16308 - Active Asteroids Rapid Response

Cycle: 28, Proposal Category: GO

(Availability Mode: SUPPORTED)

INVESTIGATORS

Name	*Institution*	*E-Mail*
Dr. David Jewitt (PI) (Contact)	**University of California - Los Angeles**	**jewitt@ucla.edu**
Max Mutchler (CoI) (Contact)	Space Telescope Science Institute	mutchler@stsci.edu
Dr. Harold A. Weaver (CoI) (Contact)	The Johns Hopkins University Applied Physics Laboratory	hal.weaver@jhuapl.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)	Max Planck Institute for Solar System Research	ynyoung.kim@gmail.com

VISITS

Visit	*Targets used in Visit*	*Configurations used in Visit*	*Orbits Used*	*Last Orbit Planner Run*	*OP Current with Visit?*
01	(3) P2020-O1	WFC3/UVIS	1	26-Aug-2020 17:00:14.0	yes
03	(3) P2020-O1	WFC3/UVIS	1	26-Aug-2020 17:00:15.0	yes
02	(3) P2020-O1	WFC3/UVIS	1	26-Aug-2020 17:00:15.0	yes

3 Total Orbits Used

ABSTRACT

Active asteroids are a recently discovered solar system population in which diverse mechanisms generate unexpected asteroid mass loss. They are interesting scientifically because the mechanisms (rotational disruption, impact, volatile sublimation and others not yet identified) have not previously been observed in the asteroid belt. Past work with HST has shown that high resolution is crucially important for understanding the properties of the active asteroids. Here, we seek 2 orbits of Target of Opportunity time so that we can quickly respond to a new active asteroid

discovery, obtain an initial assessment of its properties and rates of change, and then make an evidence-based decision about the need for requesting more time in order to understand the object.

OBSERVING DESCRIPTION

We here request 2 exploratory ToO orbits to characterize the early-time morphology (at 30 km/pixel at nominal 1 AU geocentric distance) and establish the initial rates of change in the appearance of a newly discovered active asteroid. The first orbit would be scheduled as soon as possible after the discovery of the target active asteroid. The second should be scheduled 1 to 2 weeks after the first, to assess the nature and rates of change in the morphology and photometry. The two visits together will allow us to make a rational decision about the need for (and type of) further observations with HST. If needed, additional time will be requested through a different (Directors Discretionary Time or mid-Cycle) route. The advantage in having an allocated ToO proposal (as opposed to requesting DDT once a new object is discovered) is to reduce the lead time before the first observations are secured. DDT proposals incur a 4 to 5 week delay from the time of request, owing to the need to secure community reviews and make a determination. We can be on-target in less than half this time by having a ToO program at the ready. These savings can be crucial in determining the early-time behavior of the object, and in planning additional observations. On the other hand, immediate (few days) observations would in most cases be overkill. Accordingly, we request a non-disruptive Target of Opportunity program, which will provide the science we need but which will not require heroic scheduling.

Our basic observing strategy is to take multiple long exposures (348 s) using WFC3 and a wide bandpass filter (F350LP) for maximum sensitivity. (If the nucleus is bright, we also plan some shorter exposures, possibly with a filter having a narrower bandpass (e.g., F621M). Asteroid Scheila, with its ultra-bright nucleus V = 13.7, represents an end-member case, using an exposure time of 4 s with the F621M filter to obtain S/N = 200 on the nucleus itself in search of structure at 100 km scales. Longer exposures of 390 s provided a deep search for debris.) The F350LP filter provides a 1.6x higher count rate for a target with a solar-type spectrum, so we plan to use it in Cycle 28. If the target requires two different exposure times (Scheila did, but other active asteroids did not), and has a sufficiently accurate ephemeris, we plan to use the M1K1C-SUB aperture for the short exposures (only the region around the nucleus is important in this case, and using the subarray prevents the loss of observing efficiency associated with CCD memory dumps) and the full UVIS aperture for the long exposures. We also plan to dither the exposures to mitigate the effects from bad pixels, cosmic rays, and the inter-chip gap. Main-belt targets have apparent rates of motion typically less than 50 arcsec/hour, which 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 uncertainty of numbered asteroids is negligible (sub-arcsecond), compared to the WFC3 field-of-view of 162 x 162 arcsec. For newly discovered objects the uncertainty can be larger but, as shown even for the low surface brightness and morphologically complex example set by

