Run 2 (October) Wunderbar Results from TallBo

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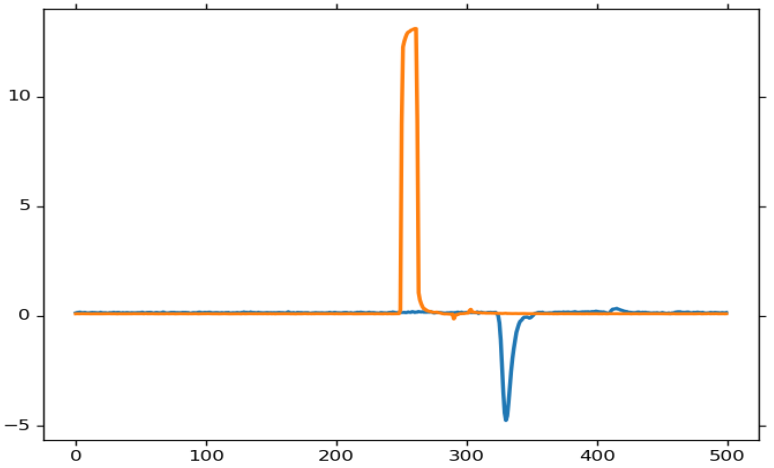
Oct 19, 2016

LED Calibration Runs

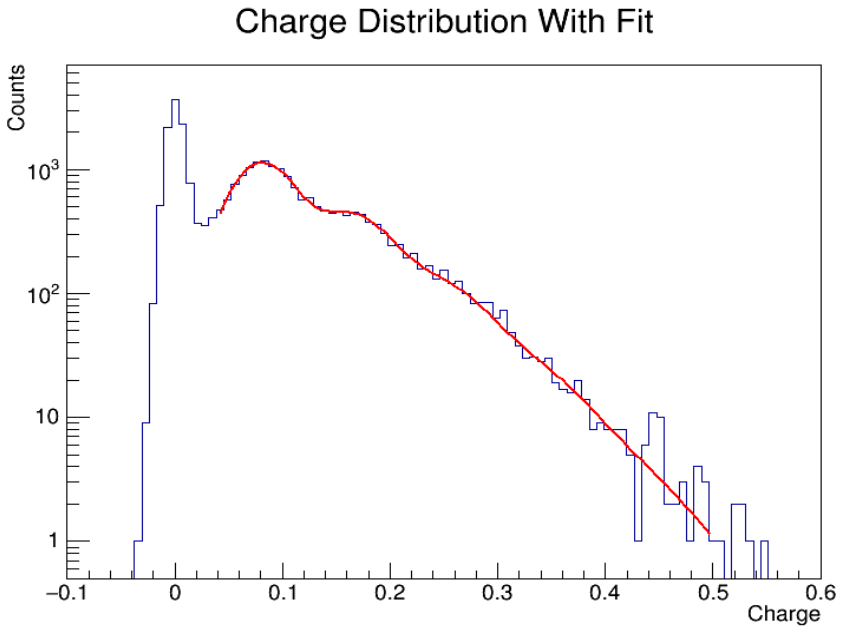
- In an effort to directly track daily gains, we did an LED run every morning
- Prompt charge calculated using a fixed window after verifying that the window was valid for all runs
    - LED pulse in [700:800]
    - PMT pulse in [800:900]
    - Baseline [0:800]



Superposition of 1000 waveforms. 5 LED runs are indistinguishable. Note x-axis offset by -500

LED Calibration Runs

- First 5 terms in Gauss/Poisson fit used



Fit results of interest...

