SBND Electronics Data Analysis

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Outline

- Objective
- Background
  - LArTPC and test beam
  - Purity
- Purity Calculation
- Multi-Channel FFT and Waveform plotting framework
- Noise RMS Analysis
- Raw Digit Event Display
- Future work
- Conclusion

LArTPC

- Time Projection Chamber (TPC)
  - Filled with Liquid Argon
  - Two Planes
    - Collection and Induction
  - High electric field
  - Used at several detectors
    - SBND, MicroBooNE, Icarus, and DUNE

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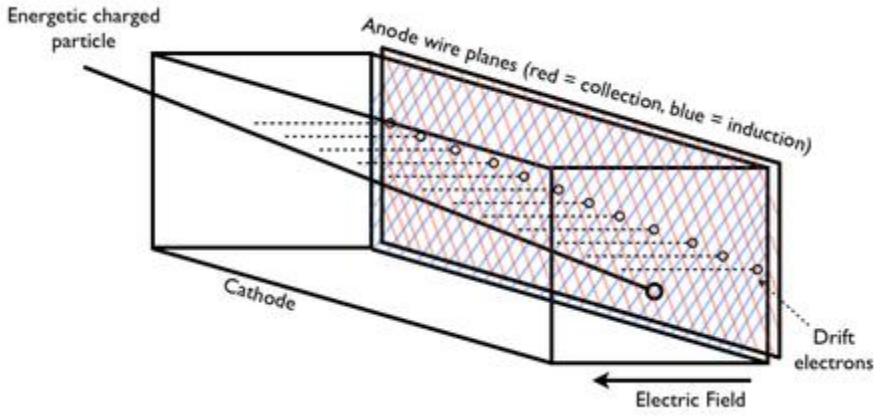

TPC at Fermilab Test Beam Facility (FTBF)

- FTBF used to test detectors with a beam of protons
  - Beam for this project was a mixture of protons, pions, and kaons
- Beam is pulsed
  - SBND TPC placed in Cryostat
  - Boards and wiring secured
- Data was collected for several days at a time
  - Cosmic muon data could also collected

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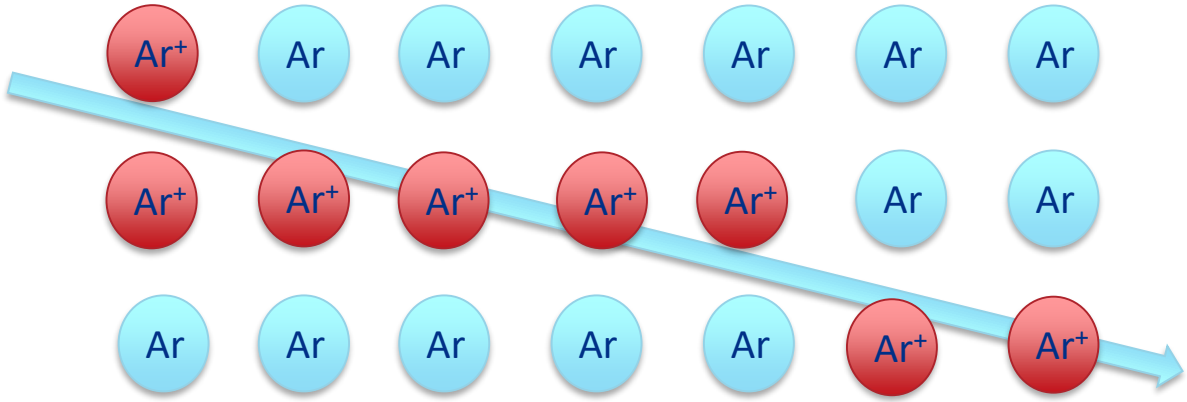
Purity Calculation

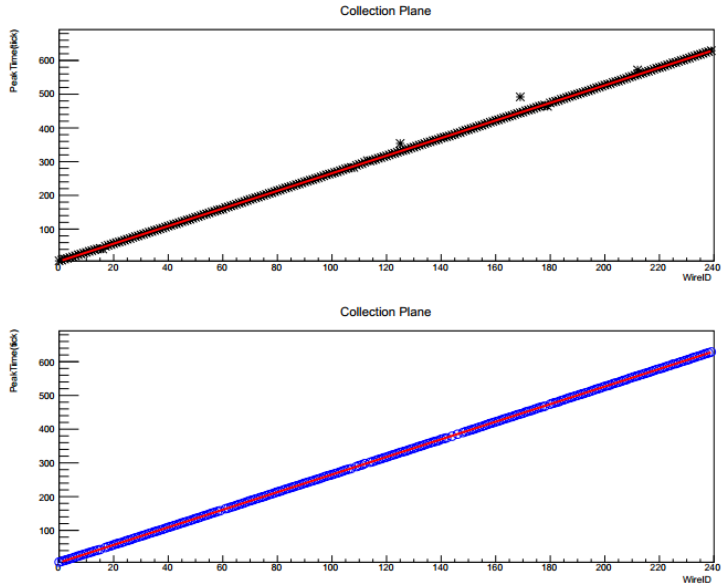
- Free electrons can easily travel through liquid Argon
  - Some get recaptured by Argon Ions
- Although a tank of pure Argon is ideal, it's not
  - Potential contamination during various filling and boiling phases
  - Innate contamination from source
- Electronegative contaminants capture free electrons
  - Oxygen, water, etc



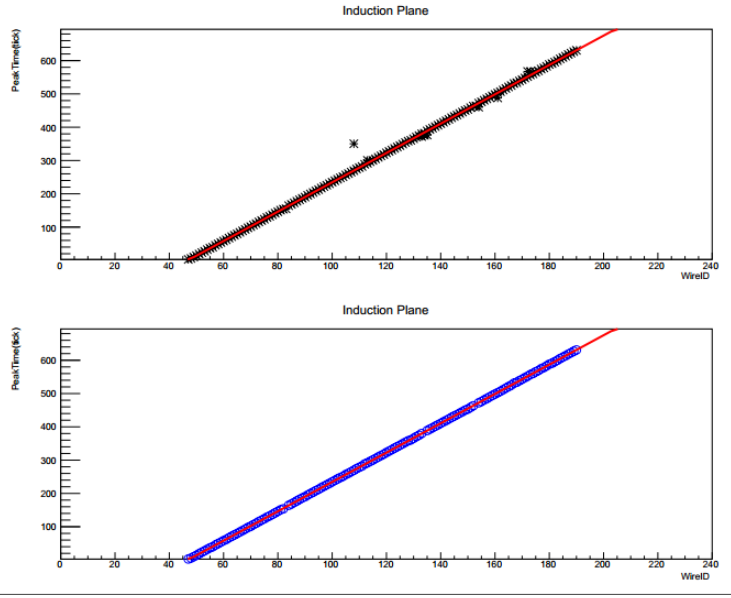
Purity Calculation

- Apply first cut on number of hits and unique wire numbers
  - Plot Peaktime vs wire number, acts as a track reconstruction
    - Induction and collection planes
  - Remove points farther than 2 ticks from fit line

