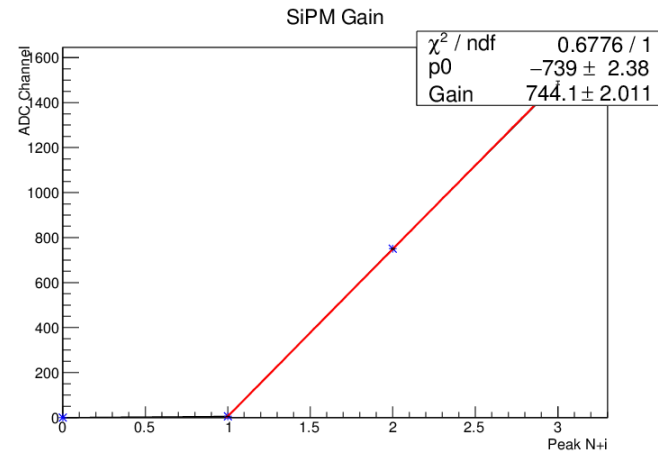
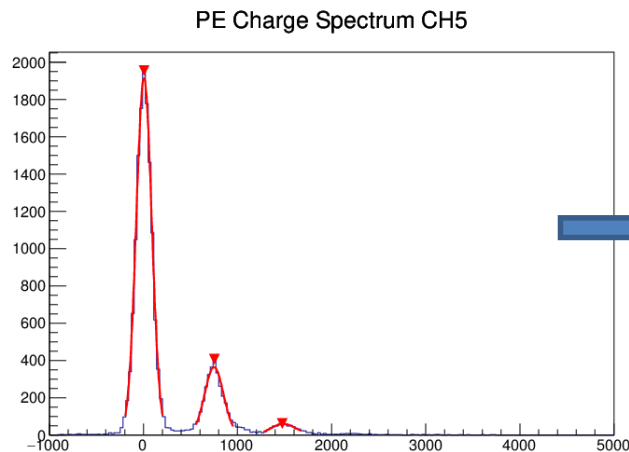


# Single PE

- Acquisition of LED signals
- Baseline subtraction
- Photoelectron distribution (wvf integration in a fixed window)
- Gain estimation

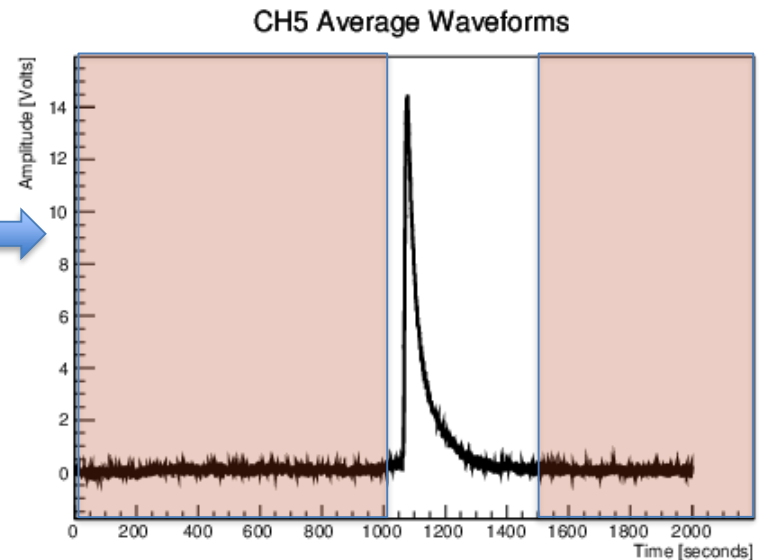
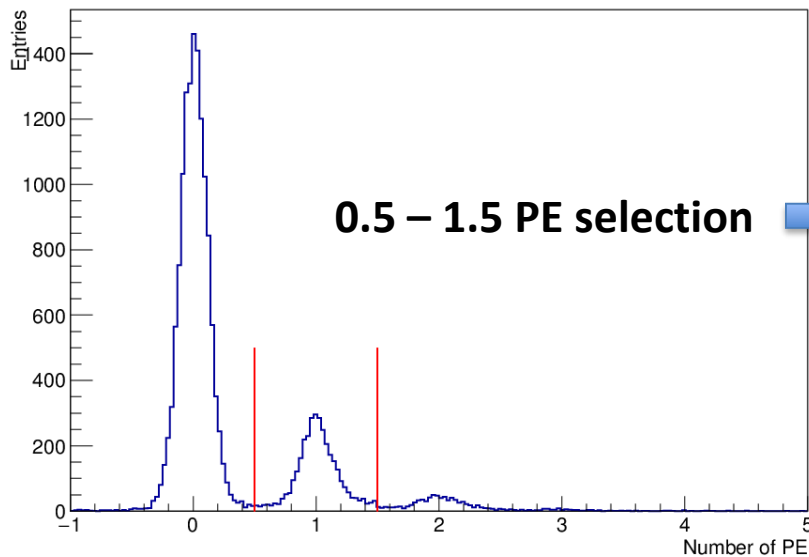


