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PHASE A DESIGN OF THE LUMIO MISSION: CHARACTERIZING LUNAR MICRO-METEOROID IMPACTS WITH A CUBESAT

Abstract

The Lunar Meteoroid Impact Observer (LUMIO) is a mission designed to observe, quantify, and characterize the impacts of micro-meteoroids on the Lunar far side and, therefore, complement in both space and time the observations currently taken from Earth. While Earth-based Lunar observations are restricted by weather, geometric and illumination conditions, a Moon-based observation campaign can improve the detection rate of impact flashes and the general quality and reliability of the final scientific product.

The mission is currently in its Phase A, after successfully passing Phase 0 and an independent study in the ESA Concurrent Design Facility that has fully confirmed its feasibility. The LUMIO spacecraft is a 12U CubeSat with a mass of around 20 kg, released into Lunar orbit by a carrier spacecraft and capable of autonomously transferring from this initial parking orbit to its final destination, a halo orbit about the Earth–Moon L2 point from which permanent full-disk observation of the Lunar far side can be performed. The mission objectives will be achieved thanks to the LUMIO-Cam, a custom-designed optical instrument capable of detecting light flashes in the visible spectrum, and an innovative on-board data processing system, capable of drastically reducing the amount of information that needs to be transmitted back to Earth. The camera is capable of generating 2.6 TB/day of data, out of which only approximately 1 MB/day will need to be transmitted to Earth, since impact identification will be performed autonomously onboard and only relevant information will be actually transmitted.

Although the Phase 0 design of LUMIO was assessed as feasible by the ESA CDF study, a number of critical issues were identified that are now being tackled during Phase A. This paper will present in detail the resulting Phase A design of the mission and the way forward to the following steps in mission implementation (Phases B-C). The paper will include a summary of the spacecraft system design and mission analysis, as well as a description of various possible scenarios for the carrier spacecraft and the initial parking orbit. Particular focus will be given to the mission operations aspects, from both the science and communications point of view. The solutions adopted for the innovative highly autonomous LUMIO navigation concept, based on Moon images taken as a by-product by the LUMIO-cam during

operations, will be described in detail, as well as the operational concept of the scientific data processing algorithm.