12235 - The energy of auroral electrons at Saturn and the associated atmospheric heating

Cycle: 18, Proposal Category: GO

(Availability Mode: SUPPORTED)

INVESTIGATORS

Name	*Institution*	*E-Mail*
Prof. Jean-Claude M. Gerard (PI) (ESA Member)	**Universite de Liege**	**jc.gerard@ulg.ac.be**
Dr. Bertrand Bonfond (CoI) (ESA Member)	Universite de Liege	b.bonfond@ulg.ac.be
Prof. John T. Clarke (CoI) (AdminUSPI)	Boston University	jclarke@bu.edu
Dr. G. Randall Gladstone (CoI)	Southwest Research Institute	randy.gladstone@swri.org
Dr. Denis Grodent (CoI) (ESA Member)	Universite de Liege	d.grodent@ulg.ac.be
Dr. Jacques Gustin (CoI) (ESA Member)	Universite de Liege	gustin@astro.ulg.ac.be
Dr. Jonathan D. Nichols (CoI) (ESA Member)	University of Leicester	jdn@ion.le.ac.uk
Dr. Wayne R. Pryor (CoI)	Central Arizona College	wayne_pryor@centralaz.edu
Dr. Aikaterini Radioti (CoI) (ESA Member)	Universite de Liege	a.radioti@ulg.ac.be

VISITS

Visit	*Targets used in Visit*	*Configurations used in Visit*	*Orbits Used*	*Last Orbit Planner Run*	*OP Current with Visit?*
11	(1) SATURN-A-FIX (2) SATURN-VISIT11-SLEW-ORBIT1 (10) SATURN-VISIT11-SLEW-ORBIT2	STIS/FUV-MAMA	2	28-Apr-2011 21:02:05.0	yes

Visit	*Targets used in Visit*	*Configurations used in Visit*	*Orbits Used*	*Last Orbit Planner Run*	*OP Current with Visit?*
21	(3) SATURN-B-FIX (4) SATURN-VISIT21-SLEW-ORBIT1 (9) SATURN-VISIT21-SLEW-ORBIT2	STIS/FUV-MAMA	2	28-Apr-2011 21:02:14.0	yes
31	(5) SATURN-C-FIX (6) SATURN-C-SLEW-S-N	STIS/FUV-MAMA	2	28-Apr-2011 21:02:23.0	yes
32	(5) SATURN-C-FIX (7) SATURN-VISIT32-SLEW-ORBIT1 (8) SATURN-VISIT32-SLEW-ORBIT2	STIS/FUV-MAMA	2	28-Apr-2011 21:02:29.0	yes

8 Total Orbits Used

ABSTRACT

Past HST observations of Saturn’s aurora have concentrated on the morphology and the relationship between the solar wind and the brightness of the aurora. With STIS back to work, time has come to move into a more quantitative era where FUV spectroscopy is used as a powerful tool to remotely sense the characteristics of the precipitated electrons and their effect on the H2 gas. In the proposed program, we focus on images and spectroscopy linking precipitated particles with the morphology observed quasi simultaneously. We have a unique opportunity to address key questions concerning the characteristic energy of the auroral electrons and their effects on the temperature of the upper atmosphere. In particular, we propose to combine HST FUV imaging with STIS long slit low and medium resolution spectroscopy to determine the spatial variations of the FUV color ratio, the altitude of the aurora and to map the temperature in the high-latitude region. A combined HST-Cassini campaign has been planned at the time of Saturn’s opposition in 2011 to complement HST spatial spectroscopy with observations from UVIS covering both hemispheres from a different vantage point. This compact and timely program is designed to provide key observations toward a better understanding of the physical interactions taking place in Saturn’s aurora.

OBSERVING DESCRIPTION

This program is based on coordinated STIS spectral observations of Saturn's FUV north aurora with simultaneous Cassini-UVIS measurements distributed over 3 visits. A time-tag image will be obtained at the beginning of each visit to view the global context of the spectra. STIS FUV images

of Saturn previously obtained by the PI and other team members have demonstrated that the STIS count rate limit is far from being reached during such observations.

Time-tagged spectral observations with the 52x0.5" long slit aperture will use the G140L and G140M gratings. The slit will scan the north auroral oval from the equatorward boundary of the oval up to several 1000s km above the north limb. The slit will be oriented with the minimum possible inclination angle on the planetary equatorial plane compatible with the spacecraft orientation constraints, with a maximum value of +/- 30°. These roll angles will be requested on an as-available basis for the orientation of HST at the time of observations.
We wish to minimize the geocoronal Ly-alpha emission by observing in Earth shadow whenever possible.

The sequence of the observations will be:

VISITS #11 and #12 (consecutive orbits 1 and 2) :

orbit 1: one 25MAMA STIS CLEAR image of the planetary disk, followed by one S-N scan of the north auroral region with the 52x0.5" slit and G140L grating. Both exposures will be time tagged.

orbit 2: one 25MAMA STIS CLEAR image of the planetary disk, followed by one S-N scan of the north auroral region with the 52x0.5" slit and G140M grating in the time-tag mode, with lambcentral = 1567 Å.

