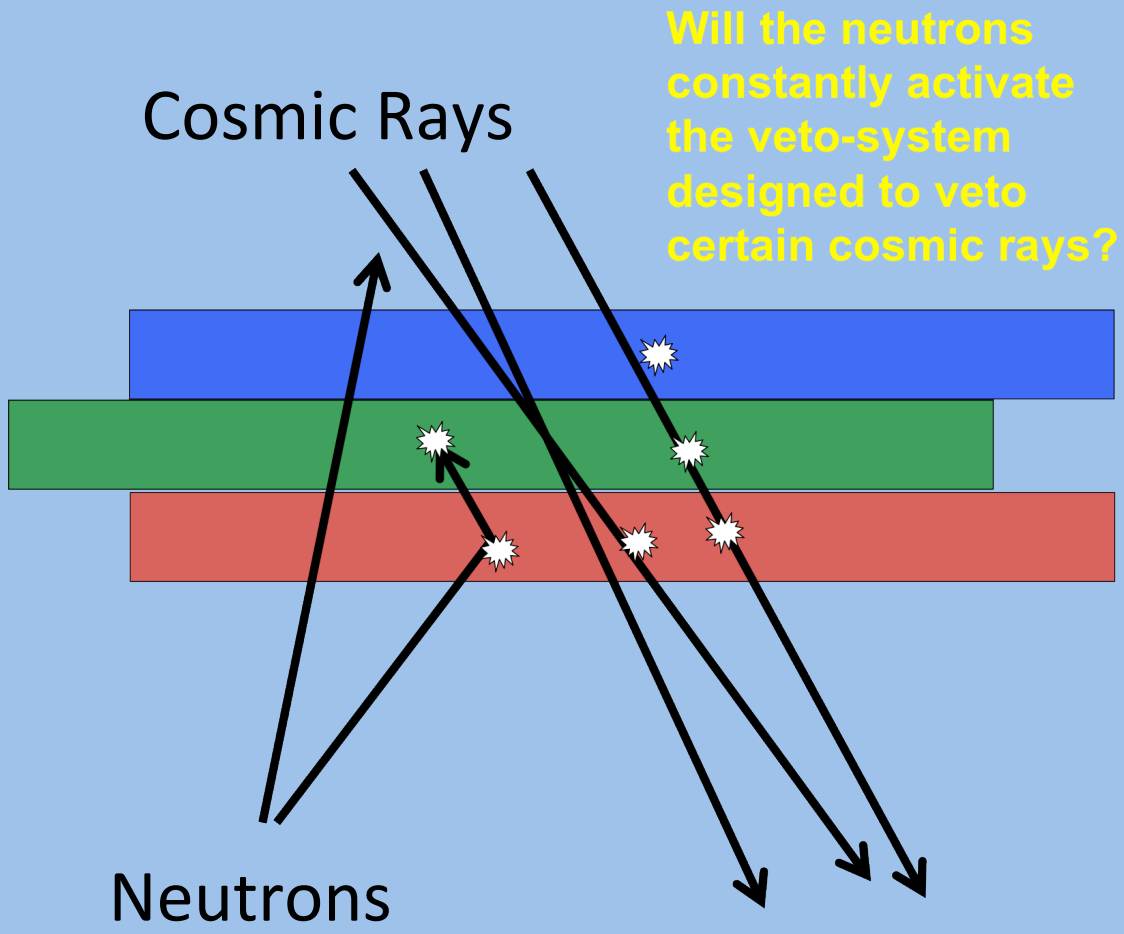
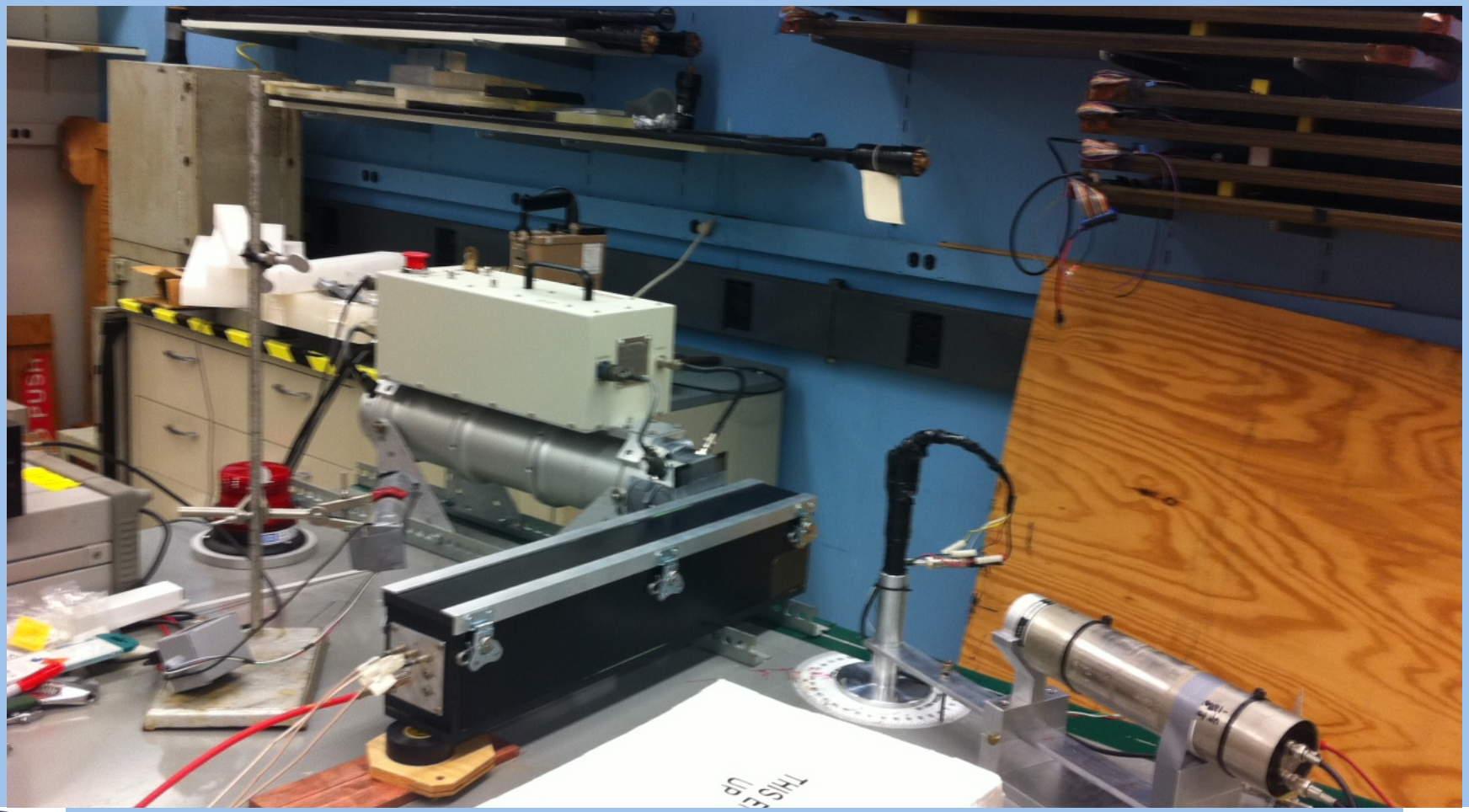
Premise of the Study

