Cassini-Huygens Mission to Saturn

Encyclopedia Titanica

The Legacy of the Cassini Titan Data Set

397D Presented by Trina L. Ray, Karl L. Mitchell, Marcia Burton, Jo Eliza Pitesky, and Rudy Boehmer

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Jet Propulsion Laboratory
California Institute of Technology

- The Cassini Project is collecting, organizing, and/or creating a set of products for use with Cassini science data so that future planetary scientists can more easily do independent research.
  - Specific to each science discipline (Titan, Saturn, Rings, Icy Satellites, Magnetosphere)
  - Example 1: when are we using reaction wheels, and at what speeds?
  - Example 2:
  - What other products would be useful or needed?

- Best time to identify and collect these products is NOW, before Project personnel disappear
  - **It is critical for the success of this effort to engage the external Titan community, particularly those who have not been deeply immersed in Cassini**

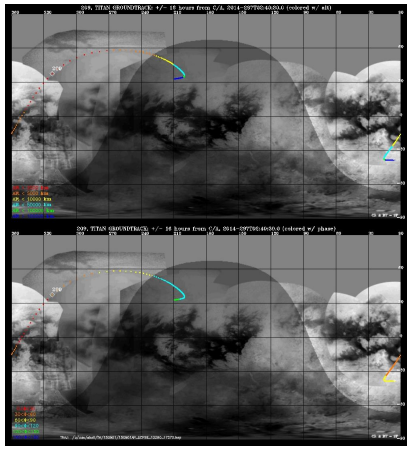
- This week, we would like to present a summary of some of the products already assembled and gather feedback
  - What's missing?
  - What is helpful? Would it be useful for future Titan scientists?

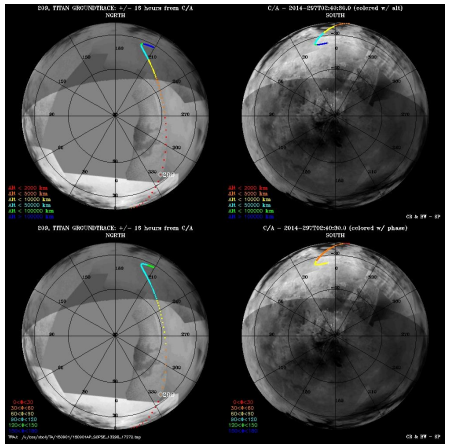
- Gathering input in three ways:
  - Lunchtime town hall-style exchange to get feedback and to hear about additional products that you all would find useful;
  - A survey which will be emailed to all attendees which can be completed after the end of TTT;
  - One-on-one meetings with anyone who would like to discuss this topic, preferably in person during TTT, but after via phone is OK

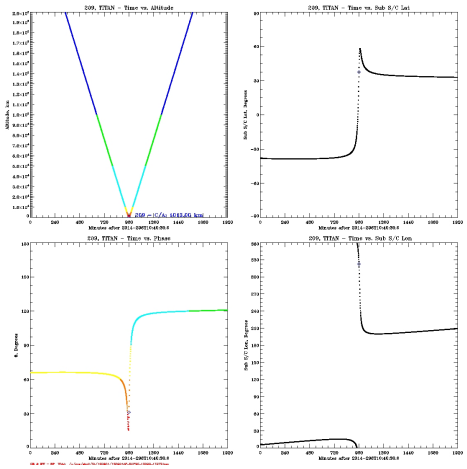
Products we already know are useful…

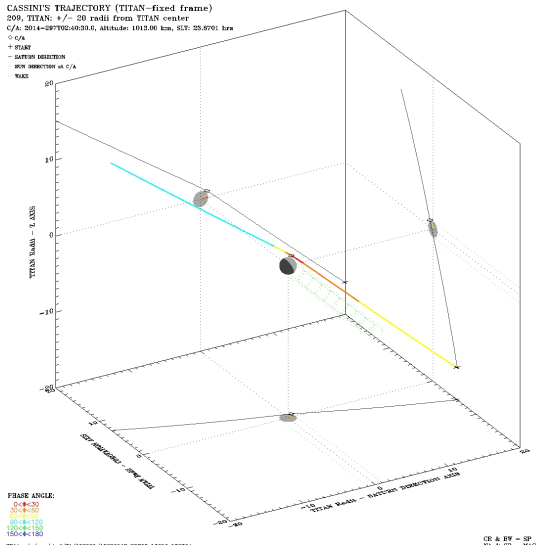
Higher resolution available in the backup slides for easier viewing

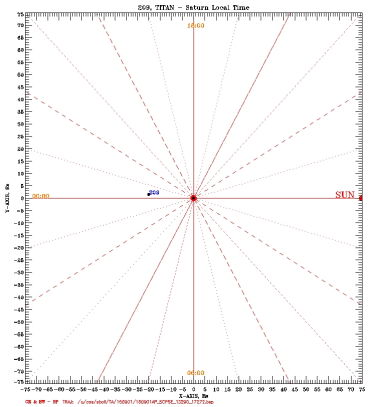
Ground tracks for each flyby showing altitude and phase angle