Collection Plane

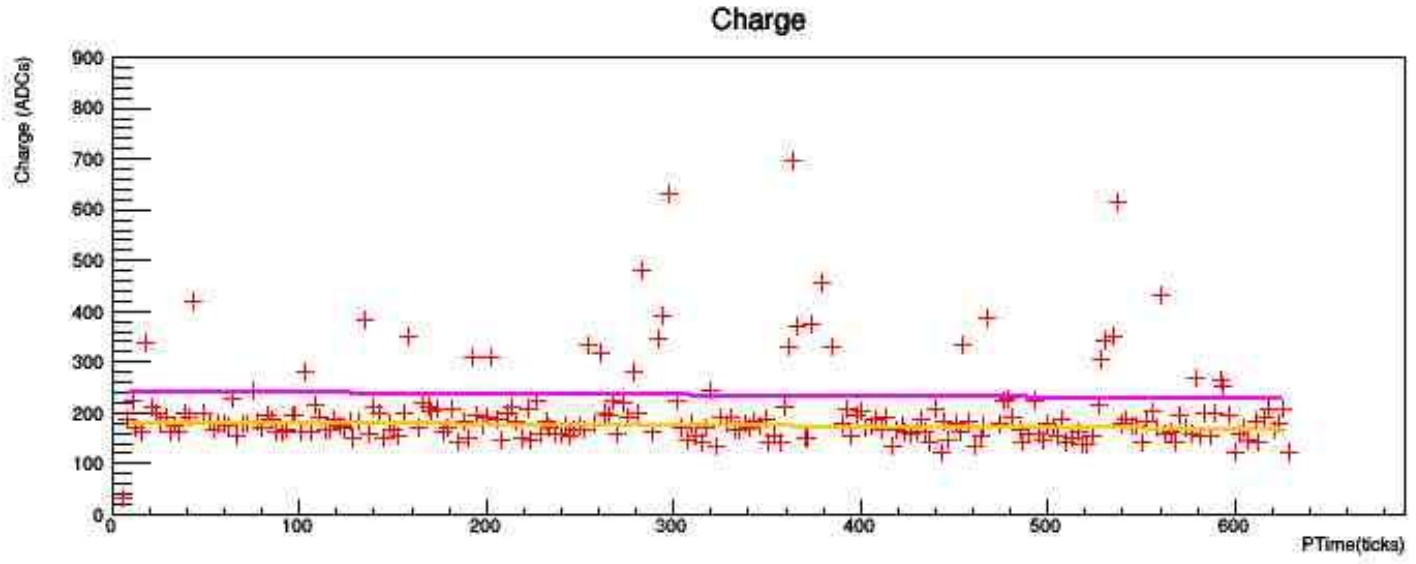


Induction Plane



Purity Calculation cont.

- Plot integral (charge) vs peak time
  - Fit with exponential, normalized based on geometry



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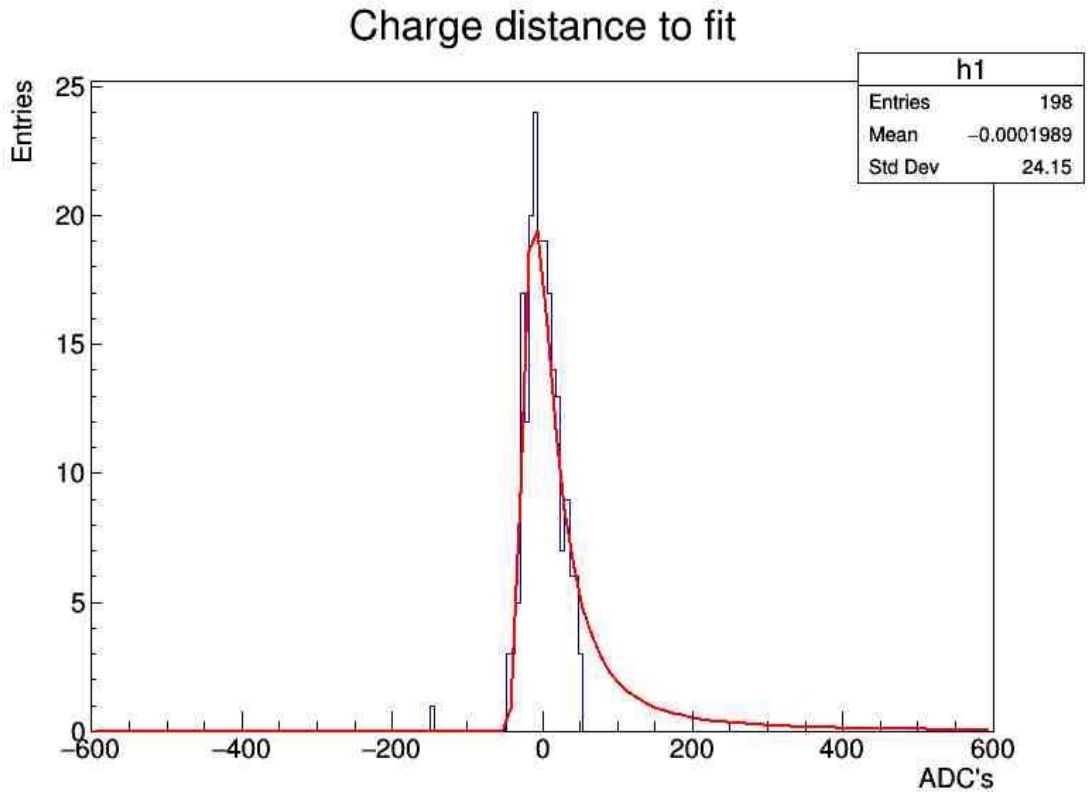
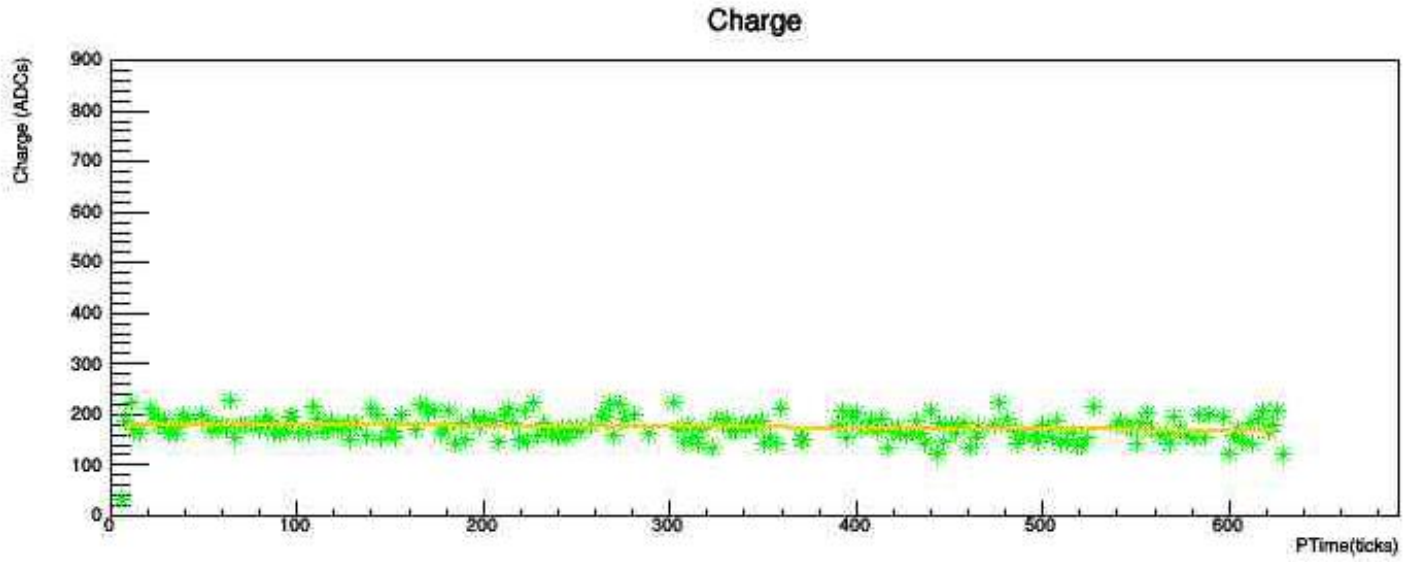
Purity Calculation cont.

