
CHARGE CALIBRATIONS OF THE HELIX TIME-OF-FLIGHT SYSTEM

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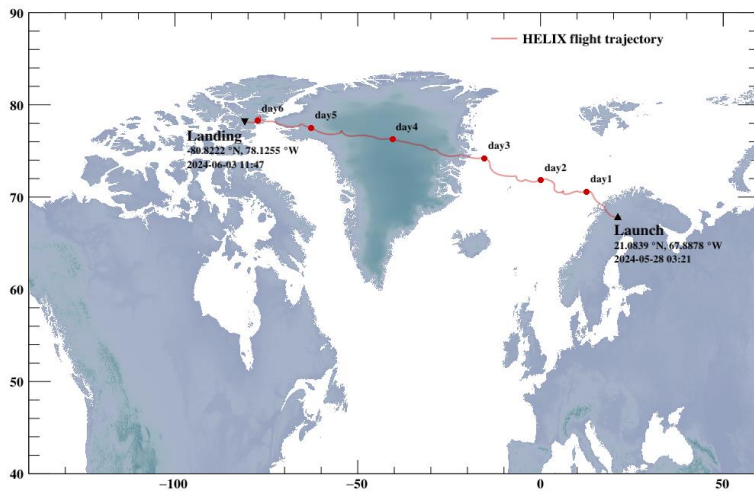
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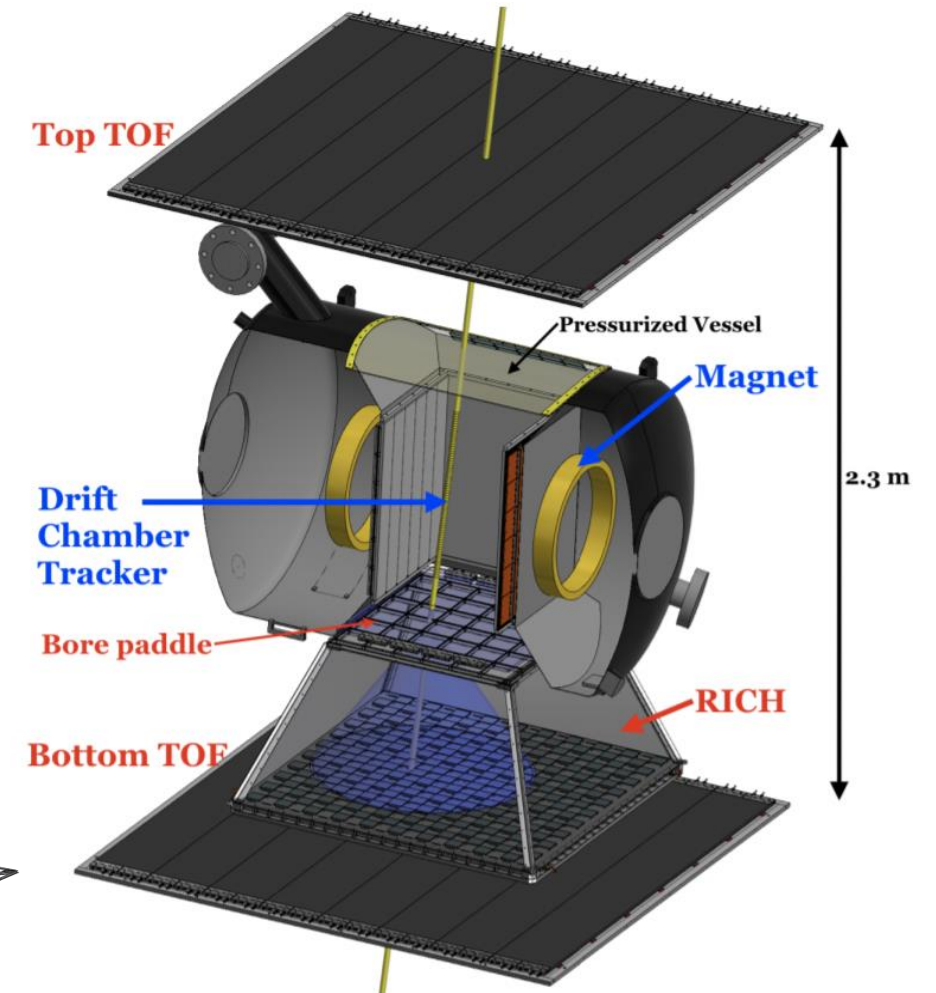
HIGH ENERGY LIGHT ISOTOPE EXPERIMENT (HELIX)