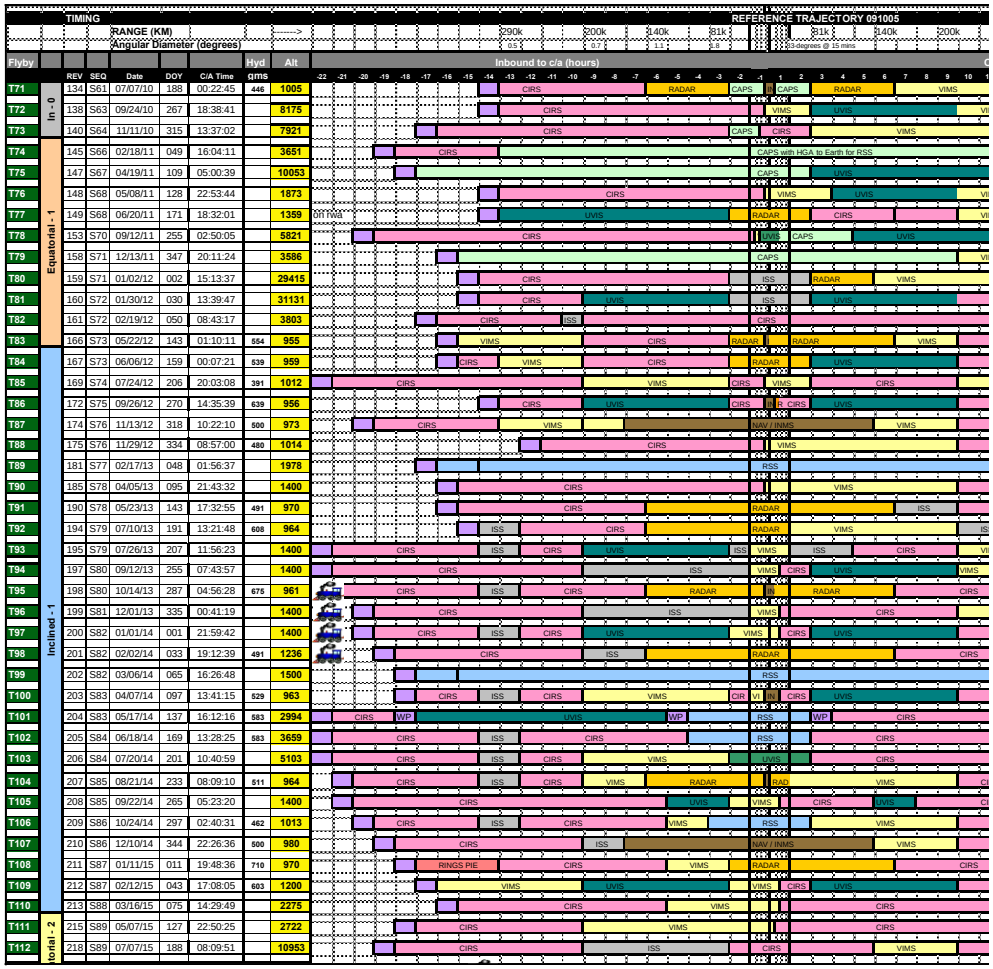




Altitude, phase angle, sub s/c lat vs time;
3-d trajectory plot;
c/a in Saturn Local Time

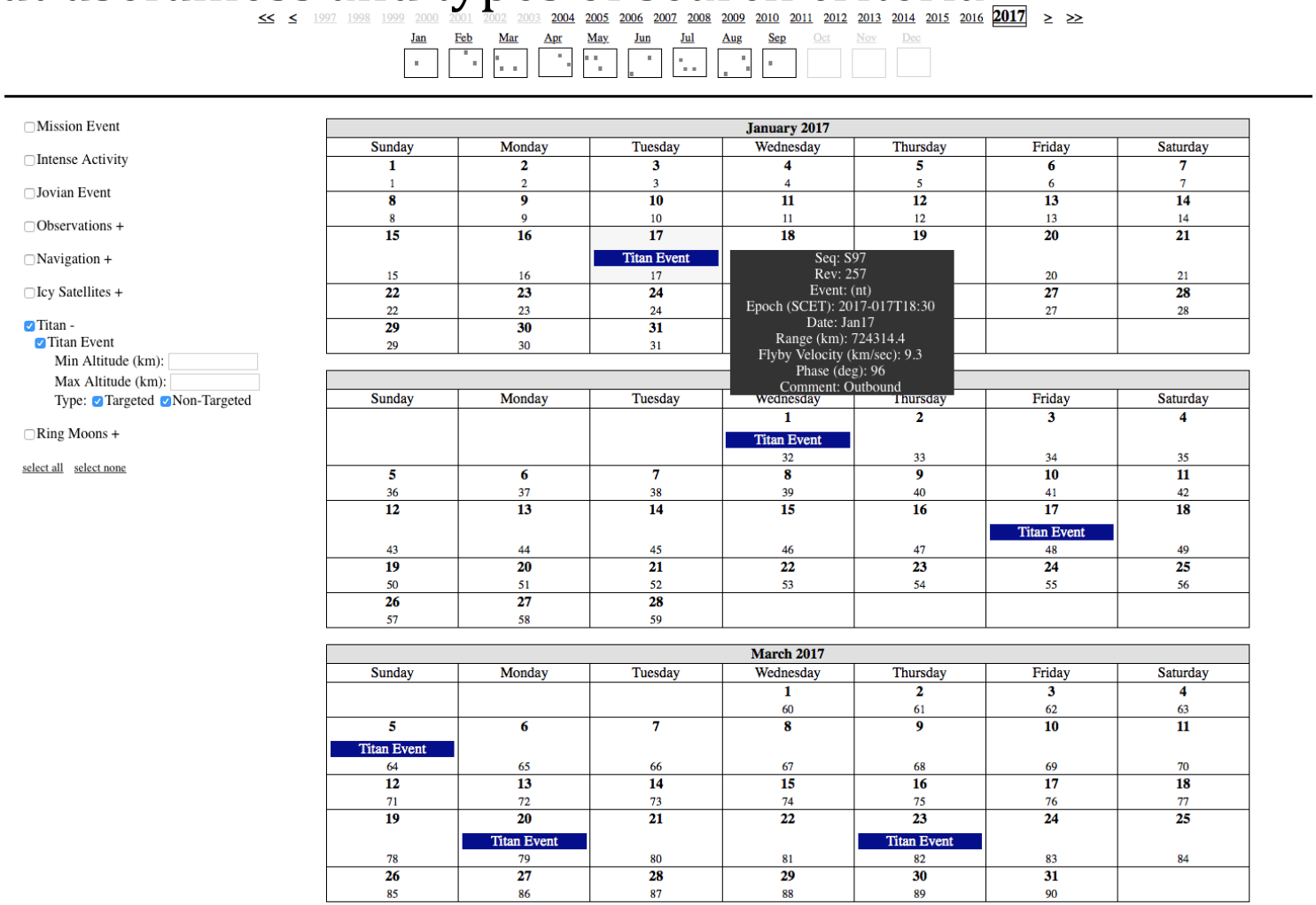
Products we already know are useful…but need to create documentation or explanation and get feedback from non-Cassini folks

