16904 - Disintegrating Comet 108P/Ciffreo

Cycle: 29, 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	(2) COMET-108P-CIFFREO	WFC3/UVIS	1	18-Jan-2022 16:00:11.0	yes
02	(2) COMET-108P-CIFFREO	WFC3/UVIS	1	18-Jan-2022 16:00:12.0	yes
03	(2) COMET-108P-CIFFREO	WFC3/UVIS	1	18-Jan-2022 16:00:13.0	yes

3 Total Orbits Used

ABSTRACT

As was first noticed on 2022 January 2, the short-period (Kuiper belt) comet 108P/Ciffreo is undergoing a fragmentation event. In low-resolution ground-based data, the ejected fragments appear only as a diffuse, low surface brightness blob separated from the main nucleus. Given such data, neither photometric nor dynamical studies are possible. We propose early-time measurements at the high angular resolution offered by HST to characterize these embedded fragments in terms of their brightness and velocity distributions, with the aim being to determine the process behind the fragmentation. Three orbits are requested to determine the sky-plane motion of the fragments so that their velocities and ejection dates can be

determined. Cometary fragmentation events are both unpredictable and short-lived and, as a result, few have been studied in detail. DDT observations are needed to obtain data while the fragment swarm is fresh and before it dissipates and fades.

OBSERVING DESCRIPTION

We request three orbits with WFC3 spread over about a week in order to achieve our two main science objectives: fragment size distribution and dynamics. This timing will permit the measurement of fragment velocities and their extrapolation to determine the release dates, assuming nominal ejection speeds of order 1 m/s. The ejected fragments may themselves be sublimating. Recoil forces from asymmetric sublimation drive a non-gravitational (rocket) acceleration of magnitude inversely proportional to fragment size. If the rocket force from sublimation in the subsolar region dominates, the fragments will remain in the orbital plane, because like radiation pressure this force is directed away from the Sun and acts only to reduce the effective solar gravity. If outgassing is negligible and instead the fragment motion is governed by the initial velocity, the fragments will generally occupy a more three- dimensional distribution, as in active asteroid P/2010 A2. Analysis of the dynamical evolution of the fragments will therefore provide a separate indication of whether sublimation played a major role in the break-up event, or if other (e.g., tidal or centrifugal) forces were prominently involved. Our basic observing strategy is to take multiple long exposures (348-400s) using WFC3 and the wide bandpass filter (F350LP) for maximum sensitivity. We use F350LP because it provides a count rate 1.6 higher for a target with a solar-type spectrum than other commonly used broadband filters (e.g., F606W). We will also dither the exposures to mitigate the effects from bad pixels, cosmic rays, and the inter-chip gap. 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). We gain an additional 0.9 magnitudes by combining five images from each orbit, giving V = 27.4. For example, on UT 2021 March 1, when heliocentric distance rH = 2.31 AU, geocentric distance 1.68 AU and phase angle 22, magnitude V = 27.4 corresponds to an object radius 65 m (geometric albedo 0.04 and C-type asteroid phase function 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. Gas emission from 108P/Ciffreo is likely to be negligible, as it is in all low activity comets at 2 AU. Even if gas drives the expulsion of matter from the nucleus, its rapid expansion velocity and intrinsically small resonance fluorescence scattering cross- section (compared to continuum scattering by dust) renders gas optically unimportant in observations of comets much beyond Earths orbit. The apparent rates of motion relative to sidereal are easily within Hubbles tracking capabilities. This rate of motion is also slow enough to keep a single pair of guide stars within the FGS pickles for an entire visibility window. The ephemeris uncertainties (from JPL Horizons) on 108P/Ciffreo are sub-arcsecond and therefore of no consequence for these observations. We understand that we will have essentially no control over the spacecraft roll angle. Observations are requested as early as possible in order to capture the early-time development of the ejected material, before it has had a change to fade and disperse. However, we do not request disruptive scheduling of these observations. In the

February - March period, 108P/Ciffreo will be about 2.2 AU from the Sun 1.5 AU from the Earth and at a phase angle near 20 degrees. Observations from about -8 below the plane of the orbit of 108P will provide a suitable perspective view of the distribution of bodies and dust in the orbit plane, which we will interpret using an existing Monte-Carlo dust dynamics model.