**Three points fitted and gain is extracted (the distance between peaks).**

\* That slide meant to show how the gain is extracted for further analysis

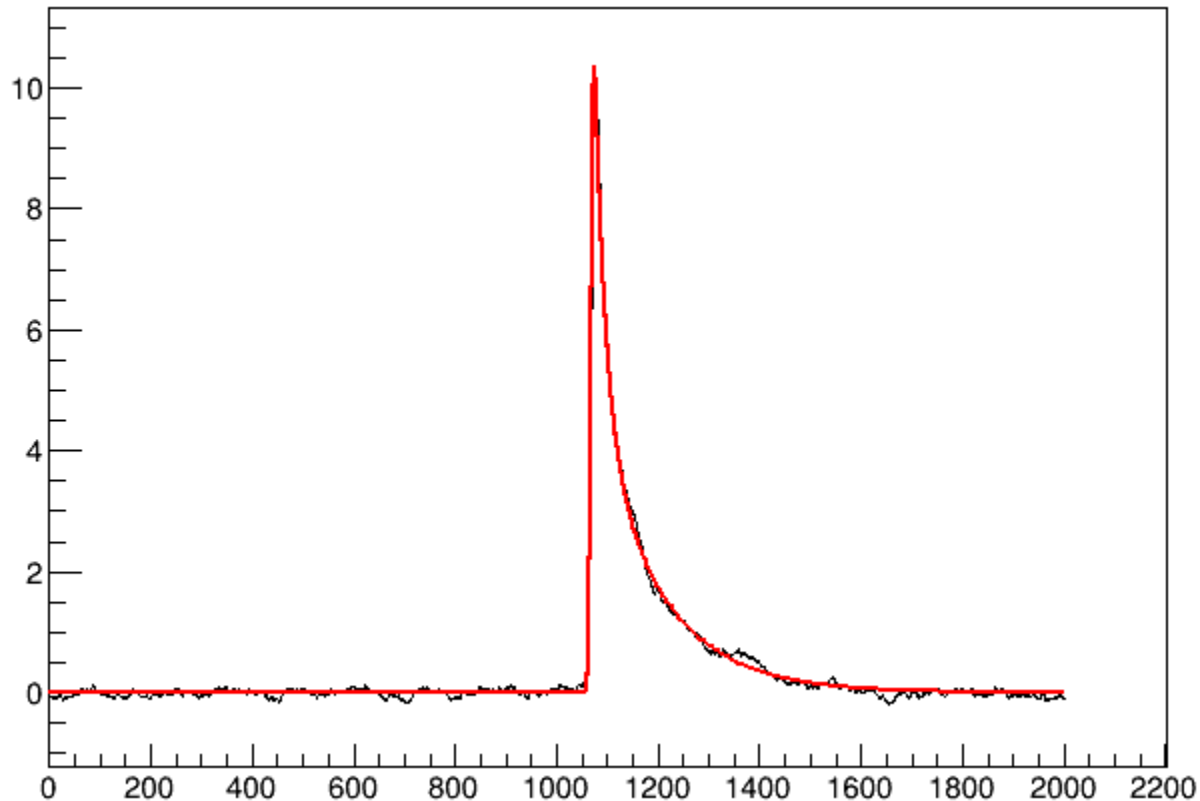
# Single PE

- Check:
  - Integral of waveform between 0.5 – 1.5 PE (gain applied to charge distribution)
  - No signal in pre-trigger and post-trigger region



# Fit SPE response

$$f(\tilde{t}) = \sum_{i=1}^3 \frac{A_i}{2\tau_i} \exp\left(\frac{\sigma^2}{2\tau_i^2} - \frac{\tilde{t}}{\tau_i}\right) \left[1 - \text{Erfc}\left(\frac{\sigma}{\sqrt{2}\tau_i} - \frac{\tilde{t}}{\sqrt{2}\sigma}\right)\right]$$



# Fit SPE response

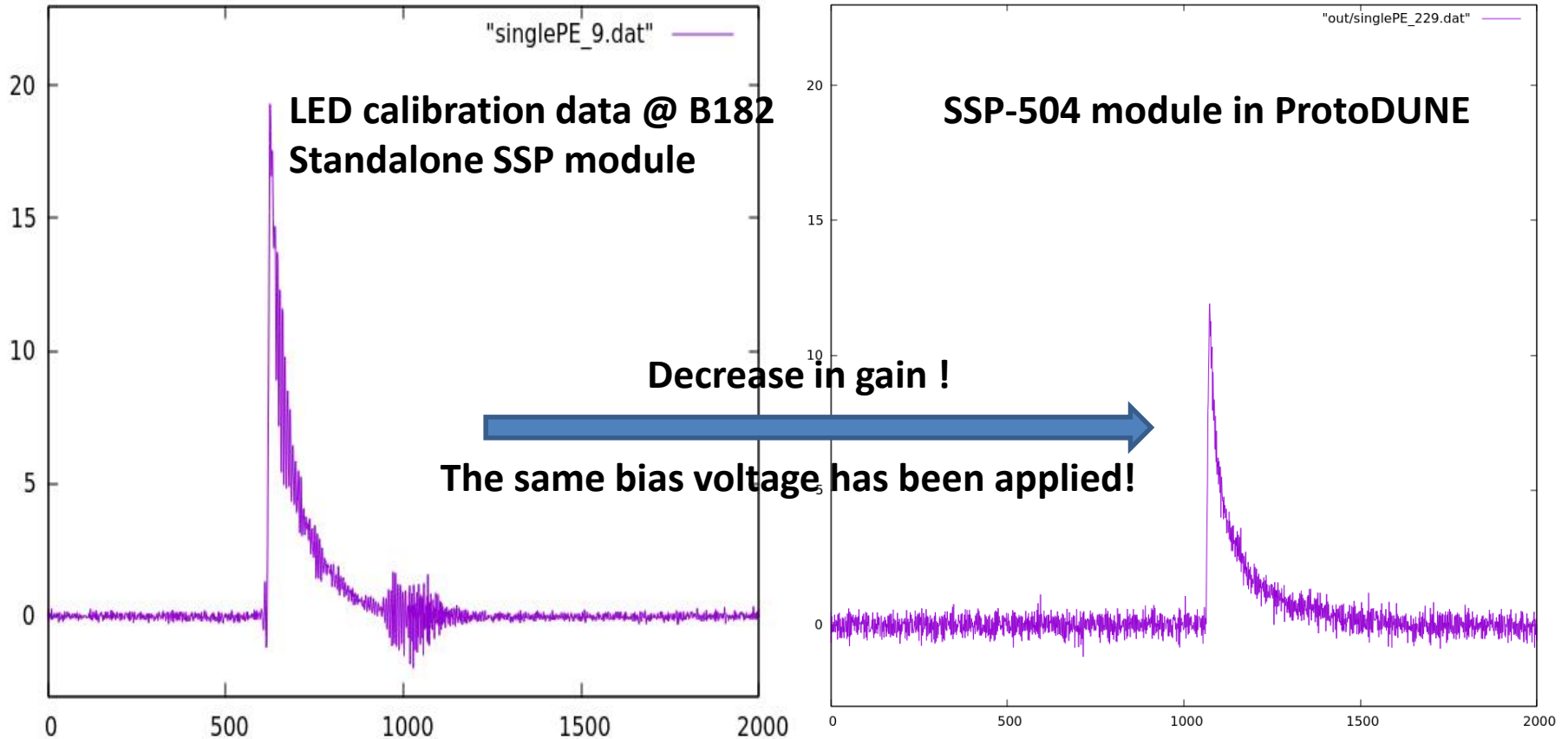
$$f(\tilde{t}) = \sum_{i=1}^3 \frac{A_i}{2\tau_i} \exp\left(\frac{\sigma^2}{2\tau_i^2} - \frac{\tilde{t}}{\tau_i}\right) \left[1 - \text{Erfc}\left(\frac{\sigma}{\sqrt{2}\tau_i} - \frac{\tilde{t}}{\sqrt{2}\sigma}\right)\right]$$