VISITS #21 and #22 (consecutive orbits 3 and 4) and
VISITS #31 and #32 (consecutive orbits 5 and 6): will repeat the same sequences.

These observations will be scheduled in coordination with the auroral observing campaigns planned for Cassini during Cycle 18. Although the detailed observation sequences of Cassini are not full defined yet, 3 periods have already been defined in the Cassini planning in support of this HST program. The dates are:

23-DEC-2010
17-APR-2011, with Cassini located near orbital periapsis
8-9-JUL-2011

The HST visits have been defined based on these observation plans, which may still be revised. Not yet knowing the orbital HST ephemeris during this cycle, the detailed scheduling will be decided in coordination with STScI.

Visit

Proposal 12235, Visit 11, scheduling Fri Apr 29 01:02:35 GMT 2011

Diagnostic Status: Warning

Scientific Instruments: STIS/FUV-MAMA

Special Requirements: BETWEEN 10-MAY-2011:12:25:00 AND 10-MAY-2011:13:30:00

Comments: Orbit 1/2 of visit 1x

STIS slit should be as parallel as possible to Saturn's rings plane

IMPORTANT
Epoch on target SATURN-A-SLEW-S-N must be updated if BETWEEN changes.

Diagnostics

(Visit 11) Warning (Form): A target acquisition should probably be performed before doing spectroscopy or coronography with STIS or COS.

