Contribution ID: **100** Type: **Poster**

CosmoLink: Portable Coincidence Detector for On-Site Muon Flux Measurement

Tuesday 1 October 2024 17:40 (20 minutes)

CosmoLink is a compact coincidence detector comprising two scintillators for portable on-site muon flux measurement. The Scintillators are coupled with wavelength shifting (WLS) fibers for efficient light guiding to Silicon photomultipliers (SiPMs). Each readout channels equipped with a Transimpedance preamp, Discriminator and peak hold circuit. Upon successful coincidence trigger the peak amplitude is digitized using Analog to Digital Converter. The coincidence count and ADC data are acquired using a low cost microcontroller. Multiple detectors can be grouped together like swarms and arranged in different geometry to collect data collectively.The acquired data is wirelessly transmitted to a central server.

Summary (500 words)

The CosmoLink project aims to develop low cost, low power and portable form factor Muon detectors for experimental and educational research. It's made of two plastic scintillators kept in stacked geometry for on-site muon flux measurement. The device consists of two scintillators each measuring 70mm x 50mm coupled with WLS fibers to guide light efficiently to Silicon photomultipliers (SiPMs). This setup allows for accurate detection and measurement of muon flux in various environments making it a tool for research, monitoring, and experimentation.

One of the key features of our device is its portability, enabled by battery operation or USB 5V power supply option. The detector can be easily transported and deployed in diverse locations from remote field sites to laboratory settings without requiring access to mains power.

The detection process starts when the scintillators capture incident muons which produce scintillation light that is efficiently guided by the WLS fibers to the SiPMs for detection. Each scintillator is equipped with a dedicated readout channel featuring TransImpedance Amplifier (TIA), Discriminators and peak hold circuit. The transimpedance gain of the preamp is 1000 and the Discriminator threshold was carefully chosen to avoid darknoise from the SiPM. The peak amplitude of the signal is held high upto 500 microseconds. Upon detection of a muon event the peak value is converted to digital format using an onboard Analog to Digital Converter.

Coincidence triggering, facilitated by the central microcontroller ensures that only events detected by both scintillators simultaneously are considered valid. This mechanism reduces false positives and enhances the reliability of muon flux measurements. Once a valid trigger occurs, the acquired data, including Coincidence counts, peak amplitudes and timestamps are transmitted wirelessly to a server for storage and analysis.

Multiple detectors can be deployed in various geometries to cover large areas and obtain collective measurements. This capability transforms the device into a large-pixel area detector enabling comprehensive monitoring and analysis of muon flux patterns across different spatial scales.The unit also incorporates sensors for temperature, pressure, humidity and light, as well as a GPS module and accelerometer for real-time location and orientation tracking.

Currently one unit of this detector was developed and being used for on-site measurements of cosmic Muon flux. Its compact size, battery operation and wireless data transmission capabilities make it an ideal choice for researchers, educators, and enthusiasts seeking to explore muon flux dynamics in diverse environments.

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Session Classification: Tuesday posters session

Track Classification: System Design, Description and Operation