12894 - Methane migration on a Uranus-class planet: symmetric or seasonal?

Cycle: 20, 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	(2) URANUS-MOSAIC-BLUE (3) URANUS-MOSAIC-RED-1 (4) URANUS-MOSAIC-RED-2 (5) URANUS CCDFLAT WAVE	STIS/CCD	3	13-Aug-2012 21:54:24.0	yes
02	(5) URANUS	WFC3/UVIS	1	13-Aug-2012 21:55:05.0	yes

4 Total Orbits Used

ABSTRACT

We propose 3 STIS orbits and one WFC3 orbit to obtain spatially resolved 300-1000 nm spectra of the ice giant Uranus, which will be used to determine (1) whether its northern high latitudes have the same methane depletion that has been inferred at high southern latitudes from similar 2002 observations, or whether it has a different depletion indicating seasonal forcing, (2) cloud and haze structure changes since 2002 (5 years before equinox), and (3) the current cloud structure at high northern latitudes that will be accessible during Cycle 20 (5 years after equinox). The complete lack of discrete cloud features pole-ward of 45 S correlates with the inferred local depletion of methane gas and raises questions about methane depletion at high northern latitudes where discrete cloud features have been recently observed. We propose to answer this question firmly by use of spectral differences in methane and hydrogen absorption near 825 nm. This will constrain the methane distribution over the latitude range from 25 S to 70 N, over which the cloud and haze distribution will also be tightly constrained by spectral limb darkening observations. The three STIS orbits will orient the spectral slit along Uranus' polar axis and step from the edge to the center of the disk, taking advantage of the zonal symmetry of Uranus to reduce total observing time by half. The orbit of WFC3 imaging over a broad range of wavelengths provides key information in support of complex corrections needed to produce well calibrated spectra. These results will be relevant to extra-solar science, as Uranus represents a size class that is the most abundant among Kepler extra-solar planet candidates.

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 0.057" 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.

REAL TIME 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" and "pc use only" features to allow suppression of WAVECALS from beginning of orbits (they have been specified at the end of the orbits) and to specify the "NEW ALIGNMENT" flag per PC's instructions.

Visit

Proposal 12894, STIS (01), implementation Tue Aug 14 01:55:14 GMT 2012

Diagnostic Status: No Diagnostics

Scientific Instruments: STIS/CCD

Special Requirements: SCHED 100%; ORIENT 299.5D TO 299.7 D

Comments: Slit-orientation must be parallel to the rotation axis of Uranus (PA = 254.60/74.60 in early Oct 2012) to use Uranus' east-west symmetry. See comments for exposures 2, 4, and 7. To fill orbits, those exposures may be slightly modified.

Patterns

#	Primary Pattern		Secondary Pattern	Exposures
(1)	Pattern Type=LINE	Coordinate Frame=CELESTIAL		(2)
	Purpose=MOSAIC	Pattern Orientation=164.6		
	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=164.6		
	Number Of Points=18	Angle Between Sides=		
	Point Spacing=.0569	Center Pattern=false		
	Line Spacing=			

