Silicon Photomultipliers for the Japanese Experiment Module – Extreme Universe Space Observatory (JEM-EUSO) Focal Surface

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Abstract

The Japanese Experiment Module – Extreme Universe Space Observatory (JEM-EUSO) mission is designed to explore the most energetic particles known to occur in nature, ultra-high-energy cosmic rays (UHECRS). By looking down at the night sky from the International Space Station (ISS), JEM-EUSO will be able to see the fluorescence and Cherenkov photons produced by air showers generated by UHECRS in our atmosphere. JEM-EUSO will have the highest exposure of any UHECRS test ever attempted. Current plans for its design call for a focal surface utilizing photomultiplier tubes (PMTs). While PMTs have been used in similar projects before, a new technology may be replacing them as the better alternative. Silicon photomultipliers (SiPMs) are quickly becoming this new option. SiPMs demonstrate many of the same qualities of PMTs while also improving qualities in certain areas. One characteristic is that SiPMs are smaller than PMTs and so can provide higher angular resolution. SiPMs are also not affected by external magnetic fields which gives them an advantage while in orbit. Given that SiPMs are a developing technology, optimization of such detectors still must be researched and understood. [SiPMs also have the potential for higher detection efficiency than PMTs.] For SiPMs to replace PMTs, a more power efficient and noise canceling scheme must be developed. Since the SiPMs intrinsic background is affected by ambient temperature, the focus of this research is to test the capabilities of these detectors at cryogenic temperatures. The current goal of the research on SiPMs at Fermilab is to create a small photon detection module (PDM) to be tested for the JEM-EUSO focal surface.