



15706 - Causes of activity in newly discovered active asteroids P/2019 A4 and P/2019

A7

Cycle: 26, Proposal Category: GO
(Availability Mode: SUPPORTED)

INVESTIGATORS

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VISITS

<i>Visit</i>	<i>Targets used in Visit</i>	<i>Configurations used in Visit</i>	<i>Orbits Used</i>	<i>Last Orbit Planner Run</i>	<i>OP Current with Visit?</i>
01	(1) P2019A4-V1	WFC3/UVIS	1	15-Apr-2019 13:01:39.0	yes
02	(3) P2019A4-V2	WFC3/UVIS	1	15-Apr-2019 13:01:40.0	yes
03	(3) P2019A4-V2	WFC3/UVIS	1	15-Apr-2019 13:01:41.0	yes
04	(2) P2019A7	WFC3/UVIS	1	15-Apr-2019 13:01:41.0	yes
05	(2) P2019A7	WFC3/UVIS	1	15-Apr-2019 13:01:42.0	yes
06	(2) P2019A7	WFC3/UVIS	1	15-Apr-2019 13:01:43.0	yes

6 Total Orbits Used

ABSTRACT

We propose to study the nuclei and dust environments of the recently discovered active asteroids P/2019 A4 and P/2019 A7 at the highest possible resolution. Our primary goal is to determine the causes of the activity, specifically if driven by the sublimation of ice or caused by an instantaneous process such as an impact or rotational instability. To this purpose, we propose to characterise the nuclei, search for potential bound or unbound companions, and study the dust environment and its evolution with time. As A4 is located in the middle main belt, sublimation-driven activity, if found, would place a strong new constraint on the location of the snow line in the early solar system. A7 is located in the outer main belt and hence more likely to contain ice, but the discovery circumstances are different from those of typical main belt comets with sublimation-driven activity. Our proposed observations will help to understand this difference. We propose three 1-orbit visits to either object between 2019 April and mid-June. Given their discovery in 2019 January, we could not propose these observations at the last regular deadline for GO proposals. Waiting for Cycle 27 will mean that the dust diagnostic of the current activity will have been dispersed by solar radiation pressure.

OBSERVING DESCRIPTION

We will observe active asteroids P/2019 A4 and P/2019 A7 during 3 1-orbit visits each between 2019 April and early June. The first visit should be scheduled as soon as possible to catch the objects at the minimum possible geocentric distance (highest angular resolution). The second and third visits should be scheduled at roughly monthly intervals to study the motion of potential fragments or a binary component and to exploit the changing angles between the line of sight from Earth and the orbital planes of the objects for analysis of the dust motion.

The predicted ranges of total magnitude between 2019 April and June is $V = 20.7 \dots 21.7$ (A4) and $V = 21.5 \dots 22.4$ (A7). We expect that the nuclei or largest fragment will be 1-2 mag fainter, $V = 22 \dots 24$. 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 ~ 225 s using the C1K1C-subarray of WFC3. We will perform a 2×2 subsampling dither box pattern, obtaining 2 exposures at each dither point.

This strategy gives us a total exposure time of $1800\text{s} = 30\text{min}$ 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)

Proposal 15706 (STScI Edit Number: 0, Created: Monday, April 15, 2019 at 12:01:43 PM Eastern Standard Time) - Overview 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 (24), exposure time of 225s, F606W filter, and default background values a signal-to-noise-ratio (S/N) of 80 (29) within a circle of 0.08arcsec (ETC Request IDs: WFC3UVIS.im.1312246 and WFC3UVIS.im.1312247). 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 $p=0.06$ (Nugent et al., 2016) and phase function coefficient $G=0.15$ (Bowell et al., 1989).

