

# The Path Towards Improving Autonomy and Reliability of Complex CubeSat Missions

*Session: Autonomy and reliability of small satellites for deep-space exploration*

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In March 2022, an ESA-funded activity called “Increasing RAMS for Small Satellites” has been kicked-off. The project, conducted by a consortium formed by Deimos (prime contractor), Politecnico di Milano and Delft University of Technology, has the general scope to “specify and design a FDIR system for missions in non-deterministic environment with limited resources”, with a specific focus on Small Satellite/CubeSat missions.

One of the project tasks, more specifically, is to select a study case represented by a CubeSat complex mission (e.g. a deep space one, possibly studied by the ESA Concurrent Design Facility) and analyse in detail both its mission and system requirements. Based on this study case, relevant RAMS analyses will be carried out, the findings of which will be used as inputs for the development of a FDIR concept, paying particular attention to how the limited spacecraft resources can be balanced in presence of critical failures.

For this specific task, the consortium has initially identified two possible study cases: LUMIO and M-ARGO. LUMIO (LUNar Meteoroid Impacts Observer) is a 12U CubeSat mission to a halo orbit at Earth–Moon L2 that will observe, quantify, and characterize meteoroid impacts on the Lunar farside by detecting their flashes, complementing Earth-based observations on the Lunar nearside, to provide global information on the Lunar Meteoroid Environment and contribute to Lunar Situational Awareness. M-ARGO is a 12U deep-space CubeSat which will rendezvous with a near-Earth asteroid and characterize its physical properties for the presence of in situ resources, demonstrating for the first time the capability of CubeSat systems to independently explore deep space. Both missions are characterized by a high level of autonomy and complexity in a harsh environment, thus representing excellent study cases for the ongoing ESA RAMS/FDIR activity. During the first stage of the activity, LUMIO has been eventually selected as the study case that will be further elaborated by the project.

The presentation will guide the audience through the peculiar mission and spacecraft design characteristics of these two potential study cases, giving particular emphasis to the one that has been eventually selected (LUMIO). The specificities of the RAMS analysis and FDIR concept for this study case will be highlighted, looking in particular at aspects such as the improvement of reliability while maintaining the CubeSat philosophy, the tuning of mission and system requirements in view of facilitating the design and implementation of the FDIR concept, and the current gaps within the RAMS/FDIR body of knowledge for this class of missions.