Solar System Targets

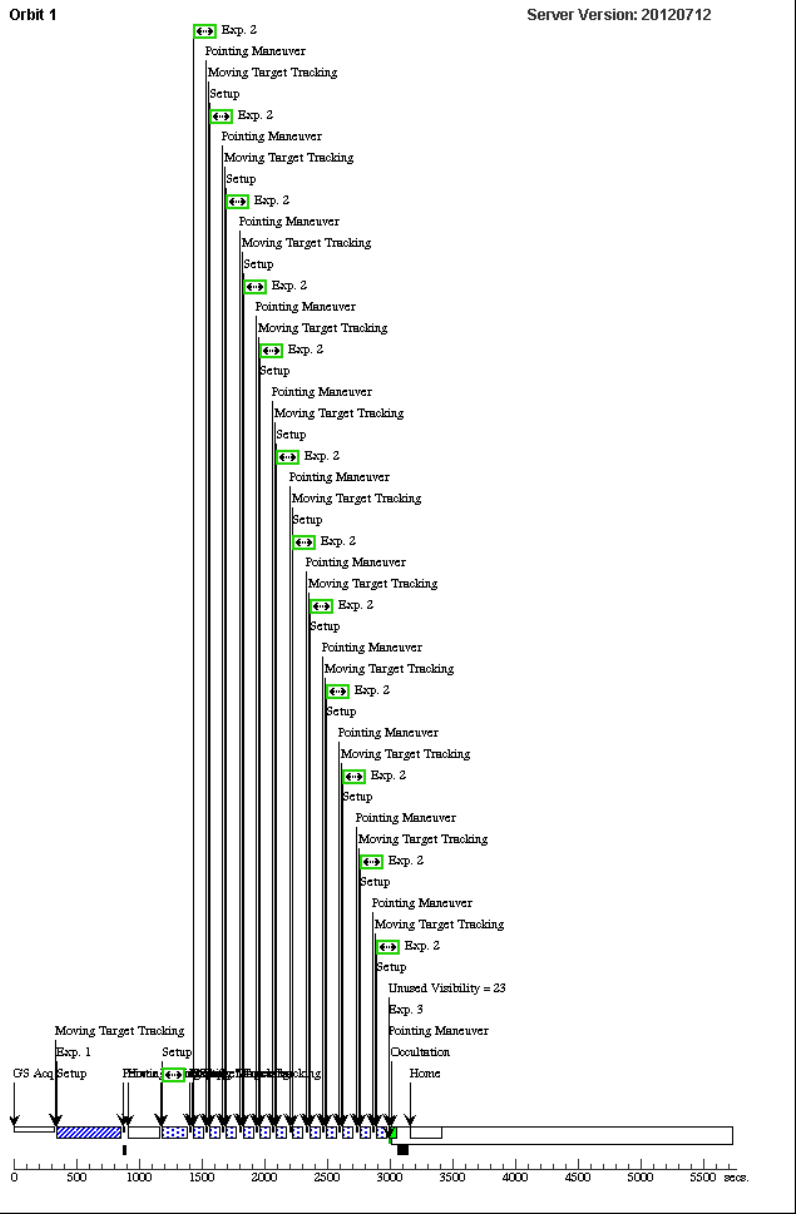
#	Name	Level 1	Level 2	Level 3	Window	Ephem Center
(2)	URANUS-MOSAIC-BLUE	STD=URANUS	TYPE=POS_ANGLE,RAD=1.8252,ANG=344.6,REF=NORTH			EARTH
(3)	URANUS-MOSAIC-RED-1	STD=URANUS	TYPE=POS_ANGLE,RAD=1.9346,ANG=344.6,REF=NORTH			EARTH
(4)	URANUS-MOSAIC-RED-2	STD=URANUS	TYPE=POS_ANGLE,RAD=0.9104,ANG=344.6,REF=NORTH			EARTH
(5)	URANUS	STD=URANUS				EARTH

