15504 - UV Spectroscopy of Lucy Mission Targets

Cycle: 26, Proposal Category: GO

(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) 3548-EURYBATES	WFC3/UVIS	1	10-Dec-2018 17:07:30.0	yes
02	(2) 21900-ORUS	WFC3/UVIS	1	10-Dec-2018 17:07:31.0	yes

2 Total Orbits Used

ABSTRACT

The Trojan asteroids are a significant population of primitive bodies trapped in Jupiter's stable L4 and L5 Lagrange regions. Their physical properties and existence in these particular orbits constrain the chemical and dynamical processes in our early Solar System. NASA's recently selected Lucy mission will perform the first reconnaissance of these asteroids and will answer many fundamental questions about the population. The compositions of the Trojans are not well understood. Spectroscopy and spectrophotometry in visible and near-infrared wavelengths show red slopes (spectra with reflectivity increasing towards the long wavelength end of the spectrum) and no diagnostic spectral absorption features. However, past spectral and photometric observations suggest there are unobserved features in ultraviolet wavelengths.

We propose to obtain ultraviolet spectroscopy with WFC3 of four Trojan asteroids that are targets of the Lucy mission. Lucy will not have the

capability to obtain ultraviolet spectra. The proposed observations can only be made using Hubble. We will determine if there are UV spectral features, as suggested by visible wavelength observations, and connect these features to candidate compositional components. These observations will enable connections between the compositions of Trojans and dynamical models of the early Solar System.

OBSERVING DESCRIPTION

During Cycle 26, we will obtain UV spectra of 2 Jovian Trojan asteroids that are targets of NASA's recently selected Lucy mission: (3548) Eurybates and (21900) Orus. Another two targets, (617) Patroclus and (11351) Leucus, were observed in Cycle 25. Together, these objects span the range of compositions observed in the Trojan population. The proposed targets span three spectral types (C, D, P) and include members of the "red" and "less red" spectral groups.

We will observe these objects with the Wide Field Camera 3 UVIS configuration with the G280 spectral element and F300X for the complementary direct imaging. The wavelength range provided by the G280 spectral element (200-400 nm, spectral resolution of ~70) will complement the visible spectroscopy data already available for Trojan asteroids from ground based observatories. This instrument configuration was also chosen because its resolution and throughput enable observations of appropriate signal-to-noise to be done efficiently for each object.

Our required signal-to noise ratio (SNR) as ~50 at 3000 Angstroms. We have two scientific goals which define our observing requirements: (1) examining the downturn toward the UV (~0.43 microns) that is suggestive of an unobserved UV spectral feature for less-red objects and (2) searching for absorption features that are diagnostic of volatiles, organics, and salts. This SNR requirement guarantees adequate signal to noise in the spectral region ~0.4 microns where the downturn has been observed previously and near the spectral features observed on other small bodies. By setting our SNR requirements at 3000 Angstroms, we avoid the sharp dropoff in flux at shorter wavelengths which would dramatically increase our required exposure time.

We used the Wide Field Camera 3 Spectroscopic Exposure Time Calculator (ETC) to determine our total exposure times for each object. Each calculation used a point source and the HST Solar Spectrum spectral distribution. In order to give a conservative estimate of SNR, we used high values for standard zodiacal light normalizations, standard earth shine light normalizations, and air glow.

The target ephemerides were examined in Aladin for a period when the object is brightest and can be observed with HST during Cycle 26. The magnitudes calculated by JPL Horizons are determined using the object's H (Solar System absolute magnitude) value. These values are subject to uncertainties resulting from the rotational light curves of the targets. Therefore, we need to take into consideration the light curve variation for each

target. In order to calculate the minimum SNR for the observing window, we add the maximum light curve variation from the Minor Planet Center Lightcurve Database (http://www.minorplanetcenter.net/iau/lists/LightcurveDat.html) to the predefined faintest magnitude. This precaution gives us conservative estimates which guarantee acceptable SNR.

(3548) Eurybates and (21900) Orus require a single orbit each. For our defined sequence, we use two dither positions. We take a direct image with SNR>30 and the total exposure time at each object is determined by the time available in each orbit. The observing window is defined by the SNR>50 at 3000 Angstrom requirement.

(3548) Eurybates, 1 orbit
Eurybates is a less red C-type object. Eurybates can be observed with V<16.8 (lightcurve corrected to V<17.0) from Aug 7 to Oct 8 2019. With a total spectral exposure time of t=1928s, we expect SNR~60 at 3000 Angstroms.