Cassini Solstice Mission Titan Flyby Summary



1	Reference Trajectory 110818	Refers to the version of the reference trajectory used for creating the "one pager"; relevant to time and altitude of closest approach (c/a) and other geometrical data. Version is in YY/MM/DD format.
	Revision 9, 140220	See above.
2	Range (km)	distance from spacecraft to Titan's surface at specified time relative to c/a
3	Angular diameter (degrees)	Angular diameter of Titan at specified time
4	Flyby	All Titan targeted flybys were labeled in order, with a few special exceptions at the start of the mission (T0, TA, TB, T3, T4, T5…). In some cases, indicated in the format revTI_T#, where rev is defined below and T# is the usual Titan flyby (e.g. T105 is the same as 208TI_T105)
5	Mission phase (not labeled; the column between "Flyby" and "Rev")	Refers to different inclination "phases" of the mission, alternating between orbits highly inclined to the ring plane (e.g. In-1, Inclined-2) and orbits in or near the ring plane (e.g. Equatorial-1, Equatorial-2). F-ring is for near the end of mission.
	Rev	The spacecraft orbital "revolution", counted from the beginning of the mission, on which this Titan flyby occurred. Revs commence at apoapse.
	SEQ	The spacecraft sequence, counted from the beginning of the mission, in which this Titan flyby occurred. Sequences ranged in duration from 6-10 weeks.
	Date	Calendar date for closest approach to Titan.
	DOY	Day of the year (e.g. January 1 = 001) for closest approach to Titan.
	C/A Time	Time in SCET (Spacecraft Event Time) of closest approach
	Hyd gms	Grams of hydrazine used during this flyby. Yellow background for predicted values; blue background for actual as-flown value.
	Alt	Altitude in km of the spacecraft from Titan's surface at closest approach
	Inbound to c/a (hours) , Outbound from c/a (hours)	Refers to black row immediately below this legend, stretching across the timeline. Events are indicated as epoch relative to the time of closest approach (time 0, not shown on the black

Products we think are useful… need feedback from non-Cassini folks about usefulness and types of search criteria



Products we think are useful: something similar to MarsTrek

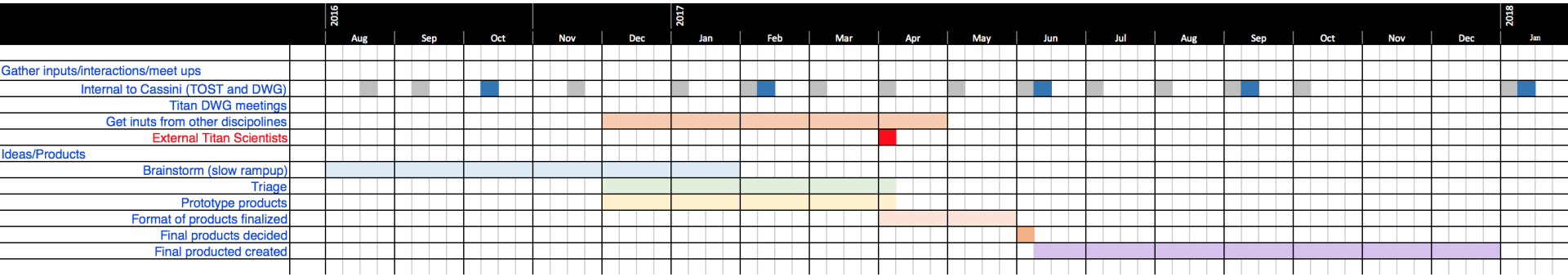
- Mars Trek is a NASA web-based portal for exploration of Mars. This portal showcases data collected by NASA at various landing sites. It features an easy-to-use browsing tool which provides layering and viewing of high resolution Mars data products in 2D and Globe view allowing users to fly over the surface of Mars. It also provides a set of tools including 3D printing, elevation profiles, sun angle calculations, Sun and Earth position, as well as bookmarks for the path journeyed over by "The Martian" …

Would this be useful for new Titan scientists?

Product/graphics/animations that have been created for flybys, or the website.

Products we know are useful… need feedback from non-Cassini folks about what hasn't been translated yet from "Cassini speak"

- Narrative write up capturing:
  - Intent
  - Idiosyncrasies (e.g. the flyby number scheme)
- Summary tables (e.g list of solar, stellar, and earth occultations)
- Engineering data
  - Comprehensive list of data loss and why
  - Thruster times, wheel speeds, etc.
- Instrument specific contributions
  - VIMS powerpoint guidebooks (intent of observation), final map
  - RADAR flyby-by-flyby product, final maps
  - When individual instruments got good data (e.g. CAPS or INMS)
  - Useful: ISS cloud spreadsheet, final map
  - etc.



- The path forward
  - This meeting (first and likely best interaction with external Titan scientists)
    - Lunchtime town hall-style exchange to get feedback and to hear about additional products that you all would find useful;
    - A survey which will be emailed to all attendees which can be completed after the end of TTT;
    - One-on-one meetings with anyone who would like to discuss this topic, preferably in person during TTT, but after via phone is OK
  - Final set and format of discipline legacy products is still TBD, but most of the decisions will be made by the June Cassini PSG so that we can deploy some remaining Cassini JPL workforce to create as much as possible before EOM.
- Thank you all very much for your attention and contribution to the Cassini legacy…long may it help your research!

