COND#=+7.064040026491E+007,   |dp|=+9.876877148970E-006
Iteration#008   COND#=+7.064076491811E+007,   |dp|=+2.126028804037E-006
Iteration#009   COND#=+7.064084476980E+007,   |dp|=+5.243989820643E-007
Iteration#010   COND#=+7.064086480133E+007,   |dp|=+1.204666781923E-007
Iteration#011   COND#=+7.064086939640E+007,   |dp|=+2.888402451845E-008
Iteration#012   COND#=+7.064087052773E+007,   |dp|=+6.772024509287E-009
Iteration#013   COND#=+7.064087083207E+007,   |dp|=+1.606949553438E-009
Iteration#014   COND#=+7.064087089304E+007,   |dp|=+3.792640856221E-010
Iteration#015   COND#=+7.064087086843E+007,   |dp|=+8.955087329071E-011
Iteration#016   COND#=+7.064087088632E+007,   |dp|=+2.122690099365E-011
Iteration#017   COND#=+7.064087092413E+007,   |dp|=+5.002159052738E-012
Iteration#018   COND#=+7.064087090962E+007,   |dp|=+1.447908350104E-012
Iteration#019   COND#=+7.064087085826E+007,   |dp|=+6.153345236105E-013
Iteration#020   COND#=+7.064087085732E+007,   |dp|=+6.937504917003E-013
Iteration#021   COND#=+7.064087091323E+007,   |dp|=+5.430049838921E-013
Iteration#022   COND#=+7.064087091445E+007,   |dp|=+2.722523516887E-013
Iteration#023   COND#=+7.064087088106E+007,   |dp|=+3.764667365058E-013
Iteration#024   COND#=+7.064087087428E+007,   |dp|=+7.202177042578E-013
Iteration#025   COND#=+7.064087090413E+007,   |dp|=+7.736982081102E-013
Iteration#026   COND#=+7.064087086075E+007,   |dp|=+7.540348270433E-013
Iteration#027   COND#=+7.064087088034E+007,   |dp|=+6.032709322815E-013
Iteration#028   COND#=+7.064087090919E+007,   |dp|=+2.798256095500E-013
Iteration#029   COND#=+7.064087090466E+007,   |dp|=+1.531677689047E-013
Iteration#030   COND#=+7.064087089087E+007,   |dp|=+2.225180367167E-013
IPF Least Squares Filter Completed with Error |dp1| + |dp2| = +2.2251803671668311E-013
----------------------------------------------------------------------
Total Execution Time: 141 seconds



**********************************************************************
IPF EXECUTION-LOG FILE NAME:  LG996121.dat
INSTRUMENT TYPE:              MIPS_SED_center
IPF FILTER EXECUTION DATE:    27-Aug-2003    TIME: 11:06
IPF FILTER VERSION USED:      IPF.V2.0.1Beta
**********************************************************************

**************************************
SLIT FLAG ENABLED! ENTERING SLIT MODE.
**************************************


------------------- Loading & Preparing Input Files -------------------
AAFILE:  AA996121 Loaded!        AAFILE dimension = 48801 X 21
ASFILE:  AS996121 Loaded!
CAFILE:  CA996121 Loaded!        CAFILE dimension = 30 X 15
CBFILE:  CB996121 Loaded!        CBFILE dimension = 18 X 15
CCFILE:  CC996121 Created!       CCFILE dimension = 48 X 19
CSFILE:  CS996121 Loaded!
Loading Input Files Completed!
----------------------------------------------------------------------

------------------------- Selected Mask Vectors ------------------------
index =   1  2  3  4  5  6  7  8  9 10 11 12 13 14 15 16 17 18 19 20
----------------------------------------------------------------------
mask1 = [ 1  1  1  0  0  0  0  0  0  0  0  0  0  0  0  0  0 ]
mask2 = [ 1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1 ]
----------------------------------------------------------------------
```

