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IRADCAL: A MONOLITHIC INORGANIC SCINTILLATOR AND THIN SCINTILLATORS TO MEASURE LOW ENERGY ELECTRON, PROTON AND HEAVY ION ALBEDO SPECTRUMS FROM LUNAR SURFACE

Abstract

Due to the absence of an intrinsic magnetic field and of a collisional atmosphere, the Moon is directly exposed to: Solar Wind: 0.5 to 10 keV ions and lower energy electrons Solar Energetic Particles (SEPs): 10 keV to several 100 MeV ions and electrons, Galactic Cosmic Rays (GCRs): 100 MeV to 10 GeV ions and electrons, Anomalous Cosmic Rays (ACRs): 1 to 100 MeV particles.Monitoring the SEPs and GCRs allows to assess the radiation environment of the Moon, in view of the upcoming return of humans to the Moon and of the related radiation risks. SEPs and GCRs arriving at the Moon's surface can be absorbed, or scattered, or can remove another atom from the lunar regolith, or can produce cosmogenic nuclides, their interaction with the lunar regolith produces albedo energetic particles. In the context of TLM (Turkish Lunar Mission) project we are developing small acceptance particle detector payload to measure

the albedo electron, proton and heavy ion fluxes backscattered from the lunar surface. In low lunar orbit the FoV (+/- 10 deg) of our payload will look at the Moon surface. The IRADCAL detectors are composed of, from top to down, MLI (Multi-Layer Insulator); a circular thin plastic scintillator seen by four Silicon Photomultipliers (SIPMs), placed to form a cross on ligth guide surrounding the scintillator(S1); 26x26x70 mm crystal scintillator CsI(Tl)(S2); a thin crystal scintillator seen by two SIPMs(S3). The design parameters are; Energy spectrum range for contained protons from 400 keV to 150 MeV, electrons from 50 keV to 10 MeV and heavy ions up to CNO group with 20 MeV/n. The IRADCAL will provide two dE/dX values from two thin scintillators, Etot or dE/dX from thick scintillator and dE/E ratios that will be crucial for particle identification. We are developing multi layer perceptron using deep neural network algorithm to estimate Depth of Interaction (DoI). The S1 provides also level1 trigger and the hit position that used with DoI point will define whether the particle is escaping from sides and up/down going separation. The thicker S3 will define whether the event is contained. It will fit in 2U cubesat with 2.5 kg and 15 Watts of power required. Further it will have capabilities such as remote control of discriminator threshold levels and of trigger logic as well as automatic bias compensation an online calibration, on board computer to preprocess the data.