- Multi-phase **balloon-borne** experiment
- Measure **isotopic abundance of cosmic rays** of 0.2-10 GeV/n
- ≈ 6.3 day flight in 2024



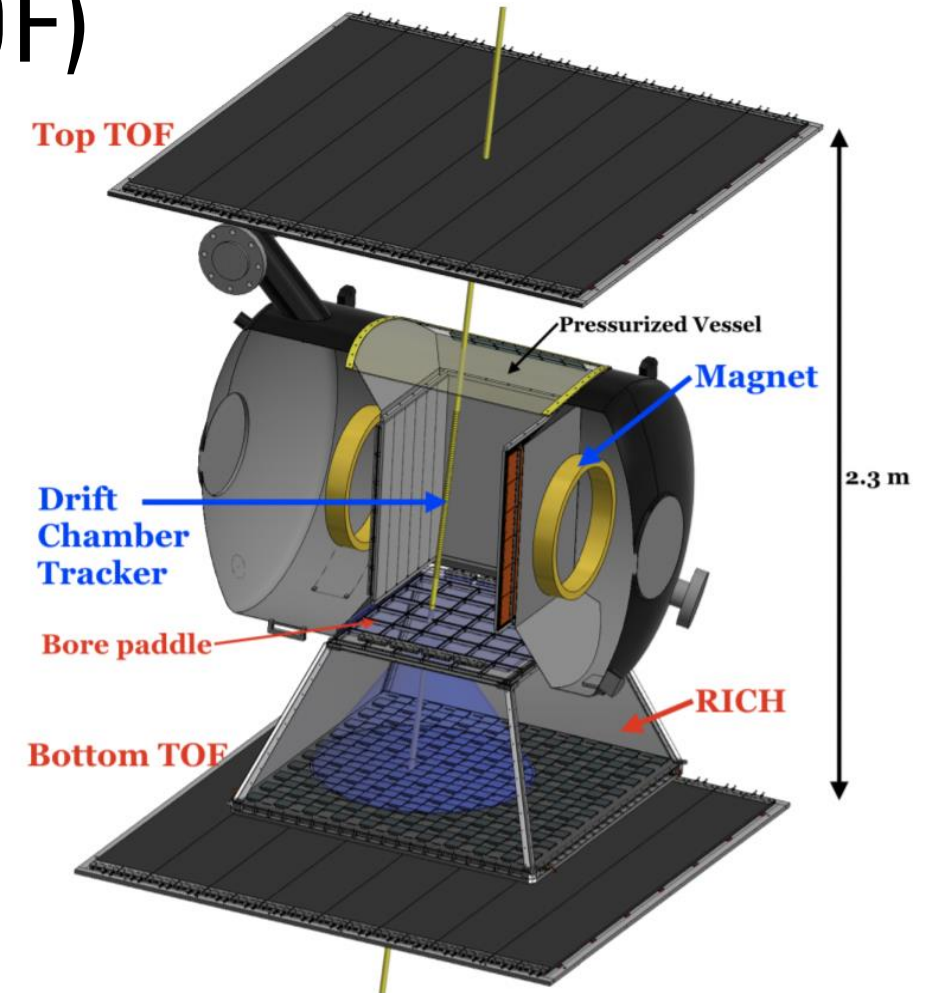
HELIX SUBDETECTORS

- **D**rift **C**hamber **T**racker (DCT)
- **T**ime-**o**f-**F**light (TOF)
- **R**ing **I**maging **C**herenkov (RICH) detector



