15328 - Orbital period and formation process of the exceptional binary asteroid system 288P

Cycle: 25, 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) 288P	WFC3/UVIS	1	16-Jan-2018 15:01:28.0	yes
02	(1) 288P	WFC3/UVIS	1	16-Jan-2018 15:01:29.0	yes
03	(1) 288P	WFC3/UVIS	1	16-Jan-2018 15:01:30.0	yes
04	(1) 288P	WFC3/UVIS	1	16-Jan-2018 15:01:31.0	yes
05	(1) 288P	WFC3/UVIS	1	16-Jan-2018 15:01:32.0	yes
06	(1) 288P	WFC3/UVIS	1	16-Jan-2018 15:01:33.0	yes

6 Total Orbits Used

ABSTRACT

The 288P (300163) binary asteroid system is unique and puzzling for its unusual combination of properties. It combines a wide separation with near-equal component sizes, and a high eccentricity with alignment of the mutual and heliocentric orbital planes. In addition, it is one of five known active asteroids with sublimation-driven dust production. Orbital fits to high-resolution data obtained in Cycle 24 are inconclusive regarding the orbital period and therefore the total angular momentum content, crucial to discriminate between formation of the binary system via rotational fission or impact. We request five orbits of HST/WFC3 time to measure the time evolution of the component separation under the favourable viewing geometry along the system's minor axis around the perigee passage in December 2017, to constrain with high certainty the orbital period and eccentricity of the system, and therefore its total angular momentum content. This is crucial to discriminate between the two formation scenarios and to understand the connection between the activity and the binary nature. As 288P is heading towards aphelion, the next opportunity to resolve its components will be in 2021.

OBSERVING DESCRIPTION

We propose to observe 288P at five epochs between 2017 August and 2018 February. The timing of each visit is flexible within +/-1 week. The first two visits will distiguish between different groups of orbit solutions compatible with Cycle 24 data. Visits 3-5 will serve to constrain the eccentricity of a Group 1 orbit, and to search for changes in the orbital elements induced by the activity. All five orbits will be suited for the search for additional satellites.

We expect each component to have V~22. The orbital visibility for a solar system target near the ecliptic plane is 54 min (Section 6.3 of the HST Primer document).
In each orbit, we will take 8 exposures of ~225s using the 1k subarray of WFC3 and perform a subsampling dither box pattern, obtaining 2 exposures at each dither point. We will carefully drizzle our subsampled images to a finer output pixel scale to extract the extra spatial information gathered by our subsampling strategy. This enhanced resolution will give us the highest accuracy in measuring the projected component distance and thus constrain their mutual orbit. The dithering will also enable us to reject hot pixels and cosmic ray hits.

This strategy gives us a total exposure time of 1800s = 30min, and estimated overheads of 6min for guide-star acquisition, 2.6min for the first exposure, a total of 14.7min for the subsequent 7 exposures, and 1.5min for the three spacecraft maneuvers required for dithering, which adds up to a total execution time of 54min per orbit. This dither strategy is identical to the one employed successfully during Cycle 24, ensuring maximum

comparability of the data.

We will use the wide bandpass filter F606W for an optimum trade-off between sensitivity and highest resolution: the bandpass (475 -- 700 nm) covers the maximum of the solar spectrum, and is in the wavelength range where the PSF is smallest (FWHM<0.07 arcsec, from the WFC3 Instrument Handbook for Cycle 25), such that we can optimally exploit our subsampling dither strategy. In addition, F606W is the same filter we used to observe 288P in GO 12597, 14790, 14864, and 14884, enabling a direct comparison of the data sets.

The WFC3 exposure time calculator returns for a solar-spectrum point source at V=22, exposure time of 225s, F606W filter, and default background values a signal-to-noise-ratio of 79 within a circle of 0.08 arcsec (ETC Request ID: WFC3UVIS.im.939003). The small aperture is needed to separate the fluxes from the two components as far as possible given the expected overlapping of the PSFs. A point source at V=27.4 will be detectable at SNR=5 in the standard 0.2arcsec aperture after stacking all eight exposures, allowing us to search for additional satellites down to a diameter of 130m that may have been hidden in the dust during all previous HST observations of the system (for an assumed geometric albedo of 0.04, heliocentric and geocentric distances of 3 and 2 AU, respectively, and during opposition).

To discriminate between different orbital period regimes (Group 2 vs. Group 1+3), it is critical that the system be observed at very specific times, when the predicted component separation differs maximally between the two regimes. Therefore, Visits 1 and 2 should be scheduled within +/-1 week of 2017 August 28 and November 16. Visits 3 - 5 should follow in ~1 month steps between late December and late February to take full advantage of the perigee passage on December 31, ensuring maximum angular separation and maximum sensitivity of the component separation to the eccentricity at apoapsis.

