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DESINGS AND PRODUCTION OF LIGHT AND LOW POWER CONSUMING PORTABLE SCINTILLATION DETECTOR FOR FUTURE CUBESAT MISSIONS

Abstract

In this study, a multi-purpose environmental risk assessment approach have been developed through the integration of a portable or wearable scintillation detector using a Silicon Photomultiplier, which could be used to detect the high energy particles in low Earth orbit. It could be used for future cubesat missions as produced locally, cheap, light and low-power consuming detector. Photomultiplier tubes are generally used to convert low-energy photons generated as a result of the interaction of gamma rays within the scintillator into electrical signals. However, in this study, SiPM was preferred as a more compact alternative that operates at low voltage and has high mechanical durability. One of the important reasons for using SiPM is that its dimensions are much smaller compared to standard PMTs, making it suitable for portable detector design. Experimental tests were conducted using laboratory sources to calibrate energy resolution and timing performance. Features such as small detector size, durability, and the fact that SiPMs are not affected by magnetic fields will provide advantages for space missions. This research is based on an experimental design and focuses on the development, testing, and optimization of a SiPM-based detector. On the other hand, Monte-Carlo simulation tools such as FLUKA were used to define the behavior of the detector. Data collection tools include scintillator crystals and SiPMs, signal processing circuits, microcontrollers, and commercially available PMT-based scintillation detectors that can be used as references. SiPMs and various crystals were acquired, and preliminary studies and feasibility analyses were conducted to meet requirements such as SiPM “bias voltage” and “breakdown voltage.” Calibration measurements have been conducted by using radioactive point sources with well-known energies in order to verify that prototype produces correct outputs and to validate its energy resolution and efficiency. The obtained spectra will be analyzed to evaluate the energy resolution of the detector. Alternative modules will be integrated into the system via a microcontroller and its multi-directional operational capability will be tested. The measurements showed that the signal amplitudes obtained from the detector are proportional to the energy of the source. In addition, the detector’s clear response to radioactive sources and the observation of higher-amplitude signals indicate that these signals originate from cosmic muons.