



16929 - Disintegration of Long-Period Comet C/2021 A1

Cycle: 29, Proposal Category: GO/DD

(Availability Mode: SUPPORTED)

INVESTIGATORS

<i>Name</i>	<i>Institution</i>	<i>E-Mail</i>
Dr. David Jewitt (PI) (Contact)	University of California - Los Angeles	jewitt@ucla.edu
Dr. Jing Li (CoI)	University of California - Los Angeles	jli@igpp.ucla.edu
Dr. Jessica Agarwal (CoI) (ESA Member)	Technische Universitaet Braunschweig	agarwal@mps.mpg.de
Dr. Yoonyoung Kim (CoI) (ESA Member)	Technische Universitaet Braunschweig	yoonyoung.kim@tu-braunschweig.de
Max Mutchler (CoI) (Contact)	Space Telescope Science Institute	mutchler@stsci.edu

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) C2021-A1	WFC3/UVIS	1	17-May-2022 09:00:13.0	yes
02	(1) C2021-A1	WFC3/UVIS	1	17-May-2022 09:00:13.0	yes
03	(1) C2021-A1	WFC3/UVIS	1	17-May-2022 09:00:14.0	yes
04	(2) C2021-A1-B	WFC3/UVIS	1	17-May-2022 09:00:14.0	yes

4 Total Orbits Used

ABSTRACT

Long-period comet nuclei are volatile rich products of accretion in the protoplanetary disk of the Sun, preserved at about 10 K in the Oort cloud. They include some of the most primitive macroscopic objects in the solar system. We now know that comet nuclei spontaneously and suddenly disintegrate and that disintegration probably dominates sublimation as the main destructive process operating on these bodies when in the inner solar system. Crucially, disintegration may account for the long-recognized "fading problem" discovered by Oort in 1950: comets fade because they fall

apart, not because they run out of ice. Unfortunately, our confidence that disintegration is important is not matched by an understanding of the process or its cause. This is because disintegrations are unpredictable, sudden, and difficult to observe. Proposed models center around internal pressure build-up, explosion of amorphous ice, and centripetal disruption caused by outgassing torques, but we do not possess the high quality (resolution, sensitivity and temporal resolution) data needed to determine what is really happening. C/2021 A1 began disintegration in early 2022 March, providing a rare opportunity to study a disintegration with the full power of HST. We propose an efficient, 4 orbit DDT observation, with 3 orbits scheduled early to assess the fragment field and measure size, velocity and acceleration distributions, and a single orbit in June to examine the distribution of material perpendicular to the orbit plane. Only by obtaining this type of high resolution, high sensitivity, time-resolved data can we hope to characterize and understand cometary disintegration.

OBSERVING DESCRIPTION

We request 4 orbits with WFC3 to examine the disintegration of C/2021 A1. Our basic observing strategy is to take multiple long exposures (348-400 s) using WFC3 and a wide bandpass filter (F350LP) for maximum sensitivity. We use F350LP because the F350LP count rate is 1.6x higher for a target with a solar-type spectrum than other commonly used broadband filters (e.g., F606W). We also plan to dither the exposures to mitigate the effects from bad pixels, cosmic rays, and the inter-chip gap. The sampling of the observations is a principal concern. HST observations of disintegrating comet P/2010 V1 (Ikeya-Murakami) show that fragments evolve photometrically and morphologically on a 1 day timescale and that they cannot be linked unambiguously on timescales > 2 days. For example, in P/2010 V1, fragments in January 2016 could not be connected to fragments observed 3 weeks later, impeding the ability to measure non-gravitational accelerations and to reach conclusions about the ice content and activity states of the fragments. However, with approximately daily sampling, the linkage problems would largely disappear. Accordingly, we request 3 orbits distributed with approximately 1 to 2 day spacing, for a total of 3 to 6 days coverage, to be scheduled as soon as practical. Three orbits (as opposed to two) are the minimum needed to confirm astrometric linkages between fragments, including the possibility of non-linear motions due to outgassing acceleration. Early scheduling of these 3 orbits is needed to sample the disintegration before the small fragments have faded to invisibility. We request immediate scheduling, but not disruptive scheduling for this purpose, with a nominal desired observing window in early to mid-April. We request 1 additional orbit on UT 2022 June 7, this being the date on which the Earth passes through the projected orbit plane of C/2021 A1. Observations from within the orbit plane provide a model-free perspective on the distribution of material above and below the plane, including the best possible measure of the out-of-plane ejection velocity of the material. We do not know what fraction of the comet material will remain observable in June but, given the sensitivity mentioned below, we expect to detect the larger surviving fragments. The WFC3 Exposure Time Calculator indicates that, for a point source, solar-type spectrum, a signal-to-noise ratio of 6 is reached in 348 s at $V = 26.5$ in the F350LP filter (ETC request ID WFC3UVIS.im.765972; optimal extraction yields SNR=13). For example, at opposition and heliocentric distance $R = 1$ AU, magnitude V

