



16770 - The return of Rosetta's comet 67P/Churyumov-Gerasimenko

Cycle: 29, Proposal Category: GO

(UV Initiative)

(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) 67P-CHURYUMOV-GERASIMENKO	STIS/CCD STIS/NUV-MAMA	1	27-Oct-2021 15:00:43.0	yes
02	(1) 67P-CHURYUMOV-GERASIMENKO	STIS/CCD STIS/NUV-MAMA	1	27-Oct-2021 15:00:44.0	yes
03	(1) 67P-CHURYUMOV-GERASIMENKO	COS/FUV COS/NUV	1	27-Oct-2021 15:00:44.0	yes

<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>
04	(1) 67P-CHURYUMOV-GERASIMENKO	COS/FUV COS/NUV	1	27-Oct-2021 15:00:45.0	yes
05	(2) 67P-CHURYUMOV-GERASIMENKO-V5	STIS/CCD STIS/NUV-MAMA	1	27-Oct-2021 15:00:46.0	yes
06	(2) 67P-CHURYUMOV-GERASIMENKO-V5	STIS/CCD STIS/NUV-MAMA	1	27-Oct-2021 15:00:46.0	yes

6 Total Orbits Used

ABSTRACT

We request 4 orbits of HST STIS and COS observations of comet 67P/Churyumov-Gerasimenko (hereafter 67P) during its close approach to Earth to obtain large-scale coma measurements for direct comparison with the localized Rosetta spacecraft results. We will measure the bulk production rates (mol/s) of the main volatiles (H₂O, CO₂, and CO), search for extended sources of volatiles in the coma, and investigate the sulphur chemistry of 67P. HST's sensitivity and spectroscopic abilities in the Far Ultraviolet make it uniquely capable to simultaneously measure the Far-Ultraviolet atomic and molecular emission of chemically coupled or otherwise interdependent species in the 100-15,000 km of the coma (i.e. CS, S, and S₂ ; CO, CO₂⁺ and OH). Observations that can connect the results for the inner coma with that of fragment species more typically observed at scales of 1000s of km (A'Hearn 2017) are essential to interpret large surveys of chemical abundances of comets. The details of how comets formed still need to be worked out by the modellers, but we need to make sure that the inputs for those models have had observational biases removed.

The observation should be executed between October 14 and December 20, 2021, which brackets the close approach of the comet to Earth on November 2 at 0.42 au. We plan to dedicate two consecutive orbits for exposures with STIS G230L exposures, and two consecutive orbits for exposures with COS G160M. The STIS exposures and COS exposures should be executed within one week. For the STIS observations, we request that the slit orientation is aligned within 30 deg perpendicular to the sun-comet direction, which is allowed by the HST roll angle range during our observing window.

OBSERVING DESCRIPTION

We plan to observe comet 67P/Churyumov-Gerasimenko for a total of 4 orbits, split between the STIS and COS instruments.

Proposal 16770 (STScI Edit Number: 6, Created: Wednesday, October 27, 2021 at 2:00:47 PM Eastern Standard Time) - Overview

Timing requirements: We request that the observations are acquired around closest approach at 0.42 AU on UT Nov. 2, 2021, but allow for a window of 2 months because the 2021 apparition of the comet is very favorable and the comet remains within 0.45 AU from Earth between Oct. 14 - Dec. 20, 2021, during which the brightness only varies between $v \sim 10.14$ to 10.85 mag. Although we request that the exposures are acquired close in time to each other so that we can add them together to improve the SNR, we do not require that all exposures are acquired in consecutive orbits, conforming to the limit of 2 consecutive orbits for observations of moving targets for Cycle 29. Instead, we request that the 2 STIS exposures are acquired back-to-back and that the 2 COS exposures are also acquired back-to-back within a week of the STIS exposures.

