



16087 - Optical Evolution of Interstellar Object 2I/Borisov

Cycle: 27, 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>
11	(3) C2019-Q4-V11	WFC3/UVIS	1	28-Jul-2020 09:00:19.0	yes
12	(4) C2019-Q4-V12	WFC3/UVIS	1	28-Jul-2020 09:00:20.0	yes
13	(4) C2019-Q4-V12	WFC3/UVIS	1	28-Jul-2020 09:00:20.0	yes
14	(4) C2019-Q4-V12	WFC3/UVIS	1	28-Jul-2020 09:00:21.0	yes
15	(4) C2019-Q4-V12	WFC3/UVIS	1	28-Jul-2020 09:00:21.0	yes

5 Total Orbits Used

ABSTRACT

We propose a 5 orbit study designed to continue characterization of the changing activity of interstellar object 2I/Borisov (formerly C/2019 Q4) in the post-perihelion phase. We will assess the dust particle ejection using data from a range of viewing perspectives as input to an established Monte

Carlo dynamics model, to infer particle size, size distribution, velocity and velocity distribution, for comparison with dust populations in solar system comets. Observations as the HST crosses the projected orbit plane will probe the out-of-plane distribution of dust. As the comet recedes (to 6 AU at the end of Cycle 27) and consequently cools and fades, we will probe the near-nucleus region with less and less contamination by dust. The proposed observations capitalize on the high angular resolution of HST, and will extend time-sequence observations of this unique object obtained in public-domain data with the same observational set-up under GO 16009 and 16041.

OBSERVING DESCRIPTION

We request 5 mid-cycle orbits using WFC3 and the F350LP filter to image 2I in the remainder of Cycle 27 (ending 2020 Sep 30, when $r_H = 6.6$ AU). The broad F350LP filter (effective center 6230Å, FWHM 4760Å) gives maximum sensitivity to faint coma. The orbits would be spaced by about one month to give sampling complementary to that already obtained. In one month, 2I moves away from the Sun by another 0.5 AU. Precise timing of the visits is not critical, except for V4, which is designed to image 2I from a vantage point in the orbit plane of the object (on UT 2020 July 31). This perspective provides unique constraints on the out-of-plane distribution of dust, and will be used to assess the dust ejection velocity. Mid-Cycle observations extending from the first visit on 2019 Oct 12 (GO 16009) to the end of Cycle 27 on 2020 September 30 (this proposal) will provide the most complete and yet economical sampling of the time-varying activity of this remarkable object. We expect that all of the observations will be immediately in the public domain. We will secure six 270 s integrations in each orbit, with dithering to provide protection from chip defects. According to the WFC3 ETC, a single 270 s exposure reaches $V=26.5$ at $SNR=5$. Combining 6 images will take us 1 magnitude fainter, to $V=27.5$, and will also provide protection from cosmic ray strikes on individual images. Deep imaging is needed to assess the near-nucleus environment and identify fragments, or set limits to their presence. We will also use individual images to examine photometric stability of the core on the (~ 1 hour) orbital timescale. Sub-pixel astrometry from all orbits will assist with orbit fitting and the search for non-gravitational acceleration. The 3-sigma ephemeris uncertainty is currently < 5 arcsec through the remainder of this Cycle and will shrink as more astrometry is added to the orbit fit. Therefore, ephemeris uncertainties are of no concern to the proposed observations. 2I is outside the 55 deg HST Sun exclusion zone for the entire proposal period.