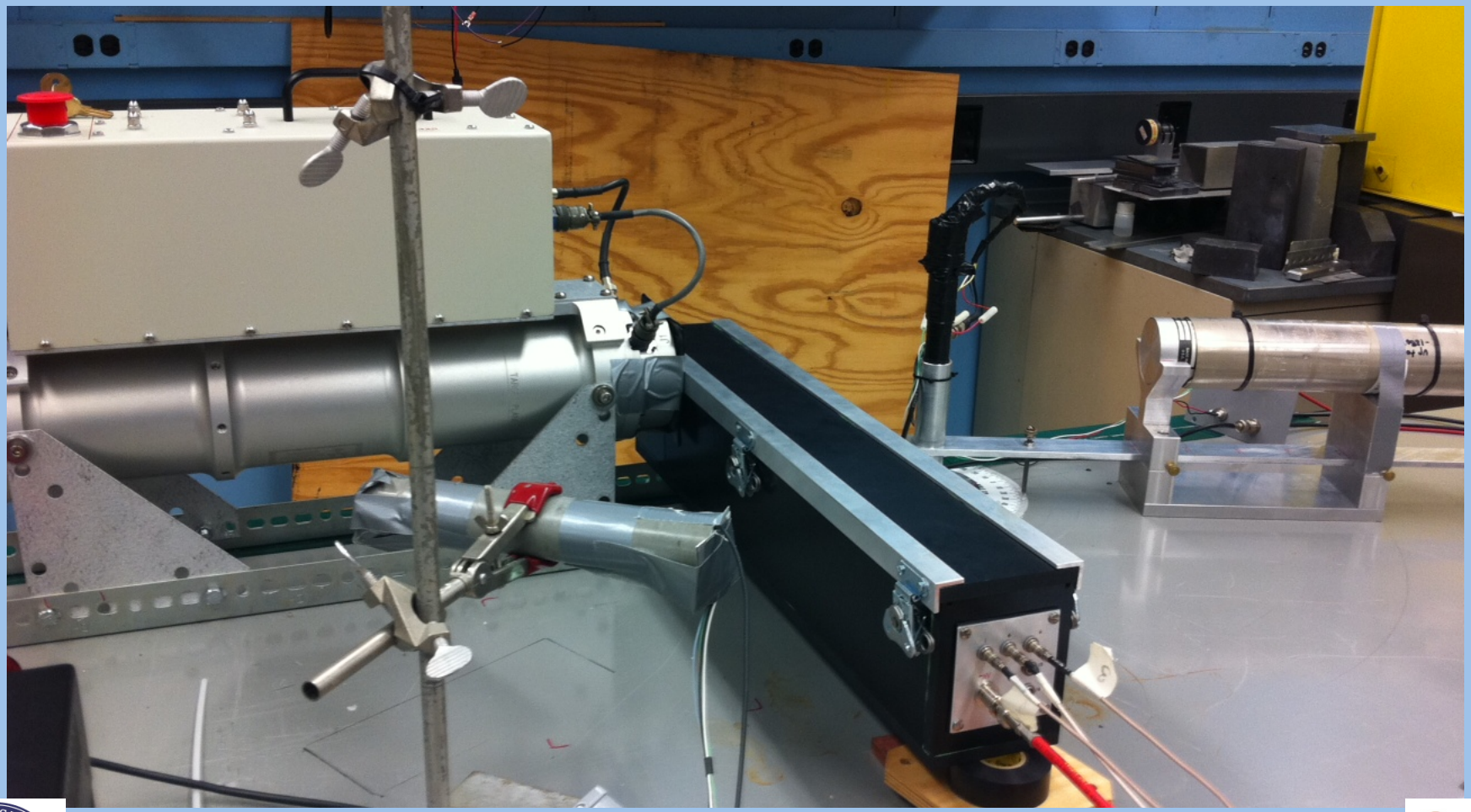
- The Mu2e experiment at Fermilab plans to use a two-out-of-three coincident requirement in a plastic scintillator based detector to veto events in which a cosmic ray may have influenced the system.
- This cosmic ray veto system (CRV) must operate efficiently in a high-radiation environment
- In this study, fast neutrons resulting from muon capture were analyzed in order to determine their influence on the CRV.
- At the University of Chicago, three plastic scintillator bars were placed in front of a Deuterium-Deuterium neutron generator in order to represent the CRV in a high-radiation environment, in order to understand the sensitivity of the plastic scintillator to the fast neutrons


Cosmic Rays
Will the neutrons constantly activate the veto-system designed to veto certain cosmic rays?
Neutrons

