14113 - Methane Distribution and Transport in the Active Atmosphere of Uranus

Cycle: 23, Proposal Category: GO

(Availability Mode: AVAILABLE)

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) URANUS (2) URANUS-MOSAIC-BLUE (3) URANUS-MOSAIC-RED-1 (4) URANUS-MOSAIC-RED-2 CCDFLAT WAVE	STIS/CCD	3	30-Jul-2015 21:08:26.0	yes
02	(1) URANUS	WFC3/UVIS	1	30-Jul-2015 21:08:34.0	yes

4 Total Orbits Used

ABSTRACT

We propose three STIS orbits to obtain spatially resolved 300-1000 nm spectra of the ice giant Uranus and one WFC3 orbit in support of complex STIS calibration corrections. Similar observations made in 2012 revealed an equatorial rise in methane since 2002 and a high-latitude depletion in

the north comparable to that seen in the south in 2002, in defiance of expectations. Both low-latitude and polar regions displayed small scale latitudinal variations that are potential indicators of vertical motions. A brightening of the polar region in 2014 suggests either aerosol increases or further decreases in methane or a combination of these effects. The improved view of the north polar region in late 2015 will allow extension of our analysis to higher latitudes and measurement of temporal changes at most latitudes accessible in 2012. We will use differences in methane and hydrogen absorption near 825 nm to constrain the methane distribution over the latitude range from 25 S to 90 N. During its orbits the STIS slit will be aligned parallel to Uranus' polar axis and stepped from the edge to the center of the disk, taking advantage of the zonal symmetry of Uranus to reduce total observing time by half. These results will be relevant to extra-solar science, as Uranus represents a size class that is abundant among Kepler extra-solar planet candidates. HST provides wavelength coverage with spectral and spatial resolution not available from any other facility due to Uranus' small angular size, and this capability may not be available in the near future due both to limited HST lifetime and the expected eventual formation of an obscuring north polar haze on Uranus.

OBSERVING DESCRIPTION

Re-observe Uranus with STIS, as was done in 2002 (Program 9035); 3 orbits. One orbit of WFC3 imaging. Original description from Program 9035 (updated slightly):

During the first orbit, we will use STIS with grating G430L and a 0.1" slit for wavelengths 290-570 nm and 70 second exposure time each. The slit orientation with be parallel to the central meridian. Considering overhead times, 13 positions will be possible distributed between the central meridian and the evening limb equally spaced by 0.15". At wavelengths below 540 nm, Uranus does not display much latitudinal contrasts. Thus, the significant center-to- limb variations are expected to be well recorded by those slit positions. For the next two orbits, we propose to use STIS with grating G750L and 0.1" slit for wavelengths 524- 1027 nm and 86 second exposure time each. Sampling the 1.85" radius of Uranus at 0.056" sampling from central meridian to evening limb with an additional exposure on each side to account for impecfect centering in the acquisition requires 36 exposures (18 per orbit). We plan to read out only 7" around Uranus to reduce overhead times. For both gratings, we expect about 5, 000 electrons per pixel at the brightest part of Uranus at the brightest wavelength, which typically gives signal-to-noise ratios of 50 per pixel. The gain 1 setting will be used. Wavecals and G750L fringe flats will be scheduled between orbits. Overhead for data management will not be required since we will read out only 140 rows. The target acquisition will be a diffuse acquisition on Uranus with flux-centered checkbox of 33 pixels with aperture F28X50LP and 5 sec exposure time. The target acquisition exposure will help in the navigation of the exposures with the G750L grating. The overlapping spectral region will facilitate navigation of the remaining exposures. We tested our target acquisition method with WFPC2 images in 21 different filters. The root-mean-square deviation in east-west centering between our acquisition method and a limb fitting method was 0.03". The

deviation was only 0.02" for an average image of many red and near-infrared WFPC2 images which approximates the throughput of the F28X50LP aperture. Thus, we are confindent that centering on Uranus will be more accurate than required.

