13864 - Hubble Imaging of a Newly Discovered Active Asteroid

Cycle: 22, Proposal Category: GO

(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	(1) 2014S4-GIBBS	WFC3/UVIS	1	01-Oct-2014 21:07:25.0	yes
02	(1) 2014S4-GIBBS	WFC3/UVIS	1	01-Oct-2014 21:07:26.0	yes

2 Total Orbits Used

ABSTRACT

Active asteroids (aka Main-Belt comets or MBCs) have the orbital characteristics of asteroids but also show transient, comet-like activity caused by mass-loss. Examples of mass-loss likely caused by sublimation, impact, and rotational effects have been established, while numerous additional processes are capable of launching material from asteroids. We propose two orbits of non-disruptive, target-of-opportunity observations of the next discovered active asteroid in order to help determine the process driving mass loss.

OBSERVING DESCRIPTION

This proposal extends our very productive ToO program approved in Cycle 21 (triggered on P/2013 P5; Jewitt et al. 2013). We request two single-orbit HST visits to image a newly-discovered MBC. The basic objective is to characterize the early-time morphology and establish the initial rates of change in the appearance, so that the need for additional HST observations and their optimum cadence can be realistically determined. In some cases the initial observations alone may be enough to determine whether the morphology is more consistent with sublimation or another origin. In others (as with P/2013 P5), the ToO orbits motivate follow-up through the DDT program. 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. We used 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. We used long exposures of 390 s through the F606W filter to provide a deep search for debris. The F350LP filter provides an 1.6 higher count rate for a target with a solar-type spectrum, so we used that filter for cycle 21 and plan to use it in cycle 22. If the target requires two different exposure times (Scheila did, but other MBCs did not), 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. Previous HST observations show that the timescale for substantial change ranges from weeks (P/2013 P5, Scheila, P/2013 R3) to several months (P/2010 A2, 300163). Therefore, while the first observation should be scheduled as soon as possible after discovery of activity, the science does not require that the first visit be secured within the first three weeks. So ours is a non-disruptive Target of Opportunity program, which will not require heroic scheduling. The first visit will set the scene, by establishing the high-resolution morphology of the object. The second visit, ideally separated from the first by 14 days, will reveal the changes. The two visits together will allow us to make a rational decision about the need for further observations with HST. Main-belt targets have apparent rates of motion which are easily within Hubble's 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. For newly discovered objects the uncertainty can be larger but, as we showed even for the low surface brightness and morphologically complex example set by P/2010 A2, attaining the required accuracy is straightforward. Ephemeris issues are of no concern to this observation. We understand that we will 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. Finally, we note that our team can prepare and submit a Phase 2 proposal within hours of activation of this ToO program. The trigger for these observations is the discovery of an object in the main-belt having a Tisserand parameter TJ > 3.1 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 > 3.1 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 (the blue dots in Figure 1). With one exception, the known MBCs have been discovered serendipitously by sky surveys conducted for other purposes. We expect this mode of discovery to continue. Co-I Larson is PI of the Catalina Sky Survey (CSS) which discovered coma at (596) Scheila and co-discovered P/2013 R3. The CSS will be used to obtain astrometric and photometric data on objects discovered elsewhere (or by CSS itself) in support of the HST observations in this proposal. Over the last 7 yrs MBCs have been discovered by on-going surveys at the average rate of about one per year. From this, and bearing in mind statistical fluctuations, we estimate that the probability that an MBC will be discovered in the next HST Cycle is 50% to 100%.

