Cosmic Ray Muon Detector Array Program

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Abstract

When a cosmic ray passes through our atmosphere, the charged particles collide with the nuclei of the air molecules, producing secondary particles such as muons. A cosmic ray detector array was built to collect this data.

Raspberry Pi single-board processing computer, set up and data acquisition

The pictures below illustrate the setup for the Raspberry Pi single-board processing computer with its detectors replacing large computers, the time and price of the Pronto is much below the ending value. The Raspberry Pi allows the team to use a Linux-based operating system, such as Fedora, enabling data transfer and data acquisition. Our detector control software and data acquisition program (QCC fIP) was installed on the Pi. The pictures below show the Linux command line on which students can execute commands and data is transferred from the Pi.

Cosmic ray collision point reconstruction

To determine the position and time (x0,y0,z0) of the collision point we used a linearly independent-signatures algorithm. Using the algorithm, the cosmic ray track is described by a linear function,

\[ x(t) = x_0 + vt, \]

\[ y(t) = y_0 + wt, \]

\[ z(t) = z_0 + wt, \]

Where \( v, w \) are the components of the linear function of the cosmic ray in the plane perpendicular to the line.

Distinguishing real signals from noise: false coincidences

The difference between a real arrival pattern of a detector and a real drop in pressure is important in order to determine the number of cosmic rays participating in the atmosphere. This difference must be large enough to make sure that the signal is indeed a cosmic ray and not a false coincidence.

Wiring block diagram for scintillator efficiency measurements done at Brookhaven Lab

Our group at QCC has been working on block diagrams and made plans for measurements made by other students within our group at BNL. Below is a wiring diagram for a muon telescope setup used to measure scintillator efficiency; here two smaller cosmic ray counters sandwich the scintillator under test and the cosmic ray field is the rate of coincidences is measured.

Reflectivity measurements on wincey tunic, cotton, and on wincey tunic paper, and single vs. double wrapped counters:

Our HI-184 scintillator was left open in a 25 cm, at a five-inch distance from the center of the scintillator (seen in the Brookhaven Lab).

Expected Cosmic ray rate = \( \frac{\text{multiplier}}{\text{area}} \times \frac{\text{multiplier}}{\text{area}} \) = \( \frac{1}{\text{area}} \)