Visibility: While 67P is relatively nearby during its closest approach at 0.4 au, it's apparent motion on the sky is about 136 arcsec/motion, which is well within HST's tracking capabilities. During the window UT Oct. 14, 2021 - Dec. 20, 2021, the comet is far outside the solar constraint with a solar elongation between 110-136 degrees. The comet is within the lunar constraint of 9 degrees on Oct. 26 - 27, 2021, and Nov. 24 - 25, and these days should be avoided.

Observation design:

A: We will use 2 orbits of STIS G230L/NUV-MAMA centered at 2376 Å with a 52x0.5 arcsec aperture to get OH at 2835 Å and 3085 Å; CS at 2576 Å; CO₂⁺ at 2890 Å, and S₂ between 2830-3050 Å. We would like to orient the STIS long slit close to the perpendicular direction with respect to the sun-comet line, in order to create a spatial profile of the gas distribution. Based on the ephemeris of 67P in October 2021 and the APT Phase II planning tool, the permitted range of roll angles for HST when pointing at 67P is about 230 - 290 deg, allowing the slit to be oriented within 30 deg of our desired orientation, which is about 185 deg position angle (east of north). Each orbit will consist of an ACQ image, a spectroscopic exposure, and finished by direct imaging for context. Because we do not need more than two consecutive orbits, we will disable moving target gyro bias update to maximize visibility time.

B: 2 orbits of COS/FUV G160M center 1623 Å, to detect the SI multiplets at 1667 Å and 1479 Å; to detect the CO Fourth Positive Group emission features (1400 - 1700 Å), and to detect the CI features at 1561 Å and 1657 Å. Each orbit will consist of an ACQ and two exposures with two different FP-POS. We will disable moving target gyro bias update to maximize visibility time for these two orbits as well.

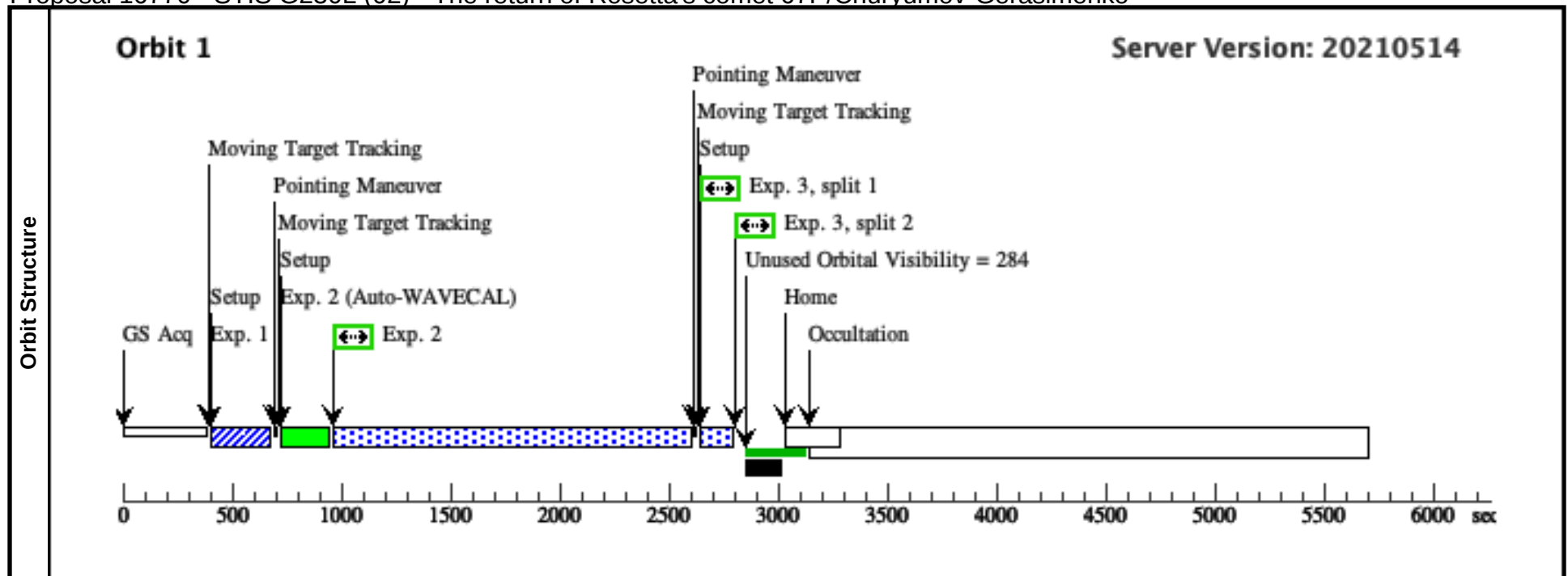
Target acquisition: The 3-sigma ephemeris uncertainty of target during our observing window is up to 1.2" based on JPL Horizons, which is well within the target acquisition region for both STIS and COS. There is no need to use ACQ/SEARCH for COS.

