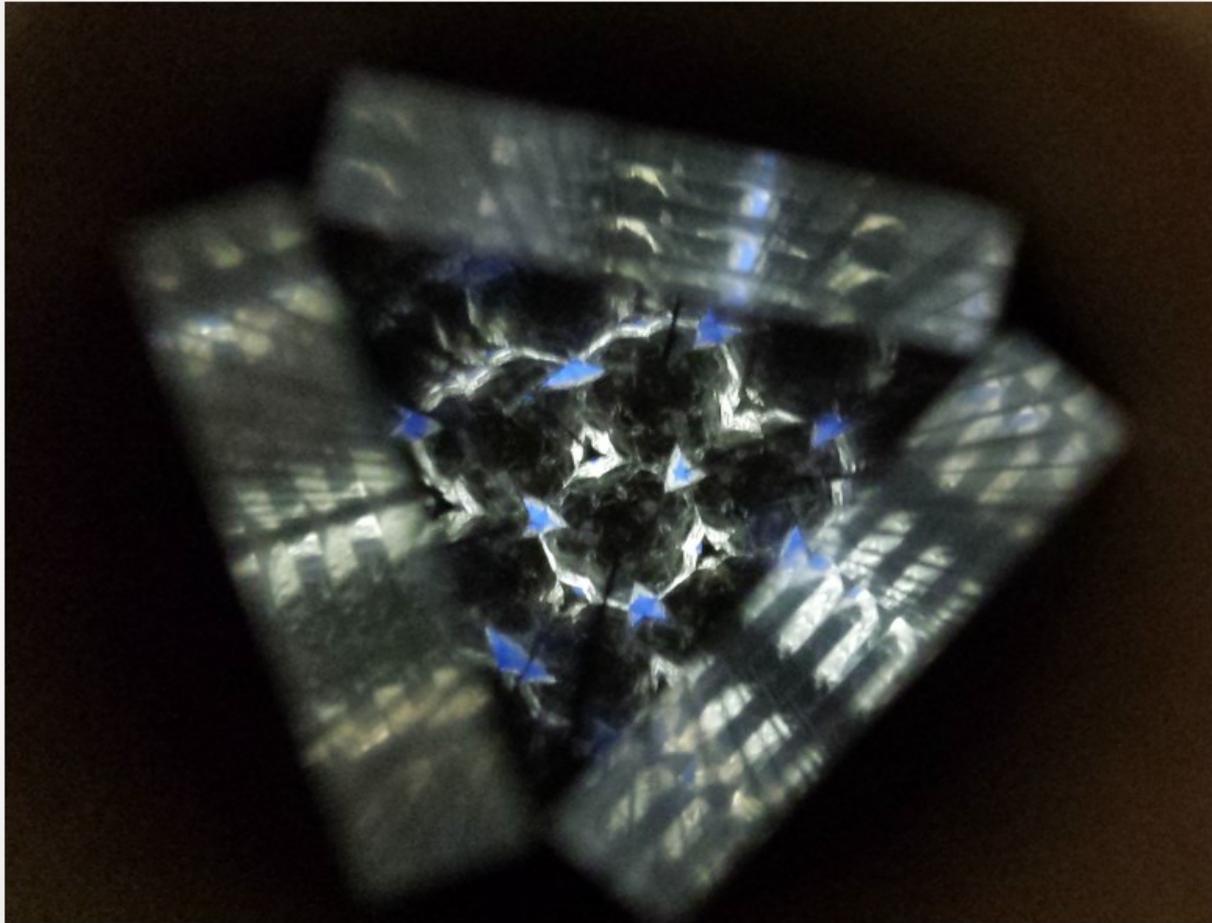


# Attenuation Length at TallBo



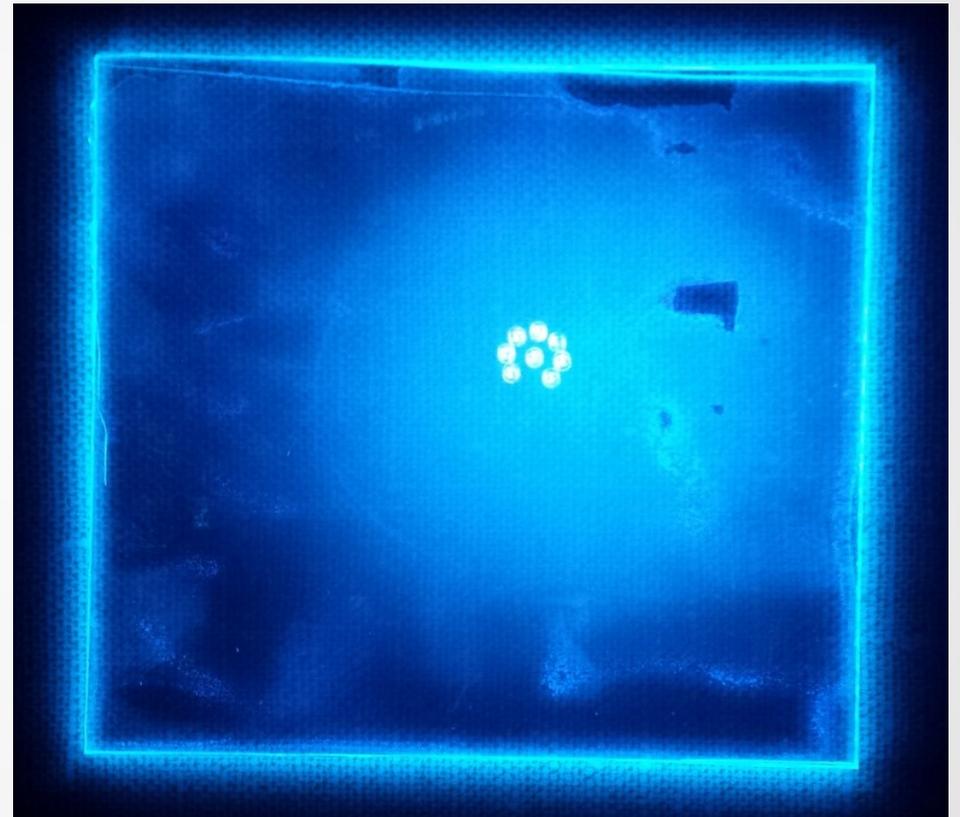
Zander Moss

# Lightguides

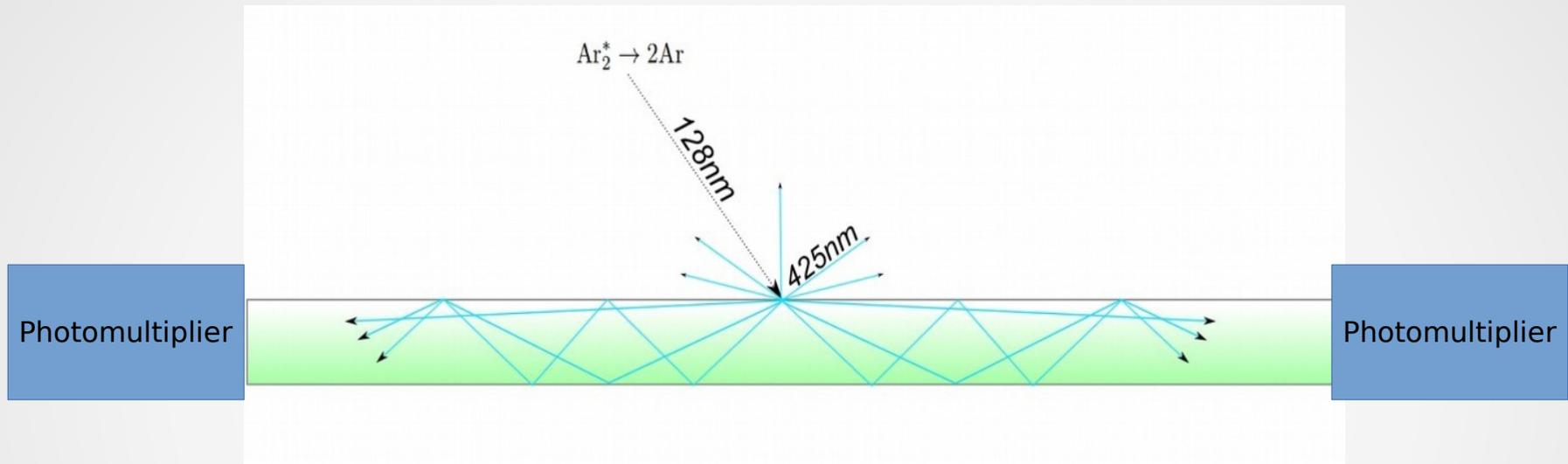
uBooNE plates are cloudy due to high TPB concentrations at the surface.