-------- Realtime Justification --------

Time-critical observations: In order to take advantage of the almost perfect east-west symmetry of Uranus (to a lesser degree of Neptune), the slit needs to be aligned along the central meridians. This restricts scheduling of the observations within a few days of opposition for Uranus.

------ Calibration Justification -------

The STIS wavecals and G750L fringe flats have been specified to occur at the end of the orbits so that they may occur during occultation.

--------- Additional Comments ----------

All WFC3 exposures have CR-SPLIT=NO to reduce overhead. POS-TARG offsets for quad filter WFC3 exposures have been specified to place target approximately 20 arcseconds closer to center of array relative to "optimal" aperture locations. This places the planet approximately 10 arcseconds towards the center of the array relative to the "QUAD-FIX" fiducial points. This has been done to reduce telescope move magnitudes (between different quads), while still leaving a 512 x 512 pixel area around the target outside of the quad filter vignetted regions.

The proposal uses "available" (WAVECAL=NO) and "pc use only" (wavecal exposure NEW ALIGNMENT) features to allow suppression of WAVECALS from beginning of orbits (they have been specified at the end of the orbits) and to allow WAVECALS to run into occultation, respectively (from program 12894 PC instructions).

We have added postflash to the narrowband long-wavelength exposures, as they are the only ones that show CTI trails from CR hits (see program 12894 WFC3 exposures). Uranus is bright enough that it and scattering from it make postflash unnecessary in the remaining exposures.

Visit

Proposal 14113, Visit 01, implementation Fri Jul 31 01:08:36 GMT 2015

Diagnostic Status: No Diagnostics

Scientific Instruments: STIS/CCD

Special Requirements: SCHED 100%; ORIENT 301.4D TO 301.7 D

Patterns

#	Primary Pattern		Secondary Pattern	Exposures
(1)	Pattern Type=LINE	Coordinate Frame=CELESTIAL		(2)
	Purpose=MOSAIC	Pattern Orientation=166.25		
	Number Of Points=13	Angle Between Sides=		
	Point Spacing=0.1521	Center Pattern=false		
	Line Spacing=			
(2)	Pattern Type=LINE	Coordinate Frame=CELESTIAL		(4), (7)
	Purpose=MOSAIC	Pattern Orientation=166.25		
	Number Of Points=18	Angle Between Sides=		
	Point Spacing=.05624	Center Pattern=false		
	Line Spacing=			