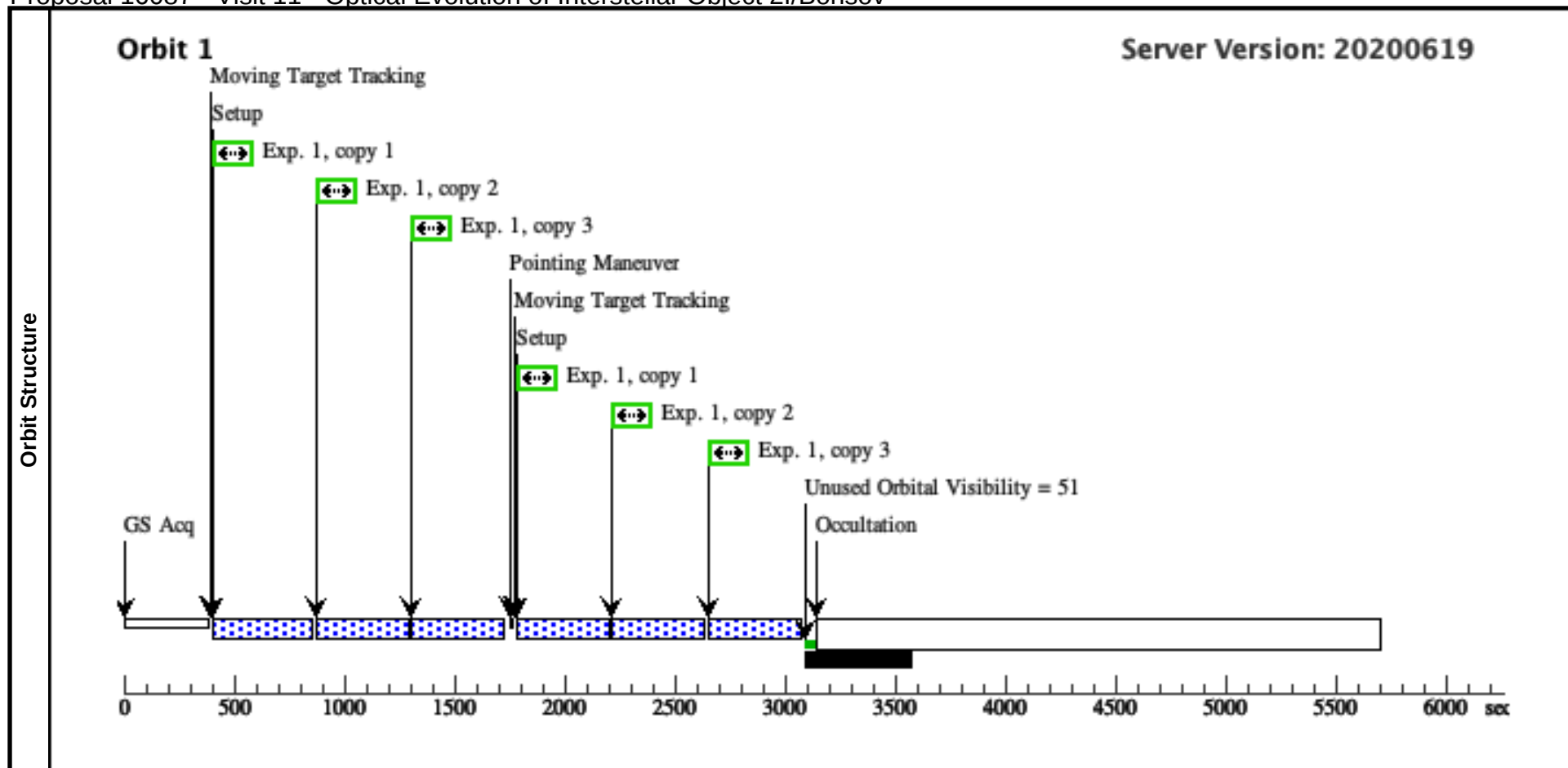
Visits V1, V2, V3 are single-orbit visits spaced approximately monthly in order to monitor the time-dependence of the morphology and photometry at the highest resolution. The first observation, V1, is requested near DOY 105 $\pm$ 10 days, in order to observe the comet from the maximum angle of the Earth above the orbital plane. This perspective provides the clearest separation of particle trajectories in the orbital plane, essential for accurate Monte Carlo modeling. Visits V2 (DOY 145 $\pm$ 10) and V3 (DOY 180 $\pm$ 10) span the interval to V4 and plane-crossing. Visit V4 is requested to coincide with orbit plane crossing on UT 2020 July 31. The angle above the plane varies by about 0.1 degree per day at this time, so that observations