- Create histogram of difference between fit and data
  - Fit with Landau function to get sigma



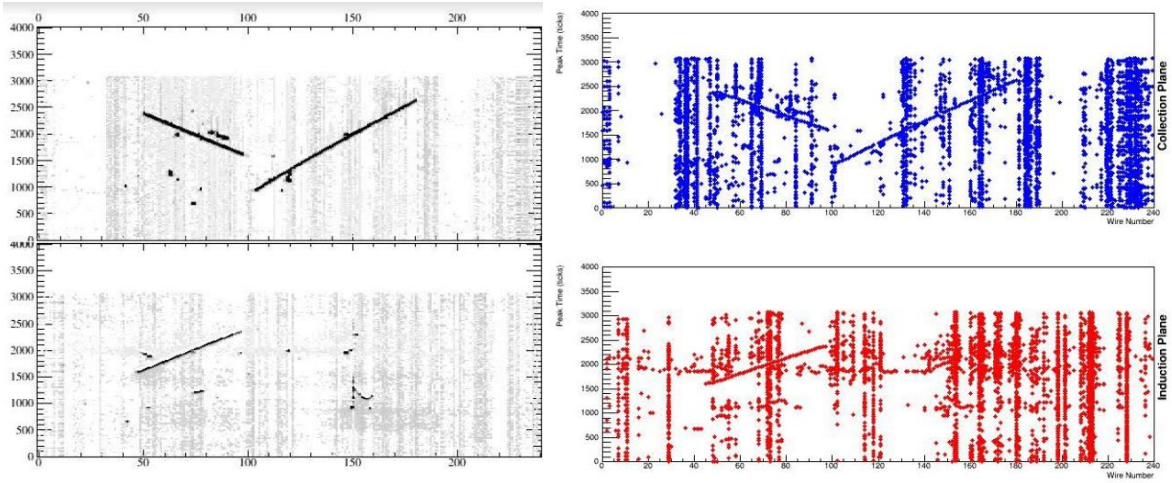
Purity Calculation cont.

- Refit with sigma cuts
  - Keep values and store into file that is used as input for a minimizer of a maximum likelihood estimator (MLE)
  - Lifetime is extracted