	X2 / NDF	SPE	σ SPE	μ PE
Oct 12	1.39	0.071	0.004	0.93
Oct 13	0.97	0.071	0.003	0.93
Oct 14	0.82	0.065	0.004	1.04
Oct 15	1.15	0.070	0.005	0.98
Oct 16	0.89	0.068	0.004	1.02

Important to note (if you wanted to do anything with these values)
These LED runs were done such that the units are mV*(1.6 ns)
Previous LED run was done with finer graining of mV*(400 ps)

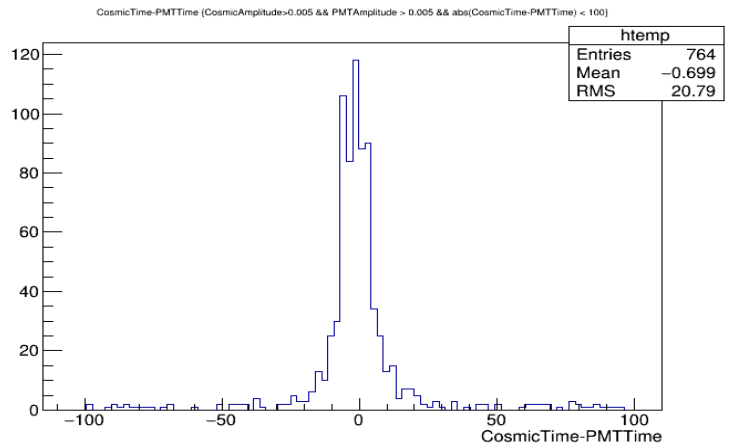
Analysis of SiPM Triggered Runs

SiPM: Use fixed window [500:2500]

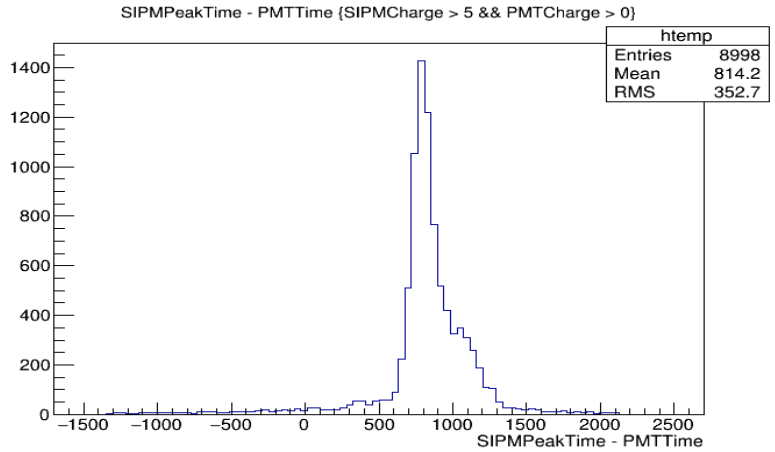
PMT: Use time relative to SiPM to establish analysis window.

- Define search window as [t_{SIPM}-1200,t_{SIPM}-600]
- Find maximum amplitude in search window
- Define integration window [t_{max}-40, t_{max}+60]
- @ ~160 ns this will essentially capture prompt only

Cosmic: Cosmic pulses (when present) arrive very nearly in time with PMT, use same window