Proposal 13864 - Visit 01 - Hubble Imaging of a Newly Discovered Active Asteroid

Visit

Proposal 13864, Visit 01, implementation Thu Oct 02 01:07:28 GMT 2014

Diagnostic Status: No Diagnostics

Scientific Instruments: WFC3/UVIS

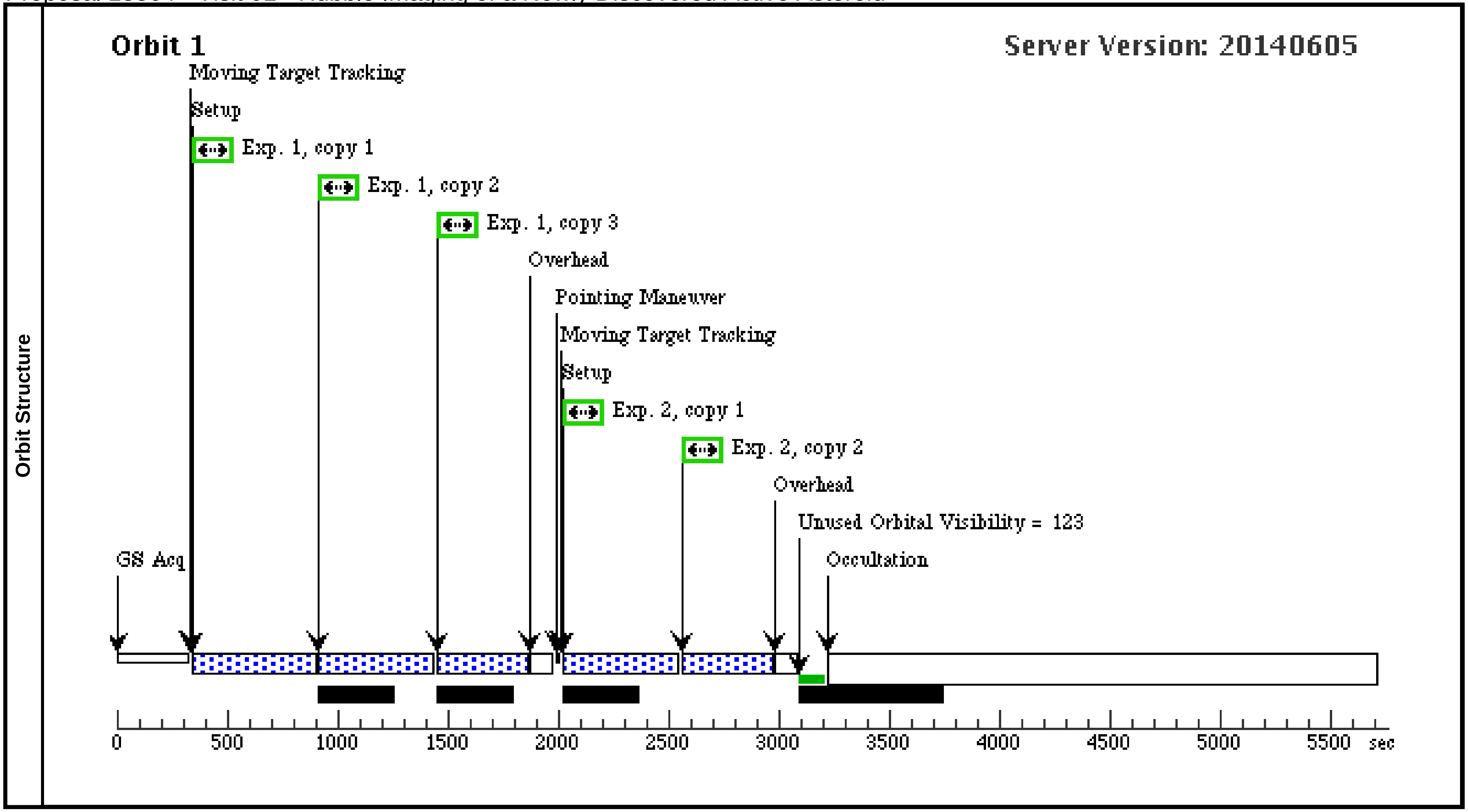
Special Requirements: (none)

Solar System Targets

#	Name	Level 1	Level 2	Level 3	Window	Ephem Center
(1)	2014S4-GIBBS	TYPE=COMET,Q=2.391662587768245,E=0.2420719086106455,I=10.96709082187444,O=106.50360151037,W=253.4153978927824,T=28-AUG-2014:05:17:20,TTimeScale=TDB,EQUINOX=J2000,EPOCH=19-SEP-2014:00:00:00,EpochTimeScale=TDB				EARTH

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1		(1) 2014S4-GIBBS	WFC3/UVIS, ACCUM, UVIS2	F350LP	CR-SPLIT=NO			410 Secs X 3 (1230 Secs)	
								[==>(Copy 1)] *[==>(Copy 2)]* *[==>(Copy 3)]*	***[1]***
2		(1) 2014S4-GIBBS	WFC3/UVIS, ACCUM, UVIS2	F350LP	CR-SPLIT=NO	POS TARG 0.2,2.0		410 Secs X 2 (820 Secs)	
								[==>(Copy 1)] *[==>(Copy 2)]*	***[1]***


Orbit Structure
Orbit 1
Server Version: 20140605
Moving Target Tracking
Setup
Exp. 1, copy 1
Exp. 1, copy 2
Exp. 1, copy 3
Overhead
Pointing Maneuver
Moving Target Tracking
Setup
Exp. 2, copy 1
Exp. 2, copy 2
Overhead
Unused Orbital Visibility = 123
Occultation
GS Acq
0 500 1000 1500 2000 2500 3000 3500 4000 4500 5000 5500 sec

Proposal 13864 - Visit 02 - Hubble Imaging of a Newly Discovered Active Asteroid

Visit

Proposal 13864, Visit 02, implementation — Thu Oct 02 01:07:28 GMT 2014

Diagnostic Status: No Diagnostics

Scientific Instruments: WFC3/UVIS

Special Requirements: AFTER 01 BY 10 D TO 20 D

Solar System Targets

#	Name	Level 1	Level 2	Level 3	Window	Ephem Center
(1)	2014S4-GIBBS	TYPE=COMET,Q=2.391662587768245,E=0.2420719086106455,I=10.96709082187444,O=106.50360151037,W=253.4153978927824,T=28-AUG-2014:05:17:20,TTimeScale=TDB,EQUINOX=J2000,EPOCH=19-SEP-2014:00:00:00,EpochTimeScale=TDB				EARTH

Exposures

#	Label	Target	Config,Mode,Aperture	Spectral Els.	Opt. Params.	Special Reqs.	Groups	Exp. Time (Total)/[Actual Dur.]	Orbit
1		(1) 2014S4-GIBBS	WFC3/UVIS, ACCUM, UVIS2	F350LP	CR-SPLIT=NO			410 Secs X 3 (1230 Secs)	
								[==>(Copy 1)] *[==>(Copy 2)]* *[==>(Copy 3)]*	***[1]***
2		(1) 2014S4-GIBBS	WFC3/UVIS, ACCUM, UVIS2	F350LP	CR-SPLIT=NO	POS TARG 0.2,2.0		410 Secs X 2 (820 Secs)	
								[==>(Copy 1)] *[==>(Copy 2)]*	***[1]***

Proposal 13864 - Visit 02 - Hubble Imaging of a Newly Discovered Active Asteroid