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CASTALIA PROPOSAL: EXPLOITING A SCIENCE MISSION FOR ASTEROID DEFLECTION

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ABSTRACT

The Castalia mission, a proposed candidate mission for the ESA M4 mission call (Cosmic Vision 2015-2025 program), aims to explore and characterize a specimen of a recently discovered object, the Main Belt Comet (MBC) 133P/Elst-Pizarro. MBCs are objects that reside in the asteroid belt but have a comet-like appearance with dusty comae and tails at certain parts of their orbits. They straddle boundary between volatile-poor asteroids and volatile-rich comets. The mission will therefore provide a unique insight into the distribution of volatiles in early planetary formation and the interaction of water and organic compounds in the asteroid belt and with Earth. The exploitation of instrument science data gained from the mission is also applicable for the analogue demonstration of asteroid deflection techniques, namely, ablation via a laser or solar sublimation and the gravity tractor.

Launched on a Soyuz/Fregat from Kourou in 2024(-2026) the Castalia spacecraft would arrive six months before the estimated reactivation of 133P/Elst-Pizarro and this will be followed with a twelve month dedicated science phase. Ten on-board scientific instruments will perform remote sensing and in-situ characterization, including but not limited to the emission of gas and dust, flux momentum, inferred composition and density. These measurements, gained from the visual-near infrared imager, dust impact detector, dust composition analyzer and neutral/ion mass spectrometer, are directly applicable to understanding the sublimation environment. The impact sensor on the dust impact detector, for example, will provide information on the mass flow and velocity of the sublimated material. It also offers a platform to

monitor the deposition and degradation caused by the sublimated material. This can assist in improving the engineering contamination model spacecraft design. Results gained can therefore be assessed as an analogue for a low thrust deflection technique as applied to solar or laser induced ablation. Detailed analysis of the surface is also performed in a close orbit and with hovering maneuvers occurring at a few radii distance from the object. Hovering enables the repetitive passage through the emission cone, enabling the emission assessment of the active regions to occur. Hovering is also required on the gravity tractor, where the technique is dependent on the masses of the asteroid and the spacecraft, the asteroid's center of mass, warning time and the spacecraft' ability to maintain a constant and controlled hover-distance. Hovering, regardless of the application is a demanding GNC requirement.

This paper therefore presents an overview of the Castalia mission, including its science objectives and system design. It will then explore how the results and technological advances of its mission scenario and payload design can be applied as a stepping stone for planetary defense activities, specifically laser ablation.

The mission and system design was performed by a consortium of OHB System AG, DLR Institute of Space Systems and an international team of scientists using concurrent engineering techniques. Castalia is presented as a fully funded ESA-only mission, with all scientific instruments supplied by a nationally-funded consortia.

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