The optimum timing of Visit 1 implies that we request early implementation a month prior to the beginning of Cycle 25 (change request 88265 submitted on June 29, 2017). We could not request this observation in a Cycle 24 mid-cycle proposal, because the last data on which the current orbit fit is based were aquired only one day prior to the second mid-cycle deadline.

Visit

Proposal 15328, Visit 01, completed Tue Jan 16 20:01:34 GMT 2018

Diagnostic Status: Warning

Scientific Instruments: WFC3/UVIS

Special Requirements: BETWEEN 21-AUG-2017:00:00:00 AND 04-SEP-2017:00:00:00

Diagnostics

(Exposure 1 (Pattern 1, Exps 1-1 in Visit 01)) Warning (Form): FLASH level may be too low for this exposure or a short subexposure. See extended explanation in the diagnostic browser

Patterns

#	Primary Pattern		Secondary Pattern	Exposures
(1)	Pattern Type=WFC3-UVIS-DITHER-BOX Purpose=DITHER Number Of Points=4 Point Spacing=0.173 Line Spacing=0.112	Coordinate Frame=POS-TARG Pattern Orientation=23.884 Angle Between Sides=81.785 Center Pattern=false		(1)

Solar System Targets

#	Name	Level 1	Level 2	Level 3	Window	Ephem Center
(1)	288P	TYPE=COMET,Q=2.433757796112896,E=0.201280124072449,I=3.240701450960771,O=83.19018988764668,W=281.3064762224968,T=16-JUL-2011:11:50:43,TTimeScale=TDB,EQUINOX=J2000,EPOCH=18-AUG-2013:00:00:00,EpochTimeScale=TDB				EARTH