Proposal 16770 - STIS G230L (01) - The return of Rosetta's comet 67P/Churyumov-Gerasimenko

Visit	Proposal 16770, STIS G230L (01), failed										Wed Oct 27 19:00:47 GMT 2021
	Diagnostic Status: No Diagnostics										
	Scientific Instruments: STIS/NUV-MAMA, STIS/CCD										
	Special Requirements: ORIENT 220D TO 260 D; BETWEEN 14-OCT-2021:00:00:00 AND 20-DEC-2021:00:00:00; VISIBILITY INTERVAL NO GYRO BIAS UPDATE ON MOVING TARGET										
Solar System Targets	#	Name	Level 1	Level 2	Level 3	Window	Ephem Center				
	(1)	67P-CHURYUMOV-GERASIMENKO	TYPE=COMET,Q=1.210613814968979,E=0.649713733698611,I=3.871753825377044,O=36.33518841638918,W=22.13089737728478,T=02-NOV-2021:01:28:47,TimeScale=TDB,EQUINOX=J2000,EPOCH=18-OCT-2021:00:00:00,EpochTimeScale=TDB					EARTH			
Comments: Description=Comet 67P/Churyumov-Gerasimenko											
Extended=YES											
Exposures	#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]		Orbit
	1	ACQ	(1) 67P-CHURYUMOV-GERASIMENKO	STIS/CCD, ACQ, F28X50LP	MIRROR			Sequence 1-3 Non-Int in STIS G230L (01)	2 Secs (2 Secs) [==>]		[1]
	2	(STIS.sp.15 28120)	(1) 67P-CHURYUMOV-GERASIMENKO	STIS/NUV-MAMA, ACCUM, 52X0.5	G230L 2376 A			Sequence 1-3 Non-Int in STIS G230L (01)	1600 Secs (1600 Secs) [==>]		[1]
	3	IMAGE	(1) 67P-CHURYUMOV-GERASIMENKO	STIS/CCD, ACCUM, F28X50LP	MIRROR			Sequence 1-3 Non-Int in STIS G230L (01)	2 Secs (2 Secs) [==>(Split 1)] [==>(Split 2)]		[1]
Orbit Structure	Orbit 1										
	Server Version: 20210514										

