Results from n3He Target Chamber Voltage Scan

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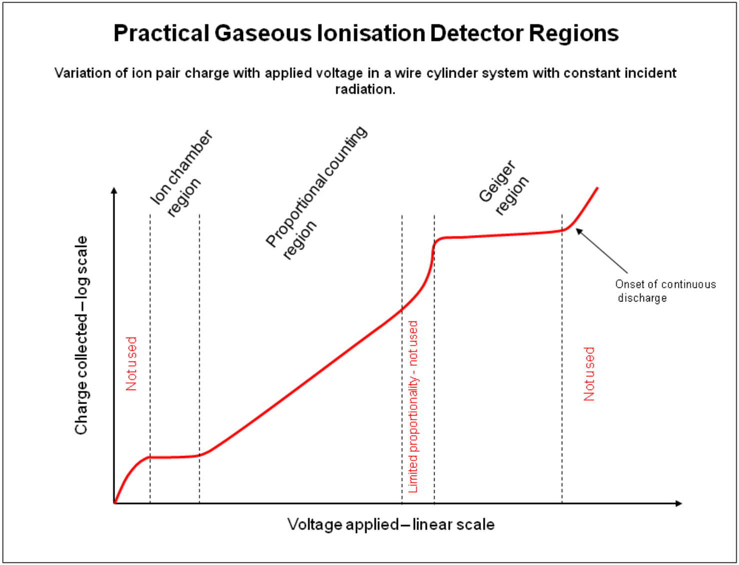
Basic Modes of Operation



Fitting Method

For fitting the proportional region first a constant line from 200 - 340V was fit in the ionization region for most wires. This was used to set $p0$ in the piece wise function

$$f(x) = \begin{cases} p0 & \text{if } x < p2 \\ p0 + p1(x - p2)^2 & \text{if } x > p2 \end{cases} \quad (1)$$

Root Formula Definition:

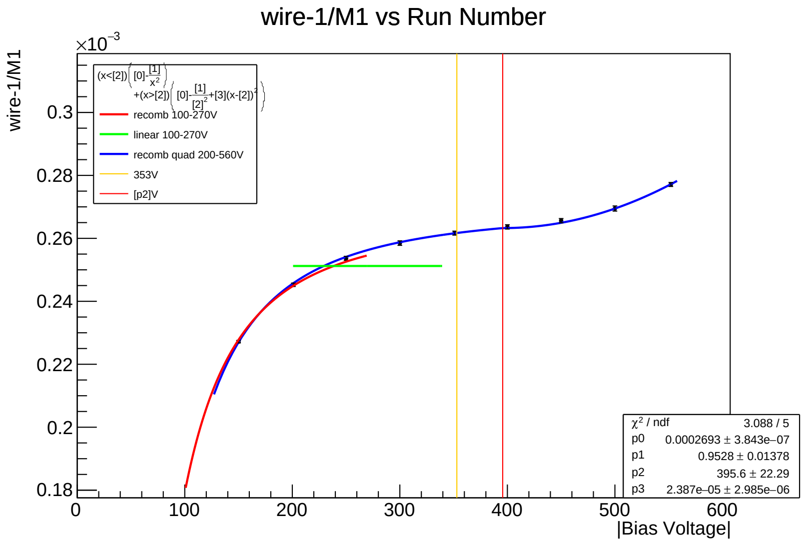
```
TF1 *fm3 = new TF1("fm3","(x<[2])*[0]
+(x>[2])*([0]+([1]*(x-[2]))**2)",200,560);
```

giving a continuous curve that starts linear and transitions at voltage $p2$ to quadratic. Outer wires from 1-70 where ion chamber region was very small or nonexistent were fit as:

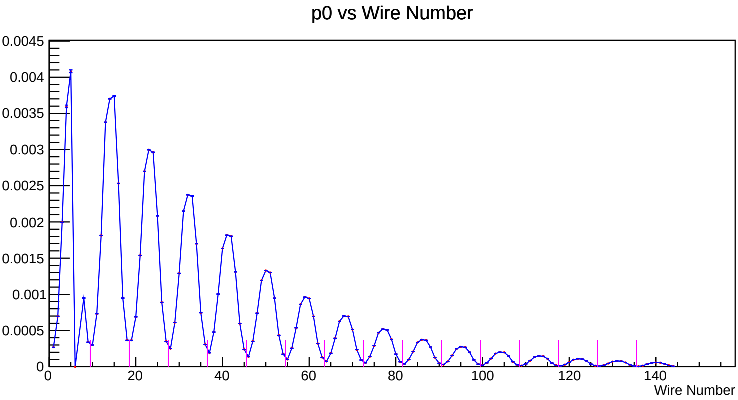
$$f(x) = \begin{cases} p0 - p1/x^2 & \text{if } x < p2 \\ (p0 - p1/p2^2 + p3(x - p2)^2 & \text{if } x > p2 \end{cases} \quad (2)$$

```
TF1 *fm3 = new TF1("fm3","(x<[2])*([0]-[1]/x**2) + (x>[2])*
+ ([3]*(x-[2]))**2)",100,560);
```