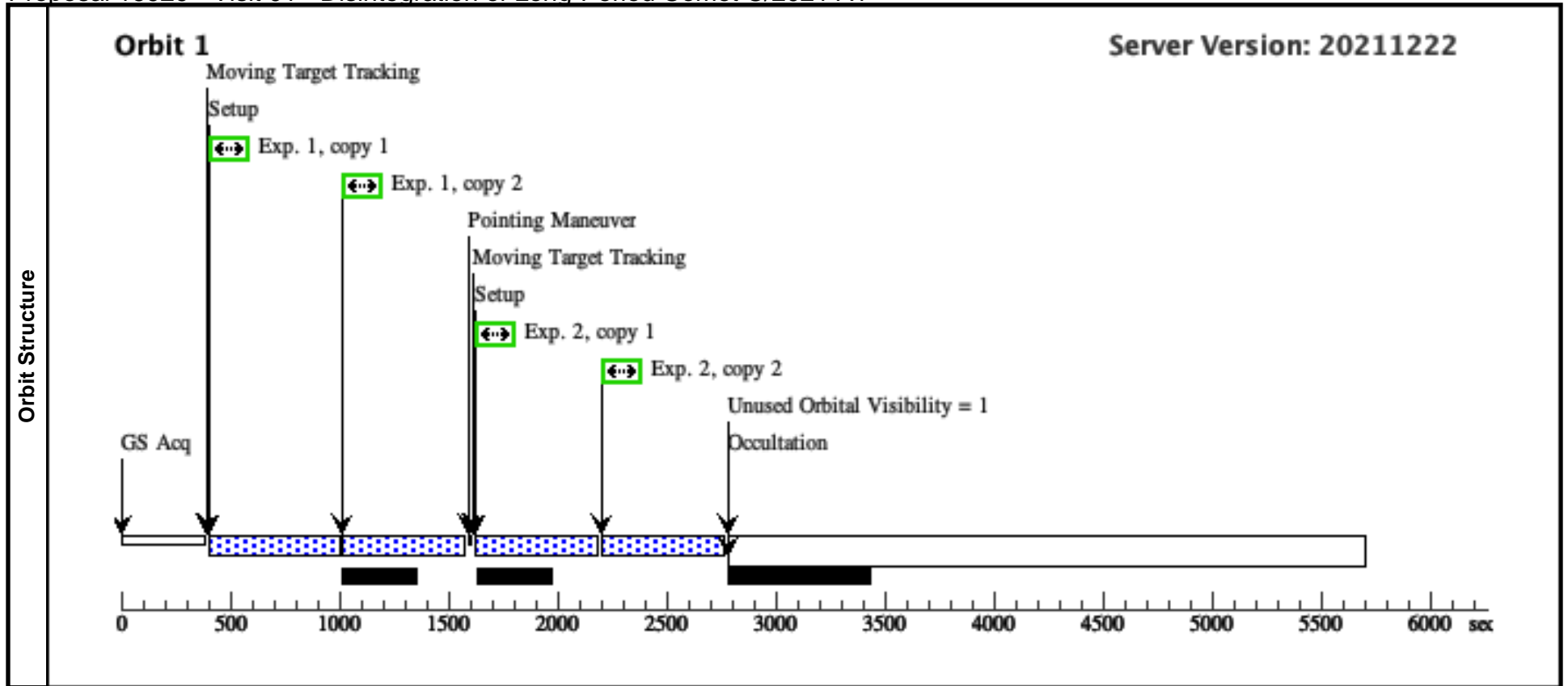
Proposal 16929 (STScI Edit Number: 4, Created: Tuesday, May 17, 2022 at 8:00:15 AM Eastern Standard Time) - Overview