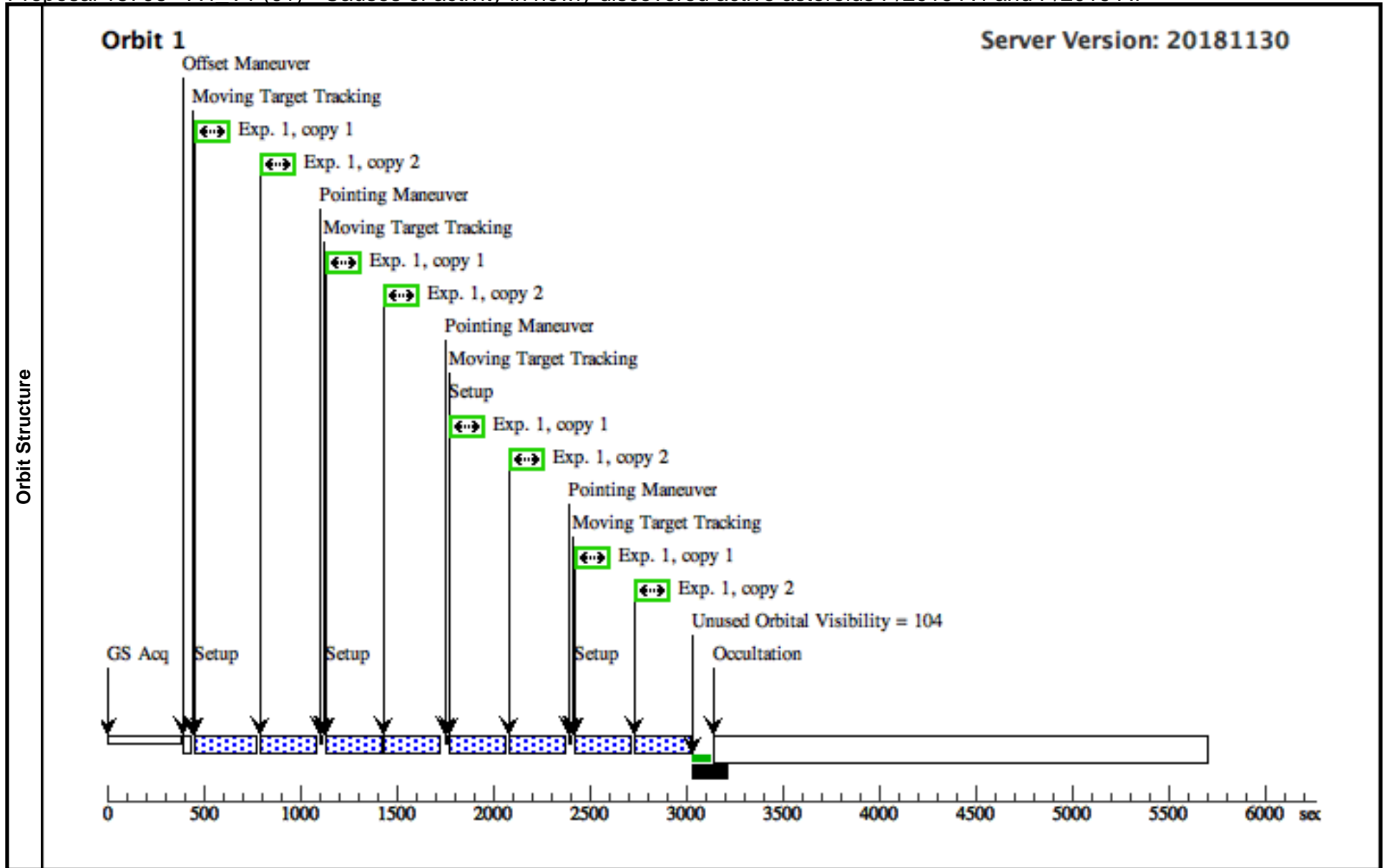
The position uncertainty predicted for A4 in early April is currently of order 10 arcsec. We request a late ephemeris update option at the phase 2 stage to be able to flexibly deal with possible late updates of the ephemeris based on new astrometric measurements. The ephemeris uncertainty for A7 is small compared to the WFC3 field of view.

