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DEVELOPMENT OF A NANOSAT RADIATION ENVIRONMENT MONITOR (NANOREM) BASED ON COTS COMPONENTS

Abstract

The space radiation environment is harmful to both spacecraft and astronauts. In order to understand the risks posed, spacecraft are equipped with radiation environment and effects monitoring instruments. The data set acquired from such devices - though highly detailed - has a limited spatial and temporal coverage. There is a demand for now/forecasting of the dynamic space radiation environment, with real time data requirements that are best addressed by a network of compact radiation monitors flying concurrently aboard many spacecraft (low cost, low resource demand). This information will allow improvements of existing radiation models, which in turn affects spacecraft design and mission operation.

Cubesats are rapidly extending their capabilities, enabling more ambitious scientific, commercial and military satellite missions. These small spacecraft are growing in number and size, staying operational for longer and even moving beyond LEO into harsh radiation environments. Cubesats embrace rapid development cycles and the use of (upscreened) Commercial-Off-The-Shelf technology - they are now tackling improving reliability and Radiation Hardness Assurance (RHA). A small, low cost radiation environment monitor is key to radiation risk assessment and mitigation, providing the data needed to analyze and validate the performance of onboard technologies.

This paper will detail the development of the NanoREM instrument performed at the Technical University Delft in collaboration with an industry leading CubeSat manufacturer. NanoREM is a low cost, Cubesat compatible semiconductor diode telescope for charged particle spectrometry and coarse calorimetry. The instrument consists of a stack of silicon sensors (PIN diodes) for ΔLET measurement, coupled with a signal processing board for readout. The instrument prototype weighs 700g, occupies a 0.8U volume and implements a telescope casing made out of a metal/polymer sandwich for improved radiation shielding.

The prototype has demonstrated the operational performance of the instrument design during test campaigns in November 2018 and March 2019. The tests include cosmic ray experiments carried out in the UK and the Netherlands as well as Am-241 chip source measurements. Ongoing development aims to miniaturize the instrument and add a payload data handling board to interface with the Cubesat bus. NanoREM acting as a core component of the RHA framework will facilitate the proliferation of reliable, high production volume and standardized small satellites. This is a critical development for upcoming small satellite missions such as LEO constellations and deep space exploration, and agrees well with Cubesat design philosophy – Build, Fly, Improve.