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to within < 0.1 degree of plane crossing provide should be readily scheduled and will provide a strong measure of the out-of-plane extent of the coma. Visit V5 is requested as close as possible to the end of Cycle 27, by which time 2I will be outbound at 6.6 AU from the Sun (greater than the discovery distance) and Earth will be 5 degrees below the orbit plane. V4 is the only orbit for which the constraint is tight: we need to be within 1 day of July 31d 03h in order to attain the in-plane geometry and the closer to this time the better. We understand that we will have essentially no control over the spacecraft roll angle, which means that we will not be able to optimize the orientation of the dust coma on the CCD (e.g., to orient the tail along the longest dimension of the detector). However, the field-of-view of the camera is large enough and the target coma small enough that we should obtain excellent data, no matter what spacecraft roll angle is used.

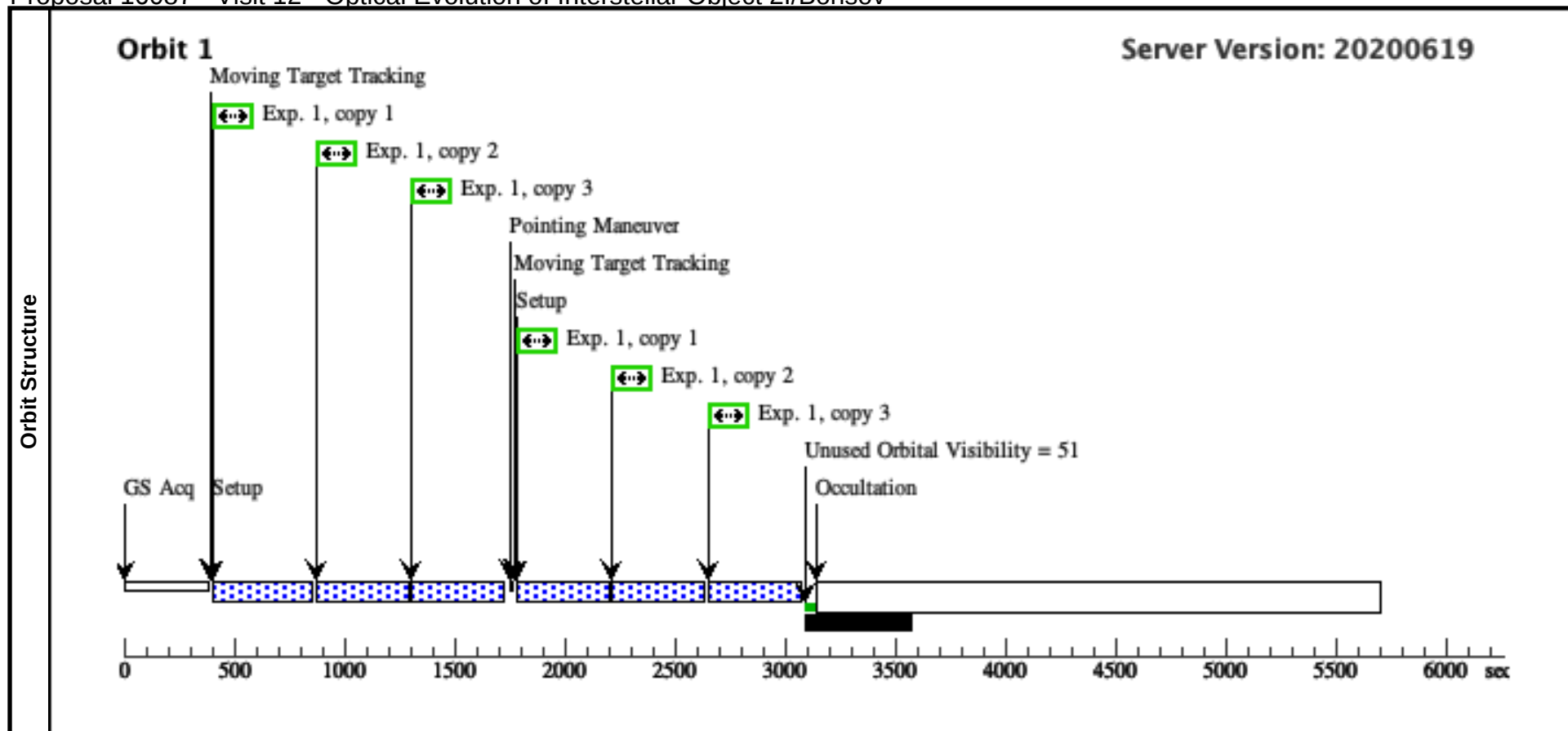
Proposal 16087 - Visit 11 - Optical Evolution of Interstellar Object 2I/Borisov