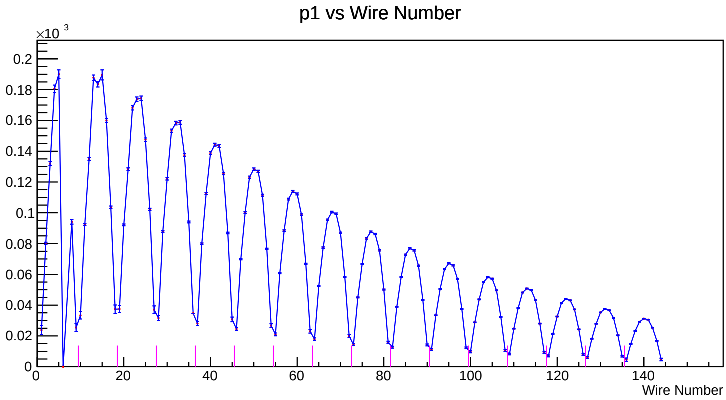
Outer Wire Fitting Example



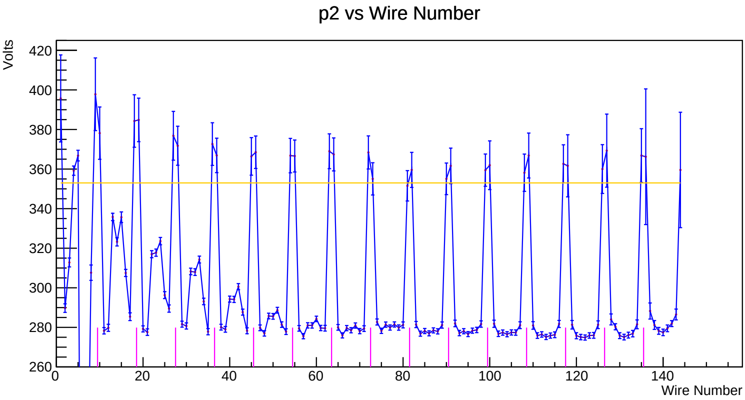
p0 vs Wire Number



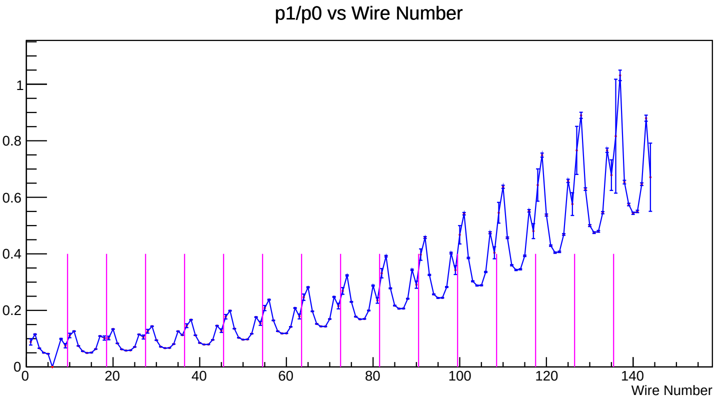
p1 vs Wire Number



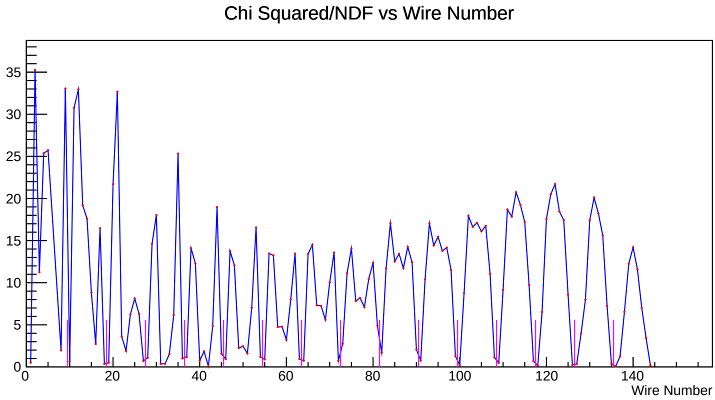
p2 vs Wire Number



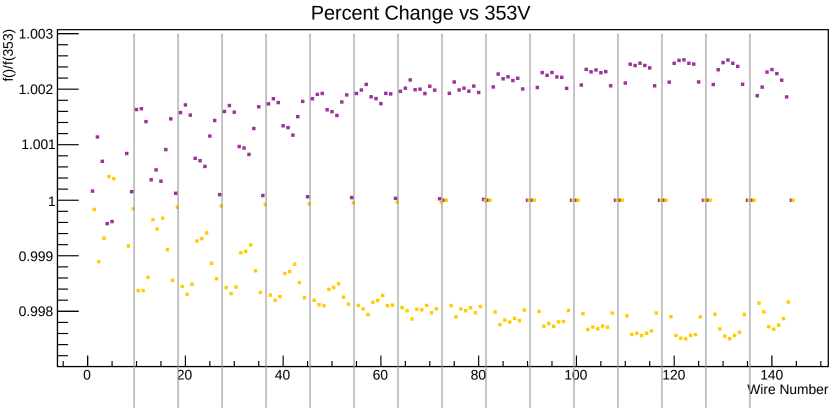
p1/p0 vs Wire Number



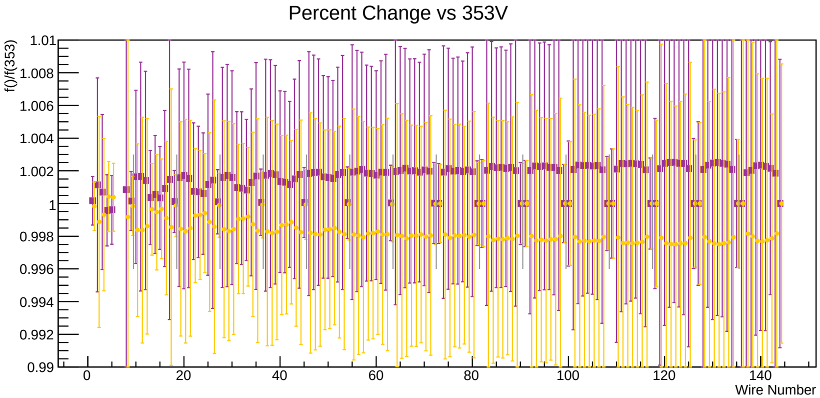
χ^2/NDF vs Wire Number



Effect of 1V Ripple - without error bars



Effect of 1V Ripple - with error bars



single wire asymmetry

Depending which wire ionization occurs around it will have a different rate of ionization collection with most wires collecting slightly more ionization than occurred around the wire. This gives an effective increase in the gain that changes across the chamber.

$$A_1 = \frac{g_{amp} g_{gas} I^{\uparrow} - g_{amp} g_{gas} I^{\downarrow}}{g_{amp} g_{gas} I^{\uparrow} + g_{amp} g_{gas} I^{\downarrow}} \tag{3}$$

$$= \frac{g_{amp} g_{gas}}{g_{amp} g_{gas}} \frac{I^{\uparrow} - I^{\downarrow}}{I^{\uparrow} + I^{\downarrow}} \tag{4}$$

$$= \frac{I^{\uparrow} - I^{\downarrow}}{I^{\uparrow} + I^{\downarrow}} \tag{5}$$

