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Supporting M5 Science Missions to Small Bodies – An OHB Perspective

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Abstract

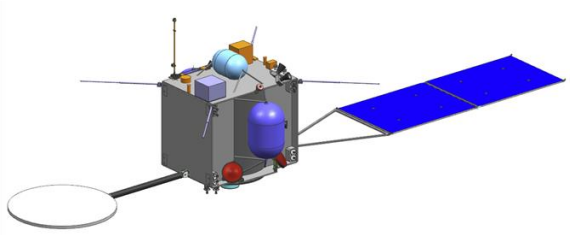
DePhine, Castalia, CASTAway and MarcoPolo-M5 were all proposed as possible mission concepts to ESA's next (M)edium class mission call. Thirty-seven proposals were submitted to ESA in October 2016, and evaluated against their scientific justification, payload selection, spacecraft design and programmatics. Ultimately, three mission candidates were selected by ESA in May 2018. OHB System provided industrial support by demonstrating how four of these different mission scenarios could be implemented. For each, a baseline scenario, with additional mass and cost saving opportunities were explored, assisted by concurrent engineering techniques. Each mission was proposed to be ESA-led, but within the context of international collaboration.

1. Introduction

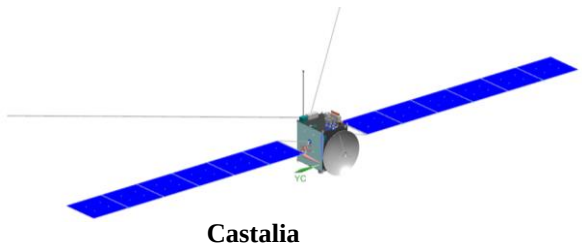
M5 is the fifth medium-class mission in the ESA Cosmic Vision Plan. It follows on from Solar Orbiter (M1), Euclid (M2), PLATO (M3) and ARIEL (M4). Thirty-seven proposal were received from a community wide science call, and evaluated against a competitive and peer-review process. OHB System supported four of these mission concepts – DePhine, Castalia, CASTAway & MarcoPolo-M5 – which demonstrates OHB's increasing role in space-science as a Large System Integrator. OHB was also awarded the prime contract of PLATO (exoplanet telescope, phase B2/C/D). This presentation reports on the key space-science competences at OHB; combining concurrent engineering techniques with industrial knowledge. The overarching science justification are fused with a feasible mission architecture and subsystem design. The mission call necessitated a launch in 2029/30+, with a preference for a European launcher (VegaC or Ariane 6 class) and qualified equipment, and a high technology readiness spacecraft (TRL 5/6 at mission adoption). All missions were proposed to be ESA-led, with options for international collaboration. There was no mission or in-orbit duration requirement (except the associated cost impact). There was also no constraint on the spacecraft and payload mass (dependent only on the limit of the launcher).

2. Mission & Spacecraft Concepts

The mission and spacecraft-system design of the four M5 concepts were developed using the Concurrent Engineering Design Facility (CEFO) at OHB. An international teams of scientists, mission analysis, (sub)system engineers and costs experts were combined simultaneously in a series of guided design-loops. The level of analysis is comparable to an internal phase 0, enabling the key drivers and main trade-off to be assessed. The results, as shown in Figure 1, demonstrates compliance to the M5 boundary conditions, and the feasibility of the mission architecture & spacecraft (sub)system design.



DePhine



Castalia

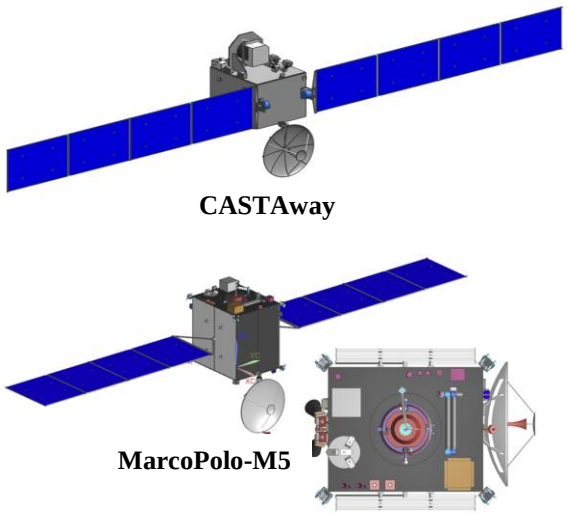


Figure 1: Spacecraft Designs

DePhine was proposed to explore the origins and evolution of the Martian satellite system of Deimos and Phobos [1][2]. The spacecraft will be injected directly into Mars transfer orbit, where it will first enter a quasi-satellite orbit with Deimos. Compressive mapping is performed and the spacecraft performs a number of low velocity flyby events. The spacecraft then transfers into a 2:1 resonance with Phobos. Multiple flyby and remote sensing observations (similar to those for Deimos) will be performed for comparative analysis. **Castalia** was proposed as a mission to rendezvous with a Main Belt Comet (MBC), 133P/Elst-Pizarro [3][4]. MBCs challenge the traditional definition of asteroids and comets, the early evolution of the main asteroid belt, and the origins of water on Earth. Castalia would rendezvous with 133P/Elst-Pizarro using electric propulsion. The spacecraft arrives before perihelion, where it hovers down towards the MBC's surface during periods of activity, performing in-situ measurements of the gas and dust. **CASTAway** combines a long-range (point-source) telescopic survey of the main asteroid belt, with a number of pre-planned asteroid flyby events [5][6]. The spacecraft will loop thorough the main asteroid belt, providing a comprehensive survey of the main asteroid belt at multiple size scales. **MarcoPolo-M5** seeks to rendezvous with a primitive D-type asteroid [7]. It will characterise the surface and interior in detail and then return material from the surface back to Earth.

3. Summary

Analysis demonstrated the initial feasibility of the DePhine, Castalia, CASTAway and MarcoPolo-M5 missions for the M5 call opportunity. Although ultimately not selected by ESA, they can be conceived with the boundary conditions of an ESA Medium class mission opportunity (or comparable to a US Discovery Class mission). The flexibility of using concurrent engineering technique enabled additional mass and cost saving measures to be examined. This addressed the uncertainty in the launcher performance. Similarly, the mission profiles can be easily supplemented to provide a greater, more compelling scientific return (e.g. transfer & orbit selection, number of flybys, small deployable lander). The speculative performance (or saving) relative was examined relative to the performance of the launcher.

References

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