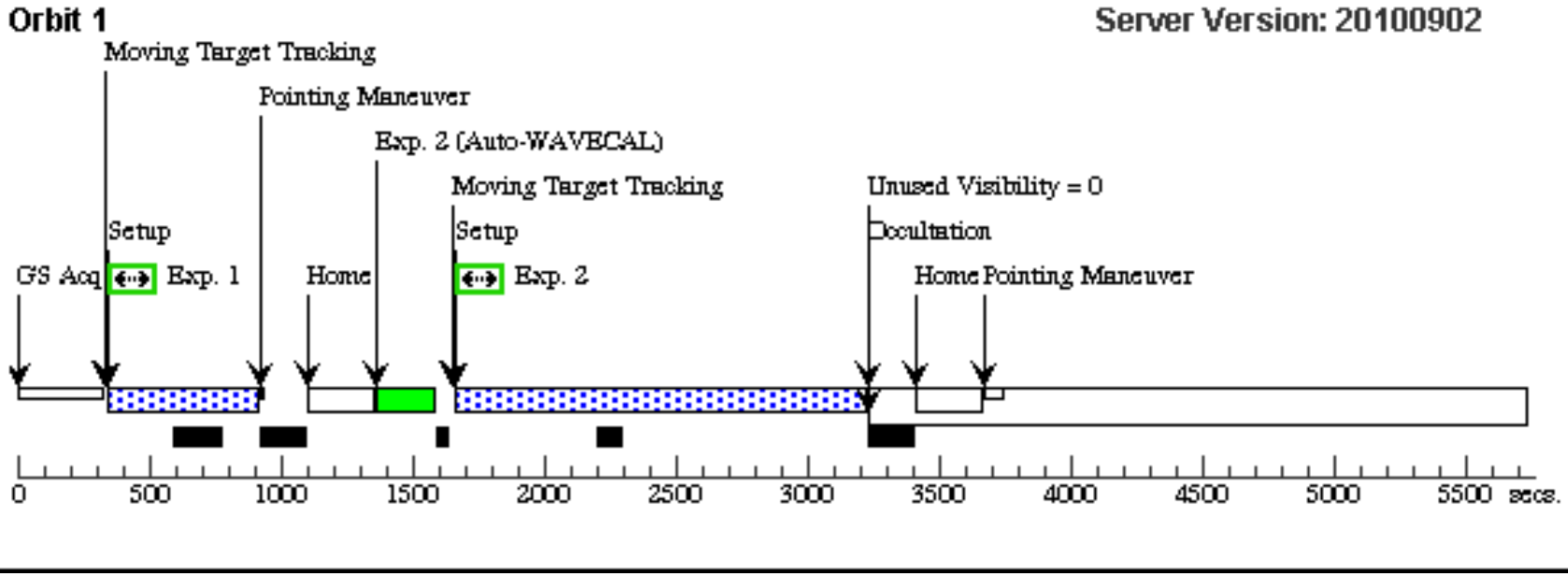
Solar System Targets

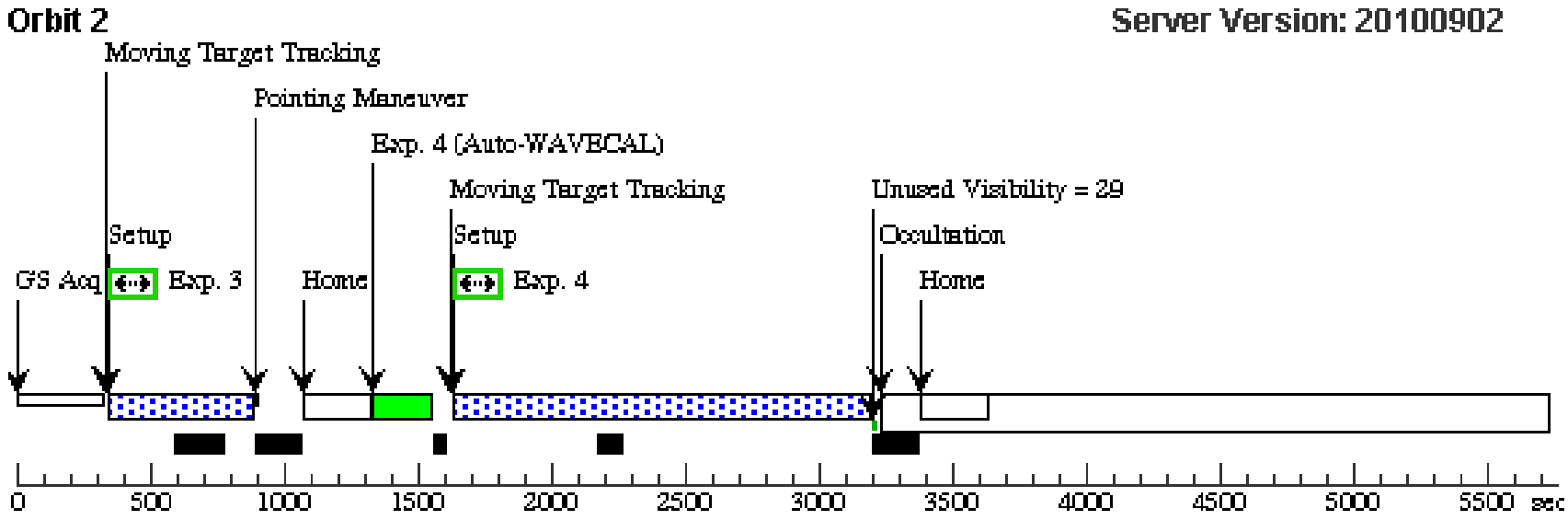
#	Name	Level 1	Level 2	Level 3	Window	Ephem Center
(1)	SATURN-A-FIX	STD=SATURN	TYPE=POS_ANGLE,RAD=0.0,ANG=0,REF=NORTH			EARTH
Comments: Image center (STIS FOV center) should be ~on Saturn center						
(2)	SATURN-VISIT11-SLEW-ORBIT1	STD=SATURN	TYPE=POS_ANGLE,RAD=7.0,ANG=0,REF=NORTH,R_RAD=144,EPOCH=10-MAY-2011:13:10:25			EARTH
*Comments: Apply S-N slew to STIS long slit, from ~55° centric latitude to ~7000 km above limb (~above NP). SLEW=3.5" in 1500 s (201.6"/day). The slew is towards the north of Saturn RAD and ANG are for slit center Auroral zone is well covered (slew+2*slit half width =3.5"+2*0.5"/2=4"), even with +/- 1" offset from nominal pointing. RAD and R_RAD assume that planet tilt is small (~0°) so that slew is perpendicular to ecliptic plane (for simplicity) EPOCH is indicative and depends on final schedule. STIS slit should be as // as possible to Saturn equatorial plane (within 30°)*						
(10)	SATURN-VISIT11-SLEW-ORBIT2	STD=SATURN	TYPE=POS_ANGLE,RAD=7.0,ANG=0,REF=NORTH,R_RAD=144,EPOCH=10-MAY-2011:14:44:18			EARTH
*Comments: Apply S-N slew to STIS long slit, from ~55° centric latitude to ~7000 km above limb (~above NP). SLEW=3.5" in 1500 s (201.6"/day). The slew is towards the north of Saturn RAD and ANG are for slit center Auroral zone is well covered (slew+2*slit half width =3.5"+2*0.5"/2=4"), even with +/- 1" offset from nominal pointing. RAD and R_RAD assume that planet tilt is small (~0°) so that slew is perpendicular to ecliptic plane (for simplicity) EPOCH is indicative and depends on final schedule. STIS slit should be as // as possible to Saturn equatorial plane (within 30°)*						