The maximum apparent motion of the targets is only ~ 62 arcsec/hr (0.02 arcsec/s), which is well within Hubble's tracking capabilities.

Proposal 15706 - A4_V1 (01) - Causes of activity in newly discovered active asteroids P/2019 A4 and P/2019 A7

Mon Apr 15 17:01:43 GMT 2019

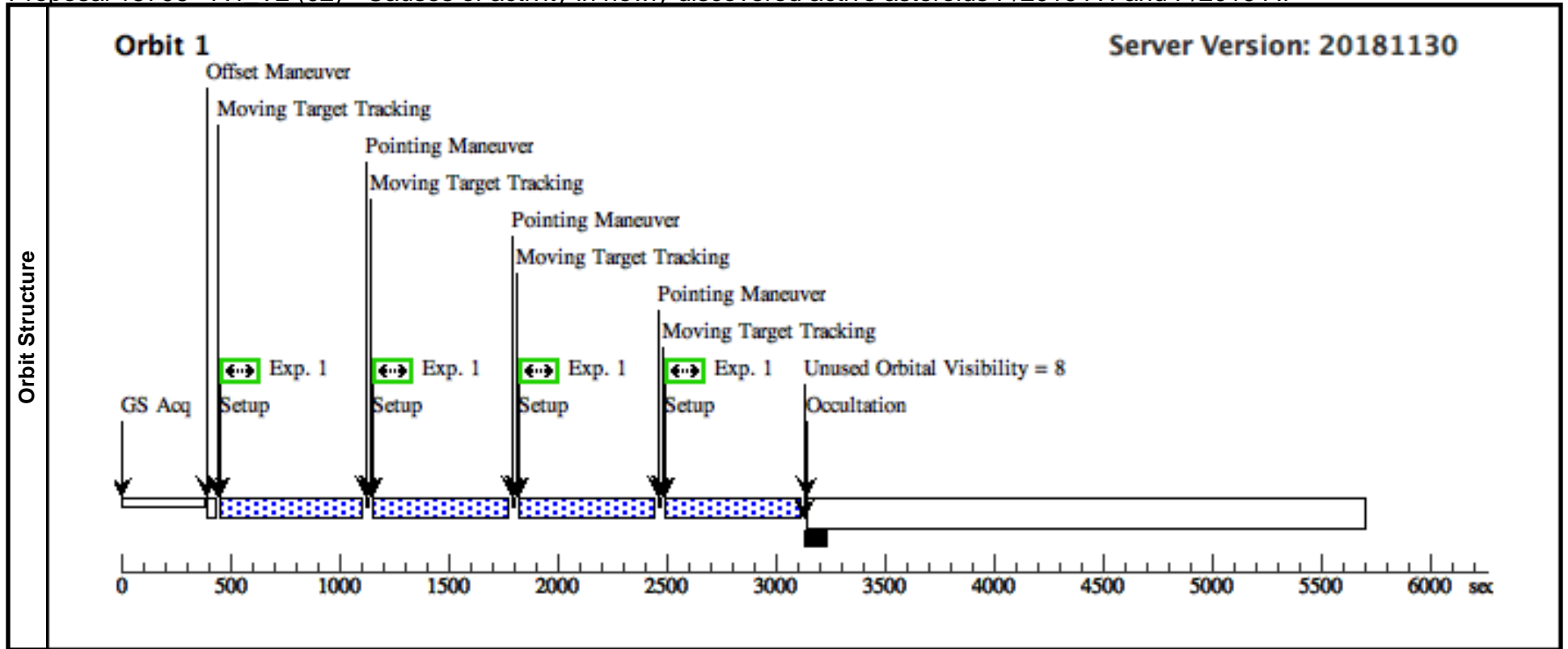
Visit	Proposal 15706, A4_V1 (01), completed Diagnostic Status: Warning Scientific Instruments: WFC3/UVIS Special Requirements: BETWEEN 01-APR-2019:00:00:00 AND 14-APR-2019:00:00:00										
	(Exposure 1 (Pattern 1, Exps 1-1 in A4_V1 (01))) Warning (Form): FLASH level may be too low for this exposure or a short subexposure. See extended explanation in the diagnostic browser										
Diagnosics											
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)	P2019A4-V1	TYPE=ASTEROID,A=2.61358374632 4236,E=0.08960734196836118,I=13.3 2039689241388 ,O=119.2995371407606,W=341.78146 97490555,M=10.258094656676,EQUI NOX=J2000,EPOCH=18-JAN-2019:00:00:00,EpochTimeScale=TDB					EARTH			
Comments: Description=Active asteroid Extended=YES Ephemeris Uncertainty: 23000 Kilometers											
Exposures	#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]		Orbit
	1	(1) P2019A4-V1		WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB	F606W		REQ EPHEM CORR ECA4V1	Pattern 1, Exps 1-1 in A4_V1 (01) (1)	220 Secs X 2 (1760 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 disappears if the ETC is run with calculating the zodiacal light for the actual target position on 2019 April 01.											