Solar System Targets

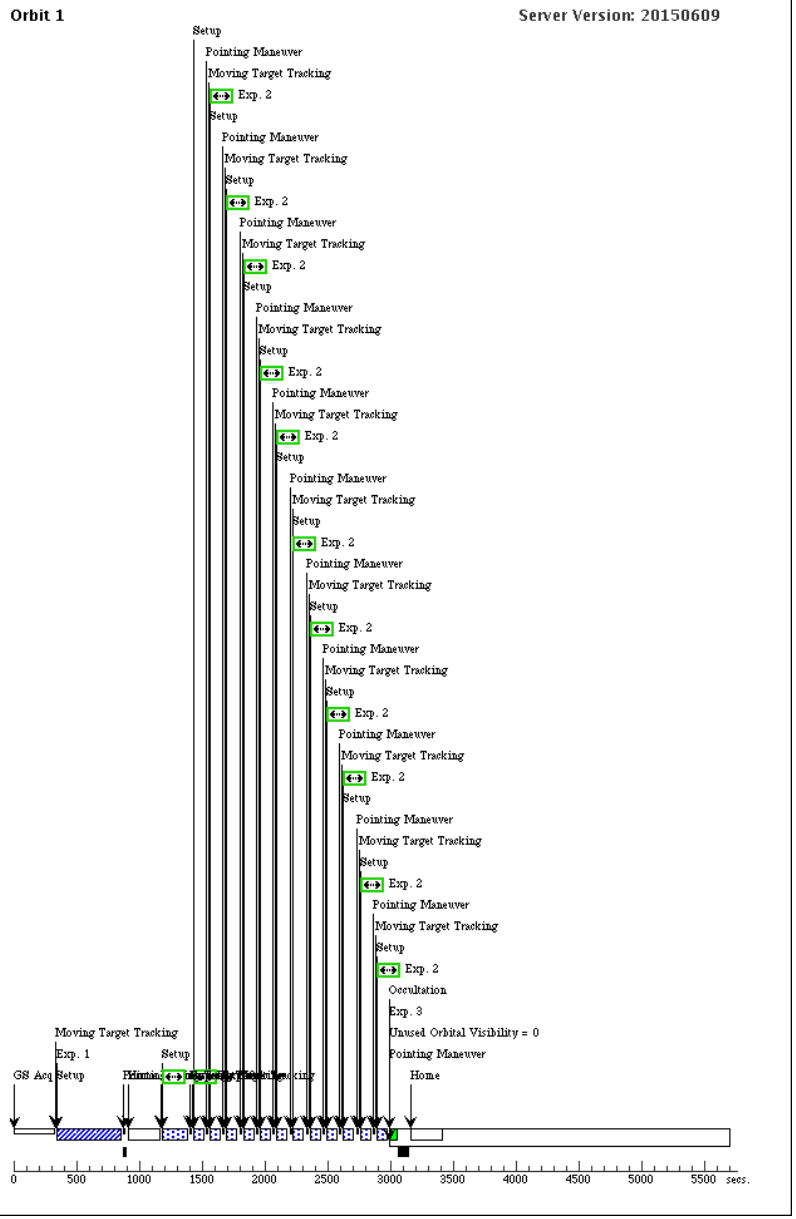
#	Name	Level 1	Level 2	Level 3	Window	Ephem Center
(1)	URANUS	STD=URANUS				EARTH
(2)	URANUS-MOSAIC-BLUE	STD=URANUS	TYPE=POS_ANGLE,RAD=1.8252,ANG=346.25,REF=NORTH			EARTH
Comments: Note Uranus' pole PA is 256.25 deg (E from N) at opposition on 12 OCT 2015, so offset angle is PA+90 deg.						
(3)	URANUS-MOSAIC-RED-1	STD=URANUS	TYPE=POS_ANGLE,RAD=1.91224, ANG=346.25,REF=NORTH			EARTH
Comments: Note Uranus' pole PA is 256.25 deg (E from N) at opposition on 12 OCT 2015, so offset angle is PA+90 deg.						
(4)	URANUS-MOSAIC-RED-2	STD=URANUS	TYPE=POS_ANGLE,RAD=0.89984, ANG=346.25,REF=NORTH			EARTH
Comments: Note Uranus' pole PA is 256.25 deg (E from N) at opposition on 12 OCT 2015, so offset angle is PA+90 deg.						