Experimental Set-up



Experimental Set-up



General Information

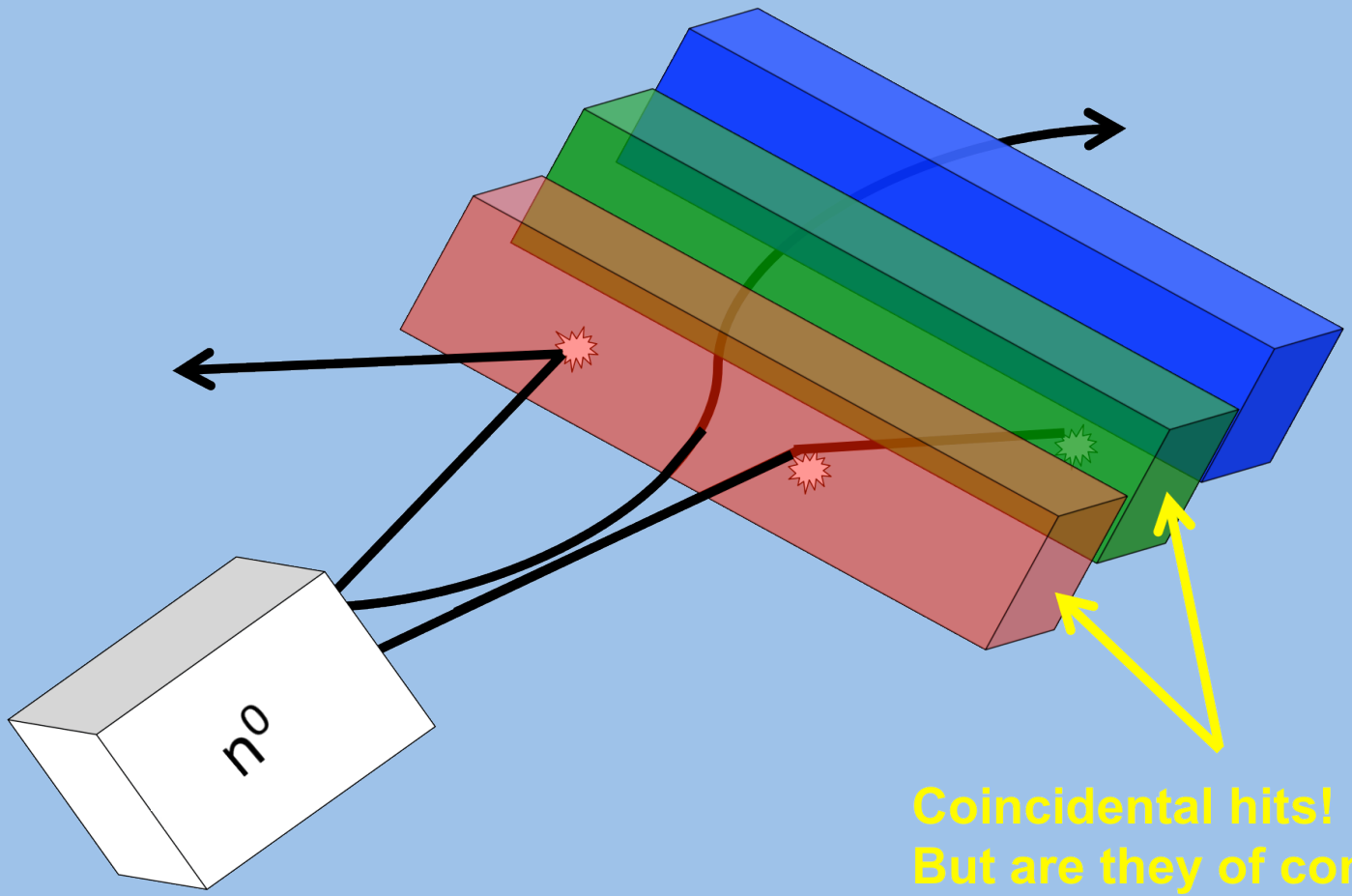
Channels 1, 2, and 3 represent the digitized information from the PMTs attached to the plastic scintillator bars.

Chan 1 : Nearest to the generator and is conventionally represented in Red

Chan 2 : The middle scintillator bar and is represented in Green

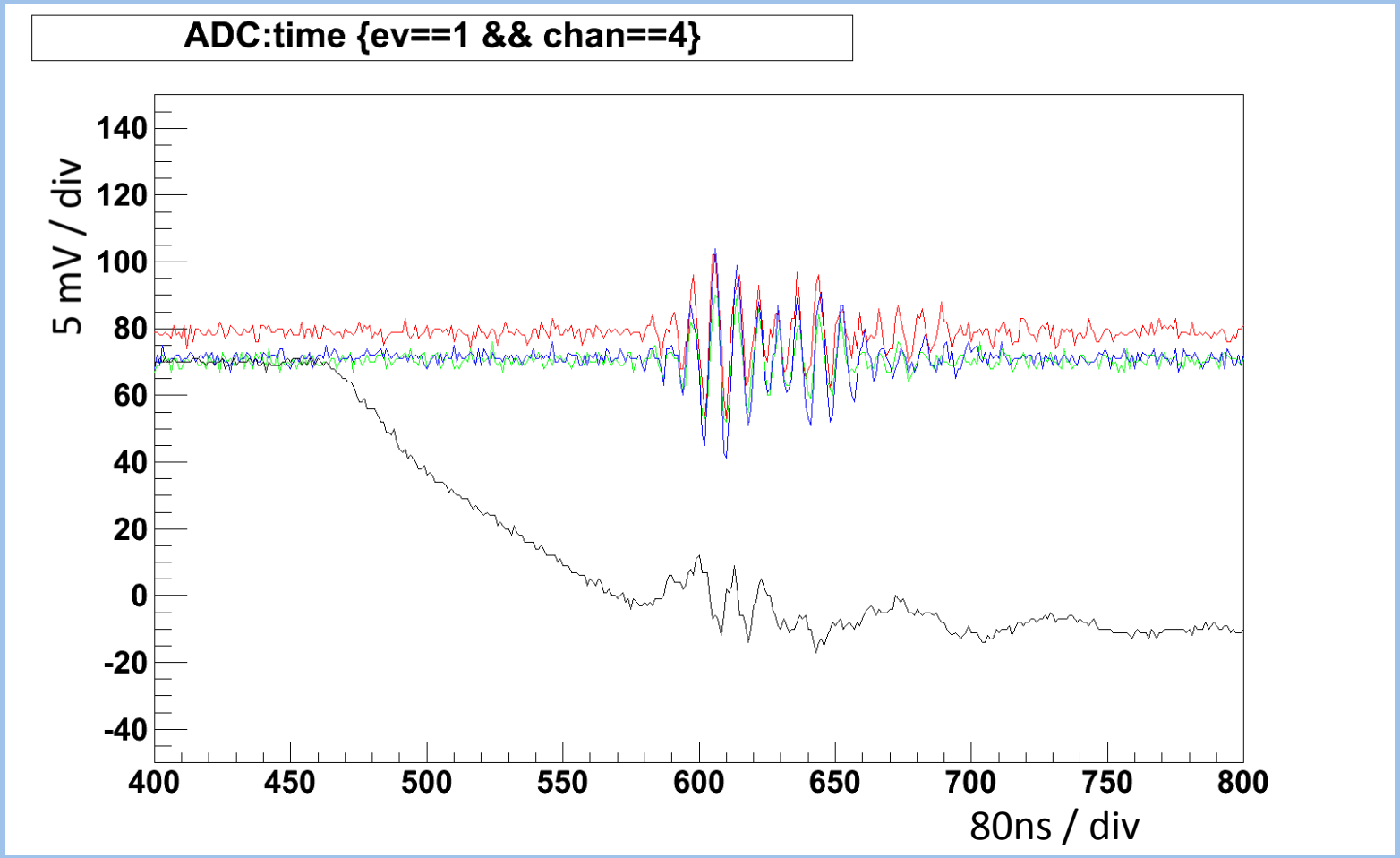
Chan 3 : Farthest from the generator and represented in Blue

The fourth channel is the trigger, which displays when the event (collision in the neutron generator) begins to occur. Displayed in **Black**.

