Jet Propulsion Laboratory
California Institute of Technology

WFIRST CGI Starshade Readiness Status

Feng Zhao (3830), Instrument Manager
Jet Propulsion Laboratory
California Institute of Technology
October 6, 2016

Copyright 2016 California Institute of Technology. Government sponsorship acknowledged

Outline

- **CGI Starshade ready option baseline**
  - Formation flying acquisition:
  - Additional function by CGI Imager
  - Additional function by CGI LOWFS camera
  - Starshade science mode
  - Notional starshade mode parameters
- **Next steps**

CGI Starshade Ready Baseline – Option AA

Use these masks in existing open positions

Option AA: add 3 filters.

Drive FSM from LOWFS, similar to CGI

Same as CGI **Imaging camera**

Telescope focus

FSM

DM1

DM2

Pupil mask

Occulting mask

Lyot mask

Field stop mask

Filter wheel

IMG

FPA

PBS

to LOWFS

IFS

FPA

Shared with CGI.

Add three dichroic masks to occulting mask changer

Starlight from Starshade

Pass band

Beacon laser

Planet light

Same as CGI **Polarization imaging**

Details in backup charts

Baseline agreed from proposed option space (8/11/2016)

Option	CGI	A		AA (Baseline)	AAA
Description	Coronagraph	Coronagraph IFS		Coronagraph IFS	Broadband IFS
Features		Minimal changes		Broad band spectroscopy. Broad band blue imaging.	Adds blue spectrum
Instantaneous optical bandwidth	18%	18%		34%	34%
IFS Spectral ranges	600-970 nm in 3 ranges	600-970 nm in 3 ranges		600-970 nm in 2 ranges	425-1000 nm in 3 ranges
Imager spectral ranges	440-490 nm HLC 540-590 nm HLC 810-860 nm SPC 860-910 nm SPC	All CGI imager and IFS bands (left)		430-970 nm in 3x 34% ranges	425-1000 nm in 3x 34% ranges
New hardware/optics		3 dichroic/ masks at Occulting Mask changer	**A+**: also add 1 BP filter to Color Filter wheel	As A, plus MLA rotator and 3 BP filters in Color Filter wheel	As AA, plus broadband IFS
Detail on spectral ranges					
IFS Spectral ranges	*600-720 nm* *700-840 nm* *810-970 nm*	*600-720 nm* *700-840 nm* *810-970 nm*		*600-850 nm* *685-970 nm*	*425-600 nm* *600-725 nm* *706-1000 nm*
Imager spectral ranges	*440-490 nm HLC* *590-540 nm HLC* *810-860 nm SPC* *860-910 nm SPC*	*600-720 nm* *700-840 nm* *810-970 nm* *2 blue 10% ranges (HLC, left)*		*430-600 nm* *600-850 nm* *685-970 nm*	*425-600 nm* *600-725 nm* *706-1000 nm*

National Aeronautics and Space Administration
Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

Draft Starshade Mode Parameters (under review, to be released to IPAC website soon)