Visit	Proposal 16087, Visit 11, completed										Tue Jul 28 13:00:22 GMT 2020
	Diagnostic Status: No Diagnostics										
	Scientific Instruments: WFC3/UVIS										
	Special Requirements: BETWEEN 30-MAR-2020:06:00:00 AND 30-MAR-2020:13:00:00; BETWEEN 01-APR-2020:12:00:00 AND 02-APR-2020:01:00:00										
Patterns	#	Primary Pattern				Secondary Pattern				Exposures	
	(1)	Pattern Type=LINE Purpose=DITHER Number Of Points=2 Point Spacing=0.8 Line Spacing=		Coordinate Frame=POS-TARG Pattern Orientation=45 Angle Between Sides= Center Pattern=false						(1)	
Solar System Targets	#	Name	Level 1	Level 2	Level 3	Window	Ephem Center				
	(3)	C2019-Q4-V11	TYPE=COMET,Q=2.0066154765591 97,E=3.357057274677898,I=44.05348 671638512 ,O=308.1499528970442,W=209.12439 7765598,T=08-DEC- 2019:13:18:12,TTIMEscale=TDB,EQ UINOX=J2000,EPOCH=05-JAN- 2020:00:00:00,EpochTimeScale=TDB, R0=2.808 ,DT=0. ,A1=-4.111801624298E-8,A2=- 2.939796209335E-8,A3=- 1.149449539185E-7 ,ALN=0.1112620426,NM=2.15,NN=5. 093,NK=4.6142,AMRAT=0.								EARTH
Comments: Description=Interstellar comet Extended=YES											
Exposures	#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]		Orbit
	1		(3) C2019-Q4-V11	WFC3/UVIS, ACCUM, UVIS2-2K2C-SUB	F350LP	CR-SPLIT=NO	POS TARG 10,15	Sequence 1-1 Non-Int in Visit 11 Pattern 1, Exps 1-1 in Sequence 1-1 Non-Int in Visit 11 (1)	260 Secs X 3 (1560 Secs) [==>(Pattern 1, Copy 1)] [==>(Pattern 1, Copy 2)] [==>(Pattern 1, Copy 3)] [==>(Pattern 2, Copy 1)] [==>(Pattern 2, Copy 2)] [==>(Pattern 2, Copy 3)]	[1]	