(21900) Orus, 1 orbit
Orus is a red D-type object. Leucus can be observed with V<17.15 (lightcurve corrected to V<17.33) from Aug 30 to Sep 7 2019. With a total exposure time of t=1928s, we expect SNR~50 at 3000 Angstroms.

Visit

Proposal 15504, Eurybates (01), implementation Mon Dec 10 22:07:32 GMT 2018

Diagnostic Status: No Diagnostics

Scientific Instruments: WFC3/UVIS

Special Requirements: BETWEEN 07-AUG-2019:18:00:00 AND 08-AUG-2019:09:00:00; BETWEEN 08-AUG-2019:18:00:00 AND 10-AUG-2019:12:00:00; BETWEEN 11-AUG-2019:06:00:00 AND 12-AUG-2019:12:00:00; BETWEEN 13-AUG-2019:06:00:00 AND 14-AUG-2019:00:00:00; BETWEEN 15-AUG-2019:00:00:00 AND 16-AUG-2019:06:00:00; BETWEEN 18-AUG-2019:04:00:00 AND 19-AUG-2019:18:00:00; BETWEEN 20-AUG-2019:12:00:00 AND 22-AUG-2019:14:00:00; BETWEEN 23-AUG-2019:06:00:00 AND 24-AUG-2019:04:00:00; BETWEEN 24-AUG-2019:09:00:00 AND 29-AUG-2019:10:00:00; BETWEEN 29-AUG-2019:18:00:00 AND 30-AUG-2019:06:00:00; BETWEEN 31-AUG-2019:06:00:00 AND 02-SEP-2019:00:00:00; BETWEEN 02-SEP-2019:18:00:00 AND 03-SEP-2019:12:00:00; BETWEEN 05-SEP-2019:12:00:00 AND 07-SEP-2019:06:00:00; BETWEEN 10-SEP-2019:12:00:00 AND 11-SEP-2019:12:00:00; BETWEEN 14-SEP-2019:06:00:00 AND 15-SEP-2019:12:00:00; BETWEEN 16-SEP-2019:00:00:00 AND 17-SEP-2019:16:00:00; BETWEEN 21-SEP-2019:06:00:00 AND 22-SEP-2019:04:00:00; BETWEEN 23-SEP-2019:00:00:00 AND 23-SEP-2019:18:00:00; BETWEEN 24-SEP-2019:18:00:00 AND 25-SEP-2019:12:00:00; BETWEEN 27-SEP-2019:00:00:00 AND 28-SEP-2019:06:00:00; BETWEEN 30-SEP-2019:06:00:00 AND 01-OCT-2019:14:00:00; BETWEEN 03-OCT-2019:00:00:00 AND 04-OCT-2019:10:00:00

Comments: This observation is organized as followed:

1. Direct Image A. exposure time=25 seconds. post flash=12
Pos Targ X=0, Y=-50 to get it in the center of chip 2.

2. Spec 1. exposure time=964 seconds, cr_split=2.
Pos Targ X=0, Y=-50.

dither= 13x distance of WFC3-UVIS-DITHER-LINE. (point spacing 0.145 x 13= 1.885")
3. Spec 2. exposure time=964 seconds, cr_split=2.
Pos Targ X=1.287, Y=-48.622

4. Direct Image B. exposure time=25 seconds. post flash=12
Pos Targ X=1.287, Y=-48.622

1 & 2 are at the same position, 3 & 4 are at the same position. These are paired to place the direct image in the same location as the dispersed images.

The observability windows are dictated by V<16.8 (with lightcurve added V<17.0). This window opens on Aug 7 and closes on Oct 8 2019. The specific windows were determined by investigating when other bright and/or numerous objects would be in the field.