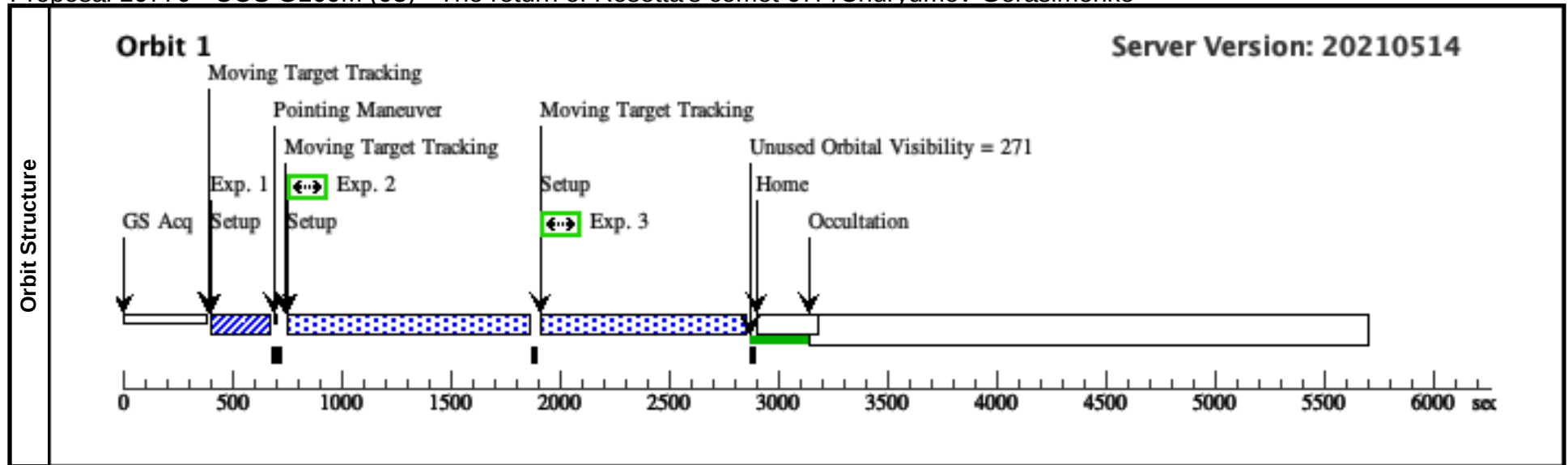
Proposal 16770 - STIS G230L (02) - The return of Rosetta's comet 67P/Churyumov-Gerasimenko

Visit	Proposal 16770, STIS G230L (02), failed										Wed Oct 27 19:00:47 GMT 2021
	Diagnostic Status: No Diagnostics										
	Scientific Instruments: STIS/NUV-MAMA, STIS/CCD										
	Special Requirements: SAME ORIENT AS 01; AFTER 01 BY 0.8 Orbits TO 1.2 Orbits; BETWEEN 14-OCT-2021:00:00:00 AND 20-DEC-2021:00:00:00; VISIBILITY INTERVAL NO GYRO BIAS UPDATE ON MOVING TARGET										
Solar System Targets	#	Name	Level 1	Level 2	Level 3	Window	Ephem Center				
	(1)	67P-CHURYUMOV-GERASIMENKO	TYPE=COMET,Q=1.210613814968979,E=0.649713733698611,I=3.871753825377044,O=36.33518841638918,W=22.13089737728478,T=02-NOV-2021:01:28:47,TTimeScale=TDB,EQUINOX=J2000,EPOCH=18-OCT-2021:00:00:00,EpochTimeScale=TDB					EARTH			
	Comments: Description=Comet 67P/Churyumov-Gerasimenko										
	Extended=YES										
Exposures	#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit	
	1	ACQ	(1) 67P-CHURYUMOV-GERASIMENKO	STIS/CCD, ACQ, F28X50LP	MIRROR			Sequence 1-3 Non-Int in STIS G230L (02)	2 Secs (2 Secs)		
									[==>]	[1]	
	2	(STIS.sp.1528120)	(1) 67P-CHURYUMOV-GERASIMENKO	STIS/NUV-MAMA, ACCUM, 52X0.5	G230L2376 A			Sequence 1-3 Non-Int in STIS G230L (02)	1600 Secs (1600 Secs)		
									[==>]	[1]	
	3	IMAGE	(1) 67P-CHURYUMOV-GERASIMENKO	STIS/CCD, ACCUM, F28X50LP	MIRROR			Sequence 1-3 Non-Int in STIS G230L (02)	2 Secs (2 Secs)		
									[==>(Split 1)]		
									[==>(Split 2)]	[1]	