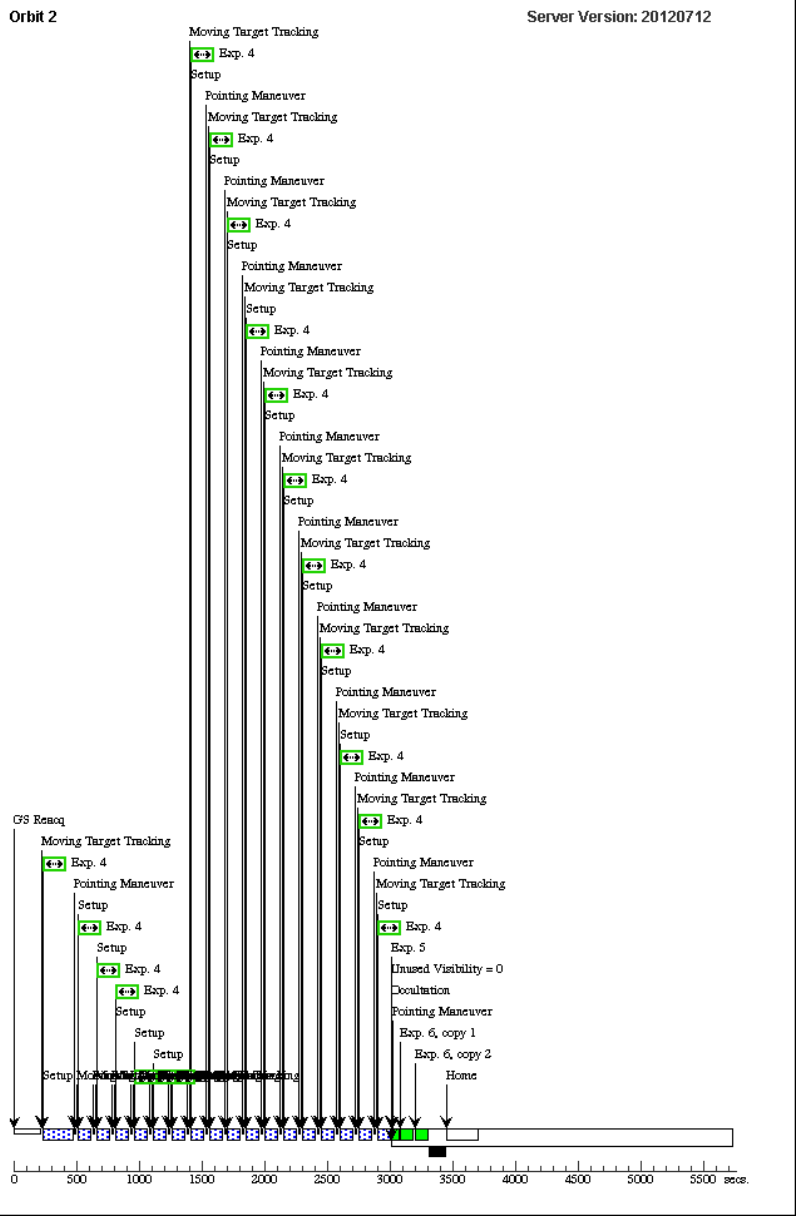
Exposures

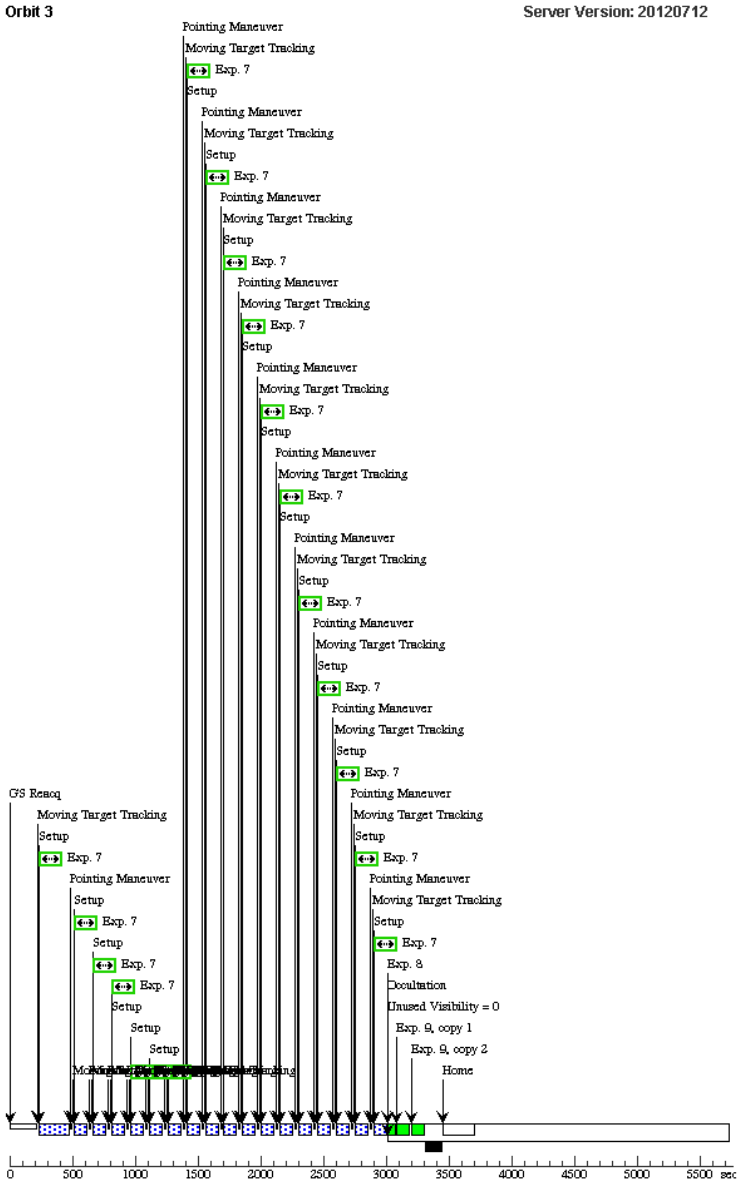
#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time/[Actual Dur.]	Orbit
1		(5) URANUS	STIS/CCD, ACQ, F28X50LP	MIRROR	ACQTYPE=DIFFUSE; DIFFUSE-CENTER=FLUX-CENTROID; CHECKBOX=33	GS ACQ SCENARIO BASE1B3		5 Secs *[==>]*	***[1]***
2	G430L	(2) URANUS-MOSAIC-BLUE	STIS/CCD, ACCUM, 52X0.1E1	G430L 4300 A	SIZEAXIS2=140; CR-SPLIT=NO; WAVECAL=NO	GS ACQ SCENARIO BASE1B3	Pattern 1, Exps 2-2 in STIS (01) (1)	70 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]***
Comments: Exposure time may be adjusted slightly to fill assigned orbit.									
3	WAVECAL G430L	WAVE	STIS/CCD, ACCUM, 52X0.1	G430L 4300 A		NEW ALIGNMENT		*[==>]*	***[1]***
4		(3) URANUS-MOSAIC-RED-1	STIS/CCD, ACCUM, 52X0.1E1	G750L 7751 A	SIZEAXIS2=140; CR-SPLIT=NO	GS ACQ SCENARIO BASE1B3	Pattern 2, Exps 4-4 in STIS (01) (2)	86 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]***
Comments: Exposure time may be adjusted slightly to fill assigned orbit.									
5	WAVECAL G750L	WAVE	STIS/CCD, ACCUM, 52X0.1	G750L 7751 A		NEW ALIGNMENT		*[==>]*	***[2]***

