15167 - Unmasking the Dark Side of Iapetus

Cycle: 25, Proposal Category: GO

(UV Initiative)

(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) IAPETUS-LEADING CCDFLAT	STIS/CCD STIS/NUV-MAMA	2	28-Jun-2018 18:00:35.0	yes
04	(1) IAPETUS-LEADING	STIS/CCD STIS/NUV-MAMA	2	28-Jun-2018 18:00:37.0	yes
03	(2) IAPETUS-TRAILING CCDFLAT	STIS/CCD STIS/NUV-MAMA	2	28-Jun-2018 18:00:38.0	yes

6 Total Orbits Used

ABSTRACT

We propose to take advantage of the unique capabilities of STIS in a UV-intensive series of observations to obtain high-SNR spectra of the bright and dark hemispheres of Iapetus over a critical near-UV range where Cassini instruments lack coverage (190-350 nm). The leading face of Iapetus acts a sort of canvas, painted with material from Saturn's captured moon Phoebe, itself an interloper from the Kuiper Belt, that may provide important

clues to the composition and processing history of primordial material from the early stages of planet formation. This underscores the long-recognized importance of identifying the composition of the dark material on Iapetus and placing it in the context of other primitive Solar System objects. In spite of extensive Cassini observations, this has proven to be an elusive goal because of the lack of unique spectral signatures of possible dark materials in the wavelengths observed by Cassini. Each proposed darkening agent (nanoiron/hematite, aromatic and aliphatic tholins, NH3) has a distinctive signature within this previously unobserved spectral window. STIS observations will provide a critical test of proposed compositions for the dark material and its origin. We will draw on our team's extensive experience with STIS observations, Cassini UVIS and VIMS spectra, Earth-based near-IR spectroscopy, and radiative transfer scattering models to compare the observed spectra with predictions for a variety of candidate materials. The Iapetus results will complement recent STIS observations of other icy Saturn satellites (Program 13694 Hendrix) and the STIS-based investigation of the mysterious redness of Saturn's rings (Program 12478 Cuzzi).

OBSERVING DESCRIPTION

Our scientific goal is to observe the near-UV to visible spectrum of the dark (leading) and bright (trailing) hemispheres of Iapetus, unique among Saturn's moons in having such a strong global asymmetry in reflectivity. The dark (leading) hemisphere may be sweeping up dust from outer regions of the Saturn system, such as particles from the Phoebe ring, but the composition of the dark material has not yet been securely established. Using STIS near-UV and visible measurements, we will obtain high-SNR spectra that include a particularly diagnostic wavelength range between 200-350 nm that is not accessible to Cassini instruments. The two leading proposed contaminants of the dark side -- iron nanoparticles and tholins -- have distinctly different spectra in this range. Based on previous STIS results for the spectra of Saturn's rings, we expect to be able to discriminate between these two possibilities, which would have important implications for the cosmogony of the Saturn satellite system.

Our observing strategy is to maximize the SNR of the low-albedo dark hemisphere by allocating 4 of our 6 orbits to the dark side. To minimize time spent on guide star and target acquisition, we will make use of contiguous orbits for each of two visits. For each visit, the first orbit will begin with a G750L STIS/CCD spectrum (and the necessary flat field images to enable correction for fringing), followed by a G430L STIS/CCD spectrum; the remainder of the first orbit will be devoted to a long STIS/MAMSA G230L exposure. The remainging three orbits of the IAPETUS_LEADING (dark hemisphere) visit will be exclusively devoted to long G230L exposures to enhance the total SNR of the UV-starved low albedo spectrum of the dark side of Iapetus. For the bright hemisphere visit, the second orbit will be devoted to a single long G230L exposure. We use a slit of 52x0.5 (as was used for Rhea in PID 13694; comparable in diameter to Iapetus) because the angular diameter of Iapetus from Earth for this observing window is 0.19 - 0.21 arcsec, uncomfortably large for the 52x0.2 slit; this obviates the need for ACQ/PEAK exposures.