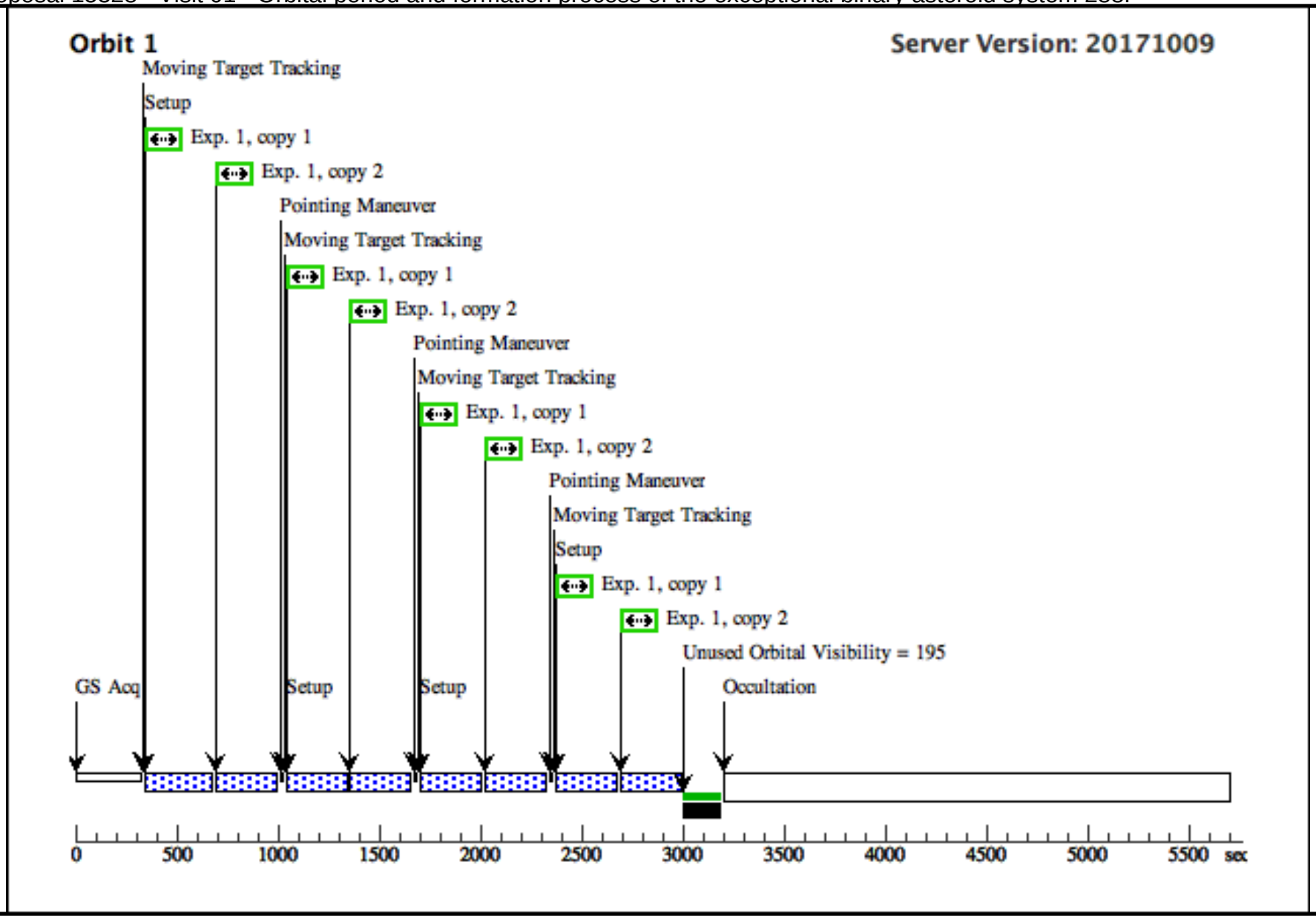
Comments: Extended=NO

Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	(WFC3UVIS.im.1004647)	(1) 288P	WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB	F606W	CR-SPLIT=NO		Pattern 1, Exps 1-1 in Visit 01 (1)	230 Secs X 2 (1840 Secs) *[==>(Pattern 1, Copy 1)]* *[==>(Pattern 1, Copy 2)]* *[==>(Pattern 2, Copy 1)]* *[==>(Pattern 2, Copy 2)]* *[==>(Pattern 3, Copy 1)]* *[==>(Pattern 3, Copy 2)]* *[==>(Pattern 4, Copy 1)]* *[==>(Pattern 4, Copy 2)]*	***[1]***

Comments: The flash warning is not triggered if running the ETC with the zodiacal light calculated for the actual sky positions of the target at the targeted epochs of visits 1-5. The background is on Aug-20 45 e-/px, and between 17 and 20 e-/px for visits 2-5. (ETC runs WFC3UVIS.im.1004647, 1004651, 1004654,1004655, 1004656).

Orbit Structure



Visit

Proposal 15328, Visit 02, completed Tue Jan 16 20:01:34 GMT 2018

Diagnostic Status: Warning

Scientific Instruments: WFC3/UVIS

Special Requirements: BETWEEN 09-NOV-2017:00:00:00 AND 23-NOV-2017:00:00:00

Diagnostics

(Exposure 1 (Pattern 1, Exps 1-1 in Visit 02)) Warning (Form): FLASH level may be too low for this exposure or a short subexposure. See extended explanation in the diagnostic browser

Patterns

#	Primary Pattern		Secondary Pattern	Exposures
(1)	Pattern Type=WFC3-UVIS-DITHER-BOX Purpose=DITHER Number Of Points=4 Point Spacing=0.173 Line Spacing=0.112	Coordinate Frame=POS-TARG Pattern Orientation=23.884 Angle Between Sides=81.785 Center Pattern=false		(1)

Solar System Targets

#	Name	Level 1	Level 2	Level 3	Window	Ephem Center
(1)	288P	TYPE=COMET,Q=2.433757796112896,E=0.201280124072449,I=3.240701450960771,O=83.19018988764668,W=281.3064762224968,T=16-JUL-2011:11:50:43,TTimeScale=TDB,EQUINOX=J2000,EPOCH=18-AUG-2013:00:00:00,EpochTimeScale=TDB				EARTH