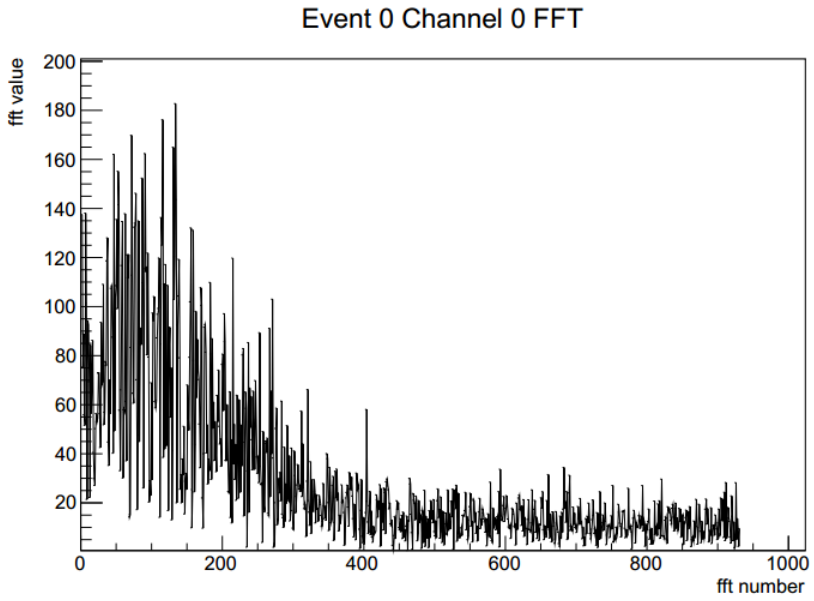
Event Display

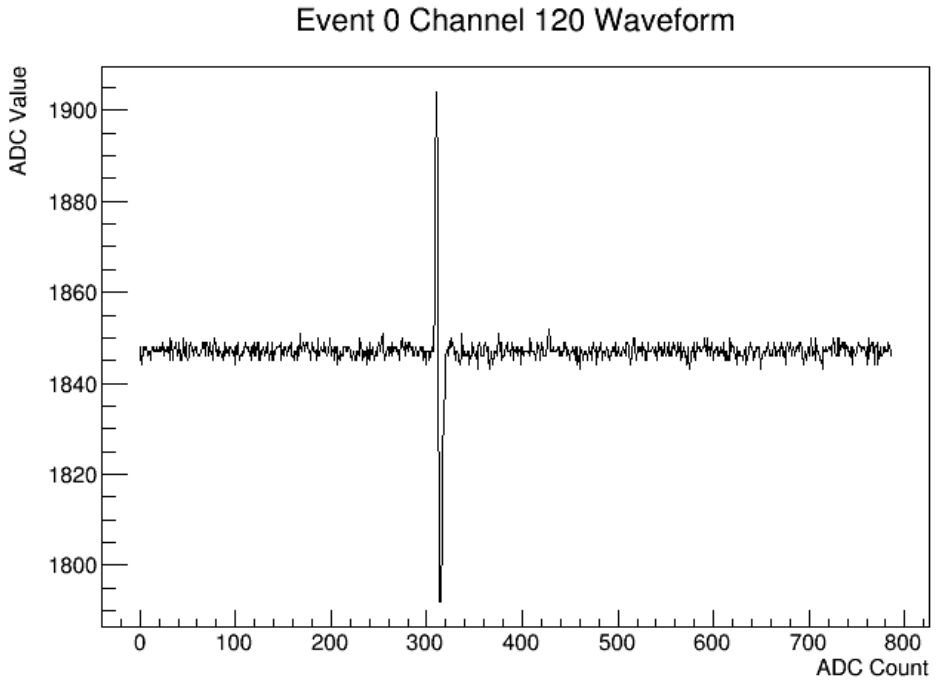
- Current event display works great
  - However, is loaded with features
  - Using for small checkups such as thresholds is slow
    - For changing Collection and Induction planes separately
- Created a fast Event display that uses the output of Purity.cc
  - “Lite version”
    - Fast and reliable



Multi-Channel Analysis

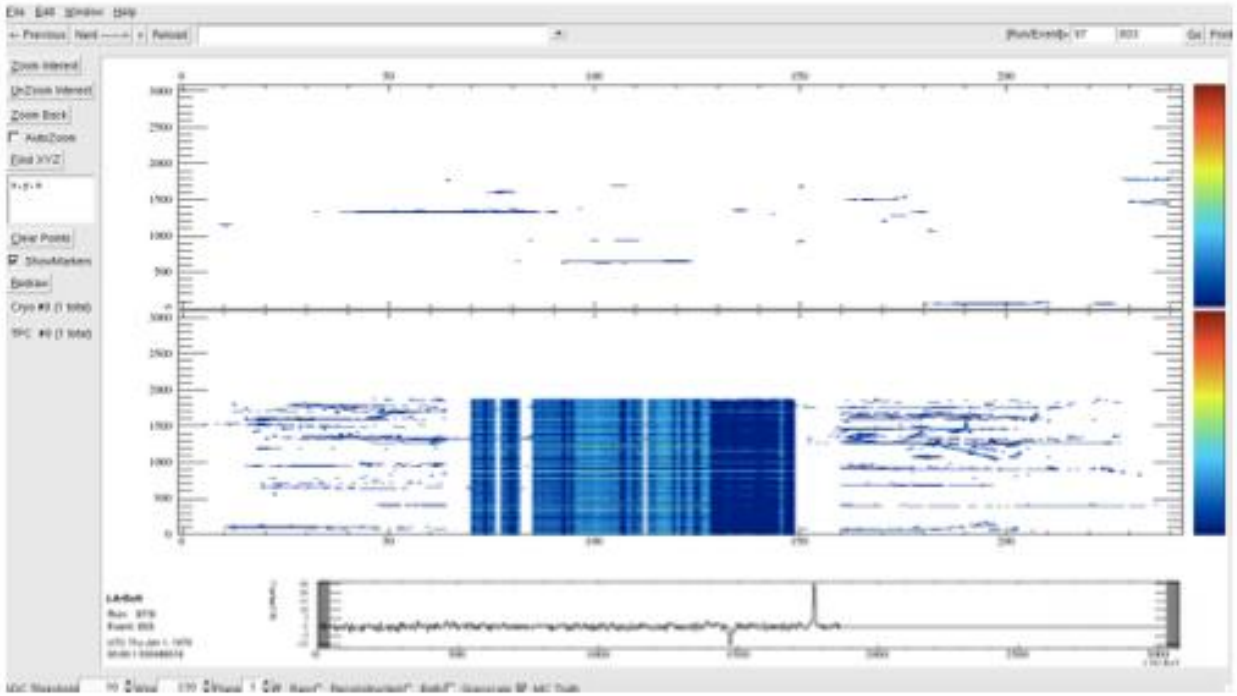
- Current Plotting scripts analysis works
  - However, per event and per channel basis
- Need a script to gather all of the channel data to analyze on an event basis
  - FFT and waveform plotting





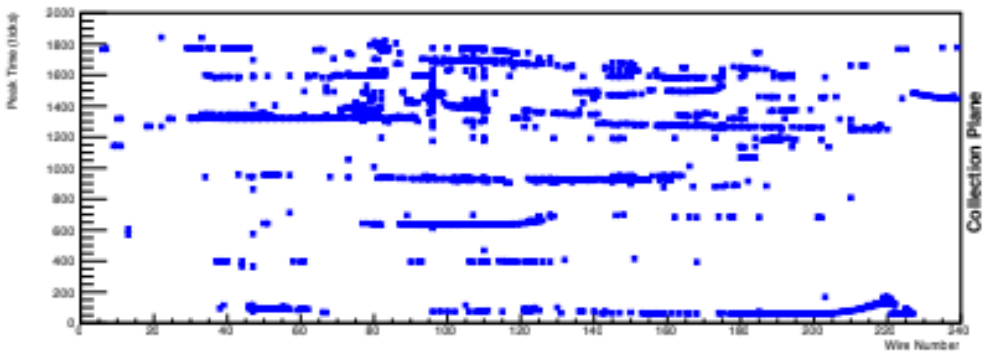
Data

- Data was not correct
- Malfunction in wires
  - Collection had inverted peaks
  - Induction had noisy wires and a broken motherboard

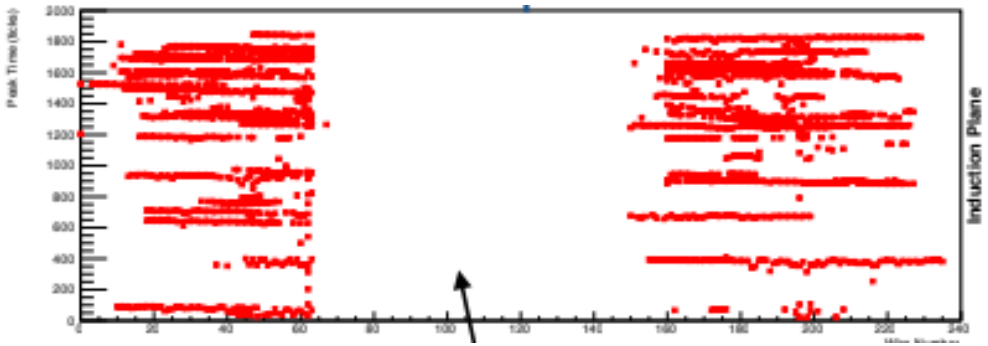


Data cont.