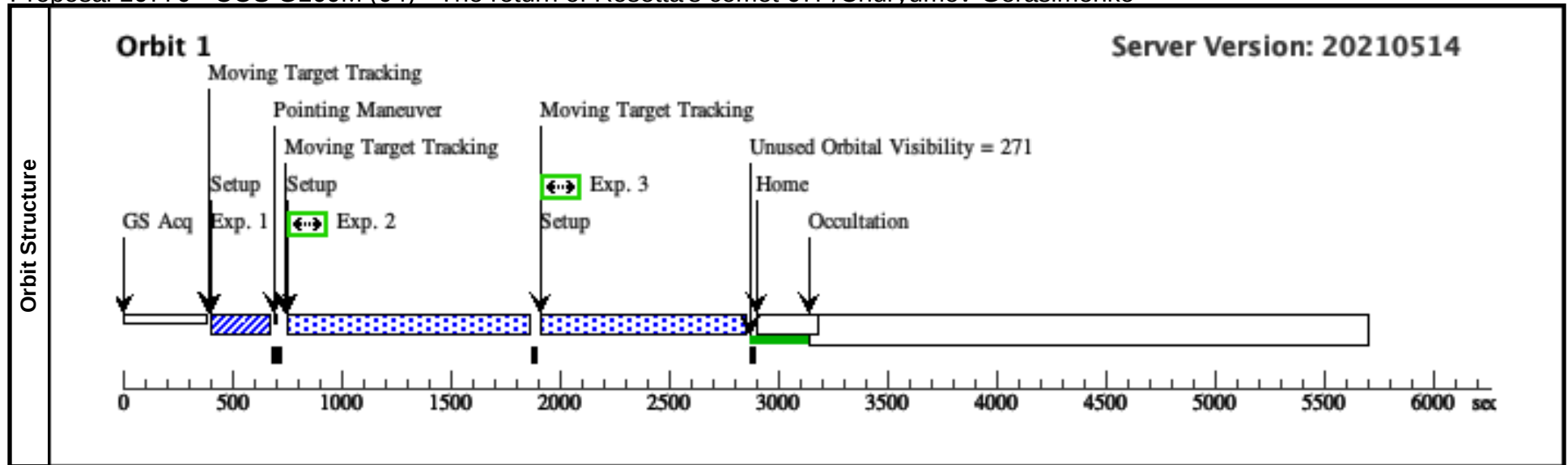
Proposal 16770 - COS G160M (03) - The return of Rosetta's comet 67P/Churyumov-Gerasimenko

Visit	Proposal 16770, COS G160M (03), completed										Wed Oct 27 19:00:47 GMT 2021	
	Diagnostic Status: Warning											
	Scientific Instruments: COS/FUV, COS/NUV											
	Special Requirements: AFTER 02 BY 0.01 D TO 7 D; BETWEEN 14-OCT-2021:00:00:00 AND 20-DEC-2021:00:00:00; VISIBILITY INTERVAL NO GYRO BIAS UPDATE ON MOVING TARGET											
Diagnostics	(ACQ (03.001)) Warning (Form): Sensitive exposures should have an ETC run number provided.											
	(Exposure 2 (Sequence 1-3 Non-Int in COS G160M (03))) Warning (Form): COS FUV PSA science exposures with extended targets have special calibration limitations. See "Errors and Warnings" for more details.											
	(Exposure 3 (Sequence 1-3 Non-Int in COS G160M (03))) Warning (Form): COS FUV PSA science exposures with extended targets have special calibration limitations. See "Errors and Warnings" for more details.											
Solar System Targets	#	Name	Level 1	Level 2	Level 3	Window	Ephem Center					
	(1)	67P-CHURYUMOV-GERASIMENKO	TYPE=COMET,Q=1.210613814968979,E=0.649713733698611,I=3.871753825377044,O=36.33518841638918,W=22.13089737728478,T=02-NOV-2021:01:28:47,TimeScale=TDB,EQUINOX=J2000,EPOCH=18-OCT-2021:00:00:00,EpochTimeScale=TDB					EARTH				
Comments: Description=Comet 67P/Churyumov-Gerasimenko Extended=YES												
Exposures	#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]		Orbit	
	1	ACQ	(1) 67P-CHURYUMOV-GERASIMENKO	COS/NUV, ACQ/IMAGE, PSA	MIRRORA			Sequence 1-3 Non-Int in COS G160M (03)	20 Secs (20 Secs)			
									[==>]		[1]	
	2	(COS.sp.152 8111)	(1) 67P-CHURYUMOV-GERASIMENKO	COS/FUV, TIME-TAG, PSA	G160M 1623 A	BUFFER-TIME=10000; FP-POS=1		Sequence 1-3 Non-Int in COS G160M (03)	885 Secs (885 Secs)			
									[==>]		[1]	
3	(COS.sp.152 8111)	(1) 67P-CHURYUMOV-GERASIMENKO	COS/FUV, TIME-TAG, PSA	G160M 1623 A	BUFFER-TIME=10000; FP-POS=2		Sequence 1-3 Non-Int in COS G160M (03)	885 Secs (885 Secs)				
								[==>]		[1]		



