14670 - Exploring a highly perturbed debris disk associated with an exiled exoplanet

Cycle: 24, Proposal Category: GO

(Availability Mode: SUPPORTED)

INVESTIGATORS

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VISITS

Visit	*Targets used in Visit*	*Configurations used in Visit*	*Orbits Used*	*Last Orbit Planner Run*	*OP Current with Visit?*
01	(1) HD-106906	STIS/CCD	1	07-Sep-2016 18:01:17.0	yes
02	(2) HR-4570	STIS/CCD	1	07-Sep-2016 18:01:19.0	yes
03	(1) HD-106906	STIS/CCD	1	07-Sep-2016 18:01:20.0	yes

Visit	*Targets used in Visit*	*Configurations used in Visit*	*Orbits Used*	*Last Orbit Planner Run*	*OP Current with Visit?*
04	(1) HD-106906	STIS/CCD	1	07-Sep-2016 18:01:21.0	yes

4 Total Orbits Used

ABSTRACT

We have resolved the debris disk surrounding the 13 Myr-old, F5V star HD 106906 using the Gemini Planet Imager (GPI) and archival coronagraphic data from the ACS/HRC. The GPI H-band images reveal a nearly edge-on torus of dust-scattered light with an evacuated region ~50 AU in radius and a roughly symmetric morphology to ~100 AU (limited by the field of view). The optical ACS/HRC data show a highly asymmetric disk structure from ~250 AU radius (the inner working angle of the data), to ~500 AU radius (a sensitivity limited value). HD 106906 also has an 11 Jupiter mass companion at 650 AU projected separation, and we find that it is misaligned with the debris disk by 21 degrees. The planet may have been dynamically ejected from the system, perturbing the debris disk. We explored the possibility that it has circumplanetary material, finding tentative evidence that HST's optical PSF is extended for HD 106906b compared to 11 other reference stars in the field. However, the HST data are limited such that we cannot confirm the extended PSF structure, and we have no information about the debris disk in the 100-250 AU region where it transitions from a symmetric to an asymmetric morphology, possibly revealing the planet's periastron distance. Here we propose timely STIS coronagraphic observations designed to critically test our finding of extended PSF structure for the exoplanet, and to image the disk structure between 100 and 250 AU radius. These data will have a significant, multi-disciplinary scientific impact on understanding the dynamical co-evolution of planets and debris disks and the nature of circumplanetary material.

OBSERVING DESCRIPTION

(1) To mitigate the effects of uncorrected geometric distortion, we aim to place HD 106906b in the central region of the STIS field. This is achieved by occulting the star at the WEDGEB1.8 position and using the specified ORIENTs.

(2) HD 106906 is a bright star (mv = 7.8 mag) and its PSF halo interferes with the detection of its debris disk as well as the planet located at 7.1" radius from the star. To achieve PSF subtraction we will image the science target at three roll angles (3 orbits) and image a PSF reference star (1 orbit). For the ACS/HRC data, the PSF reference star was HD 103746. This provided an excellent PSF subtraction as it is spectrally matched to HD 106906.

(3) The debris disk is vertically thick, particularly on the east side. The PSF reference star (HD 103746) will be used to achieve high fidelity PSF

subtraction to accurately map the vertical morphology of the disk.

(4) A key difference between the ACS/HRC PSF and STIS PSF is that the latter is not as well sampled (25 mas/pix vs. 51 mas/pix, respectively) and has diffraction spikes. By rolling the telescope to three different ORIENTs, the diffraction spikes and other effects of the instrumental diffraction and scattering pattern will rotate through the intrinsic astrophysical signal surrounding the planet. In the long exposure sequences we image at the WEDGEB1.8 position, and also at a POS-TARG X=-0.5" away from this position, thus achieving additional dithering for PSF analysis.

(5) To obtain a few images at a smaller inner angle, each orbit finishes with a sequence of shorter integrations at POS-TARG X=-17". Here the WEDGE B width is approximately 0.6".

(6) The best PSF subtractions occur when the PSF star is imaged in an adjacent orbit with the science target star. Therefore, in Visit 01 we specify a timing SEQUENCE of four orbits in the following order: science -> psf -> science -> science. Therefore orbit 2 which is the PSF reference star observation has orbits 1 and 3 adjacent to it. The SEQUENCE should have consecutive orbits and not be interrupted by other types of observations.