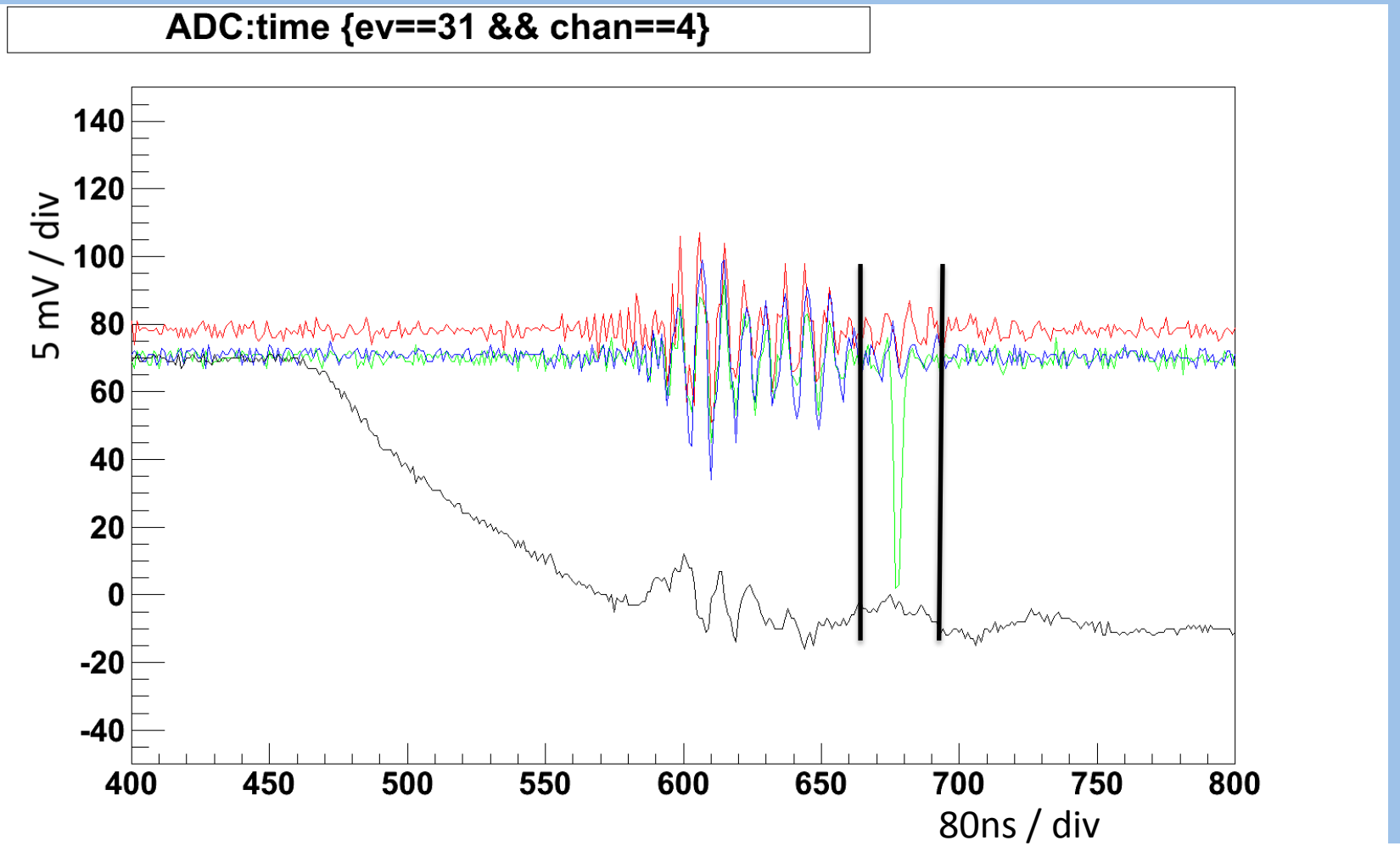


Coincidental hits!
But are they of concern?