Visit

Proposal 16904, Visit 01

Tue Jan 18 21:00:13 GMT 2022

Diagnostic Status: No Diagnostics

Scientific Instruments: WFC3/UVIS

Special Requirements: SCHED 100%; BETWEEN 09-FEB-2022:15:00:00 AND 10-FEB-2022:20:00:00; BETWEEN 31-JAN-2022:00:00:00 AND 05-FEB-2022:18:00:00; BETWEEN 13-FEB-2022:09:00:00 AND 15-FEB-2022:15:00:00; BETWEEN 16-FEB-2022:02:00:00 AND 16-FEB-2022:20:00:00; VISIBILITY INTERVAL NO GYRO BIAS UPDATE ON MOVING TARGET

Solar System Targets

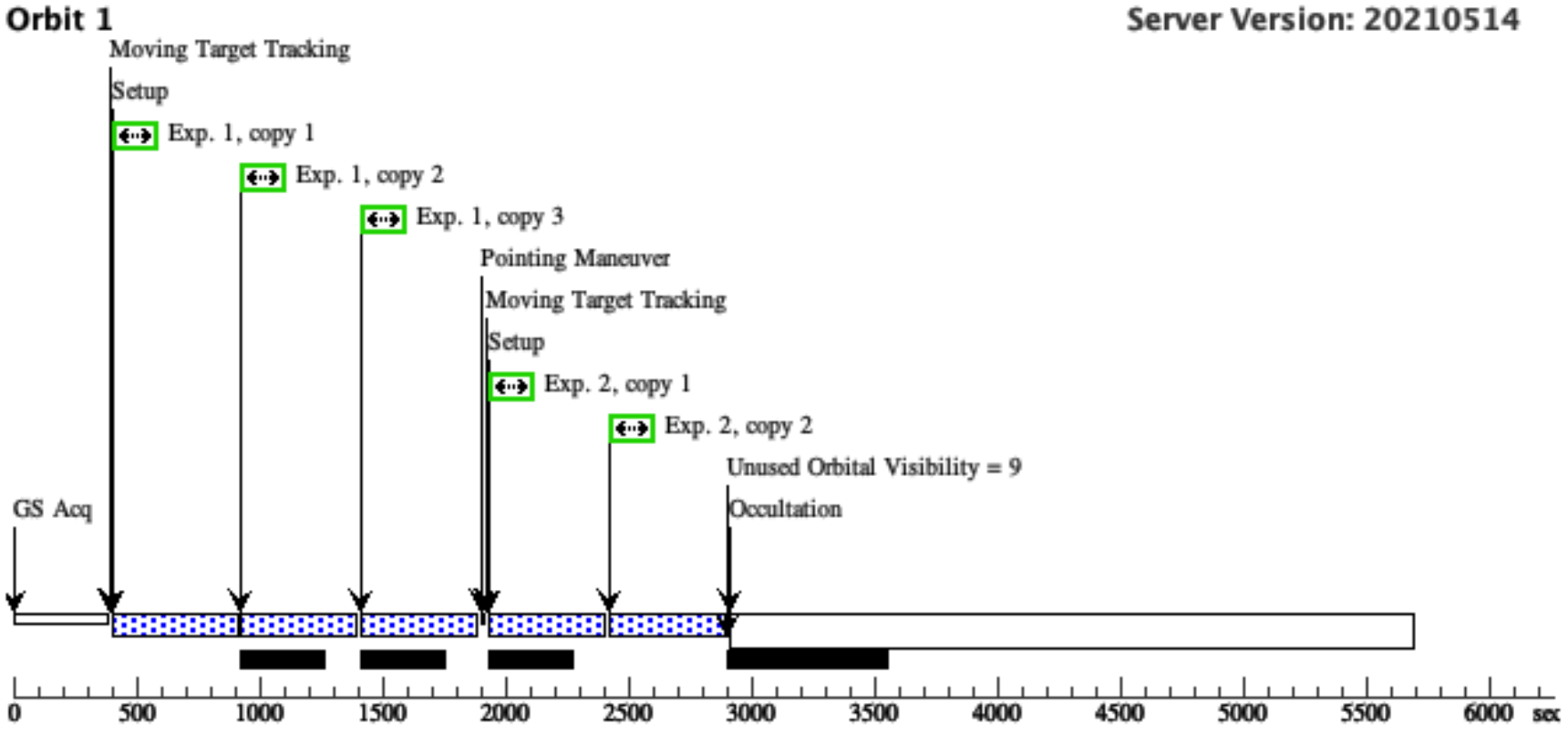
#	Name	Level 1	Level 2	Level 3	Window	Ephem Center
(2)	COMET-108P-CIFFREO	TYPE=COMET,Q=1.676339083838281,E=0.549930518846976,I=13.3124641650165 6,O=52.92407308081733,W=358.246135975604,T=21-OCT-2014:22:14:10,TTimeScale=TDB,EQUINOX=J2000,EPOCH=29-APR-2017:00:00:00,EpochTimeScale=TDB				EARTH