In clear plates, due to internal reflection, a large fraction of emission occurs at plate edges.

Can we take advantage of this?



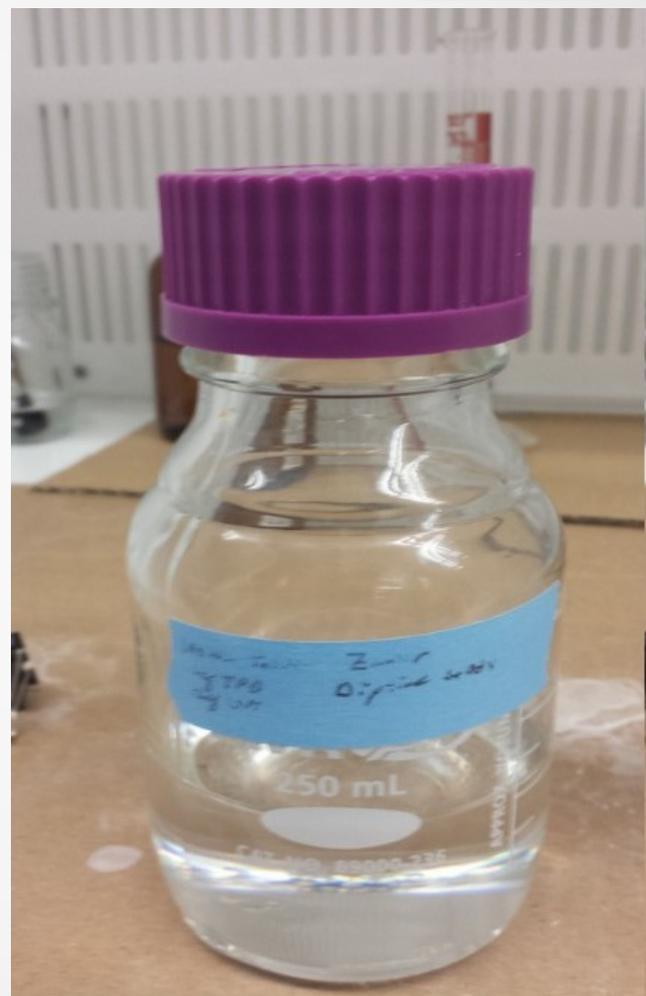
# The Bar



- Instrument the ends of the bars.
- Arrange bars into a large “paddle” to gain sensitive surface area, saving money on photomultiplier devices.
- Need to characterize overall efficiency and attenuation length.

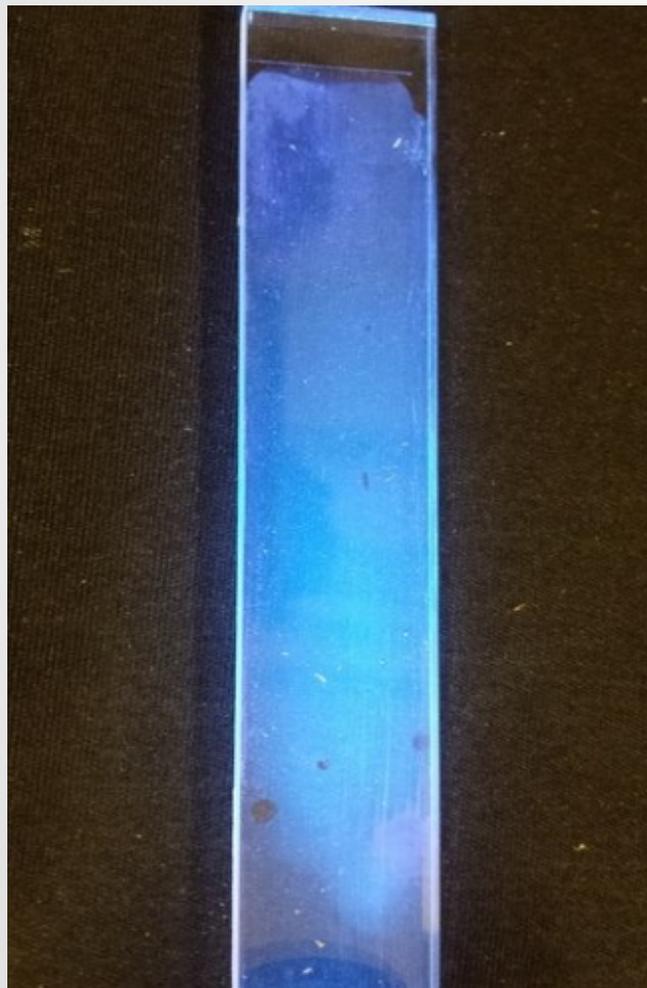
# Coating Composition

- 100mL Toluene
- 20mL Ethanol
- 1g TPB (tetraphenyl butadiene: wavelength shifter)
- 2g UV Transmitting Acrylic (in solution)
- (Acrylic solute + low TPB concentration provides clarity, matched indices of refraction)



# The Bars

Attenuation Length  $\sim 20\text{cm}$

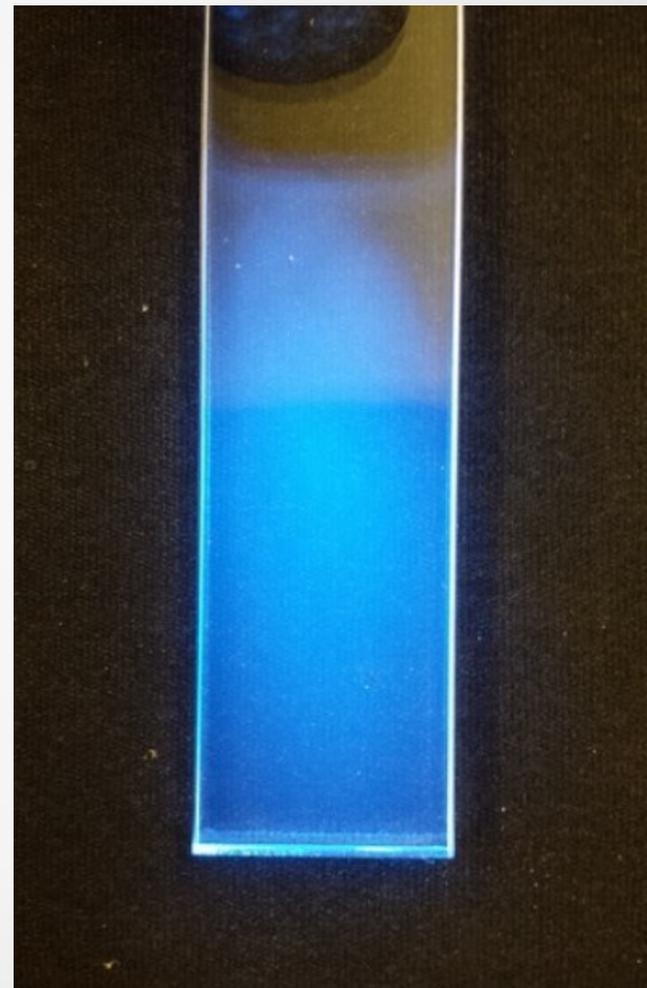


Hand Painted

Attenuation Length ??