P/2010 A2, attaining 1 to 2 arcsec accuracy is straightforward. Ephemeris issues are of no concern to this observation. We understand that we may have essentially no control over the spacecraft roll angle, which means we will not be able to optimize the orientation of the dust tail on the CCD (i.e., to orient the tail along the longest dimension of the detector). However, the field-of-view of the camera is large enough that we should obtain excellent data on a portion of the tail, no matter what spacecraft roll angle is used. We have investigated the feasibility of detecting gas emission from active asteroids in the OH (0,0) band centered 3100A (this is generally the strongest gaseous emission in comets). We find that it cannot be done using HST unless the production rate is implausibly large. Even from the ground with the largest telescopes, the (optically bright) CN band near 3880A is not detected in active asteroids or in many classical comets at 3 AU heliocentric distance (Jewitt et al. 2009, 2014). Therefore, high-resolution imaging of dust remains the best way to study activity in the active asteroids, and hence this ToO proposal. Finally, we note that our team can prepare and submit a revised Phase 2 proposal within a day of activation of this ToO program.

The trigger for these observations is the discovery of an object in the main-belt (a < 5.2 AU) having a Tisserand parameter TJ greater than 3.08 (Jewitt et al. 2015) and showing a coma or tail. Comets have TJ < 3, asteroids have TJ > 3. The parameter is useful only in the context of the circular, restricted three-body approximation. As a result, objects with TJ very close to 3 can be either cometary or asteroidal in nature. In practice, we take TJ > 3.08 as the dividing line, since objects with larger TJ cannot be dynamically linked to the classical comets. The Tisserand constraint is quite stringent, and avoids any possibility of confusion with classical comets. With one exception, the known active asteroids have been discovered serendipitously by sky surveys conducted for other purposes. We expect this mode of discovery to continue, and we estimate that the probability that an active asteroid will be discovered in the next HST Cycle is 75% to 100%.

A new active asteroid, P/2020 O1, was announced two days ago, closing an 18+ month gap in the discovery of such objects. With Tisserand parameter 3.3 it clearly lies dynamically with the asteroids but shows a comet-like tail. This is exactly the target our program is designed for. We are asking to use our Cycle 28 ToO allocation for active asteroids since we have already used our similar Cycle 27 allocation on another target (both were for 2 orbits). We ask for our Cycle 28 allocation of 2 orbits to be applied early, in the last months of Cycle 27. We ask for the Cycle 28 allocation to be applied as soon as possible - a few months before the start of Cycle 28. The target will evolve too much for us to wait for Cycle 28 to begin. Visit 1 should be as soon as is practical, so that the object does not change too much before we image it. We requested in the proposal that the 2nd visit be scheduled 1 to 2 weeks after the first. Here, we request instead that the 2nd visit be scheduled as close as possible to UT September 19.5, this being the date on which the Earth crosses the orbital plane. A date within +/-2 days would be good - the closer the better for the science.