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time/[Actual Dur.]	Orbit
1	A1 IMAGE in	(1) SATURN-A-FIX	STIS/FUV-MAMA, TIME-TAG, 25MAMA	MIRROR	BUFFER-TIME=99	GS ACQ SCENARIO BASE1B3	Sequence 1-2 Non-Int in Visit 11	395 Secs *[==>]*	 ***[1]***
2	A1 SPECTRO S-N scan G140L 1425	(2) SATURN-VISIT11-SLEW-ORBIT1	STIS/FUV-MAMA, TIME-TAG, 52X0.5	G140L 1425 A	BUFFER-TIME=500	GS ACQ SCENARIO BASE1B3	Sequence 1-2 Non-Int in Visit 11	1500 Secs *[==>]*	 ***[1]***
Comments: assumes pointing and radial slew									
3	A2 IMAGE in	(1) SATURN-A-FIX	STIS/FUV-MAMA, TIME-TAG, 25MAMA	MIRROR	BUFFER-TIME=99	NEW OBSET FULL ACQ; GS ACQ SCENARIO BASE1B3	Sequence 3-4 Non-Int in Visit 11	366 Secs *[==>]*	 ***[2]***
4	A2 SPECTRO S-N scan G140L 1425	(10) SATURN-VISIT11-SLEW-ORBIT2	STIS/FUV-MAMA, TIME-TAG, 52X0.5	G140L 1425 A	BUFFER-TIME=500	GS ACQ SCENARIO BASE1B3	Sequence 3-4 Non-Int in Visit 11	1500 Secs *[==>]*	 ***[2]***
Comments: assumes pointing and radial slew									

Orbit Structure





Proposal 12235 - Visit 21 - The energy of auroral electrons at Saturn and the associated atmospheric heating

Visit

Proposal 12235, Visit 21, completed Fri Apr 29 01:02:37 GMT 2011

Diagnostic Status: Warning

Scientific Instruments: STIS/FUV-MAMA

Special Requirements: ORIENT 106D TO 164 D; BETWEEN 17-APR-2011:21:30:00 AND 17-APR-2011:22:30:00

Comments: Orbit 1/2 of visit 2x
Cassini Rev 147

STIS slit should be as parallel as possible to Saturn's rings plane

IMPORTANT
Epoch on target SATURN-B-SLEW-S-N must be updated if BETWEEN changes.

Diagnostics

(Visit 21) Warning (Form): A target acquisition should probably be performed before doing spectroscopy or coronography with STIS or COS.

