Hall A SBS

GRINCH Gas Cherenkov Detector

Jack Jackson
William & Mary and the Super BigBite Collaboration

Overview

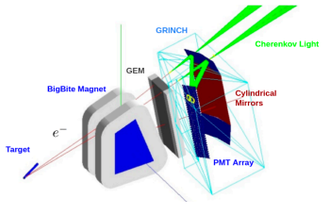
The **G**as **R**ing **I**magi**n**g **Ch**erenkov (GRINCH) is a heavy gas Cherenkov threshold detector used in the Hall A's Super BigBite Spectrometer series of experiments at Jefferson Lab. Used in tandem with the BigBite calorimeter, GRINCH purpose is particle identification, helping distinguish pions from electrons. Installed in Spring of 2021, GRINCH saw use in GMn, GEn-II, and GEn-RP. Included in this poster are a brief overview of the GRINCH, as well as some preliminary results in the GRINCH's use during GEn-II.

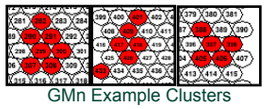
GRINCH Design

510 (29-mm) photomultiplier tubes (PMTs) in a honeycomb array

Heavy C_4F_8O gas 2.7 GeV Pion Threshold

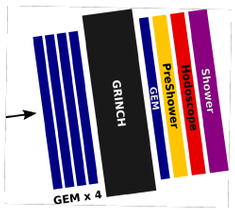
5 high-reflective cylindrical mirrors

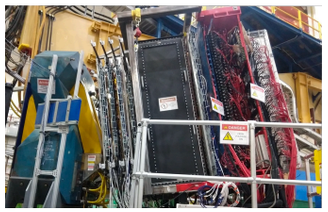




GMn Example Clusters

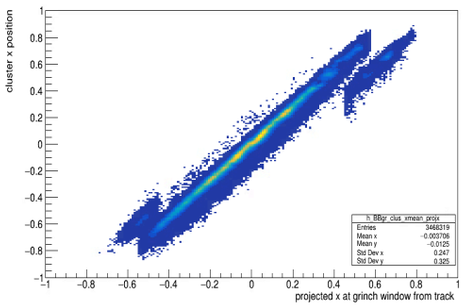
Electron events are detected in the GRINCH by clusters created by Cherenkov light cones as seen in phot-multiplier tubes (PMTs). When used in conjunction with other BigBite detectors, GRINCH allows for increased identification power of pions & electrons at the same momentum.





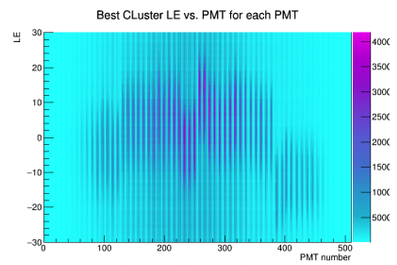
GRINCH Alignment

A quick check of clusters' x track potion (vertical) projected onto the face of GRINCH shows reasonable linear correlation for the center of the detector. The top and bottom mirrors exhibit similar behaviors to other experiments, but may need to be accounted for in the future.

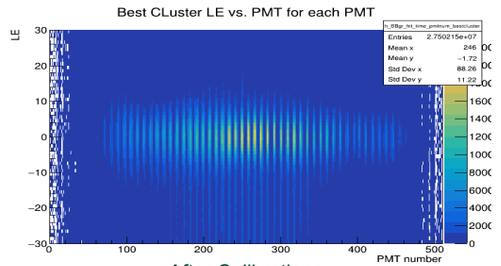


GRINCH Calibrations

Most hardware calibrations were done during the GRIINCH's commissioning before the GMn experiment. For GEn-II, leading edge (LE) calibrations needed to be done for each kinetic change.