In short, we will observe using all spectral elements (G750L, G430L, and G230L) for full wavelength coverage on the first orbit of each visit, then a G230L exposure for remaining orbit(s) for each visit. We request four continguous orbits for IAPETUS-LEADING (the dark hemisphere) in order to maximize the exposure time of the G230L element on this low-albedo side of Iapetus by minimizing the overhead in guide star acquisition and ACQ. We have restricted the observing geometry to be within +/- 5 degrees of the central meridian centered on the bright and dark hemispheres. (WFPC2 observations of Saturn's rings show a variation in the magnitude and width of the opposition surge, and similar results have been found for Saturn satellites).

Because of the long orbital period of Iapetus (79 days), there are relatively few windows of opportunity for this restricted geometry. We have removed the restriction from previous Phase II submissions on the minimum phase angle at the time of observation, to ease schedulability, as recommended by Crystal Manfolk. If the requested observing windows cannot be scheduled within the Cycle 25 observation period, we understand that the next provisional window for the leading hemisphere observations would be in October 2018. This would be ideal from our point of view, since it could preserve the strict requirement that the CML be within 5 degrees of 90 for the dark leading hemisphere, which would ensure the least possible contamination of the dark hemisphere spectrum by encroaching bright material visible from a small crescent of the bright hemisphere. Expanding the range of allowed CML to +/- 20 degrees of 90 degrees would result in about 20% contamination of the spectrum by the bright material, significantly complicating our analysis.

*** Warnings about long G230L exposures are benign because there will be no saturation even for the longest possible exposure within a single orbit. ***

Visit

Proposal 15167, Iapetus-Leading - two orbits (01), implementation Thu Jun 28 22:00:40 GMT 2018

Diagnostic Status: Warning

Scientific Instruments: STIS/NUV-MAMA, STIS/CCD

Special Requirements: (none)

Comments: Use all spectral elements for full wavelength coverage on first orbit, then G230L exposure for the second orbit of this visit. The second visit of two orbits for Iapetus-Leading follows this visit by one to two orbits because of restrictions on the number of successive moving target orbits for a single visit.
**** Warnings about long G230L exposures are benign because there will be no saturation even for the longest possible exposure within a single orbit. ****

Diagnostics

(G230L on Iapetus-Leading (01.005)) Warning (Form): Sensitive exposures should have an ETC run number provided.

(orbit 2 of visit 1 - long G230L exposure of Iapetus-leading (01.006)) Warning (Form): Sensitive exposures should have an ETC run number provided.