```
---------------  Selected Initial Gyro Bias Parameters  ---------------
User Entered 1 : Use AFILE database - from S/C filter
IPF Linearized Using Following Nominal Gyro Bias Estimates
bg0 = [+1.4103596909709606E-006 +1.8992229094009036E-007 +2.3749894380924006E-007 ]
cg0 = [+0.0000000000000000E+000 +0.0000000000000000E+000 +0.0000000000000000E+000 ]
-----------------------------------------------------------------------

---------------  Gyro Pre-Processor Run Completed  --------------------
     AGFILE CREATED:  AG996121.m     ACFILE CREATED:  AC996121.m
-----------------------------------------------------------------------
Total Gyro Preprocessor Execution Time: 19 seconds

FRAME TABLE ENTRIES FOR PCRS LOADED TO TPCRS
q_PCRS4 = [ +5.2603126189317361E-007     q_PCRS5 = [ +7.3379987833742897E-007
            +3.7451819048221893E-004                 +5.2236196154513707E-004
            -1.4045531552277380E-003                 -1.4047712280184723E-003
            +9.9999894348258311E-001 ];              +9.9999887687698918E-001 ];
q_PCRS8 = [ -5.1968404336718985E-007     q_PCRS9 = [ -7.1963421681856818E-007
            +3.8455385122900486E-004                 +5.3239763239987400E-004
            +1.3513933841514693E-003                 +1.3516841804518383E-003
            +9.9999901292650617E-001 ];              +9.9999894475050310E-001 ];
-------------------------------------------------------------------------------
------ Initial Conditions for State -----  ------   Inital Square-Root Cov (diag)   -----
p1(01)  = a00  = +0.0000000000000000E+000  Sigma_initial(01,01) = 1.0000000000000000E+000
p1(02)  = b00  = +0.0000000000000000E+000  Sigma_initial(02,02) = 1.0000000000000000E+000
p1(03)  = c00  = +0.0000000000000000E+000  Sigma_initial(03,03) = 1.0000000000000000E+000
p1(04)  = a10  = +0.0000000000000000E+000  Sigma_initial(04,04) = 9.9999000000000000E+004
p1(05)  = b10  = +0.0000000000000000E+000  Sigma_initial(05,05) = 9.9999000000000000E+004
p1(06)  = c10  = +0.0000000000000000E+000  Sigma_initial(06,06) = 9.9999000000000000E+004
p1(07)  = d10  = +0.0000000000000000E+000  Sigma_initial(07,07) = 9.9999000000000000E+004
p1(08)  = a20  = +0.0000000000000000E+000  Sigma_initial(08,08) = 9.9999000000000000E+004
p1(09)  = b20  = +0.0000000000000000E+000  Sigma_initial(09,09) = 9.9999000000000000E+004
p1(10)  = c20  = +0.0000000000000000E+000  Sigma_initial(10,10) = 9.9999000000000000E+004
p1(11)  = d20  = +0.0000000000000000E+000  Sigma_initial(11,11) = 9.9999000000000000E+004
p1(12)  = a01  = +0.0000000000000000E+000  Sigma_initial(12,12) = 9.9999000000000000E+004
p1(13)  = b01  = +0.0000000000000000E+000  Sigma_initial(13,13) = 9.9999000000000000E+004
p1(14)  = c01  = +0.0000000000000000E+000  Sigma_initial(14,14) = 9.9999000000000000E+004
p1(15)  = d01  = +0.0000000000000000E+000  Sigma_initial(15,15) = 9.9999000000000000E+004
p1(16)  = e01  = +0.0000000000000000E+000  Sigma_initial(16,16) = 9.9999000000000000E+004
p1(17)  = f01  = +0.0000000000000000E+000  Sigma_initial(17,17) = 9.9999000000000000E+004
-----------------------------------------------------------------------------------------
p2f(01) = am1  = +0.0000000000000000E+000
p2f(02) = am2  = +0.0000000000000000E+000  Sigma_initial(18,18) = 1.0000000000000001E-001
p2f(03) = am3  = +1.0000000000000000E+000
p2f(04) = beta = +1.0000000000000000E+000  Sigma_initial(19,19) = 1.0000000000000001E-001
p2f(05) = qT1  = +1.4257389017362338E-006  Sigma_initial(20,20) = 1.0000000000000001E-001
p2f(06) = qT2  = -8.8328078008885079E-004  Sigma_initial(21,21) = 1.0000000000000000E-002
p2f(07) = aT3  = +1.6141373392967960E-003  Sigma_initial(22,22) = 1.0000000000000000E-002
p2f(08) = qT4  = +9.9999830718540750E-001
p2f(09) = qR1  = +0.0000000000000000E+000  Sigma_initial(23,23) = 3.4281576788666959E-002
p2f(10) = qR2  = +0.0000000000000000E+000  Sigma_initial(24,24) = 2.4007572013584836E-003
p2f(11) = qR3  = +0.0000000000000000E+000  Sigma_initial(25,25) = 2.7434407822204804E-003
p2f(12) = qR4  = +1.0000000000000000E+000
p2f(13) = brx  = +0.0000000000000000E+000  Sigma_initial(26,26) = 2.0491803278688525E-004
p2f(14) = bry  = +0.0000000000000000E+000  Sigma_initial(27,27) = 2.0491803278688525E-004
p2f(15) = brz  = +0.0000000000000000E+000  Sigma_initial(28,28) = 2.0491803278688525E-004
p2f(16) = crx  = +0.0000000000000000E+000  Sigma_initial(29,29) = 4.1991400161246979E-008
p2f(17) = cry  = +0.0000000000000000E+000  Sigma_initial(30,30) = 4.1991400161246979E-008
p2f(18) = crz  = +0.0000000000000000E+000  Sigma_initial(31,31) = 4.1991400161246979E-008
p2f(19) = bgx  = +0.0000000000000000E+000  Sigma_initial(32,32) = 2.0491803278688525E-004
p2f(20) = bgy  = +0.0000000000000000E+000  Sigma_initial(33,33) = 2.0491803278688525E-004
p2f(21) = bgz  = +0.0000000000000000E+000  Sigma_initial(34,34) = 2.0491803278688525E-004
p2f(22) = cgx  = +0.0000000000000000E+000  Sigma_initial(35,35) = 4.1991400161246979E-008
```