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		(2) COMET-108P-CIFFREO	WFC3/UVIS, ACCUM, UVIS2-FIX	F350LP			Sequence 1-2 Non-Int in Visit 01	360 Secs X 3 (1080 Secs)	
								[==>(Copy 1)]	
								[==>(Copy 2)]	***[1]***
								[==>(Copy 3)]	
2		(2) COMET-108P-CIFFREO	WFC3/UVIS, ACCUM, UVIS2-FIX	F350LP		POS TARG 0.4,2.5	Sequence 1-2 Non-Int in Visit 01	360 Secs X 2 (720 Secs)	
								[==>(Copy 1)]	***[1]***
								[==>(Copy 2)]	

Orbit Structure



Proposal 16904 - Visit 02 - Disintegrating Comet 108P/Ciffreo

Visit

Proposal 16904, Visit 02 Tue Jan 18 21:00:13 GMT 2022

Diagnostic Status: No Diagnostics

Scientific Instruments: WFC3/UVIS

Special Requirements: SCHED 100%; AFTER 01 BY 2 D TO 5 D; BETWEEN 09-FEB-2022:15:00:00 AND 10-FEB-2022:20:00:00; BETWEEN 31-JAN-2022:00:00:00 AND 05-FEB-2022:18:00:00; BETWEEN 13-FEB-2022:09:00:00 AND 15-FEB-2022:15:00:00; BETWEEN 16-FEB-2022:02:00:00 AND 16-FEB-2022:20:00:00; VISIBILITY INTERVAL NO GYRO BIAS UPDATE ON MOVING TARGET

Solar System Targets

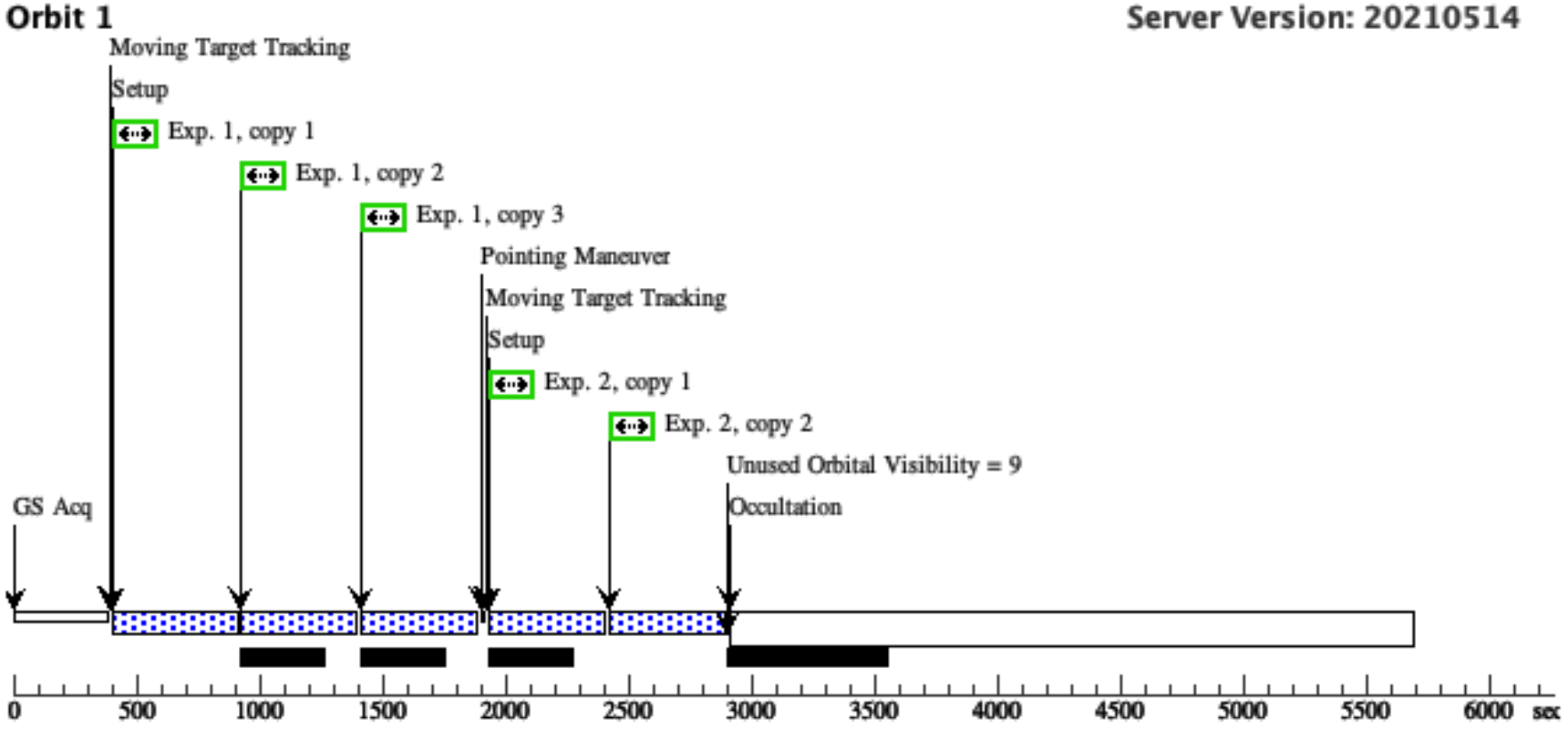
#	Name	Level 1	Level 2	Level 3	Window	Ephem Center
(2)	COMET-108P-CIFFREO	TYPE=COMET,Q=1.676339083838281,E=0.549930518846976,I=13.3124641650 1656 ,O=52.92407308081733,W=358.246135975604,T=21-OCT-2014:22:14:10,TTimeScale=TDB,EQUINOX=J2000,EPOCH=29-APR-2017:00:00:00,EpochTimeScale=TDB				EARTH