$$\tilde{t} = t - t_0$$

Ch	$A_1, A_2, \sigma, \tau_1, \tau_2, t_0, A_3, \tau_3$
229	132.526, 176.65, 3.67213, 125.617, 21.4057, 1068.39, 490.906, 125.508
230	230.707, 27.0883, 3.34362, 54.7898, 11.3953, 1067.43, 535.133, 120.22
231	154.069, 168.623, 3.21402, 108.451, 20.841, 1067.7, 514.355, 108.458
232	118.341, 197.816, 3.79305, 120.905, 20.2468, 1068.65, 478.679, 120.856
233	384.398, 47.6593, 4.4439, 37.5832, 12.9598, 1069.23, 376.593, 142.594
235	116.612, 214.87, 4.09919, 119.714, 26.4409, 1068.61, 478.662, 119.729

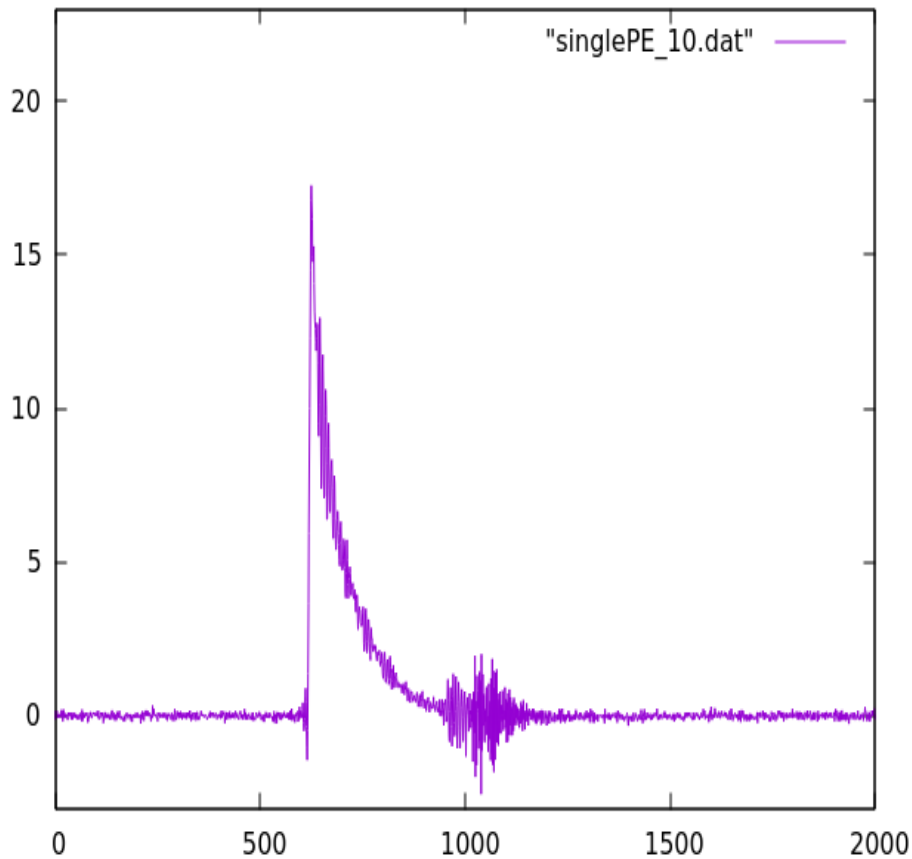
# SPE comparison – non quartz

Cell #2 in pDUNE (SSP 504)