JPL

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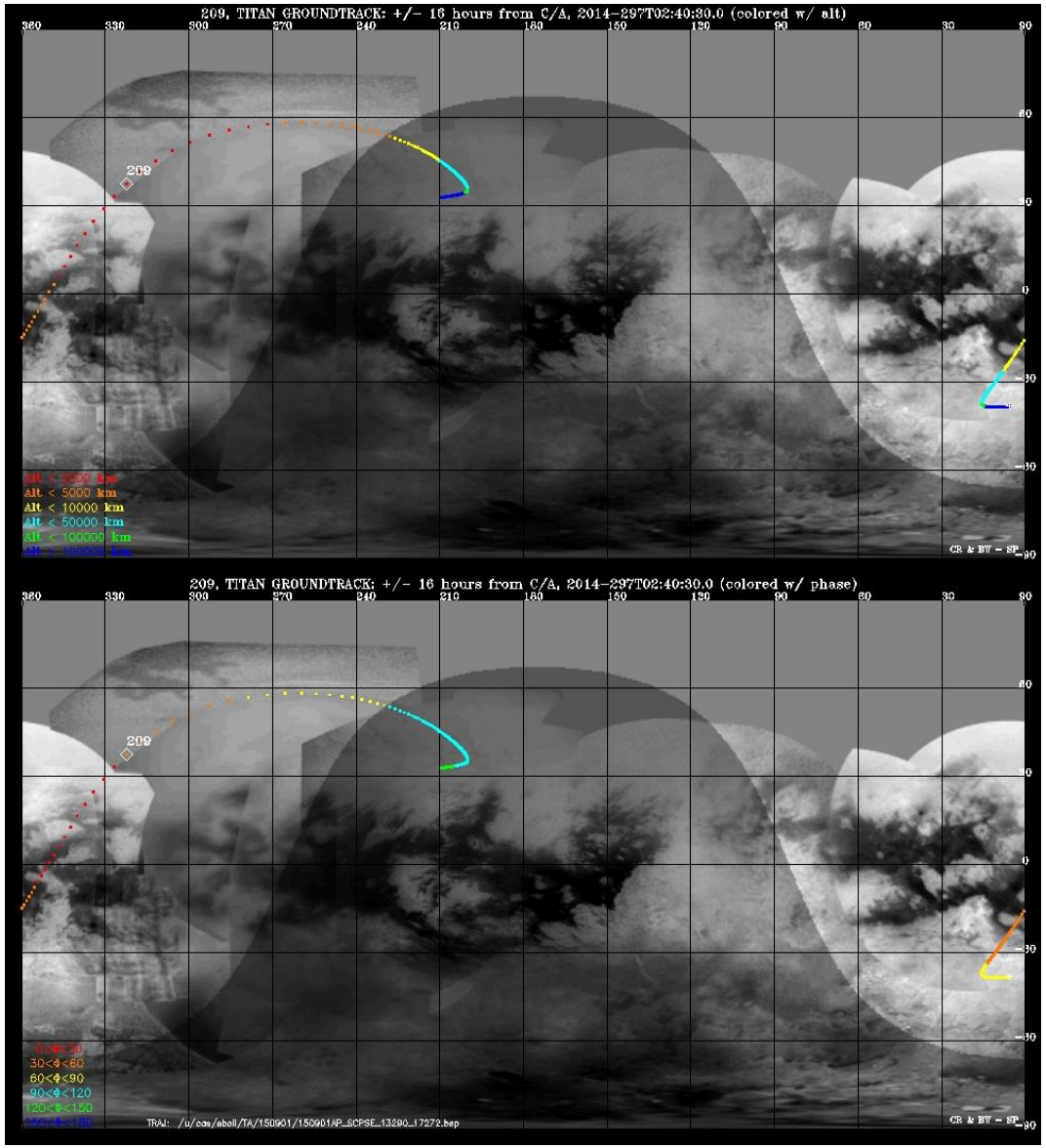