```
p2f(23) = cgy  = +0.0000000000000000E+000  Sigma_initial(36,36) = 4.1991400161246979E-008
p2f(24) = cgz  = +0.0000000000000000E+000  Sigma_initial(37,37) = 4.1991400161246979E-008
-------------------------------------------------------------------------------------------

--------------------   IPF KALMAN FILTER STARTED  ---------------------
Iteration#001: |dp|= +1.905784448253E-001   RMS(|Res|)=+1.905784448253E-001
Iteration#002: |dp|= +6.667902502433E-002   RMS(|Res|)=+6.667902502433E-002
Iteration#003: |dp|= +5.869659470241E-003   RMS(|Res|)=+5.869659470241E-003
Iteration#004: |dp|= +3.989704442852E-003   RMS(|Res|)=+3.989704442852E-003
Iteration#005: |dp|= +8.566554077126E-004   RMS(|Res|)=+8.566554077126E-004
Iteration#006: |dp|= +3.743648135142E-004   RMS(|Res|)=+3.743648135142E-004
Iteration#007: |dp|= +9.741946074431E-005   RMS(|Res|)=+9.741946074431E-005
Iteration#008: |dp|= +2.656447499957E-005   RMS(|Res|)=+2.656447499957E-005
Iteration#009: |dp|= +1.236738002659E-005   RMS(|Res|)=+1.236738002659E-005
Iteration#010: |dp|= +1.578344765378E-006   RMS(|Res|)=+1.578344765378E-006
Iteration#011: |dp|= +1.200412919415E-006   RMS(|Res|)=+1.200412919415E-006
Iteration#012: |dp|= +1.856838693729E-007   RMS(|Res|)=+1.856838693729E-007
Iteration#013: |dp|= +1.101691104891E-007   RMS(|Res|)=+1.101691104891E-007
Iteration#014: |dp|= +2.818317998841E-008   RMS(|Res|)=+2.818317998841E-008
Iteration#015: |dp|= +8.378311951682E-009   RMS(|Res|)=+8.378311951682E-009
Iteration#016: |dp|= +3.481613996513E-009   RMS(|Res|)=+3.481613996513E-009
Iteration#017: |dp|= +4.914307944178E-010   RMS(|Res|)=+4.914307944178E-010
Iteration#018: |dp|= +4.693785373864E-010   RMS(|Res|)=+4.693785373864E-010
Iteration#019: |dp|= +1.871261264500E-010   RMS(|Res|)=+1.871261264500E-010
Iteration#020: |dp|= +9.217809625973E-011   RMS(|Res|)=+9.217809625973E-011
Iteration#021: |dp|= +5.029694762398E-011   RMS(|Res|)=+5.029694762398E-011
Iteration#022: |dp|= +1.068253133604E-010   RMS(|Res|)=+1.068253133604E-010
Iteration#023: |dp|= +1.185424180431E-010   RMS(|Res|)=+1.185424180431E-010
Iteration#024: |dp|= +2.438667822928E-010   RMS(|Res|)=+2.438667822928E-010
Iteration#025: |dp|= +8.970683003531E-011   RMS(|Res|)=+8.970683003531E-011
Iteration#026: |dp|= +8.852776973482E-011   RMS(|Res|)=+8.852776973482E-011