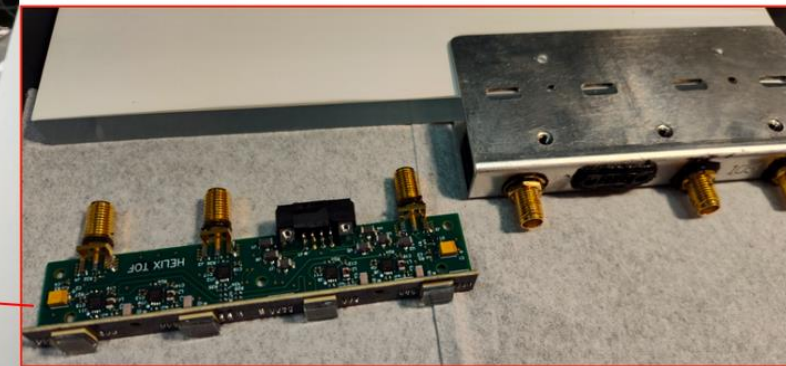
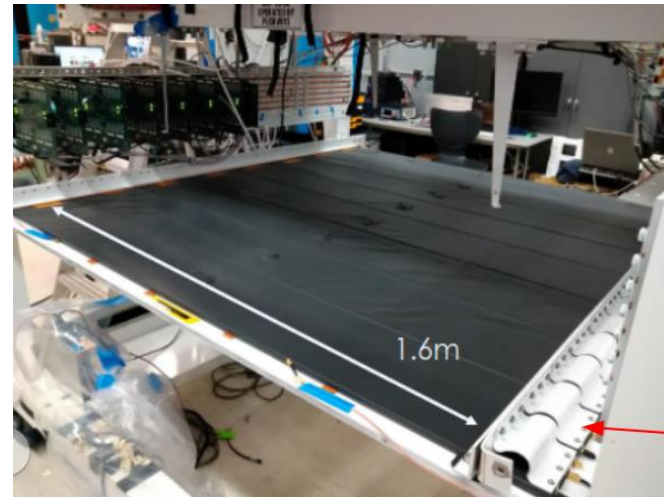
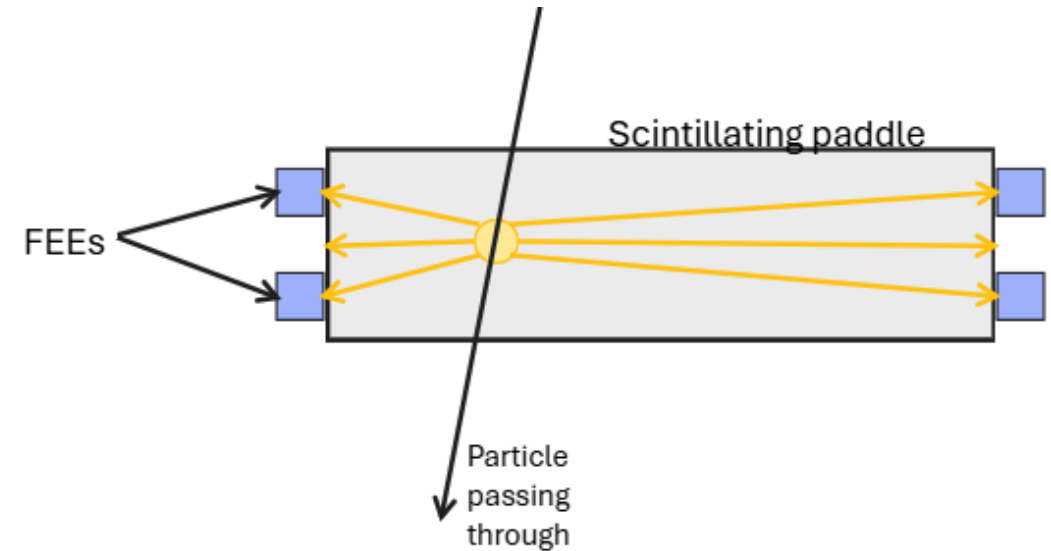
TIME-OF-FLIGHT SYSTEM (TOF)

- TOF paddles allow us to detect the **charge** and **velocity** of particles passing through
- 3 paddles from the detector: **top, bottom, bore**
- The particle must **pass through all 3 paddles** to form the system trigger



TOP AND BOTTOM TOF PADDLES

- 8 **scintillating** paddles per layer
- Top and bottom are 2.3m apart
- 1.6m long, 40cm wide, 1cm thick
- 8 **silicon photomultipliers** (SiPM) and 2 **front end electronics** (FEE) at each end
- Light scatters **isotropically**
- 64 FEEs in total

