CASTAWAY: A MISSION TO MAP THE EVOLUTION OF OUR SOLAR SYSTEM. N.E. Bowles[1], C. Snodgrass[2], A. Gibbings[3], J.P. Sanchez[4], J. A. Arnold[1], K. L. Donaldson Hanna[1], the CASTAway proposal team,[1]University of Oxford, UK (neil.bowles@physics.ox.ac.uk), [2]The Open University, UK [3]OHB System AG, Germany, [4]Cranfield University, UK

Introduction: CASTAway is a mission concept to explore our Solar System's Main Asteroid Belt (MAB). Variations in composition across the asteroid and comet populations can provide a tracer for the dynamical evolution of the Solar System. This presentation will describe the CASTAway mission concept and how it can provide a comprehensive survey of the objects in the MAB.

Key Science Questions and Objectives: CASTAway combines a long-range (point source) telescopic survey of thousands of objects, targeted close encounters with 10 – 20 asteroids [1] and serendipitous searches into a single mission concept. With a carefully targeted trajectory that loops through the MAB, CASTAway will provide a comprehensive survey of the main belt at multiple size scales. Specific science questions and objectives that CASTAway seeks to address include:

a) How do asteroid surface compositions relate to meteorite mineralogy?
b) How do measured surface compositions of asteroids vary?
c) How do surface composition, morphology and regolith cover vary between asteroids?
d) Is our understanding of surface ages correct?
e) How do visible wavelengths photometric "mega-surveys" (e.g. Gaia, Large Synoptic Survey Telescope etc.) correlate with composition?

Spacecraft and Instruments Overview: The CASTAway concept uses a high Technology Readiness Level (TRL) spacecraft design (Figure 1) and instrument suite (Figure 2) for the mission's flyby and point source survey capabilities. The science payload consists of three linked instruments: a) The Main Telescope for CASTAway (MTC) that comprises a 50 cm (baseline) diameter telescope feeding a Visible Context Imager (VCI) for narrow angle (~10-20 m at 1000 km) imaging and a moderate resolution (R = 30-100) spectrometer with spectral coverage from 0.6-5 µm. b) Thermal Infrared imager for temperature, albedo and composition mapping of the target asteroids during flybys. c) Asteroid Detection cameras, based on micro advanced stellar compass (µASC) star tracking cameras. A minimum of four science star trackers will be used to detect new objects in the 1-10 m size range. In addition there are opportunities for determination of asteroid mass etc. using radio science techniques.

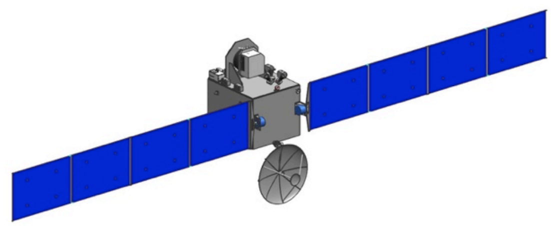

Figure 1. CASTAway spacecraft design concept (OHB Systems AG). The deployed wingspan is 16 m tip-to-tip. From [2]

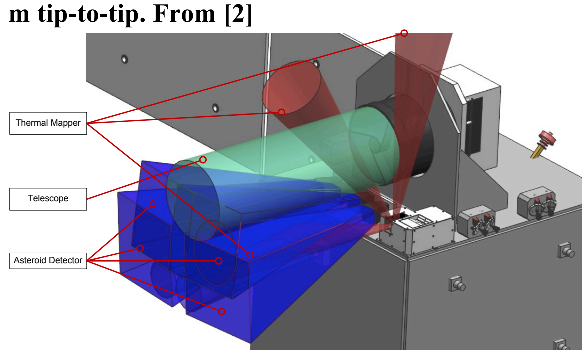

Figure 2. Payload accommodation and instrument fields of view. From [2].

The spacecraft (Figure 1, [2]), its subsystems and associated mission architecture were developed using the concurrent engineering facilities at OHB System AG in Bremen, Germany. A simple space-based telescope and space segment is proposed. The baseline spacecraft design is compatible with a Soyuz-like performance. Optional mass saving measures are also available. An improvement of only 23 % w.r.t the Soyuz (as expected for the Ariane 6.2 in the mid 2020s) enables the deeper exploration of the main belt with an improved delta-v and flexibility of the launch window. A larger number of scientifically compelling flyby targets would also be enabled.