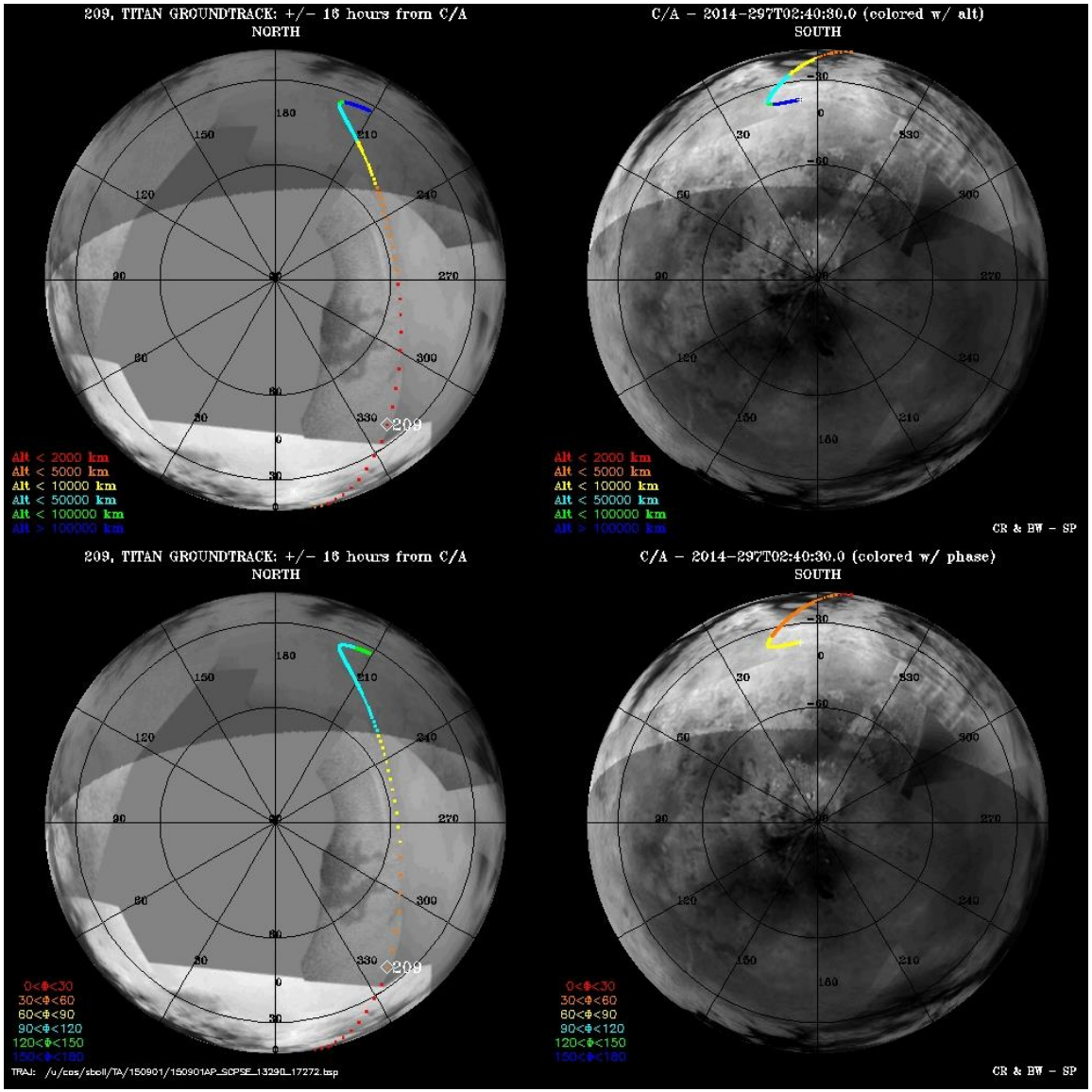
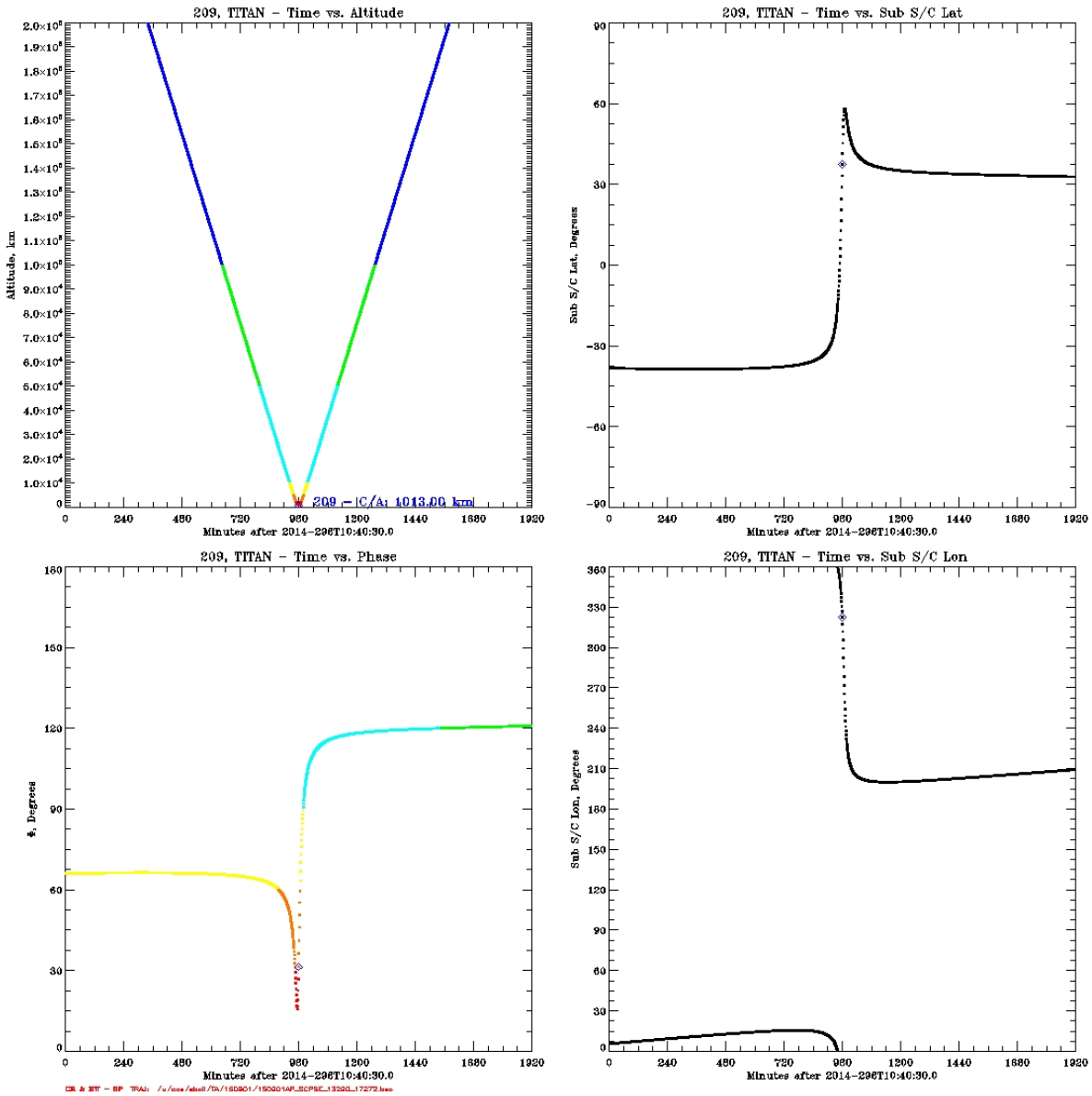
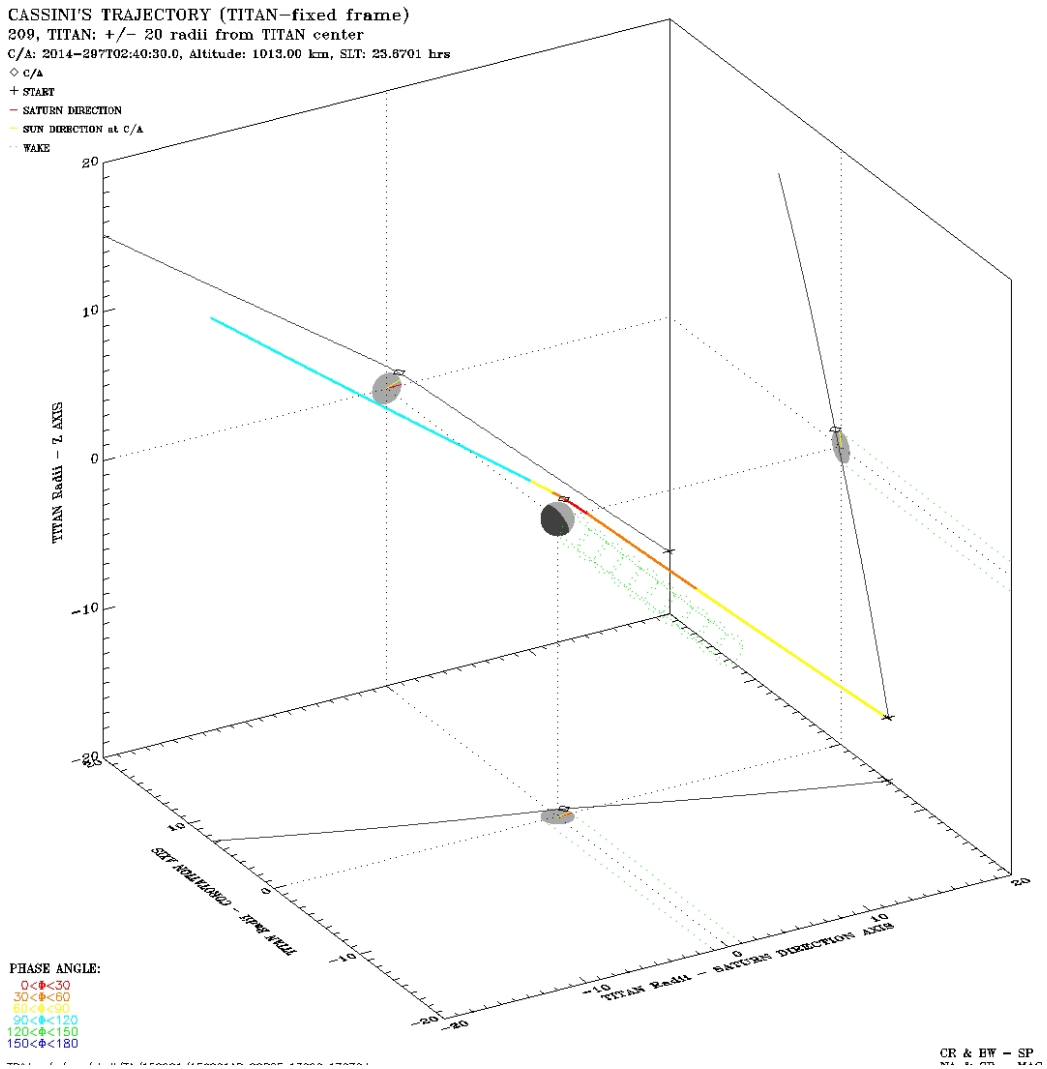