Two Wire Geometric Asymmetry

$$R_{ij}^{\uparrow/\downarrow} = \frac{g_{amp,i} g_{gas,i} I_i^{\uparrow/\downarrow}}{g_{amp,j} g_{gas,j} I_j^{\uparrow/\downarrow}} \tag{6}$$

$$A_2 = \frac{R_{ij}^{\uparrow} - R_{ij}^{\downarrow}}{R_{ij}^{\uparrow} + R_{ij}^{\downarrow}} \tag{7}$$

$$= \frac{\frac{g_{amp,i} g_{gas,i} I_i^{\uparrow}}{g_{amp,j} g_{gas,j} I_j^{\uparrow}} - \frac{g_{amp,i} g_{gas,i} I_i^{\downarrow}}{g_{amp,j} g_{gas,j} I_j^{\downarrow}}}{\frac{g_{amp,i} g_{gas,i} I_i^{\uparrow}}{g_{amp,j} g_{gas,j} I_j^{\uparrow}} + \frac{g_{amp,i} g_{gas,i} I_i^{\downarrow}}{g_{amp,j} g_{gas,j} I_j^{\downarrow}}} \tag{8}$$

$$= \frac{\frac{g_{amp,i} g_{gas,i}}{g_{amp,j} g_{gas,j}}}{\frac{g_{amp,i} g_{gas,i}}{g_{amp,j} g_{gas,j}}} \frac{\frac{I_i^{\uparrow}}{I_j^{\uparrow}} - \frac{I_i^{\downarrow}}{I_j^{\downarrow}}}{\frac{I_i^{\uparrow}}{I_j^{\uparrow}} + \frac{I_i^{\downarrow}}{I_j^{\downarrow}}} = \quad = \frac{\frac{I_i^{\uparrow}}{I_j^{\uparrow}} - \frac{I_i^{\downarrow}}{I_j^{\downarrow}}}{\frac{I_i^{\uparrow}}{I_j^{\uparrow}} + \frac{I_i^{\downarrow}}{I_j^{\downarrow}}} \tag{9}$$