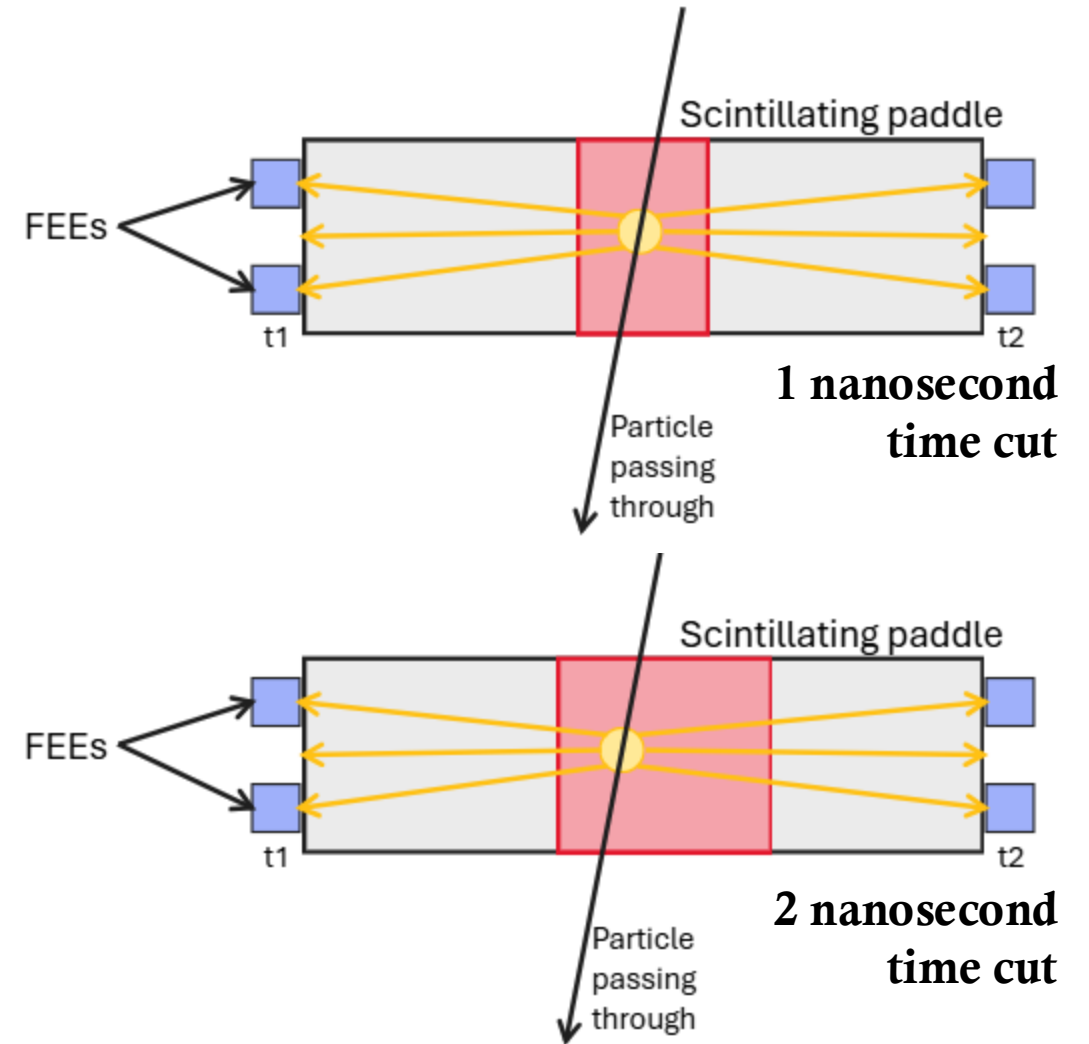


MOTIVATION

- Top and bottom TOF paddle will **uniformly detect each cosmic ray**
- Read the **same charge throughout** the detector
- Obtain more **accurate** charge measurements

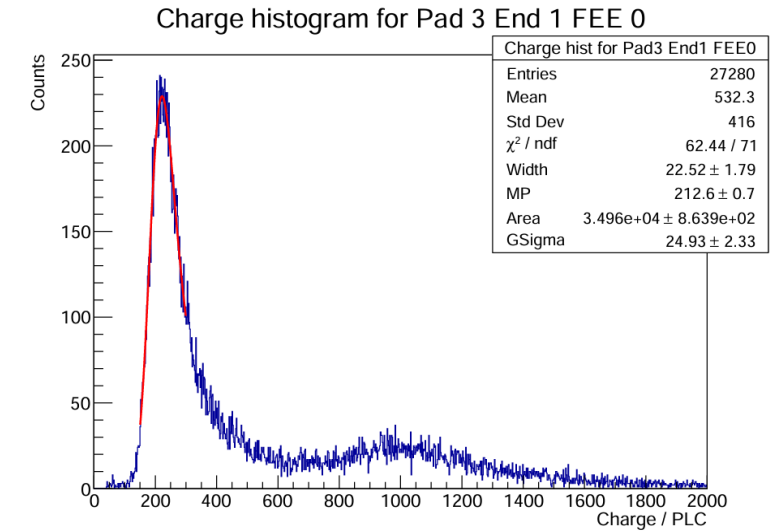
TOF PADDLE TIME CUTS

- Determine the time it takes for the light to reach the FEEs
- Apply time cut
 - $|t_1 - t_2| \leq 1\text{ns or } 2\text{ns}$
- t_1 and t_2 must be roughly equal for the particle to be roughly centered to properly perform the calibration

