Cosmic Ray Muon Events in the NIMROD Detector Array

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A technique to monitor the long-term stability of detector gains and the reproducibility of gain settings in experimental runs with NIMROD would be particularly valuable. Recently, we have explored the possibility of using measurements of the response of NIMROD detectors to the cosmic ray muon flux for this purpose. Cosmic ray muons are secondary cosmic ray events which shower the earth's surface in a large cascade with a mean energy of 2 GeV. As they pass scintillating elements, they deposit a small fraction of their energy to that detector. In NIMROD's CsI detectors, the Muon spectrum was analyzed by studying a run performed *sans* beam. Muon contributions were isolated by comparing which CsI detectors were fired in coincidence on an event-by-event basis in the NIMROD detector array. We performed this experiment by taking data overnight using the GOOSY data acquisition system. We identified the muons by comparing which detectors fired for each event. Cosmic rays have a higher probability of causing four detectors in a vertical line to fire at once (see figure 1).

The various coincidences possible within the detector are depicted in figure 1 for a muon incidence from above. In total, four coincidence spectra were produced for each detector. The detectors used to produce each possible coincidence were detectors A and B; detectors A and C; detectors A, B, and D; and finally detectors A, B, C, and D.

As indicated in figure 2, there are two main portions of the singles (no coincidence) spectrum.

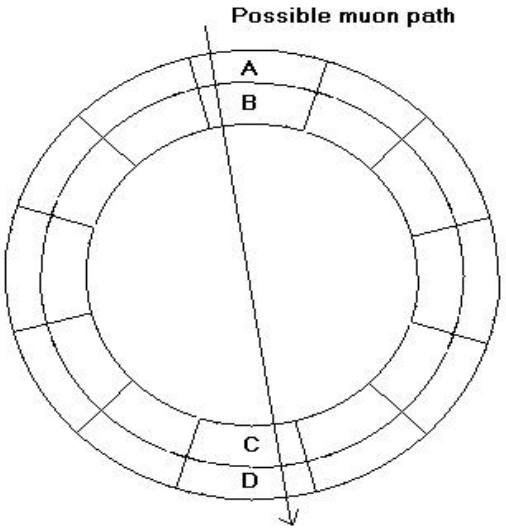

Figure 1: Nimrod detector, with each letter representing a detector. 4 coincidences were studied: A, B, C and D; A, B, and D; A and C; and A and B

One group is between 500 and 1025, and the other group starts at 1025 and tails off at 1800. As the coincidence becomes more demanding, the group between 500 and 1025 is greatly diminished and the peak between 1025

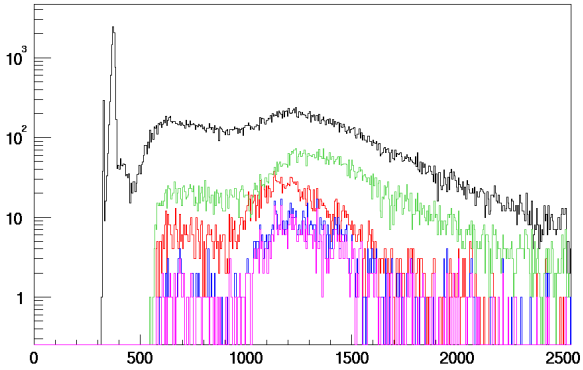

Figure 2: A log plot overlay of the four imposed coincidences and the singles spectrum (slow signal, detector 23). The top line is the singles, followed by A and B; A and C; A, B and D; and A, B, C and D.

and 1600 remains with the spectrum. The most probable source of this group of events is cosmic

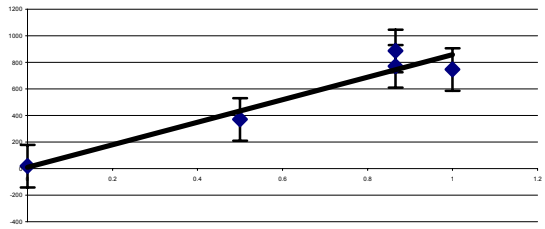

Figure 3: The angular distribution: the number of counts in four coincidence versus the absolute value since of the average angel to the ground

rays. Figure 3 shows the angular distribution of the four-coincidence spectra. This further indicates that this is the muon spectrum as muons should statistically follow this angular distribution.