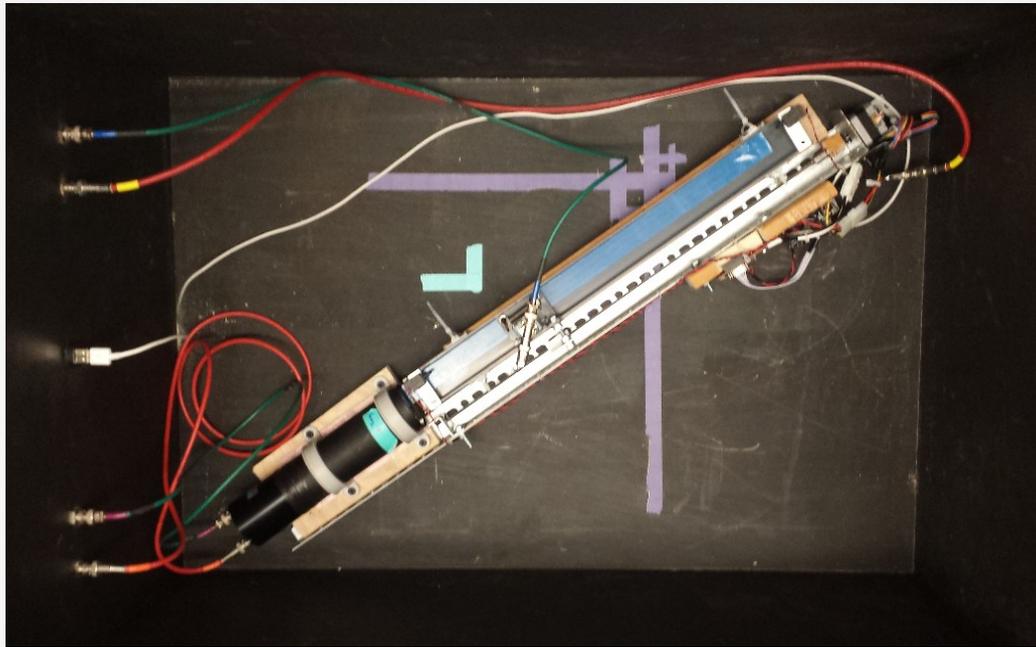


Dipping Rig



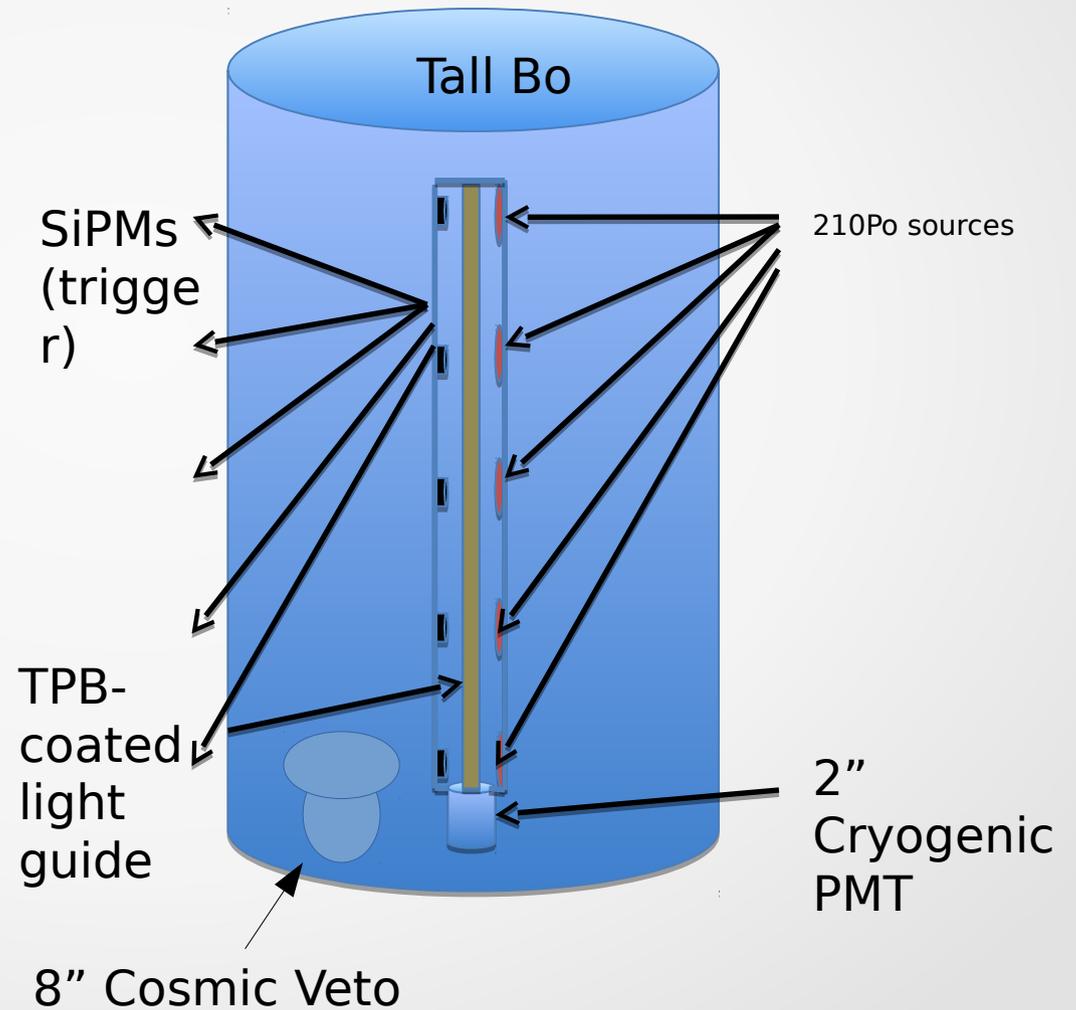
Dip Coated

# Attenuation Length

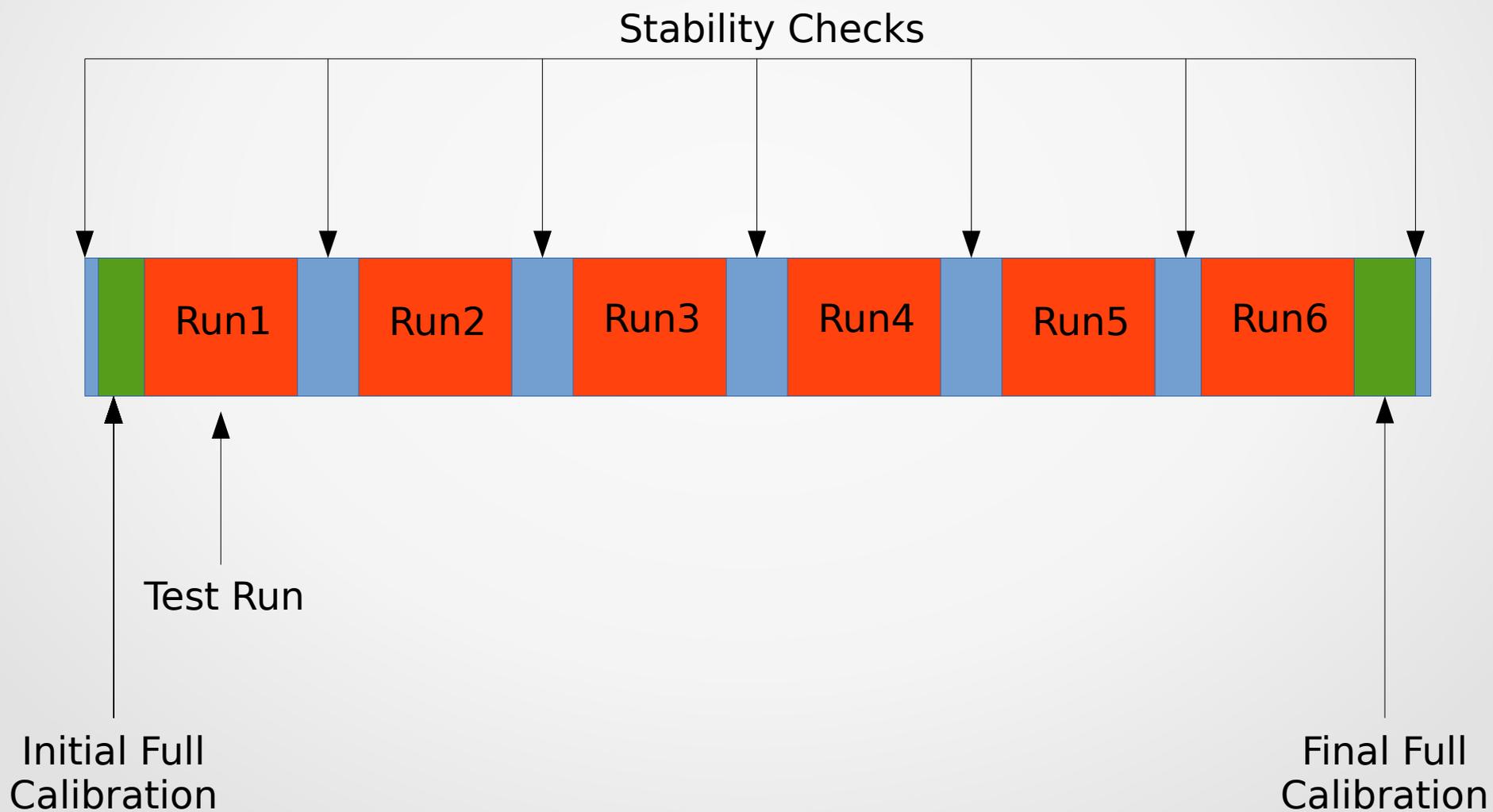


- Attenuation length in air has been characterized.
- Results in air will not necessarily match those in argon.
- Excellent, quick way to compare coating methods.