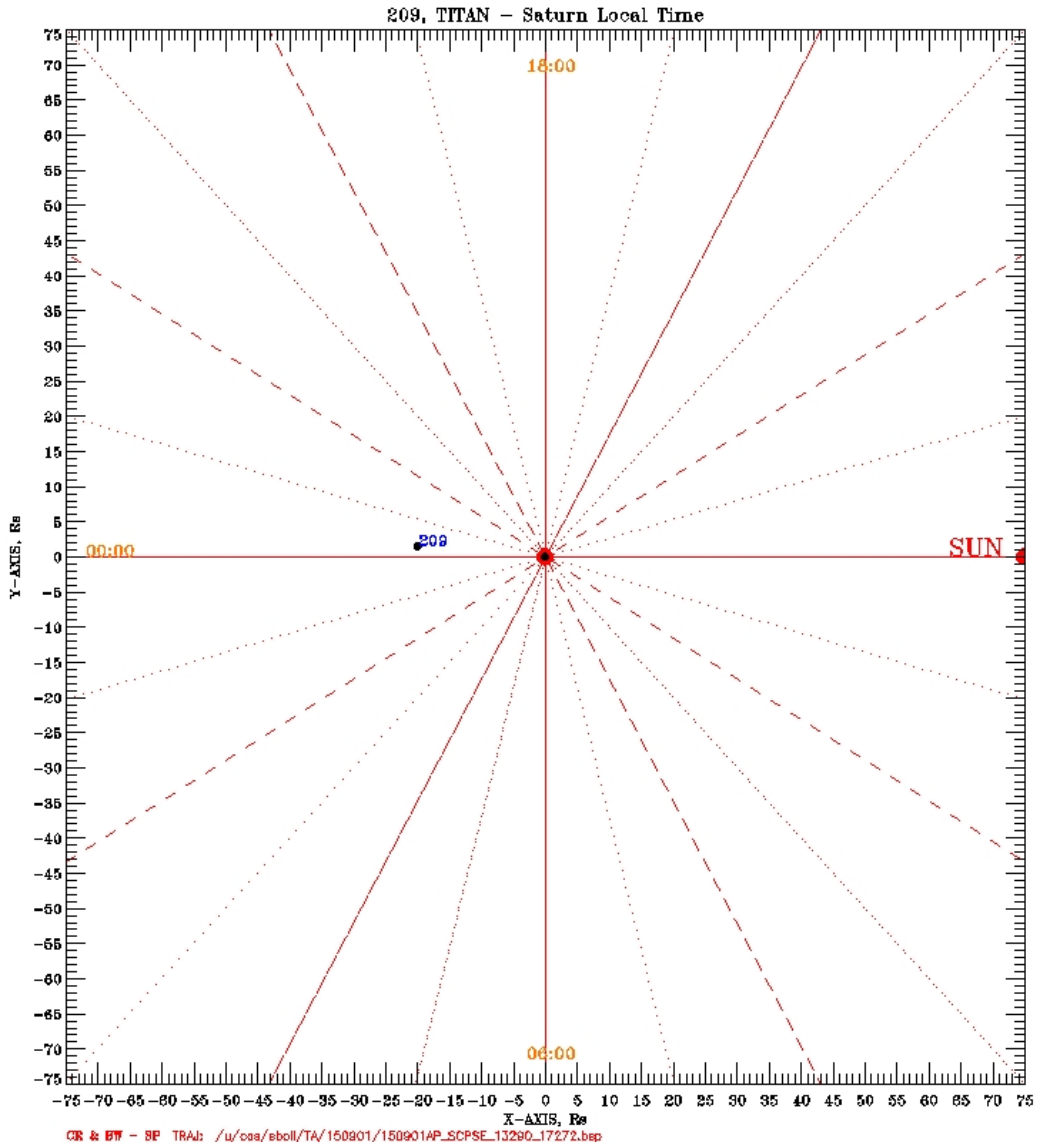
- Backup slides with diagrams at higher resolution