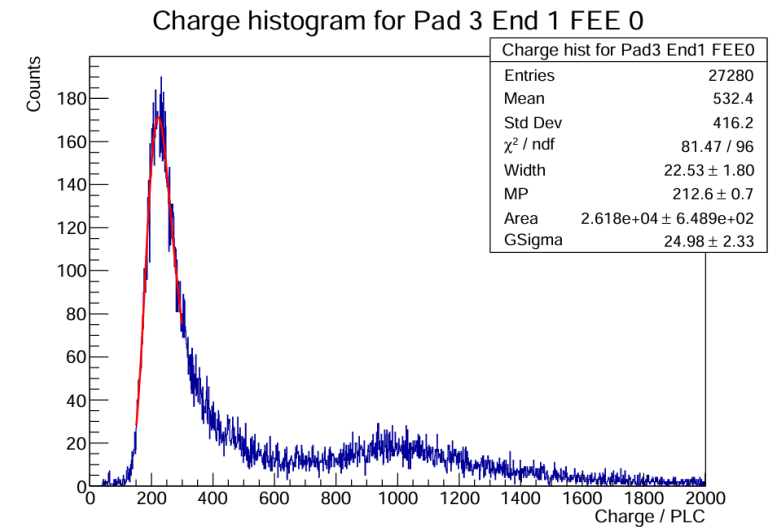


CHARGE HISTOGRAMS

- x-axis: Charge/PLC
- Fit a **langau** function
- Determine the **most probable value** (MPV)



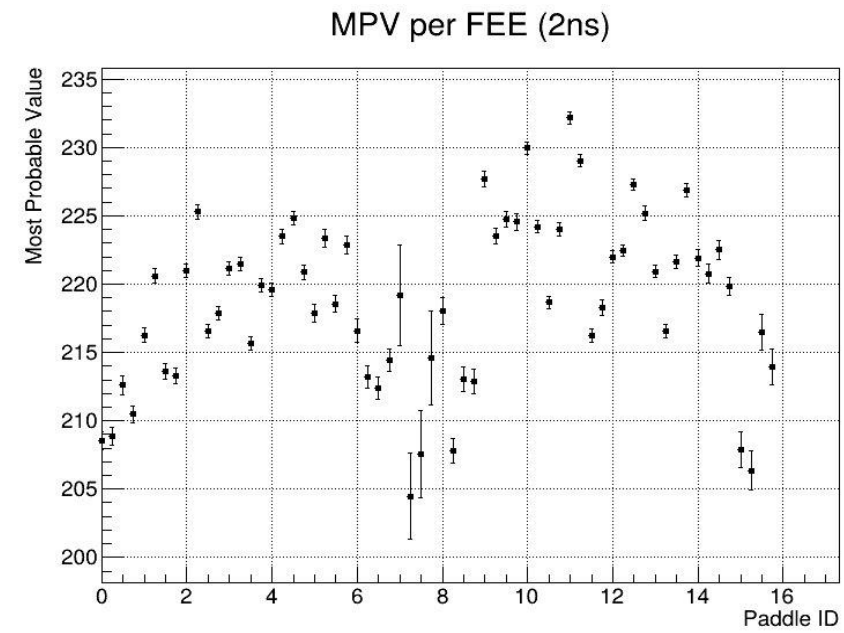
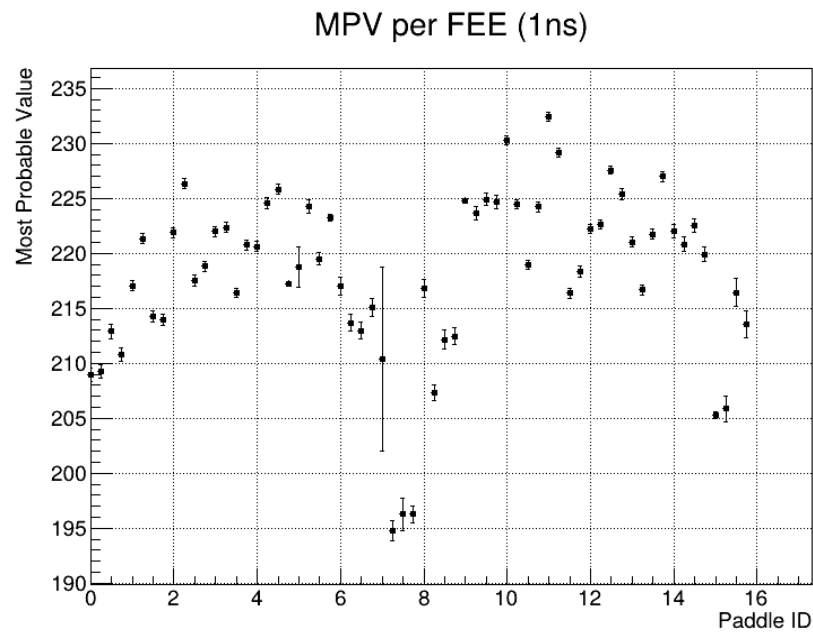
1 nanosecond