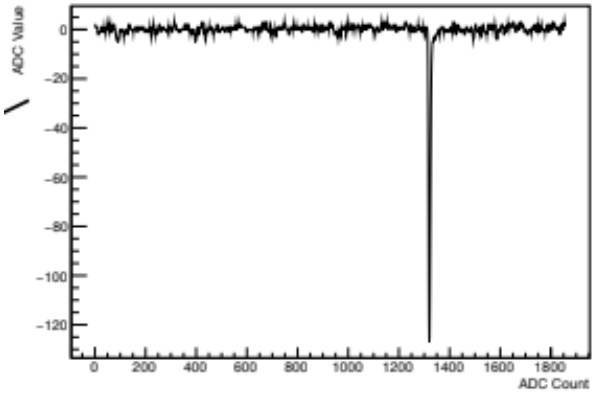
Collection Plane

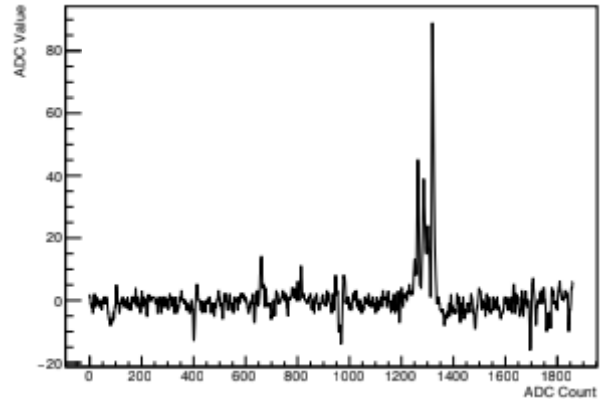


Induction Plane



Ignored because of high noise





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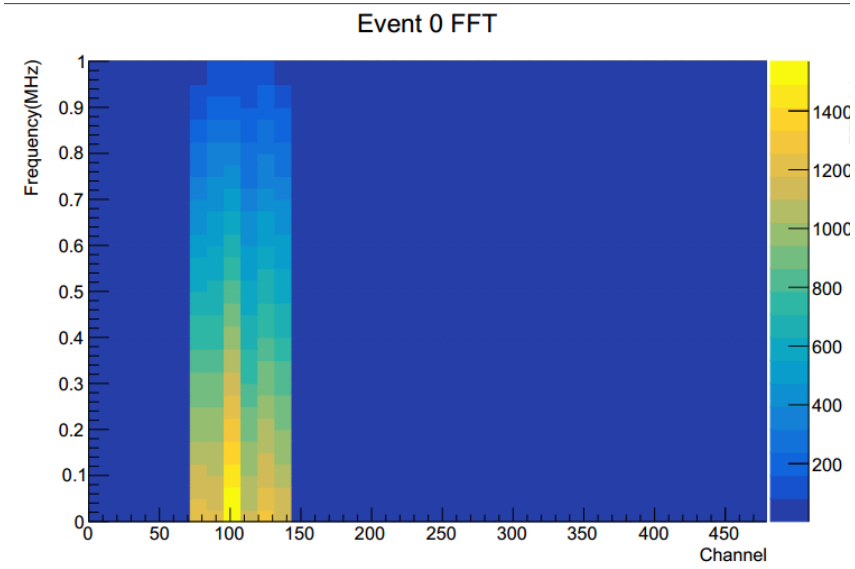
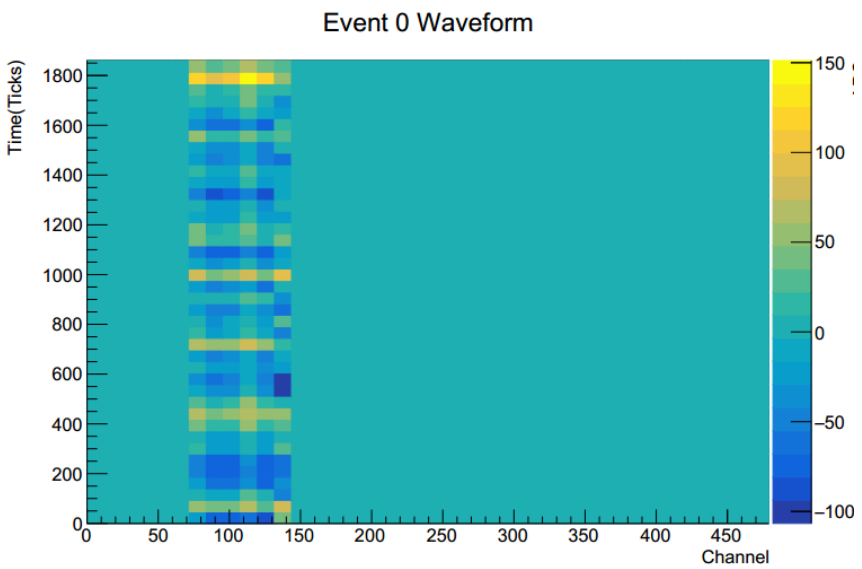
Multi-Channel Analysis cont.