Solar System Targets

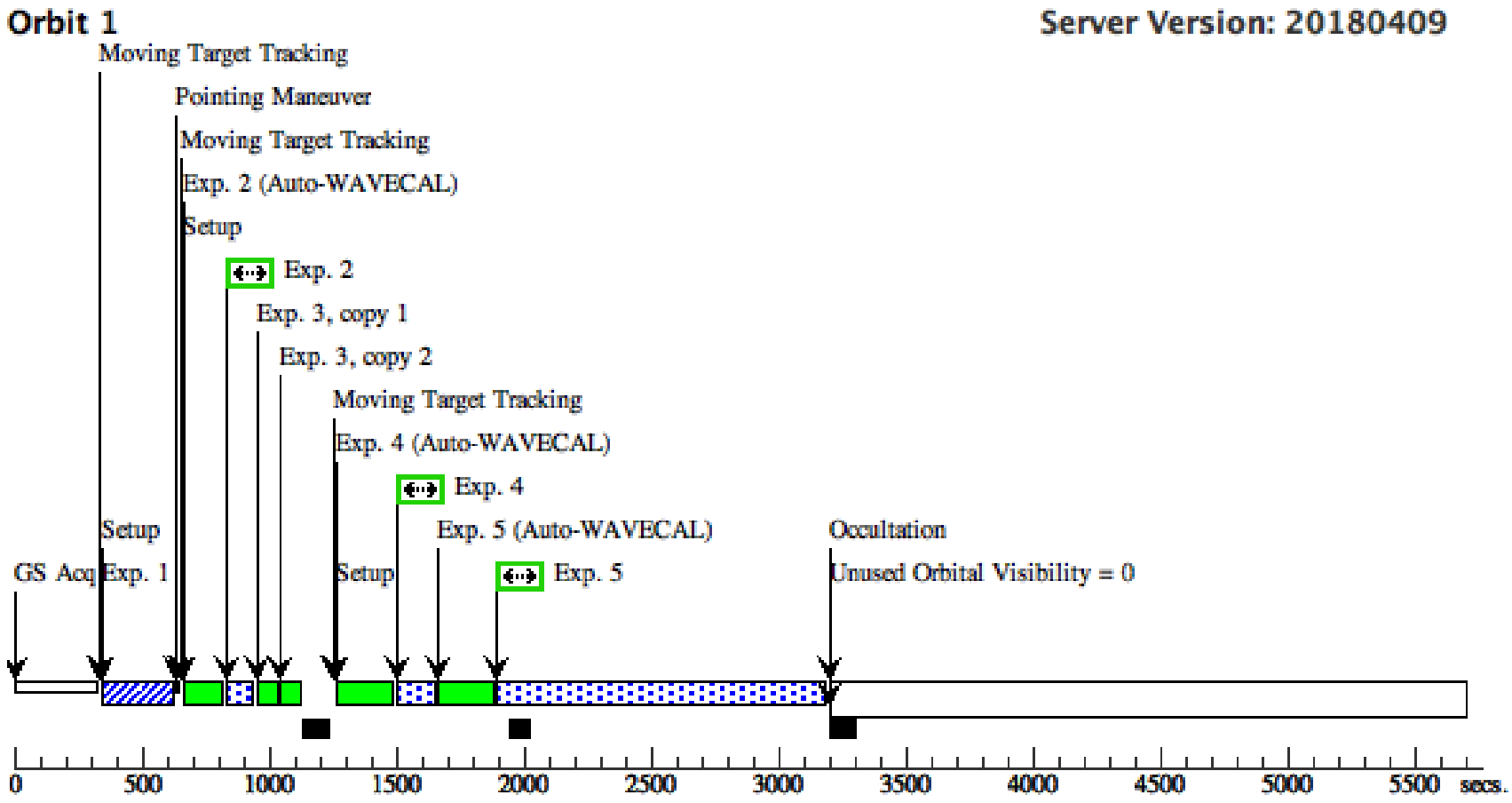
#	Name	Level 1	Level 2	Level 3	Window	Ephem Center
(1)	IAPETUS-LEADING	STD=SATURN	STD=IAPETUS		SEP OF IAPETUS-LEADING SATURN FROM EARTH GT 45", SEP OF IAPETUS-LEADING RHEA FROM EARTH GT 10", SEP OF IAPETUS-LEADING TITAN FROM EARTH GT 10", CML OF IAPETUS-LEADING FROM EARTH BETWEEN 85 95	EARTH