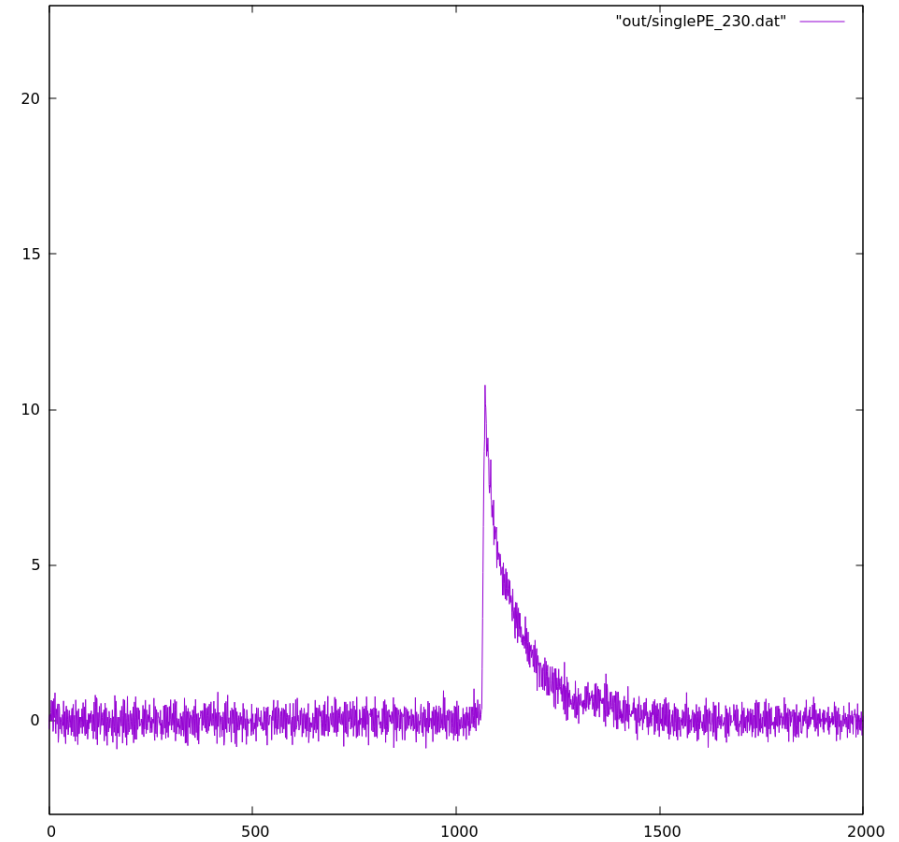


# SPE comparison - non quartz

Cell #3 in 182 Building (Standalone SSP)

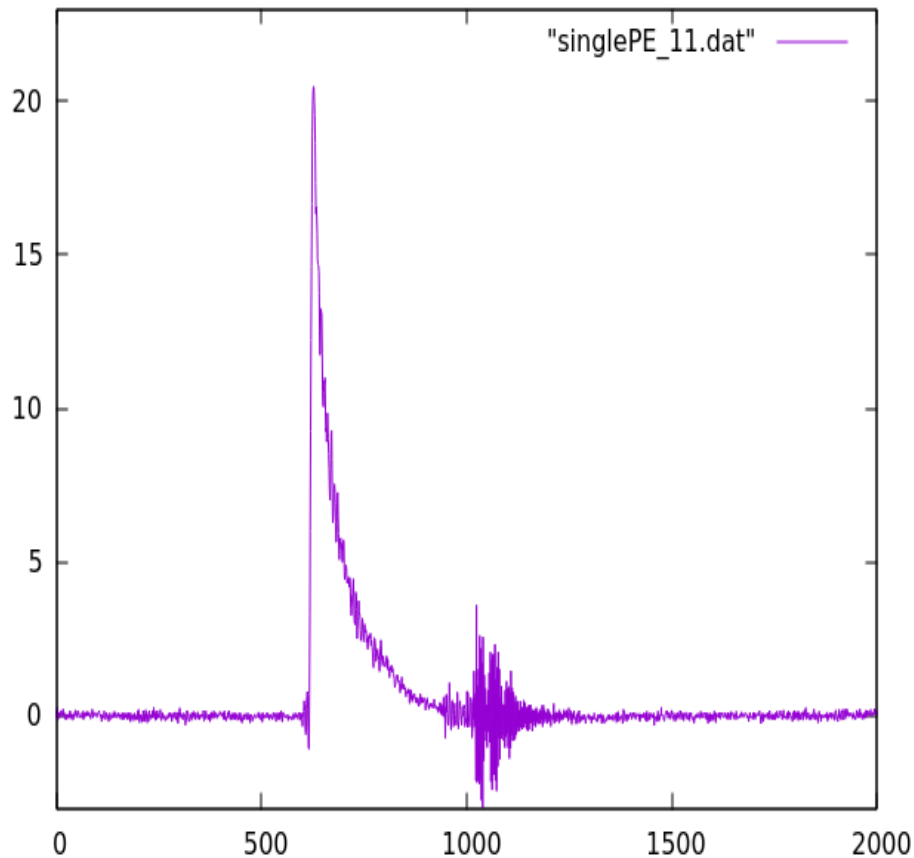


Cell #3 in pDUNE (SSP 504)