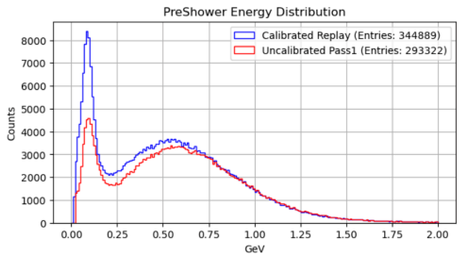
Before Calibrations

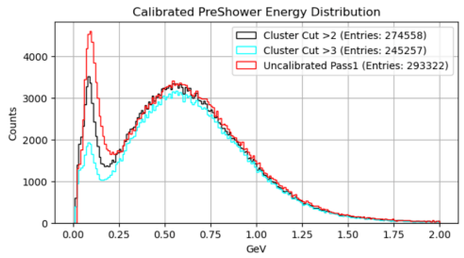


After Calibrations

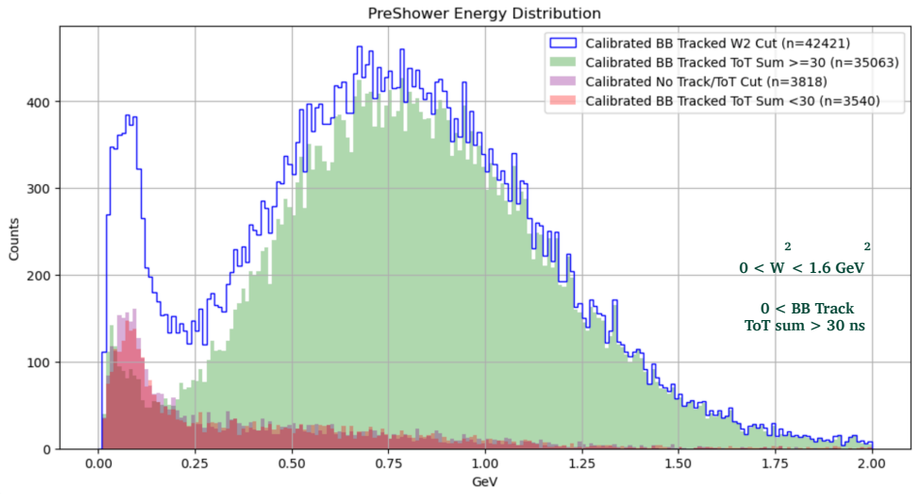
Data Analysis

LE calibrations lead to a raw gain of events (left). The next step is to compare data that passes cuts on the number of clusters fired in the GRINCH PMTs (right). Significant pion reduction occurs at the Cluster size>3 regime, which roughly corresponds to a ToT LE sum > 30 nanoseconds (ns). Data below from kinematic 2.

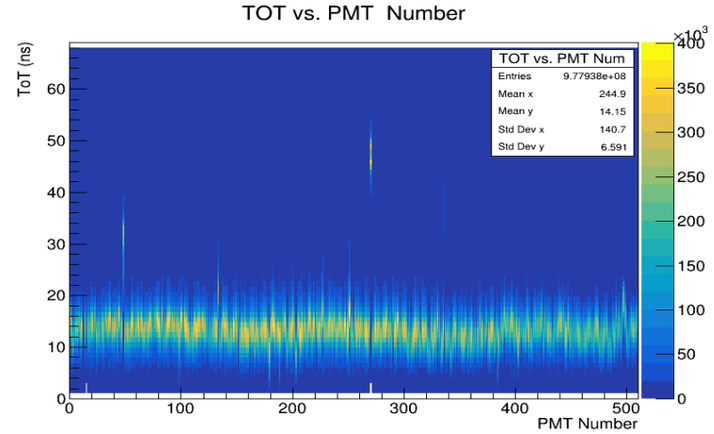




By making cuts on kinematic variables, we are able to begin to look at GRINCH pion rejection efficiency.



GRINCH Calibrations



The ToT for each PMT are fairly well aligned.

Coupled with the LE calibrations, we are able to use the ToT sum for observed clusters as an electron even selection (pion rejection).

Overview

GRNCH was designed and built specifically for the BigBite spectrometer in Hall A. During its use in the SBS experiments, the GRINCH successfully helped better distinguish between pions and electrons. Many calibrations done during GMn held, while kinematic specific calibrations were implemented for the GEn-II running. Analysis framework developed during both GMn & GEn-II are currently in use for both ongoing calibrations as well as detector performance.

Moving Forward

Full cut studies on ToT vs. Cluster size and how these values change physics statistics.

Find the pion rejection efficiency across all three kinematics.

Possibly use Monte Carlo simulation to check pion rejection efficiency.

Acknowledgments

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