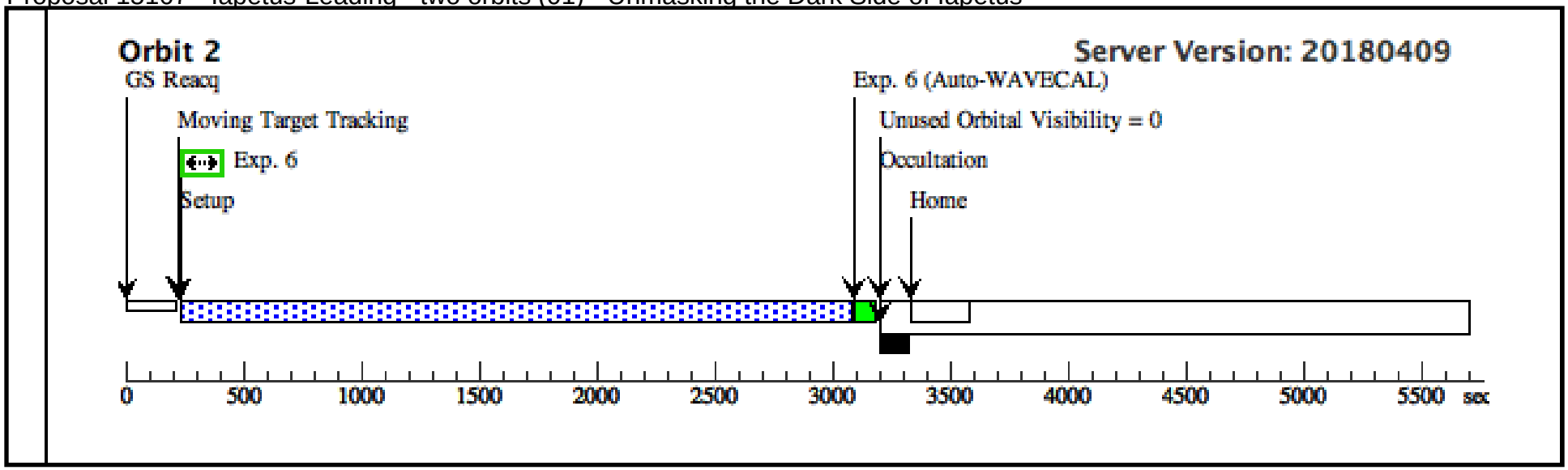
Comments: Description=Leading (Dark) hemisphere of Iapetus - near eastern elongation

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	ACQ	(1) IAPETUS-LEADING	STIS/CCD, ACQ, F28X50LP	MIRROR	ACQTYPE=DIFFUSE; CHECKBOX=5.0; DIFFUSE-CENTER=GEOMETRIC-CENTER			0.5 Secs (0.5 Secs) *[==>]*	***[1]***
2	G750L on Iapetus-Leading	(1) IAPETUS-LEADING	STIS/CCD, ACCUM, 52X0.5	G750L 7751 A	CR-SPLIT=NO			20 Secs (20 Secs) *[==>]*	***[1]***
3	G750L flat	CCDFLAT	STIS/CCD, ACCUM, 52X0.5	G750L 7751 A				5 Secs X 2 (10 Secs) *[==>(Copy 1)]* *[==>(Copy 2)]*	***[1]***
Comments: Flatfield necessary to remove fringing of G750L									
4	G430L on Iapetus-Leading	(1) IAPETUS-LEADING	STIS/CCD, ACCUM, 52X0.5	G430L 4300 A	CR-SPLIT=NO			60 Secs (60 Secs) *[==>]*	***[1]***
5	G230L on Iapetus-Leading	(1) IAPETUS-LEADING	STIS/NUV-MAMA, ACCUM, 52X0.5	G230L 2376 A				1253 Secs (1253 Secs) *[==>]*	***[1]***
6	orbit 2 of visit 1 - long G230L exposure of Iapetus-leading	(1) IAPETUS-LEADING	STIS/NUV-MAMA, ACCUM, 52X0.5	G230L 2376 A				2839 Secs (2839 Secs) *[==>]*	***[2]***

Orbit Structure

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Setup
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Home
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
sec

Visit

Proposal 15167, Iapetus-Leading2 - two orbits (04), implementation Thu Jun 28 22:00:40 GMT 2018

Diagnostic Status: Warning

Scientific Instruments: STIS/NUV-MAMA, STIS/CCD

Special Requirements: AFTER 01 BY 3 Orbits TO 4 Orbits

Comments: This is the second visit of two orbits for Iapetus leading. It should follow the first visit of two orbits for the same target after 1 to two orbits.
**** Warnings about long G230L exposures are benign because there will be no saturation even for the longest possible exposure within a single orbit. ****

Diagnostics

(G230L on Iapetus-Leading (04.002)) Warning (Form): Sensitive exposures should have an ETC run number provided.

(orbit 2 of visit 1 - long G230L exposure of Iapetus-leading (04.003)) Warning (Form): Sensitive exposures should have an ETC run number provided.