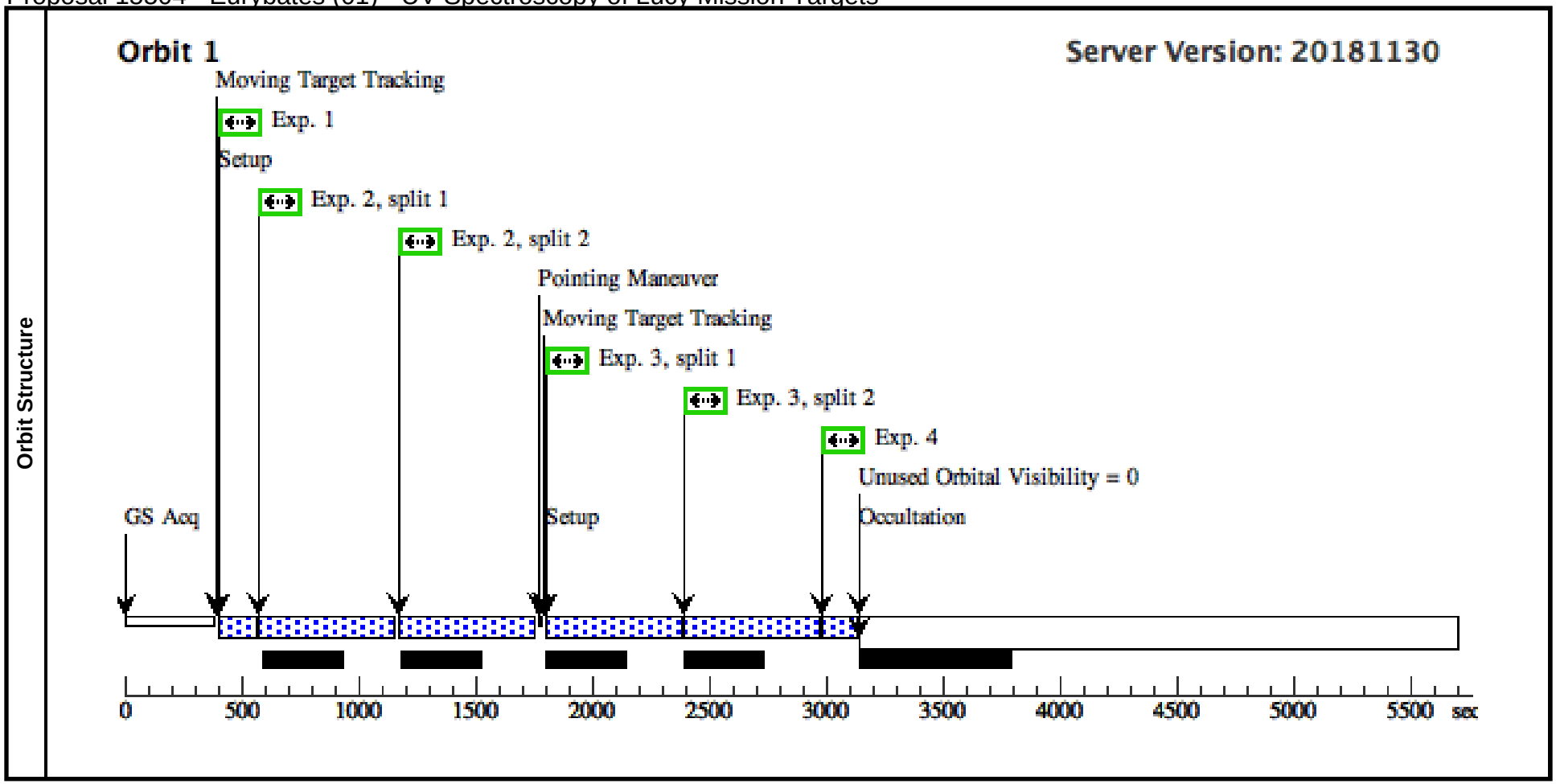
Solar System Targets

#	Name	Level 1	Level 2	Level 3	Window	Ephem Center
(1)	3548-EURYBATES	TYPE=ASTEROID,A=5.17511511350 6851,E=0.0909488607811488,I=8.071 6342051452 ,O=43.54663408449642,W=26.974299 21064895,M=52.17891051251581,EQ UINOX=J2000,EPOCH=17-FEB- 2012:00:00:00,EpochTimeScale=TDB				EARTH

Comments: Description=LR, C-type
Extended=NO

Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	Eurybates-Direct Image A (WFC3UVIS.im.1184523)	(1) 3548-EURYBATES	WFC3/UVIS, ACCUM, G280-REF	F300X	FLASH=12	POS TARG null,-50	Sequence 1-4 Non-Int in Eurybates (01)	25 Secs (5 Secs) *[==>5.0 Secs]*	***[1]***
2	Eurybates- Spec 1 (WFC3UVIS.sp.1187686)	(1) 3548-EURYBATES	WFC3/UVIS, ACCUM, UVIS	G280	CR-SPLIT=2	POS TARG null,-50	Sequence 1-4 Non-Int in Eurybates (01)	964 Secs (924 Secs) *[==>462.0 Secs (Split 1)]* *[==>462.0 Secs (Split 2)]*	***[1]***
3	Eurybates- Spec 2 (WFC3UVIS.sp.1187686)	(1) 3548-EURYBATES	WFC3/UVIS, ACCUM, UVIS	G280	CR-SPLIT=2	POS TARG 1.287,-48.622	Sequence 1-4 Non-Int in Eurybates (01)	964 Secs (924 Secs) *[==>462.0 Secs (Split 1)]* *[==>462.0 Secs (Split 2)]*	***[1]***
4	Eurybates-Direct Image B (WFC3UVIS.im.1184523)	(1) 3548-EURYBATES	WFC3/UVIS, ACCUM, G280-REF	F300X	FLASH=12	POS TARG 1.287,-48.622	Sequence 1-4 Non-Int in Eurybates (01)	25 Secs (5 Secs) *[==>5.0 Secs]*	***[1]***