Iteration#027: |dp|= +1.390075520672E-010   RMS(|Res|)=+1.390075520672E-010
Iteration#028: |dp|= +1.286448913739E-010   RMS(|Res|)=+1.286448913739E-010
Iteration#029: |dp|= +1.009065245535E-010   RMS(|Res|)=+1.009065245535E-010
Iteration#030: |dp|= +1.544761947010E-010   RMS(|Res|)=+1.544761947010E-010
IPF Kalman Filter Completed with Error |dp1| + |dp2| = +1.5447619470104271E-010
-----------------------------------------------------------------------

-----------------  IPF LEAST SQUARES FILTER STARTED  ------------------
Iteration#001   COND#=+6.915041441993E+007,   |dp|=+1.909193414469E-001
Iteration#002   COND#=+7.123807622832E+007,   |dp|=+6.805095321280E-002
Iteration#003   COND#=+6.843130452604E+007,   |dp|=+4.086433207292E-003
Iteration#004   COND#=+6.861019092019E+007,   |dp|=+6.933277044119E-004
Iteration#005   COND#=+6.861550122814E+007,   |dp|=+1.245542905162E-004
Iteration#006   COND#=+6.862107033544E+007,   |dp|=+2.400562686089E-005
Iteration#007   COND#=+6.862183308363E+007,   |dp|=+5.048512015803E-006
Iteration#008   COND#=+6.862206284757E+007,   |dp|=+1.024914794502E-006
Iteration#009   COND#=+6.862210591249E+007,   |dp|=+2.257106689156E-007
Iteration#010   COND#=+6.862211625645E+007,   |dp|=+4.725407899822E-008
Iteration#011   COND#=+6.862211839178E+007,   |dp|=+1.048590341207E-008
Iteration#012   COND#=+6.862211885360E+007,   |dp|=+2.251147454053E-009
Iteration#013   COND#=+6.862211897169E+007,   |dp|=+4.943420218336E-010
Iteration#014   COND#=+6.862211899802E+007,   |dp|=+1.066370034182E-010
Iteration#015   COND#=+6.862211900730E+007,   |dp|=+2.322603579988E-011
Iteration#016   COND#=+6.862211899827E+007,   |dp|=+5.568819457292E-012
Iteration#017   COND#=+6.862211899955E+007,   |dp|=+1.452337824185E-012
Iteration#018   COND#=+6.862211901097E+007,   |dp|=+4.539509828504E-013
Iteration#019   COND#=+6.862211898040E+007,   |dp|=+1.247237039058E-012
Iteration#020   COND#=+6.862211900884E+007,   |dp|=+8.622678601735E-013
Iteration#021   COND#=+6.862211898719E+007,   |dp|=+3.902541718044E-013
Iteration#022   COND#=+6.862211901463E+007,   |dp|=+1.526071098657E-012
Iteration#023   COND#=+6.862211901773E+007,   |dp|=+9.642515194979E-013
Iteration#024   COND#=+6.862211897934E+007,   |dp|=+3.530034613449E-013
Iteration#025   COND#=+6.862211899750E+007,   |dp|=+7.960335285001E-013
```