Proposal 15706 - A4_V2 (02) - Causes of activity in newly discovered active asteroids P/2019 A4 and P/2019 A7

Mon Apr 15 17:01:44 GMT 2019

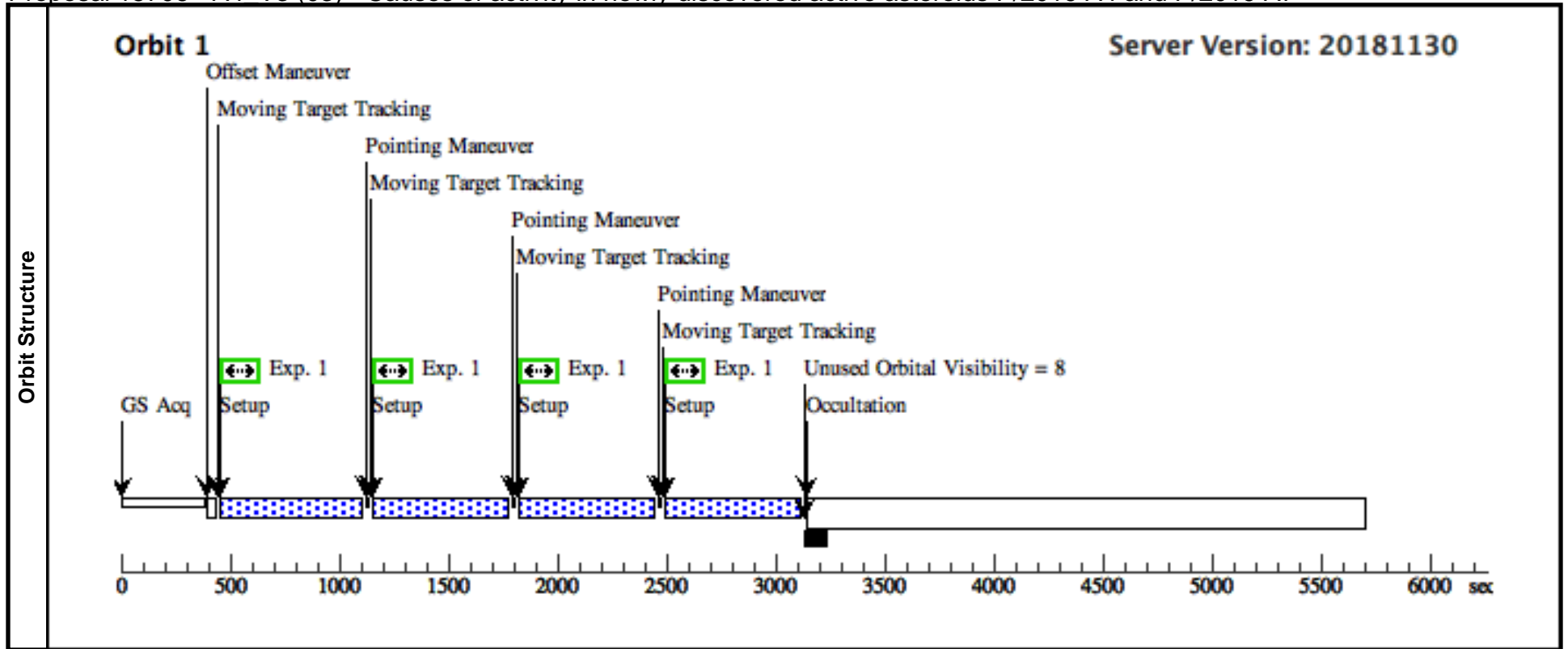
Visit	Proposal 15706, A4_V2 (02), implementation Diagnostic Status: No Diagnostics Scientific Instruments: WFC3/UVIS Special Requirements: BETWEEN 22-APR-2019:00:00:00 AND 12-MAY-2019:00:00:00; GROUP 02,03 WITHIN 2D; ON HOLD <i>On Hold Comments: The target ephemeris and position uncertainty need to be updated before the visit executes.</i>									
	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)	P2019A4-V2	TYPE=ASTEROID,A=2.61354856171 0995,E=0.0896028018538064,I=13.31 897611728256 ,O=119.3001705986976,W=341.90951 70765762,M=12.716814643128,EQUI NOX=J2000,EPOCH=29-JAN- 2019:00:00:00,EpochTimeScale=TDB					EARTH		
<i>Comments: Description=Active asteroid Extended=YES Ephemeris Uncertainty: 23000. Kilometers</i>										
Exposures	#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
	1	(WFC3UVIS.im.1322746)	(3) P2019A4-V2	WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB	F606W	CR-SPLIT=NO	REQ EPHEM CORR ECA4V2	Pattern 1, Exps 1-1 in A4_V2 (02) (1)	550 Secs (2200 Secs) [=>(Pattern 1)] [=>(Pattern 2)] [=>(Pattern 3)] [=>(Pattern 4)]	[1]
<i>Comments: The flash-warning disappears if the ETC is run with calculating the zodiacal light for the actual target position on 2019 May 01.</i>										