Solar System Targets

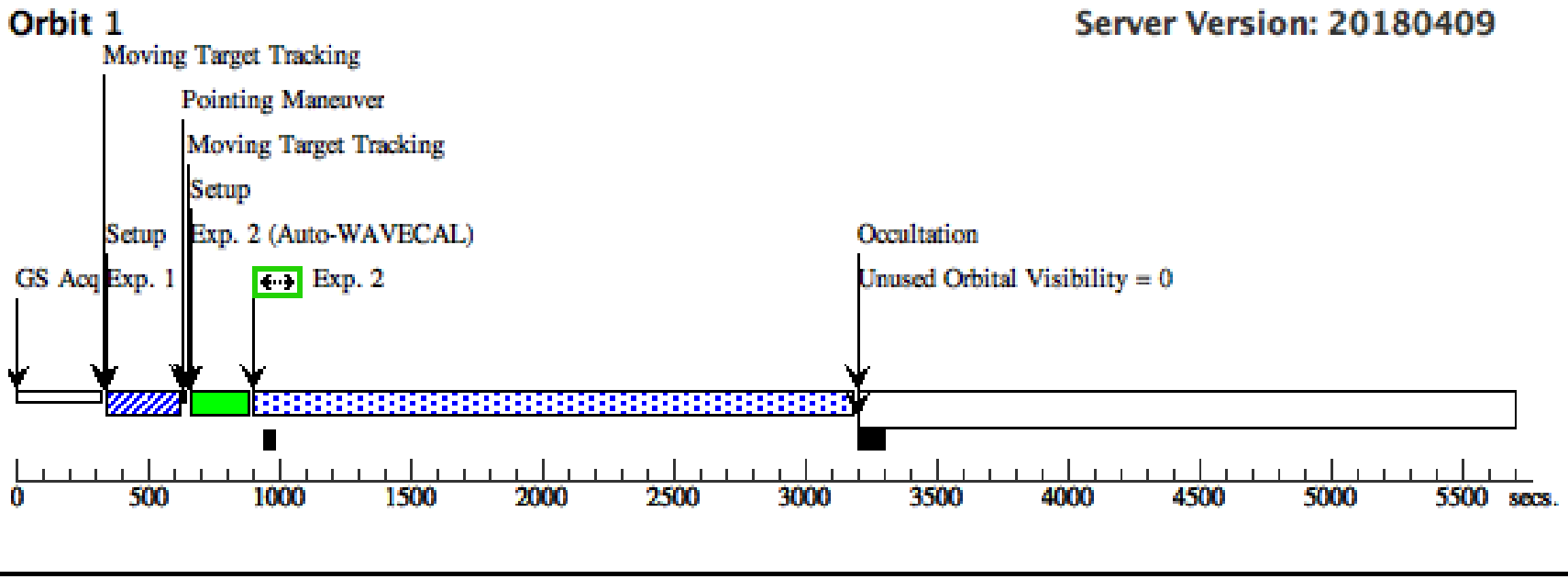
#	Name	Level 1	Level 2	Level 3	Window	Ephem Center
(1)	IAPETUS-LEADING	STD=SATURN	STD=IAPETUS		SEP OF IAPETUS-LEADING SATURN FROM EARTH GT 45", SEP OF IAPETUS-LEADING RHEA FROM EARTH GT 10", SEP OF IAPETUS-LEADING TITAN FROM EARTH GT 10", CML OF IAPETUS-LEADING FROM EARTH BETWEEN 85 95	EARTH