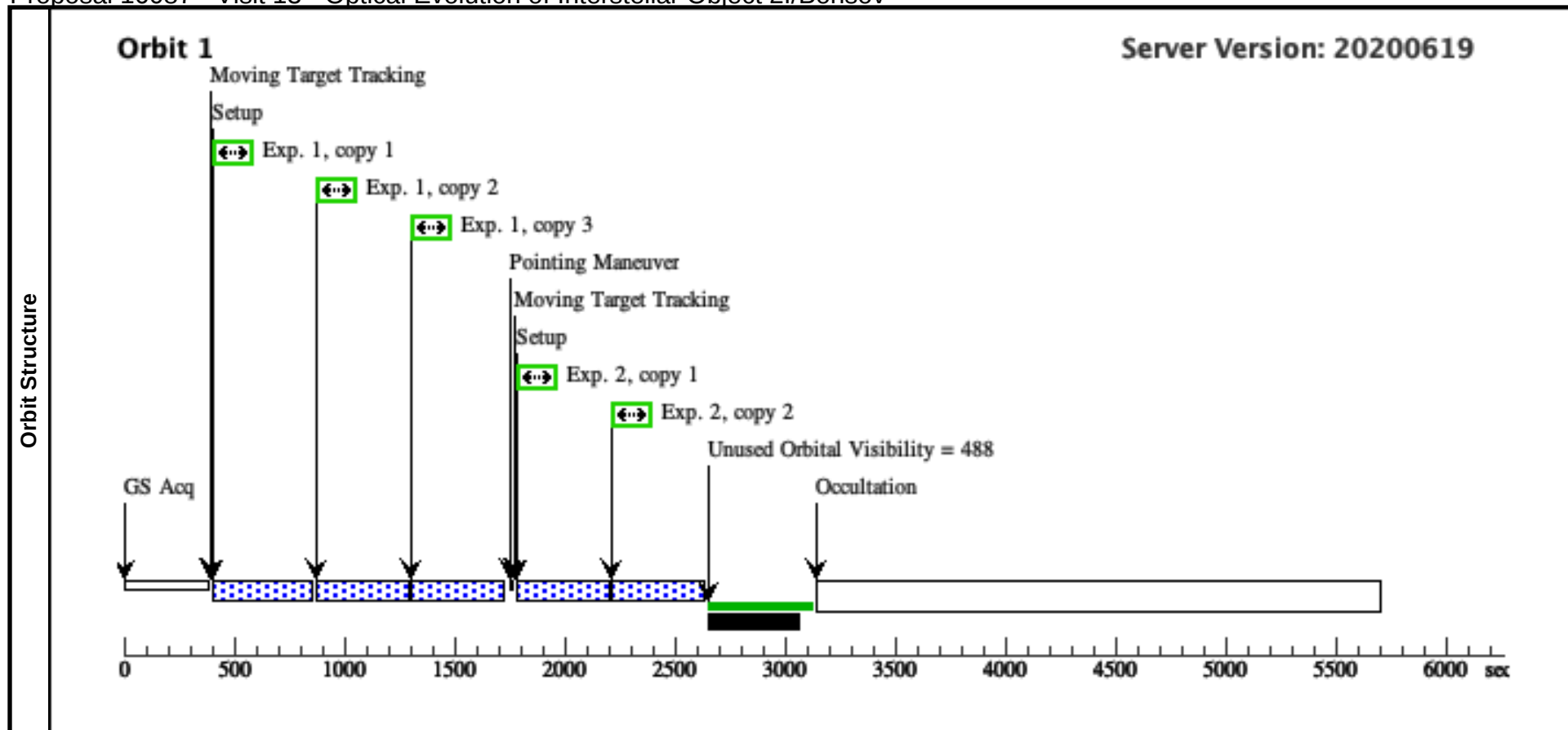
Proposal 16087 - Visit 12 - Optical Evolution of Interstellar Object 2I/Borisov