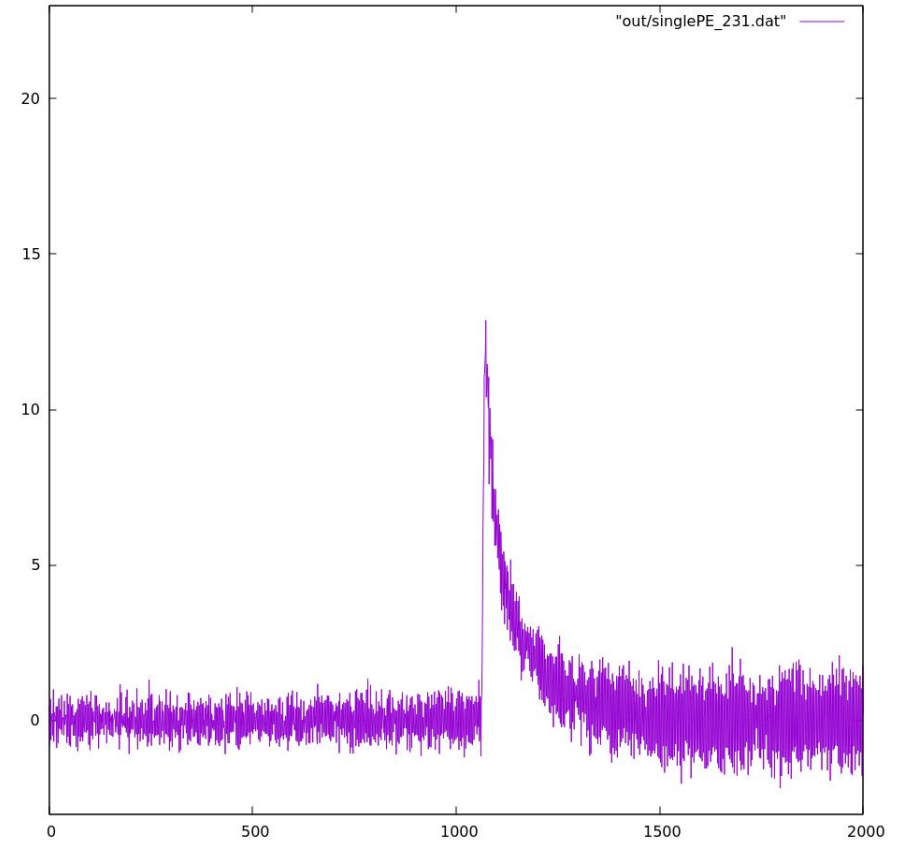


# SPE comparison - non quartz

Cell #4 in 182 Building (Standalone SSP)

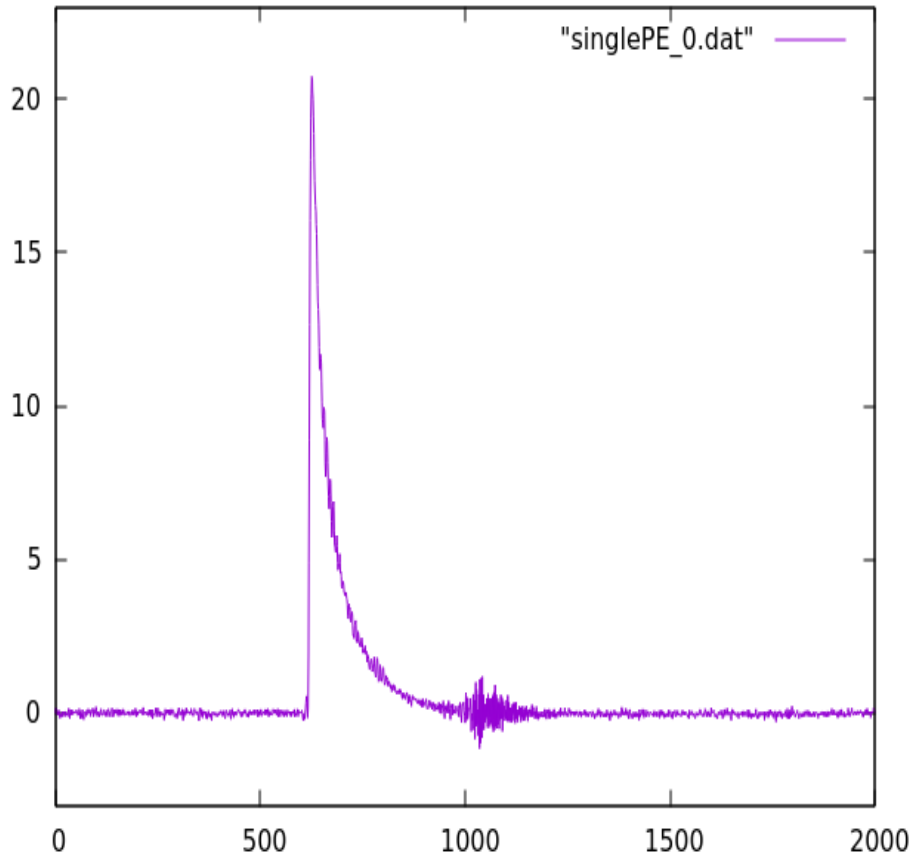


Cell #4 in pDUNE (SSP 504)

