



## 15972 - Active Asteroids Target of Opportunity

Cycle: 27, Proposal Category: GO

(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) GAULT	WFC3/UVIS	2	30-Jul-2020 13:00:13.0	yes

2 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. Our 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 and establish the initial rates of change in the appearance. 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 (Director's 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. We request a non-disruptive Target of Opportunity program, which will provide the science we need but will not require heroic scheduling.

Our basic observing strategy is to take multiple long exposures (348s) 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 4s with the F621M filter to obtain  $S/N = 200$  on the nucleus itself in search of structure at 100 km scales. Longer exposures of 390s 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 27. 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 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 of 162x162 arcsec. 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 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 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  $TJ > 3.08$  (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%.

We would like to trigger our Cycle 27, non-disruptive ToO program GO 15972 on active asteroid (6478) Gault. The object is not new; activity was first reported in 2019 and a number of observational programs have targeted the object. What is new is the announcement that Gault has now entered the inactive phase, which means that the nucleus is newly accessible, whereas in all previous observations it was concealed by dust. Our specific science objective is to test the hypothesis that the activity is produced by rotational instability, something that HST alone can do with high precision photometry in two consecutive orbits. We could not have foreseen the sudden emergence of the nucleus and so could not have proposed for this observation as a GO in Cycle 28. In one study of pre-discovery data, continuous activity was found over the previous 6 years (Chandler et al. *Astrophysical Journal Letters*, 877, article id. L12, 9 pp. (2019)), so the activity shut-down is a rare and unexpected opportunity for us. The previous HST allocation (GO 15678, PI Meech) was unable to pull out the nucleus from the dust, something we need to do to understand the object and test the mechanism.



Orbit Structure

### Orbit 1