```
Iteration#026   COND#=+6.862211898504E+007,   |dp|=+4.735739368358E-013
Iteration#027   COND#=+6.862211898631E+007,   |dp|=+4.784673573935E-013
Iteration#028   COND#=+6.862211901945E+007,   |dp|=+6.586674071933E-013
Iteration#029   COND#=+6.862211901062E+007,   |dp|=+3.170785373578E-013
Iteration#030   COND#=+6.862211901039E+007,   |dp|=+1.381425453024E-013
IPF Least Squares Filter Completed with Error |dp1| + |dp2| = +1.3814254530235044E-013
-----------------------------------------------------------------------
Total Execution Time: 3008 seconds
```

3 USER COMMENTS

This section left blank.

IPF TEAM CONTACT INFORMATION

IPF Team email		ipf@sirtfweb.jpl.nasa.gov	
David S. Bayard	X4-8208	David.S.Bayard@jpl.nasa.gov	(TEAM LEADER)
Dhemetrio Boussalis	X4-3977	boussali@grover.jpl.nasa.gov	
Paul Brugarolas	X4-9243	Paul.Brugarolas@jpl.nasa.gov	
Bryan H. Kang	X4-0541	Bryan.H.Kang@jpl.nasa.gov	
Edward.C.Wong	X4-3053	Edward.C.Wong@jpl.nasa.gov	(TASK MANAGER)

ACKNOWLEDGEMENTS

This work was performed at the Jet Propulsion Laboratory, California Institute of Technology, under contract with the National Aeronautics and Space Administration.

References

[1] D.S. Bayard, B.H. Kang, *SIRTF Instrument Pointing Frame Kalman Filter Algorithm*, JPL D-Document D-24809, September 30, 2003.

[2] B.H. Kang, D.S. Bayard, *SIRTF Instrument Pointing Frame (IPF) Software Description Document and User's Guide*, JPL D-Document D-24808, September 30, 2003.

[3] D.S. Bayard, B.H. Kang, *SIRTF Instrument Pointing Frame (IPF) Kalman Filter Unit Test Report*, JPL D-Document D-24810, September 30, 2003.

[4] *Space Infrared Telescope Facility In-Orbit Checkout and Science Verification Mission Plan*, JPL D-Document D-22622, 674-FE-301 Version 1.4, February 8, 2002.

[5] *Space Infrared Telescope Facility Observatory Description Document*, Lockheed Martin LMMS/P458569, 674-SEIT-300 Version 1.2, November 1, 2002.

[6] *SIRTF Software Interface Specification for Science Centroid INPUT Files (CAFILE, CSFILE)*, JPL SOS-SIS-2002, November 18, 2002.

[7] *SIRTF Software Interface Specification for Inferred Frames Offset INPUT Files (OFILE)*, JPL SOS-SIS-2003, November 18, 2002.

[8] *SIRTF Software Interface Specification for PCRS Centroid INPUT Files (CBFILE)*, JPL SIS-FES-015, November 18, 2002.

[9] *SIRTF Software Interface Specification for Attitude INPUT Files (AFILE, ASFILE)*, JPL SIS-FES-014, January 7, 2002.

[10] *SIRTF Software Interface Specification for IPF Filter Output Files (IFFILE, LGFILE, TARFILE)*, JPL SOS-SIS-2005, November 18, 2002.

[11] R.J. Brown, *Focal Surface to Object Space Field of View Conversion.* Systems Engineering Report SER No. S20447-OPT-051, Ball Aerospace & Technologies Corp., November 23, 1999.