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New Missions Enabled by New Propulsion Technology and Systems (9)

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SELECTION 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 has successfully completed 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 one of the most crucial design choices for the LUMIO spacecraft. It accomplishes various functions: orbital transfer from the initial Lunar orbit to the final halo orbit around L2, station keeping, reaction wheel desaturation, end of life disposal maneuvers. The total required Delta-V budget for orbital transfer and station keeping is 203 m/s, plus an additional total impulse of 110 Ns for reaction control tasks.

This paper will present a detailed summary of the phase A selection and design of the LUMIO propulsion system, based on the full list of requirements generated by the mission analysis. The main challenges of this process and the way how they have been tackled will be presented and discussed, including: use of two separate systems or an integrate one for main propulsion and reaction control tasks; availability of sufficiently reliable European propulsion options, to reduce the general mission costs; feasibility of replacing a chemical/cold gas system with electric propulsion; possible need for custom changes to the design of the selected COTS option (e.g. due to tank sizing); importance of the thermal, electrical and mechanical interfaces with the spacecraft; mutual influence between the propulsion system design and the safety and autonomy aspects of the spacecraft.