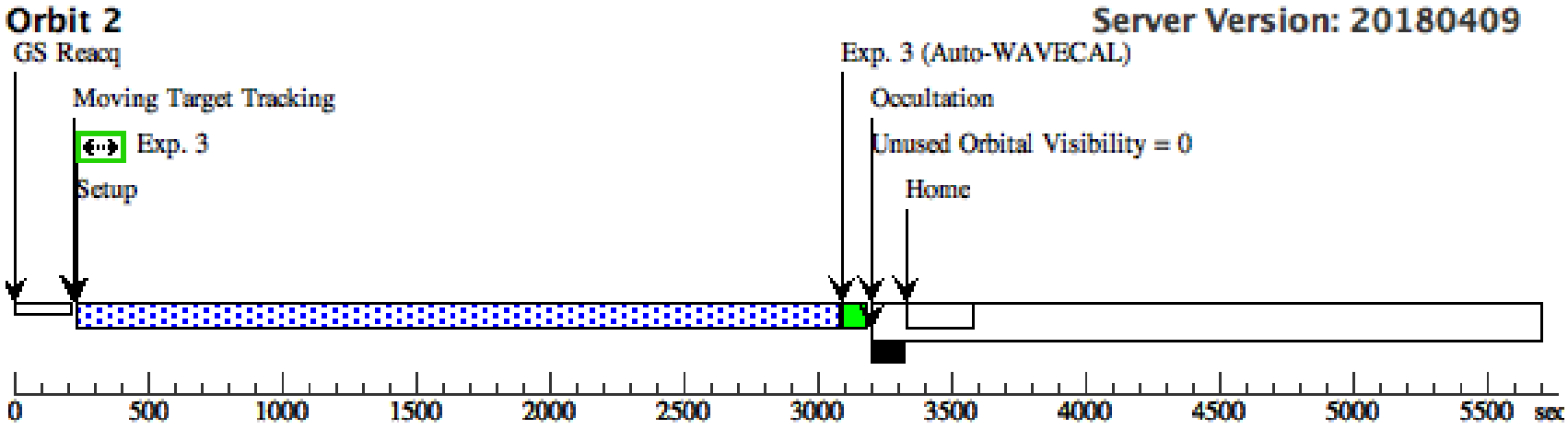
Comments: Description=Leading (Dark) hemisphere of Iapetus - near eastern elongation

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	ACQ	(1) IAPETUS-LEADING	STIS/CCD, ACQ, F28X50LP	MIRROR	ACQTYPE=DIFFUSE; CHECKBOX=5.0; DIFFUSE-CENTER=GEOMETRIC-CENTER			0.5 Secs (0.5 Secs) *[==>]*	***[1]***
2	G230L on Iapetus-Leading	(1) IAPETUS-LEADING	STIS/NUV-MAMA, ACCUM, 52X0.5	G230L 2376 A				1253 Secs (2248 Secs) *[==>2248.0 Secs]*	***[1]***
3	orbit 2 of visit 1 - long G230L exposure of Iapetus-leading	(1) IAPETUS-LEADING	STIS/NUV-MAMA, ACCUM, 52X0.5	G230L 2376 A				2839 Secs (2839 Secs) *[==>]*	***[2]***

Orbit Structure





Visit

Proposal 15167, Iapetus-Trailing- two orbits (03), completed Thu Jun 28 22:00:40 GMT 2018

Diagnostic Status: Warning

Scientific Instruments: STIS/NUV-MAMA, STIS/CCD

Special Requirements: (none)

Comments: Use all spectral elements for full wavelength coverage on first orbit, then G230L exposure for remaining orbit of this visit

Diagnostics

(G230L on Iapetus-Trailing (03.005)) Warning (Form): Sensitive exposures should have an ETC run number provided.

(orbit 2 of visit 1 - long G230L exposure of Iapetus-trailing (03.006)) Warning (Form): Sensitive exposures should have an ETC run number provided.

