

A CubeSat mission for Moon and its vicinity exploration

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Abstract

The LUNar Cubesat Initiative Aimed to Novel and Unique Science (LUCIANUS) is a CubeSat mission concept focused on the Moon and its proximity.

In last years, increasing miniaturization and energetic efficiency in payload design has made CubeSat systems attractive for scientific missions and in orbit demonstrations, not only in the vicinity of the Earth, but also in deep space environment. LUCIANUS proposes to demonstrate these new capabilities in a cis-lunar scientific mission, composed by the ARDAN and BARBICANE sub-missions to cover different scientific and technological challenges.

ARDAN consists in two identical 8U CubeSats, 14 kg margined mass, released at 500km and capable to get their operational orbit independently; ARDAN s/c orbit on a sequences of circular Lunar orbit (100km; 76km and 41km) sequentially lowered to allow different, and increasing resolutions in the data acquisition. The overall maneuvers cost less than 200 m/s and the strategy allows covering the Moon surface every 15 days. ARDAN trajectory design is led by the on-board science: this sub-mission aims at lunar resource prospecting and environment analysis, each one equipped with an IR camera, VISTA (a miniaturized thermogravimetry analyser) and ALENA (Analyser for Lunar Energetic Neutral Atoms), a reduced version of the ELENA sensor for ENA mapping on board of the BepiColombo; both the latter proposed by INAF-IAPS.

The IR camera records subtle thermal gradients on the lunar surface to detect, map and characterize in size lunar lava tubes; VISTA and ALENA detect the distribution of suspended dust and neutral atoms, to study their interactions with light magnetic fields and solar radiations which drive ARDAN to fly at very low altitude.

BARBICANE is a single 12U CubeSat, 21 kg margined mass, equipped with miniaturized Gamma Ray Bursts (GRB) detector. The spacecraft would orbit on a Near Rectilinear Orbits (NRO) in the Moon-Earth Three-Body System – 15800 x 85000 km wide - to prospect the vehicle behavior in those, never exploited, non-keplerian trajectories. NRO are interesting location in the Moon Village framework, as they are suitable for supporting surface vehicles from the Moon surface to cis-lunar outpost continuous transfer back and forth.

BARBICANE would embark VISTA payload as well: during the raising of the spacecraft, from 500km release altitude to NRO, VISTA will provide high altitudes dust distribution data - complementary to ARDAN -.

LUCIANUS space segments are all equipped with Corner Cube Reflectors to tightly track their positions.

LUCIANUS mission aims at supporting and complementing the lunar exploration goals currently identified by the scientific community, involving a fleet of CubeSats: such small satellites exploitation

allows increasing the surface coverage and the mission robustness. Scientific objectives and technological challenges are presented in the paper, together with the mission timeline and phases. The preliminary design solutions identified to address the scientific and technological goals are discussed at system and subsystem levels to demonstrate the LUCIANUS mission feasibility by exploiting already off-the-shelf components to be shortly ready to launch.

Miniatuized solutions are proposed for all subsystems, particularly for propulsion and ADCS. Details on the design are provided for all subsystems and the budgets are eventually presented.

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