= 26.5 corresponds to an object radius 20 m (geometric albedo 0.04 assumed). These are upper limits to the point source thresholds because at least some of the fragments are embedded in their own dust comae. However, it is clear that HST offers unprecedented sensitivity to faint fragments.

Proposal 16929 - Visit 01 - Disintegration of Long-Period Comet C/2021 A1

Tue May 17 13:00:15 GMT 2022

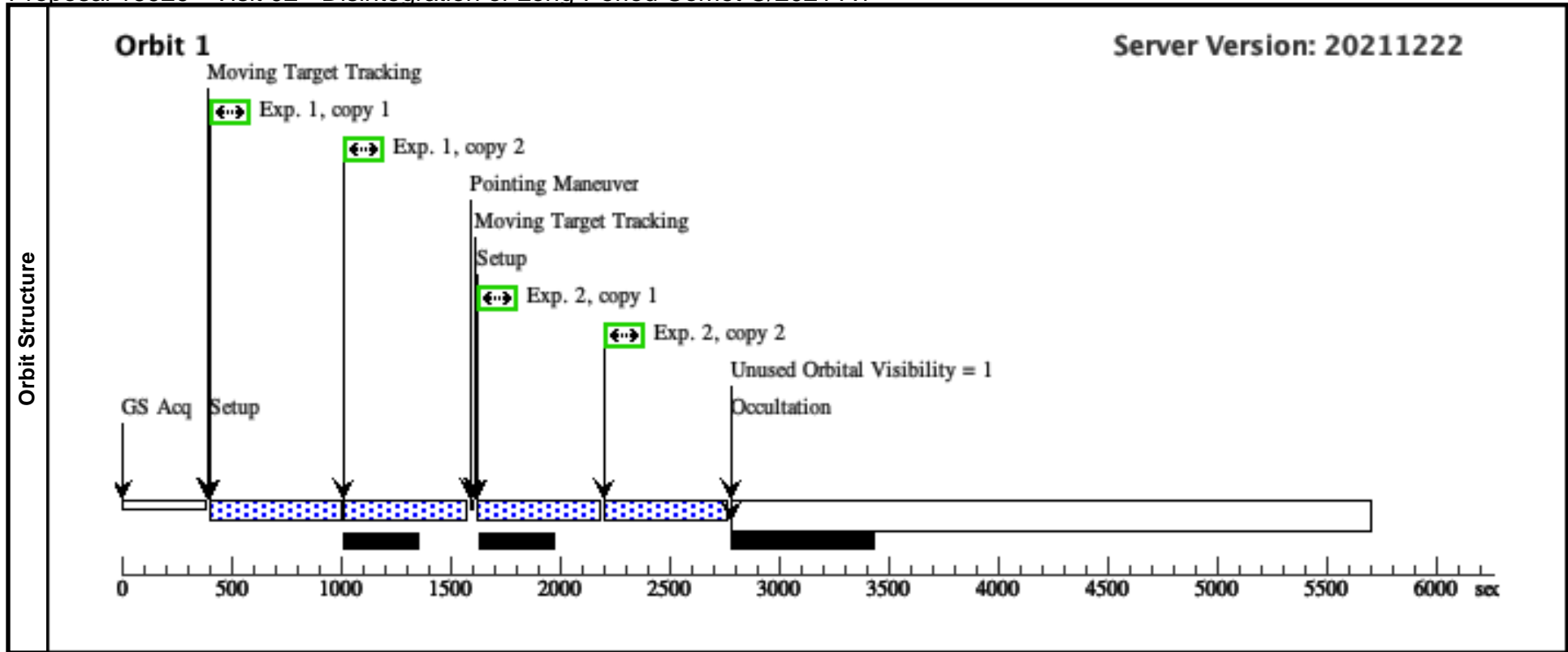
Visit	Proposal 16929, Visit 01, completed Diagnostic Status: No Diagnostics Scientific Instruments: WFC3/UVIS Special Requirements: BETWEEN 05-APR-2022:04:00:00 AND 05-APR-2022:10:00:00; BETWEEN 05-APR-2022:16:00:00 AND 06-APR-2022:00:00:00; BETWEEN 06-APR-2022:03:00:00 AND 06-APR-2022:09:00:00; BETWEEN 06-APR-2022:17:00:00 AND 07-APR-2022:03:00:00									
Solar System Targets	#	Name	Level 1	Level 2	Level 3	Window	Ephem Center			
	(1)	C2021-A1	TYPE=COMET,Q=0.6152301521444 987,E=1.000100458487891,I=132.685 813010451 ,O=255.8891005421364,W=225.08771 42804849,T=03-JAN- 2022:07:01:27,TTimeScale=TDB,EQ UINOX=J2000,EPOCH=11-JUL- 2021:00:00:00,EpochTimeScale=TDB, R0=2.808 ,DT=0. ,A1=5.805860996246E-8,A2=- 2.026799678802E- 8,A3=1.105900406837E-8 ,ALN=0.1112620426,NM=2.15,NN=5. 093,NK=4.6142,AMRAT=0.				EARTH			
Comments: Description=disintegrating comet Extended=YES										
Exposures	#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
	1	(1) C2021-A1	(1) C2021-A1	WFC3/UVIS, ACCUM, UVIS2-FIX	F350LP			Sequence 1-2 Non-Int in Visit 01	450 Secs X 2 (900 Secs)	
									[==>(Copy 1)]	[1]
									[==>(Copy 2)]	
2	(1) C2021-A1	(1) C2021-A1	WFC3/UVIS, ACCUM, UVIS2-FIX	F350LP		POS TARG 0.40,2.4		Sequence 1-2 Non-Int in Visit 01	450 Secs X 2 (900 Secs)	
									[==>(Copy 1)]	[1]
									[==>(Copy 2)]	



