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Calibration of ICARUS Detector Walls

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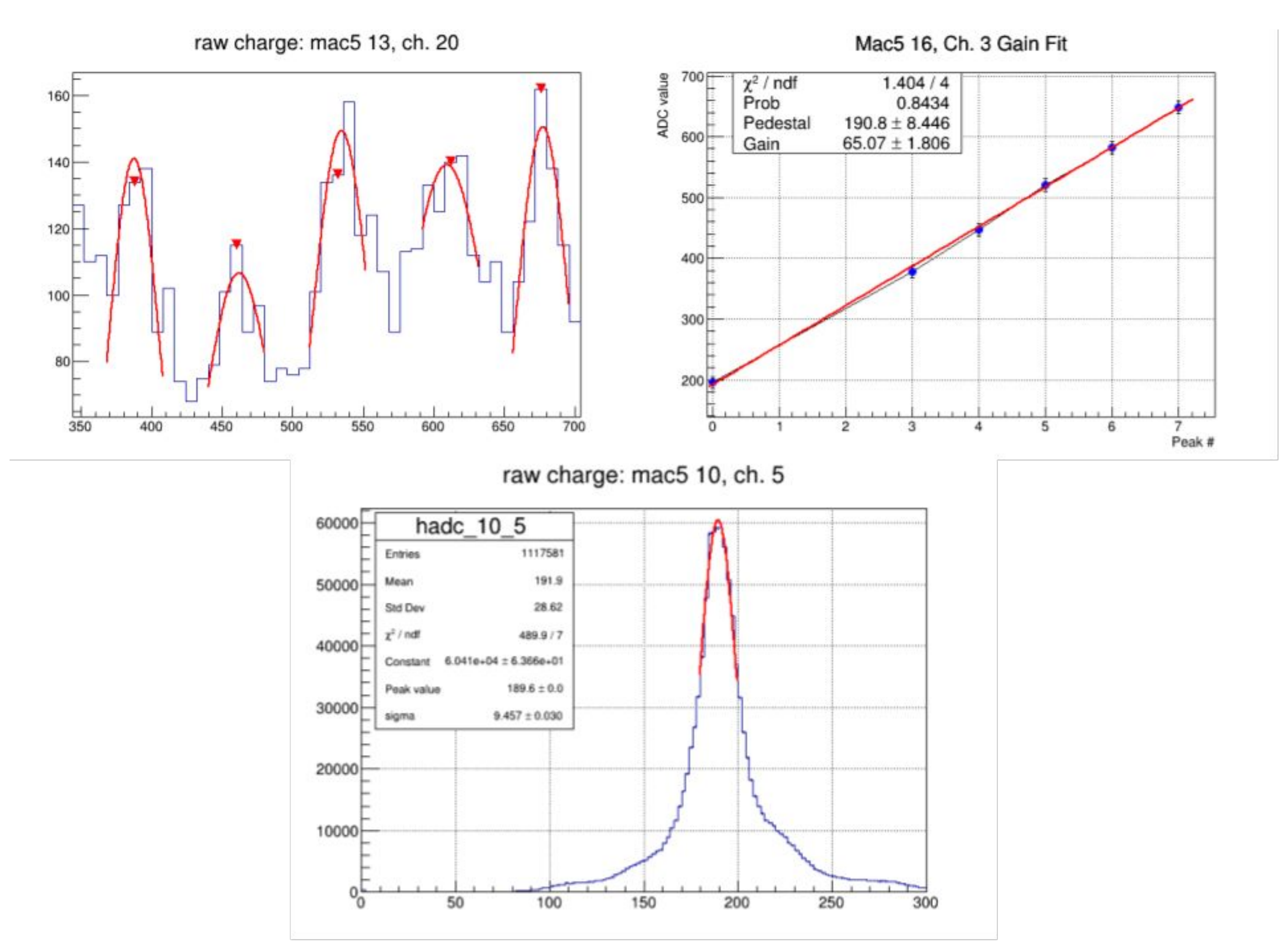
Abstract

Fermilab is working on shielding cosmic rays from entering the ICARUS detector using a Cosmic Ray Tagger (CRT). Calibrating this device is critical for the main goal of settling the dispute of the fourth neutrino. By analyzing the data collected by the different Front End Boards (FEB) of the detector, we were able to help with the calibration of this new detector. Our analysis provided information on the better suited FEB's, for CRT it was the center. It also provided better statistics when the bins from the plots were halved and when the machine we run for longer periods.