Proposal 16308 - Visit 01 - Active Asteroids Rapid Response

Visit

Proposal 16308, Visit 01, completed Wed Aug 26 21:00:16 GMT 2020

Diagnostic Status: No Diagnostics

Scientific Instruments: WFC3/UVIS

Special Requirements: BEFORE 31-AUG-2020:00:00:00

Patterns

#	Primary Pattern		Secondary Pattern	Exposures
(2)	Pattern Type=WFC3-UVIS-DITHER-LINE Purpose=DITHER Number Of Points=2 Point Spacing=0.145 Line Spacing=	Coordinate Frame=POS-TARG Pattern Orientation=46.84 Angle Between Sides= Center Pattern=false		(1)

Solar System Targets

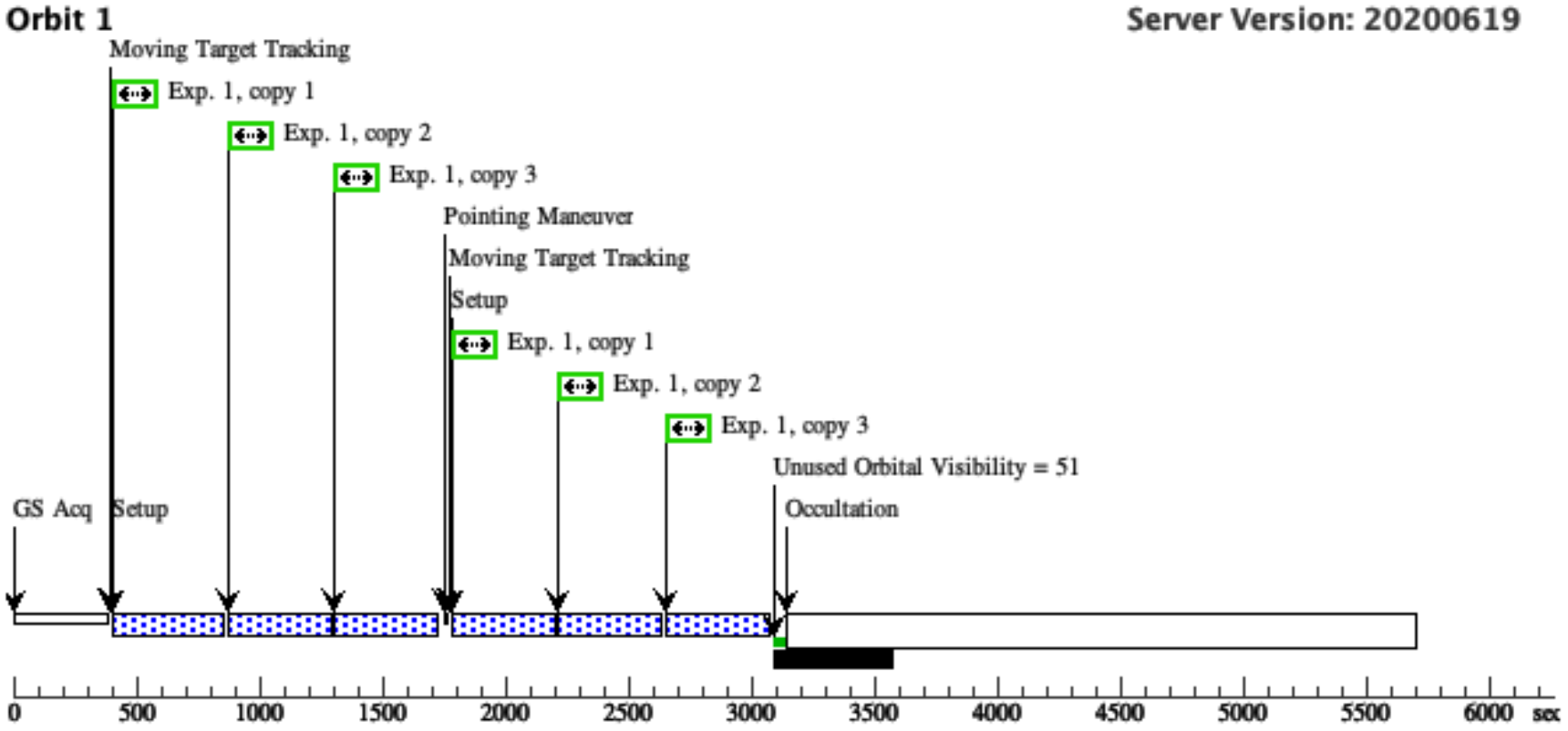
#	Name	Level 1	Level 2	Level 3	Window	Ephem Center
(3)	P2020-O1	TYPE=COMET,Q=2.3284117640256 89,E=0.1202406464087957,I=5.22101 5403141787 ,O=176.0099167680168,W=104.61327 50749502,T=03-MAY- 2020:03:50:25,TTimeScale=TDB,EQ UINOX=J2000,EPOCH=23-JUL- 2020:00:00:00,EpochTimeScale=TDB				EARTH

