



## 12478 - The Mysterious Redness of Saturn's Rings

Cycle: 19, Proposal Category: GO

(Availability Mode: SUPPORTED)

### INVESTIGATORS

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### VISITS

<i>Visit</i>	<i>Targets used in Visit</i>	<i>Configurations used in Visit</i>	<i>Orbits Used</i>	<i>Last Orbit Planner Run</i>	<i>OP Current with Visit?</i>
01	(1) SATURN-RINGS (3) RHEA-OFFSET	STIS/CCD STIS/NUV-MAMA	1	18-May-2012 21:09:50.0	yes
02	(2) DIONE-OFFSET (4) SATURN-RINGS-COPY	STIS/CCD STIS/NUV-MAMA	4	18-May-2012 21:10:08.0	yes

5 Total Orbits Used

### ABSTRACT

The origin of Saturn's rings remains unresolved. Are they primordial or recently formed? Did they originate from a Saturn system resident, or from some more distant heliocentric interloper? Understanding the composition of the rings may provide crucial clues to solving these puzzles. Saturn's rings are almost pure water ice, contaminated by unknown trace constituents that are strongly absorbing at UV wavelengths, making the rings slightly

red. The Cassini spacecraft has been in orbit at Saturn since 2004, and has made remarkable discoveries, yet the composition of the material which provides this UV absorption remains unknown. Several diverse candidates are under discussion, allowing very different formation scenarios for the origin of the rings. Using the unique capabilities of HST to explore a critical range of the UV spectrum inaccessible to Cassini instruments, we propose a series of STIS spectral observations to determine the nature of these trace absorbers. We will use primarily G230L, with a small fraction of time devoted to G430L to strengthen our identifications.

## **OBSERVING DESCRIPTION**

The proposed observations will obtain excellent quality STIS-UV reflectivities in the 150- 320nm spectral region, bridging an existing gap. There is simply no other way to study this critical spectral region, and whatever evidence we find for carbon-based material, NH<sub>3</sub>, ozone, or nanophase metal will be of unique importance in helping us understand the parentage of the rings. To untangle possibly blended spectral features (eg., ozone and graphite) or accurately characterize the shape of a smooth spectrum, we need to achieve SNR of at least 20 at 180-200nm. We will thus devote the bulk of our observing time to the G230L detector, which covers from below the 170nm water ice UV edge out to almost 320nm. The slit will be oriented such that it is aligned along one ansa of the rings, which will allow for maximum radial resolution, with one end of it covering part of the planet. We have verified with APT that the desired ORIENT range can be easily scheduled.

We have estimated SNRs at several wavelengths by assuming an extended source with a solar spectrum normalized to a 336nm intensity of 1012 ergs/cm<sup>2</sup>-s A-arcsec<sup>2</sup>, given by broadband filter and unsaturated G430L data from our prior HST programs and checked back to the solar flux, and scaled to other wavelengths by the known ring broadband spectrum (Cuzzi et al. 2002). For an exposure time of 2100 sec per orbit, we will achieve SNR of 10 at 180nm, increasing to 67 at 200nm. To do this we will use spectral averaging by roughly 16 bins, retaining spectral resolution of 2.5nm, adequate to well-resolve likely spectral structure. We will also bin by 50 spatial pixels, leaving us four radial resolution elements in the B ring. Thus after 5 orbits we achieve SNR 22 at 180nm. We have flexibility to bin by more or less, depending on the results. We will carefully inspect the data prior to averaging, to ensure that misalignment of solar spectral features with pipeline calibration spectra is not introducing noise. In addition, we will take a single 60 sec exposure on one or more orbits using G430L, giving us high SNR (80) at longer wavelengths. This will provide more leverage on the composition of the absorber (see figure 3), and a cross-calibration with Cassini-VIMS at visual wavelengths, with little observing time impact. For the G230L exposures we will use the 52x0.2 slit, and for the G430L exposures we will use the 52x0.5 slit; we have determined that these exposure times and slit widths accommodate the MAMA count rate restrictions for bright objects, and do not saturate the CCD at the longer wavelengths in the passband, where the rings are brighter. We have verified by APT tests that the total time can be broken into shorter exposures if needed, and acquisition and positioning can be incorporated.