209, TITAN GROUNDTRACK: +/- 16 hours from C/A, 2014-297T02:40:30.0 (colored w/ alt)
360 330 300 270 240 210 180 150 120 90 60 30 90
60
30
0
-30
-60
-90
209
Alt < 5000 km
Alt < 10000 km
Alt < 50000 km
Alt < 100000 km
CR & BW - SP
209, TITAN GROUNDTRACK: +/- 16 hours from C/A, 2014-297T02:40:30.0 (colored w/ phase)
360 330 300 270 240 210 180 150 120 90 60 30 90
60
30
0
-30
-60
-90
209
30<Φ<60
60<Φ<90
90<Φ<120
120<Φ<150
TRAJ: /u/cas/ebell/TA/150901/150901AP_SCPSE_13290_17272.bep
CR & BW - SP

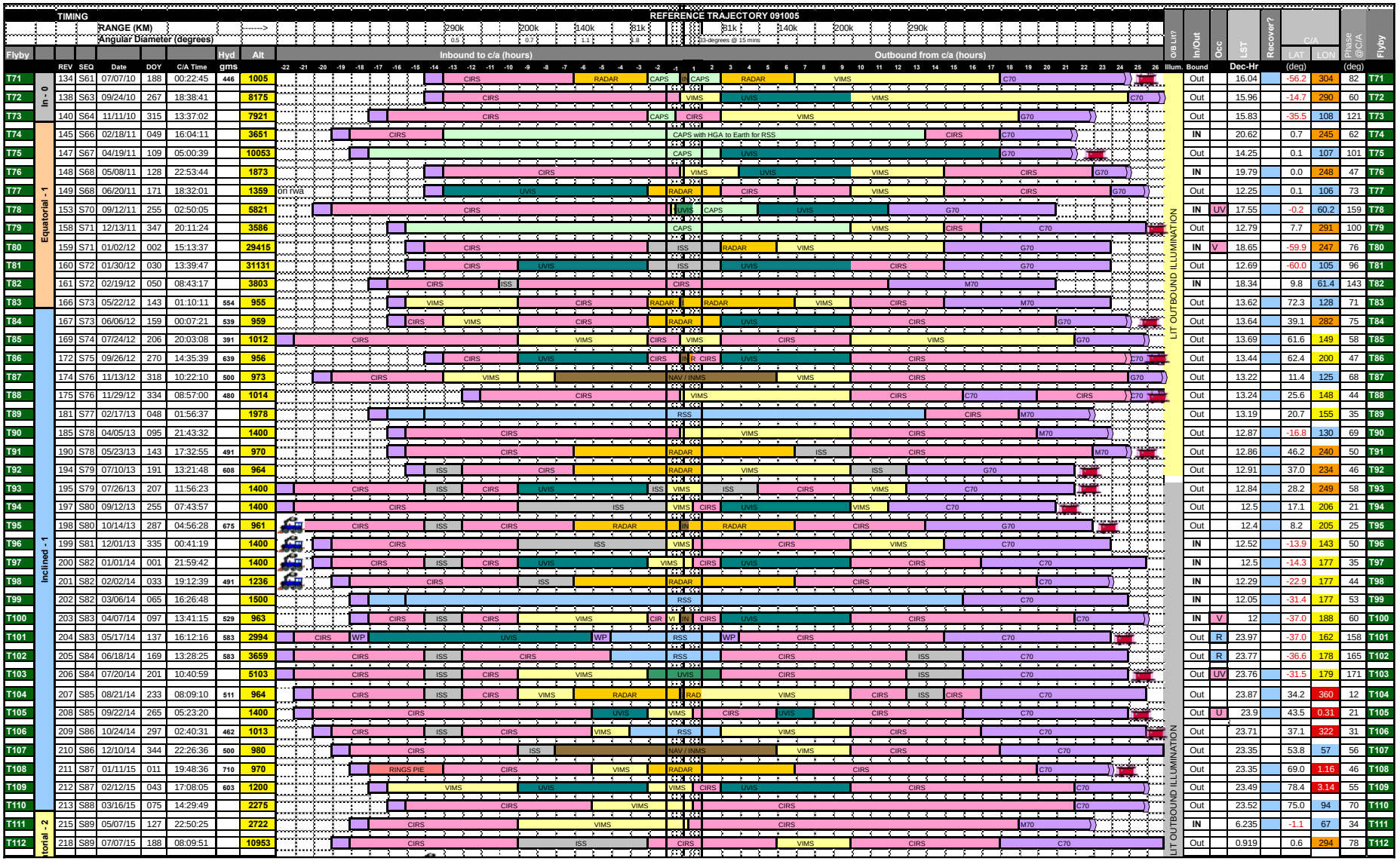

209, TITAN GROUNDTRACK: +/- 16 hours from C/A
NORTH
Alt < 2000 km
Alt < 5000 km
Alt < 10000 km
Alt < 50000 km
Alt < 100000 km
Alt > 100000 km
C/A - 2014-297T02:40:30.0 (colored w/ alt)
SOUTH
CR & BW - SP
209, TITAN GROUNDTRACK: +/- 16 hours from C/A
NORTH
0<Φ<30
30<Φ<60
60<Φ<90
90<Φ<120
120<Φ<150
150<Φ<180
TRAJ: /u/cos/sboll/TA/150901/150901AP_SCPSE_13290_17272.bsp
C/A - 2014-297T02:40:30.0 (colored w/ phase)
SOUTH
CR & BW - SP


209, TITAN - Time vs. Altitude
Altitude, km
209 - |C/A: 1013.00 km|
Minutes after 2014-296T10:40:30.0
209, TITAN - Time vs. Sub S/C Lat
Sub S/C Lat, Degrees
Minutes after 2014-296T10:40:30.0
209, TITAN - Time vs. Phase
$, Degrees
Minutes after 2014-296T10:40:30.0
209, TITAN - Time vs. Sub S/C Lon
Sub S/C Lon, Degrees
Minutes after 2014-296T10:40:30.0


CASSINI'S TRAJECTORY (TITAN−fixed frame)
209, TITAN: +/− 20 radii from TITAN center
C/A: 2014−297T02:40:30.0, Altitude: 1013.00 km, SLT: 23.6701 hrs
◇ C/A
+ START
− SATURN DIRECTION
− SUN DIRECTION at C/A
WAKE
TITAN Radii − Z AXIS
TITAN Radii − CONVERSE AXIS
TITAN Radii − SATURN DIRECTION AXIS
PHASE ANGLE:
0<Φ<30
30<Φ<60
60<Φ<90
90<Φ<120
120<Φ<150
150<Φ<180
CR & BW − SP


209, TITAN – Saturn Local Time
18:00
00:00
06:00
209
SUN
Y-AXIS, Rs
X-AXIS, Rs
CR & BW – SP TRAJ: /u/oss/sboll/TA/150901/150901AP_SCPSE_13290_17272.bsp