Asymmetries from Elise's Presentation

Two detector asymmetry from NDGamma

$$A_{exp} = \frac{(\sum S_{up} - \sum S_{dn})_{d1} - (\sum S_{up} - \sum S_{dn})_{d2}}{(\sum S_{up} + \sum S_{dn})_{d1} + (\sum S_{up} + \sum S_{dn})_{d2}} \tag{10}$$

Beam Asymmetry

$$A_B = \frac{(\sum S_{up} - \sum S_{dn})_{d1} + (\sum S_{up} - \sum S_{dn})_{d2}}{(\sum S_{up} + \sum S_{dn})_{d1} + (\sum S_{up} + \sum S_{dn})_{d2}} \tag{11}$$

Detector Asymmetry

$$A_D = \frac{(\sum S_{up} + \sum S_{dn})_{d1} - (\sum S_{up} + \sum S_{dn})_{d2}}{(\sum S_{up} + \sum S_{dn})_{d1} + (\sum S_{up} + \sum S_{dn})_{d2}} \tag{12}$$

Geometric Asymmetry - Nadia NPDG Analysis

$$\alpha = \left[\frac{N_i^{\uparrow}}{N_i^{\downarrow}}\right]\left[\frac{N_{i+6}^{\uparrow}}{N_{i+6}^{\downarrow}}\right] \tag{13}$$

$$A_i^{raw} = \frac{\sqrt{\alpha}-1}{\sqrt{\alpha}+1} \tag{14}$$

Beam Power Scan

- Very rarely was beam power changed significantly during a run where we took data.
- Instead use runs over full duration of data taking to sample different powers
- 16 runs chosen
- M1 Integral ran from 4e6 to 7.5e6
- nearly 100% beam power change

List of Runs

19484(shutter closed)

18014
22014
26014
29914
34014
38024
41914
46014
48012
48014
48015
50014
52014
54014
57014

Method

- Integrated each pulse in a run for all wires and M1

$$x_{j,i} = \frac{1}{60 \times N} \sum_{k=1}^{N} s_{j,i}(k) \quad N = 49 \text{ or } 1624 \tag{15}$$

where $x_{j,i}$ is the integrated total of the ith pulse in the jth run.

- Average pulse integrals and form standard error for run averages

$$Avg = \langle x_j \rangle = \frac{1}{q} \sum_{i=1}^{q} x_{j,i} \tag{16}$$

$$q = \text{number of uncut entries in run}$$

$$StdErr = \frac{\sigma}{\sqrt{q}} = \frac{1}{\sqrt{q}} \sqrt{\langle x^2 \rangle - \langle x \rangle^2} \tag{17}$$

- M1 cut used to remove dropped pulses if $M1[600] < 0.9\langle M1[600] \rangle$
- M1 and Chamber correlations not accounted for.

Method

A beam off power supply off run was used as the pedestal and designated by $j = 0$. The wire and M1 values were pedestal subtracted before division.

$$R_j = \frac{\langle x_j \rangle - \langle x_0 \rangle}{\langle M1_j \rangle - \langle M1_0 \rangle} \tag{18}$$

Error Propagation:

$$C = A - B \tag{19}$$

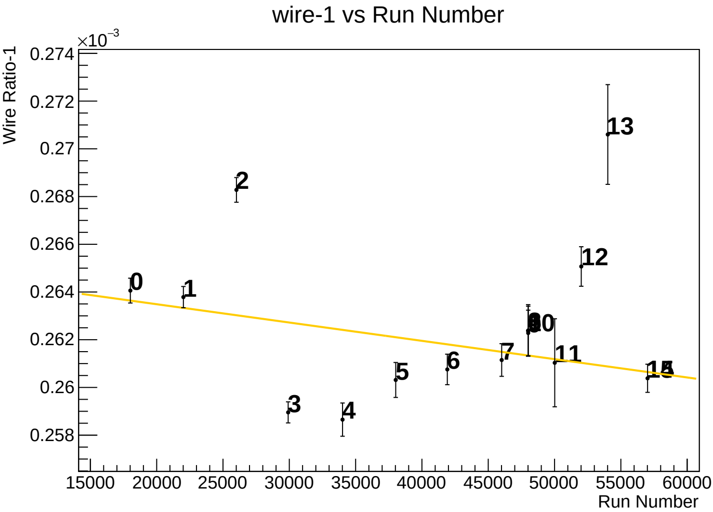
$$\sigma_C = \sqrt{\sigma_A^2 + \sigma_B^2} \tag{20}$$

