15623 - The Hill sphere of new active asteroid P/2018 P3 at high resolution

Cycle: 26, Proposal Category: GO/DD

(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) P2018P3	WFC3/UVIS	1	29-Nov-2018 12:01:40.0	yes
02	(2) P2018P3V2	WFC3/UVIS	1	29-Nov-2018 12:01:41.0	yes
03	(3) P2018P3V3	WFC3/UVIS	1	29-Nov-2018 12:01:42.0	yes

3 Total Orbits Used

ABSTRACT

We request 3 orbits of DD time to study the newly discovered active asteroid P/2018 P3 at superb spatial resolution (<30km) of its Hill sphere. This resolution is facilitated by the asteroid's close perigee passage in late September, and will enable us to perform a sensitive search for both indications of a wide binary system, and gravitationally unbound fragments resulting from a (near-)catastrophic collision. The results will help us to constrain the

process behind the activity of P3. We will also study the 3-dimensional motion of dust from P3, putting additional constraint on the type of activity. The processes triggering and sustaining asteroid activity are currently not well understood, but they are likely the same that drive the evolution and comminution of the asteroid population at large. Opportunities to resolve the Hill sphere of an active asteroid are rare, and the next such opportunity for P3 will only arise in 2023. Comparably favourable circumstances led to the discovery of the first known wide binary system with similarly sized components (288P) in 2016. It is subject to on-going research if the previously unobserved special configuration of 288P has been shaped by its activity or if the two are independent phenomena. The proposed observations can help to resolve this question.

OBSERVING DESCRIPTION

We observe active asteroid P3 during 3 visits of 1 orbit each between September and December 2018. The first visit should be scheduled as soon as possible to catch P3 near perihelion (October 08) and perigee (September 21). The second visit should be scheduled about two weeks after the first to study the motion of potential fragments or a binary system. Both these observations will be obtained while the Earth is above the orbital plane of P3. In order to study the 3D distribution of dust, constrain the orbit of a potential binary system, and measure the motion of potential slow and unbound fragments, the third visit should be scheduled well after the Earth's plane crossing on November 22, but while still a reasonable resolution of the Hill sphere can be obtained. The optimum time for visit 3 is therefore late December (plane angle ~-3.5deg, pixel scale ~44 km).

The predicted total magnitude of P3 is V=19.7 in late September, decreasing to 21.5 by late December. We expect that the nucleus or largest fragment will be 1-2 mag fainter, V = 22 - 23.

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. For the three single orbits we will 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 allow us to determine the relative position of fragments or binary components at the highest possible accuracy. 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 per orbit, 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.

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<0.07arcsec, from the WFC3 instrument handbook for Cycle 26), such that we can optimally exploit our subsampling dither strategy.

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 (S/N) of 80 within a circle of 0.08arcsec (ETC Request ID: WFC3UVIS.im.1285904). The small aperture is needed to separate the flux from the nucleus or fragment from that of the surrounding coma. A fragment with V=26 will be detected at S/N=8 (WFC3UVIS.im.1285906), such that we expect to detect fragments down to 180m diameter for standard assumptions on a C-type asteroid with geometric albedo p=0.06 \citep (Nugent et al., 2016) and phase function coefficient G=0.15 (Bowell et al. 1989).

The position uncertainty predicted for P3 at the end of September is currently large. However, continuing astrometry of this bright object will reduce this error to ~1arcsec by the time of the proposed first visit.

The maximum apparent motion of P3 is only ~25 arcsec/hr (0.0069 arcsec/s), which is well within Hubble's tracking capabilities.