Orbit Structure
Orbit 1
Server Version: 20181130
Moving Target Tracking
Exp. 1
Setup
Exp. 2, split 1
Exp. 2, split 2
Pointing Maneuver
Moving Target Tracking
Exp. 3, split 1
Exp. 3, split 2
Exp. 4
Unused Orbital Visibility = 0
GS Acq
Setup
Occultation
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
sec

Visit

Proposal 15504, Orus (02), implementation Mon Dec 10 22:07:32 GMT 2018

Diagnostic Status: Warning

Scientific Instruments: WFC3/UVIS

Special Requirements: BETWEEN 30-AUG-2019:00:00:00 AND 01-SEP-2019:00:00:00; BETWEEN 01-SEP-2019:12:00:00 AND 03-SEP-2019:03:00:00; BETWEEN 03-SEP-2019:09:00:00 AND 04-SEP-2019:01:00:00; BETWEEN 04-SEP-2019:06:00:00 AND 07-SEP-2019:21:00:00

Comments: This observation is organized as followed:

1. Direct Image A. exposure time=25 seconds. post flash=12
Pos Targ X=0, Y=-50 to get it in the center of chip 2.

2. Spec 1. exposure time=964 seconds, cr_split=2.
Pos Targ X=0, Y=-50.

dither= 13x distance of WFC3-UVIS-DITHER-LINE. (point spacing 0.145 x 13= 1.885")
3. Spec 2. exposure time=964 seconds, cr_split=2.
Pos Targ X=1.287, Y=-48.622

4. Direct Image B. exposure time=25 seconds. post flash=12
Pos Targ X=1.287, Y=-48.622

1 & 2 are at the same position, 3 & 4 are at the same position. These are paired to place the direct image in the same location as the dispersed images.

The observability windows are dictated by V<17.15 (with lightcurve added V<17.33). This window opens on Aug 30 and closes on Sep 7 2019. The specific windows were determined by investigating when other bright and/or numerous objects would be in the field.