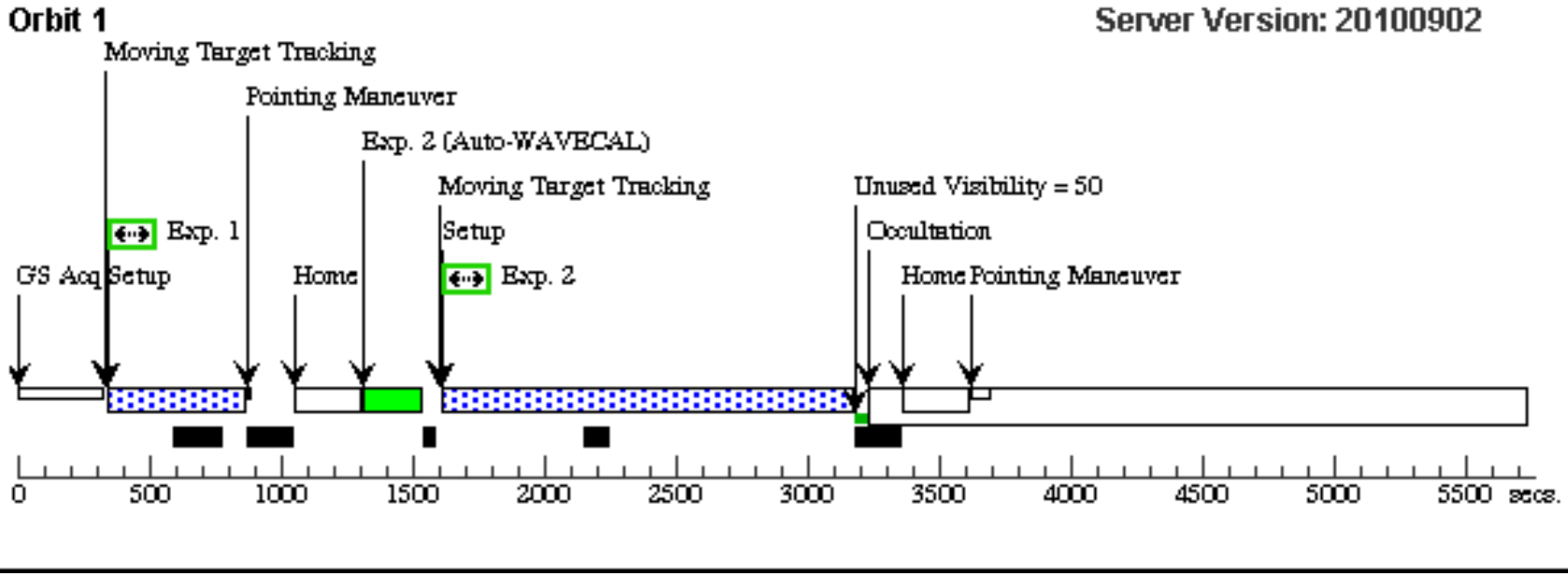
Solar System Targets

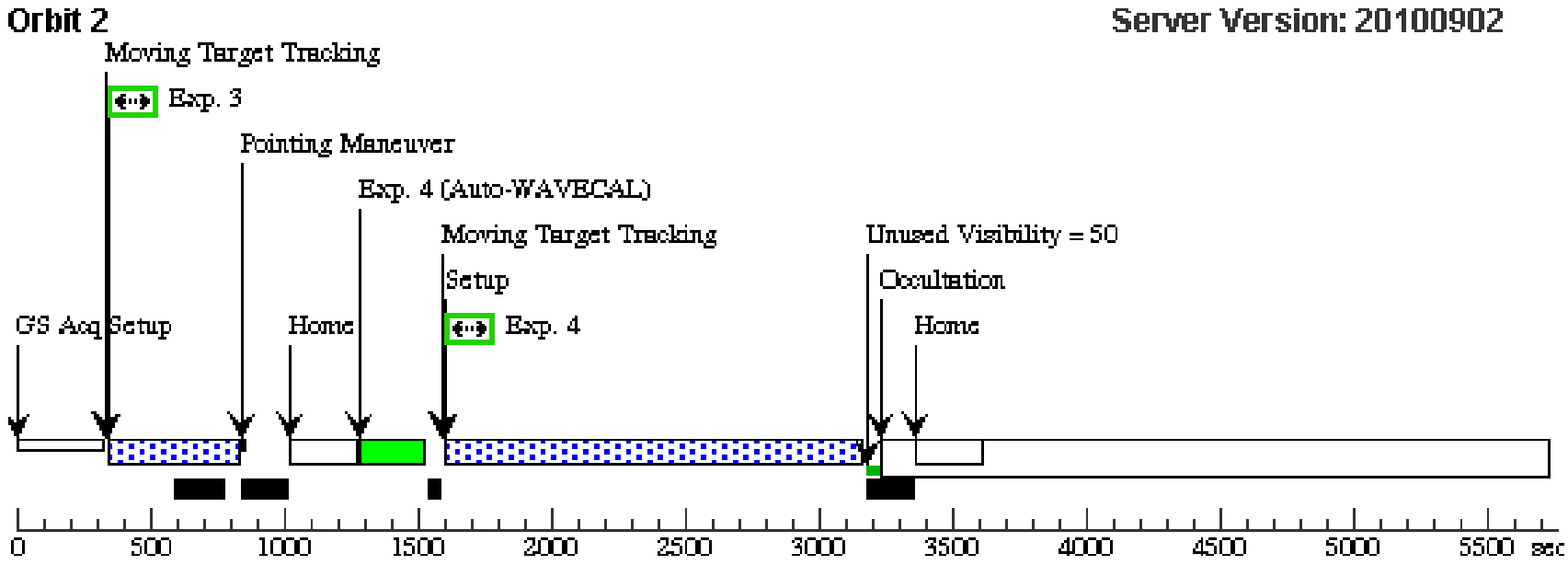
#	Name	Level 1	Level 2	Level 3	Window	Ephem Center
(3)	SATURN-B-FIX	STD=SATURN	TYPE=POS_ANGLE,RAD=0.0,ANG=0,REF=NORTH			EARTH
Comments: Image center (STIS FOV center) should be ~on Saturn center						
(4)	SATURN-VISIT21-SLEW-ORBIT1	STD=SATURN	TYPE=POS_ANGLE,RAD=6,ANG=0,REF=NORTH,R_RAD=239.55,EPOCH=17-APR-2011:22:03:05			EARTH
Comments: Apply S-N slew to STIS long slit. The slew is towards the north of Saturn RAD and ANG are for slit center. *Auroral zone is well covered (slew+2*slit half width =3.5"+2*0.5"/2=4"), even with +/- 1" offset from nominal pointing.* *RAD and R_RAD assume that planet tilt is small (~0°) so that slew is perpendicular to ecliptic plane (for simplicity)* *EPOCH is indicative and depends on final schedule.* *STIS slit should be as // as possible to Saturn equatorial plane (within 30°)*						
(9)	SATURN-VISIT21-SLEW-ORBIT2	STD=SATURN	TYPE=POS_ANGLE,RAD=7,ANG=0,REF=NORTH,R_RAD=133.87,EPOCH=17-APR-2011:23:38:12			EARTH
Comments: Apply S-N slew to STIS long slit. The slew is towards the north of Saturn RAD and ANG are for slit center. *Auroral zone is well covered (slew+2*slit half width =3.5"+2*0.5"/2=4"), even with +/- 1" offset from nominal pointing.* *RAD and R_RAD assume that planet tilt is small (~0°) so that slew is perpendicular to ecliptic plane (for simplicity)* *EPOCH is indicative and depends on final schedule.* *STIS slit should be as // as possible to Saturn equatorial plane (within 30°)*						