Using this scenario for 5 orbits, we can identify or reject a 10% absorption feature at 200-220 nm, indicative of the presence of PAHs, if they are the

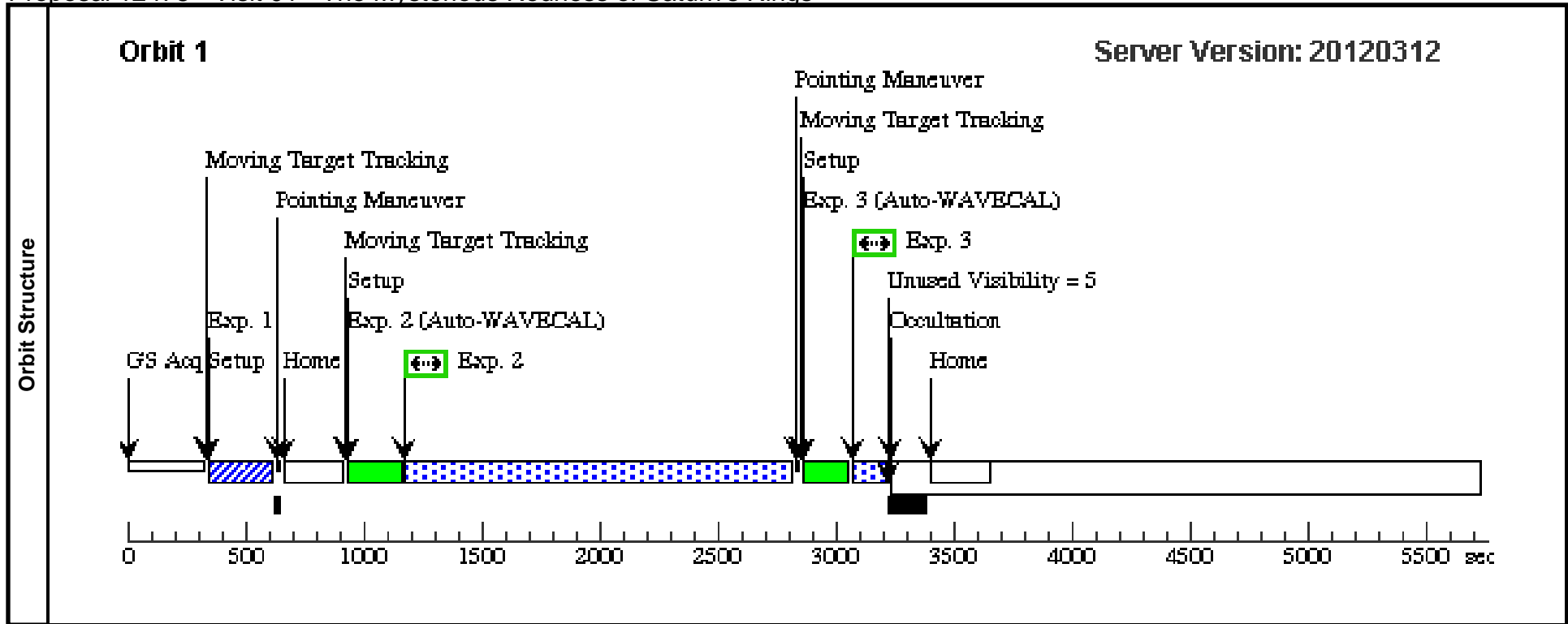
Proposal 12478 (STScI Edit Number: 8, Created: Friday, May 18, 2012 8:10:19 PM EST) - Overview

UV absorber. If a smooth and featureless spectrum is seen, we can conclude that nano-phase iron is the source of the UV absorption. Hematite has its own diagnostic spectral shape as well. Such high SNRs will also allow detection and mapping of the 260nm O<sub>3</sub> feature if present, as well as the NH<sub>3</sub> absorption edge near 200nm.