(7) The PSF reference star has a field star at PA = 184 degrees that would interfere with the observations of the science target. ORIENT constraints are specified for the PSF reference star to solve this problem. The program appears to be schedulable given all the orient and sequence constraints.

Visit

Proposal 14670, Visit 01, implementation Wed Sep 07 22:01:22 GMT 2016

Diagnostic Status: No Diagnostics

Scientific Instruments: STIS/CCD

Special Requirements: ORIENT 320.0D TO 320.1 D; SEQ 01,02,03,04 WITHIN 4 Orbits

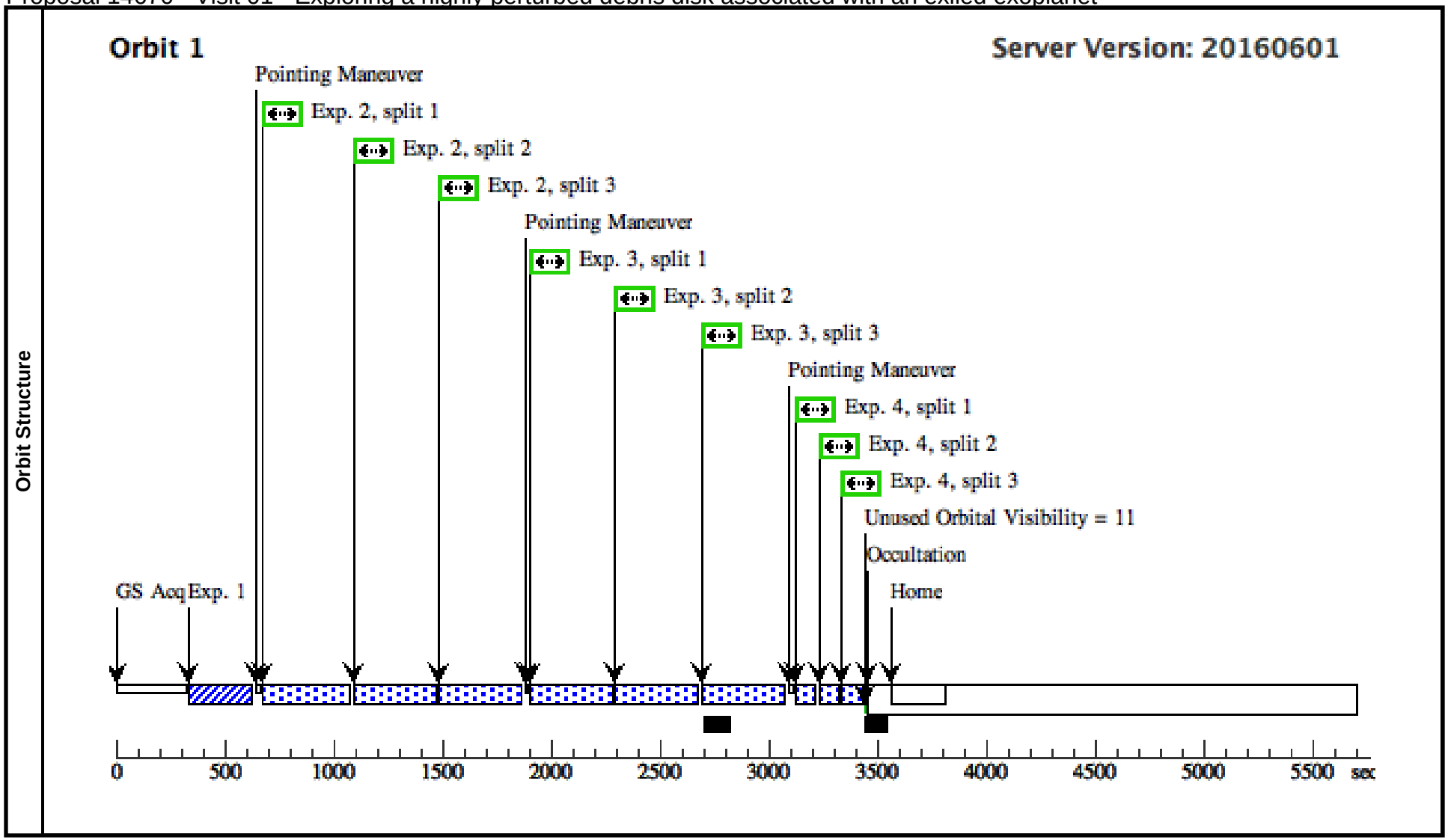
Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	HD-106906	RA: 12 17 53.1923 (184.4716346d) Dec: -55 58 31.89 (-55.97553d) Equinox: J2000	Proper Motion RA: -38.79 mas/yr Proper Motion Dec: -12.21 mas/yr Parallax: 0.01086" Epoch of Position: 2000	V=7.81	Reference Frame: ICRS

Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.This object was generated by the targetselector and retrieved from the SIMBAD database. Extended=NO

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1		(1) HD-106906	STIS/CCD, ACQ, F25ND3	MIRROR				1.0 Secs (1 Secs)	
								[==>]	***[1]***
2		(1) HD-106906	STIS/CCD, ACCUM, WEDGEB1.8	MIRROR	CR-SPLIT=3; GAIN=4			1050 Secs (1050 Secs)	
								[==>(Split 1)] *[==>(Split 2)]* *[==>(Split 3)]*	***[1]***
3	dither X=-0.5 arcsec	(1) HD-106906	STIS/CCD, ACCUM, WEDGEB1.8	MIRROR	CR-SPLIT=3; GAIN=4	POS TARG -0.5,0		1050 Secs (1050 Secs)	
								[==>(Split 1)] *[==>(Split 2)]* *[==>(Split 3)]*	***[1]***
4	PosTarg X=-17 arcsec on B Wedge	(1) HD-106906	STIS/CCD, ACCUM, WEDGEB1.8	MIRROR	CR-SPLIT=3; GAIN=4	POS TARG -17,0		180 Secs (180 Secs)	
								[==>(Split 1)] *[==>(Split 2)]* *[==>(Split 3)]*	***[1]***


Orbit 1
Server Version: 20160601
Orbit Structure
Pointing Maneuver
Exp. 2, split 1
Exp. 2, split 2
Exp. 2, split 3
Pointing Maneuver
Exp. 3, split 1
Exp. 3, split 2
Exp. 3, split 3
Pointing Maneuver
Exp. 4, split 1
Exp. 4, split 2
Exp. 4, split 3
Unused Orbital Visibility = 11
Occultation
GS Aeq
Exp. 1
Home
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
sec