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time/[Actual Dur.]	Orbit
1	B1 IMAGE in	(3) SATURN-B-FIX	STIS/FUV-MAMA, TIME-TAG, 25MAMA	MIRROR	BUFFER-TIME=99		Sequence 1-2 Non-Int in Visit 21	345 Secs	
								[==>]	***[1]***
2	B1 SPECTRO S-N scan G140L 1425	(4) SATURN-VISIT21-SLEW-ORBIT1	STIS/FUV-MAMA, TIME-TAG, 52X0.5	G140L 1425 A	BUFFER-TIME=500		Sequence 1-2 Non-Int in Visit 21	1500 Secs	
								[==>]	***[1]***
Comments: assumes pointing and radial slew for 17APR2011									
3	B2 IMAGE in	(3) SATURN-B-FIX	STIS/FUV-MAMA, TIME-TAG, 25MAMA	MIRROR	BUFFER-TIME=99	NEW OBSET FULL ACQ	Sequence 3-4 Non-Int in Visit 21	316 Secs	
								[==>]	***[2]***
4	B2 SPECTRO S-N scan G140M 1567	(9) SATURN-VISIT21-SLEW-ORBIT2	STIS/FUV-MAMA, TIME-TAG, 52X0.5	G140M 1567 A	BUFFER-TIME=750		Sequence 3-4 Non-Int in Visit 21	1500 Secs	
								[==>]	***[2]***
Comments: assumes pointing and radial slew for 17APR2011									

Orbit Structure





Visit

Proposal 12235, Visit 31, failed Fri Apr 29 01:02:37 GMT 2011

Diagnostic Status: Warning

Scientific Instruments: STIS/FUV-MAMA

Special Requirements: BETWEEN 28-JAN-2011:13:00:00 AND 28-JAN-2011:14:00:00

Comments: Orbit 1/2 of visit 3x

STIS slit should be as parallel as possible to Saturn's rings plane

****IMPORTANT****
Epoch on target SATURN-C-SLEW-S-N must be updated if BETWEEN changes.

NOTE: Other scheduling times are possible on January 28, 2011 with appropriate changes to EPOCH and BETWEEN.

Diagnostics

(Visit 31) Warning (Form): A target acquisition should probably be performed before doing spectroscopy or coronography with STIS or COS.

Solar System Targets

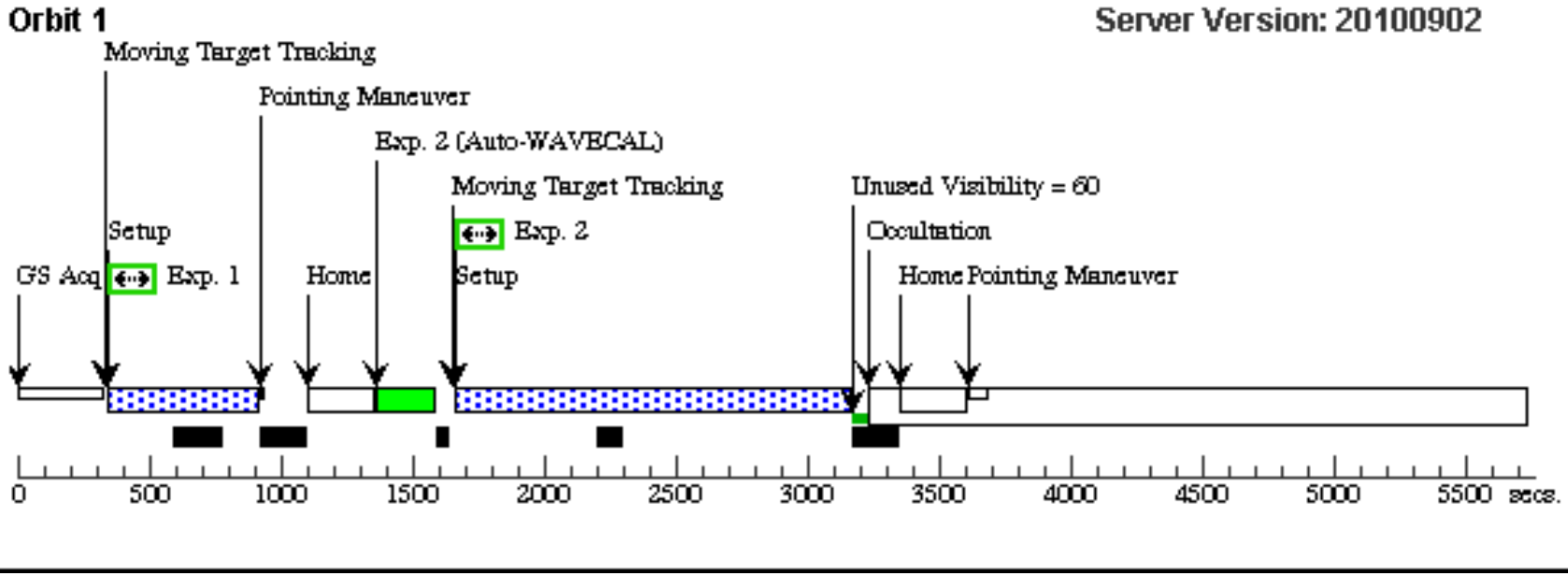
#	Name	Level 1	Level 2	Level 3	Window	Ephem Center
(5)	SATURN-C-FIX	STD=SATURN	TYPE=POS_ANGLE,RAD=0.0,ANG =0,REF=NORTH			EARTH
Comments: Image center (STIS FOV center) should be ~on Saturn center						
(6)	SATURN-C-SLEW-S-N	STD=SATURN	TYPE=POS_ANGLE,RAD=6.8,ANG =0,REF=NORTH,R_RAD=201.6,EPO CH=28-JAN-2011:12:11:13			EARTH