Trajectory Options: Optimized trajectories, based on a database of 100,000 asteroids, already demonstrate the feasibility to perform 10 or more

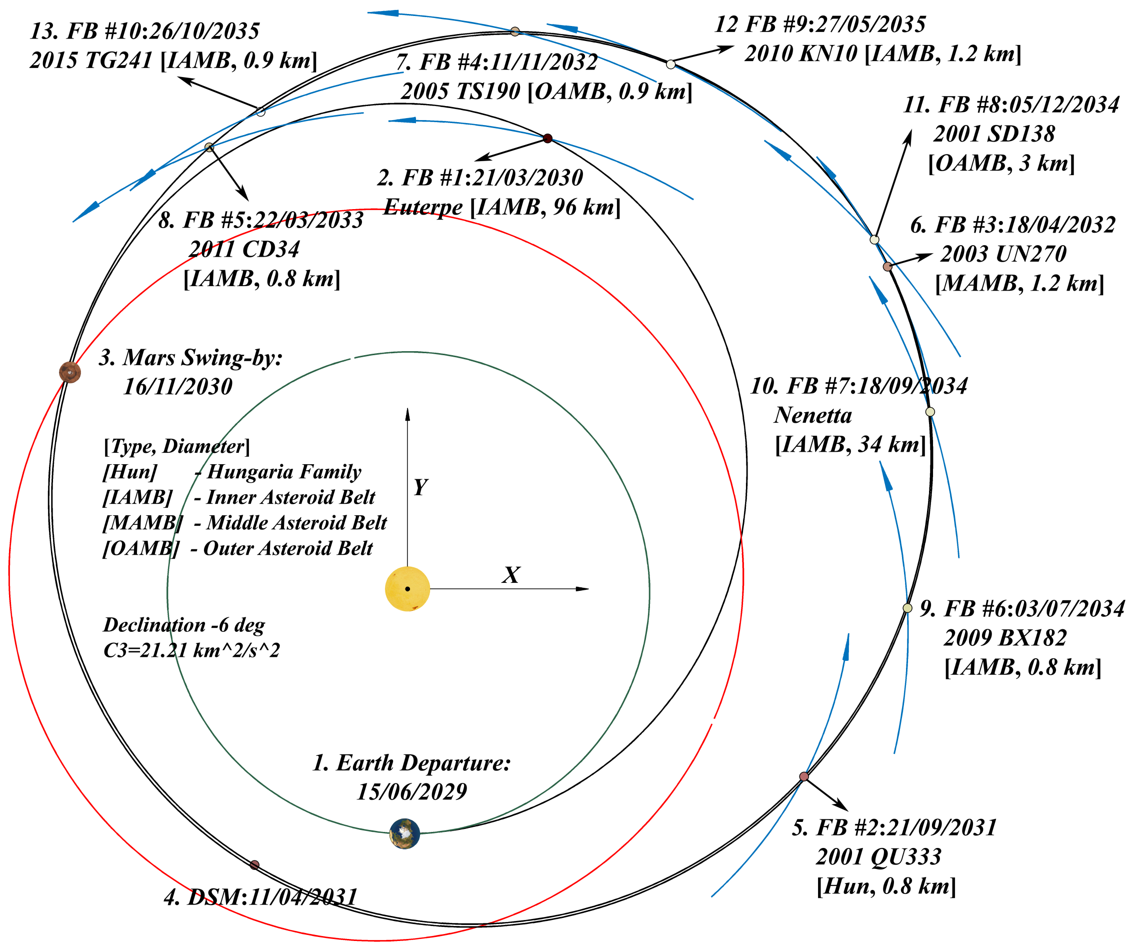

Figure 3. Baseline trajectory for CASTAway with Mars swingby, multiple options and opportunities in the 2029-31 time frame of e.g. ESA's M5 mission call (taken from [1]).

asteroid flybys within 7 years and European medium-lift launcher capabilities (i.e. Soyuz/Ariane 62). Trajectories (e.g. Figure 3, [1]) will not only encounter objects of varying spectral class and double the number of main belt objects visited by spacecraft, but also spend nearly 2000 days surveying the interior of the belt and allowing allowing > 10,000 asteroids to be spectroscopically surveyed and discovering small (1-10 m) size objects.

Conclusions: The CASTAway mission concept will map compositional diversity of the asteroid belt to constrain our models of the evolution of our Solar System and provide essential context to current and future generations of small bodies sample return missions. It can achieve this with a spacecraft and payload that has high levels of technology readiness and fits within the programmatic and cost caps for e.g. an European Space Agency "M" or medium class mission.

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References: **[1]** JP Sanchez, et al. (2016) "Asteroid belt multiple flyby options for M-Class Missions", in: *67th International Astronautical Congress*, 26-30 September 2016, Guadalajara, Mexico. [2] A. Gibbings, et al. (2016), An Inventory Tour of the Main Asteroid Belt, in: *67th International Astronautical Congress International Astronautical Federation, Guadalajara, Mexico, 26-30 September 2016*.