Using Cosmic Ray Veto to Increase Radiation Sensitivity at KURF

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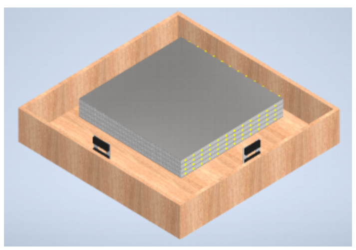
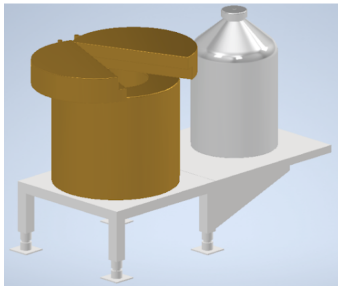
Introduction

Colliding cosmic rays can produce high energy muons that cause considerable background for particle detectors. Working underground significantly reduces this problem, but muons can travel up to 10 km in air and can penetrate the Earth. A muon detector built by the Center for Neutrino Physics is placed on top of a germanium detector below 300 feet of limestone at Kimballton Underground Research Facility (KURF). The muon detector vetoes muon hits on the germanium detector that mimic radiation energies. The muon detector provides us with the ability to accurately classify muons that pass through the germanium detector and veto, or delete, those false hits from the data collected by the germanium detector.

The Detectors

Muon Detector

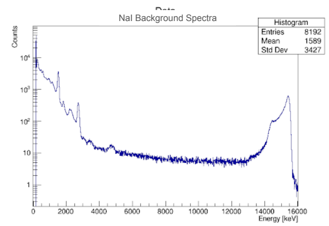




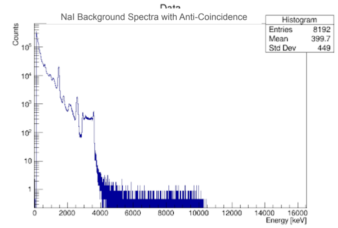
Germanium Detector

Muon Veto

Anti-Coincidence

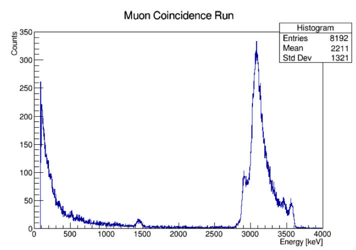


Background spectra taken using a NaI scintillator with a high energy peak hypothesized to be caused by muons. Using anticoincidence, we explored this matter.



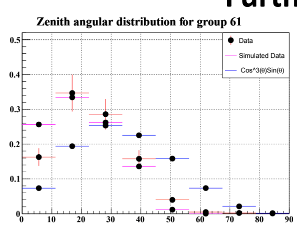
Final spectra using muon veto confirms our hypothesis that the highest-energy depositions were caused by muons.

Coincidence



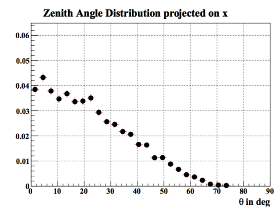
Running the NaI detector in coincidence with the muon detector the muon energies were not recorded. We hypothesize that this absence correlates to the relative positions of the two detectors.

Further Results

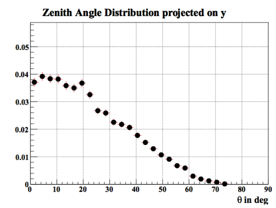


Recorded muon data corresponds well with simulated data. Zenith angle of the incoming muons skews toward smaller angles as predicted.

Conclusions



The angular distribution on the x and y axes confirms that our data is not significantly biased by the chosen threshold of 2 photoelectrons (PE).



The muon counts are inversely proportional to the theta angle, as we expected.

In the future, we anticipate using the coupled detectors to further investigate the disparity between data vetoed in the anti-coincidence veto and data caught during the coincidence veto.

We will continue monitoring the performance of the veto at KURF as compared to at Virginia Tech's home labs. Alternative logic choices between channels have been proposed which may lead to higher efficiency and more effective data.

Acknowledgements

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References

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