Proposal 16929 - Visit 02 - Disintegration of Long-Period Comet C/2021 A1

Tue May 17 13:00:15 GMT 2022

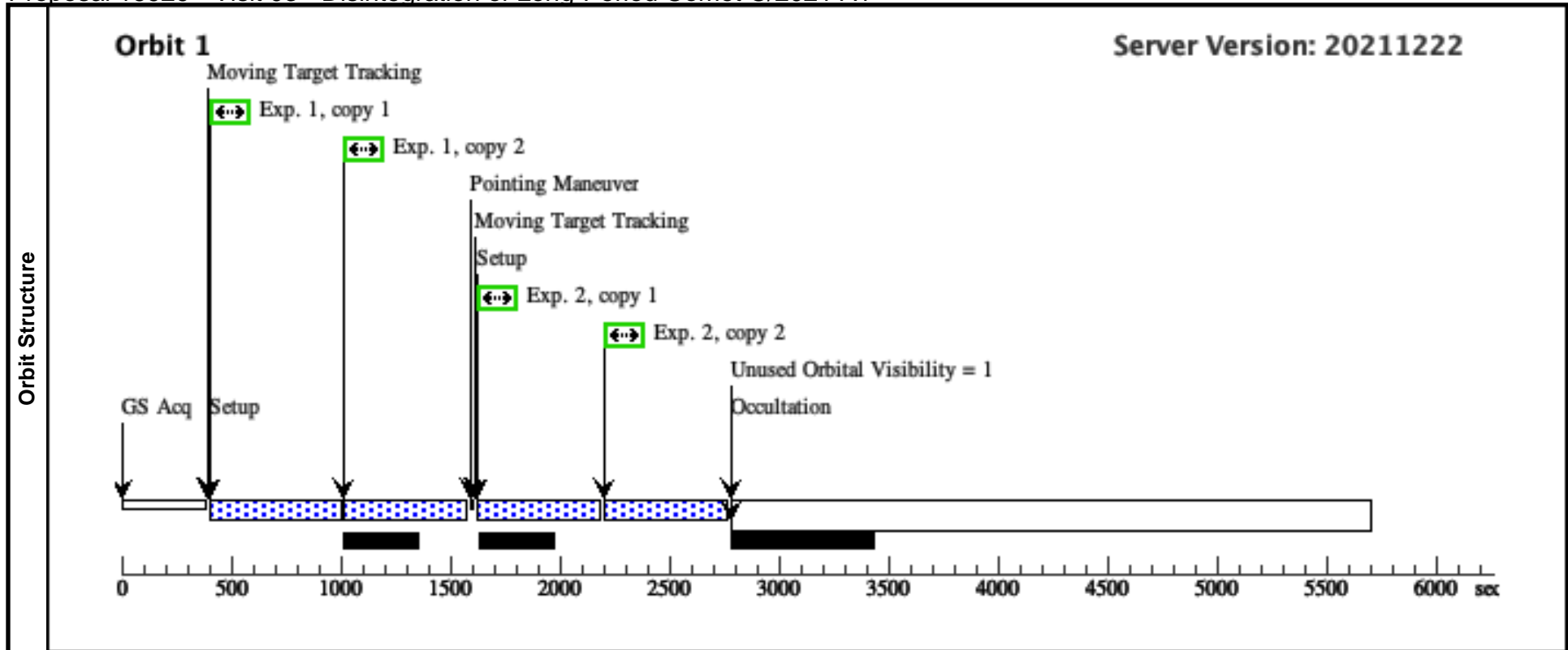
Visit	Proposal 16929, Visit 02, completed Diagnostic Status: No Diagnostics Scientific Instruments: WFC3/UVIS Special Requirements: AFTER 01 BY 1426 M TO 3 D; BETWEEN 05-APR-2022:04:00:00 AND 05-APR-2022:10:00:00; BETWEEN 05-APR-2022:16:00:00 AND 06-APR-2022:00:00:00; BETWEEN 06-APR-2022:03:00:00 AND 06-APR-2022:09:00:00; BETWEEN 06-APR-2022:17:00:00 AND 07-APR-2022:03:00:00; BETWEEN 07-APR-2022:08:00:00 AND 07-APR-2022:12:00:00; BETWEEN 07-APR-2022:19:00:00 AND 08-APR-2022:18:00:00										
Solar System Targets	#	Name	Level 1	Level 2	Level 3	Window	Ephem Center				
	(1)	C2021-A1	TYPE=COMET,Q=0.6152301521444 987,E=1.000100458487891,I=132.685 813010451 ,O=255.8891005421364,W=225.08771 42804849,T=03-JAN- 2022:07:01:27,TimeScale=TDB,EQ UINOX=J2000,EPOCH=11-JUL- 2021:00:00:00,EpochTimeScale=TDB, R0=2.808 ,DT=0. ,A1=5.805860996246E-8,A2=- 2.026799678802E- 8,A3=1.105900406837E-8 ,ALN=0.1112620426,NM=2.15,NN=5. 093,NK=4.6142,AMRAT=0.					EARTH			
	Comments: Description=disintegrating comet Extended=YES										
Exposures	#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit	
	1	(1) C2021-A1	WFC3/UVIS, ACCUM, UVIS2-FIX	F350LP				Sequence 1-2 Non-Int in Visit 02	450 Secs X 2 (900 Secs) [=>(Copy 1)] [=>(Copy 2)]	[1]	
	2	(1) C2021-A1	WFC3/UVIS, ACCUM, UVIS2-FIX	F350LP		POS TARG 0.40,2.4		Sequence 1-2 Non-Int in Visit 02	450 Secs X 2 (900 Secs) [=>(Copy 1)] [=>(Copy 2)]	[1]	