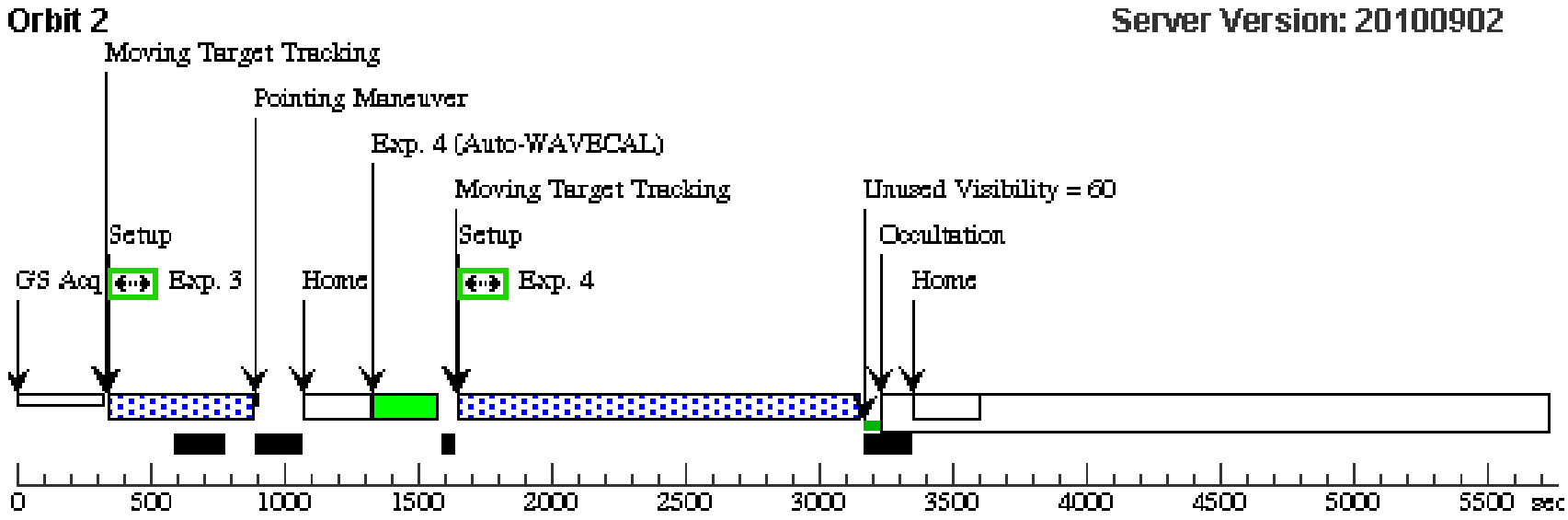
Comments: Apply S-N slew to STIS long slit, from ~55° centric latitude to ~7000 km above limb (~above NP).
SLEW=3.5" in 1500 s (201.6"/day). The slew is towards the north of Saturn
RAD and ANG are for slit center
*Auroral zone is well covered (slew+2*slit half width =3.5"+2*0.5"/2=4"), even with +/- 1" offset from nominal pointing.*
RAD and R_RAD assume that planet tilt is small (~0°) so that slew is perpendicular to ecliptic plane (for simplicity)
EPOCH is indicative and depends on final schedule.
STIS slit should be as // as possible to Saturn equatorial plane (within 30°)

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time/[Actual Dur.]	Orbit
1	C1 IMAGE in	(5) SATURN-C-FIX	STIS/FUV-MAMA, TIME-TAG, 25MAMA	MIRROR	BUFFER-TIME=99		Sequence 1-2 Non-Int in Visit 31	395 Secs *[==>]*	 ***[1]***
2	C1 SPECTRO S-N scan G140L 1425	(6) SATURN-C-SLEW-S-N	STIS/FUV-MAMA, TIME-TAG, 52X0.5	G140L 1425 A	BUFFER-TIME=500		Sequence 1-2 Non-Int in Visit 31	1440 Secs *[==>]*	 ***[1]***
Comments: assumes pointing and radial slew for 08JUL2011									
3	C2 IMAGE in	(5) SATURN-C-FIX	STIS/FUV-MAMA, TIME-TAG, 25MAMA	MIRROR	BUFFER-TIME=99	NEW OBSET FULL ACQ	Sequence 3-4 Non-Int in Visit 31	366 Secs *[==>]*	 ***[2]***
4	C2 SPECTRO S-N scan G140M 1567	(6) SATURN-C-SLEW-S-N	STIS/FUV-MAMA, TIME-TAG, 52X0.5	G140M 1567 A	BUFFER-TIME=750		Sequence 3-4 Non-Int in Visit 31	1440 Secs *[==>]*	 ***[2]***
Comments: assumes pointing and radial slew for 08JUL2011									

Orbit Structure





Visit

Proposal 12235, Visit 32, completed Fri Apr 29 01:02:38 GMT 2011

Diagnostic Status: Warning

Scientific Instruments: STIS/FUV-MAMA

Special Requirements: BETWEEN 2011.076:17:45 AND 2011.076:18:15

Comments: Repeat of failed visit 31.