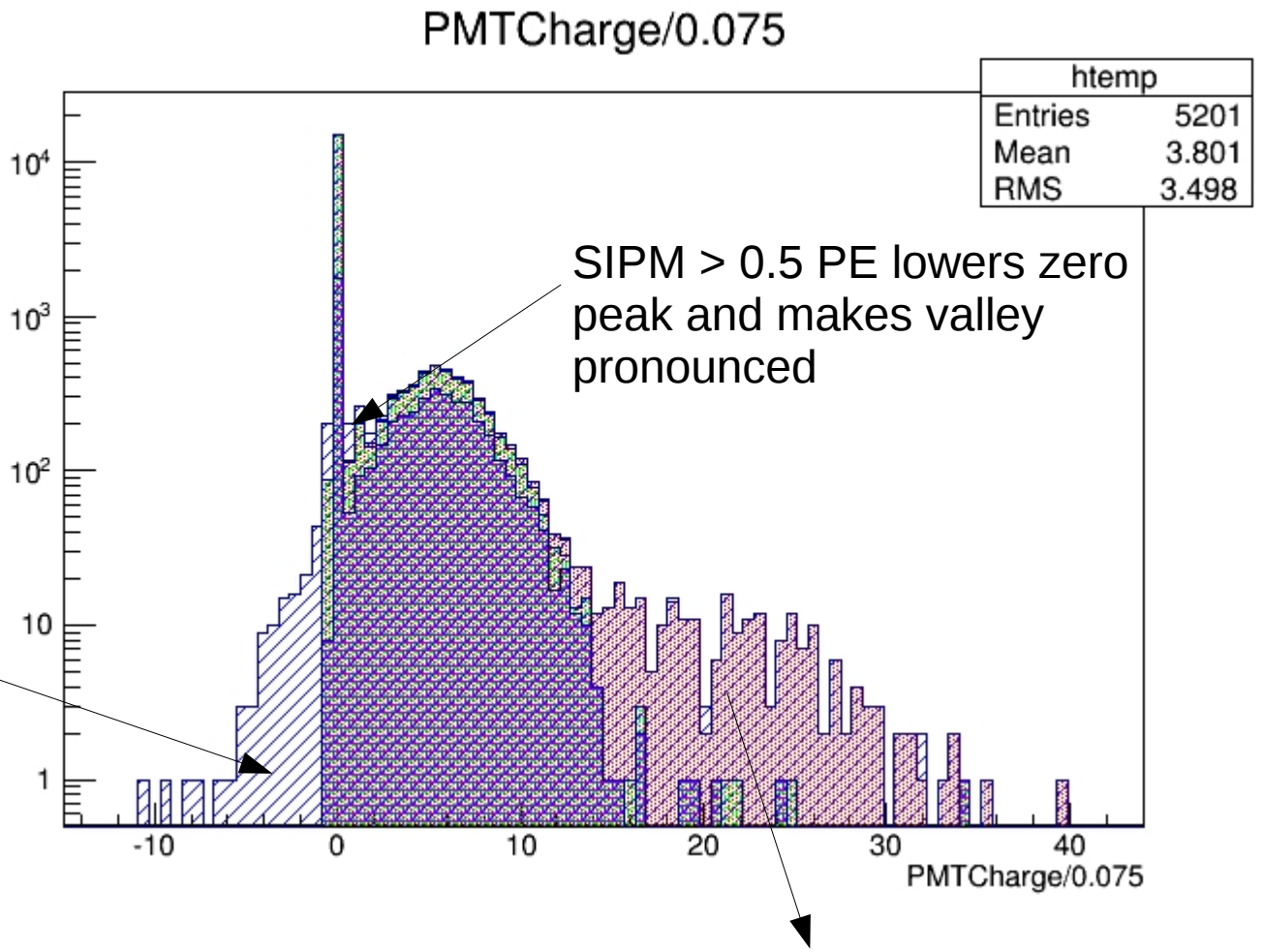


Cosmic Peak Time – PMT Peak Time



SiPM Peak Time – PMT Time

Cuts

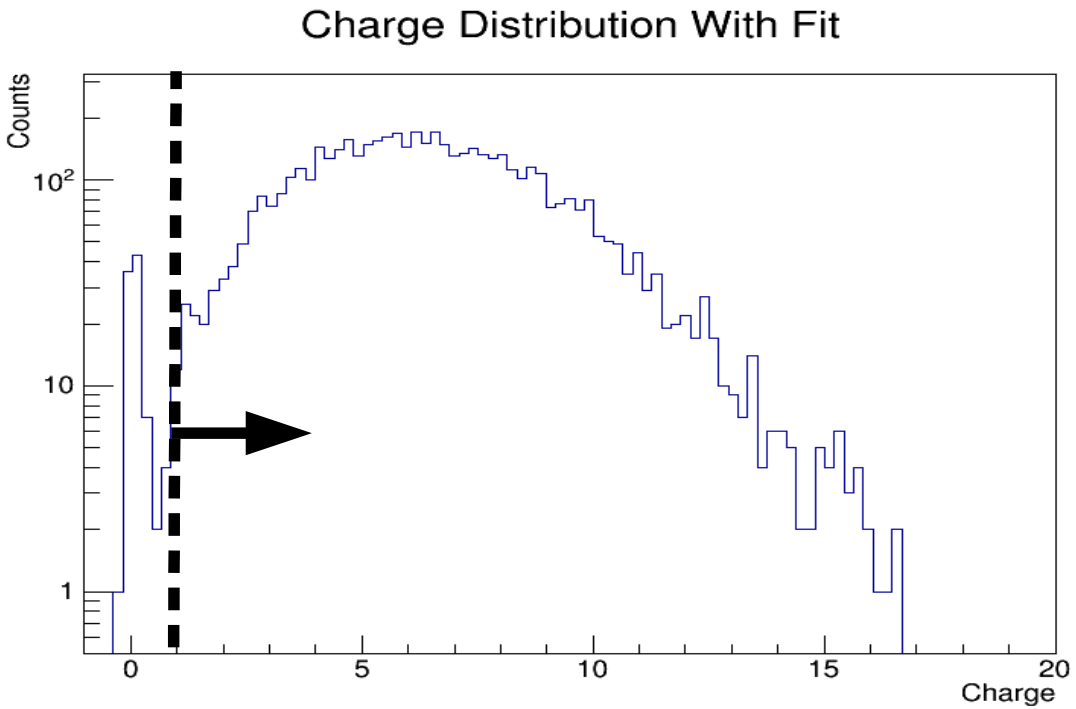

PMTCharge/0.075
htemp
Entries 5201
Mean 3.801
RMS 3.498
SIPM > 0.5 PE lowers zero peak and makes valley pronounced
Baseline cut kills these
Cosmic cut kills these
10^4
10^3
10^2
10
1
-10
0
10
20
30
40
PMTCharge/0.075

Method 1: Simple Integration

Post cuts the main peak(s) are well separated from pedestal

Lowest distributions peak (visually) >~5, can safely ignore 0 peak with < 1% loss of events