Coronagraph Instrument (CI) Parameters				
Name	**Value**	**Unit**	**Description**	**Source**
CI_SS_IWA_bandpass1	72	mas		Eric Cady MG7.mat
CI_SS_IWA_bandpass2	102	mas		Stefan Martin
CI_SS_IWA_bandpass3	145	mas		Stefan Martin
CI_SS_IWA	2.0	lambda/D	Inner radius of FOV	Stefan Martin
CI_SS_OWA	20	lambda/D	Outer radius of FOV	CGI System Engineering Team
CI_SS_Imaging_throughput_bandpass1	32	%	Starshade imaging mode not including QE	cycle 6
CI_SS_Imaging_throughput_bandpass2	41	%	Starshade imaging mode not including QE	cycle 6
CI_SS_Imaging_throughput_bandpass3	36	%	Starshade imaging mode not including QE	cycle 6
CI_SS_IFS_throughput_bandpass2	27	%	Throughput Starshade IFS mode not including QE	cycle 6
CI_SS_IFS_throughput_bandpass3	25	%	Throughput Starshade IFS mode not including QE	cycle 6
CI_SS_Imaging_contrast	2.50E-10	#	Planet-star brightness ratio before post-processing w/ SNR >= 5	Stefan Martin
CI_SS_IFS_number_dispersed_pixels	40	#	IFS Number of dispersed pixels	Stefan Martin
CI_SS_IFS_bandpass	27	%	IFS instantaneous bandpass	Stuart Shaklan
CI_SS_bandpass1_wave	493	nm	Central wavelength bandpass (SS imaging)	Stuart Shaklan
CI_SS_bandpass1_width	27	%	Bandwidth bandpass	Stuart Shaklan
CI_SS_bandpass1_wave_min	425	nm	minimum wavelength in bandpass	Stuart Shaklan
CI_SS_bandpass1_wave_max	560	nm	maximum wavelength in bandpass	Stuart Shaklan
CI_SS_bandpass1_wave_range	425-560	nm	wavelength range in bandpass	Stuart Shaklan
CI_SS_bandpass2_wave	694	nm	Central wavelength bandpass (SS imaging/IFS)	Stefan Martin
CI_SS_bandpass2_width	27	%	Bandwidth bandpass	Stefan Martin
CI_SS_bandpass2_wave_min	600	nm	minimum wavelength in bandpass	Stefan Martin
CI_SS_bandpass2_wave_max	787	nm	maximum wavelength in bandpass	Stefan Martin
CI_SS_bandpass2_wave_range	600-787	nm	wavelength range in bandpass	Stefan Martin
CI_SS_bandpass3_wave	853	nm	Central wavelength bandpass (SS imaging/IFS)	Stefan Martin
CI_SS_bandpass3_width	27	%	Bandwidth bandpass	Stefan Martin
CI_SS_bandpass3_wave_min	736	nm	minimum wavelength in bandpass	Stefan Martin
CI_SS_bandpass3_wave_max	970	nm	maximum wavelength in bandpass	Stefan Martin
CI_SS_bandpass3_wave_range	736-970	nm	wavelength range in bandpass	Stefan Martin
CI_SS_IFS_wave1	694	nm	IFS central wavelength	Stuart Shaklan
CI_SS_IFS_min1	600	nm	IFS minimum wavelength	Stuart Shaklan
CI_SS_IFS_max1	787	nm	IFS maximum wavelength	Stuart Shaklan
CI_SS_IFS_wave2	853	nm	IFS central wavelength	Stuart Shaklan
CI_SS_IFS_min2	736	nm	IFS minimum wavelength	Stuart Shaklan
CI_SS_IFS_max2	970	nm	IFS maximum wavelength	Stuart Shaklan

CGI Starshade Ready Delta Summary (as of 9/2016)

- **Hardware delta:**
  - Filters (3X LOWFS, 3X color filters)
  - Shutter (blocking light from starshade thruster plume during science mode)
  - Possible additional mechanisms, and modifications to detector electronics
- **Algorithms, functions and software delta:**
  - CGI imager: Starshade beacon laser guiding/sensing (with target star) function
  - LOWFS camera: Starshade beacon laser pointing sensing and control function (90% duty cycle)
  - LOWFS camera: Starshade off band light for shear sensing (10% duty cycle)
  - Starshade con-ops
- **GSE delta:**
  - Starshade simulator GSE
- **Schedule delta:**
  - Schedule delta to CGI delivery to Payload:
    - Starshade ready modes testing during CGI I&T (prior to delivery to Payload), TBD weeks
    - If CGI imaging camera, and/or LOWFS camera are on CGI critical path, then additional schedule delta during sensors development
  - Schedule delta to Payload/Observatory I&T:
    - TBD days to Payload/Observatory I&T for starshade ready modes testing
- **Science delta:**
  - TBD science delta. First-cut science delta from SITs

Summary and Next Steps

Summary:

- **Team is making excellent progress on technology maturation**

Next Steps:

- **Initial cost delta: 10/17/2016**
- **Release starshade mode parameters by end of 10/2016**
- **First meeting/report to HQ: ~12/1/2016**
- **SRR/MDR: 6/1/2017**

Jet Propulsion Laboratory
California Institute of Technology

jpl.nasa.gov