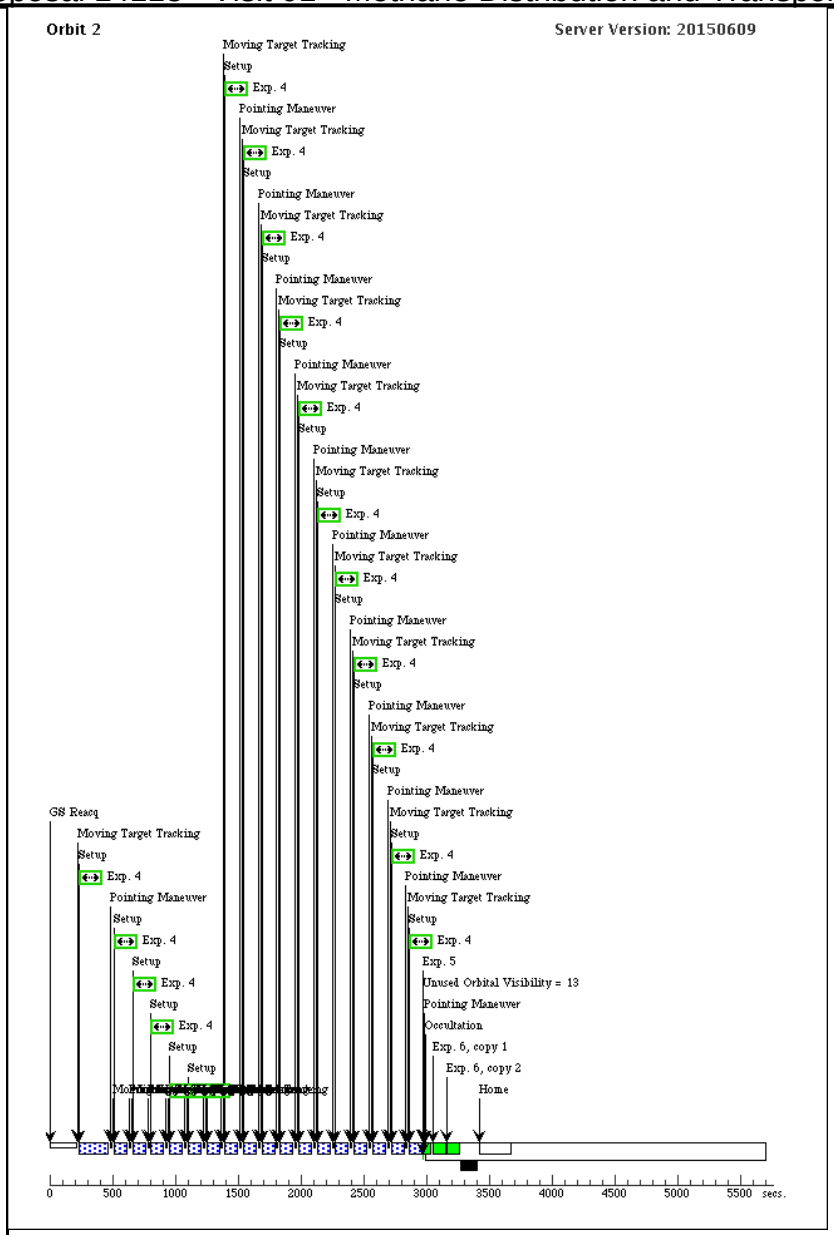
Exposures

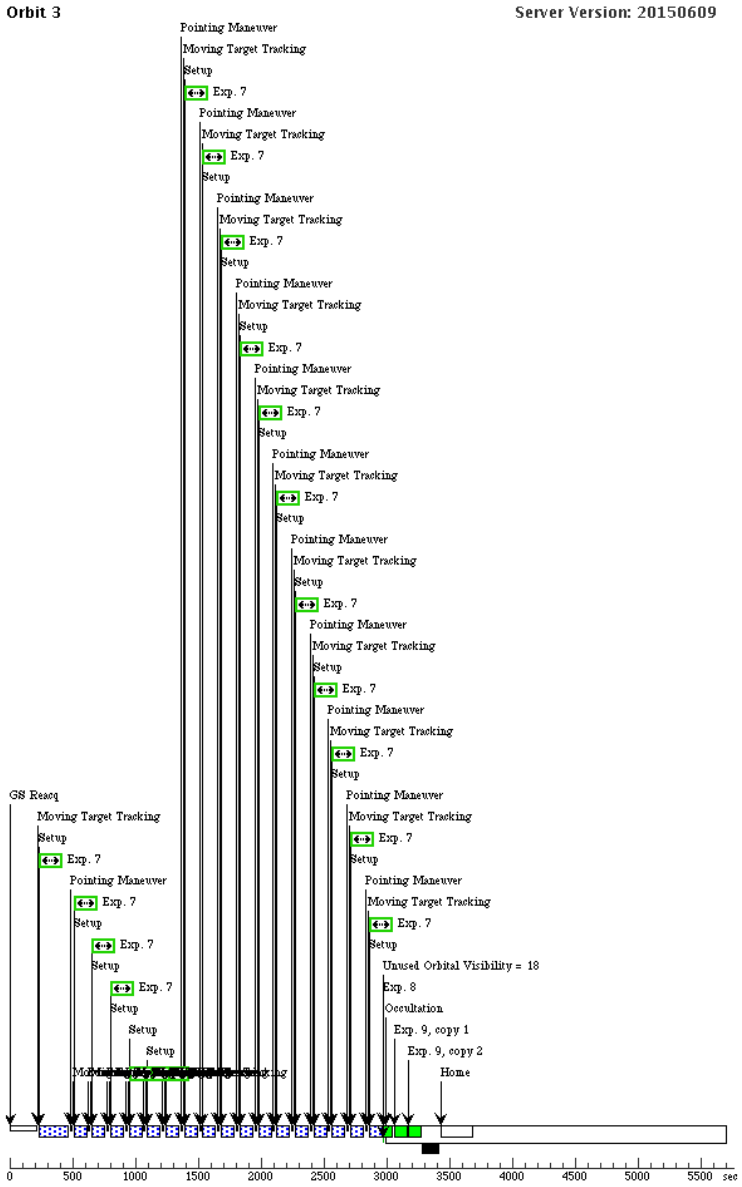
#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1		(1) URANUS	STIS/CCD, ACQ, F28X50LP	MIRROR	ACQTYPE=DIFFUSE; DIFFUSE-CENTER=FLUX-CENTROID; CHECKBOX=33	GS ACQ SCENARIO BASE1B3	Sequence 1-3 Non-Int in Visit 01	5 Secs (5 Secs) *[==>]*	*[1]*
2		(2) URANUS-MOS AIC-BLUE	STIS/CCD, ACCUM, 52X0.1E1	G430L 4300 A	CR-SPLIT=NO; SIZEAXIS2=140; WAVECAL=NO	GS ACQ SCENARIO BASE1B3	Sequence 1-3 Non-Int in Visit 01 Pattern 1, Exps 2-2 in Sequence 1-3 Non-Int in Visit 01 (1)	70 Secs (910 Secs) *[==>(Pattern 1)]* *[==>(Pattern 2)]* *[==>(Pattern 3)]* *[==>(Pattern 4)]* *[==>(Pattern 5)]* *[==>(Pattern 6)]* *[==>(Pattern 7)]* *[==>(Pattern 8)]* *[==>(Pattern 9)]* *[==>(Pattern 10)]* *[==>(Pattern 11)]* *[==>(Pattern 12)]* *[==>(Pattern 13)]*	*[1]*
3	WAVECAL G430L	WAVE	STIS/CCD, ACCUM, 52X0.1	G430L 4300 A		NEW ALIGNMENT	Sequence 1-3 Non-Int in Visit 01	*[==>]*	*[1]*