Visit

Proposal 14670, PSF reference (02), implementation Wed Sep 07 22:01:22 GMT 2016

Diagnostic Status: No Diagnostics

Scientific Instruments: STIS/CCD

Special Requirements: ORIENT 270D TO 359.9 D; ORIENT 0D TO 180 D

Fixed Targets

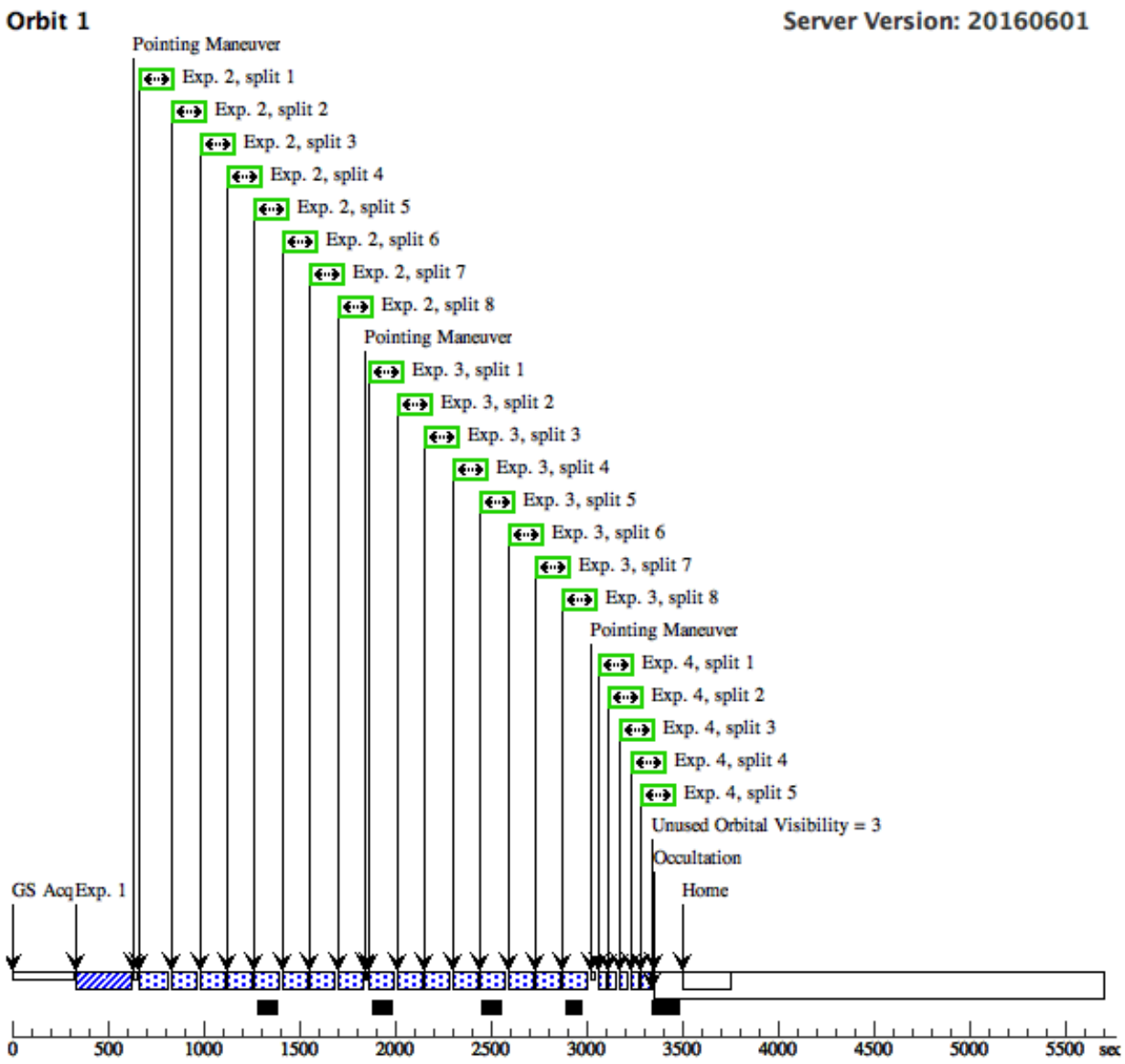
#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(2)	HR-4570	RA: 11 56 43.9152 (179.1829800d) Dec: -47 04 20.56 (-47.07238d) Equinox: J2000	Proper Motion RA: -126.93 mas/yr Proper Motion Dec: 23.99 mas/yr Parallax: 0.02062" Epoch of Position: 2000	V=6.267	Reference Frame: ICRS

Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.
Extended=NO

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1		(2) HR-4570	STIS/CCD, ACQ, F25ND3	MIRROR				0.2 Secs (0.2 Secs)	
								[==>]	***[1]***
2		(2) HR-4570	STIS/CCD, ACCUM, WEDGEB1.8	MIRROR	CR-SPLIT=8; GAIN=4			800 Secs (800 Secs)	
								[==>(Split 1)] *[==>(Split 2)]* *[==>(Split 3)]* *[==>(Split 4)]* *[==>(Split 5)]* *[==>(Split 6)]* *[==>(Split 7)]* *[==>(Split 8)]*	***[1]***
3	dither X=-0.5	(2) HR-4570	STIS/CCD, ACCUM, WEDGEB1.8	MIRROR	CR-SPLIT=8; GAIN=4	POS TARG -0.5,0.0		800 Secs (800 Secs)	
								[==>(Split 1)] *[==>(Split 2)]* *[==>(Split 3)]* *[==>(Split 4)]* *[==>(Split 5)]* *[==>(Split 6)]* *[==>(Split 7)]* *[==>(Split 8)]*	***[1]***
4	PosTarg X=-17 arcsec on B Wedge	(2) HR-4570	STIS/CCD, ACCUM, WEDGEB1.8	MIRROR	CR-SPLIT=5; GAIN=4	POS TARG -17,0		60 Secs (60 Secs)	
								[==>(Split 1)] *[==>(Split 2)]* *[==>(Split 3)]* *[==>(Split 4)]* *[==>(Split 5)]*	***[1]***