Integrate from [1:] to obtain μ_{PE}



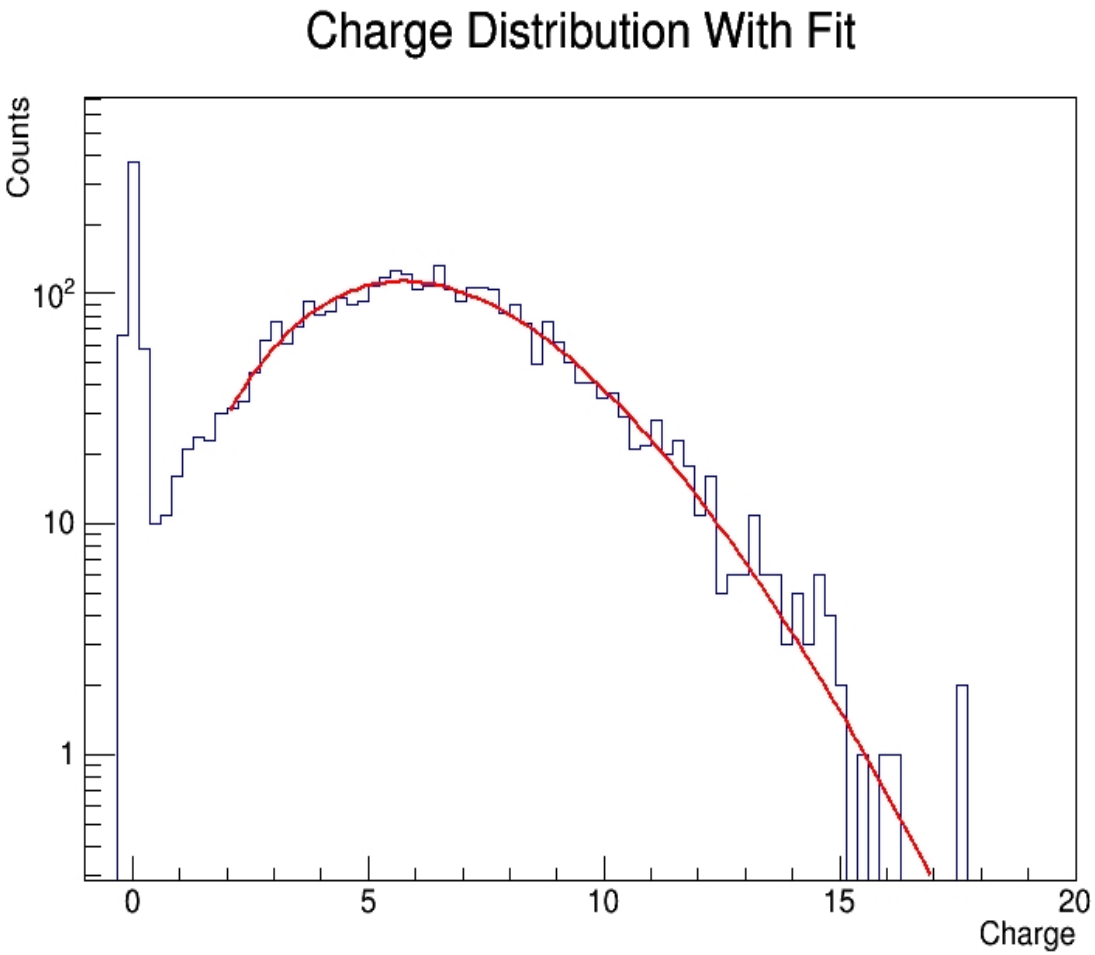
Method 2: Fit

With cuts in place fitting works reasonably well. Fit converges nicely in general

$\chi 2$ /NDF = 1.11 +/- 0.23

$$MPE(x) = C \sum_{n=1}^{20} \frac{e^{-\mu} \mu^{n}}{n!} e^{\frac{-(x-ng)^2}{2n\sigma_{SPE}^2}}$$

Extract mean from fit



Comparison

In principle, assuming all goes well, these two results should match each other nicely

In practice there is a difference...

$$\mu_{\text{PE-Simple}} / \mu_{\text{PE-Fit}} = 0.92 \text{ +/- } 0.04$$

Turns out this is because the fit method systematically disagrees with the LED obtained gain value.

If perfectly calibrated this should be 1

$$MPE(x) = C \sum_{n=1}^{20} \frac{e^{-\mu}\mu^{n}}{n!} e^{\frac{-(x-ng)^2}{2n\sigma_{SPE}^2}}$$