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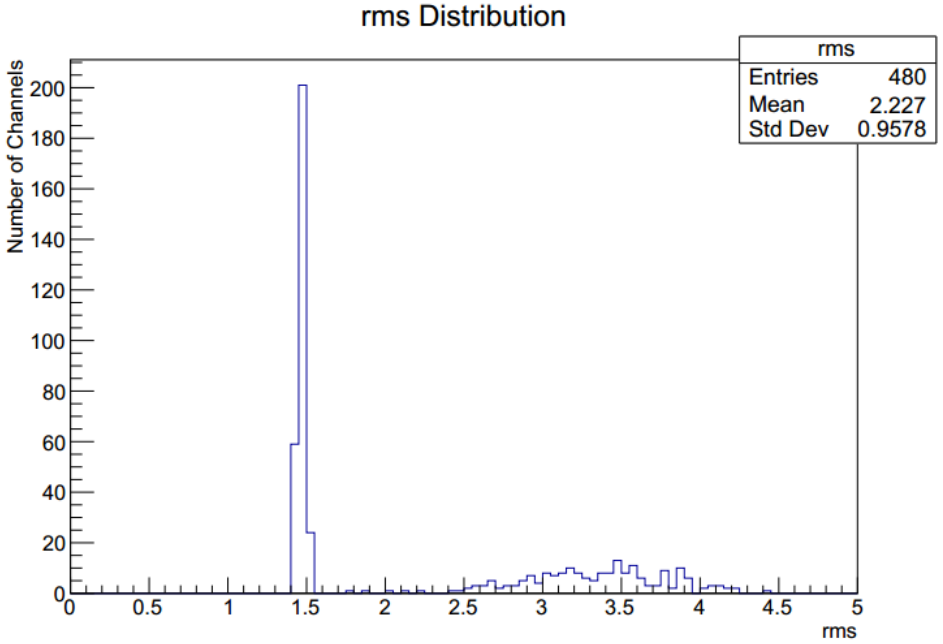
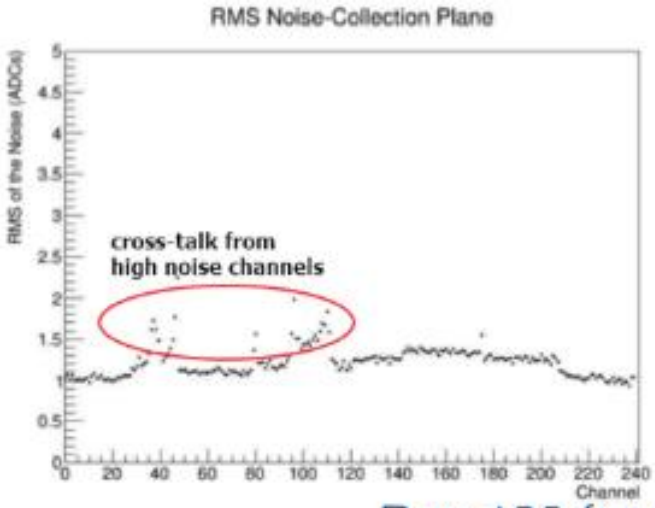
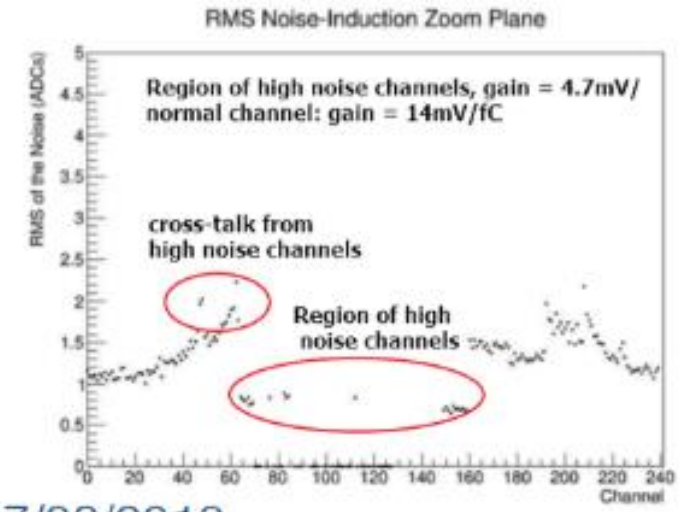
Noise RMS

- From the purity calculation, values away from the linear fit are used to calculate the RMS of the noise
- Currently exits on an event basis
  - Now averages over the entire set of events in a file
  - Induction and Collection plane are separate

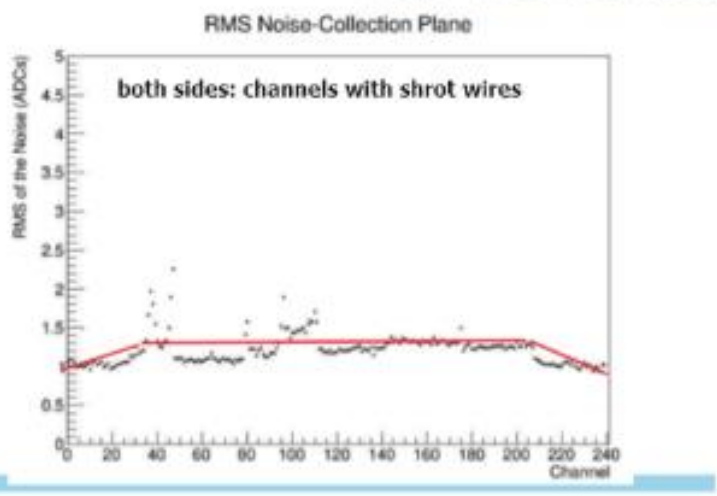


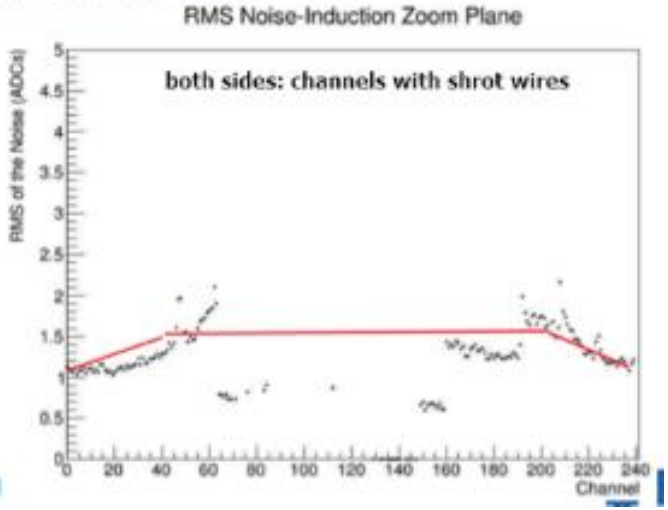
RMS Plots





Run 139 from 07/03/2018





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Results

- Purity is added to framework
  - Part of VST git repository
- Noise RMS is finished
  - Useful for analyzing the channels
    - Pinpointing bad channels
- FFT & Waveform vs Channel is finished
  - Part of VSTAnalysis git repository
- Event display is done
  - Operates as long as Purity.cc operates