STIS slit should be as parallel as possible to Saturn's rings plane

****IMPORTANT****
Epoch on target SATURN-D-SLEW-S-N must be updated if BETWEEN changes.

NOTE: Other scheduling times are possible with appropriate changes to EPOCH and BETWEEN.

Diagnostics

(Visit 32) Warning (Form): A target acquisition should probably be performed before doing spectroscopy or coronography with STIS or COS.

Solar System Targets

#	Name	Level 1	Level 2	Level 3	Window	Ephem Center
(5)	SATURN-C-FIX	STD=SATURN	TYPE=POS_ANGLE,RAD=0.0,ANG =0,REF=NORTH			EARTH

Comments: Image center (STIS FOV center) should be ~on Saturn center

(7)	SATURN-VISIT32-SLEW-ORBIT1	STD=SATURN	TYPE=POS_ANGLE,RAD=5.5,ANG =0,REF=NORTH,R_RAD=316.8,EPO CH=17-MAR-2011:17:13:09			EARTH

Comments: Apply S-N slew to STIS long slit, from ~55° centric latitude to ~7000 km above limb (~above NP).
SLEW=3.5" in 1500 s (316.8"/day). The slew is towards the north of Saturn
RAD and ANG are for slit center
*Auroral zone is well covered (slew+2*slit half width =3.5"+2*0.5"/2=4"), even with +/- 1" offset from nominal pointing.*
RAD and R_RAD assume that planet tilt is small (~0°) so that slew is perpendicular to ecliptic plane (for simplicity)
EPOCH is indicative and depends on final schedule.
STIS slit should be as // as possible to Saturn equatorial plane (within 30°)

EPOCH set for visit 32 exposure 2 to start at 2011.076:18:25:10 (minus Saturn->Earth light travel time).

(8)	SATURN-VISIT32-SLEW-ORBIT2	STD=SATURN	TYPE=POS_ANGLE,RAD=5.5,ANG =0,REF=NORTH,R_RAD=316.8,EPO CH=17-MAR-2011:18:48:48			EARTH

Comments: Apply S-N slew to STIS long slit, from ~55° centric latitude to ~7000 km above limb (~above NP).
SLEW=3.5" in 1500 s (316.8"/day). The slew is towards the north of Saturn
RAD and ANG are for slit center
*Auroral zone is well covered (slew+2*slit half width =3.5"+2*0.5"/2=4"), even with +/- 1" offset from nominal pointing.*
RAD and R_RAD assume that planet tilt is small (~0°) so that slew is perpendicular to ecliptic plane (for simplicity)
EPOCH is indicative and depends on final schedule.
STIS slit should be as // as possible to Saturn equatorial plane (within 30°)

EPOCH set for visit 32 exposure 4 to start at 2011.076:20:00:49 (minus Saturn->Earth light travel time).

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time/[Actual Dur.]	Orbit
1	C1 IMAGE in	(5) SATURN-C-FIX	STIS/FUV-MAMA, TIME-TAG, 25MAMA	MIRROR	BUFFER-TIME=99		Sequence 1-2 Non-Int in Visit 32	395 Secs *[==>]*	 ***[1]***
2	C1 SPECTRO S-N scan G140L 1425	(7) SATURN-VISIT 32-SLEW-ORBIT1	STIS/FUV-MAMA, TIME-TAG, 52X0.5	G140L 1425 A	BUFFER-TIME=500		Sequence 1-2 Non-Int in Visit 32	1440 Secs *[==>]*	 ***[1]***
Comments: assumes pointing and radial slew for 08JUL2011									
3	C2 IMAGE in	(5) SATURN-C-FIX	STIS/FUV-MAMA, TIME-TAG, 25MAMA	MIRROR	BUFFER-TIME=99	NEW OBSET FULL ACQ	Sequence 3-4 Non-Int in Visit 32	366 Secs *[==>]*	 ***[2]***
4	C2 SPECTRO S-N scan G140M 1567	(8) SATURN-VISIT 32-SLEW-ORBIT2	STIS/FUV-MAMA, TIME-TAG, 52X0.5	G140M 1567 A	BUFFER-TIME=750		Sequence 3-4 Non-Int in Visit 32	1440 Secs *[==>]*	 ***[2]***
Comments: assumes pointing and radial slew for 08JUL2011									

Orbit Structure