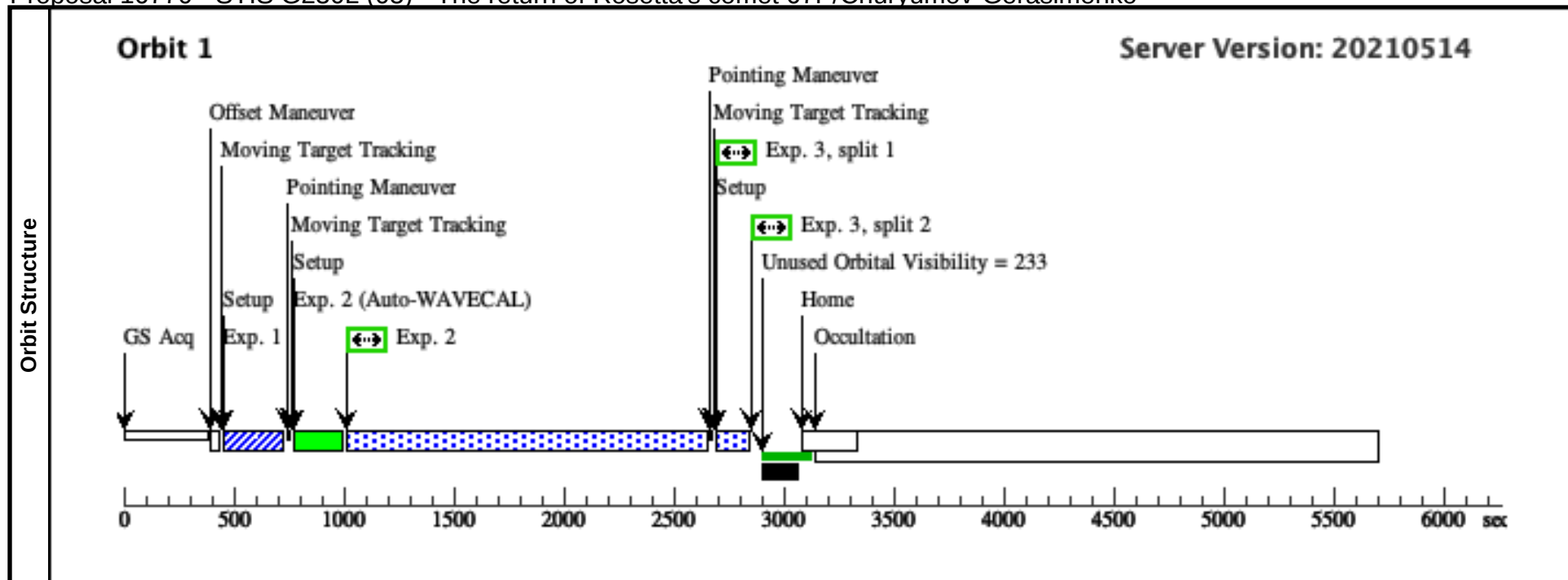
Proposal 16770 - COS G160M (04) - The return of Rosetta's comet 67P/Churyumov-Gerasimenko