2 nanoseconds

CALIBRATIONS

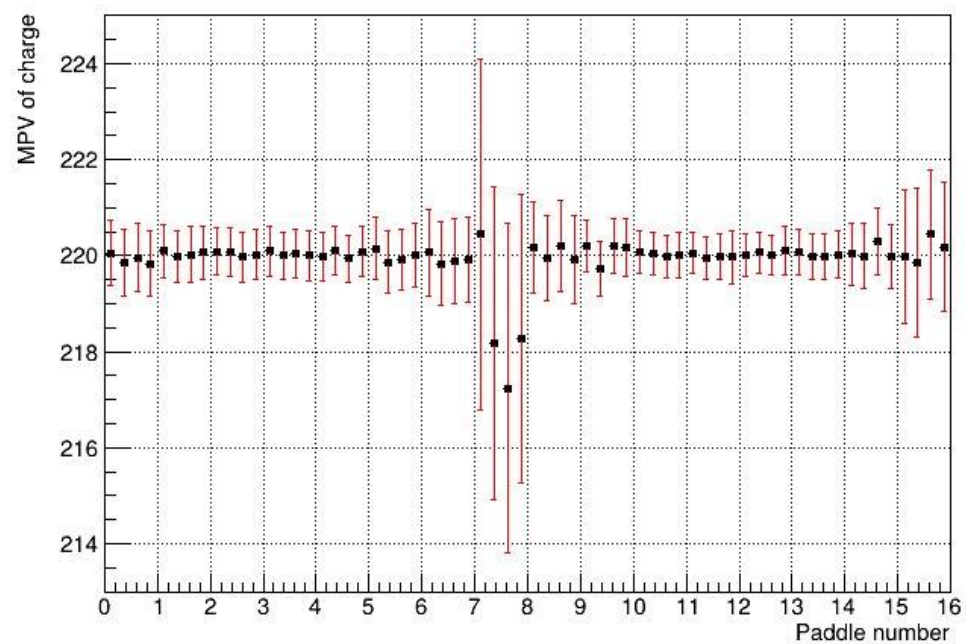
- $\text{MPV} \div 220 = \text{Correction value}$