Proposal 16929 - Visit 03 - Disintegration of Long-Period Comet C/2021 A1

Tue May 17 13:00:15 GMT 2022

Visit	Proposal 16929, Visit 03, completed Diagnostic Status: No Diagnostics Scientific Instruments: WFC3/UVIS Special Requirements: AFTER 01 BY 4 D TO 8 D; BETWEEN 06-APR-2022:17:00:00 AND 07-APR-2022:03:00:00; BETWEEN 07-APR-2022:08:00:00 AND 07-APR-2022:12:00:00; BETWEEN 07-APR-2022:19:00:00 AND 08-APR-2022:18:00:00; BETWEEN 09-APR-2022:04:00:00 AND 09-APR-2022:17:00:00; BETWEEN 10-APR-2022:14:00:00 AND 11-APR-2022:06:00:00; BETWEEN 11-APR-2022:10:00:00 AND 11-APR-2022:19:00:00																														
Solar System Targets	<table border="1"> <thead> <tr> <th>#</th> <th>Name</th> <th>Level 1</th> <th>Level 2</th> <th>Level 3</th> <th>Window</th> <th>Ephem Center</th> </tr> </thead> <tbody> <tr> <td>(1)</td> <td>C2021-A1</td> <td>TYPE=COMET,Q=0.6152301521444 987,E=1.000100458487891,I=132.685 813010451 ,O=255.8891005421364,W=225.08771 42804849,T=03-JAN-2022:07:01:27,TimeScale=TDB,EQ UINOX=J2000,EPOCH=11-JUL-2021:00:00:00,EpochTimeScale=TDB, R0=2.808 ,DT=0. ,A1=5.805860996246E-8,A2=-2.026799678802E-8,A3=1.105900406837E-8 ,ALN=0.1112620426,NM=2.15,NN=5.093,NK=4.6142,AMRAT=0.</td> <td></td> <td></td> <td></td> <td></td> <td>EARTH</td> </tr> </tbody> </table> <p><i>Comments: Description=disintegrating comet</i> <i>Extended=YES</i></p>	#	Name	Level 1	Level 2	Level 3	Window	Ephem Center	(1)	C2021-A1	TYPE=COMET,Q=0.6152301521444 987,E=1.000100458487891,I=132.685 813010451 ,O=255.8891005421364,W=225.08771 42804849,T=03-JAN-2022:07:01:27,TimeScale=TDB,EQ UINOX=J2000,EPOCH=11-JUL-2021:00:00:00,EpochTimeScale=TDB, R0=2.808 ,DT=0. ,A1=5.805860996246E-8,A2=-2.026799678802E-8,A3=1.105900406837E-8 ,ALN=0.1112620426,NM=2.15,NN=5.093,NK=4.6142,AMRAT=0.					EARTH															