Proposal 15706 - A4_V3 (03) - Causes of activity in newly discovered active asteroids P/2019 A4 and P/2019 A7

Mon Apr 15 17:01:44 GMT 2019

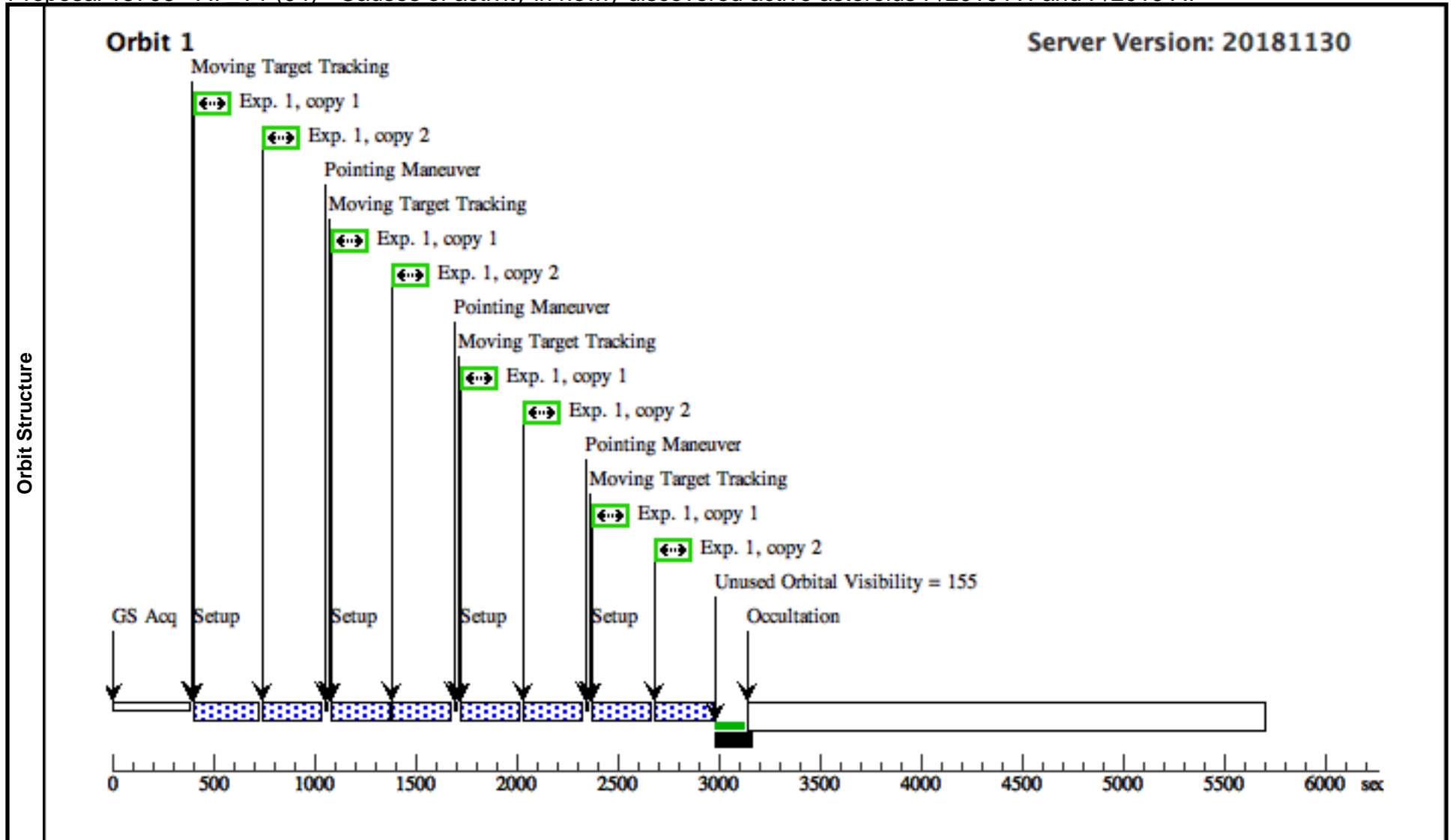
Visit	Proposal 15706, A4_V3 (03), implementation Diagnostic Status: No Diagnostics Scientific Instruments: WFC3/UVIS Special Requirements: BETWEEN 22-APR-2019:00:00:00 AND 12-MAY-2019:00:00:00; ON HOLD <i>On Hold Comments: The target ephemeris and position uncertainty need to be updated before the visit executes.</i>									
	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)	P2019A4-V2	TYPE=ASTEROID,A=2.61354856171 0995,E=0.0896028018538064,I=13.31 897611728256 ,O=119.3001705986976,W=341.90951 70765762,M=12.716814643128,EQUI NOX=J2000,EPOCH=29-JAN- 2019:00:00:00,EpochTimeScale=TDB					EARTH		
<i>Comments: Description=Active asteroid Extended=YES Ephemeris Uncertainty: 23000. Kilometers</i>										
Exposures	#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
	1	(WFC3UVIS.im.1322769)	(3) P2019A4-V2	WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB	F606W	CR-SPLIT=NO	REQ EPHEM CORR ECA4V3	Pattern 1, Exps 1-1 in A4_V3 (03) (1)	550 Secs (2200 Secs) [=>(Pattern 1)] [=>(Pattern 2)] [=>(Pattern 3)] [=>(Pattern 4)]	[1]
<i>Comments: The flash-warning disappears if the ETC is run with calculating the zodiacal light for the actual target position on 2019 June 01.</i>										



Proposal 15706 - A7_V1 (04) - Causes of activity in newly discovered active asteroids P/2019 A4 and P/2019 A7