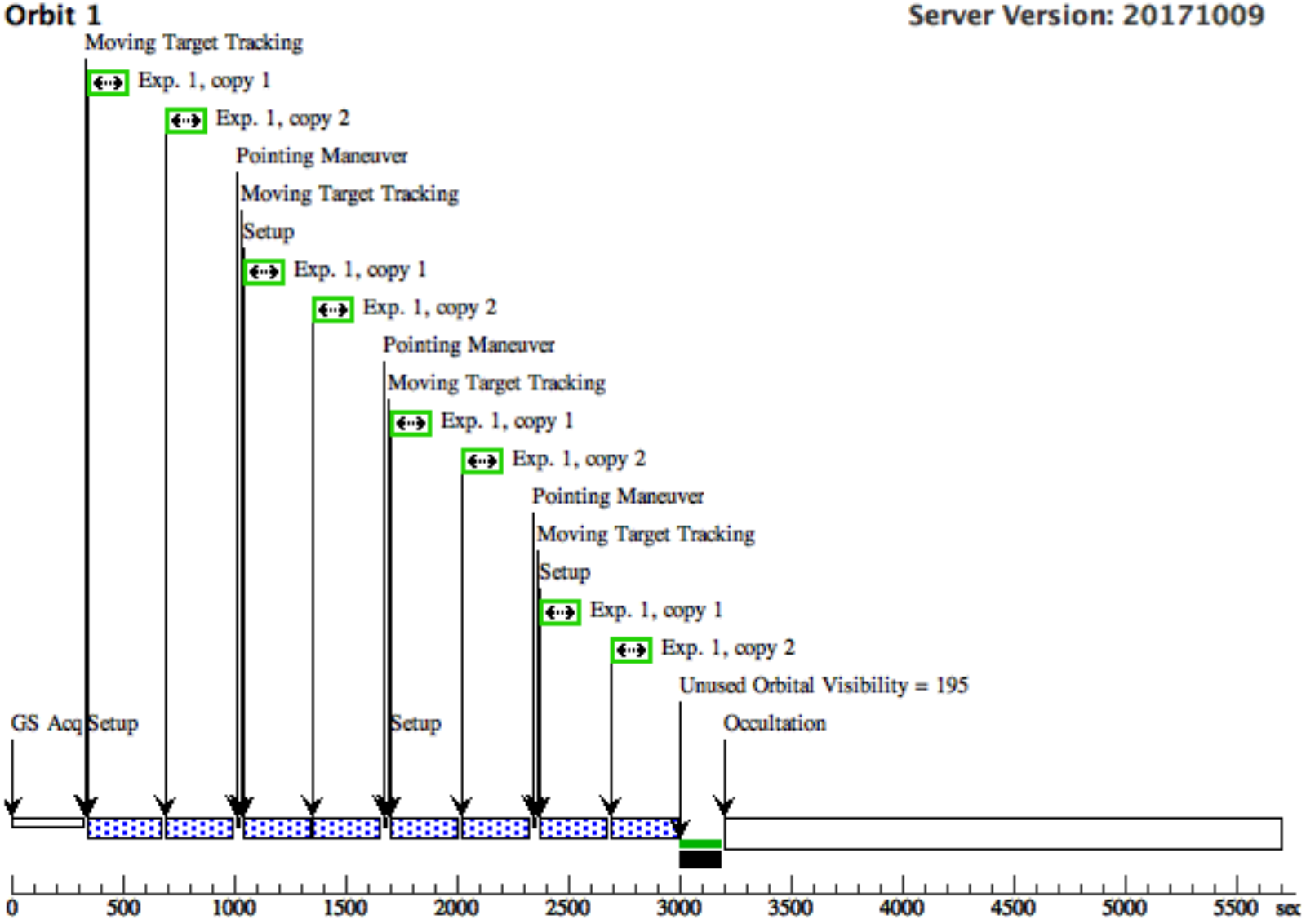
Comments: Extended=NO

Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	(WFC3UVIS.im.1004647)	(1) 288P	WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB	F606W	CR-SPLIT=NO		Pattern 1, Exps 1-1 in Visit 02 (1)	230 Secs X 2 (1840 Secs) *[==>(Pattern 1, Copy 1)]* *[==>(Pattern 1, Copy 2)]* *[==>(Pattern 2, Copy 1)]* *[==>(Pattern 2, Copy 2)]* *[==>(Pattern 3, Copy 1)]* *[==>(Pattern 3, Copy 2)]* *[==>(Pattern 4, Copy 1)]* *[==>(Pattern 4, Copy 2)]*	***[1]***

Comments: The flash warning is not triggered if running the ETC with the zodiacal light calculated for the actual sky positions of the target at the targeted epochs of visits 1-5. The background is on Aug-20 45 e-/px, and between 17 and 20 e-/px for visits 2-5. (ETC runs WFC3UVIS.im.1004647, 1004651, 1004654,1004655, 1004656).

Orbit Structure



Visit

Proposal 15328, Visit 03, failed Tue Jan 16 20:01:34 GMT 2018

Diagnostic Status: Warning

Scientific Instruments: WFC3/UVIS

Special Requirements: BETWEEN 24-DEC-2017:00:00:00 AND 07-JAN-2018:00:00:00

Diagnostics

(Exposure 1 (Pattern 1, Exps 1-1 in Visit 03)) Warning (Form): FLASH level may be too low for this exposure or a short subexposure. See extended explanation in the diagnostic browser

Patterns

#	Primary Pattern		Secondary Pattern	Exposures
(1)	Pattern Type=WFC3-UVIS-DITHER-BOX Purpose=DITHER Number Of Points=4 Point Spacing=0.173 Line Spacing=0.112	Coordinate Frame=POS-TARG Pattern Orientation=23.884 Angle Between Sides=81.785 Center Pattern=false		(1)