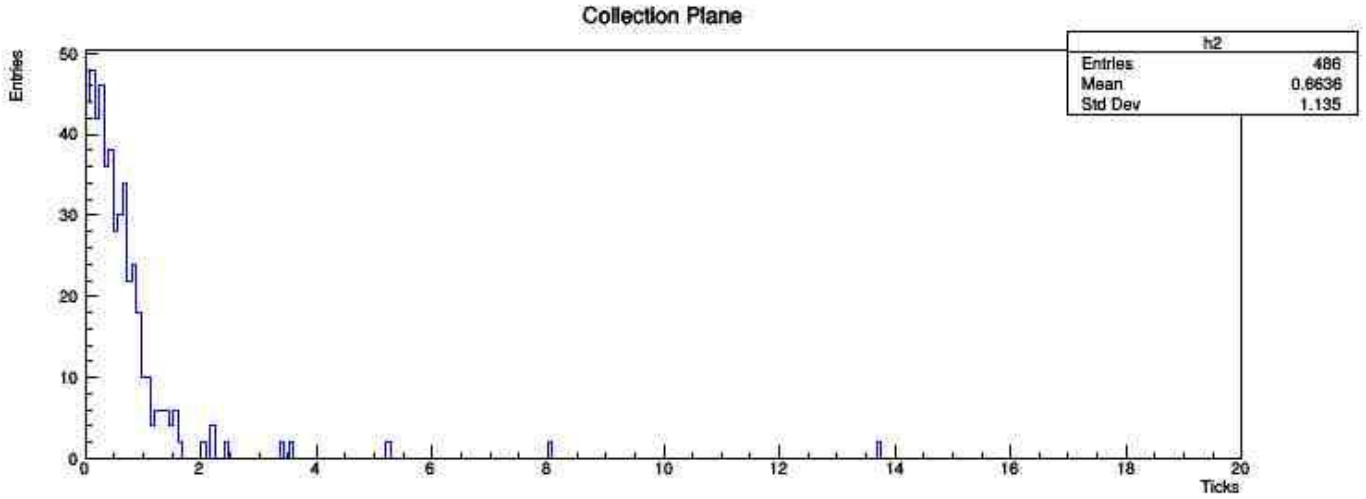
Future Work

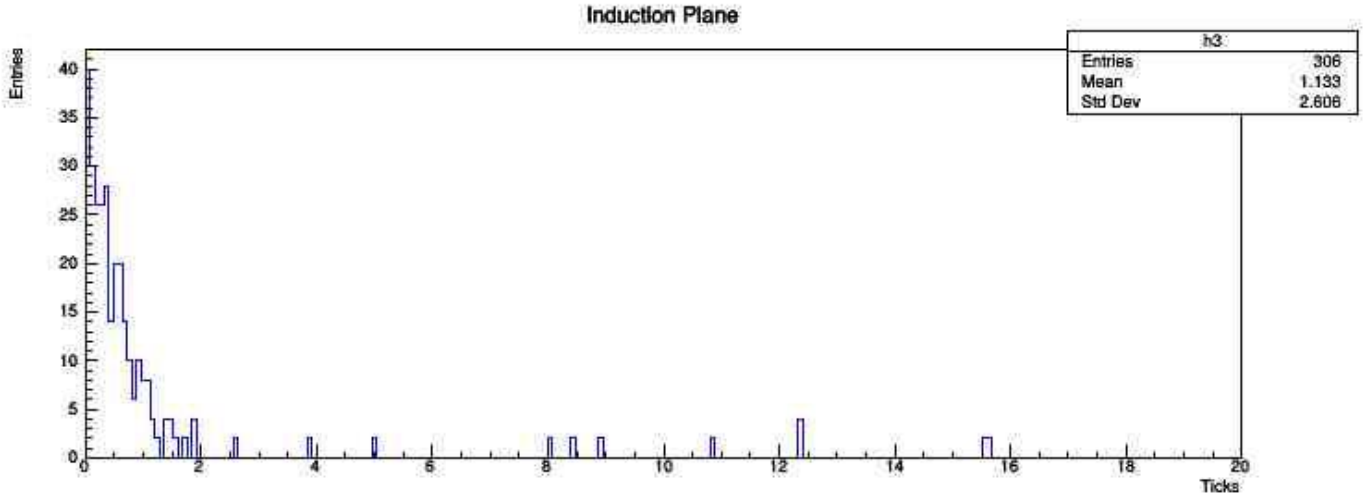
- Tune the Purity.cc code for data from simulation
  - Modifying “sigma” cuts
- RMS used to set threshold based on the event
  - To eliminate general settings
- Finalize a script for analyzing the general trend of lifetimes

Acknowledgments

- I would like to thank the following people for their patience and help as they were always available to answer my many questions.
  - Minerba, Gray, Thomas, Dominic
- Thank you to my Fermilab mentors for helping me with general work at Fermi and with my education path
  - Donovan, Javier, and Elliot
- Finally, I would also like to thank Fermilab and the SIST committee, for such an amazing summer experience
  - Sandra, Judy, Laura

Distance from linear fit





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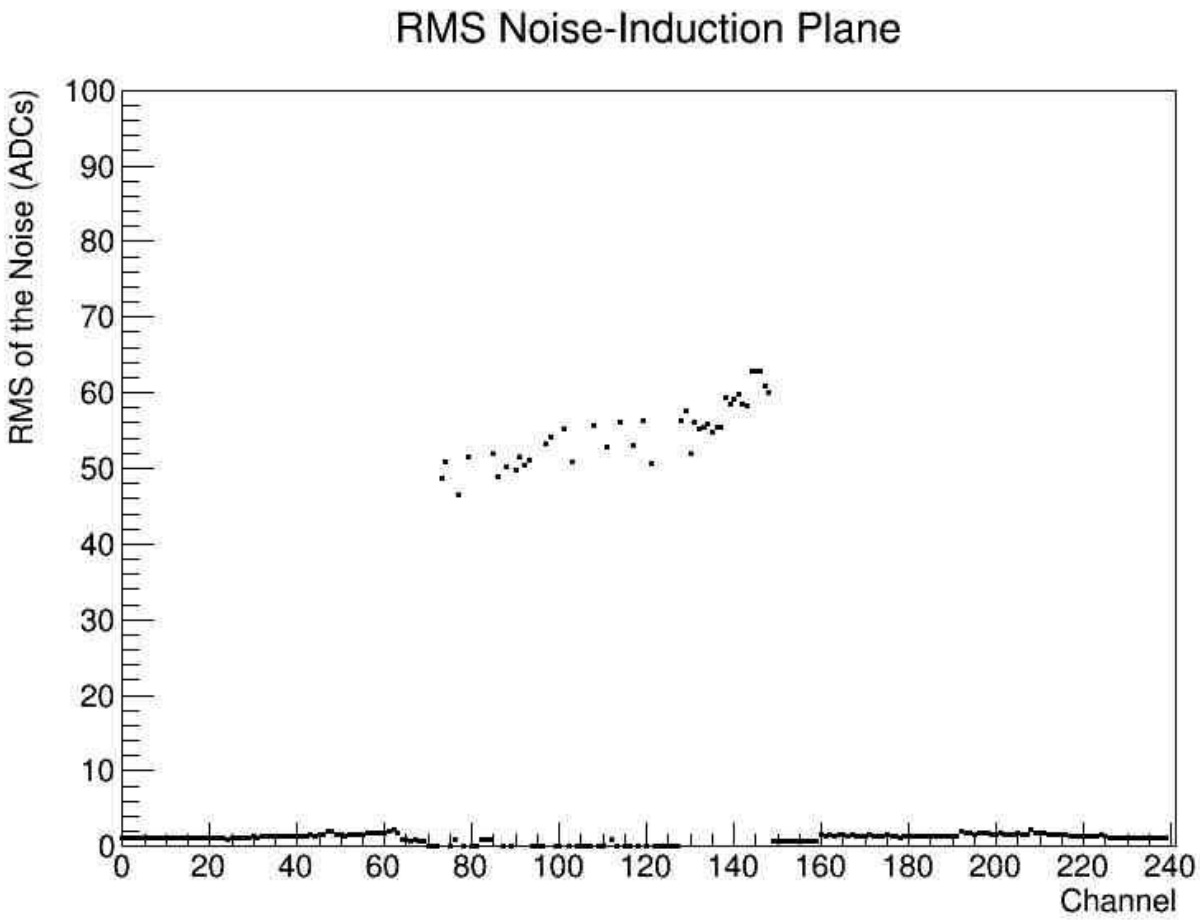
Data Induction Plane Noise