Proposal 15623 - Visit 01 - The Hill sphere of new active asteroid P/2018 P3 at high resolution

Visit

Proposal 15623, Visit 01, completed Thu Nov 29 17:01:43 GMT 2018

Diagnostic Status: Warning

Scientific Instruments: WFC3/UVIS

Special Requirements: BETWEEN 22-SEP-2018:00:00:00 AND 10-OCT-2018:00:00:00

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)	P2018P3	TYPE=COMET,Q=1.756991698115274,E=0.4160241687876102,I=8.910116391330794,O=59.2365710289956,W=305.7892364559521,T=09-OCT-2018:07:56:52,TTimeScale=TDB,EQUINOX=J2000,EPOCH=22-AUG-2018:00:00:00,EpochTimeScale=TDB				EARTH

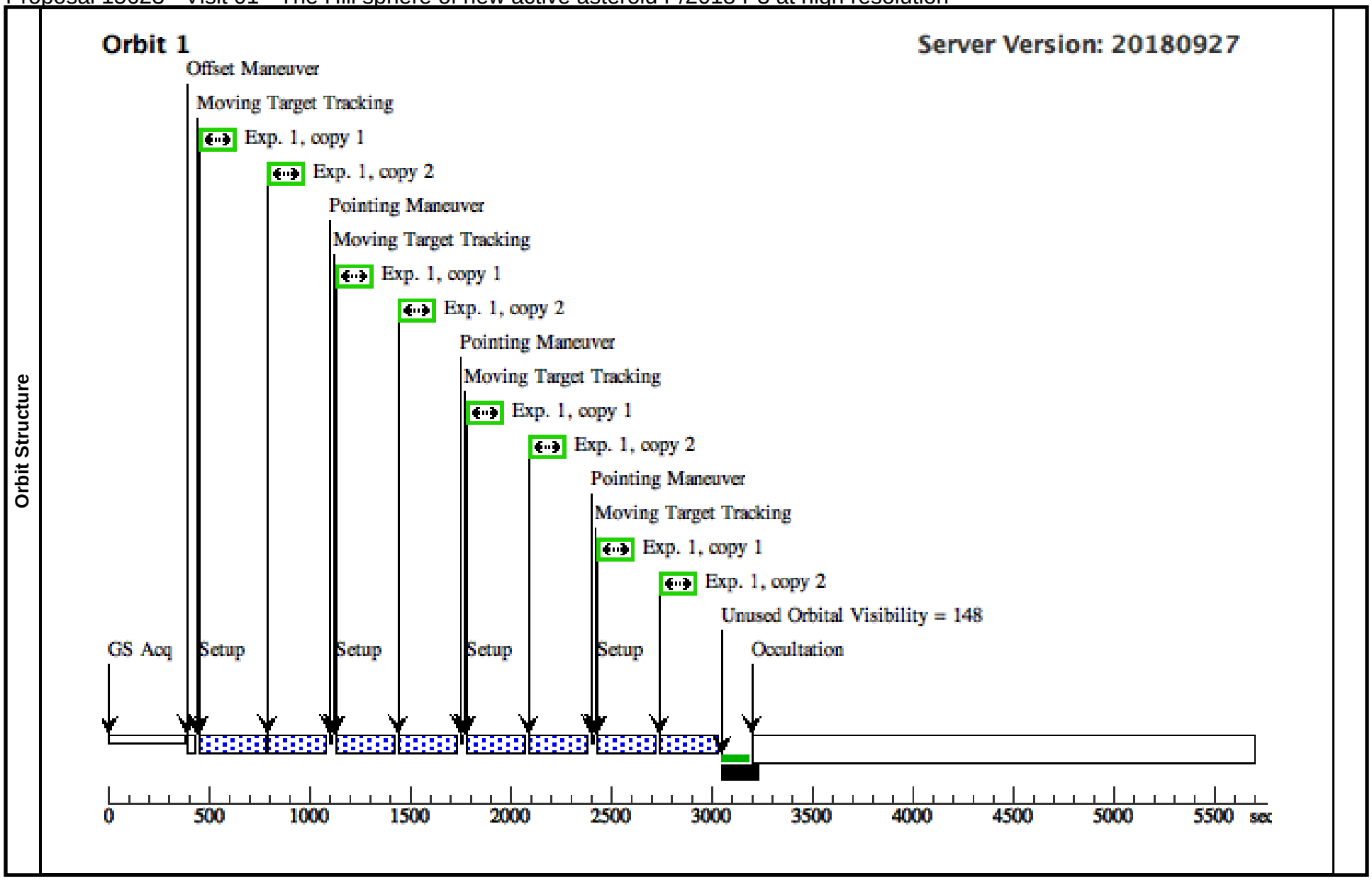
Comments: Description=COMET P/2018 P3

Ephemeris Uncertainty: 12000 Kilometers

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1		(1) P2018P3	WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB	F606W	CR-SPLIT=NO	REQ EPHEM CORR 0000V1	Pattern 1, Exps 1-1 in Visit 01 (1)	222 Secs X 2 (1776 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 level warning disappears if the ETC is run with the zodiacal light calculated for the specific sky position and time (30 Sep). The background level is then 15 e-/pix (ETC request WFC3UVIS.im.1287993).


Orbit 1
Server Version: 20180927
Orbit Structure
Offset Maneuver
Moving Target Tracking
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Exp. 1, copy 2
Pointing Maneuver
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
Exp. 1, copy 1
Exp. 1, copy 2
Unused Orbital Visibility = 148
GS Acq
Setup
Setup
Setup
Setup
Occultation
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
sec

Proposal 15623 - Visit 02 - The Hill sphere of new active asteroid P/2018 P3 at high resolution

Visit

Proposal 15623, Visit 02, completed Thu Nov 29 17:01:43 GMT 2018

Diagnostic Status: Warning

Scientific Instruments: WFC3/UVIS

Special Requirements: BETWEEN 12-NOV-2018:00:00:00 AND 19-DEC-2018:00:00:00

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
(2)	P2018P3V2	TYPE=COMET,Q=1.756522583690934,E=0.4158611818158186,I=8.909229937235208,O=59.21252717415003,W=305.8681459350315,T=09-OCT-2018:10:25:23,TTimeScale=TDB,EQUINOX=J2000,EPOCH=18-SEP-2018:00:00:00,EpochTimeScale=TDB				EARTH