Solar System Targets

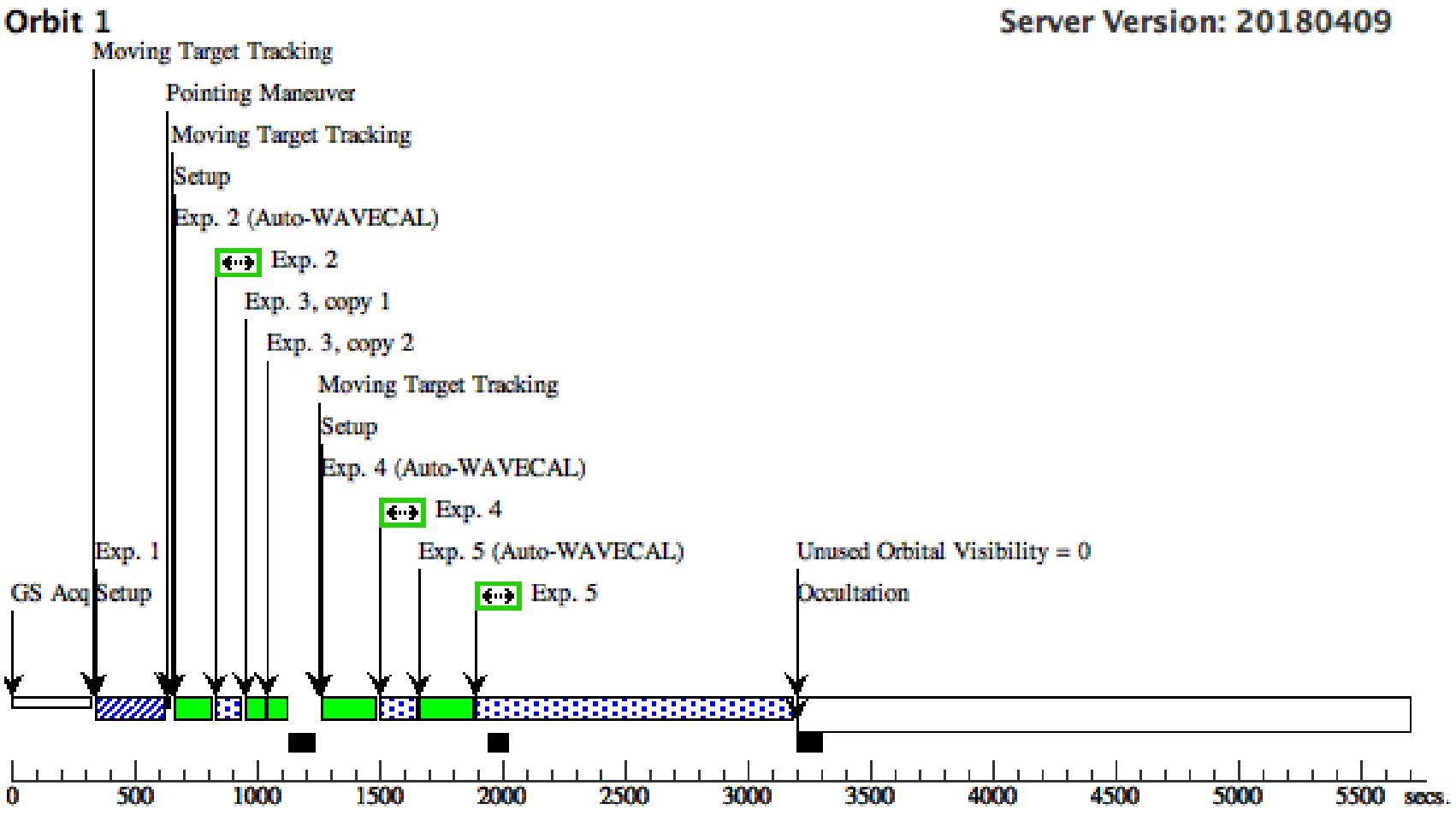
#	Name	Level 1	Level 2	Level 3	Window	Ephem Center
(2)	IAPETUS-TRAILING	STD=SATURN	STD=IAPETUS		SEP OF IAPETUS-TRAILING SATURN FROM EARTH GT 45", SEP OF IAPETUS-TRAILING RHEA FROM EARTH GT 10", SEP OF IAPETUS-TRAILING TITAN FROM EARTH GT 10", CML OF IAPETUS-TRAILING FROM EARTH BETWEEN 265 275	EARTH