Visit	Proposal 16087, Visit 12, completed										Tue Jul 28 13:00:22 GMT 2020		
	Diagnostic Status: No Diagnostics												
	Scientific Instruments: WFC3/UVIS												
	Special Requirements: BETWEEN 13-APR-2020:10:00:00 AND 15-APR-2020:13:00:00												
Patterns	#	Primary Pattern					Secondary Pattern					Exposures	
	(1)	Pattern Type=LINE Coordinate Frame=POS-TARG Purpose=DITHER Pattern Orientation=45 Number Of Points=2 Angle Between Sides= Point Spacing=0.8 Center Pattern=false Line Spacing=										(1)	
Solar System Targets	#	Name	Level 1	Level 2	Level 3	Window	Ephem Center						
	(4)	C2019-Q4-V12	TYPE=COMET,Q=2.0066240085872 65,E=3.356191268153205,I=44.05262 620283894 ,O=308.1489154698829,W=209.12460 56235187,T=08-DEC- 2019:13:04:38,TTIMEscale=TDB,EQ UINOX=J2000,EPOCH=31-JUL- 2020:00:00:00,EpochTimeScale=TDB, R0=2.808 ,DT=0. ,A1=7.312064170837E-8,A2=- 3.252092599869E-8,A3=0. ,ALN=0.1112620426,NM=2.15,NN=5. 093,NK=4.6142,AMRAT=0.									EARTH	
	Comments: Description=Interstellar comet Extended=YES												
Exposures	#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]		Orbit		
	1		(4) C2019-Q4-V12	WFC3/UVIS, ACCUM, UVIS2-2K2C-SUB	F350LP	CR-SPLIT=NO	POS TARG 15,15	Sequence 1-1 Non-Int in Visit 12 Pattern 1, Exps 1-1 in Sequence 1-1 Non-Int in Visit 12 (1)	260 Secs X 3 (1560 Secs) [==>(Pattern 1, Copy 1)] [==>(Pattern 1, Copy 2)] [==>(Pattern 1, Copy 3)] [==>(Pattern 2, Copy 1)] [==>(Pattern 2, Copy 2)] [==>(Pattern 2, Copy 3)]		[1]		



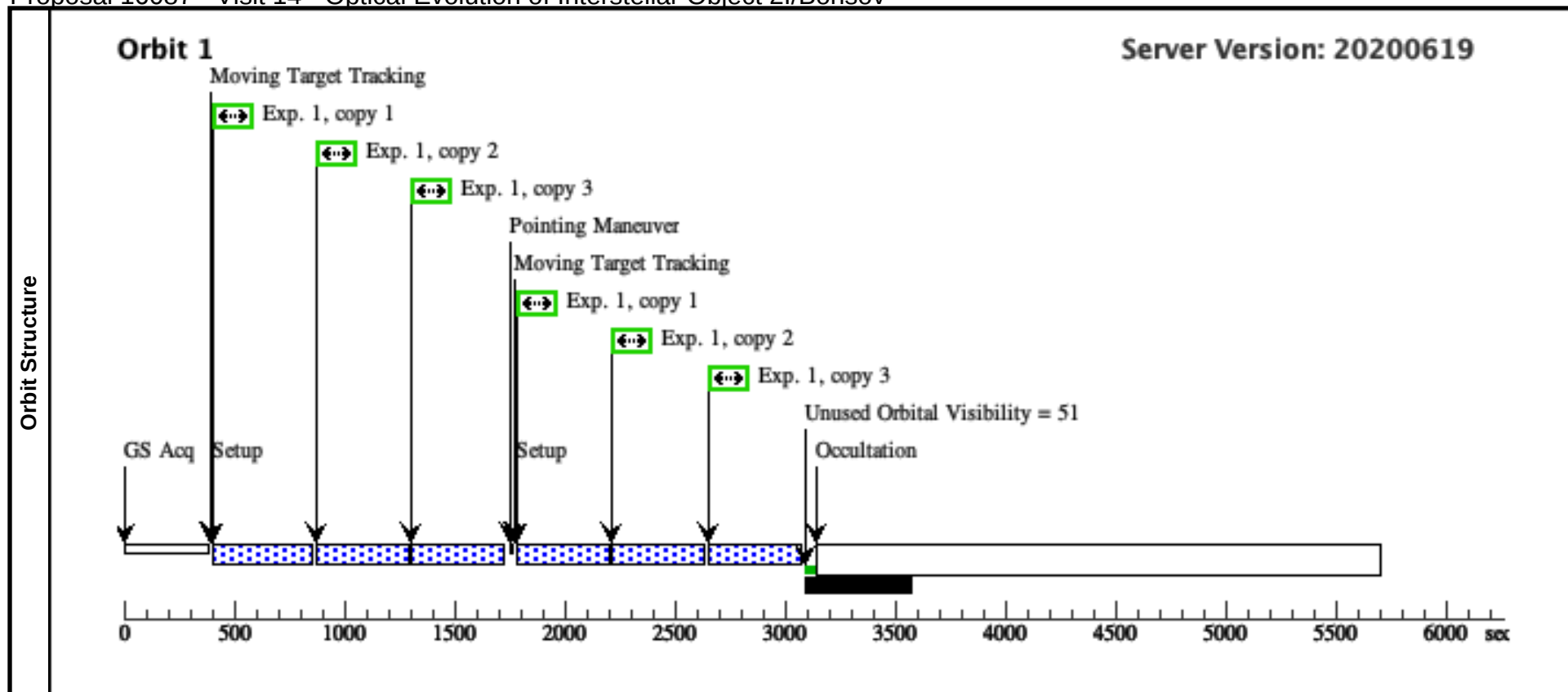
Proposal 16087 - Visit 13 - Optical Evolution of Interstellar Object 2I/Borisov