#	Name	Level 1	Level 2	Level 3	Window	Ephem Center																									
(1)	C2021-A1	TYPE=COMET,Q=0.6152301521444 987,E=1.000100458487891,I=132.685 813010451 ,O=255.8891005421364,W=225.08771 42804849,T=03-JAN-2022:07:01:27,TimeScale=TDB,EQ UINOX=J2000,EPOCH=11-JUL-2021:00:00:00,EpochTimeScale=TDB, R0=2.808 ,DT=0. ,A1=5.805860996246E-8,A2=-2.026799678802E-8,A3=1.105900406837E-8 ,ALN=0.1112620426,NM=2.15,NN=5.093,NK=4.6142,AMRAT=0.					EARTH																								
Exposures	<table border="1"> <thead> <tr> <th>#</th> <th>Label</th> <th>Target</th> <th>Config,Mode,Aperture</th> <th>Spectral Els.</th> <th>Opt. Params.</th> <th>Special Reqs.</th> <th>Groups</th> <th>Exp. Time (Total)/[Actual Dur.]</th> <th>Orbit</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>(1) C2021-A1</td> <td>WFC3/UVIS, ACCUM, UVIS2-FIX</td> <td>F350LP</td> <td></td> <td></td> <td></td> <td>Sequence 1-2 Non-Int in Visit 03</td> <td>450 Secs X 2 (900 Secs) [=>(Copy 1)] [=>(Copy 2)]</td> <td>[1]</td> </tr> <tr> <td>2</td> <td>(1) C2021-A1</td> <td>WFC3/UVIS, ACCUM, UVIS2-FIX</td> <td>F350LP</td> <td></td> <td>POS TARG 0.40,2.4</td> <td></td> <td>Sequence 1-2 Non-Int in Visit 03</td> <td>450 Secs X 2 (900 Secs) [=>(Copy 1)] [=>(Copy 2)]</td> <td>[1]</td> </tr> </tbody> </table>	#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit	1	(1) C2021-A1	WFC3/UVIS, ACCUM, UVIS2-FIX	F350LP				Sequence 1-2 Non-Int in Visit 03	450 Secs X 2 (900 Secs) [=>(Copy 1)] [=>(Copy 2)]	[1]	2	(1) C2021-A1	WFC3/UVIS, ACCUM, UVIS2-FIX	F350LP		POS TARG 0.40,2.4		Sequence 1-2 Non-Int in Visit 03	450 Secs X 2 (900 Secs) [=>(Copy 1)] [=>(Copy 2)]	[1]
#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit																						
1	(1) C2021-A1	WFC3/UVIS, ACCUM, UVIS2-FIX	F350LP				Sequence 1-2 Non-Int in Visit 03	450 Secs X 2 (900 Secs) [=>(Copy 1)] [=>(Copy 2)]	[1]																						
2	(1) C2021-A1	WFC3/UVIS, ACCUM, UVIS2-FIX	F350LP		POS TARG 0.40,2.4		Sequence 1-2 Non-Int in Visit 03	450 Secs X 2 (900 Secs) [=>(Copy 1)] [=>(Copy 2)]	[1]																						



