57th IAA SYMPOSIUM ON SAFETY, QUALITY AND KNOWLEDGE MANAGEMENT IN SPACE ACTIVITIES (D5)
Prediction, Testing, Measurement and Effects of space environment on space missions (3)

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THE CORRELATION OF RADIATION SIMULATIONS WITH IN-ORBIT DATA FROM THE GREENCUBE MEO CUBESAT MISSION

Abstract

The space environment represents a significant challenge for satellites and can affect the functionality and performance of space missions. One of the most challenging aspects of the space environment is radiation. Beyond the Low Earth Orbit, radiations are trapped in the Van Allen belts, which extend into the region of the Medium Earth Orbit (MEO) and to the Geostationary orbit (GEO). Due to the increasing number of planned nano-satellite missions for unconventional orbital regimes, it becomes important to understand what are the effects of radiation on nano-satellite components. GreenCube is a 3U CubeSat, developed to in-orbit validate the functionality of a miniaturised and autonomous cultivation laboratory. GreenCube was designed and developed by the S5Lab (Sapienza Space System and Space Surveillance Laboratory) from Sapienza University of Rome, in collaboration with ENEA (Italian National Agency for New Technologies, Energy and Sustainable Economic Development) and the University of Naples Federico II. The project was coordinated by the Italian Space Agency (ASI). GreenCube was successfully launched on the 13th of July 2022 on the maiden flight of Vega-C, and injected into MEO at an altitude of approximately 5800km. Shortly after launch, the biology experiment was performed. Despite an expected lifetime of a few months, GreenCube is still operating. The environment of the inner Van Allen radiation belt, where GreenCube operates, is characterised by the presence of high-energy protons and electrons. The interaction between this radiation environment and the nanosatellite can affect the electronics, causing reboots of the main onboard computer, Single Events Effects or Latch-ups, that could lead to mission failure. Hence, the in-orbit data acquired during the GreenCube mission were used to understand the effects of the radiation environment on the CubeSat electronics, after prolonged operations. Analysis of the satellite systems reboots, which were discriminated from the software lockups induced by operational

telecommands, has enabled the correlation to the particular radiation environment conditions that have caused such events. This correlation is expected to improve the understanding of the potential impact of the radiation environment on the COTS (Commercial Off-The-Shelf) component in this specific orbit. In this paper, after a brief introduction of the GreenCube mission, an analysis of the MEO radiation environment is presented, and compared with the data acquired in orbit, in order to investigate and understand which are the effects of the radiation environment on the GreenCube electronics components.