Visit	Proposal 16087, Visit 13, completed										Tue Jul 28 13:00:22 GMT 2020
	Diagnostic Status: No Diagnostics										
	Scientific Instruments: WFC3/UVIS										
	Special Requirements: BETWEEN 19-APR-2020:00:00:00 AND 20-APR-2020:16:00:00										
Solar System Targets	#	Name	Level 1	Level 2	Level 3	Window	Ephem Center				
	(4)	C2019-Q4-V12	TYPE=COMET,Q=2.0066240085872 65,E=3.356191268153205,I=44.05262 620283894 ,O=308.1489154698829,W=209.12460 56235187,T=08-DEC- 2019:13:04:38,TimeScale=TDB,EQ UINOX=J2000,EPOCH=31-JUL- 2020:00:00:00,EpochTimeScale=TDB, R0=2.808 ,DT=0. ,A1=7.312064170837E-8,A2=- 3.252092599869E-8,A3=0. ,ALN=0.1112620426,NM=2.15,NN=5. 093,NK=4.6142,AMRAT=0.	EARTH							
	Comments: Description=Interstellar comet Extended=YES										
Exposures	#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit	
	1		(4) C2019-Q4-V12	WFC3/UVIS, ACCUM, UVIS2-2K2C-SUB	F350LP	CR-SPLIT=NO	POS TARG 15,15	Sequence 1-2 Non-In t in Visit 13	260 Secs X 3 (780 Secs)		
									[==>(Copy 1)] [==>(Copy 2)] [==>(Copy 3)]	[1]	
	2		(4) C2019-Q4-V12	WFC3/UVIS, ACCUM, UVIS2-2K2C-SUB	F350LP	CR-SPLIT=NO	POS TARG 16,16	Sequence 1-2 Non-In t in Visit 13	260 Secs X 2 (520 Secs)		
									[==>(Copy 1)] [==>(Copy 2)]	[1]	