Solar System Targets

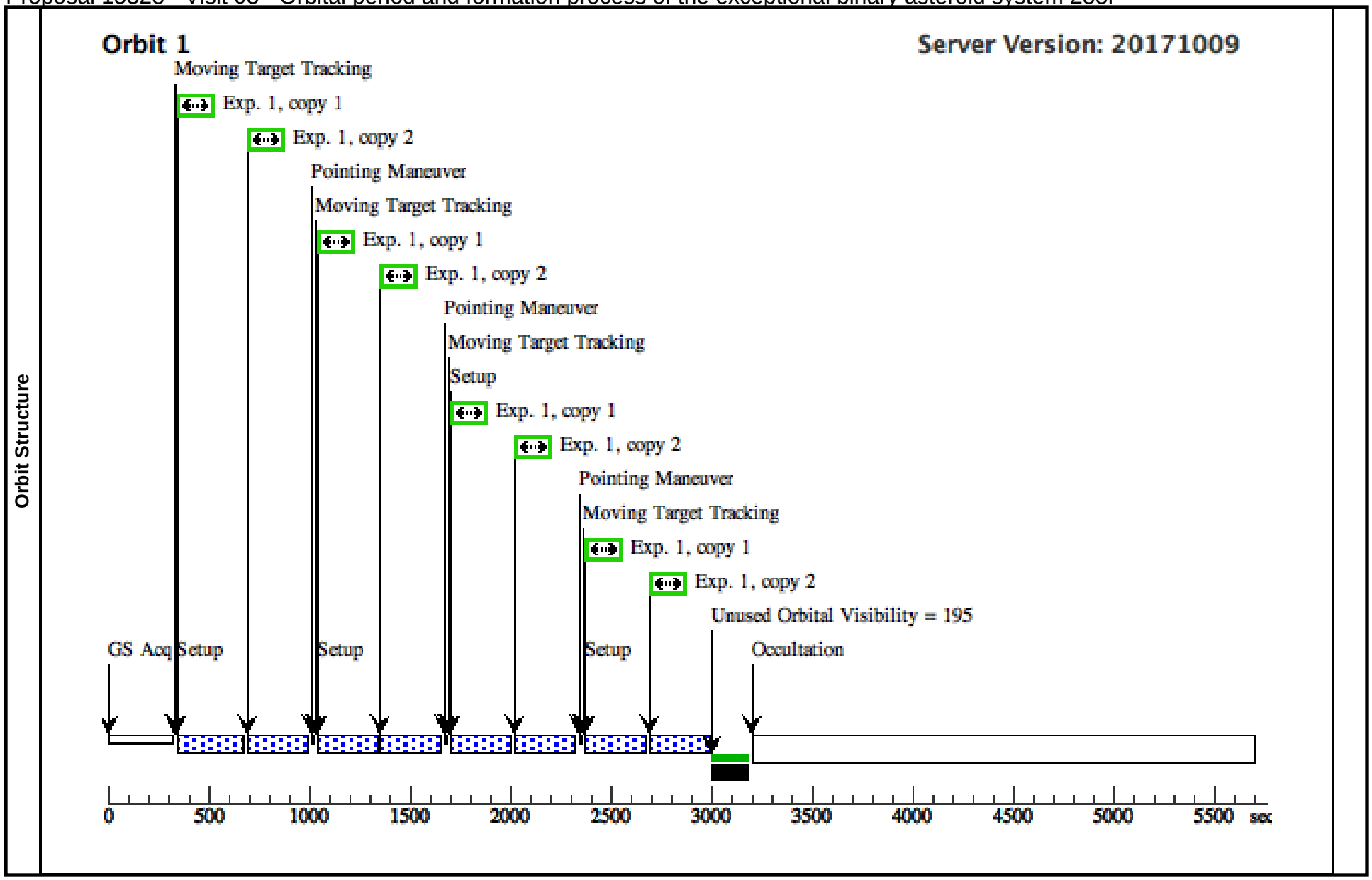
#	Name	Level 1	Level 2	Level 3	Window	Ephem Center
(1)	288P	TYPE=COMET,Q=2.433757796112896,E=0.201280124072449,I=3.240701450960771,O=83.19018988764668,W=281.3064762224968,T=16-JUL-2011:11:50:43,TTimeScale=TDB,EQUINOX=J2000,EPOCH=18-AUG-2013:00:00:00,EpochTimeScale=TDB				EARTH

Comments: Extended=NO

Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	(WFC3UVIS.im.1004647)	(1) 288P	WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB	F606W	CR-SPLIT=NO		Pattern 1, Exps 1-1 in Visit 03 (1)	230 Secs X 2 (1840 Secs) *[==>(Pattern 1, Copy 1)]* *[==>(Pattern 1, Copy 2)]* *[==>(Pattern 2, Copy 1)]* *[==>(Pattern 2, Copy 2)]* *[==>(Pattern 3, Copy 1)]* *[==>(Pattern 3, Copy 2)]* *[==>(Pattern 4, Copy 1)]* *[==>(Pattern 4, Copy 2)]*	***[1]***

Comments: The flash warning is not triggered if running the ETC with the zodiacal light calculated for the actual sky positions of the target at the targeted epochs of visits 1-5. The background is on Aug-20 45 e-/px, and between 17 and 20 e-/px for visits 2-5. (ETC runs WFC3UVIS.im.1004647, 1004651, 1004654,1004655, 1004656).