$$C = \frac{A}{B} \tag{21}$$

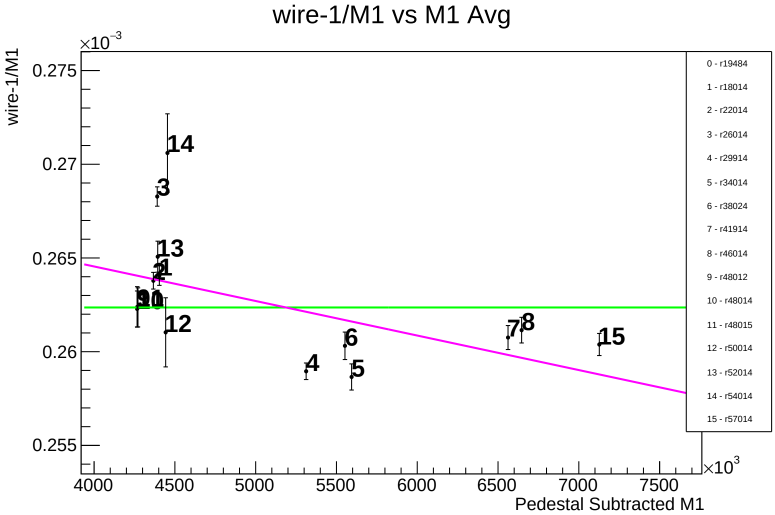
$$\sigma_C = \frac{A}{B}\sqrt{\left(\frac{\sigma_A}{A}\right)^2 + \left(\frac{\sigma_B}{B}\right)^2} \tag{22}$$

where σ is the uncertainty for the values.

Wire 1 / M1 vs. Run Number

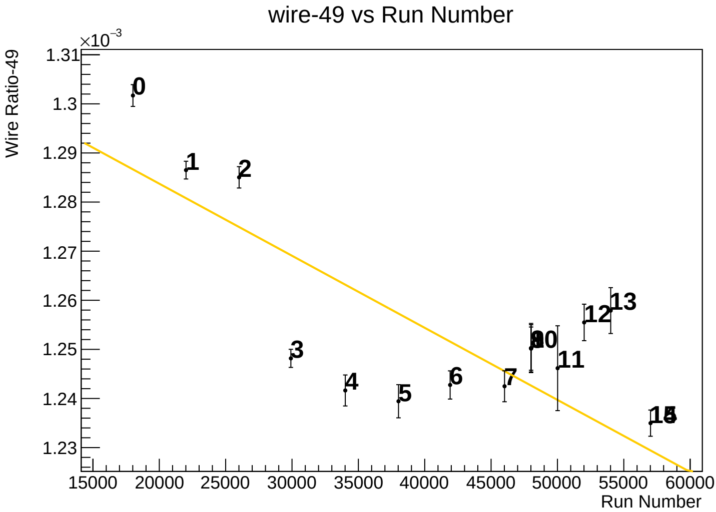


Wire 1 / M1 vs. M1

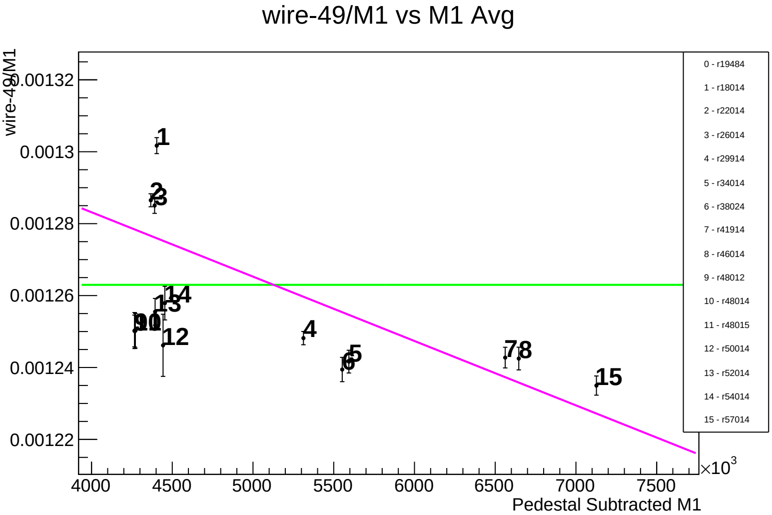


- [0] fit line (green line)
- $[0] + [1] * x$ (magenta line)
- both around χ^2/NDF from 10-14