In practice the fitter generally converges on a value of 0.94 +/- 0.04

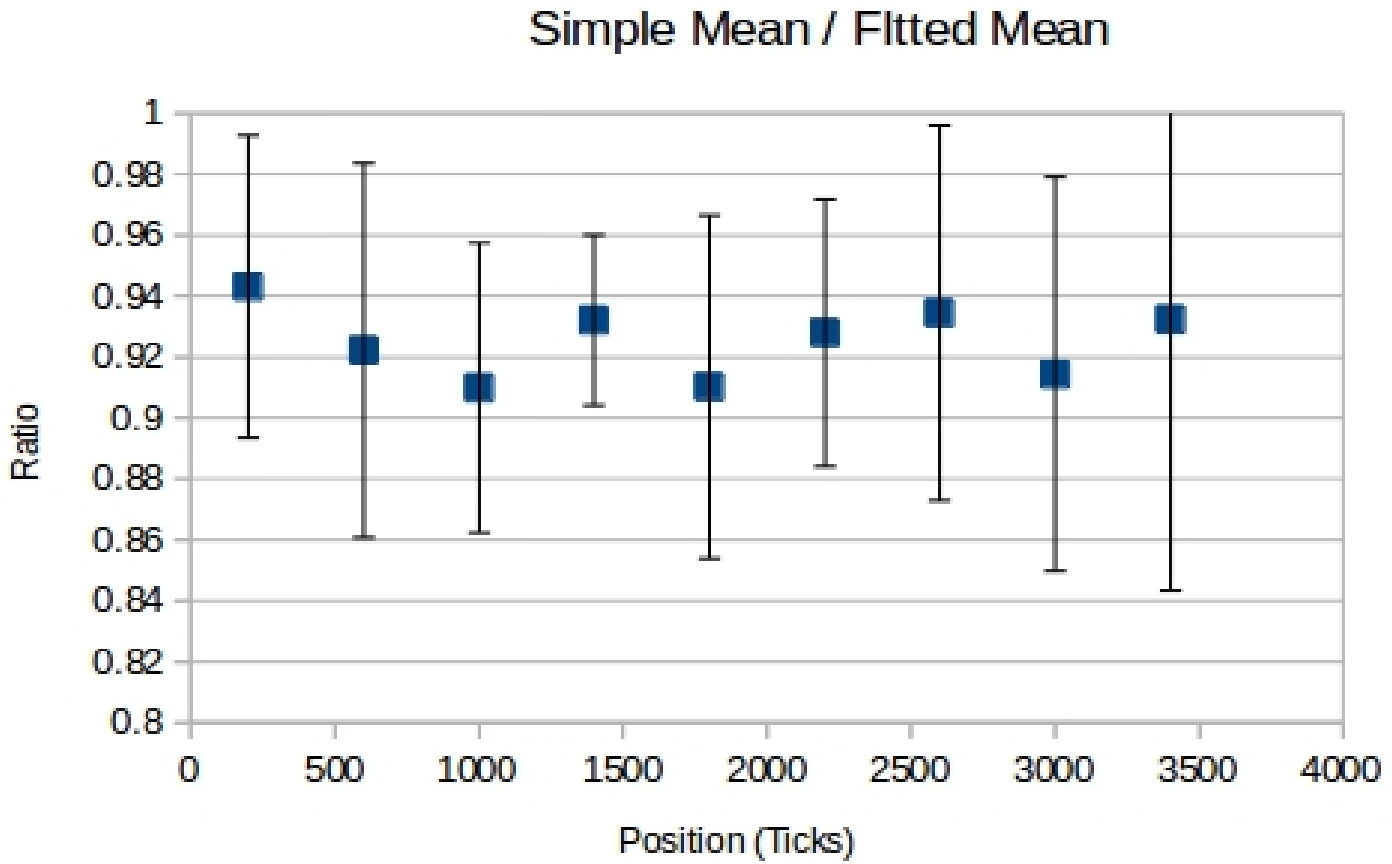
Small, but obviouly systematic. Likely due to oversimplified treatment of pedestal offset.

Attempts to perform a smarter LED fit were frustrated by coffee not being allowed in the collaboration meeting conference room.

Turns out it may be okay anyway...

Comparison

Effect is systematic between methods, but not correlated with position along bar, so we're good to use this for attenuation measurements still



Results

Fit results to exponential, omit final point (200)

	$\lambda_{PE\text{-}Sim}$	σ_{Sim}	$\lambda_{PE\text{-}Fit}$	σ_{Fit}
Bar 1	131	38	96	9
Bar 2	120	34	96	12
Bar 3	80	14	71	7
Bar 4	91	19	96	12
Bar 5	110	25	89	24
Bar 6	76	13	52	5
Bar 7	82	14	78	7
Bar 8	138	50	112	18
Bar 9	129	39	124	17
Bar 10	88	23	83	9