Orbit Structure



Visit

Proposal 14670, Visit 03, implementation Wed Sep 07 22:01:22 GMT 2016

Diagnostic Status: No Diagnostics

Scientific Instruments: STIS/CCD

Special Requirements: ORIENT 335.0D TO 335.1 D

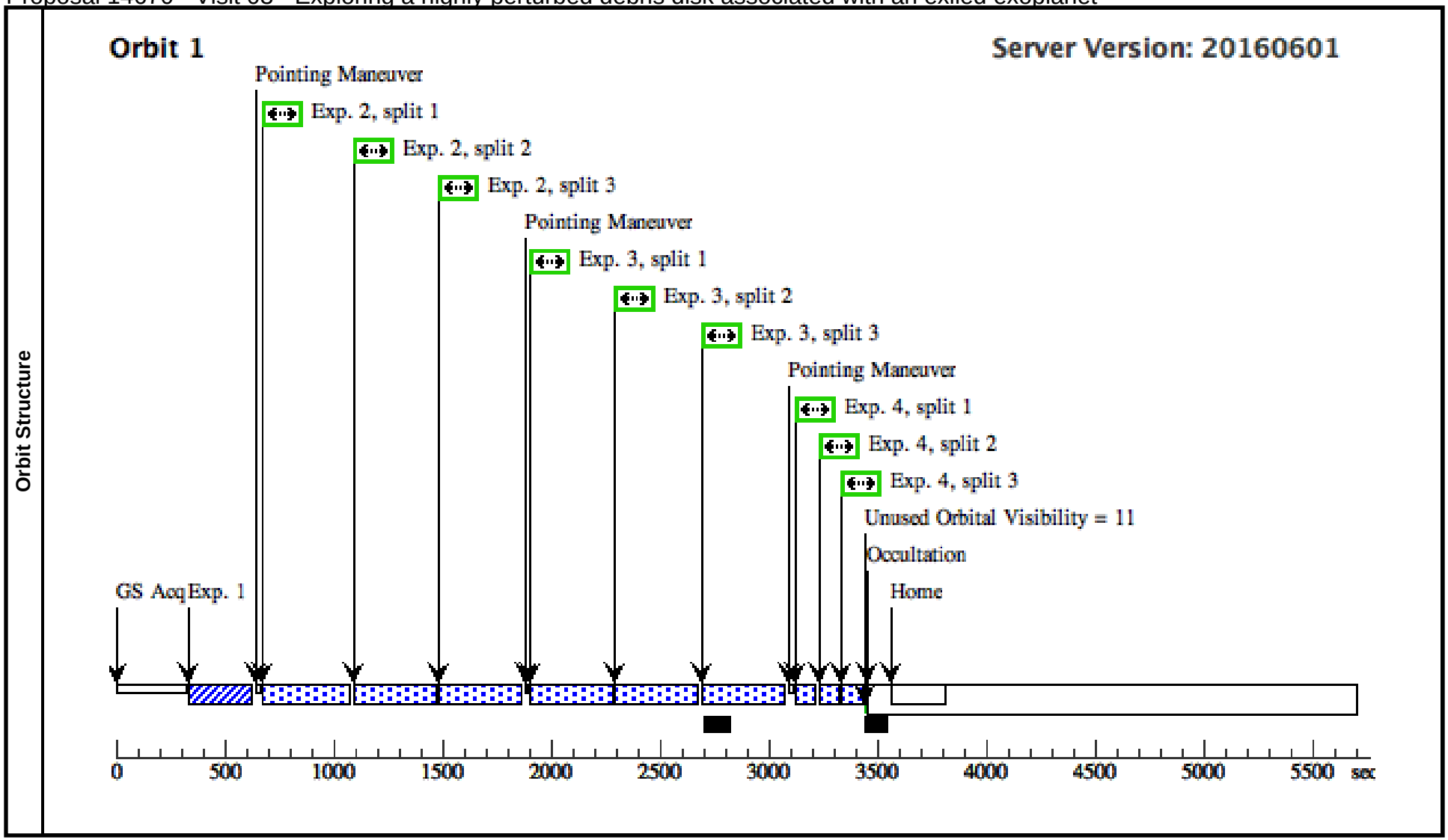
Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	HD-106906	RA: 12 17 53.1923 (184.4716346d) Dec: -55 58 31.89 (-55.97553d) Equinox: J2000	Proper Motion RA: -38.79 mas/yr Proper Motion Dec: -12.21 mas/yr Parallax: 0.01086" Epoch of Position: 2000	V=7.81	Reference Frame: ICRS

Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.This object was generated by the targetselector and retrieved from the SIMBAD database. Extended=NO

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1		(1) HD-106906	STIS/CCD, ACQ, F25ND3	MIRROR				1.0 Secs (1 Secs)	
								[==>]	***[1]***
2		(1) HD-106906	STIS/CCD, ACCUM, WEDGEB1.8	MIRROR	CR-SPLIT=3; GAIN=4			1050 Secs (1050 Secs)	
								[==>(Split 1)] *[==>(Split 2)]* *[==>(Split 3)]*	***[1]***
3	dither X=-0.5 arcsec	(1) HD-106906	STIS/CCD, ACCUM, WEDGEB1.8	MIRROR	CR-SPLIT=3; GAIN=4	POS TARG -0.5,0		1050 Secs (1050 Secs)	
								[==>(Split 1)] *[==>(Split 2)]* *[==>(Split 3)]*	***[1]***
4	PosTarg X=-17 arcsec on B Wedge	(1) HD-106906	STIS/CCD, ACCUM, WEDGEB1.8	MIRROR	CR-SPLIT=3; GAIN=4	POS TARG -17,0		180 Secs (180 Secs)	
								[==>(Split 1)] *[==>(Split 2)]* *[==>(Split 3)]*	***[1]***


Orbit 1
Server Version: 20160601
Orbit Structure
Pointing Maneuver
Exp. 2, split 1
Exp. 2, split 2
Exp. 2, split 3
Pointing Maneuver
Exp. 3, split 1
Exp. 3, split 2
Exp. 3, split 3
Pointing Maneuver
Exp. 4, split 1
Exp. 4, split 2
Exp. 4, split 3
Unused Orbital Visibility = 11
Occultation
Home
GS Aeq
Exp. 1
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
sec

