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Author: Dr. Angelo Cervone
Delft University of Technology (TU Delft), The Netherlands, a.cervone@tudelft.nl

Dr. Francesco Topputo
Politecnico di Milano, Italy, francesco.topputo@polimi.it
Dr. Stefano Speretta
Delft University of Technology (TU Delft), The Netherlands, s.speretta@tudelft.nl
Dr. Alessandra Menicucci
Delft University of Technology (TU Delft), The Netherlands, A.Menicucci@tudelft.nl
Dr. Pierluigi Di Lizia
Politecnico di Milano, Italy, pierluigi.dilizia@polimi.it
Dr. Mauro Massari
Politecnico di Milano, Italy, mauro.massari@polimi.it
Mr. Vittorio Franzese
Politecnico di Milano, Italy, vittorio.franzese@mail.polimi.it
Mr. Carmine Giordano
Politecnico di Milano, Italy, carmine.giordano@polimi.it
Mr. Gianmario Merisio
Politecnico di Milano, Italy, gianmario.merisio@polimi.it
Mr. Demetrio Labate
Leonardo Spa, Italy, demetrio.labate@leonardocompany.com
Mr. Giuseppe Pilato
Manpower c/o Leonardo, Italy, giuseppe.pilato.ext@leonardocompany.com
Dr. Emanuele Costa
Leonardo Spa, Italy, emanuele.costa01@leonardocompany.com
Mr. Eric Bertels
ISIS - Innovative Solutions In Space B.V., The Netherlands, E.BERTELS@ISISPACE.NL
Mr. A Thorvaldsen
Norway, thorvaldsen@stcorp.no
Mr. A Kukharenka
Norway, kukharenka@stcorp.no
Mr. Johan Vennekens
ESA - European Space Agency, The Netherlands, Johan.Vennekens@esa.int
Dr. Roger Walker
European Space Agency (ESA), The Netherlands, Roger.Walker@esa.int

DESIGN CHALLENGES AND OPPORTUNITIES OFFERED BY THE LUMIO SPACECRAFT: A CUBESAT FOR OBSERVING AND CHARACTERIZING MICRO-METEOROID IMPACTS ON THE LUNAR FAR SIDE

Abstract

The Earth-Moon system is constantly bombarded by meteoroids of different size and impact speed. Observation of the impacts on the Moon can enable thorough characterization of the Lunar meteoroid flux, which is similar to that of the Earth. 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 Lunar Meteoroid Impact Observer (LUMIO), one of the two winning concepts of the ESA SysNova Lunar CubeSats for Exploration challenge, is a mission designed to observe, quantify, and characterize the micro-meteoroid impacts on the Lunar far side. It 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 Earth background noise. The mission has successfully completed its Phase A in February 2021, after successfully passing Phase 0 and an independent feasibility study in the ESA Concurrent Design Facility. Although the Phase 0 design of the LUMIO spacecraft was assessed as feasible by the ESA CDF study, a number of critical issues were identified, which have been tackled by the Phase A design.

The paper will present in detail the final outcome of this Phase A design effort for the LUMIO spacecraft, as well as the development plans and way forward to the following steps in mission implementation (Phases B-C). Particularly relevant changes or updates in the spacecraft design include: a consolidated design of the LUMIO-Cam, with longer baffle for straylight protection; a set of ADCS sensors and actuators with increased redundancy; a combination of Direct-to-Earth communication and inter-satellite link with a mothership in Lunar orbit; use of Earth ranging to complement and validate the current innovative autonomous navigation strategy based on optical observations of the Earth and the Moon by means of the LUMIO-cam; re-assessment of the COTS components selection for the power and propulsion systems; detailed thermal and radiation environment analysis.