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		(2) COMET-108P-CIFFREO	WFC3/UVIS, ACCUM, UVIS2-FIX	F350LP			Sequence 1-2 Non-Int in Visit 02	360 Secs X 3 (1080 Secs)	
								[==>(Copy 1)]	***[1]***
								[==>(Copy 2)]	
								[==>(Copy 3)]	
2		(2) COMET-108P-CIFFREO	WFC3/UVIS, ACCUM, UVIS2-FIX	F350LP		POS TARG 0.4,2.5	Sequence 1-2 Non-Int in Visit 02	360 Secs X 2 (720 Secs)	
								[==>(Copy 1)]	***[1]***
								[==>(Copy 2)]	

Orbit Structure



Proposal 16904 - Visit 03 - Disintegrating Comet 108P/Ciffreo

Visit

Proposal 16904, Visit 03 Tue Jan 18 21:00:13 GMT 2022

Diagnostic Status: No Diagnostics

Scientific Instruments: WFC3/UVIS

Special Requirements: SCHED 100%; AFTER 01 BY 7 D TO 10 D; BETWEEN 09-FEB-2022:15:00:00 AND 10-FEB-2022:20:00:00; BETWEEN 31-JAN-2022:00:00:00 AND 05-FEB-2022:18:00:00; BETWEEN 13-FEB-2022:09:00:00 AND 15-FEB-2022:15:00:00; BETWEEN 16-FEB-2022:02:00:00 AND 16-FEB-2022:20:00:00; VISIBILITY INTERVAL NO GYRO BIAS UPDATE ON MOVING TARGET

Solar System Targets

#	Name	Level 1	Level 2	Level 3	Window	Ephem Center
(2)	COMET-108P-CIFFREO	TYPE=COMET,Q=1.676339083838281,E=0.549930518846976,I=13.3124641650165 6,O=52.92407308081733,W=358.246135975604,T=21-OCT-2014:22:14:10,TTimeScale=TDB,EQUINOX=J2000,EPOCH=29-APR-2017:00:00:00,EpochTimeScale=TDB				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		(2) COMET-108P-CIFFREO	WFC3/UVIS, ACCUM, UVIS2-FIX	F350LP			Sequence 1-2 Non-Int in Visit 03	360 Secs X 3 (1080 Secs)	
								[==>(Copy 1)]	***[1]***
								[==>(Copy 2)]	
								[==>(Copy 3)]	
2		(2) COMET-108P-CIFFREO	WFC3/UVIS, ACCUM, UVIS2-FIX	F350LP		POS TARG 0.4,2.5	Sequence 1-2 Non-Int in Visit 03	360 Secs X 2 (720 Secs)	
								[==>(Copy 1)]	***[1]***
								[==>(Copy 2)]	

Orbit Structure