Visit	Proposal 16770, COS G160M (04), completed										Wed Oct 27 19:00:47 GMT 2021	
	Diagnostic Status: Warning											
	Scientific Instruments: COS/FUV, COS/NUV											
	Special Requirements: AFTER 03 BY 0.8 Orbits TO 1.2 Orbits; BETWEEN 14-OCT-2021:00:00:00 AND 20-DEC-2021:00:00:00; VISIBILITY INTERVAL NO GYRO BIAS UPDATE ON MOVING TARGET											
Diagnostics	(ACQ (04.001)) Warning (Form): Sensitive exposures should have an ETC run number provided.											
	(Exposure 2 (Sequence 1-3 Non-Int in COS G160M (04))) Warning (Form): COS FUV PSA science exposures with extended targets have special calibration limitations. See "Errors and Warnings" for more details.											
	(Exposure 3 (Sequence 1-3 Non-Int in COS G160M (04))) Warning (Form): COS FUV PSA science exposures with extended targets have special calibration limitations. See "Errors and Warnings" for more details.											
Solar System Targets	#	Name	Level 1	Level 2	Level 3	Window	Ephem Center					
	(1)	67P-CHURYUMOV-GERASIMENKO	TYPE=COMET,Q=1.210613814968979,E=0.649713733698611,I=3.871753825377044,O=36.33518841638918,W=22.13089737728478,T=02-NOV-2021:01:28:47,TimeScale=TDB,EQUINOX=J2000,EPOCH=18-OCT-2021:00:00:00,EpochTimeScale=TDB					EARTH				
Comments: Description=Comet 67P/Churyumov-Gerasimenko Extended=YES												
Exposures	#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]		Orbit	
	1	ACQ	(1) 67P-CHURYUMOV-GERASIMENKO	COS/NUV, ACQ/IMAGE, PSA	MIRRORA			Sequence 1-3 Non-Int in COS G160M (04)	20 Secs (20 Secs)			
									[==>]		[1]	
	2	(COS.sp.152 8111)	(1) 67P-CHURYUMOV-GERASIMENKO	COS/FUV, TIME-TAG, PSA	G160M 1623 A	BUFFER-TIME=10000; FP-POS=3		Sequence 1-3 Non-Int in COS G160M (04)	885 Secs (885 Secs)			
									[==>]		[1]	
	3	(COS.sp.152 8111)	(1) 67P-CHURYUMOV-GERASIMENKO	COS/FUV, TIME-TAG, PSA	G160M 1623 A	BUFFER-TIME=10000; FP-POS=4		Sequence 1-3 Non-Int in COS G160M (04)	885 Secs (885 Secs)			
									[==>]		[1]	



Proposal 16770 - STIS G230L (05) - The return of Rosetta's comet 67P/Churyumov-Gerasimenko

