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PROJECT DRACO : DETECTION OF RADIATIONS IN CISLUNAR SPACE ORBITS

Abstract

The development of the LOP-G, to be a staging point for future missions to the Moon, Mars, and beyond, calls for a deeper understanding of the radiation dose that astronauts will be subjected to around the Earth-Moon Lagrangian (EML) points. This paper describes the Detection of RAdiation in Cislunar space Orbit (DRACO) mission, which aims to deploy two CubeSats around the Moon with the relevant payload and orbits to provide needed insight into this still unknown environment.

This study has been conducted during a 5 students' project as part of the Aerospace Engineering MSc degree of ISAE-SUPAERO. First, we were divided into three groups working parallel to one another on the radiative environment, the mission analysis and the functional analysis of the system. Then, all of the team worked on building a parametric model for the CubeSat platform.

Once in orbit, the CubeSats will be mainly in the interplanetary radiative environment, where they aim to measure the exposure DOSE from the Solar Proton Events. These storms consist indeed in particles whose fluences' rates and energies are high enough to cause biological damages. In particular, the payload will focus on electrons with energies between 200KeV and 1MeV, and protons with energies between 12 MeV and 100MeV.

The mission analysis team looks at the CubeSats' orbits in the Circular Restricted 3-Body Problem (CR3BP) around the second EML point L2, as well as the transfers from the Gateway to the mission orbits. The parameters taken into account for the design include stability, station keeping costs, eclipses, pertinence to mission objectives defined by the radiative environment study, and satellite survivability, to determine the most efficient solution. Orbits of the Butterfly family seem to offer interesting coverage of the Cislunar space (both near and far sides of the Moon) and acceptable transfer costs. But the monthly short Moon passage in the Earth magnetotail will expose the CubeSats to potential hazards, mainly plasmoids, which requires considering a second option for one or both of the CubeSats.

Taking into account the mission constraints derived from the mission analysis and the radiative environment study, a functional analysis of the system was performed, including life cycle and functional architecture. A parametric model of the CubeSat platform was designed as well, including the evaluation of mass, power, propulsion and communication budgets, to evaluate the different design options.