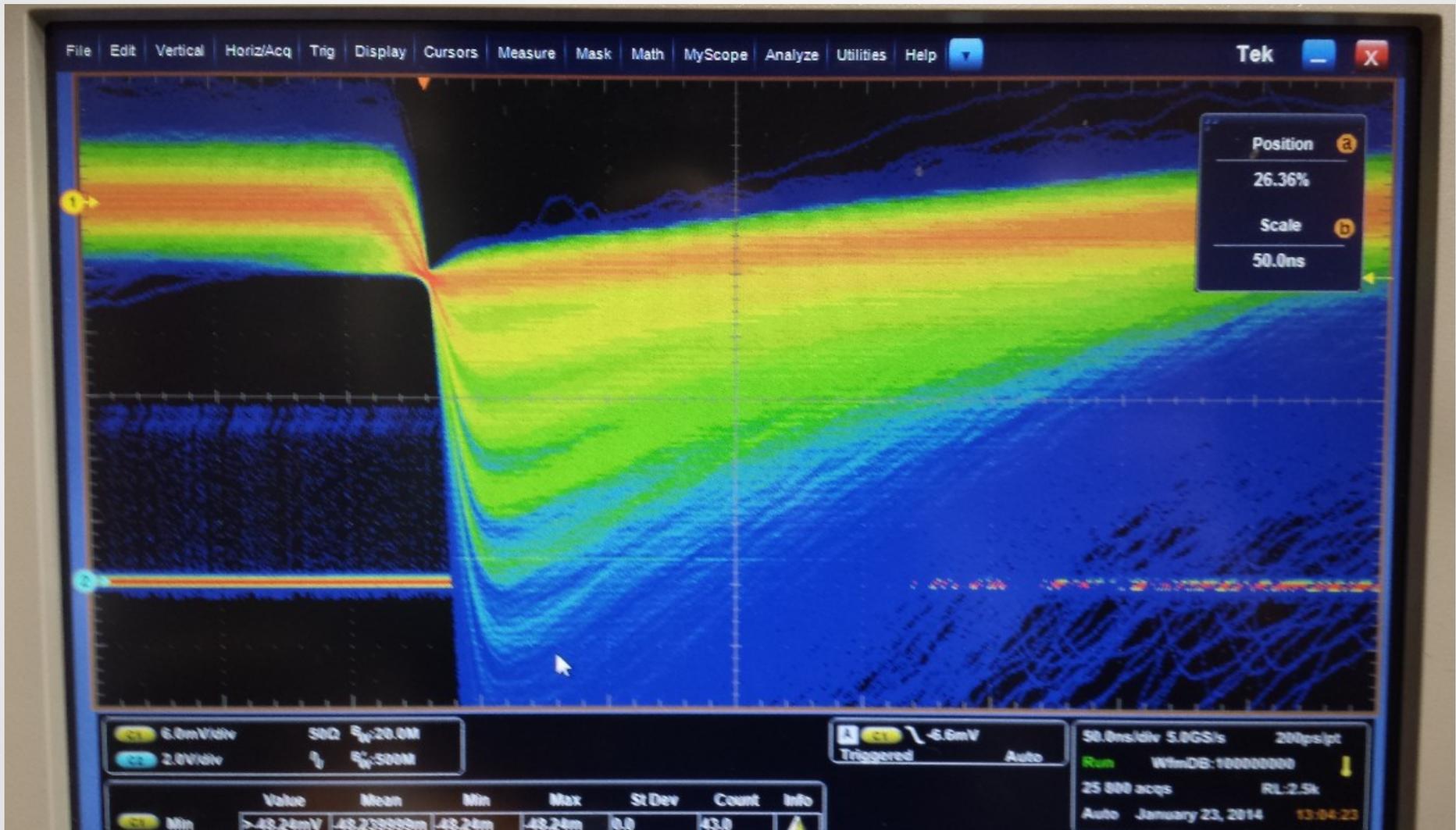
# The Setup



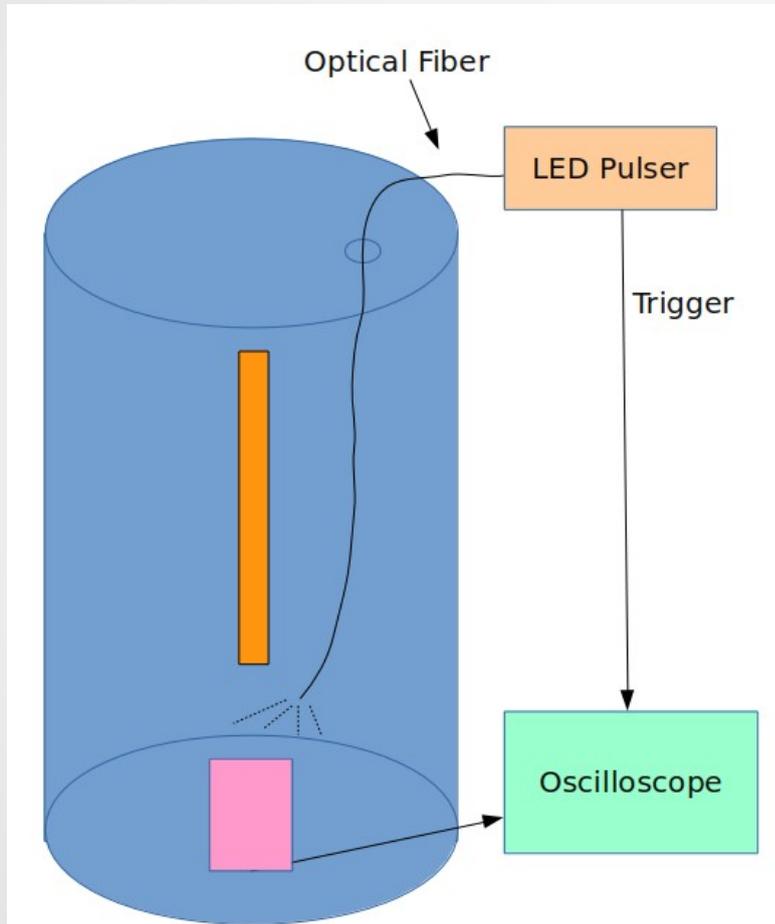
# Run Schedule



# SiPM Calibration



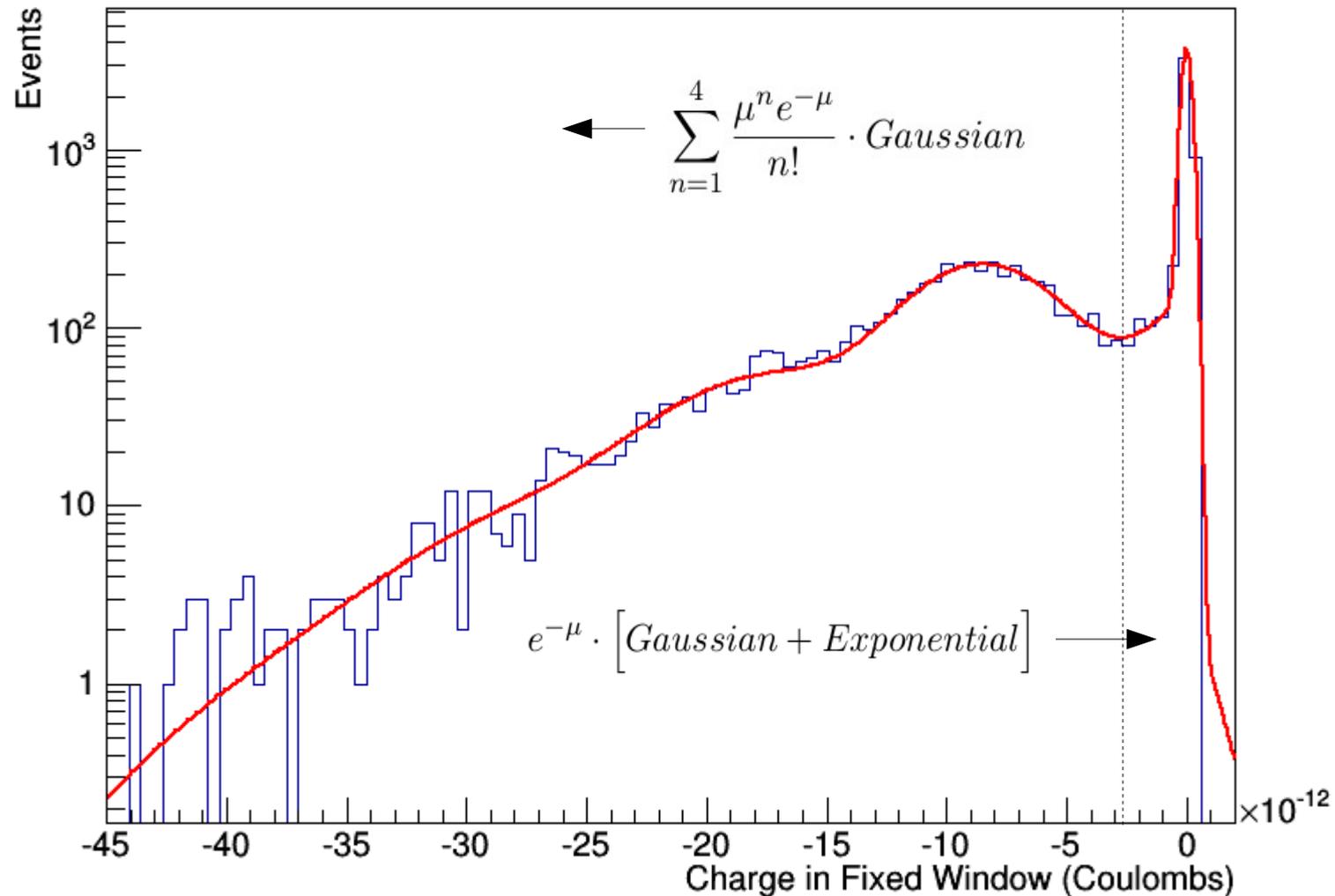
# LED Flasher



- Read waveforms in fixed window, beginning at pulser trigger.
- Adjust LED intensity to ensure the majority of nonzero waveforms are single photoelectrons.