Visit	Proposal 16770, STIS G230L (05), implementation										Wed Oct 27 19:00:47 GMT 2021	
	Diagnostic Status: No Diagnostics											
	Scientific Instruments: STIS/NUV-MAMA, STIS/CCD											
	Special Requirements: ORIENT 220D TO 260 D; BETWEEN 14-OCT-2021:00:00:00 AND 20-DEC-2021:00:00:00; VISIBILITY INTERVAL NO GYRO BIAS UPDATE ON MOVING TARGET											
Solar System Targets	#	Name	Level 1	Level 2	Level 3	Window	Ephem Center					
	(2)	67P-CHURYUMOV-GERASIMENKO-V5	TYPE=COMET,Q=1.210613663849778,E=0.649700834587701,I=3.871699730539964,O=36.33530311531698,W=22.13248241862631,T=02-NOV-2021:01:31:23,TimeScale=TDB,EQUINOX=J2000,EPOCH=15-NOV-2021:00:00:00,EpochTimeScale=TDB					EARTH				
	Comments: Description=Comet 67P/Churyumov-Gerasimenko Extended=YES											
	Ephemeris Uncertainty: 3000 Kilometers											
Exposures	#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit		
	1	ACQ	(2) 67P-CHURYUMOV-GERASIMENKO-V5	STIS/CCD, ACQ, F28X50LP	MIRROR		REQ EPHEM CORR 000001	Sequence 1-3 Non-Int in STIS G230L (05)	2 Secs (2 Secs) [==>]	[1]		
	2	(STIS.sp.15 28120)	(2) 67P-CHURYUMOV-GERASIMENKO-V5	STIS/NUV-MAMA, ACCUM, 52X0.5	G230L 2376 A		REQ EPHEM CORR 000001	Sequence 1-3 Non-Int in STIS G230L (05)	1600 Secs (1600 Secs) [==>]	[1]		
	3	IMAGE	(2) 67P-CHURYUMOV-GERASIMENKO-V5	STIS/CCD, ACCUM, F28X50LP	MIRROR		REQ EPHEM CORR 000001	Sequence 1-3 Non-Int in STIS G230L (05)	2 Secs (2 Secs) [==>(Split 1)] [==>(Split 2)]	[1]		



Proposal 16770 - STIS G230L (06) - The return of Rosetta's comet 67P/Churyumov-Gerasimenko

Visit	Proposal 16770, STIS G230L (06), implementation										Wed Oct 27 19:00:47 GMT 2021	
	Diagnostic Status: No Diagnostics											
	Scientific Instruments: STIS/NUV-MAMA, STIS/CCD											
	Special Requirements: SAME ORIENT AS 05; AFTER 05 BY 0.8 Orbits TO 1.2 Orbits; BETWEEN 14-OCT-2021:00:00:00 AND 20-DEC-2021:00:00:00; VISIBILITY INTERVAL NO GYRO BIAS UPDATE ON MOVING TARGET											
Solar System Targets	#	Name	Level 1	Level 2	Level 3	Window	Ephem Center					
	(2)	67P-CHURYUMOV-GERASIMENKO-V5	TYPE=COMET,Q=1.210613663849778,E=0.649700834587701,I=3.871699730539964,O=36.33530311531698,W=22.13248241862631,T=02-NOV-2021:01:31:23,TTimeScale=TDB,EQUINOX=J2000,EPOCH=15-NOV-2021:00:00:00,EpochTimeScale=TDB				EARTH					
	Comments: Description=Comet 67P/Churyumov-Gerasimenko Extended=YES											
	Ephemeris Uncertainty: 3000 Kilometers											
Exposures	#	Label (ETC Run)	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]		Orbit	
	1	ACQ	(2) 67P-CHURYUMOV-GERASIMENKO-V5	STIS/CCD, ACQ, F28X50LP	MIRROR		REQ EPHEM CORR 000001	Sequence 1-3 Non-Int in STIS G230L (06)	2 Secs (2 Secs)			
									[==>]		[1]	
	2	(STIS.sp.15 28120)	(2) 67P-CHURYUMOV-GERASIMENKO-V5	STIS/NUV-MAMA, ACCUM, 52X0.5	G230L 2376 A		REQ EPHEM CORR 000001	Sequence 1-3 Non-Int in STIS G230L (06)	1600 Secs (1600 Secs)			
									[==>]		[1]	
	3	IMAGE	(2) 67P-CHURYUMOV-GERASIMENKO-V5	STIS/CCD, ACCUM, F28X50LP	MIRROR		REQ EPHEM CORR 000001	Sequence 1-3 Non-Int in STIS G230L (06)	2 Secs (2 Secs)			
									[==>(Split 1)]			
									[==>(Split 2)]		[1]	