Mon Apr 15 17:01:44 GMT 2019

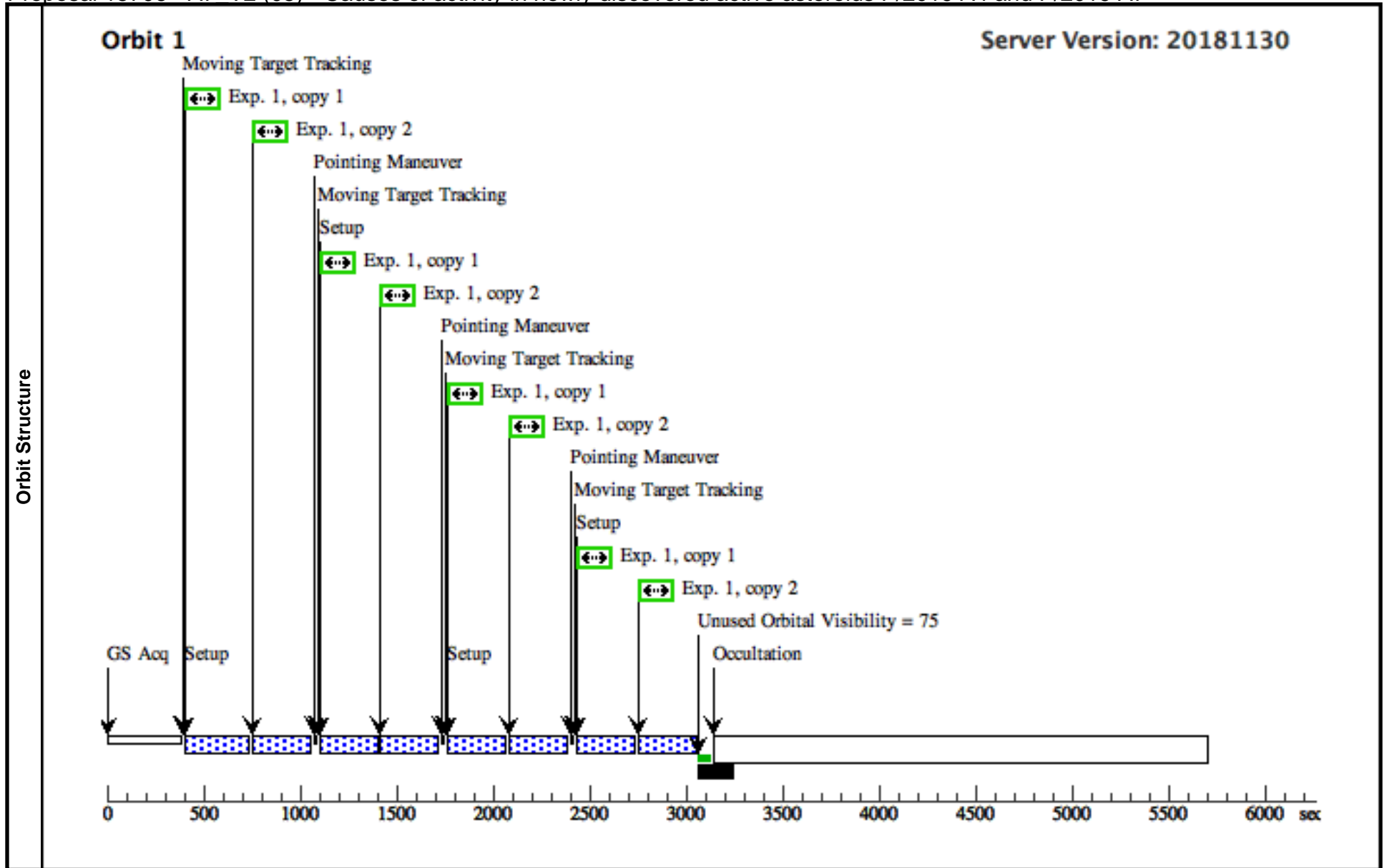
Visit	Proposal 15706, A7_V1 (04), completed Diagnostic Status: Warning Scientific Instruments: WFC3/UVIS Special Requirements: BETWEEN 01-APR-2019:00:00:00 AND 21-APR-2019:00:00:00									
	Diagnosics (Exposure 1 (Pattern 1, Exps 1-1 in A7_V1 (04))) Warning (Form): FLASH level may be too low for this 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			
	(2)	P2019A7	TYPE=ASTEROID,A=3.18830455249 9178,E=0.1607480733255885,I=17.77 2656582968 .O=280.5213002812847,W=119.54613 47673522,M=46.56029697759,EQUIN OX=J2000,EPOCH=04-OCT- 2018:00:00:00,EpochTimeScale=TDB					EARTH		
Comments: Description=Active asteroid Extended=YES										
Exposures	#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
	1	(WFC3UVI S.im.132279 2)	(2) P2019A7	WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB	F606W	CR-SPLIT=NO		Pattern 1, Exps 1-1 in A7_V1 (04) (1)	220 Secs X 2 (1760 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 disappears if the ETC is run with calculating the zodiacal light for the actual target position on 2019 April 01.										