Comments: Description=active asteroid
Extended=YES

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1		(3) P2020-O1	WFC3/UVIS, ACCUM, UVIS2-2K2C-SUB	F350LP	CR-SPLIT=NO		Sequence 1-1 Non-Int in Visit 01 Pattern 2, Exps 1-1 in Sequence 1-1 Non-Int in Visit 01 (2)	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]***

Orbit Structure



Visit

Proposal 16308, Visit 03 Wed Aug 26 21:00:16 GMT 2020

Diagnostic Status: No Diagnostics

Scientific Instruments: WFC3/UVIS

Special Requirements: (none)

Comments: HOPR repeat of visit 01

Patterns

#	Primary Pattern		Secondary Pattern	Exposures
(2)	Pattern Type=WFC3-UVIS-DITHER-LINE Purpose=DITHER Number Of Points=2 Point Spacing=0.145 Line Spacing=	Coordinate Frame=POS-TARG Pattern Orientation=46.84 Angle Between Sides= Center Pattern=false		(1)

Solar System Targets

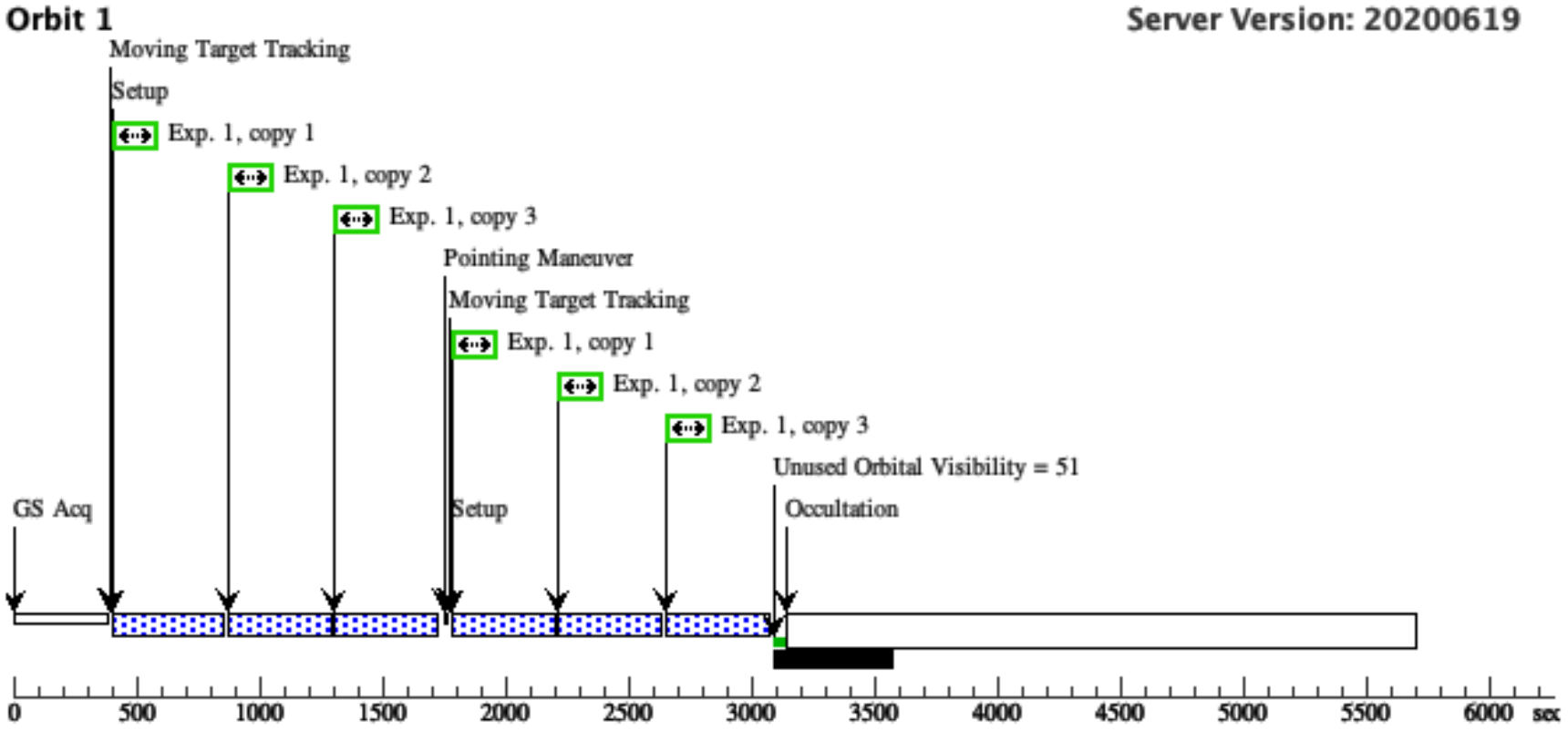
#	Name	Level 1	Level 2	Level 3	Window	Ephem Center
(3)	P2020-O1	TYPE=COMET,Q=2.328411764025689,E=0.12024064640879 57,I=5.221015403141787 ,O=176.0099167680168,W=104.6132750749502,T=03-MAY-2020:03:50:25,TTimeScale=TDB,EQUINOX=J2000,EPOCH=23-JUL-2020:00:00:00,EpochTimeScale=TDB				EARTH

