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Kenneth Zia
Utah State University

JR Dennison
Utah State Univesity

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Calibration of Muon Detector for Coincidence Cathodoluminescence Experiments

Kenneth Zia and JR Dennison
Physics Department, Utah State University

Abstract

A muon scintillation detector has been calibrated by measuring the magnitude and angular dependence of high energy cosmic background radiation events. Optimizing dark current as a function of voltage across the photomultiplier tube (PMT) detector was essential for accurate counting of current pulses as narrow as the counts in the PMT. Measurements of the cross-section zenith angle were also optimized by sweeping the detector across the horizon and from the zenith to nadir angle. The detector is now operating within proper Poisson distribution statistics for counting particle experiments, and is ready for the next step in determining coincidence between the muons and the cathodoluminescence events. Samples of highly disordered insulating material irradiated with 1-30 keV electron beams have been found to produce three forms of light emission with differing duration: arcs (<1 s duration), flares (~100 s duration), and cathodoluminescence (as long as beam is on). The arc and cathodoluminescence phenomena are well understood, while the flares are not. . Measured rates of ~2 flares per hr were within a factor of 2 of the expected altitude-dependant muon cosmic background cross-section at an altitude of Logan, UT (1370 m). Based on this suggestive evidence, we have proposed incorporation of our standard muon coincidence detection apparatus into our vacuum cathodoluminescence test facility. If muon events are shown to coincide with the flare events, this will provide definitive evidence that flares are triggered by high energy particle penetration, which causes discharge and subsequent recharging of the charged highly insulating samples during our previous electron-beam characterization tests of space materials.