Comments: Observer-specified WAVECAL inserted at end of orbit to run into occultation.									
4		(3) URANUS-MOS AIC-RED-1	STIS/CCD, ACCUM, 52X0.1E1	G750L 7751 A	SIZEAXIS2=140; CR-SPLIT=NO; WAVECAL=NO	GS ACQ SCENARIO BASE1B3	Sequence 4-6 Non-Int in Visit 01 Pattern 2, Exps 4-4 in Sequence 4-6 Non-Int in Visit 01 (2)	84 Secs (1512 Secs) *[==>(Pattern 1)]* *[==>(Pattern 2)]* *[==>(Pattern 3)]* *[==>(Pattern 4)]* *[==>(Pattern 5)]* *[==>(Pattern 6)]* *[==>(Pattern 7)]* *[==>(Pattern 8)]* *[==>(Pattern 9)]* *[==>(Pattern 10)]* *[==>(Pattern 11)]* *[==>(Pattern 12)]* *[==>(Pattern 13)]* *[==>(Pattern 14)]* *[==>(Pattern 15)]* *[==>(Pattern 16)]* *[==>(Pattern 17)]* *[==>(Pattern 18)]*	*[2]*
5	WAVECAL G750L	WAVE	STIS/CCD, ACCUM, 52X0.1	G750L 7751 A		NEW ALIGNMENT	Sequence 4-6 Non-Int in Visit 01	*[==>]*	*[2]*
Comments: Observer-specified WAVECAL inserted at end of orbit to run into occultation.									