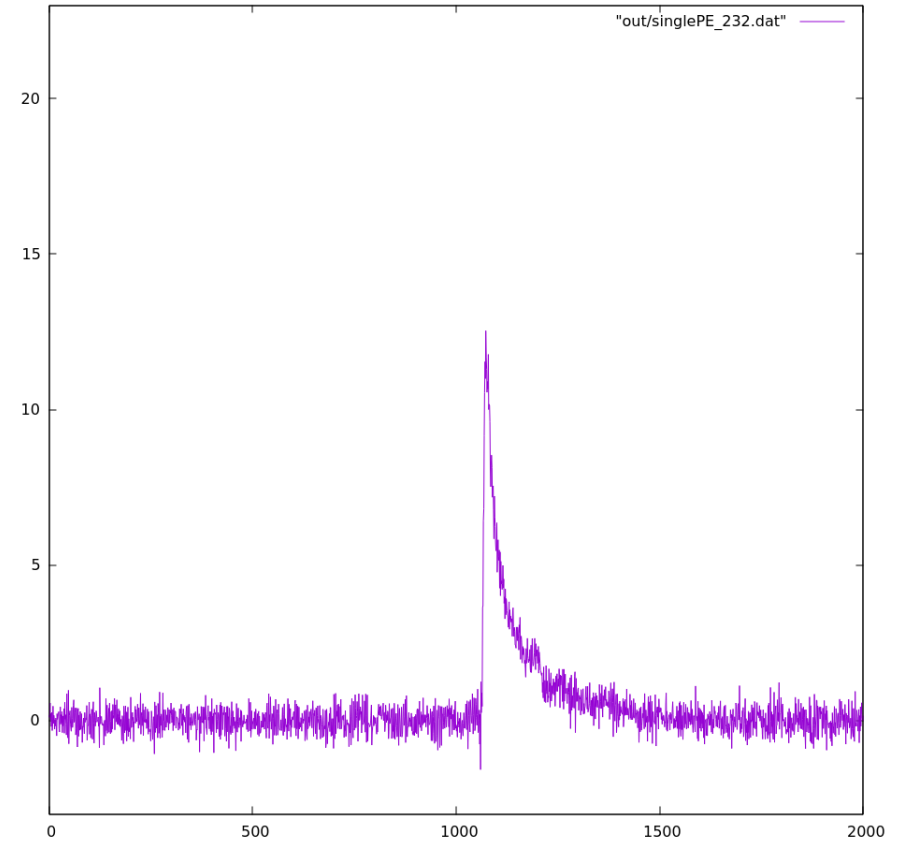


# SPE comparison

Cell #1 in 182 Building (Standalone SSP)



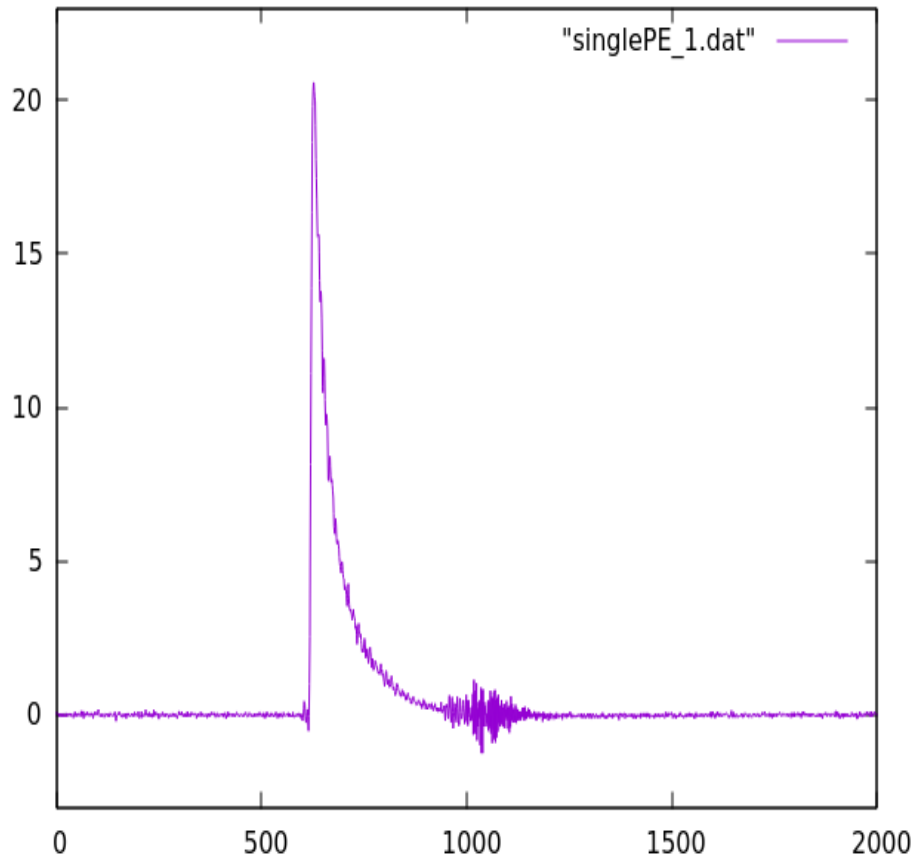
Cell #1 in pDUNE (SSP 504)



