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ASSESSMENT OF SPACE ENVIRONMENT EFFECTS ON ESD CUBESAT THROUGH NEW SPACESUITE CODE

Abstract

Spacecraft charging induced by space environments has been studied for decades in flight, on-ground and by numerical simulations. Anomalies and malfunctions have been reported in flight during plasma and radiation belts disturbances. Transient currents induced by electrostatic discharges (ESDs) can induce noise on electronic components, degrade material properties at arc site location and around and eventually lead to power losses on solar panels due to secondary arcing. Determining whether such anomalies are related to the space environment is still a difficult task that requires deep analysis of flight data, especially for ESDs because very few spacecraft are currently equipped with appropriate instrumentation. A few missions (SCATHA, CRRES, CTS, Electro-L2) have reported ESD rates from a few tens to a few thousands per year in GEO. Horyu-II spacecraft reported ESDs in LEO too. The objective of the ESD Cubesat project proposed by ONERA is to develop and test a payload for the flight demonstration of new generations of ESD counters and mitigation techniques. A cubesat platform is targeted to come up in the end with a low-mass and low-power instrument design adapted to the assembly and integration constraints on commercial satellites. This reduction in size and mass combined with the use of some components off the shelf may result in an increased susceptibility to the space environment with respect to classical missions, especially regarding radiations.

This paper presents the assessment of the space environment effects on ESD Cubesat using the Space-Suite code and models developed at ONERA and ARTENUM. We first assess surface charging induced by auroral electrons in worst-case conditions. SPIS is used to model the 3D spacecraft CAD model and compute ESD risks in the auroral zones. Depending on the cold plasma background, differential charging levels up to 300 V may develop within less than 10 seconds. Important requirements for the payload are deduced from this analysis: ESD counter location, resolution, etc. The radiation dose and charge deposited inside the cubesat will be computed using sector shielding analysis techniques available in EDGE software combined with Geant4 based transport computations with MoORA. An analysis of the effect to the on-board computer and payload will be presented. We will finally present the programmatic content for further assessment of space environment effects (ATOX, single event effects, internal charging, etc) and possibly electric thruster plume effects (erosion, contamination) and their implication on the ESD Cubesat project development.