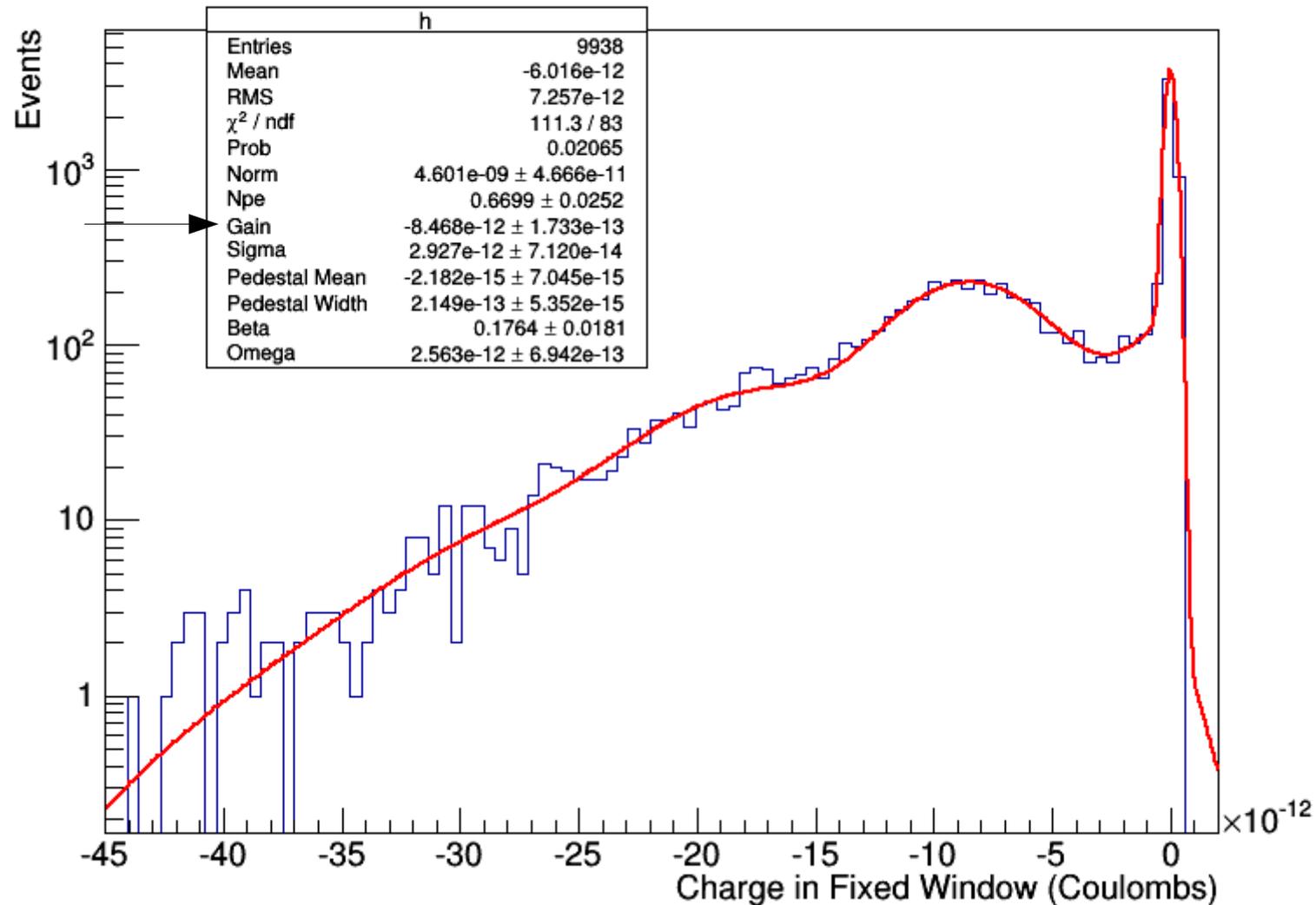
# Initial Waveform Calibration

## Initial SPE Calibration



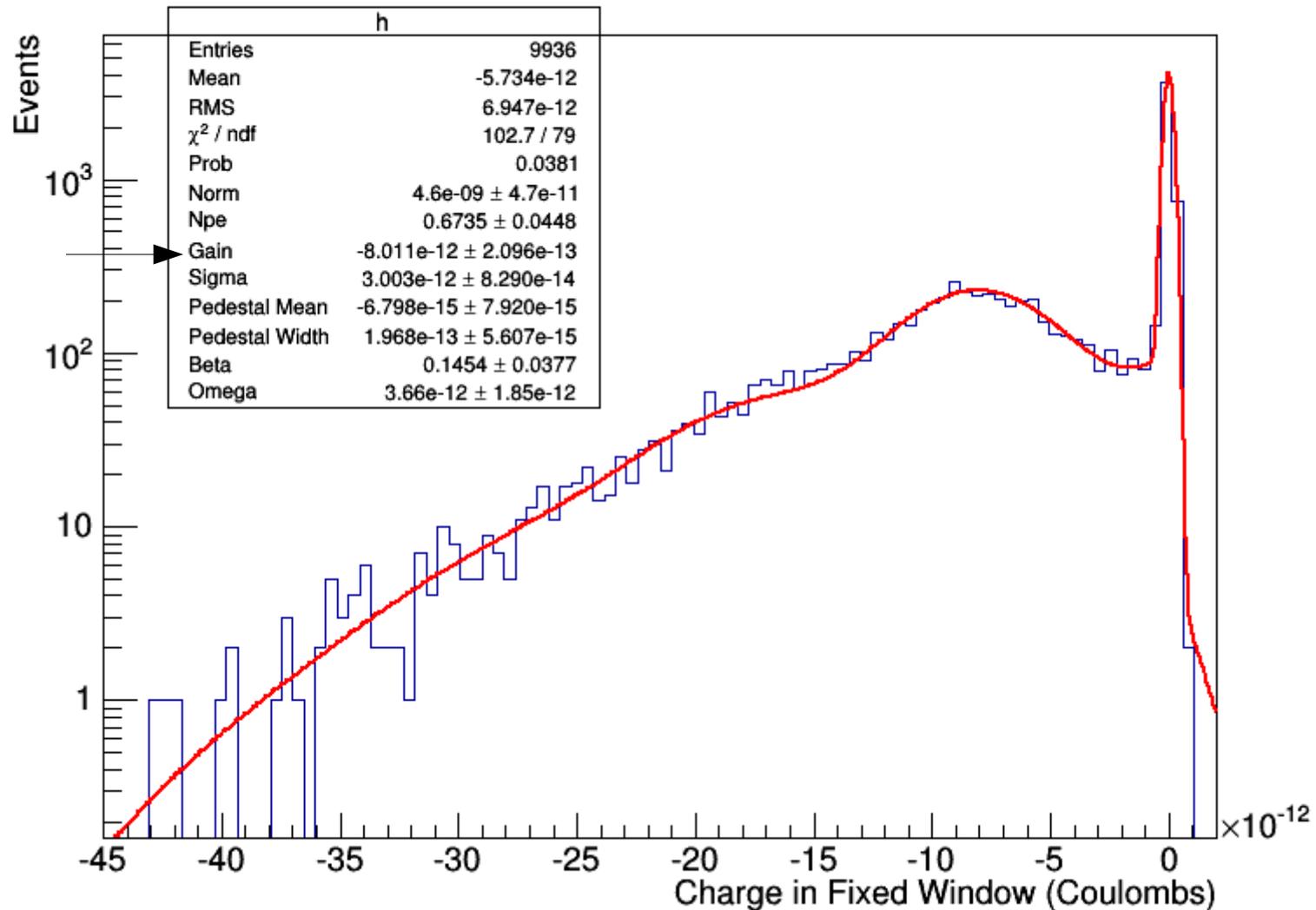
# Initial Waveform Calibration

## Initial SPE Calibration



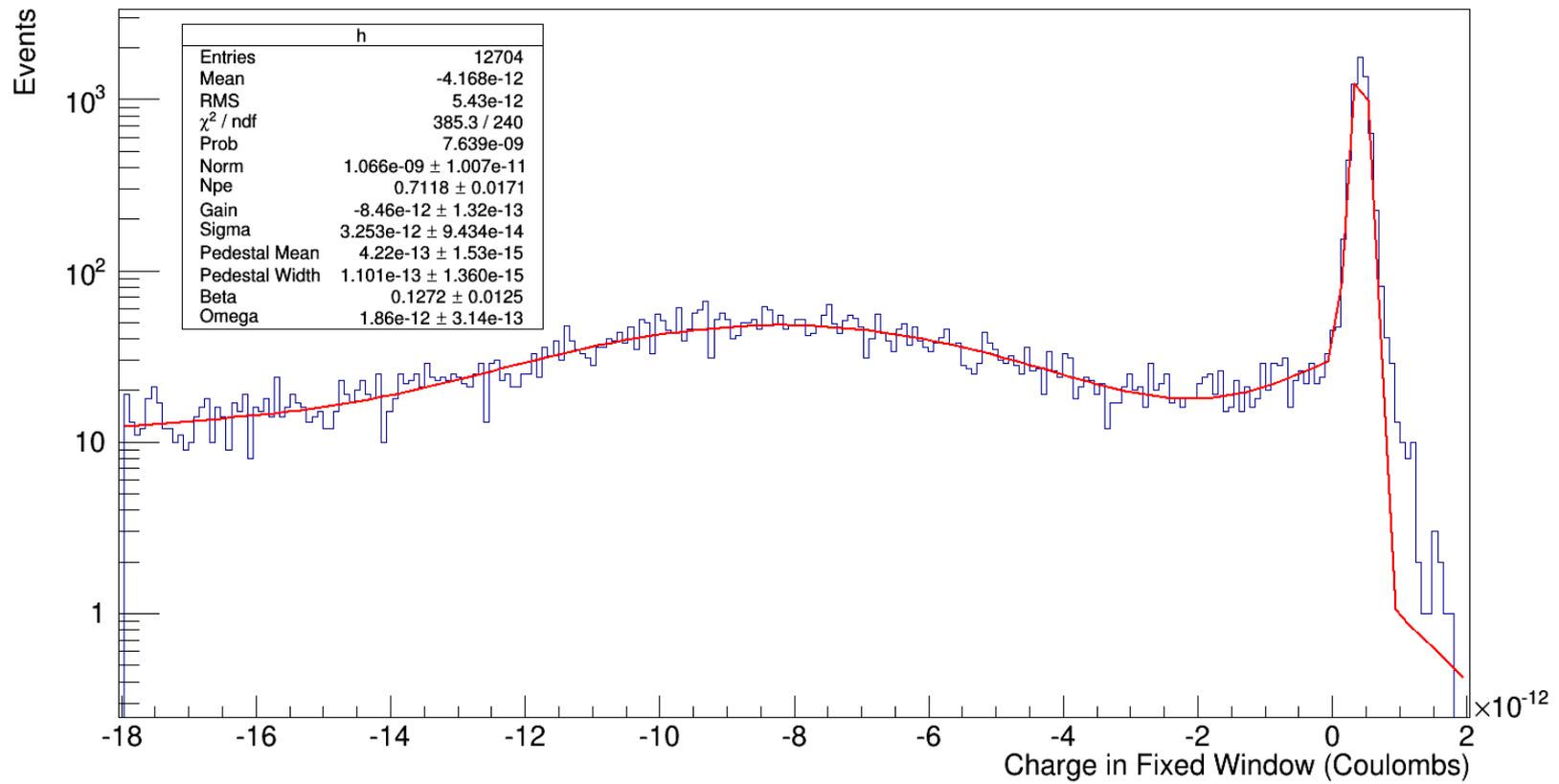