Comments: Description=COMET P/2018 P3

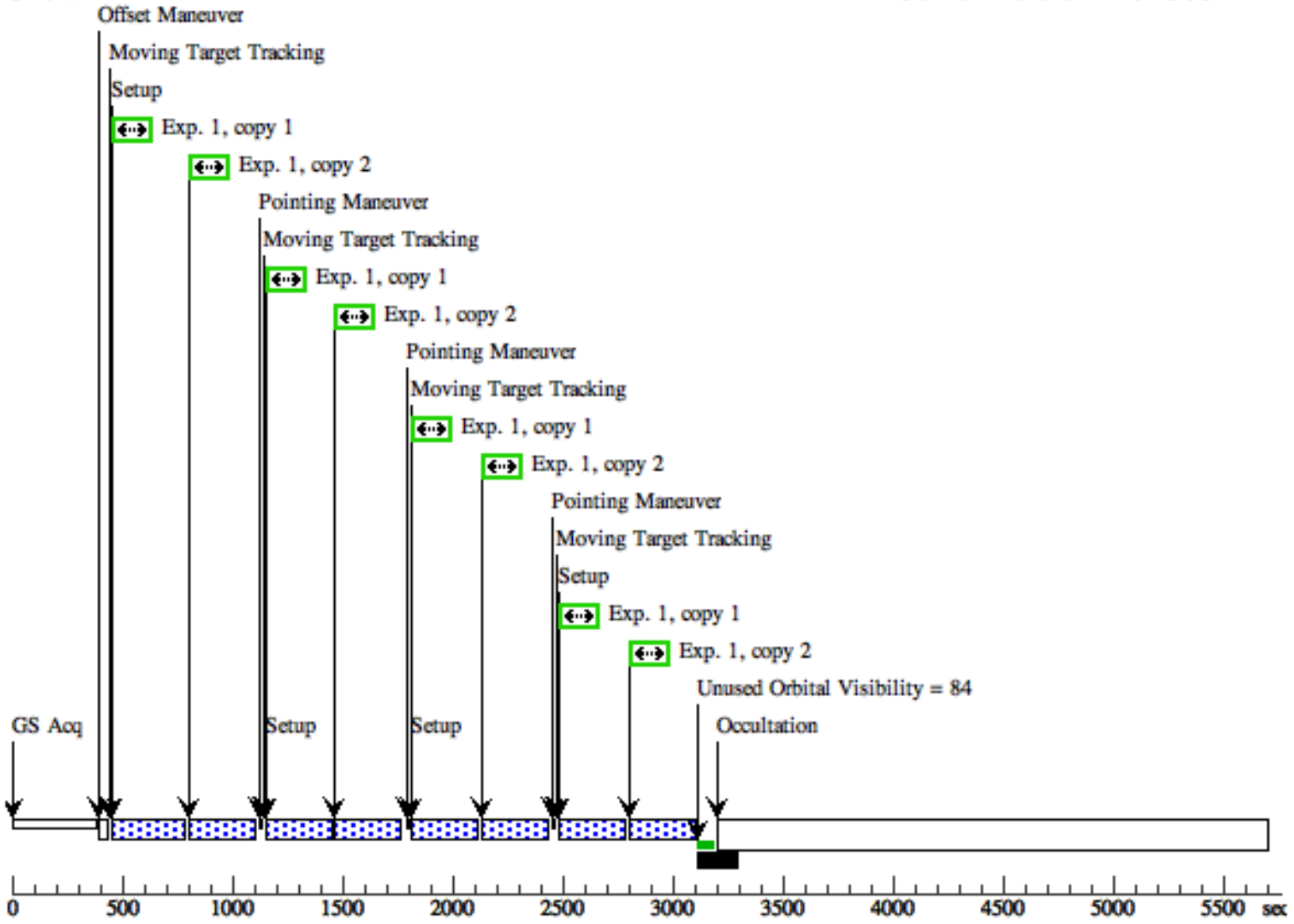
Ephemeris Uncertainty: 9000 Kilometers

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1		(2) P2018P3V2	WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB	F606W	CR-SPLIT=NO	REQ EPHEM CORR 0000V2	Pattern 1, Exps 1-1 in Visit 02 (1)	230 Secs X 2 (1840 Secs)	
								[==>(Pattern 1, Copy 1)]	***[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)]	

Comments: The FLASH level warning disappears if the ETC is run with the zodiacal light calculated for the specific sky position and time (15 Oct). The background level is then 15 e-/pix (ETC request WFC3UVIS.im.1287994).

Orbit Structure



Visit

Proposal 15623, Visit 03, implementation Thu Nov 29 17:01:43 GMT 2018

Diagnostic Status: Warning

Scientific Instruments: WFC3/UVIS

Special Requirements: BETWEEN 20-DEC-2018:00:00:00 AND 31-DEC-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
(3)	P2018P3V3	TYPE=COMET,Q=1.756522583690934,E=0.4158611818158186,I=8.909229937235208,O=59.21252717415003,W=305.8681459350315,T=09-OCT-2018:10:25:23,TTimeScale=TDB,EQUINOX=J2000,EPOCH=18-SEP-2018:00:00:00,EpochTimeScale=TDB				EARTH

Comments: Description=COMET P/2018 P3

Ephemeris Uncertainty: 9000 Kilometers

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1		(3) P2018P3V3	WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB	F606W	CR-SPLIT=NO	REQ EPHEM CORR 0000V3	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 level warning disappears if the ETC is run with the zodiacal light calculated for the specific sky position and time (25 Dec). The background level is then 21 e-/pix (ETC request WFC3UVIS.im.1287995).

Orbit Structure