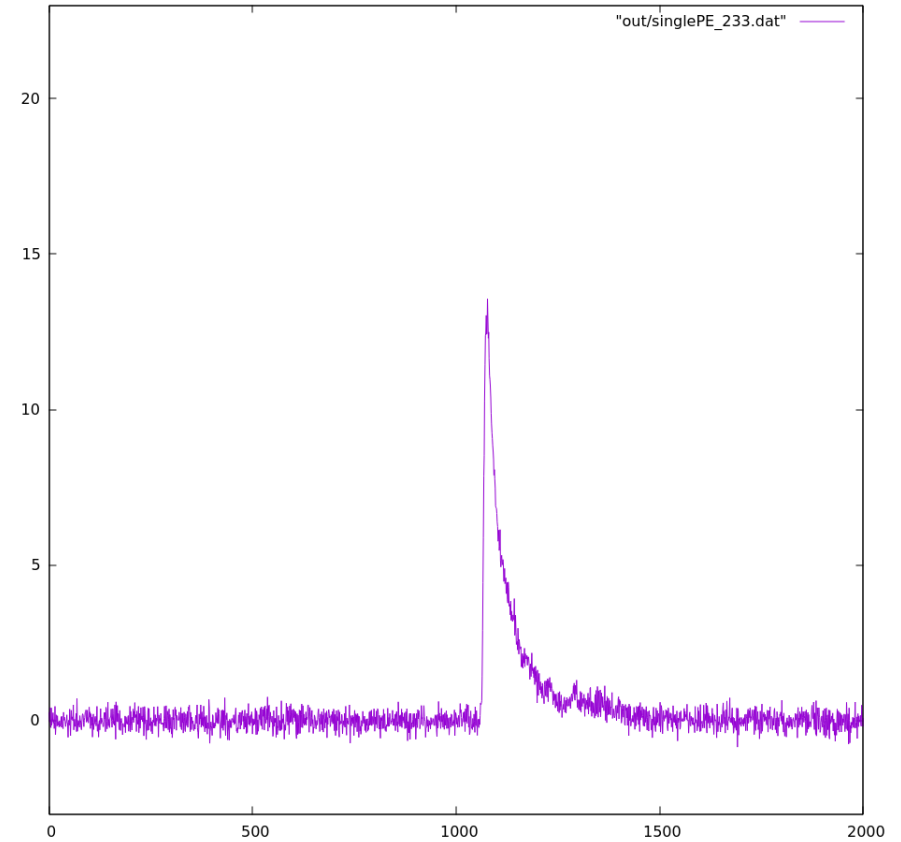


# SPE comparison

Cell #2 in 182 Building (Standalone SSP)

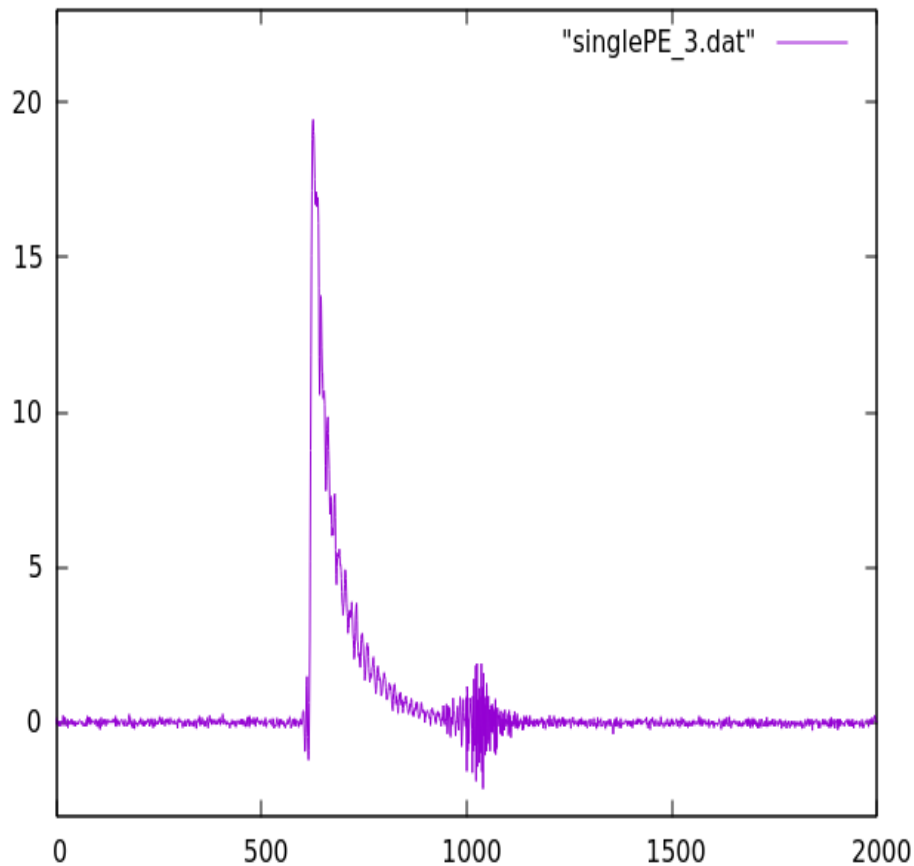


Cell #2 in pDUNE (SSP 504)

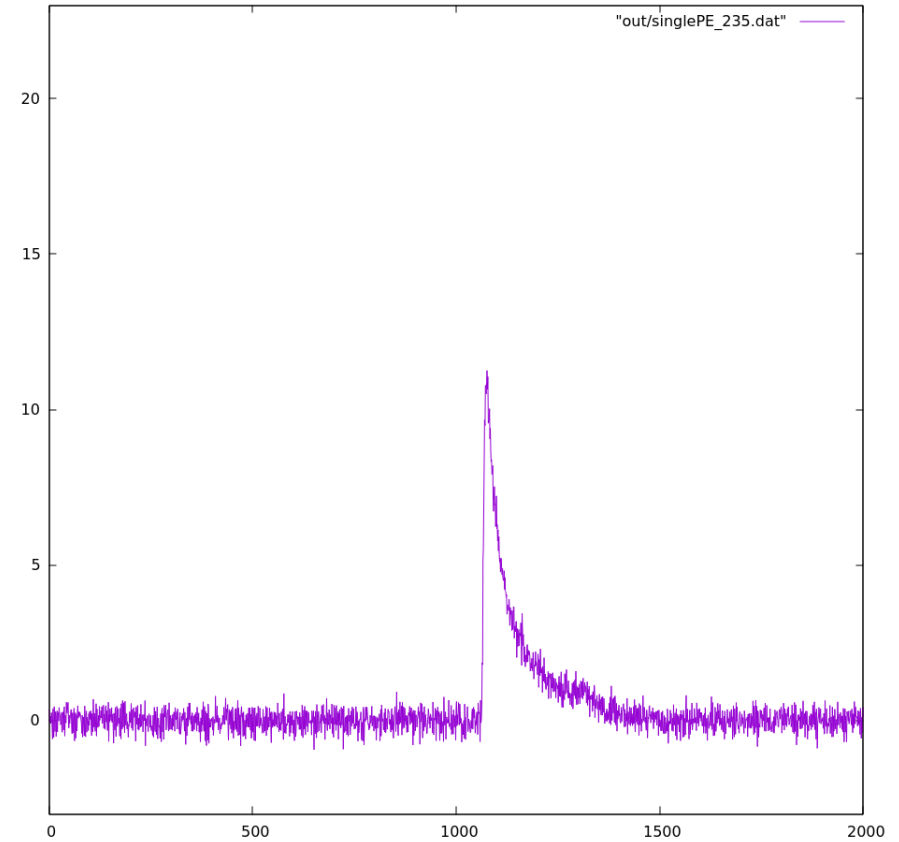


# SPE comparison

Cell #4 in 182 Building (Standalone SSP)



Cell #4 in pDUNE (SSP 504)



# Possible source of difference:

Gain of the SiPM is defined as

$$G = \frac{C_j * \Delta V}{e}$$

where  $C_j$  is the junction capacitance,  $\Delta V$  is the over voltage  $\Delta V = V_{Bias} - V_{BR}$ .

