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Performance and radiation damage mitigation strategy for SiPM on LEO space missions

Space missions require components that are lightweight, low-power, and resistant to radiation. Silicon photomultipliers are increasingly used for detecting near-UV, optical, and infrared light in space due to their compact design, low cost, low power consumption, robustness, and high photo- detection efficiency, which makes them sensitive to single photons. Although SiPMs outperform traditional photomultiplier tubes in many areas, concerns about their radiation resistance and noise remain. In this study, we estimate the radiation effects on a satellite in sun-synchronous low Earth orbit (LEO) at an altitude of 535 (worse case)-550 km during the declining phase of solar cycle 25 (2026–2029). We evaluated silicon photomultipliers produced by the Foundation Bruno Kessler (FBK) using front-side illuminated technology with metal trenches (NUV-HD-MT), assessing their response to a 50 MeV proton beam and exposure to a β-radioactive source (strontium-90). Simulations with SPENVIS and Geant4 were used to validate the experimental results. Based on our findings, we propose a photosensor annealing strategy for space-based instruments.

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