6	FRINGE FLAT G750L	CCDFLAT	STIS/CCD, ACCUM, 52X0.1	G750L 7751 A			Sequence 4-6 Non-Int in Visit 01	*[==>(Copy 1)]* *[==>(Copy 2)]*	***[2]***
Comments: Observer-specified Fringe Flat to correct near-IR fringing. To be run in occultation.									
7		(4) URANUS-MOS AIC-RED-2	STIS/CCD, ACCUM, 52X0.05E1	G750L 7751 A	CR-SPLIT=NO; SIZEAXIS2=140; WAVECAL=NO	GS ACQ SCENARIO BASE1B3	Sequence 7-9 Non-Int in Visit 01 Pattern 2, Exps 7-7 in Sequence 7-9 Non-Int in Visit 01 (2)	84 Secs (1512 Secs) *[==>(Pattern 1)]* *[==>(Pattern 2)]* *[==>(Pattern 3)]* *[==>(Pattern 4)]* *[==>(Pattern 5)]* *[==>(Pattern 6)]* *[==>(Pattern 7)]* *[==>(Pattern 8)]* *[==>(Pattern 9)]* *[==>(Pattern 10)]* *[==>(Pattern 11)]* *[==>(Pattern 12)]* *[==>(Pattern 13)]* *[==>(Pattern 14)]* *[==>(Pattern 15)]* *[==>(Pattern 16)]* *[==>(Pattern 17)]* *[==>(Pattern 18)]*	***[3]***
8	WAVECAL G750L	WAVE	STIS/CCD, ACCUM, 52X0.1	G750L 7751 A		NEW ALIGNMENT	Sequence 7-9 Non-Int in Visit 01	*[==>]*	***[3]***
Comments: Observer-specified WAVECAL inserted at end of orbit to run into occultation.									
9	FRINGE FLAT G750L	CCDFLAT	STIS/CCD, ACCUM, 52X0.1	G750L 7751 A			Sequence 7-9 Non-Int in Visit 01	*[==>(Copy 1)]* *[==>(Copy 2)]*	***[3]***
Comments: Observer-specified Fringe Flat to correct near-IR fringing. To be run in occultation									

Orbit Structure




Orbit 2
Server Version: 20150609
Moving Target Tracking
Setup
Exp. 4
Pointing Maneuver
GS Reacq
Exp. 5
Unused Orbital Visibility = 13
Occultation
Exp. 6, copy 1
Exp. 6, copy 2
Home
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
secs.


Orbit 3
Server Version: 20150609
Pointing Maneuver
Moving Target Tracking
Setup
Exp. 7
GS Reacq
Unused Orbital Visibility = 18
Exp. 8
Occultation
Exp. 9, copy 1
Exp. 9, copy 2
Home
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
sec

Visit

Proposal 14113, WFC3 (02), implementation Fri Jul 31 01:08:37 GMT 2015

Diagnostic Status: Warning

Scientific Instruments: WFC3/UVIS

Special Requirements: SCHED 100%; AFTER 01 BY 0 D TO 7 D

Comments: WFC3 Uranus images for I/F calibration of STIS observations.