Orbit 1
Server Version: 20171009
Orbit Structure
Moving Target Tracking
Exp. 1, copy 1
Exp. 1, copy 2
Pointing Maneuver
Moving Target Tracking
Exp. 1, copy 1
Exp. 1, copy 2
Pointing Maneuver
Moving Target Tracking
Setup
Exp. 1, copy 1
Exp. 1, copy 2
Pointing Maneuver
Moving Target Tracking
Exp. 1, copy 1
Exp. 1, copy 2
Unused Orbital Visibility = 195
GS Acq Setup
Setup
Setup
Occultation
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
sec

Visit

Proposal 15328, Visit 04, scheduling Tue Jan 16 20:01:34 GMT 2018

Diagnostic Status: Warning

Scientific Instruments: WFC3/UVIS

Special Requirements: BETWEEN 24-JAN-2018:00:00:00 AND 07-FEB-2018:00:00:00

Diagnostics

(Exposure 1 (Pattern 1, Exps 1-1 in Visit 04)) Warning (Form): FLASH level may be too low for this exposure or a short subexposure. See extended explanation in the diagnostic browser

Patterns

#	Primary Pattern		Secondary Pattern	Exposures
(1)	Pattern Type=WFC3-UVIS-DITHER-BOX Purpose=DITHER Number Of Points=4 Point Spacing=0.173 Line Spacing=0.112	Coordinate Frame=POS-TARG Pattern Orientation=23.884 Angle Between Sides=81.785 Center Pattern=false		(1)

Solar System Targets

#	Name	Level 1	Level 2	Level 3	Window	Ephem Center
(1)	288P	TYPE=COMET,Q=2.433757796112896,E=0.201280124072449,I=3.240701450960771,O=83.19018988764668,W=281.3064762224968,T=16-JUL-2011:11:50:43,TTimeScale=TDB,EQUINOX=J2000,EPOCH=18-AUG-2013:00:00:00,EpochTimeScale=TDB				EARTH