Cassini Solstice Mission Titan Flyby Summary



Flyby		REV	SEQ	Date	DOY	C/A Time	Hyd gms	Alt	O/B Lit?	Illum.	In/Out	Bound	Occ	LST Dec-Hr	Recover?	C/A LAT (deg)	C/A LON (deg)	Phase @C/A	Flyby
T71	In - 0	134	S61	07/07/10	188	00:22:45	446	1005			Out			16.04		-56.2	304	82	T71
T72		138	S63	09/24/10	267	18:38:41		8175			Out			15.96		-14.7	290	60	T72
T73		140	S64	11/11/10	315	13:37:02		7921			Out			15.83		-35.5	108	121	T73
T74	Equatorial - 1	145	S66	02/18/11	049	16:04:11		3651			IN			20.62		0.7	245	62	T74
T75		147	S67	04/19/11	109	05:00:39		10053			Out			14.25		0.1	107	101	T75
T76		148	S68	05/08/11	128	22:53:44		1873			IN			19.79		0.0	248	47	T76
T77		149	S68	06/20/11	171	18:32:01		1359	on Iwa		Out			12.25		0.1	106	73	T77
T78		153	S70	09/12/11	255	02:50:05		5821			IN		UV	17.55		-0.2	60.2	159	T78
T79		158	S71	12/13/11	347	20:11:24		3586			Out			12.79		7.7	291	100	T79
T80		159	S71	01/02/12	002	15:13:37		29415			IN		V	18.65		-59.9	247	76	T80
T81		160	S72	01/30/12	030	13:39:47		31131			Out			12.69		-60.0	105	96	T81
T82		161	S72	02/19/12	050	08:43:17		3803			IN			18.34		9.8	61.4	143	T82
T83		166	S73	05/22/12	143	01:10:11	554	955			Out			13.62		72.3	128	71	T83
T84	Inclined - 1	167	S73	06/06/12	159	00:07:21	539	959			Out			13.64		39.1	282	75	T84
T85		169	S74	07/24/12	206	20:03:08	391	1012			Out			13.69		61.6	149	58	T85
T86		172	S75	09/26/12	270	14:35:39	639	956			Out			13.44		62.4	200	47	T86
T87		174	S76	11/13/12	318	10:22:10	500	973			Out			13.22		11.4	125	68	T87
T88		175	S76	11/29/12	334	08:57:00	480	1014			Out			13.24		25.6	148	44	T88
T89		181	S77	02/17/13	048	01:56:37		1978			Out			13.19		20.7	155	35	T89
T90		185	S78	04/05/13	095	21:43:32		1400			Out			12.87		-16.8	130	69	T90
T91		190	S78	05/23/13	143	17:32:55	491	970			Out			12.86		46.2	240	50	T91
T92		194	S79	07/10/13	191	13:21:48	608	964			Out			12.91		37.0	234	46	T92
T93		195	S79	07/26/13	207	11:56:23		1400			Out			12.84		28.2	249	58	T93
T94		197	S80	09/12/13	255	07:43:57		1400			Out			12.5		17.1	206	21	T94
T95		198	S80	10/14/13	287	04:56:28	675	961			Out			12.4		8.2	205	25	T95
T96		199	S81	12/01/13	335	00:41:19		1400			IN			12.52		-13.9	143	50	T96
T97		200	S82	01/01/14	001	21:59:42		1400			IN			12.5		-14.3	177	35	T97
T98		201	S82	02/02/14	033	19:12:39	491	1236			IN			12.29		-22.9	177	44	T98
T99		202	S82	03/06/14	065	16:26:48		1500			IN			12.05		-31.4	177	53	T99
T100		203	S83	04/07/14	097	13:41:15	529	963			IN		V	12		-37.0	188	60	T100
T101		204	S83	05/17/14	137	16:12:16	583	2994			Out		R	23.97		-37.0	162	158	T101
T102		205	S84	06/18/14	169	13:28:25	583	3659			Out		R	23.77		-36.6	178	165	T102
T103		206	S84	07/20/14	201	10:40:59		5103			Out		UV	23.76		-31.5	179	171	T103
T104		207	S85	08/21/14	233	08:09:10	511	964			Out			23.87		34.2	360	12	T104
T105		208	S85	09/22/14	265	05:23:20		1400			Out		U	23.9		43.5	0.31	21	T105
T106		209	S86	10/24/14	297	02:40:31	462	1013			Out			23.71		37.1	322	31	T106
T107		210	S86	12/10/14	344	22:26:36	500	980			Out			23.35		53.8	57	56	T107
T108		211	S87	01/11/15	011	19:48:36	710	970			Out			23.35		69.0	1.16	46	T108
T109		212	S87	02/12/15	043	17:08:05	603	1200			Out			23.49		78.4	3.14	55	T109
T110		213	S88	03/16/15	075	14:29:49		2275			Out			23.52		75.0	94	70	T110
T111	Equatorial - 2	215	S89	05/07/15	127	22:50:25		2722			IN			6.235		-1.1	67	34	T111
T112		218	S89	07/07/15	188	08:09:51		10953			Out			0.919		0.6	294	78	T112

Goal: discipline specific legacy/guidebook products that will be useful for future discipline scientists.

-> Products we already know are useful…but we need to create documentation/explanation

00BTI(TB) Timeline - C/A 2004-348T11:38:13

00BTI (TB)

Start Time	End Time	Prime Activity	OpMode	Telem Mode	Comments
345T06:06	345T08:03	OpNav + turn to waypoint	DFPW_Normal	S_N_ER_5	Old seg start was 07:51
345T08:03	345T20:10	ISS Titan movie	DFPW_Normal	S_N_ER_3	
345T20:10	345T21:05	SP turn to Earth	DFPW_Normal	S_N_ER_3	
345T21:05	346T06:35	Downlink (Mad 34HEF)	DFPW_TCM	RTE_N_SPB	OTM 7 backup; pass extended to 9.5 hrs to help d.v. problem
346T06:35	346T08:03	OpNav + turn to waypoint	DFPW_Normal	S_N_ER_5	Shortened 30 min.
346T08:03	347T00:00	ISS Titan movie	DFPW_Normal	S_N_ER_3	
347T00:00	347T01:30	ISS Ring Rad color	DFPW_Normal	S_N_ER_3	
347T01:30	347T04:36	OpNav + turn to earth	DFPW_Normal	S_N_ER_5	
347T04:36	347T13:36	Downlink (Gold 70m)	DFPW_Normal	RTE_N_SPB	
347T13:36	347T14:57	SP turn to waypoint	DFPW_Normal	S_N_ER_3	
347T14:57	347T15:12	Moveable block dead time	DFPW_Normal	S_N_ER_3	
-20:25	-12:00	CIRS Mid-IR Temp Map	DFPW_Normal	S_N_ER_3	
-12:00	-08:00	CIRS Far-IR Nadir Comp	DFPW_Normal	S_N_ER_3	
-08:00	-04:00	UVIS EUVFUV	DFPW_Normal	S_N_ER_3	
-04:00	-02:00	REG MAP	DFPW_Normal	S_N_ER_3	
-02:00		Start Custom Period			
-02:00	-00:30	HI RES	DFPW_Normal	S_N_ER_3	
-00:30	-00:09	Transition to RCS	DFPW_Normal	S_N_ER_3	(.5,2,.5) - ISS observe thru trans
-00:09	-00:01	Turn to UVIS occs	DFPW_Normal	S_N_ER_3	Pick up at NAC to latlon(27,141), -X to Sun
-00:01	+00:27	UVIS Occs	DFPW_Normal	S_N_ER_3	FUV to 201.3,-11.2 - Turn to 2nd occ by +27min
+00:27	+00:50	Transition to RWA	DFPW_Normal	S_N_ER_3	UVIS observe thru transition
+00:50	+02:30	VIMS Darkside	DFPW_Normal	S_N_ER_3	Pickup at star 263.402/-37.104, NEG_X to SUN - offset (.1868,30,0)
+02:30	+05:00	UVIS EUVFUV	DFPW_Normal	S_N_ER_3	
+05:00		End Custom Period			
+05:00	+07:00	CIRS Mid-IR Limb Int	DFPW_Normal	S_N_ER_3	
+07:00	+10:30	VIMS darkside	DFPW_Normal	S_N_ER_3	
348T22:08	348T22:23	Moveable block dead time	DFPW_Normal	S_N_ER_3	
348T22:23	348T22:52	SP turn to Earth	DFPW_Normal	S_N_ER_3	
348T22:52	349T07:52	Downlink (Mad 70m)	DFPW_Normal	RTE_N_SPB	