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LUMIO - PAYLOAD DESIGN FOR LUNAR METEOROIDS IMPACT DETECTION

Abstract

A large number of meteoroids and micrometeoroids enter the Earth–Moon system continuously, constituting a potential threat to our planet. Lunar meteoroid impacts have caused in the past a substantial change in the lunar surface and its properties. With no atmospheric shield, the Moon is subject to a large number of impacts from meteoroids. The high impact rate on the lunar surface has important implications for future human and robotic assets that will inhabit the Moon for significant periods. Accurate flux models are crucial to support planetary defense actions, as large meteoroids can cause severe damage to people and our assets. Understanding meteoroids and associated phenomena can be valuable for the study of asteroids and comets themselves, and their dynamical paths. It can help deepen the understanding of the spatial distribution of near-Earth objects in the Solar System. The study of dust particles is also relevant to the topic of space weather. The ability to predict impacts is therefore critical to many applications, both related to engineering aspects of space exploration, and more scientific investigations regarding evolutional processes in the Solar System.

In this context, the Lunar Meteoroid Impacts Observer (LUMIO) is a CubeSat mission to observe, quantify, and characterize lunar meteoroid impacts, by detecting their impact flashes on the far side of the Moon. This complements the information available from Earth-based observatories, which are bounded to the lunar near-side, with the goal of synthesising a global recognition of the lunar meteoroid environment. LUMIO envisages a 12U form-factor CubeSat that will be placed in a halo orbit at Earth–Moon L2. The Phase B of the mission was successfully completed at the end of 2023 after a review performed by ESA. The detection is performed using the LUMIO-Cam, an optical instrument capable of observing, quantifying, and characterizing meteoroid impacts on the Lunar surface in the visible spectrum.

In this work the consolidated technical design of the LUMIO-Cam is reported. The optical layout is based on a dioptric system with seven lenses and a dichroic cube, which directs the light on two orthogonal

focal planes, splitting the band in two spectral channels. The instrument detects the radiation generated by the meteoroids impacts in the Visible and Near Infrared (VNIR) spectral region (between 450 nm and 950 nm) by implementing a double FPA configuration using EMCCD to prevent false positive and to measure flash temperature.