# Final Waveform Calibration

## Final SPE Calibration



# Stability Check

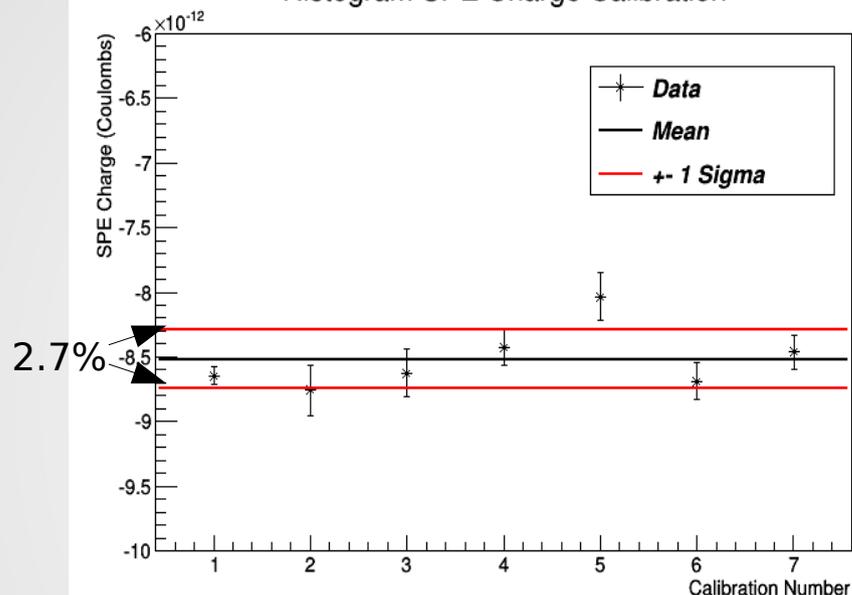
## Oscilloscope Calibration PE Spectrum



# Gain Stability

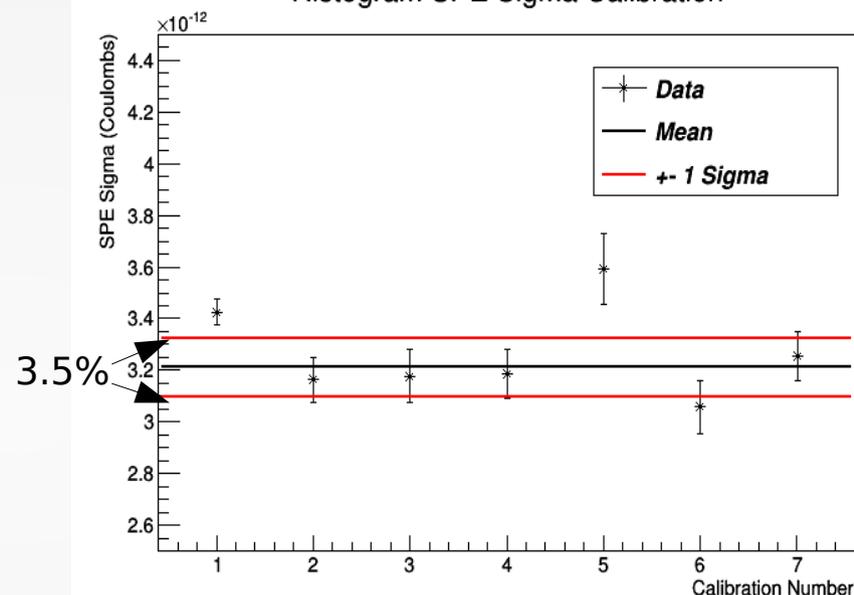
Zero Suppressed!