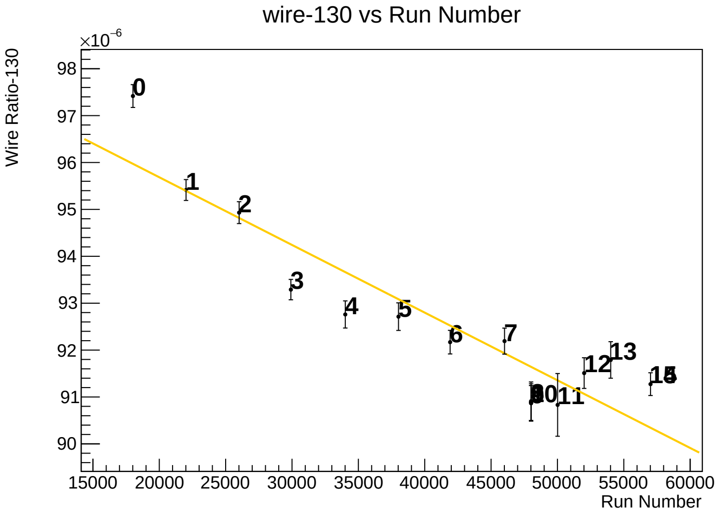
Wire 49 / M1 vs. Run Number



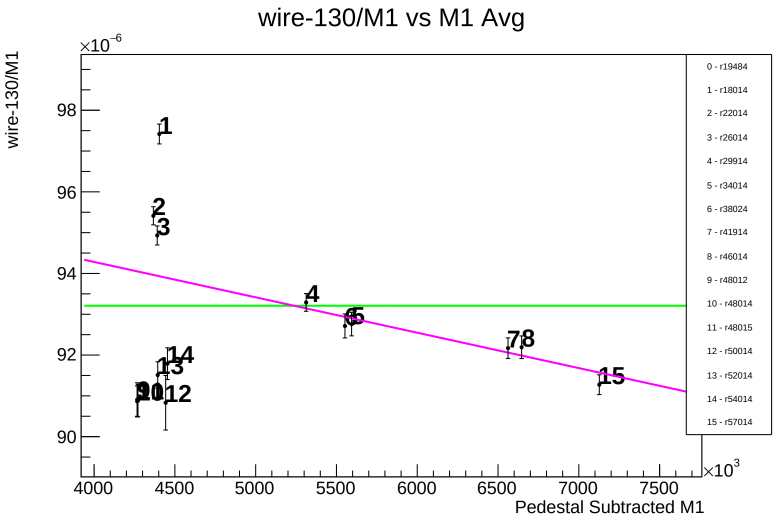
Wire 49 / M1 vs. M1



Wire 130 / M1 vs. Run Number



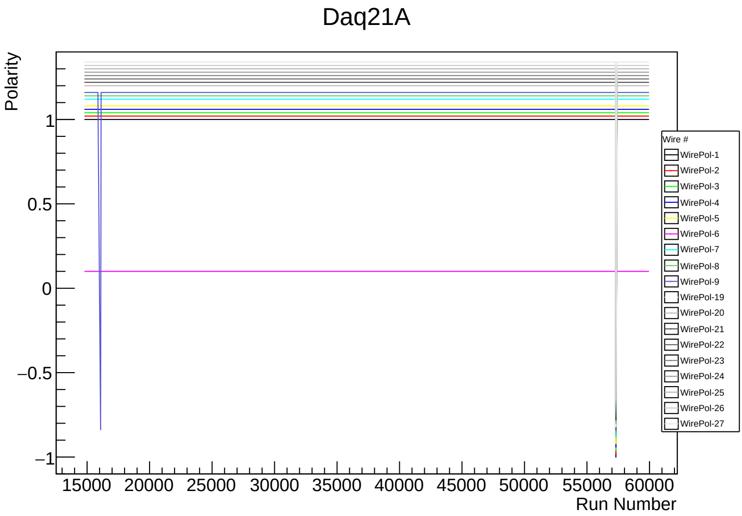
Wire 130 / M1 vs. M1



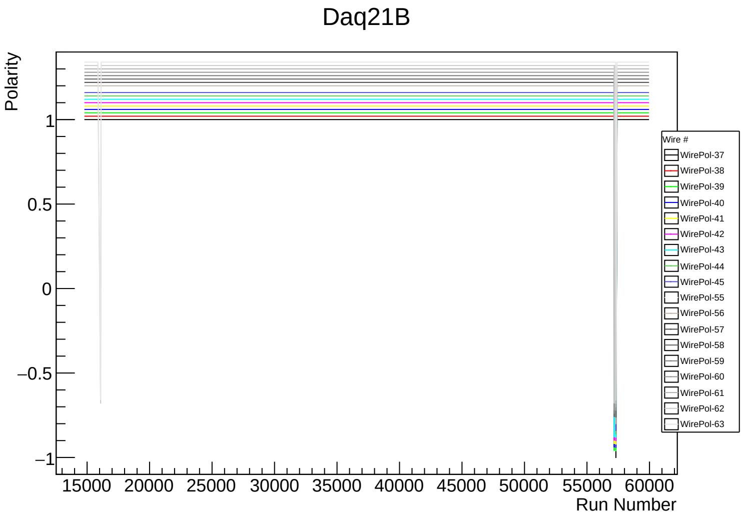
Wire Inversion Scan Method

- Used the condensed data set
- the sign of each wire was found by summing every 103rd pulse in each run, and checking if the sum was greater or less than zero.
- each wire in each run assigned value +1 or -1
- wire 6 assigned value 0 in all runs