RESULTS

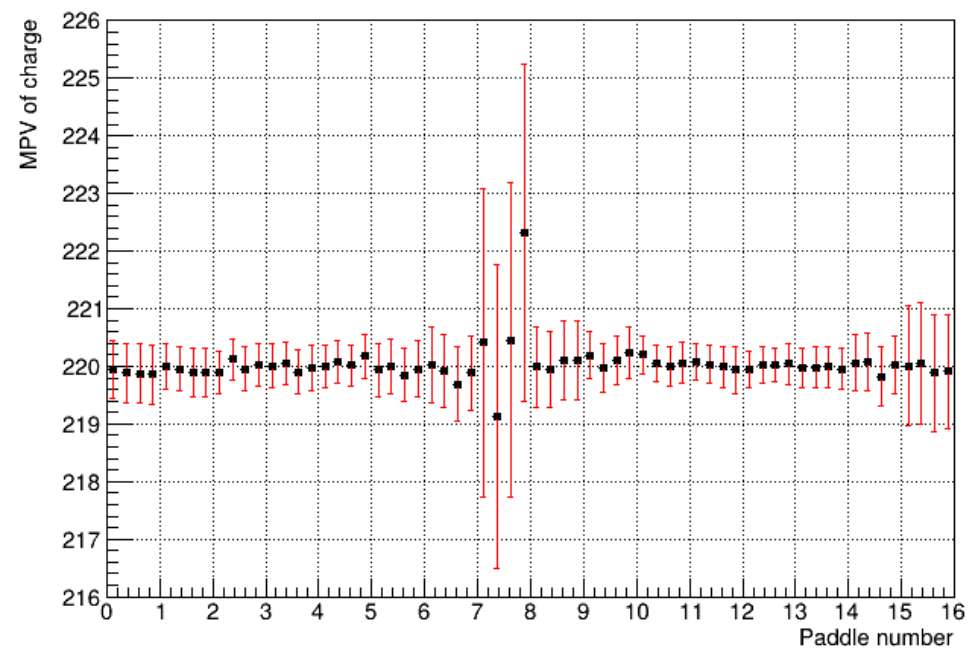
1 nanosecond

MPV per FEE



2 nanoseconds

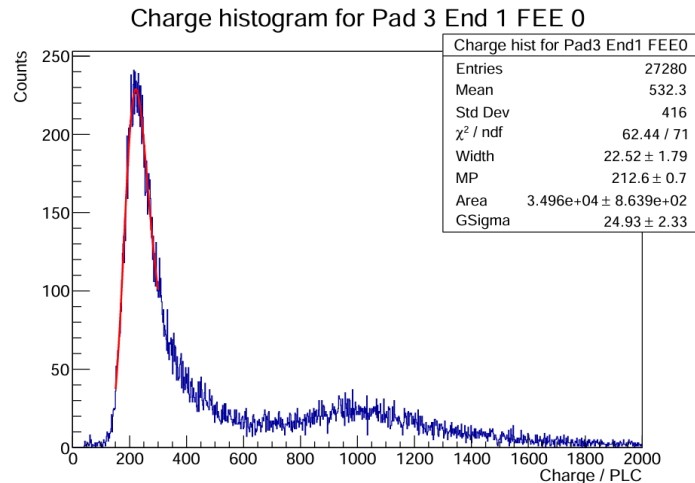
MPV per FEE



RESULTS – CORRECTION VALUES

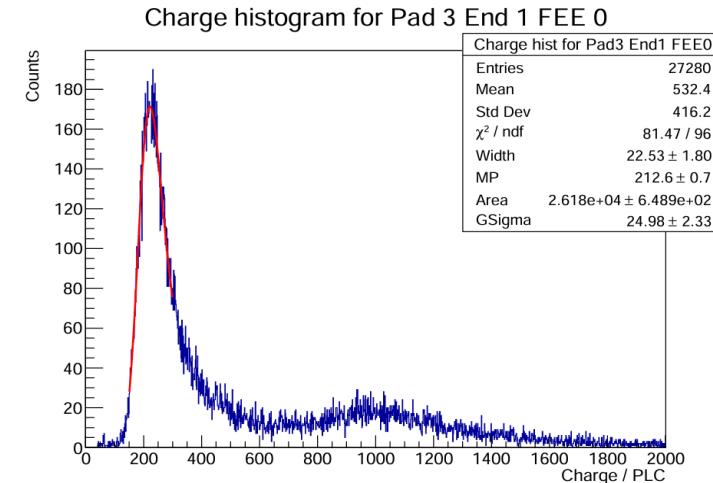
1 nanosecond

- Min: 0.947507, Max: 1.07225
- Avg correction value: 1.00570
- Pad 3 End 1 FEE 0: 1.01988



2 nanoseconds

- Min: 0.951829, Max: 1.05912
- Avg correction value: 1.00342
- Pad 3 End 1 FEE 0: 1.01967