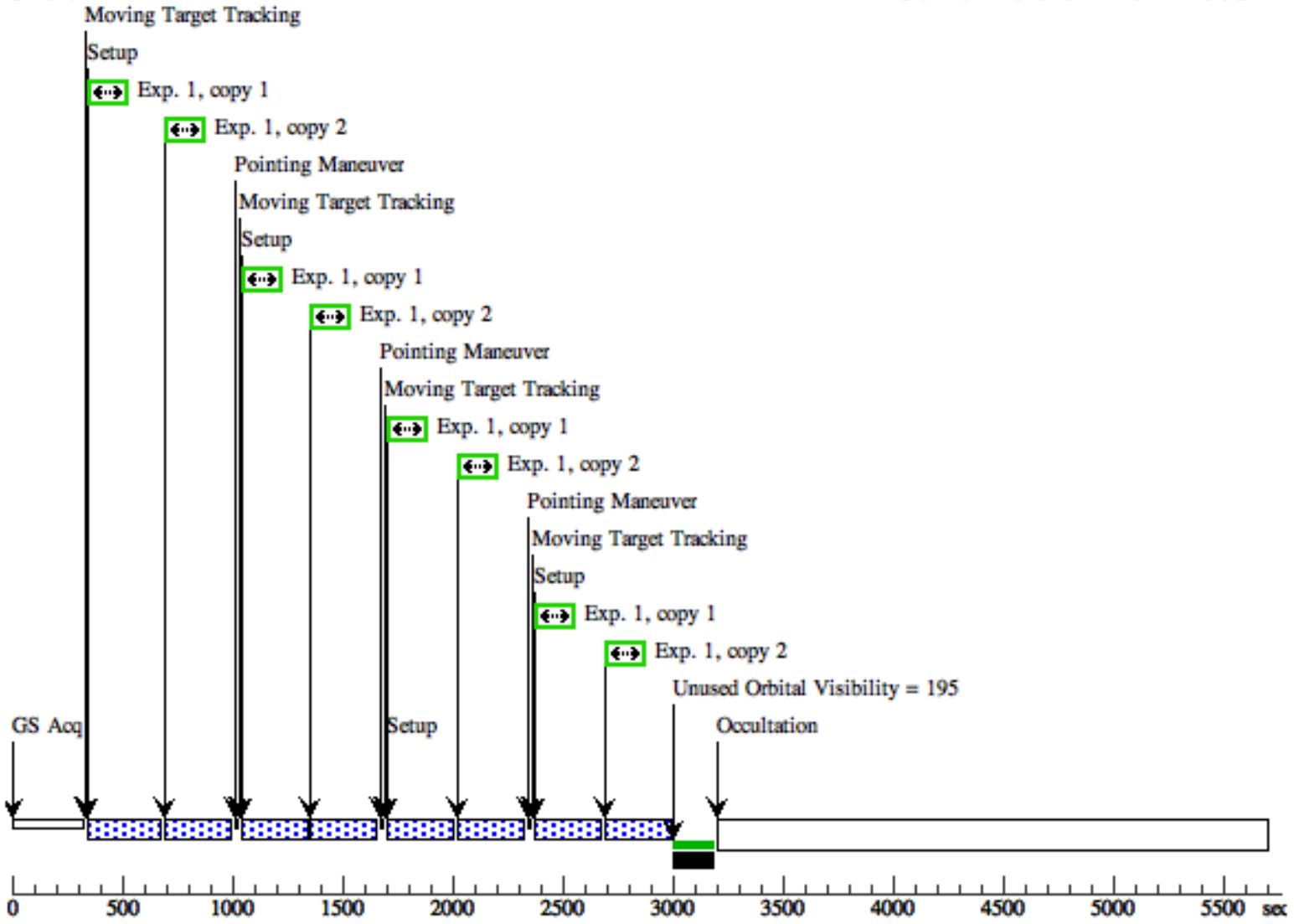
Comments: Extended=NO

Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	(WFC3UVIS.im.1004647)	(1) 288P	WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB	F606W	CR-SPLIT=NO		Pattern 1, Exps 1-1 in Visit 04 (1)	230 Secs X 2 (1840 Secs) *[==>(Pattern 1, Copy 1)]* *[==>(Pattern 1, Copy 2)]* *[==>(Pattern 2, Copy 1)]* *[==>(Pattern 2, Copy 2)]* *[==>(Pattern 3, Copy 1)]* *[==>(Pattern 3, Copy 2)]* *[==>(Pattern 4, Copy 1)]* *[==>(Pattern 4, Copy 2)]*	***[1]***

Comments: The flash warning is not triggered if running the ETC with the zodiacal light calculated for the actual sky positions of the target at the targeted epochs of visits 1-5. The background is on Aug-20 45 e-/px, and between 17 and 20 e-/px for visits 2-5. (ETC runs WFC3UVIS.im.1004647, 1004651, 1004654,1004655, 1004656).

Orbit Structure



Visit

Proposal 15328, Visit 05, implementation Tue Jan 16 20:01:34 GMT 2018

Diagnostic Status: Warning

Scientific Instruments: WFC3/UVIS

Special Requirements: BETWEEN 24-FEB-2018:00:00:00 AND 10-MAR-2018:00:00:00

Diagnostics

(Exposure 1 (Pattern 1, Exps 1-1 in Visit 05)) Warning (Form): FLASH level may be too low for this exposure or a short subexposure. See extended explanation in the diagnostic browser

Patterns

#	Primary Pattern		Secondary Pattern	Exposures
(1)	Pattern Type=WFC3-UVIS-DITHER-BOX Purpose=DITHER Number Of Points=4 Point Spacing=0.173 Line Spacing=0.112	Coordinate Frame=POS-TARG Pattern Orientation=23.884 Angle Between Sides=81.785 Center Pattern=false		(1)

Solar System Targets

#	Name	Level 1	Level 2	Level 3	Window	Ephem Center
(1)	288P	TYPE=COMET,Q=2.433757796112896,E=0.201280124072449,I=3.240701450960771,O=83.19018988764668,W=281.3064762224968,T=16-JUL-2011:11:50:43,TTimeScale=TDB,EQUINOX=J2000,EPOCH=18-AUG-2013:00:00:00,EpochTimeScale=TDB				EARTH

