CLOSE FLYBY AND CHARACTERIZATION OF LONG PERIOD COMETS LIKE C/2017 K2.  S. E. Matousek¹, J. C. Castillo-Rogez¹, B. P. S. Donitz², and T. Balint¹. ¹ Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA, United States, Contact: steve.matousek@jpl.nasa.gov.

Introduction: The convergence of increased capabilities to detect Oort Cloud Comets (OCCs) at greater distances from the inner solar system and rapidly advancing deep space smallsat and CubeSat capabilities enable rapid-response and relatively low-cost close OCC flyby opportunities. In the future, more OCCs and Interstellar Objects (ISOs) could be discovered several years prior to inner solar system passage due to increased ground-based capabilities (Fig. 1, Meech, personal communication).

![Chart showing increasing OCC discoveries](image)

Fig. 1: Increasing OCC discoveries (Meech, pers. Comm.)

Recently, a study determined that OCC C/2017 K2 could be reached with a small payload on each of two smallsats if launched from Earth by February, 2022 for an August, 2022 high-speed (~30 km/s) flyby. Several key developments enable this representative OCC rapid response after discovery: 1) Shorter development schedules demonstrated by MarCO [1] and other Earth and deep space missions, 2) Emerging smaller payloads for visible imaging and other smallsat instrumentation [2], 3) Maturing deep space propulsive capabilities for trajectory corrections, 4) Increasingly capable on-board computing resources and software reducing and reacting to instrument and sensor measurement input so that the raw data is not required to be returned to Earth. Smallsat and CubeSat OCC payload data collection far exceeds the data rate and data volume returned to Earth with smallsat-class telecom systems. Fortunately, maturing novel data processing algorithms to produce higher order data combine with faster processors to increase science return.

![Diagram showing ecliptic high energy trajectory](image)

Fig. 2: Ecliptic high energy trajectory needed to reach highly inclined C/2017 K2 representative of OCC and ISO rapid response flyby missions.

These four points are illustrated by the trajectory (Fig. 2), spacecraft (Fig. 3), and concept of operations for a mission that could reach C/2017 K2 in August, 2022.

1) **Shorter development schedules.** Smallsat and CubeSat development schedules require less development time due to increased availability of subsystems and components, and decreased complexity. Shorter development schedules mean it is now possible to develop and launch a mission after discovery of large OCCs.

2) **Emerging smaller payload options for visible imaging and other smallsat instrumentation.** Capable payloads are now possible with recent instrumentation developments. Leading the way are visible imaging options that have enough resolution and wavelength coverage to return useful data from an OCC close flyby. Other instruments are nearing maturity sufficient to fit in the limited smallsat payload envelope. NIR, UV, Microwave, and other measurements are now, or will soon be, ready.

3) **Maturing deep space propulsive capabilities for trajectory corrections.** MarCO pioneered the use of cold gas propulsion for deep space trajectory correction. Other propulsive technologies for hydrazine, bi-prop, hybrid, and electric propulsion are nearing maturity. That enables larger post-launch trajectory corrections needed for rapid response OCC flyby missions.

4) **Increasingly capable on board computing resources and software reducing and reacting to instrument and sensor measurement input so that the raw data is not required to be returned to Earth.** Smallsat and CubeSat OCC payload data collection far exceeds the data rate and data volume returned to Earth with smallsat-class telecom systems. Fortunately, maturing novel data processing algorithms to produce higher order data combine with faster processors to increase science return.
Fig. 3: Notional C/2017 K2 smallsat spacecraft with 1.0 meter High Gain Antenna at top.

Note the current NASA planetary competitive proposal Announcement of Opportunities are too small (SIMPLEx), or too large (Discovery) for this type of mission. There is also the issue of time-dependent announcements of opportunity being set in time with no option for reactivity in the current opportunities. Reaching an OCC like C/2017 K2 in the future requires taking full advantage of the emerging smallsat/CubeSat payload and spacecraft capabilities. And, revamping programmatic considerations to allow for shorter development schedules and higher launch energies required to quickly reach newly discovered OCCs and ISOs [see also 4].

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