Visit

Proposal 14670, Visit 04, implementation Wed Sep 07 22:01:22 GMT 2016

Diagnostic Status: No Diagnostics

Scientific Instruments: STIS/CCD

Special Requirements: ORIENT 350.0D TO 350.1 D

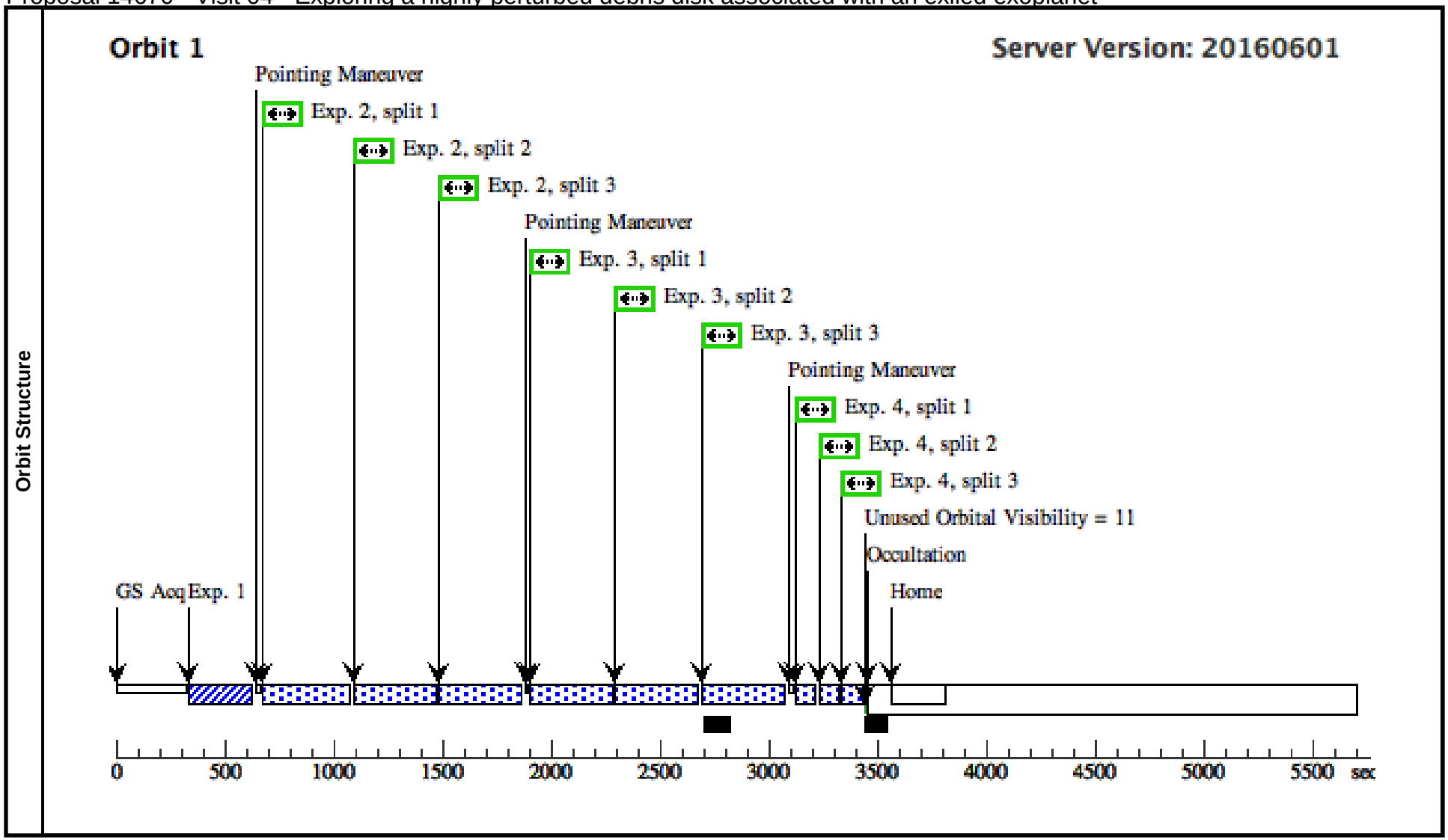
Fixed Targets

#	Name	Target Coordinates	Targ. Coord. Corrections	Fluxes	Miscellaneous
(1)	HD-106906	RA: 12 17 53.1923 (184.4716346d) Dec: -55 58 31.89 (-55.97553d) Equinox: J2000	Proper Motion RA: -38.79 mas/yr Proper Motion Dec: -12.21 mas/yr Parallax: 0.01086" Epoch of Position: 2000	V=7.81	Reference Frame: ICRS

Comments: This object was generated by the targetselector and retrieved from the SIMBAD database.This object was generated by the targetselector and retrieved from the SIMBAD database. Extended=NO

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1		(1) HD-106906	STIS/CCD, ACQ, F25ND3	MIRROR				1.0 Secs (1 Secs)	
								[==>]	***[1]***
2		(1) HD-106906	STIS/CCD, ACCUM, WEDGEB1.8	MIRROR	CR-SPLIT=3; GAIN=4			1050 Secs (1050 Secs)	
								[==>(Split 1)] *[==>(Split 2)]* *[==>(Split 3)]*	***[1]***
3	dither X=-0.5 arcsec	(1) HD-106906	STIS/CCD, ACCUM, WEDGEB1.8	MIRROR	CR-SPLIT=3; GAIN=4	POS TARG -0.5,0		1050 Secs (1050 Secs)	
								[==>(Split 1)] *[==>(Split 2)]* *[==>(Split 3)]*	***[1]***
4	PosTarg X=-17 arcsec on B Wedge	(1) HD-106906	STIS/CCD, ACCUM, WEDGEB1.8	MIRROR	CR-SPLIT=3; GAIN=4	POS TARG -17,0		180 Secs (180 Secs)	
								[==>(Split 1)] *[==>(Split 2)]* *[==>(Split 3)]*	***[1]***


Orbit 1
Server Version: 20160601
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Exp. 2, split 1
Exp. 2, split 2
Exp. 2, split 3
Pointing Maneuver
Exp. 3, split 1
Exp. 3, split 2
Exp. 3, split 3
Pointing Maneuver
Exp. 4, split 1
Exp. 4, split 2
Exp. 4, split 3
Unused Orbital Visibility = 11
Occultation
Home
GS Aeq
Exp. 1
0
500
1000
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4000
4500
5000
5500
sec