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Sat May 19 01:10:19 GMT 2012

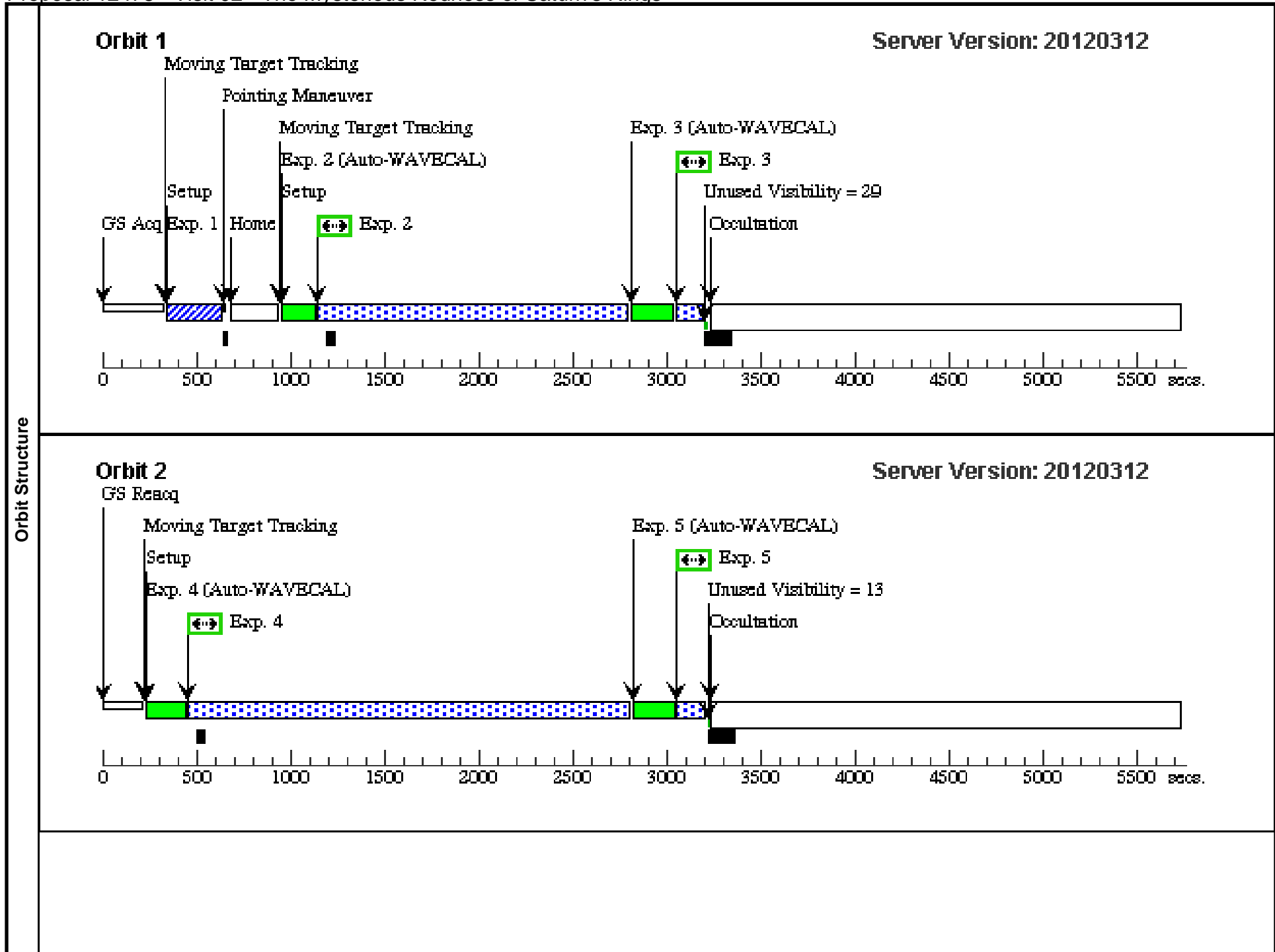
Visit	Proposal 12478, Visit 01, completed Diagnostic Status: No Diagnostics Scientific Instruments: STIS/CCD, STIS/NUV-MAMA Special Requirements: ORIENT 133D TO 135 D									
	Solar System Targets		#	Name	Level 1	Level 2	Level 3	Window	Ephem Center	
	(1)	SATURN-RINGS	STD=SATURN	TYPE=POS_ANGLE,RAD=2,ANG=8 8,REF=NORTH			SEP OF SATURN-RINGS RHEA FROM EARTH GT 10", SEP OF SATURN-RINGS TITAN FROM EARTH GT 10"	EARTH		
	(3)	RHEA-OFFSET	STD=SATURN	STD=RHEA			SEP OF RHEA-OFFSET SATURN FROM EARTH GT 20", SEP OF RHEA-OFFSET TITAN FROM EARTH GT 10"	EARTH		
Exposures	#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time/[Actual Dur.]	Orbit
	1	(1)	(3) RHEA-OFFSET	STIS/CCD, ACQ, F28X50LP	MIRROR	ACQTYPE=POINT	GS ACQ SCENARI O BASE1BN3		0.5 Secs [==>]	[1]
<i>Comments: Dione's angular diameter is ~0.14-0.18 arcsec. We could use a different satellite as a ACQ target if necessary.</i>										
	2	(STIS.sp.19 8608)	(1) SATURN-RING S	STIS/NUV-MAMA, ACCUM, 52X0.2	G230L 2376 A		GS ACQ SCENARI O BASE1BN3		2100 Secs [==>1630 Secs ]	[1]
	3	(STIS.sp.19 8622)	(1) SATURN-RING S	STIS/CCD, ACCUM, 52X0.5	G430L 4300 A	CR-SPLIT=NO			60 Secs [==>50 Secs ]	[1]