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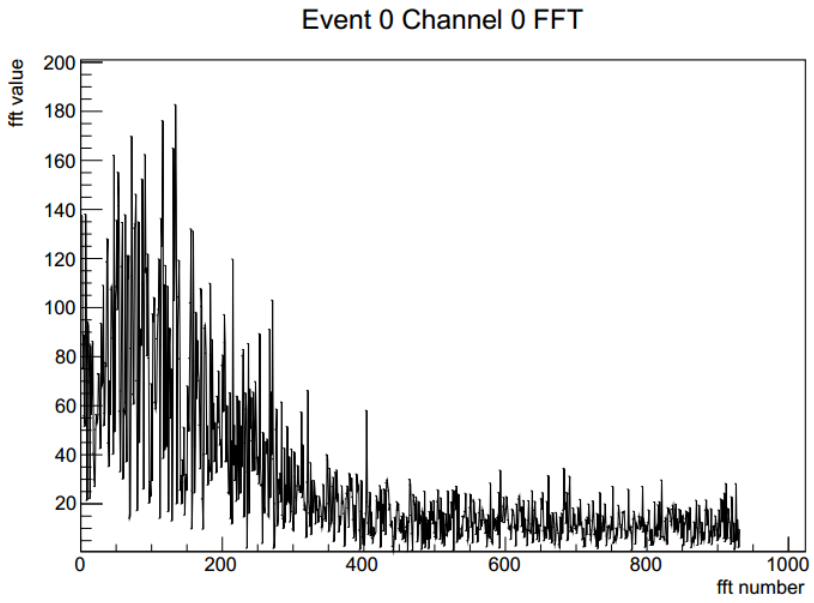
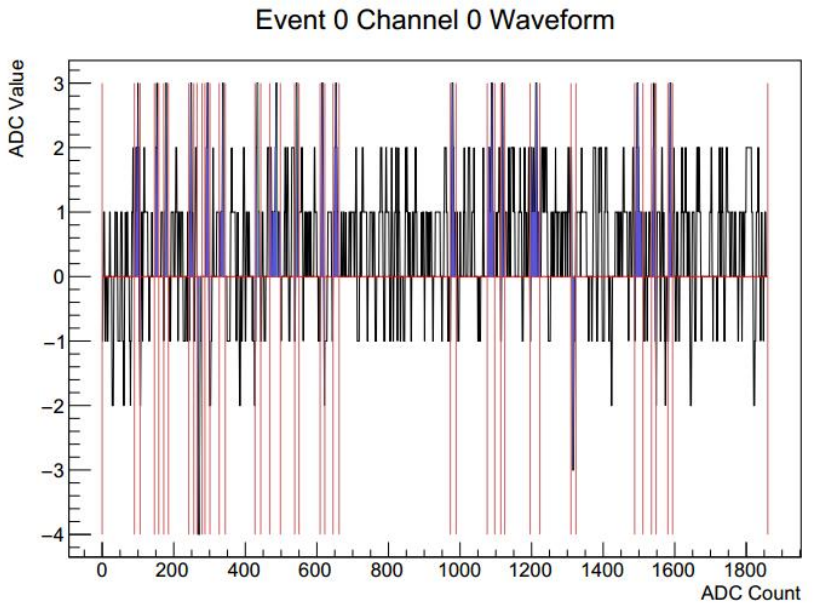
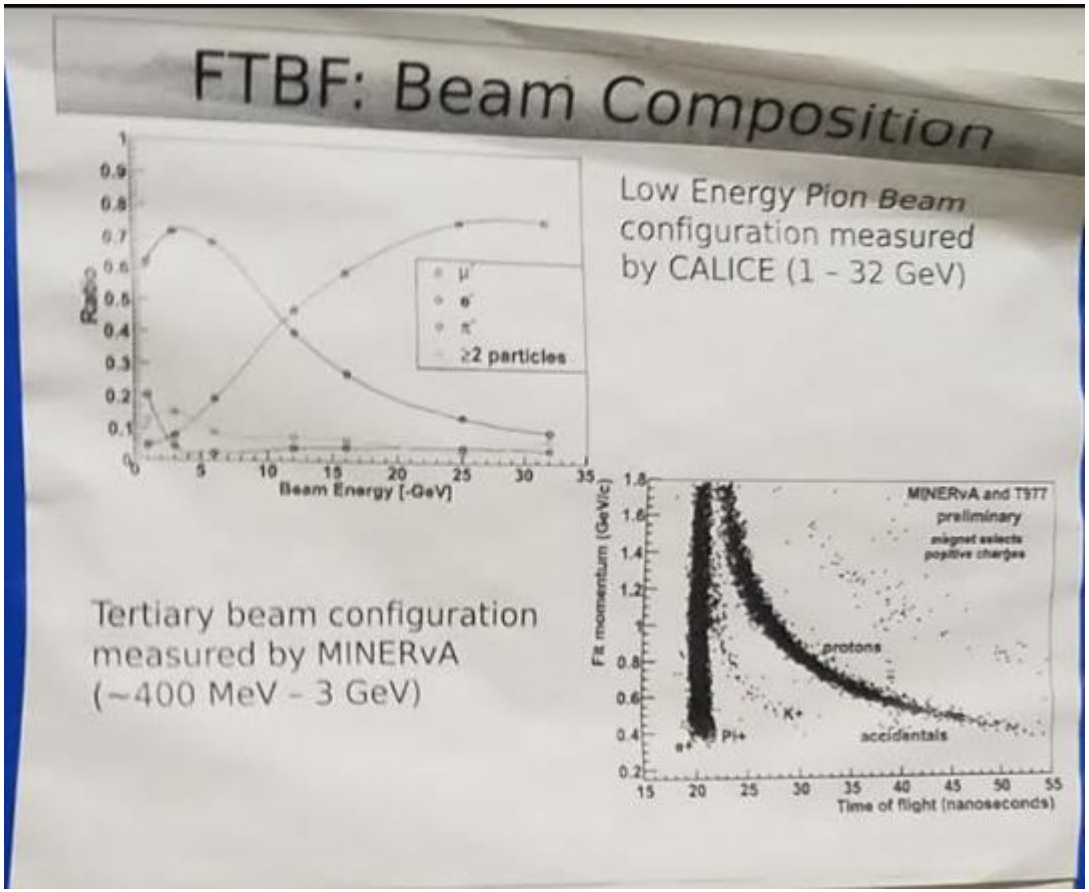
Data analysis





Beam Composition



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