Diagnostics

(Orus (02)) Warning (Orbit Planner): ORBITAL VISIBILITY OVERRUN

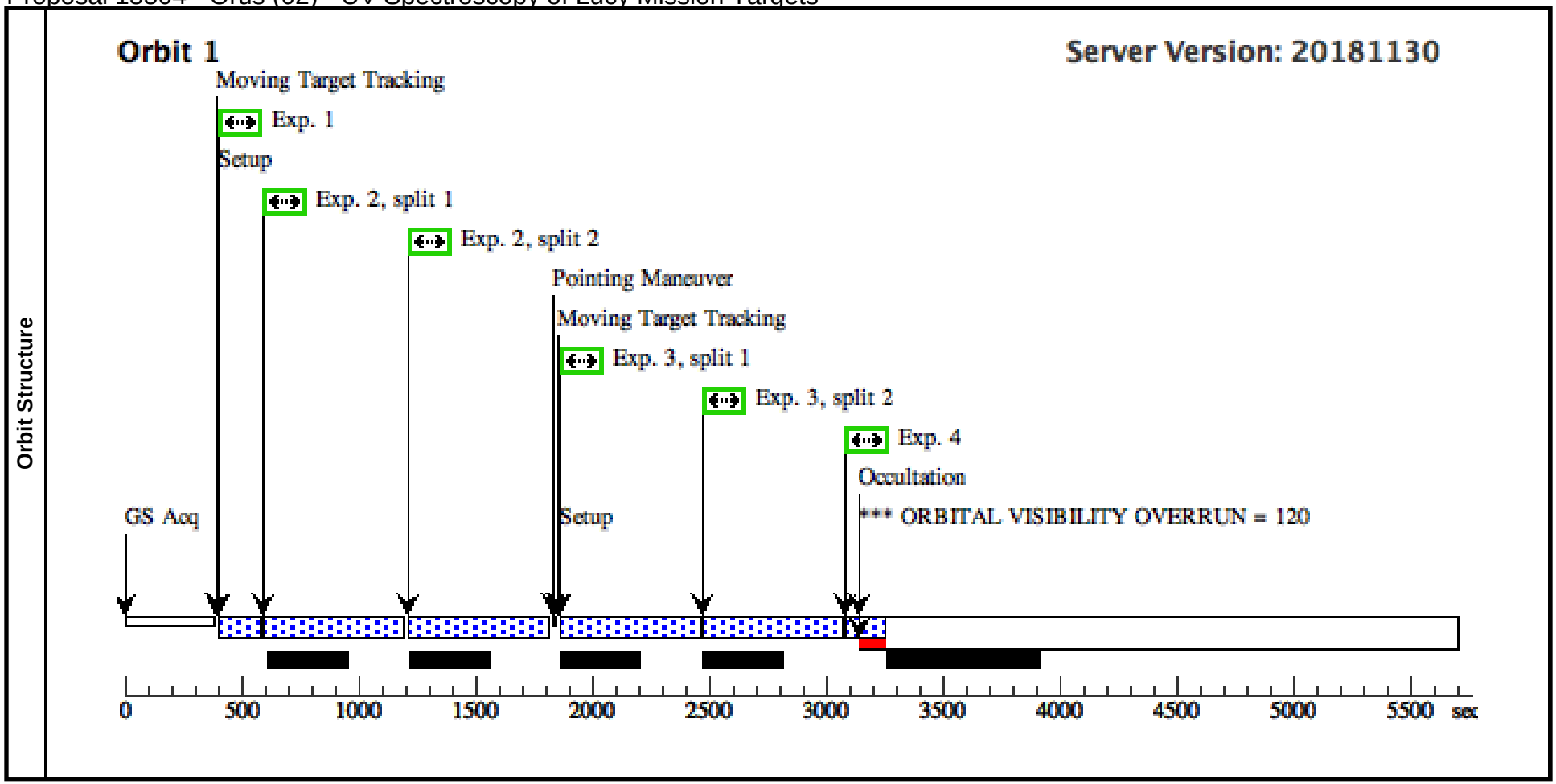
Solar System Targets

#	Name	Level 1	Level 2	Level 3	Window	Ephem Center
(2)	21900-ORUS	TYPE=ASTEROID,A=5.13644628693 4752,E=0.03797045685102873,I=8.46 4167968557787 ,O=258.5899988741201,W=182.45037 1734245,M=21.30651185899933,EQU INOX=J2000,EPOCH=29-MAY- 2012:00:00:00,EpochTimeScale=TDB				EARTH

Comments: Description=R, D-type
Extended=NO

Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	Orus- Direct Image A (WFC3UVIS.im.1192230)	(2) 21900-ORUS	WFC3/UVIS, ACCUM, G280-REF	F300X	FLASH=12	POS TARG null,-50	Sequence 1-4 Non-Int in Orus (02)	25 Secs (25 Secs) *[==>]*	***[1]***
2	Orus- Spec 1 (WFC3UVIS.sp.1192216)	(2) 21900-ORUS	WFC3/UVIS, ACCUM, UVIS	G280	CR-SPLIT=2	POS TARG null,-50	Sequence 1-4 Non-Int in Orus (02)	964 Secs (964 Secs) *[==>(Split 1)]* *[==>(Split 2)]*	***[1]***
3	Orus- Spec 2 (WFC3UVIS.sp.1192216)	(2) 21900-ORUS	WFC3/UVIS, ACCUM, UVIS	G280	CR-SPLIT=2	POS TARG 1.287,-48.622	Sequence 1-4 Non-Int in Orus (02)	964 Secs (964 Secs) *[==>(Split 1)]* *[==>(Split 2)]*	***[1]***
4	Orus- Direct Image B (WFC3UVIS.im.1192230)	(2) 21900-ORUS	WFC3/UVIS, ACCUM, G280-REF	F300X	FLASH=12	POS TARG 1.287,-48.622	Sequence 1-4 Non-Int in Orus (02)	25 Secs (25 Secs) *[==>]*	***[1]***


Orbit Structure
Orbit 1
Server Version: 20181130
Moving Target Tracking
Exp. 1
Setup
Exp. 2, split 1
Exp. 2, split 2
Pointing Maneuver
Moving Target Tracking
Exp. 3, split 1
Exp. 3, split 2
Exp. 4
Occultation
*** ORBITAL VISIBILITY OVERRUN = 120
GS Acq
Setup
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
sec