Proposal 12478 - Visit 02 - The Mysterious Redness of Saturn's Rings

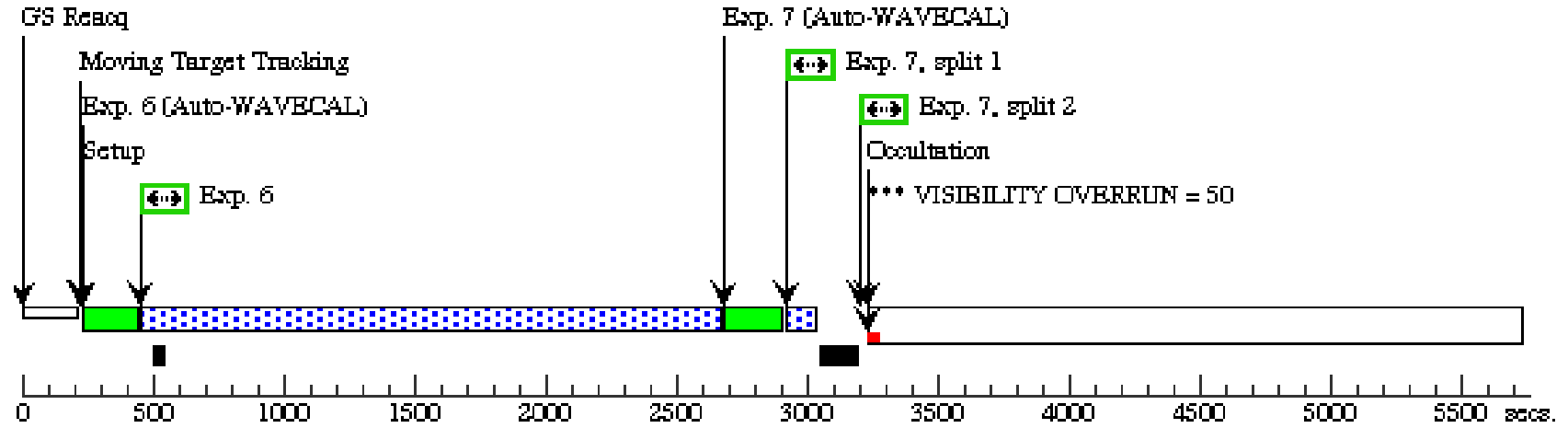
Sat May 19 01:10:21 GMT 2012

<b>Visit</b>	<b>Proposal 12478, Visit 02, implementation</b> <b>Diagnostic Status: Warning</b> Scientific Instruments: STIS/CCD, STIS/NUV-MAMA Special Requirements: ORIENT 132.94D TO 132.94 D: AFTER 01 BY 30 D TO 280 D									
	(Visit 02) Warning (Orbit Planner): VISIBILITY OVERRUN (Visit 02) Warning (Orbit Planner): VISIBILITY OVERRUN									
<b>Diagnostics</b>										
<b>Solar System Targets</b>	<b>#</b>	<b>Name</b>	<b>Level 1</b>	<b>Level 2</b>	<b>Level 3</b>	<b>Window</b>	<b>Ephem Center</b>			
	(2)	DIONE-OFFSET	STD=SATURN	STD=DIONE		SEP OF DIONE-OFFSET SATURN FROM EARTH GT 20", SEP OF DIONE-OFFSET RHEA FROM EARTH GT 10", SEP OF DIONE-OFFSET TITAN FROM EARTH GT 10"	EARTH			
	(4)	SATURN-RINGS-COPY	STD=SATURN	TYPE=POS_ANGLE,RAD=19.87,AN G=269,REF=NORTH		SEP OF SATURN-RINGS-COPY RHEA FROM EARTH GT 10", SEP OF SATURN-RINGS-COPY TITAN FROM EARTH GT 10"	EARTH			
<i>Comments: This is a duplicated of target 1. Minor changes have been made for use in visit 2.</i>										
<b>Exposures</b>	<b>#</b>	<b>Label (ETC Run)</b>	<b>Target</b>	<b>Config,Mode,Aperture</b>	<b>Spectral Els.</b>	<b>Opt. Params.</b>	<b>Special Reqs.</b>	<b>Groups</b>	<b>Exp. Time/[Actual Dur.]</b>	<b>Orbit</b>
