IAF SPACE PROPULSION SYMPOSIUM (C4)
New Missions Enabled by New Propulsion Technology and Systems (9)

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# SELECTION AND DESIGN OF THE PROPULSION SYSTEM FOR THE LUMIO MISSION: AN INTRICATE TRADE-OFF BETWEEN COST, RELIABILITY AND PERFORMANCE

**Abstract**

The Lunar Meteoroid Impact Observer (LUMIO), one of the two winning concepts of the SysNova Lunar CubeSats for Exploration call by ESA, is a mission designed to observe, quantify, and characterize the meteoroid impacts on the Lunar far side by detecting the flashes generated by the impact. While Earth-based Lunar observations are restricted by weather, geometric and illumination conditions, a Lunar-based observation campaign can improve the detection rate and, when observing the Lunar far side, complement in both space and time the observations taken from Earth.

The mission, which is currently in its Phase A, is based on a 12U CubeSat that carries the LUMIO-Cam, a custom-designed optical instrument capable of detecting light flashes in the visible spectrum. The spacecraft is placed on a halo orbit about the Earth–Moon L2 point, where permanent full-disk observation of the Lunar far side can be performed with excellent quality, given the absence of background noise due to the Earth.

The propulsion system is among the most crucial ones for the LUMIO spacecraft. It accomplishes various functions: satellite de-tumbling after release in the initial Lunar orbit, station keeping, orbital transfer from the initial Lunar orbit to the final halo orbit around L2, reaction wheel desaturation, end of life disposal maneuvers. The total required Delta-V budget estimated during Phase 0 for these functions was 195.8 m/s. Two possible COTS propulsion systems (with custom-made modifications) were proposed in Phase 0, based on a combination of mono-propellant and cold gas thrusters.

This paper will present a detailed summary of the phase A selection and design of the LUMIO propulsion system, based on the (eventually updated) requirements generated by the mission analysis. The main challenges of this design process and the way how they have been tackled will be presented and discussed, including: the availability of sufficiently reliable European propulsion options in order to reduce the general mission costs; the feasibility of replacing the current chemical/cold gas system with electric propulsion; the possible need for custom changes to the design of the selected COTS option (e.g. due to tank sizing); the importance of the thermal and mechanical interfaces with the rest of the spacecraft; the mutual influence between the propulsion system design and the safety and autonomy aspects of the spacecraft, in particular in terms of collision risks (and relative contingency plans) and required thrust authority for collision avoidance maneuvers.