Diagnostics

(F336W (02.001)) Warning (Form): FLASH level may be too low for this exposure or a short subexposure. See extended explanation in the diagnostic browser

(F467M (02.002)) Warning (Form): FLASH level may be too low for this exposure or a short subexposure. See extended explanation in the diagnostic browser

(F547M (02.003)) Warning (Form): FLASH level may be too low for this exposure or a short subexposure. See extended explanation in the diagnostic browser

(F631N (02.004)) Warning (Form): FLASH level may be too low for this exposure or a short subexposure. See extended explanation in the diagnostic browser

(F665N (02.005)) Warning (Form): FLASH level may be too low for this exposure or a short subexposure. See extended explanation in the diagnostic browser

(F763M (02.006)) Warning (Form): FLASH level may be too low for this exposure or a short subexposure. See extended explanation in the diagnostic browser

(F845M (02.007)) Warning (Form): FLASH level may be too low for this exposure or a short subexposure. See extended explanation in the diagnostic browser

(FQ889N (02.009)) Warning (Form): POS TARG & PATTERN should be used carefully with ACS ramp or WFC3 quad filters as central wavelengths & transmission efficiencies vary within the apertures.

(FQ937N (02.010)) Warning (Form): POS TARG & PATTERN should be used carefully with ACS ramp or WFC3 quad filters as central wavelengths & transmission efficiencies vary within the apertures.

(FQ727N (02.011)) Warning (Form): POS TARG & PATTERN should be used carefully with ACS ramp or WFC3 quad filters as central wavelengths & transmission efficiencies vary within the apertures.

Solar System Targets

#	Name	Level 1	Level 2	Level 3	Window	Ephem Center
(1)	URANUS	STD=URANUS				EARTH

Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	F336W	(1) URANUS	WFC3/UVIS, ACCUM, UVIS2-M512C-SUB	F336W	CR-SPLIT=NO	GS ACQ SCENARIO BASE1B3		30 Secs (30 Secs) *[==>]*	 ***[1]***
2	F467M	(1) URANUS	WFC3/UVIS, ACCUM, UVIS2-M512C-SUB	F467M	CR-SPLIT=NO			16 Secs (16 Secs) *[==>]*	 ***[1]***
3	F547M	(1) URANUS	WFC3/UVIS, ACCUM, UVIS2-M512C-SUB	F547M	CR-SPLIT=NO			6 Secs (6 Secs) *[==>]*	 ***[1]***
4	F631N (WFC3UVIS.im.415642)	(1) URANUS	WFC3/UVIS, ACCUM, UVIS2-M512C-SUB	F631N	CR-SPLIT=NO			65 Secs (65 Secs) *[==>]*	 ***[1]***
5	F665N (WFC3UVIS.im.415643)	(1) URANUS	WFC3/UVIS, ACCUM, UVIS2-M512C-SUB	F665N	CR-SPLIT=NO			52 Secs (52 Secs) *[==>]*	 ***[1]***
6	F763M	(1) URANUS	WFC3/UVIS, ACCUM, UVIS2-M512C-SUB	F763M	CR-SPLIT=NO			26 Secs (26 Secs) *[==>]*	 ***[1]***
7	F845M	(1) URANUS	WFC3/UVIS, ACCUM, UVIS2-M512C-SUB	F845M	CR-SPLIT=NO			35 Secs (35 Secs) *[==>]*	 ***[1]***
8	F953N	(1) URANUS	WFC3/UVIS, ACCUM, UVIS2-M512C-SUB	F953N	CR-SPLIT=NO; FLASH=12			250 Secs (250 Secs) *[==>]*	 ***[1]***
9	FQ889N	(1) URANUS	WFC3/UVIS, ACCUM, UVIS-QUAD-SUB	FQ889N	CR-SPLIT=NO; FLASH=12	POS TARG 15,-15		450 Secs (450 Secs) *[==>]*	 ***[1]***
10	FQ937N	(1) URANUS	WFC3/UVIS, ACCUM, UVIS-QUAD-SUB	FQ937N	CR-SPLIT=NO; FLASH=12	POS TARG -15,-15		150 Secs (150 Secs) *[==>]*	 ***[1]***
11	FQ727N	(1) URANUS	WFC3/UVIS, ACCUM, UVIS-QUAD-SUB	FQ727N	CR-SPLIT=NO; FLASH=12	POS TARG -15,15		210 Secs (210 Secs) *[==>]*	 ***[1]***

Orbit Structure