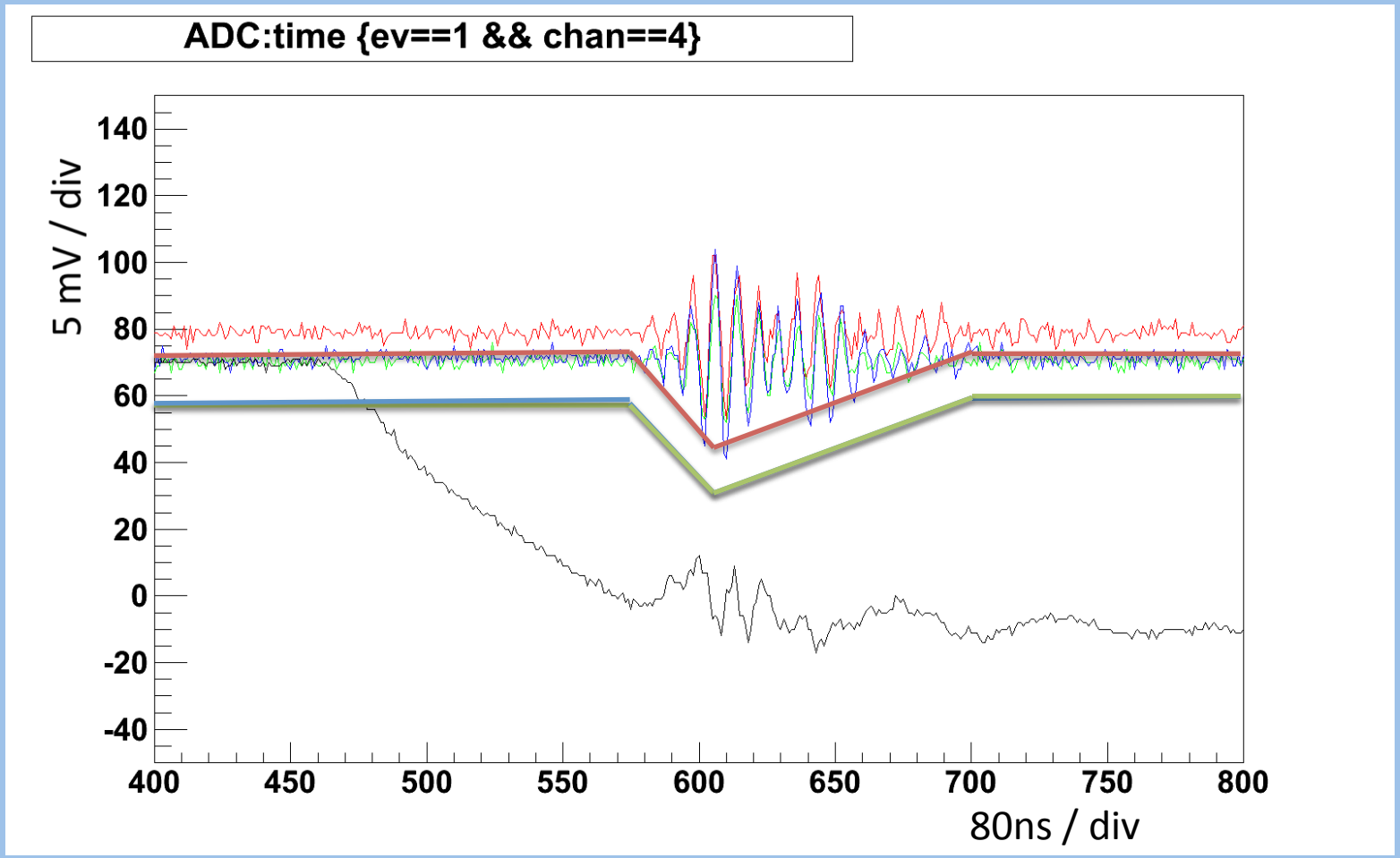
Example of an Event



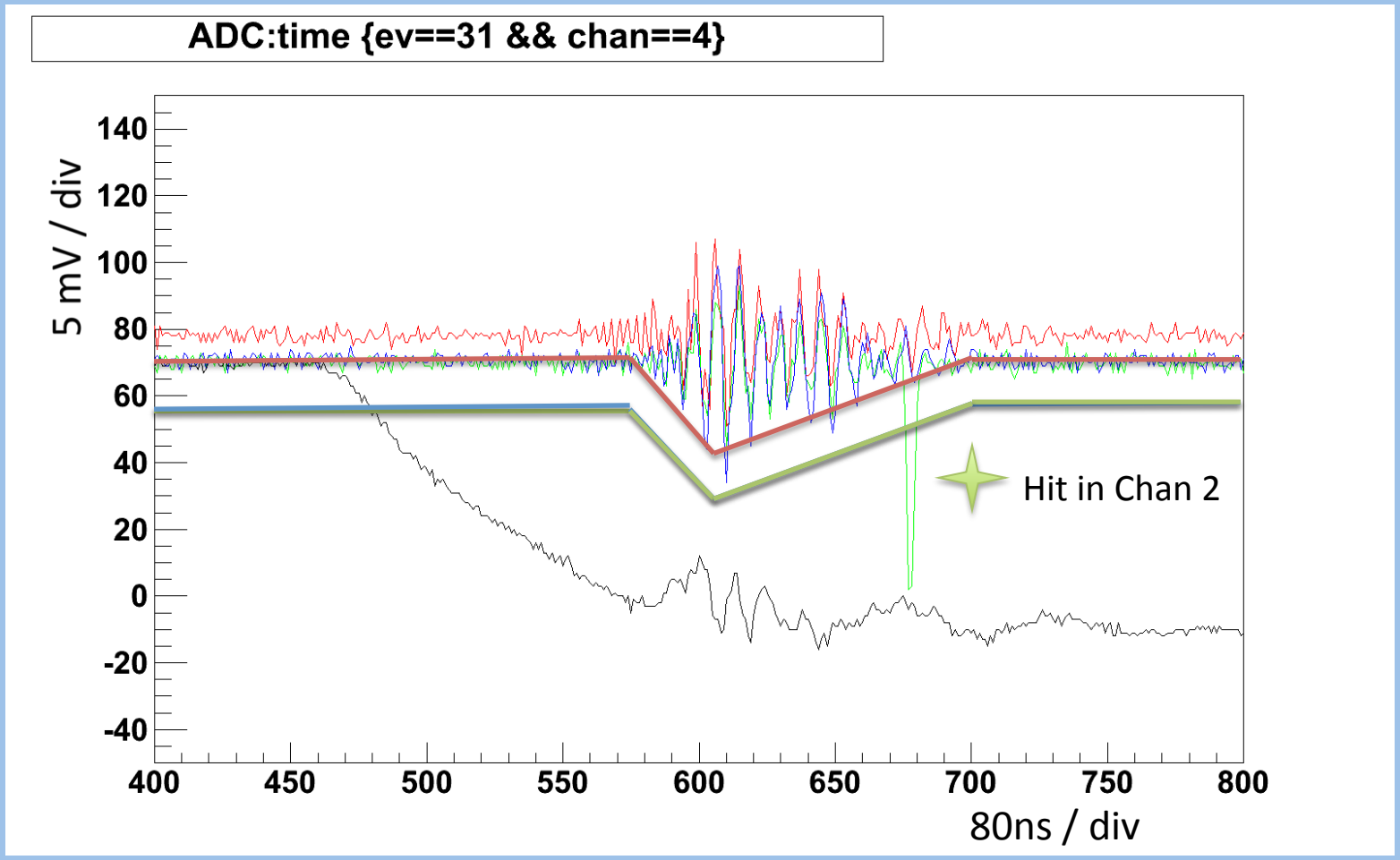
Hit Definition



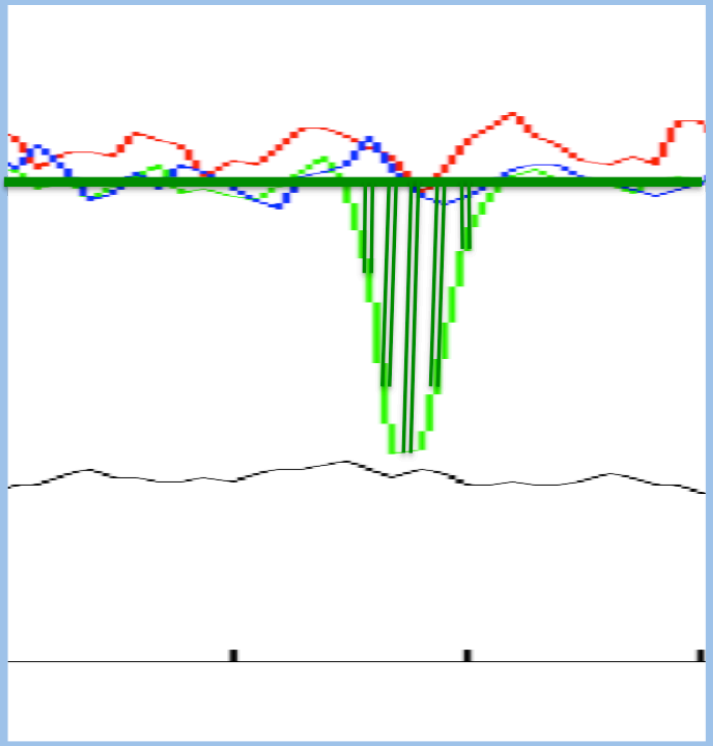
Fit to the noise



Finding a Hit

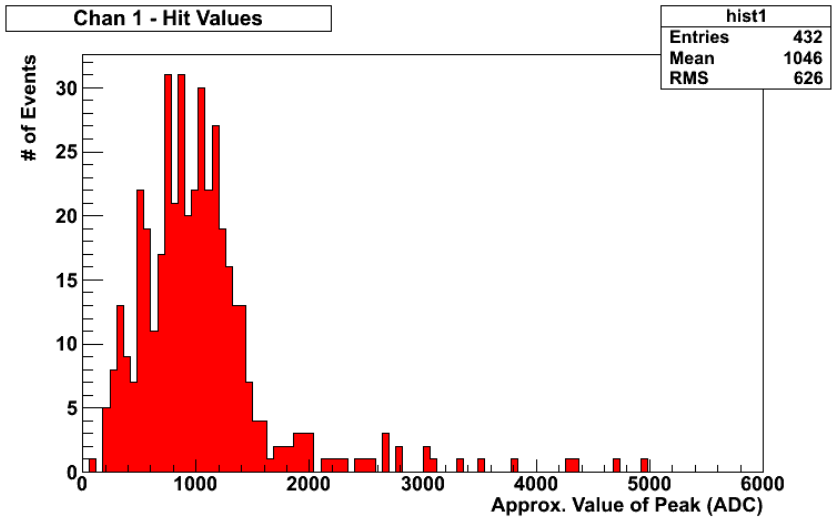


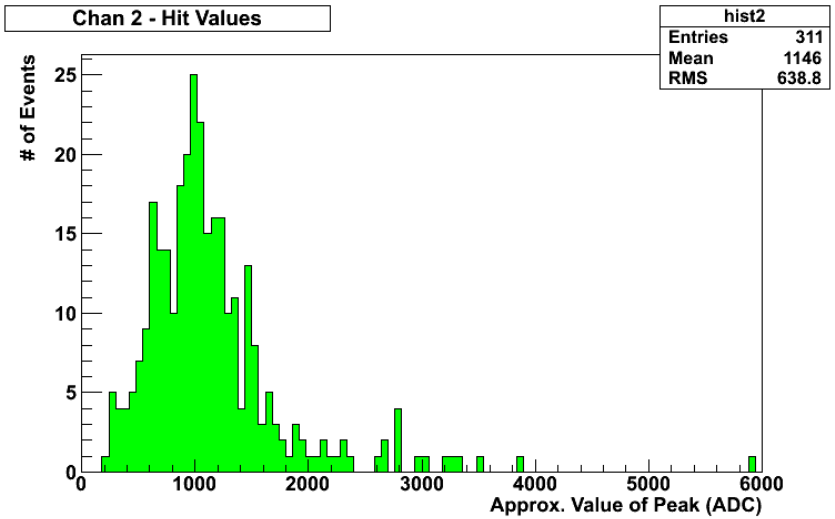
Evaluating a Hit