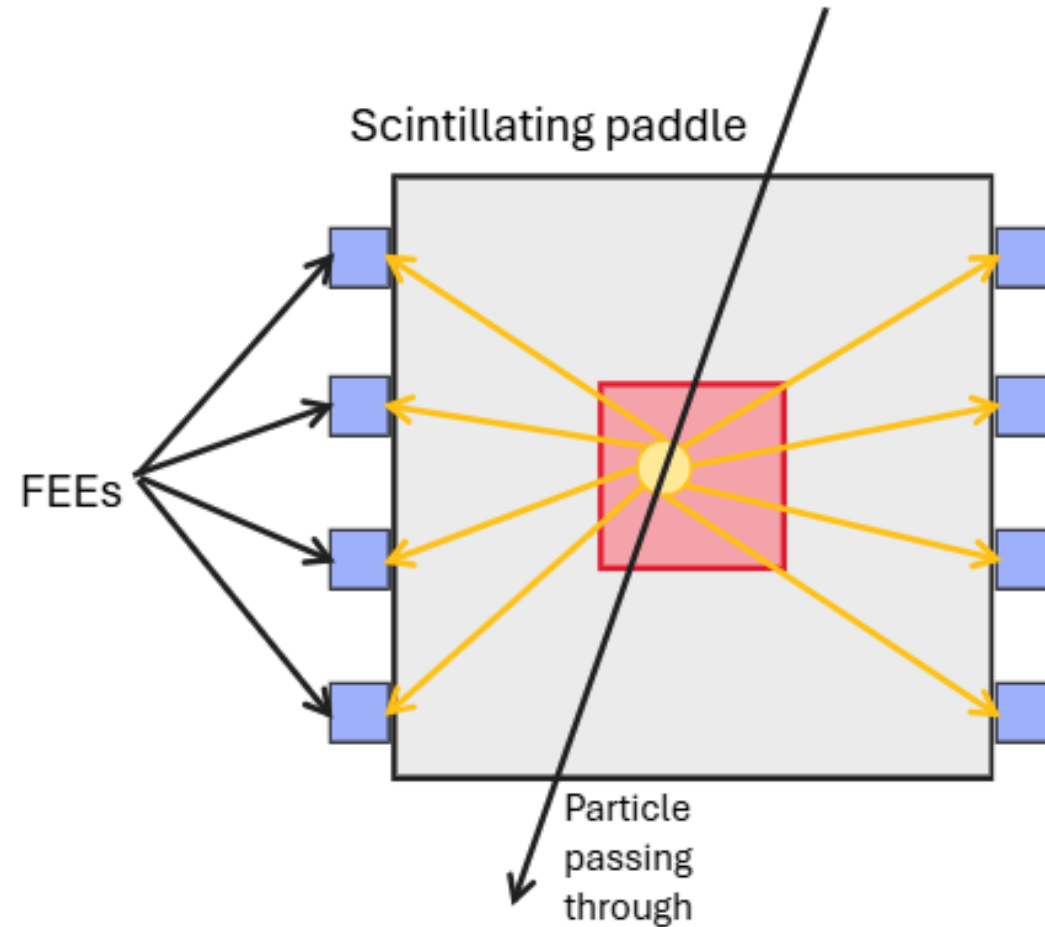


SUMMARY

1. Apply time cuts
2. Create FEE histograms and fit langau function
3. Determine MPV
4. Calculate correction values
5. Apply correction values

NEXT STEPS: BORE PADDLE CALIBRATIONS

- Area cut instead of time cut
- 4 FEEs on 2 opposing sides
- 61cm x 61cm, 1cm thick
- 1.5m below top paddles

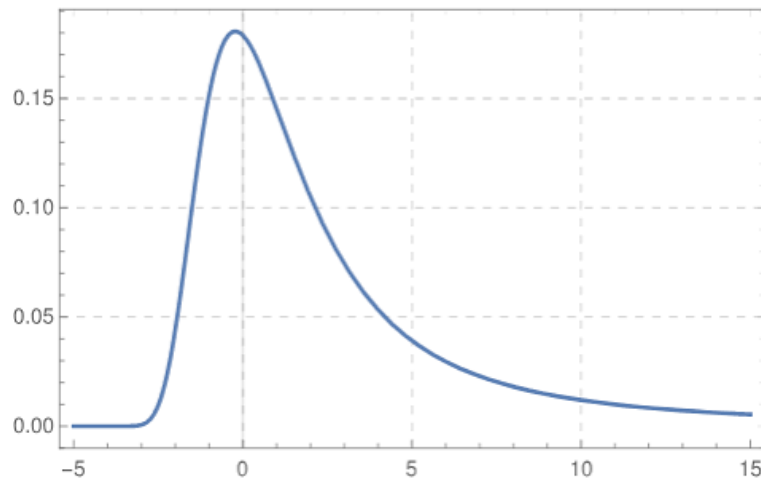


THANK YOU!

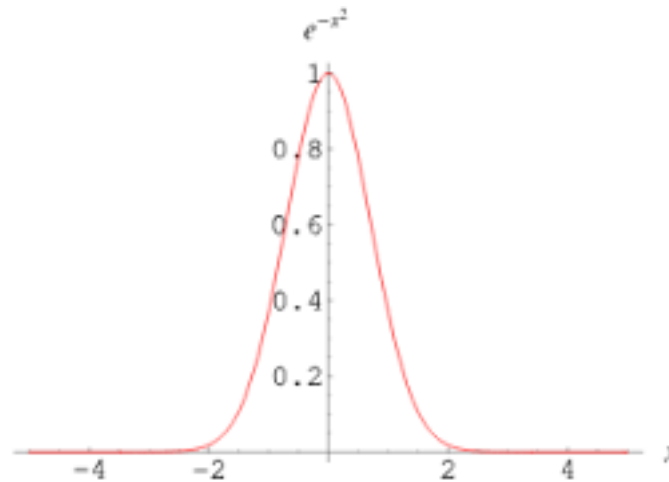
Questions?

WHAT IS A LANGAU FUNCTION?

- Convolution between **landau** and **gaussian** functions



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