Data Analysis



- The above data is collected from detector runs and is derived from the Cosmic Ray Background.
- Top Left: Spectra fit is a simple histogram, the bin counts correlate to a photo charge detected as a current signal and converted to a digital signal.
- Top Right: The peaks created from the spectra fit are used to create a Linear fit, the y-intercept indicating the gain level for that channel.
- Bottom: The pedestal fit is a representation of the gain we see below and electrical noise

Introduction

- ICARUS is part of a new line of liquid argon time projection chambers intended to shield experimental data from background noise.
- CRT is still under calibration and is undergoing testing using Background Cosmic Rays for calibration purposes.
- Our objective: analyze the data taken from the different runs to assist Fermilab Researches with Calibration

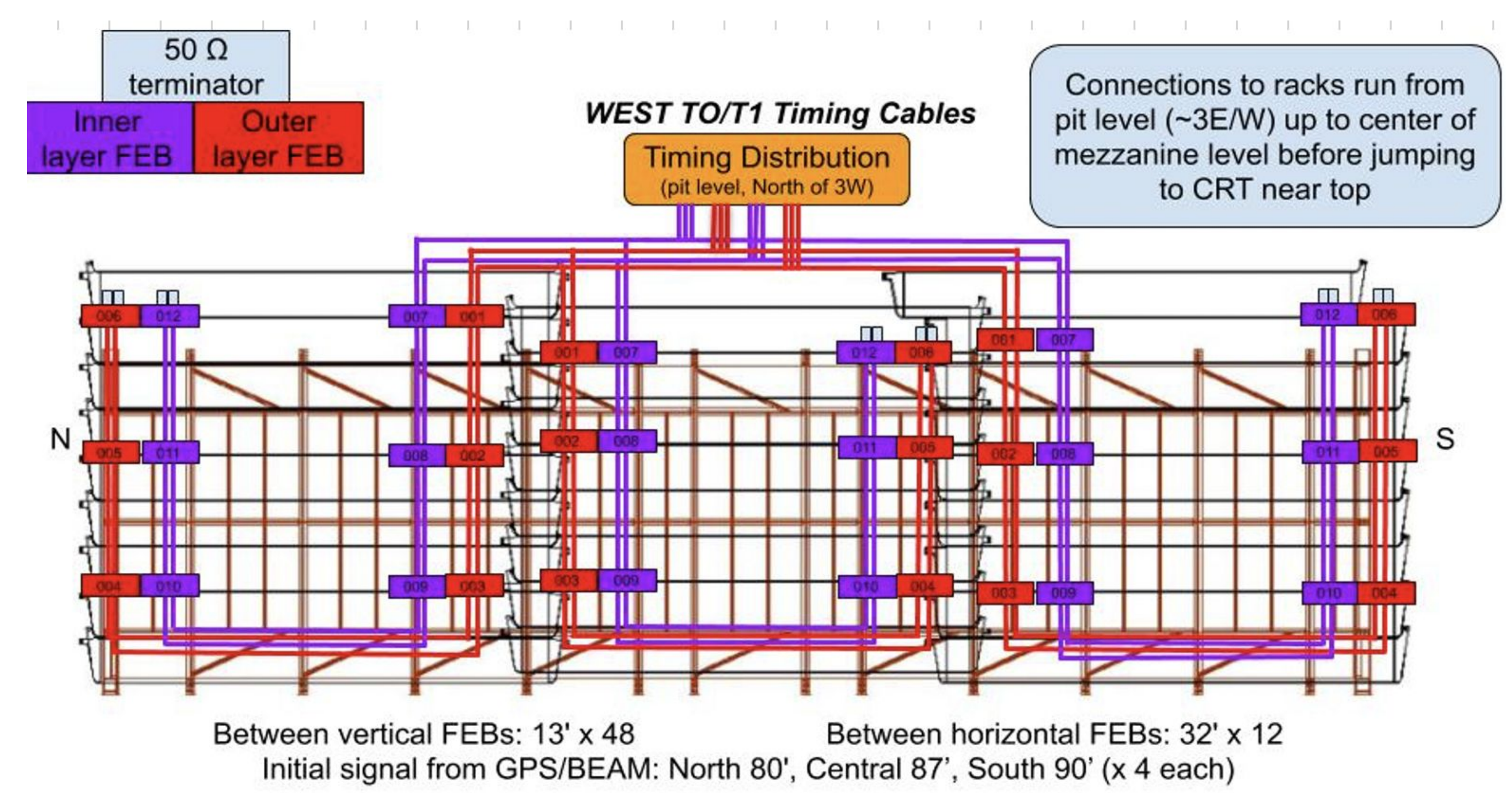
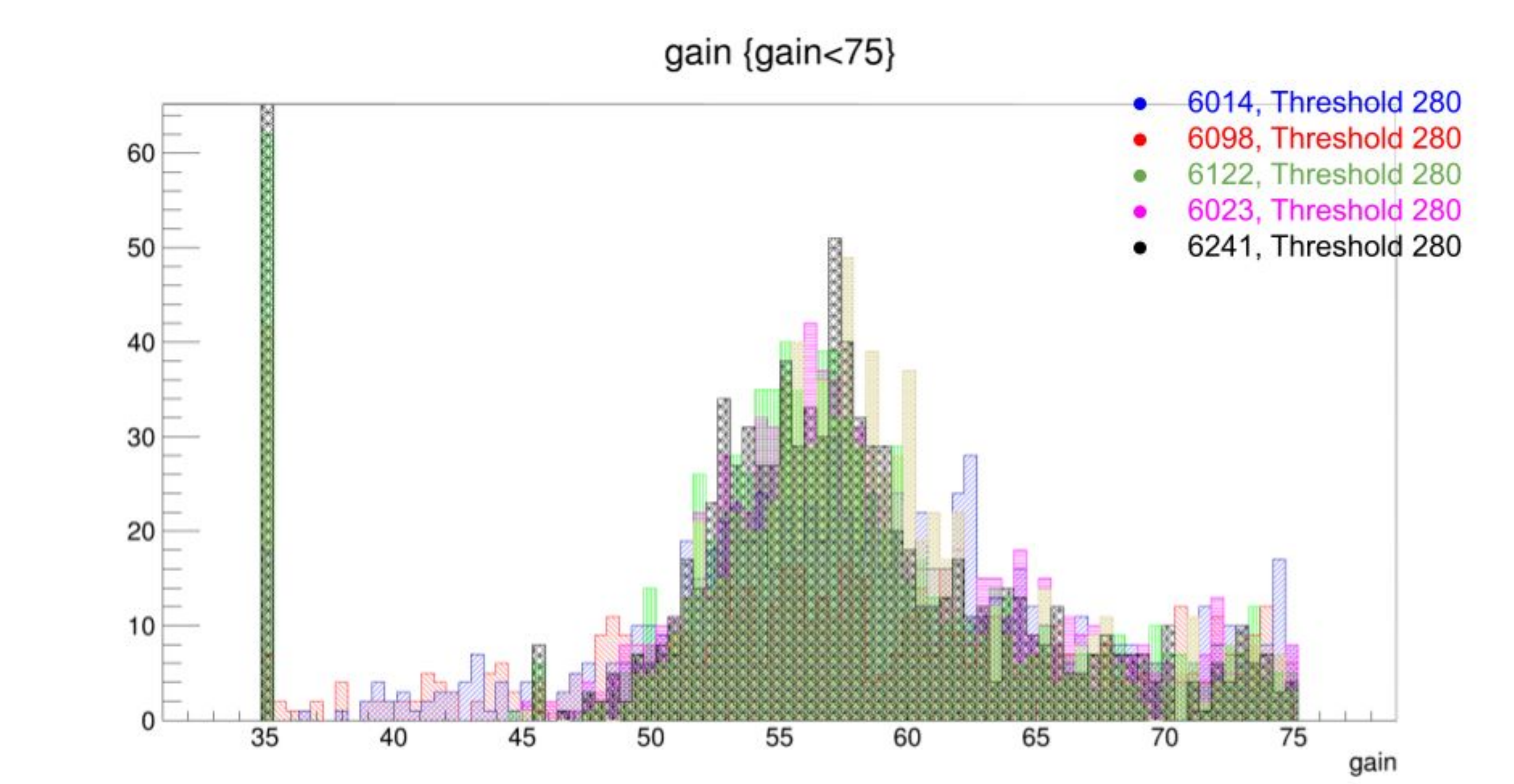