Histogram SPE Charge Calibration



Zero Suppressed!

Histogram SPE Sigma Calibration

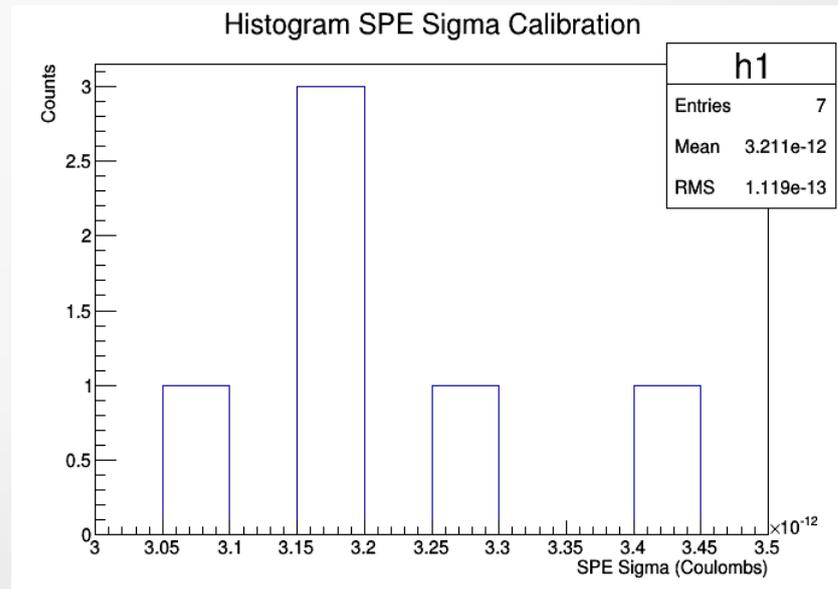
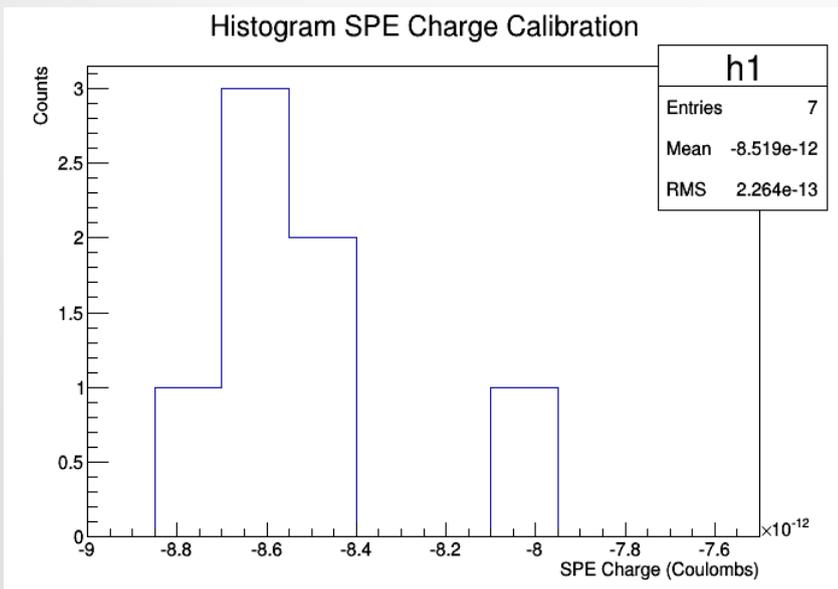
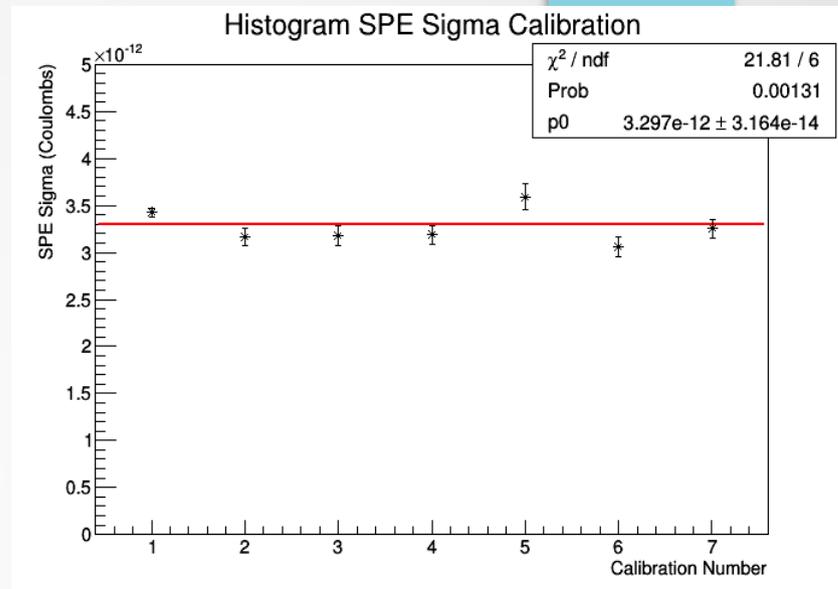
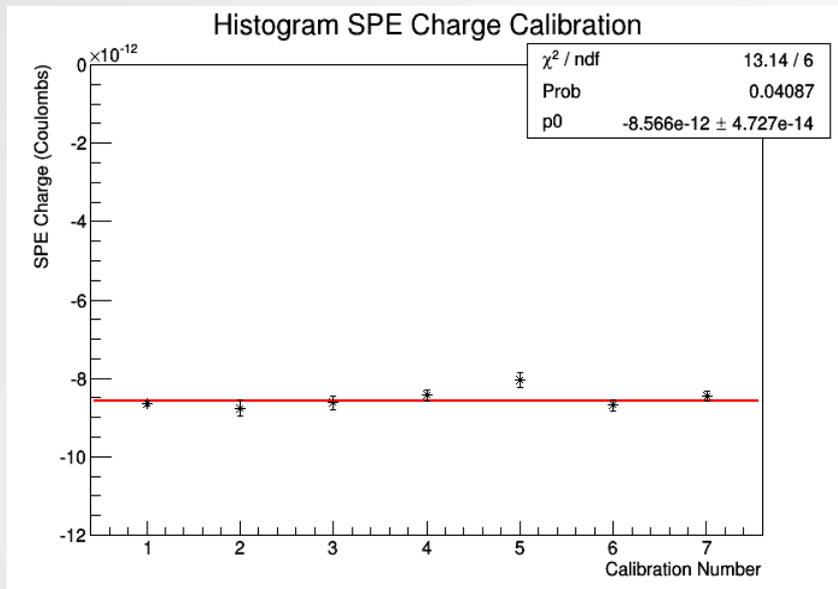


