ENABLING RAPID RESPONSE MISSIONS TO NEAR-EARTH OBJECTS, LONG PERIOD COMETS, AND INTERSTELLAR OBJECTS: RESULTS OF A KECK INSTITUTE FOR SPACE STUDIES WORKSHOP

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ABSTRACT

A workshop was held in October, 2022 at the Keck Institute for Space Studies at Caltech to identify approaches to enable rapid response missions to challenging targets, and to identify technology gaps and impediments towards achieving those missions. The workshop focused on missions to newly-discovered objects such as interstellar objects (ISO), long period (dynamically-new) comets (LPC) and potentially hazardous asteroids (PHA); it included experts in small body science, mission design and implementation, instrumentation, and planetary defense from NASA, JAXA, ESA, universities, and commercial space companies. In this report we focus solely on a rapid response mission to a newly-identified hazardous asteroid in the 50-150m diameter size range, as called for in the *Oceans, Worlds and Life* Planetary Decadal Study Report.

The workshop considered two main approaches to a rapid response mission. The first is to build-on-demand a configurable flight system using pre-designed modular elements upon detection of a new target. A variant of this approach is to pre-build and store a fully configured flight system or multiple systems. A dedicated launch on a compatible vehicle would be used to rapidly deploy the flight system to the target. The second approach is to build and launch a multi-spacecraft constellation to a loitering orbit using rideshare launches. These on-orbit assets could then be deployed/redirected to intercept a PHA. This second approach is similar to ESA's Comet Interceptor mission. The timeline for responding to a new target was assumed to be <3 months to launch a pre-built spacecraft or to deploy an in-space asset to intercept the target. For the build-on-demand approach additional time would be needed to assemble and test the modular and pre-kitted parts. The presentation will identify pros, cons, and future work to assess the feasibility of these architectures.

Observational needs include imaging (multispectral VIS-NIR, thermal, and OpNav), spectroscopy (point or imaging), and mass estimation (via optically- or radio-tracked sub-satellites). Technology gaps include gravity beacons/probes and their deployment mechanisms, and the possible need for improvements to autonomous

navigation to target dim objects. Programmatic gaps include the lack of a process to implement “rapid response” interplanetary missions, including rapid procurement, integration, frequency licensing, and other technical and regulatory constraints. Finally, if such a rapid response capability is to become reality, space agencies will need to develop an approval process and develop the infrastructure to establish a pipeline of modular craft or a constellation of on-orbit assets to be ready to react to a hazard or an opportunity.

The workshop report will be available in early 2023.

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