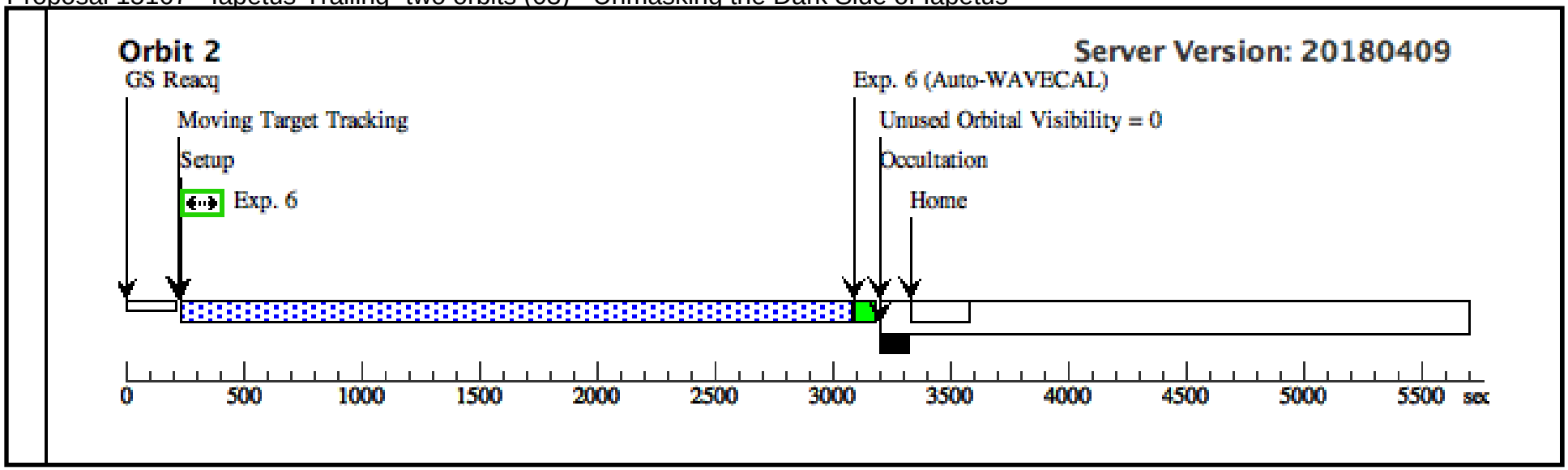
Comments: Description=Trailing (bright) hemisphere of Iapetus near western elongation

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	ACQ	(2) IAPETUS-TRAILING	STIS/CCD, ACQ, F28X50LP	MIRROR	ACQTYPE=DIFFUSE; CHECKBOX=5; DIFFUSE-CENTER=GEOMETRIC-CENTER			0.5 Secs (0.5 Secs) *[==>]*	 ***[1]***
2	G750L on Iapetus-Trailing	(2) IAPETUS-TRAILING	STIS/CCD, ACCUM, 52X0.5	G750L 7751 A	CR-SPLIT=NO			20 Secs (20 Secs) *[==>]*	 ***[1]***
3	G750L flat	CCDFLAT	STIS/CCD, ACCUM, 52X0.5	G750L 7751 A				5 Secs X 2 (10 Secs) *[==>(Copy 1)]* *[==>(Copy 2)]*	 ***[1]***
Comments: Flatfield necessary to remove fringing of G750L									
4	G430L on Iapetus-Trailing	(2) IAPETUS-TRAILING	STIS/CCD, ACCUM, 52X0.5	G430L 4300 A	CR-SPLIT=NO			60 Secs (60 Secs) *[==>]*	 ***[1]***
5	G230L on Iapetus-Trailing	(2) IAPETUS-TRAILING	STIS/NUV-MAMA, ACCUM, 52X0.5	G230L 2376 A				1253 Secs (1253 Secs) *[==>]*	 ***[1]***
6	orbit 2 of visit 1 - long G230L exposure of Iapetus-trailing	(2) IAPETUS-TRAILING	STIS/NUV-MAMA, ACCUM, 52X0.5	G230L 2376 A				2839 Secs (2839 Secs) *[==>]*	 ***[2]***

Orbit Structure

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GS Reacq
Moving Target Tracking
Setup
Exp. 6
Exp. 6 (Auto-WAVECAL)
Unused Orbital Visibility = 0
Occultation
Home
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
sec