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FEASIBILITY STUDY OF AN ENERGY COMPENSATED PIN DIODE DETECTOR INSTALLED IN A 1U LEO CUBE-SAT TO SURVEY EARTH ALBEDO GAMMA RAYS

Abstract

Spacecrafts in low earth orbit (LEO) environment are exposed to earth albedo gamma rays produced by the interaction of high-energy protons from Galactic Cosmic Rays (GCR) with the nitrogen (air) molecules in the upper earth-atmosphere. This event is named as Cosmic-Ray-Shower (CRS). The International Space Station (ISS) operating since 20 November 1998 (apogee 410 km; inclination 51.64 degree; orbital speed 7.66 km per second) is the longest serving LEO spacecraft todate. The GCR is composed of high-energy protons (87 %), electrons up to energy of 10 MeV (12 %) and heavy charged particles (1%). The energetic protons trapped in the Van Allen belt (VAB) surrounding the earth inflict major ionising radiation exposure to LEO spacecrafts. Evidently, the energetic protons trapped in the VAB and the earth albedo gamma rays (photons) originated from CRS are two completely different phenomena. Using commercial off the shelf (COTS) PIN diodes medical physicists of IBA Clinical Solutions WPE-Essen had developed an ultra low power consuming gamma detector for radiotherapy applications. Subsequently researchers at the University of Sydney have modified the gamma dosimeter for high-altitude cosmic ray experiments. The augmented device is named SUGAR (Sydney University Gamma Ray) dosimeter. Batches of SUGAR dosimeters were sent to near space altitude (35 km above sea level) using high-altitude-balloons (HAB) thereby exposed to CRS gamma rays. The data (pulse rate) received from SUGAR dosimeter was fitted (cross calibrated) using the EPCARD. Net code developed by the scientists of the Helmholtz Zentrum Munich. An accurately calibrated SUGAR dosimeter was installed in one of the two Cube-Sats (1U architecture) developed under the auspices of DESCENT project, a student Cube-Sat mission linked to outreach program of the York University, Toronto (ON) Canada. The Cube-Sat pairs will be placed in low earth orbit (ISS) in early August 2020 from the ISS by NanoRacks, an international satellite launching company. The main objective of our project will encompass an accurate survey of earth albedo gamma rays using a novel PIN diode detector throughout the anticipated orbit lifetime of two months. The measured gamma dose rates will be verified by model calculations.