Comments: Description=active asteroid Extended=YES

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1		(3) P2020-O1	WFC3/UVIS, ACCUM, UVIS2-2K2C-SUB	F350LP	CR-SPLIT=NO		Sequence 1-1 Non-Int in Visit 03 Pattern 2, Exps 1-1 in Sequence 1-1 Non-Int in Visit 03 (2)	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]***

Orbit Structure



Visit

Proposal 16308, Visit 02, scheduling Wed Aug 26 21:00:16 GMT 2020

Diagnostic Status: No Diagnostics

Scientific Instruments: WFC3/UVIS

Special Requirements: BETWEEN 17-SEP-2020:12:00:00 AND 20-SEP-2020:05:00:00

Patterns

#	Primary Pattern		Secondary Pattern	Exposures
(2)	Pattern Type=WFC3-UVIS-DITHER-LINE Purpose=DITHER Number Of Points=2 Point Spacing=0.145 Line Spacing=	Coordinate Frame=POS-TARG Pattern Orientation=46.84 Angle Between Sides= Center Pattern=false		(1)

Solar System Targets

#	Name	Level 1	Level 2	Level 3	Window	Ephem Center
(3)	P2020-O1	TYPE=COMET,Q=2.3284117640256 89,E=0.1202406464087957,I=5.22101 5403141787 ,O=176.0099167680168,W=104.61327 50749502,T=03-MAY- 2020:03:50:25,TTimeScale=TDB,EQ UINOX=J2000,EPOCH=23-JUL- 2020:00:00:00,EpochTimeScale=TDB				EARTH

Comments: Description=active asteroid
Extended=YES

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1		(3) P2020-O1	WFC3/UVIS, ACCUM, UVIS2-2K2C-SUB	F350LP	CR-SPLIT=NO		Sequence 1-1 Non-Int in Visit 02 Pattern 2, Exps 1-1 in Sequence 1-1 Non-Int in Visit 02 (2)	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]***

Orbit Structure