In building 182, modified SSP module was used while in ProtoDUNE-SP test SSP-504 module is used. The gain can depend on

$$G = \frac{V_u * t_u}{e * R * K_{amp}} * 1pe$$

$V_u$ : Voltage per channel of ADC

$t_u$ : time of one sample of the ADC

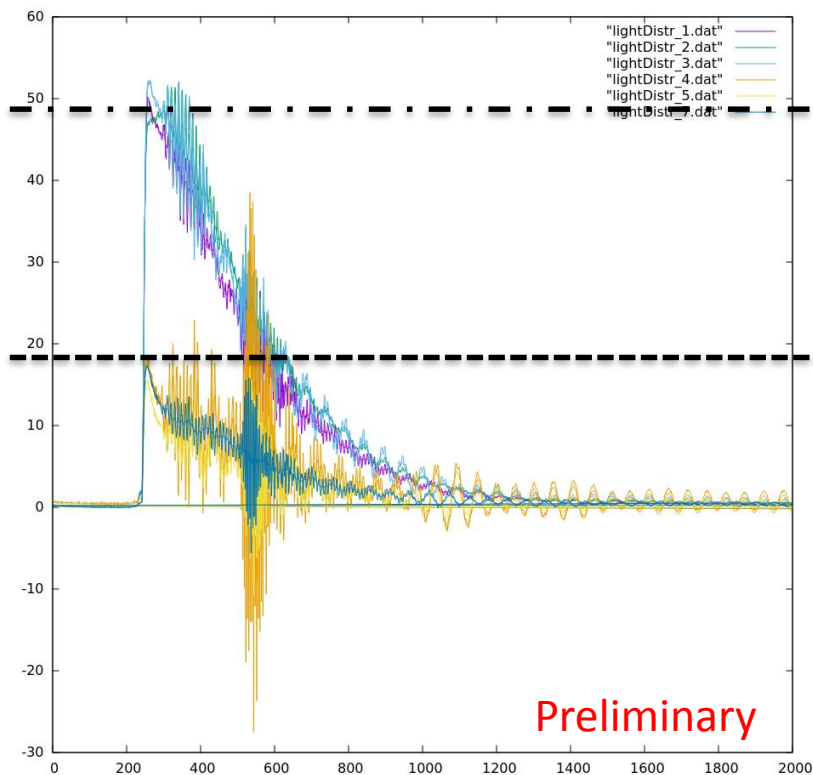
$K_{amp}$ : amplification factor of the electronics

$R$ : input impedance of the ADC

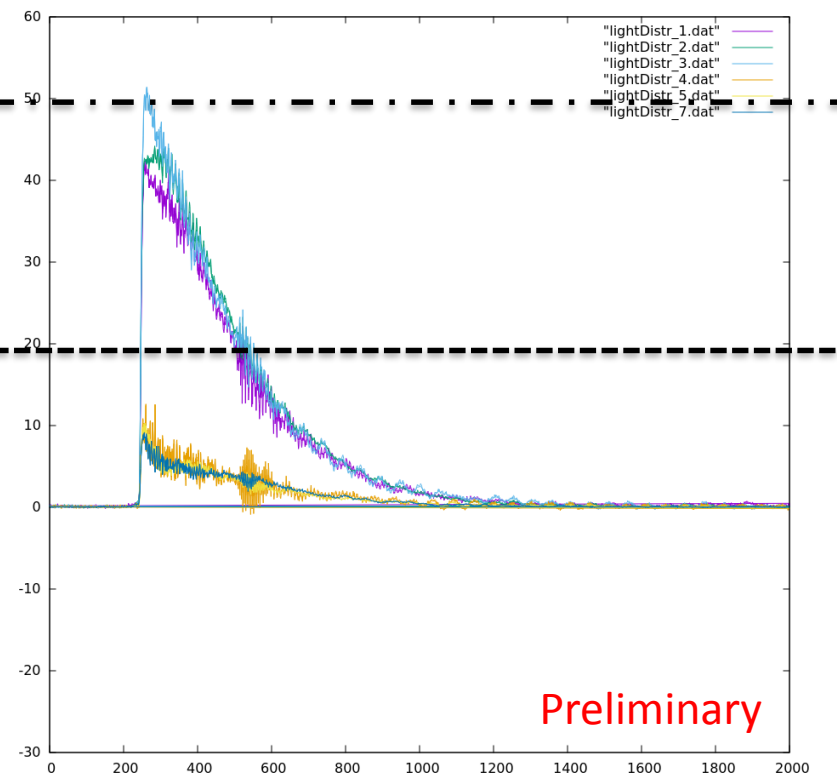
# External trigger

- External trigger from telescope used in standalone SSP
- Run number of 16 (before doping) and 22 (after Xe doping) are shown
- We had an issue with noise (grounding) for external trigger data taking.

Run 16



Run 22



Work in progress.