Proposal 16087 - Visit 14 - Optical Evolution of Interstellar Object 2I/Borisov

Visit	Proposal 16087, Visit 14, scheduled										Tue Jul 28 13:00:22 GMT 2020
	Diagnostic Status: No Diagnostics										
	Scientific Instruments: WFC3/UVIS										
	Special Requirements: SCHED 30%; BETWEEN 30-JUL-2020:22:00:00 AND 01-AUG-2020:03:00:00										
Patterns	#	Primary Pattern				Secondary Pattern				Exposures	
	(1)	Pattern Type=LINE Purpose=DITHER Number Of Points=2 Point Spacing=0.8 Line Spacing=		Coordinate Frame=POS-TARG Pattern Orientation=45 Angle Between Sides= Center Pattern=false						(1)	
Solar System Targets	#	Name	Level 1	Level 2	Level 3	Window	Ephem Center				
	(4)	C2019-Q4-V12	TYPE=COMET,Q=2.0066240085872 65,E=3.356191268153205,I=44.05262 620283894 ,O=308.1489154698829,W=209.12460 56235187,T=08-DEC- 2019:13:04:38,TTIMEscale=TDB,EQ UINOX=J2000,EPOCH=31-JUL- 2020:00:00:00,EpochTimeScale=TDB, R0=2.808 ,DT=0. ,A1=7.312064170837E-8,A2=- 3.252092599869E-8,A3=0. ,ALN=0.1112620426,NM=2.15,NN=5. 093,NK=4.6142,AMRAT=0.				EARTH				
Comments: Description=Interstellar comet Extended=YES											
Exposures	#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]		Orbit
	1		(4) C2019-Q4-V12	WFC3/UVIS, ACCUM, UVIS2-2K2C-SUB	F350LP	CR-SPLIT=NO	POS TARG 15,15	Sequence 1-1 Non-Int in Visit 14 Pattern 1, Exps 1-1 in Sequence 1-1 Non-Int in Visit 14 (1)	260 Secs X 3 (1560 Secs) [==>(Pattern 1, Copy 1)] [==>(Pattern 1, Copy 2)] [==>(Pattern 1, Copy 3)] [==>(Pattern 2, Copy 1)] [==>(Pattern 2, Copy 2)] [==>(Pattern 2, Copy 3)]	[1]	



Proposal 16087 - Visit 15 - Optical Evolution of Interstellar Object 2I/Borisov

Visit	Proposal 16087, Visit 15, implementation										Tue Jul 28 13:00:22 GMT 2020		
	Diagnostic Status: No Diagnostics												
	Scientific Instruments: WFC3/UVIS												
	Special Requirements: BETWEEN 09-SEP-2020:00:00:00 AND 17-SEP-2020:21:00:00												
Patterns	#	Primary Pattern				Secondary Pattern				Exposures			
	(1)	Pattern Type=LINE		Coordinate Frame=POS-TARG						(1)			
Purpose=DITHER		Pattern Orientation=45											
Number Of Points=2		Angle Between Sides=											
Point Spacing=0.8		Center Pattern=false											
Line Spacing=													
Solar System Targets	#	Name	Level 1	Level 2	Level 3	Window	Ephem Center						
	(4)	C2019-Q4-V12	TYPE=COMET,Q=2.0066240085872 65,E=3.356191268153205,I=44.05262 620283894 ,O=308.1489154698829,W=209.12460 56235187,T=08-DEC- 2019:13:04:38,TTIMEscale=TDB,EQ UINOX=J2000,EPOCH=31-JUL- 2020:00:00:00,EpochTimeScale=TDB, R0=2.808 ,DT=0. ,A1=7.312064170837E-8,A2=- 3.252092599869E-8,A3=0. ,ALN=0.1112620426,NM=2.15,NN=5. 093,NK=4.6142,AMRAT=0.									EARTH	
	Comments: Description=Interstellar comet Extended=YES												
Exposures	#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]		Orbit		
	1		(4) C2019-Q4-V12	WFC3/UVIS, ACCUM, UVIS2-2K2C-SUB	F350LP	CR-SPLIT=NO	POS TARG 15,15	Sequence 1-1 Non-Int in Visit 15	260 Secs X 3 (1560 Secs)		[1]		
								Pattern 1, Exps 1-1 in Sequence 1-1 Non-Int in Visit 15 (1)	[==>(Pattern 1, Copy 1)]				
								[==>(Pattern 1, Copy 2)]					
								[==>(Pattern 1, Copy 3)]					
								[==>(Pattern 2, Copy 1)]					
								[==>(Pattern 2, Copy 2)]					
								[==>(Pattern 2, Copy 3)]					