Proposal 16929 - Visit 04 - Disintegration of Long-Period Comet C/2021 A1

Tue May 17 13:00:15 GMT 2022

Visit	Proposal 16929, Visit 04, implementation Diagnostic Status: No Diagnostics Scientific Instruments: WFC3/UVIS Special Requirements: ORIENT 283D TO 295 D; BETWEEN 06-JUN-2022:00:00:00 AND 08-JUN-2022:06:00:00 <i>Comments: orient range added by PC to ease OBAD scheduling</i>									
	Solar System Targets	#	Name	Level 1	Level 2	Level 3	Window	Ephem Center		
(2)		C2021-A1-B	TYPE=COMET,Q=0.6152301549244 599,E=1.000100476563864,I=132.685 8128893857 .O=255.8891027444656,W=225.08771 46079479,T=03-JAN- 2022:07:01:27,TimeScale=TDB,EQ UINOX=J2000,EPOCH=11-JUL- 2021:00:00:00,EpochTimeScale=TDB, R0=2.808 .DT=0. .A1=5.810580730438E-8,A2=- 2.030660629272E- 8,A3=1.103076815605E-8 .ALN=0.1112620426,NM=2.15,NN=5. 093,NK=4.6142,AMRAT=0.				EARTH			
	<i>Comments: Description=disintegrating comet</i> <i>Extended=YES</i>									
Exposures	#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
	1	(2) C2021-A1-B		WFC3/UVIS, ACCUM, UVIS2-2K2C-SUB	F350LP		POS TARG 10,10	Sequence 1-1 Non-Int in Visit 04	285 Secs X 5 (1425 Secs) [=>(Copy 1)] [=>(Copy 2)] [=>(Copy 3)] [=>(Copy 4)] [=>(Copy 5)]	[1]