- Fit values for SPE mean charge and SPE RMS charge.
- Uncertainty from fit does not account for spread.
- Systematic uncertainty is calculated (shown on plots) and fed into analysis.

# Conclusions

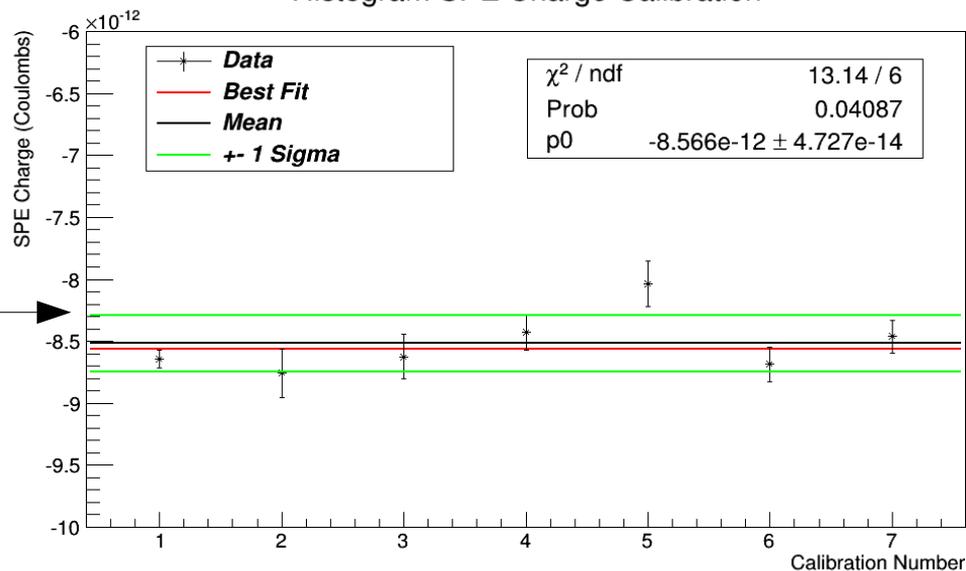
- We are confident in our calibrations of the SiPMs and the collection PMT.
- The PMT gain is quite stable over our runs (Gain to  $\pm 2.7\%$  of mean, Sigma to  $\pm 3.5\%$  of mean), and shouldn't cause trouble...

# Histogram Calibrations



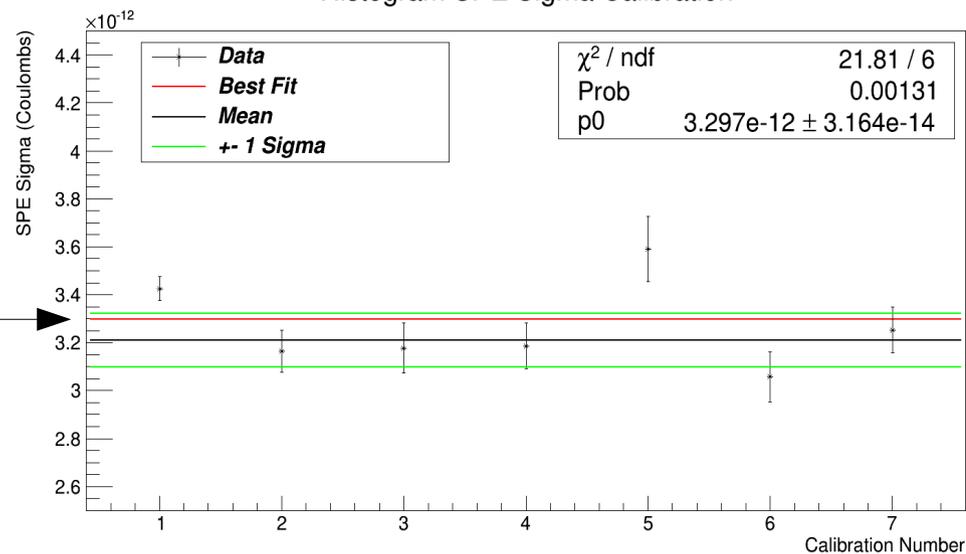
# Histogram Calibrations

### Histogram SPE Charge Calibration



2.7%

### Histogram SPE Sigma Calibration



3.5%

# 2" PMT Calibration

Noise  $\longrightarrow N \cdot e^{-\mu} \cdot (1 - \beta) \cdot \text{Gaus}(x, \mu_{noise}, \sigma_{noise})$

Thermionic  $\longrightarrow +N \cdot \beta \cdot e^{-\mu} \cdot \theta(-(x - \mu_{noise})) \cdot [\text{Expo}((x - \mu_{noise}), \omega)]$

$$+N \cdot \sum_{n=1}^4 \left[ \frac{e^{-\mu} \cdot \mu^n}{n!} \right] \cdot \text{Gaus}(x, n \cdot \mu_{spe} + \mu_{noise}, \sqrt{n \cdot \sigma_{spe}^2 + \sigma_{noise}^2})$$

1 to 4 PEs