6	CCDFLAT G750L	CCDFLAT	STIS/CCD, ACCUM, 52X0.1	G750L 7751 A				*[==>(Copy 1)]* *[==>(Copy 2)]*	***[2]***
Comments: Intended to run after URANUS-MOSAIC-RED-1 target sequence.									
7		(4) URANUS-MOSAIC-RED-2	STIS/CCD, ACCUM, 52X0.1E1	G750L 7751 A	SIZEAXIS2=140; CR-SPLIT=NO	GS ACQ SCENARIO BASE1B3	Pattern 2, Exps 7-7 in STIS (01) (2)	86 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]***
Comments: Exposure time may be adjusted slightly to fill assigned orbit.									
8	WAVECAL G750L	WAVE	STIS/CCD, ACCUM, 52X0.1	G750L 7751 A		NEW ALIGNMENT		*[==>]*	***[3]***
9	CCDFLAT G750L	CCDFLAT	STIS/CCD, ACCUM, 52X0.1	G750L 7751 A				*[==>(Copy 1)]* *[==>(Copy 2)]*	***[3]***
Comments: Intended to run after URANUS-MOSAIC-RED-2 target sequence.									

Orbit Structure




Orbit 2
Server Version: 20120712
Moving Target Tracking
Exp. 4
Setup
Pointing Maneuver
GS Reacq
Exp. 5
Unused Visibility = 0
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: 20120712
Pointing Maneuver
Moving Target Tracking
Exp. 7
Setup
GS Reacq
Exp. 8
Occultation
Unused Visibility = 0
Exp. 9, copy 1
Exp. 9, copy 2
Home
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
sec

Visit

Proposal 12894, WFC3 (02), implementation Tue Aug 14 01:55:23 GMT 2012

Diagnostic Status: Warning

Scientific Instruments: WFC3/UVIS

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

Comments: VISIT should occur within 7 days of STIS orbits so that Uranus phase angle is < 0.4 degrees difference from STIS observations.

Diagnostics

(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
(5)	URANUS	STD=URANUS				EARTH

Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time/[Actual Dur.]	Orbit
1	F336W	(5) URANUS	WFC3/UVIS, ACCUM, UVIS2-M512C-SUB	F336W	CR-SPLIT=NO	GS ACQ SCENARIO BASE1B3		30 Secs *[==>]*	*[1]*
2	F467M	(5) URANUS	WFC3/UVIS, ACCUM, UVIS2-M512C-SUB	F467M	CR-SPLIT=NO			16 Secs *[==>]*	*[1]*
3	F547M	(5) URANUS	WFC3/UVIS, ACCUM, UVIS2-M512C-SUB	F547M	CR-SPLIT=NO			6 Secs *[==>]*	*[1]*
4	F631N (NEW) (WFC3UVIS.im.415642)	(5) URANUS	WFC3/UVIS, ACCUM, UVIS2-M512C-SUB	F631N	CR-SPLIT=NO			65 Secs *[==>]*	*[1]*
5	F665N (NEW) (WFC3UVIS.im.415643)	(5) URANUS	WFC3/UVIS, ACCUM, UVIS2-M512C-SUB	F665N	CR-SPLIT=NO			52 Secs *[==>]*	*[1]*
6	F763M	(5) URANUS	WFC3/UVIS, ACCUM, UVIS2-M512C-SUB	F763M	CR-SPLIT=NO			26 Secs *[==>]*	*[1]*
7	F845M	(5) URANUS	WFC3/UVIS, ACCUM, UVIS2-M512C-SUB	F845M	CR-SPLIT=NO			35 Secs *[==>]*	*[1]*
8	FQ953N (NEW)	(5) URANUS	WFC3/UVIS, ACCUM, UVIS2-M512C-SUB	F953N	CR-SPLIT=NO			250 Secs *[==>]*	*[1]*
9	FQ889N	(5) URANUS	WFC3/UVIS, ACCUM, UVIS-QUAD-SUB	FQ889N	CR-SPLIT=NO	POS TARG 15,-15		450 Secs *[==>]*	*[1]*
10	FQ937N	(5) URANUS	WFC3/UVIS, ACCUM, UVIS-QUAD-SUB	FQ937N	CR-SPLIT=NO	POS TARG -15,-15		160 Secs *[==>]*	*[1]*
11	FQ727N	(5) URANUS	WFC3/UVIS, ACCUM, UVIS-QUAD-SUB	FQ727N	CR-SPLIT=NO	POS TARG -15,15		240 Secs *[==>]*	*[1]*

Orbit Structure