Proposal 15706 - A7_V2 (05) - Causes of activity in newly discovered active asteroids P/2019 A4 and P/2019 A7

Mon Apr 15 17:01:44 GMT 2019

Visit	Proposal 15706, A7_V2 (05), implementation Diagnostic Status: Warning Scientific Instruments: WFC3/UVIS Special Requirements: BETWEEN 22-APR-2019:00:00:00 AND 09-JUN-2019:00:00:00										
	(Exposure 1 (Pattern 1, Exps 1-1 in A7_V2 (05))) Warning (Form): FLASH level may be too low for this exposure or a short subexposure. See extended explanation in the diagnostic browser										
Diagnosics											
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)	P2019A7	TYPE=ASTEROID,A=3.18830455249 9178,E=0.1607480733255885,I=17.77 2656582968 ,O=280.5213002812847,W=119.54613 47673522,M=46.56029697759,EQUIN OX=J2000,EPOCH=04-OCT- 2018:00:00:00,EpochTimeScale=TDB					EARTH			
Comments: Description=Active asteroid Extended=YES											
Exposures	#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]		Orbit
	1	(WFC3UVIS.im.1322795)	(2) P2019A7	WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB	F606W	CR-SPLIT=NO		Pattern 1, Exps 1-1 in A7_V2 (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 disappears if the ETC is run with calculating the zodiacal light for the actual target position on 2019 May 01.											



Proposal 15706 - A7_V3 (06) - Causes of activity in newly discovered active asteroids P/2019 A4 and P/2019 A7

Mon Apr 15 17:01:44 GMT 2019

Visit	Proposal 15706, A7_V3 (06), implementation Diagnostic Status: Warning Scientific Instruments: WFC3/UVIS Special Requirements: AFTER 05 BY 0.8 Orbits TO 1.2 Orbits; BETWEEN 22-APR-2019:00:00:00 AND 09-JUN-2019:00:00:00										
	(Exposure 1 (Pattern 1, Exps 1-1 in A7_V3 (06))) Warning (Form): FLASH level may be too low for this exposure or a short subexposure. See extended explanation in the diagnostic browser										
Diagnosics											
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)	P2019A7	TYPE=ASTEROID,A=3.18830455249 9178,E=0.1607480733255885,I=17.77 2656582968 ,O=280.5213002812847,W=119.54613 47673522,M=46.56029697759,EQUIN OX=J2000,EPOCH=04-OCT- 2018:00:00:00,EpochTimeScale=TDB					EARTH			
Comments: Description=Active asteroid Extended=YES											
Exposures	#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]		Orbit
	1	(WFC3UVI S.im.132279 7)	(2) P2019A7	WFC3/UVIS, ACCUM, UVIS2-C1K1C-SUB	F606W	CR-SPLIT=NO		Pattern 1, Exps 1-1 in A7_V3 (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)]	
Comments: The flash-warning disappears if the ETC is run with calculating the zodiacal light for the actual target position on 2019 June 01.											