	1	(2)	(2) DIONE-OFFSET	STIS/CCD, ACQ, 50CCD	MIRROR	ACQTYPE=POINT	GS ACQ SCENARI O BASE1BN3		0.5 Secs [==>]	[1]
	2	(STIS.sp.19 8623)	(4) SATURN-RING S-COPY	STIS/NUV-MAMA, ACCUM, 52X0.5	G230L 2376 A		GS ACQ SCENARI O BASE1BN3		2100 Secs [==>1616.0 Secs ]	[1]
	3	(STIS.sp.19 8622)	(4) SATURN-RING S-COPY	STIS/CCD, ACCUM, 52X0.5	G430L 4300 A	CR-SPLIT=NO			60 Secs [==>50.0 Secs ]	[1]
	4	(STIS.sp.19 8624)	(4) SATURN-RING S-COPY	STIS/NUV-MAMA, ACCUM, 52X0.5	G230L 2376 A				1630.00 Secs [==>2313.0 Secs ]	[2]
	5	(STIS.sp.19 8622)	(4) SATURN-RING S-COPY	STIS/CCD, ACCUM, 52X0.5	G430L 4300 A	CR-SPLIT=NO			50.00 Secs [==>60.0 Secs ]	[2]
	6	(STIS.sp.19 8626)	(4) SATURN-RING S-COPY	STIS/NUV-MAMA, ACCUM, 52X0.5	G230L 2376 A				2180 Secs [==>2180.0 Secs ]	[3]
	7	(STIS.sp.19 8622)	(4) SATURN-RING S-COPY	STIS/CCD, ACCUM, 52X0.5	G430L 4300 A				60 Secs [==>(Split 1)] [==>(Split 2)]	[3]
	8	(STIS.sp.19 8626)	(4) SATURN-RING S-COPY	STIS/NUV-MAMA, ACCUM, 52X0.5	G230L 2376 A				2180 Secs [==>2180 Secs ]	[4]
	9	(STIS.sp.19 8622)	(4) SATURN-RING S-COPY	STIS/CCD, ACCUM, 52X0.5	G430L 4300 A				60 Secs [==>30 Secs (Split 1)] [==>30 Secs (Split 2)]	[4]



Server Version: 20120312

**Orbit 3**



Server Version: 20120312

**Orbit 4**