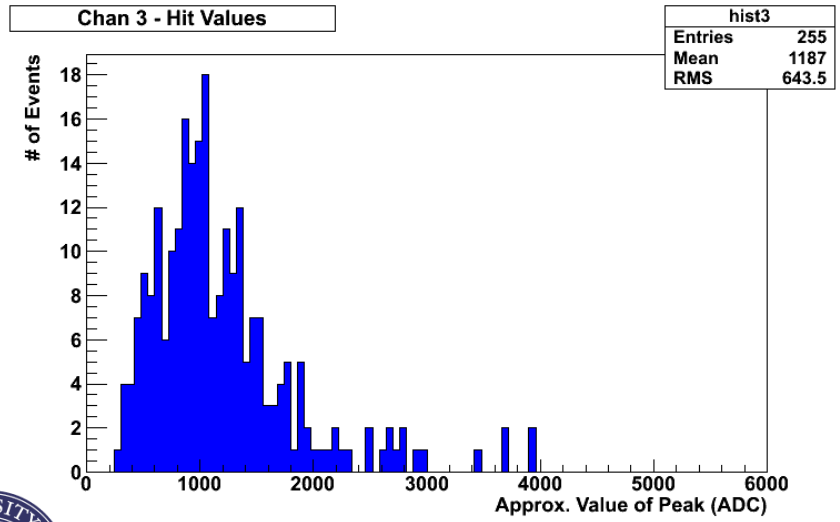


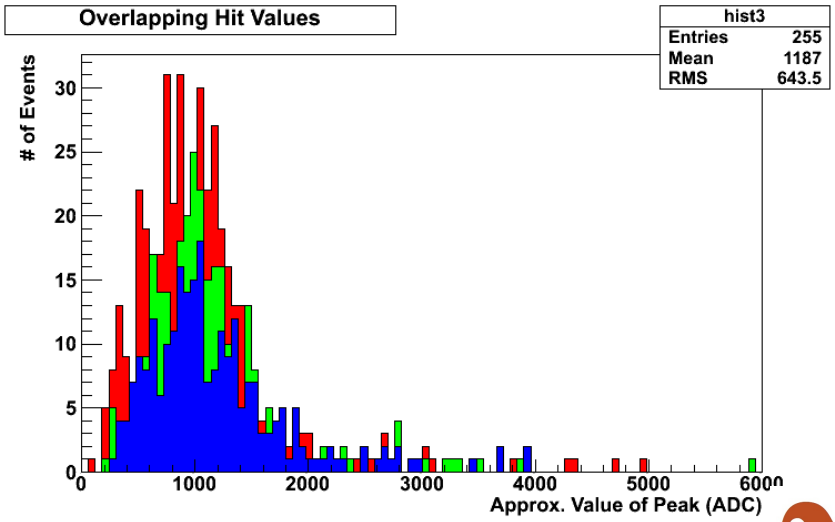
When a hit occurred the peak was immediately located. The are between this curve and pedestal were approximated by integrating. This integration represented the hit's ADC count/value, analogous to the energy deposited within the scintillator

