Novel, Portable and Low-cost Cosmic Ray Muon Telescope

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Abstract

The earth is constantly bombarded with cosmic ray particles (mainly high energy proton particles) which have galactic and solar origins. These cosmic ray particles produce extensive cosmic ray showers starting at the altitude of 15 km. Most of the secondary particles continue interacting with the air molecules while cascading toward the surface of the earth. The most abundant particles that reach to the earth surface are muons (about 80%) together with a few percents of neutrons and electrons. Muon tomography and atmospheric weather study are applications using cosmic ray muons which protect and preserve our national security, health, and environment. The Nuclear Physics Group (NPG) at Georgia State University (GSU) has been developing low-cost and portable muon detectors, and is interested in installing these detectors around the world for advancing the technology of monitoring the dynamical changes of the earth/space weather by measuring cosmic ray muon flux variations in real-time at a global scale.

The muon telescope detector consists of three layers of plastic scintillator mounted on an aluminum extrusion frame. Scintillation light is collected via a wavelength shifting fiber grooved at the surface of the scintillator and sent to a multi-pixel photon counter (MPPC) installed at the corner of the scintillator panel. The data acquisition is performed with a custom-made Raspberry Pi Hat, which also provides bias voltage to the MPPC. A prototype of this muon telescope was tested in June of 2018 behind the beam shielding blocks at the Fermilab Test Beam Facility with a 120 GeV/c proton beam.

My work mainly includes building the detector components, soldering circuit boards, assembling the detector, programming the readout electronics and running tests and data analysis. In this talk, I will highlight the design features of this detector and present the results from my data analyses.

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