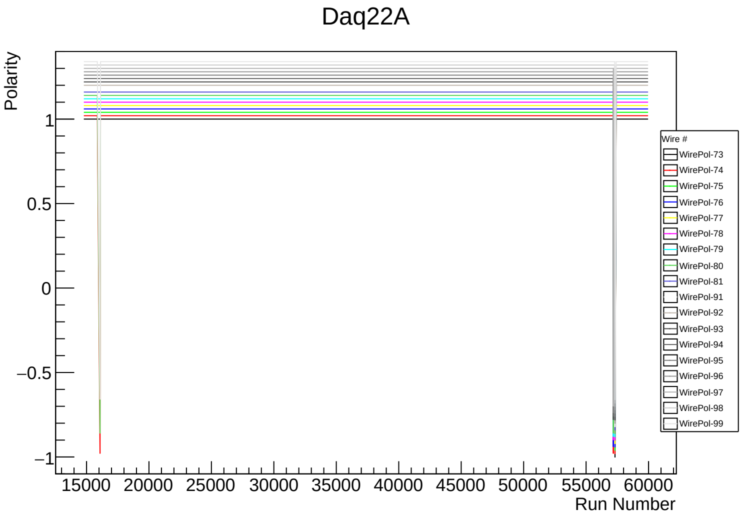
Daq1- channels 0-17



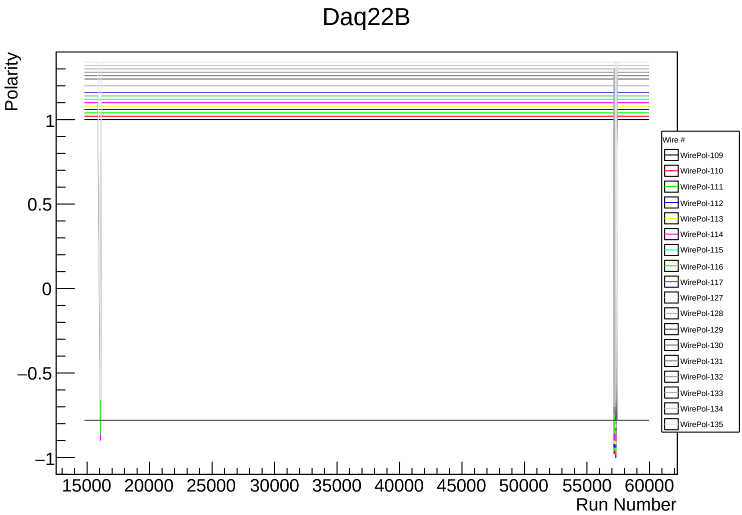
Daq1- channels 24-41



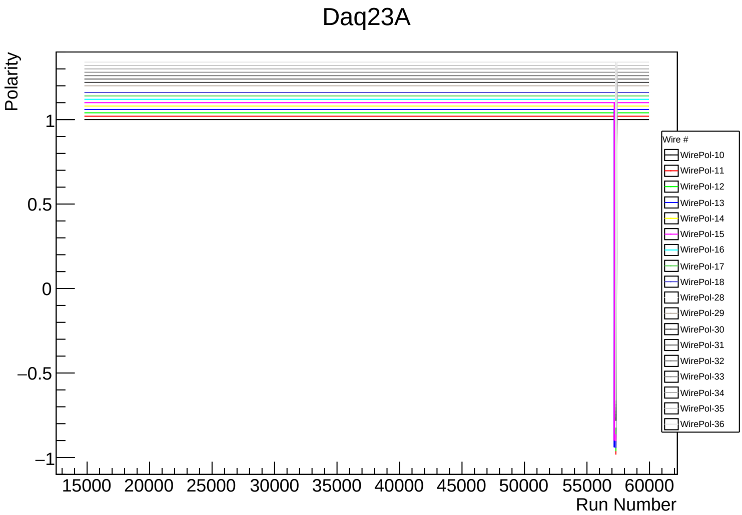
Daq2- channels 0-17



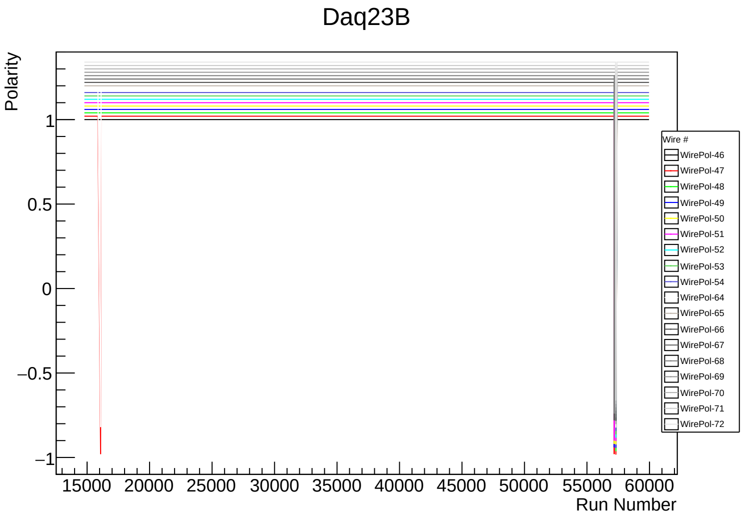
Daq2- channels 24-41



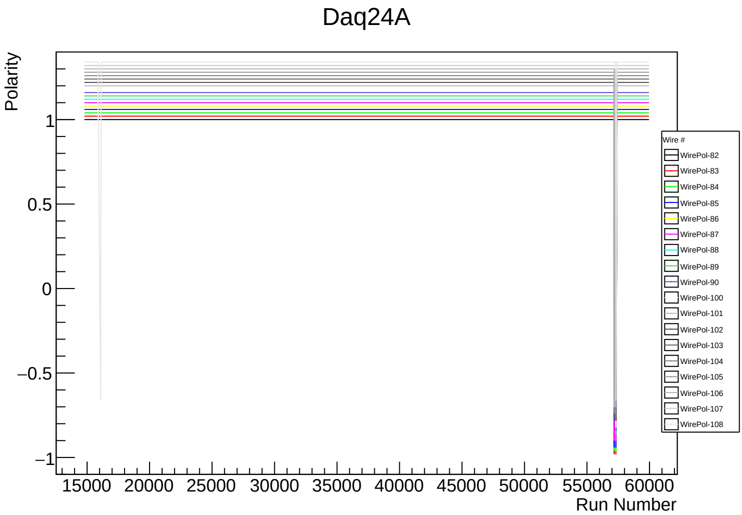
Daq3- channels 0-17



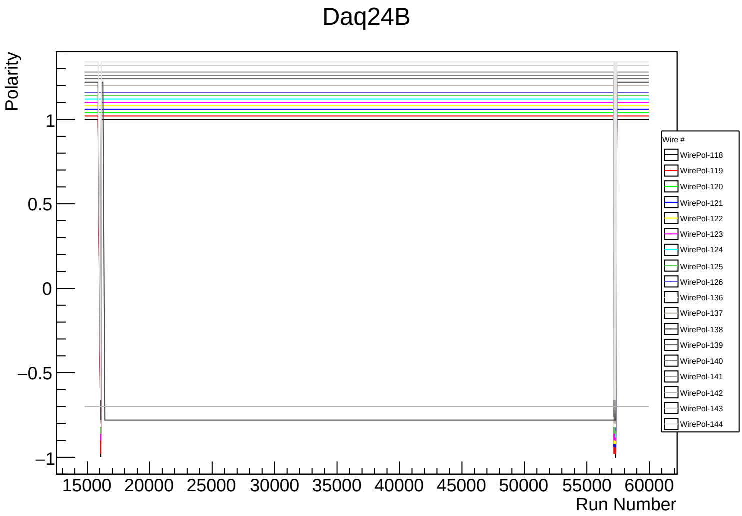
Daq3- channels 24-41



Daq4- channels 0-17



Daq4- channels 24-41



Inversion Locations

- run 16082 inverted
  - inverted wires wires: 9, 47, 62, 63, 64, 74, 80, 99, 100, 108, 114, 116, 118, 119, 123, 135, 136, 137, 138, 144
- run 16121 above reverted
- changed at run 16410 wire 138 + to -
- changed at run 57255 wire 138 - to +
- changed at run 57266 wire 138 + to -
- changed at run 57277 wire 138 - to +
- changed at run 57283 wire 138 + to -
- 57314 most wires inverted until 57403
  - wire not changed: 10, 16, 18, 29, 38, 46, 55, 59, 82, 88, 105, 107, 120, 142, 143

Inversion within a run not thoroughly checked. No indications of mid run changes from other work.