ADC Values for any hit in every event

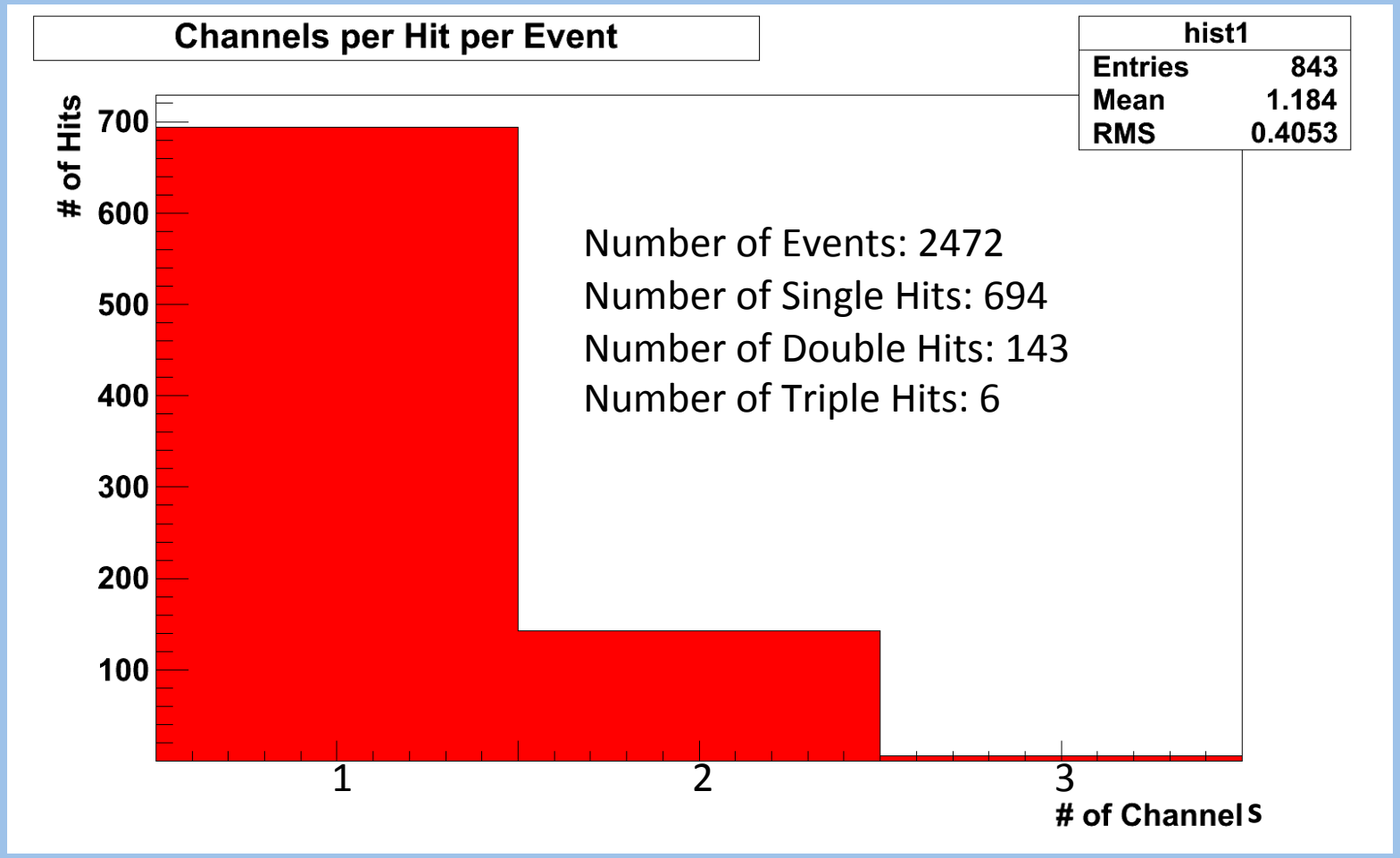




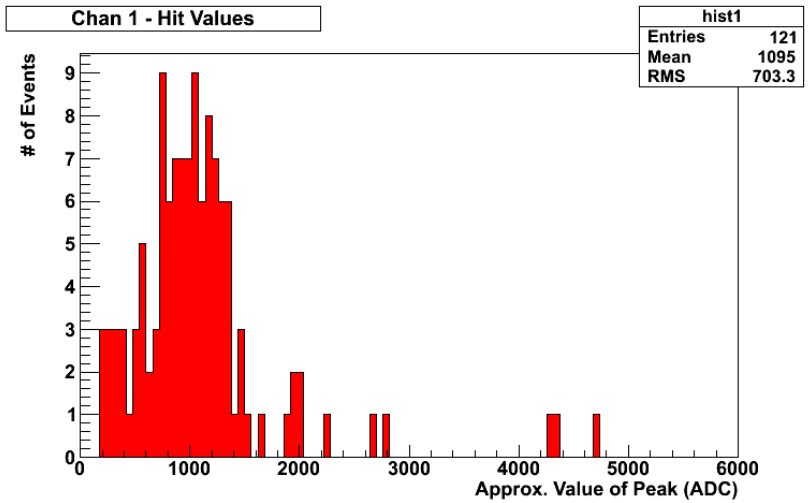


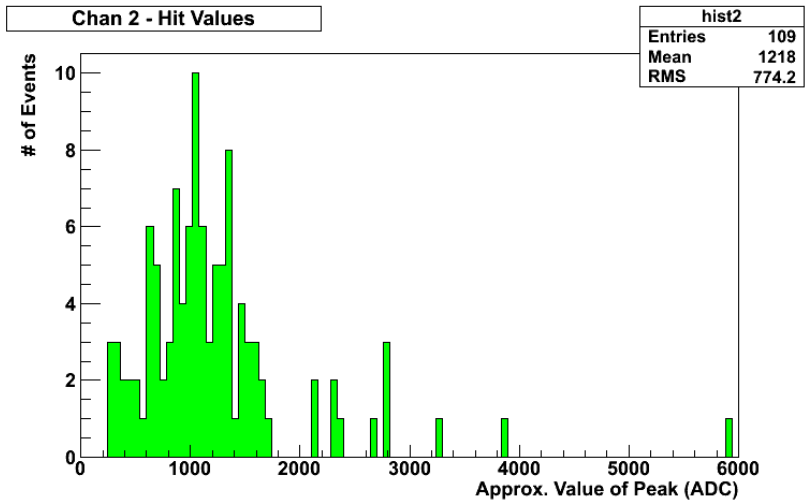


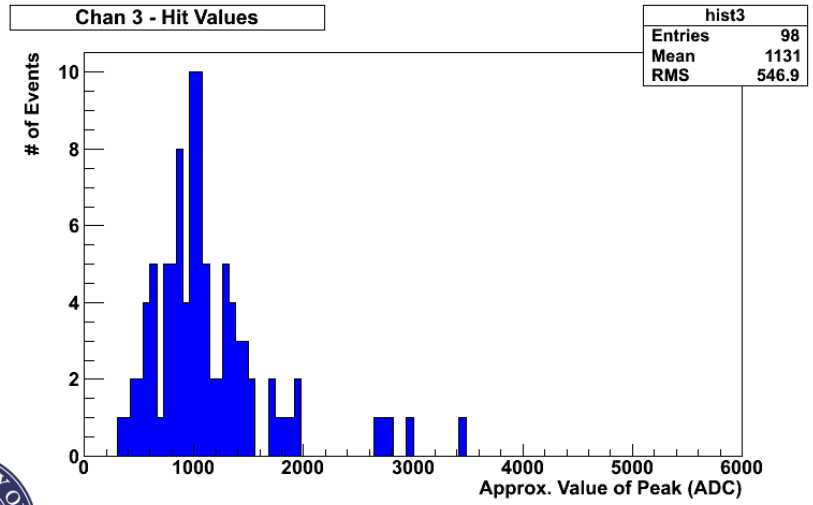
of Chan with a Hit per Event

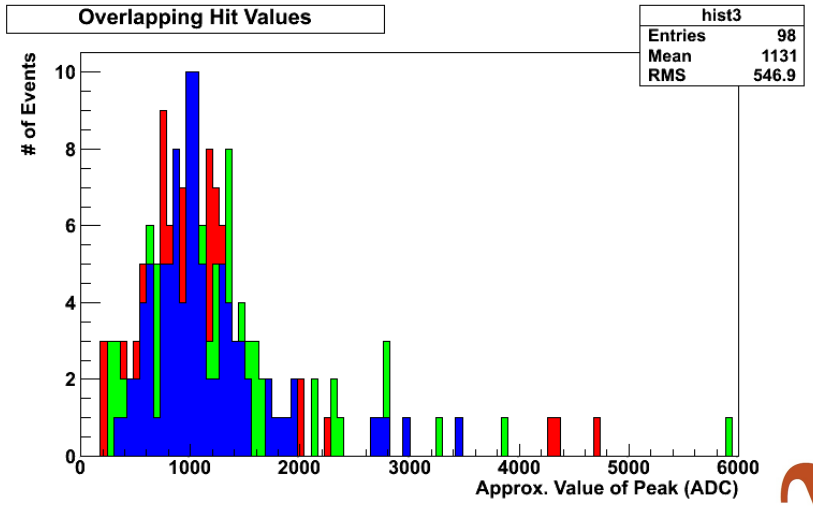


ADC Values for events with at least two channels with a hit

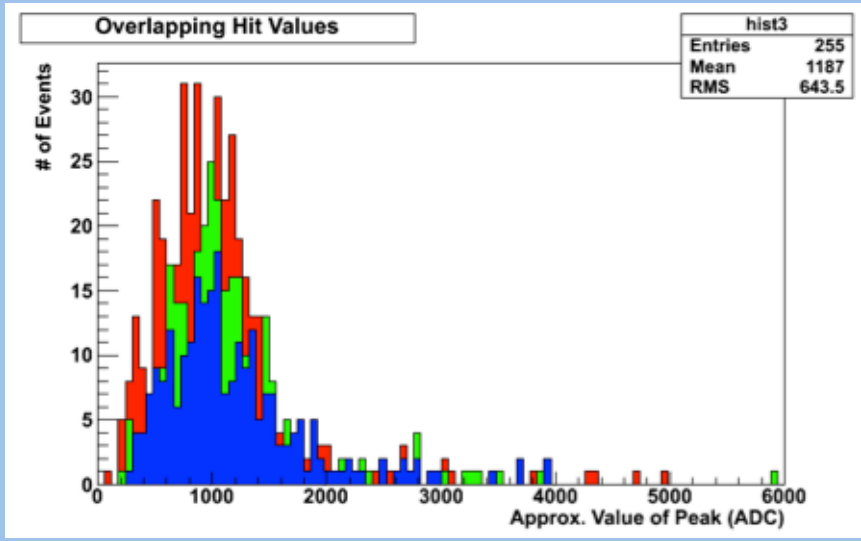




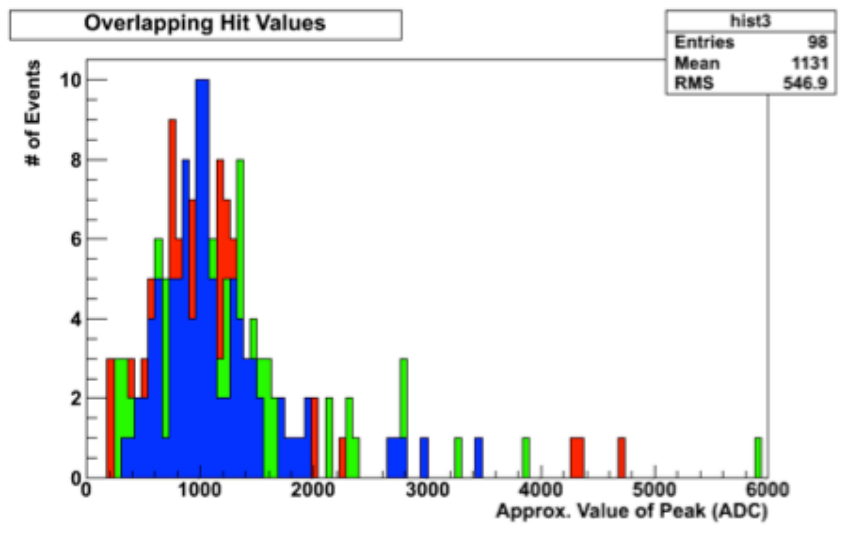




ADC values for any hit in every event



ADC values for hits in events with at least two hits



For coincidental hits, it cannot be the same gamma ionizing, so it must be correlated hits by separate yet similar particles. It could be random coincidence, but it is unlikely. It could also be a result of thermal neutrons/gammas from the generator or from background. From this analysis, it is uncertain.

Further Investigation

This was the first attempt to experimentally measure the sensitivity of the plastic scintillator to the neutron flux and there is still much to investigate. Such as:

- The composition of the hits (neutrons, gammas, ???)
- Determining the sensitivity to gammas, especially those produced from the neutron source.
- Looking into influences of thermal neutrons

Also, a test stand is currently being established at UVa's HEP building for the purpose of optimizing sensitivity to cosmic rays. It may be useful to place this detector in a beam environment at Fermilab where the neutron flux is well known to help further this sensitivity study.

Acknowledgements

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