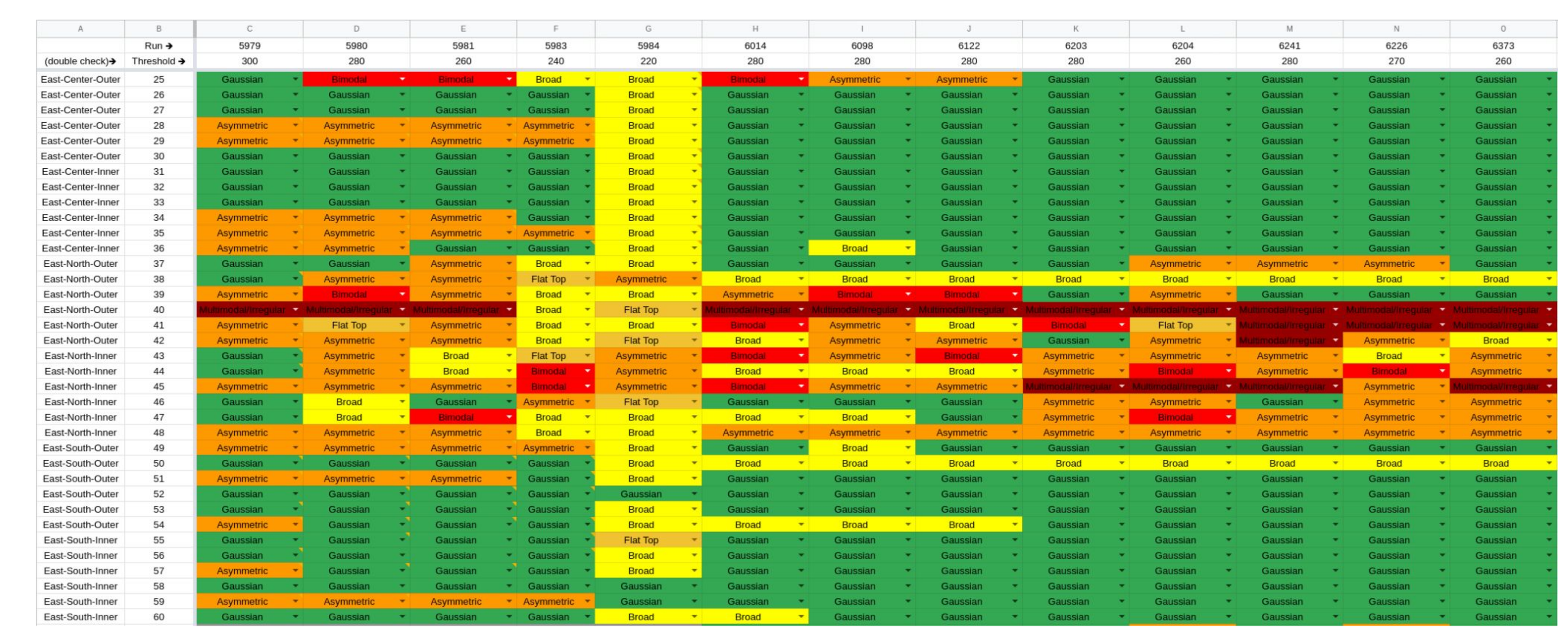
Diagram of West Detector Wall, FEBs are arranged into north, central, and south sections with inner and outer layers. The inner and outer layers are used for Time-Of-Flight (TOF) calculations, which allow researchers to reject unwanted environmental sources of cosmic rays/neutrinos



The above image is the overlaid gains from 6 different runs with a threshold of 280 ADC.As can be seen across the runs, there are commonalities in both mean and and in distribution. The heights of the various bins are due to the differing lengths of the runs. Some runs were performed over the course of 48 hours, and have far more statistics than shorter runs. An as-of-yet unresolved error has resulted in some hits being erroneously sorted into a bin at gain level 35.

Calibration

- Raw data is fed into a ROOT Script to generate histograms, allowing us to visually inspect the output from each FEB.
- The output from each FEB is used to measure gain and determine the performance of the FEB under different conditions
- This allowed us to identify various behavioral trends under different conditions to identify problems which can then be investigated further and then remedied.



The above image is a spreadsheet used for visualising the behaviors of various FEBs over the course of our participation in this project. Pedestal fits were categorized into one of a number of categories, and color coded according to the severity of their deviation from desired behavior.

Conclusion

- Center and Southern sections of the CRT detector provides the best datasets.
- Ideal threshold is at or near 280 ADC
- Adjustment of analysis scripts is necessary for fine tuning, particularly the implementation of the false-positive rejection algorithm.
- Runs of longer duration with higher statistics are necessary to address issues with accuracy.

References and Acknowledgments

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