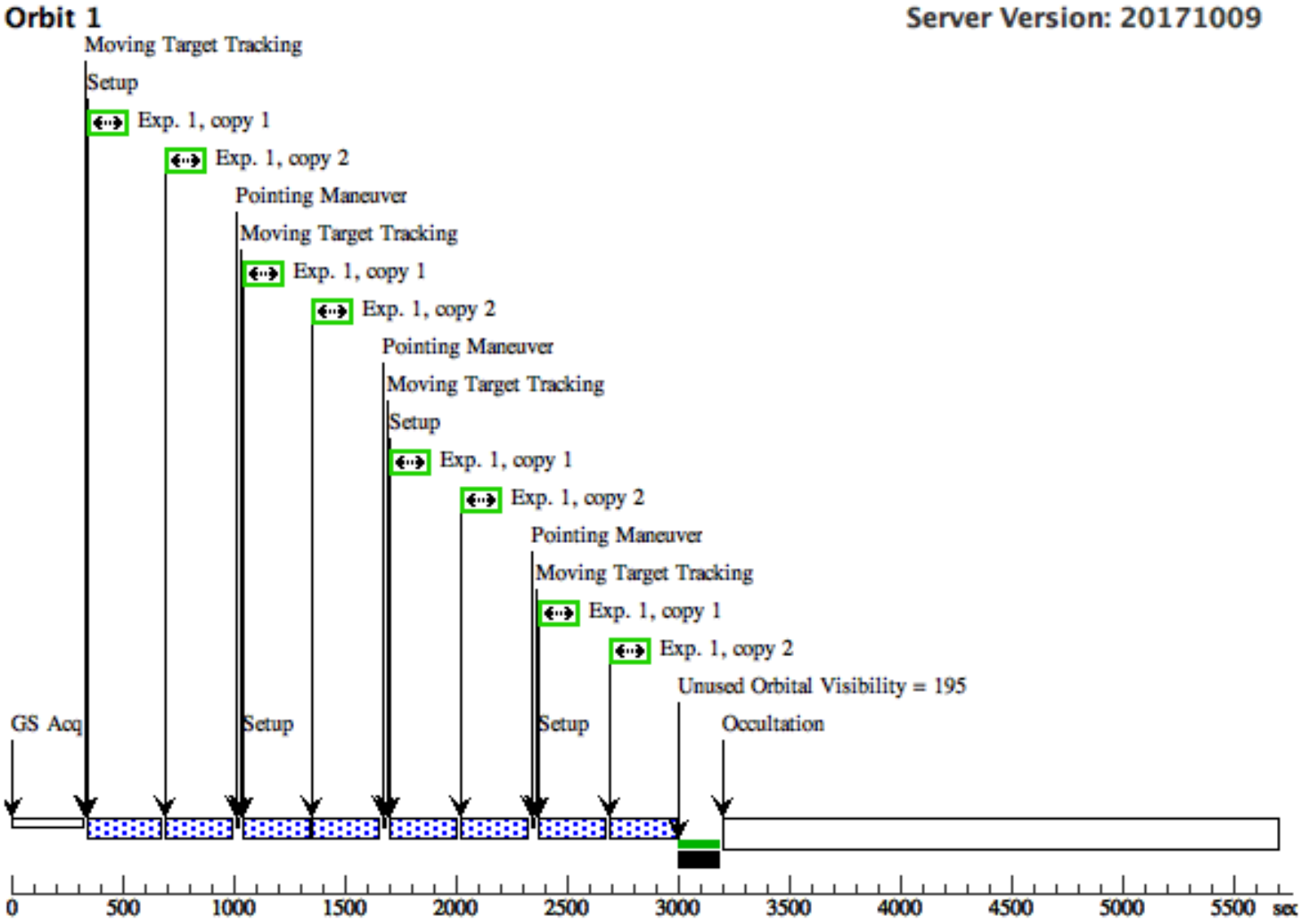
Comments: Extended=NO

Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	(WFC3UVIS.im.1004647)	(1) 288P	WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB	F606W	CR-SPLIT=NO		Pattern 1, Exps 1-1 in Visit 05 (1)	230 Secs X 2 (1840 Secs) *[==>(Pattern 1, Copy 1)]* *[==>(Pattern 1, Copy 2)]* *[==>(Pattern 2, Copy 1)]* *[==>(Pattern 2, Copy 2)]* *[==>(Pattern 3, Copy 1)]* *[==>(Pattern 3, Copy 2)]* *[==>(Pattern 4, Copy 1)]* *[==>(Pattern 4, Copy 2)]*	***[1]***

Comments: The flash warning is not triggered if running the ETC with the zodiacal light calculated for the actual sky positions of the target at the targeted epochs of visits 1-5. The background is on Aug-20 45 e-/px, and between 17 and 20 e-/px for visits 2-5. (ETC runs WFC3UVIS.im.1004647, 1004651, 1004654,1004655, 1004656).

Orbit Structure



Visit

Proposal 15328, Visit 06 Tue Jan 16 20:01:34 GMT 2018

Diagnostic Status: Warning

Scientific Instruments: WFC3/UVIS

Special Requirements: BETWEEN 06-MAY-2018:00:00:00 AND 20-MAY-2018:00:00:00

Diagnostics

(Exposure 1 (Pattern 1, Exps 1-1 in Visit 06)) Warning (Form): FLASH level may be too low for this exposure or a short subexposure. See extended explanation in the diagnostic browser

Patterns

#	Primary Pattern		Secondary Pattern	Exposures
(1)	Pattern Type=WFC3-UVIS-DITHER-BOX Purpose=DITHER Number Of Points=4 Point Spacing=0.173 Line Spacing=0.112	Coordinate Frame=POS-TARG Pattern Orientation=23.884 Angle Between Sides=81.785 Center Pattern=false		(1)

Solar System Targets

#	Name	Level 1	Level 2	Level 3	Window	Ephem Center
(1)	288P	TYPE=COMET,Q=2.433757796112896,E=0.201280124072449,I=3.240701450960771,O=83.19018988764668,W=281.3064762224968,T=16-JUL-2011:11:50:43,TTimeScale=TDB,EQUINOX=J2000,EPOCH=18-AUG-2013:00:00:00,EpochTimeScale=TDB				EARTH

Comments: Extended=NO

Exposures

#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1	(WFC3UVIS.im.1045051)	(1) 288P	WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB	F606W	CR-SPLIT=NO		Pattern 1, Exps 1-1 in Visit 06 (1)	230 Secs X 2 (1840 Secs) *[==>(Pattern 1, Copy 1)]* *[==>(Pattern 1, Copy 2)]* *[==>(Pattern 2, Copy 1)]* *[==>(Pattern 2, Copy 2)]* *[==>(Pattern 3, Copy 1)]* *[==>(Pattern 3, Copy 2)]* *[==>(Pattern 4, Copy 1)]* *[==>(Pattern 4, Copy 2)]*	***[1]***

Comments: The flash warning is not triggered if running the ETC with the zodiacal light calculated for the actual sky positions of the target at the targeted epoch of visit 6. The background on May-15 is 15 e-/px (ETC runs WFC3UVIS.im.1045051).

Orbit Structure