Beam Off Asymmetry Analysis - Progress 2 revision.1

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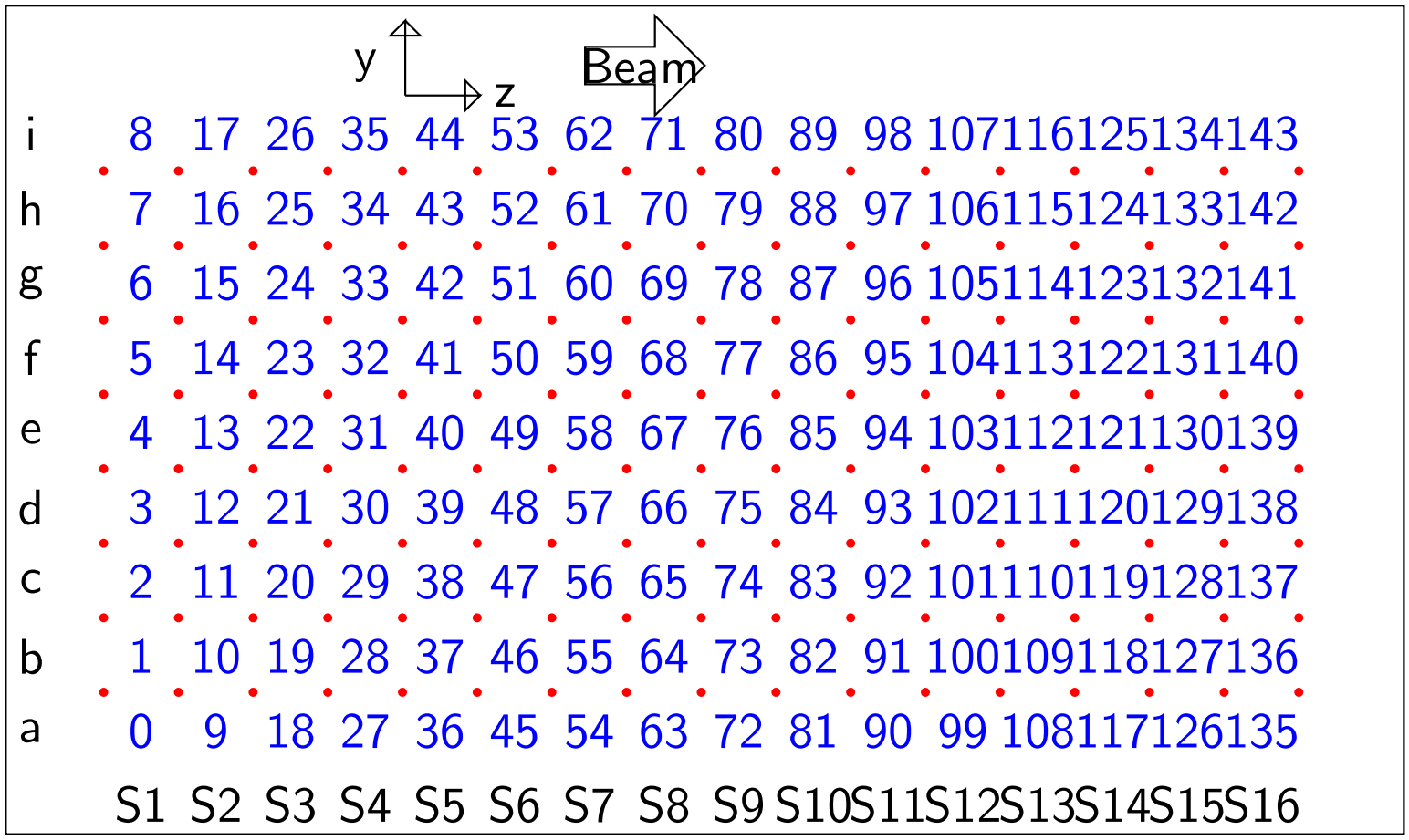
Wire Numbering



- HV 17 HV Frames with 8 wires each
- Signal 16 signal Frames with 9 wires each

List of Runs

- A list of good beam off runs has been provided by Kabir
- Initial analysis will focus on the run range 38100-38700 as subset of the runs used in Kabir's initial analysis truncating approximatelly 80 runs off both ends while maintaining the main central points of interest.

	Run List	
Date Range	Initial Run	Final Run
2015-06-25	38081	38124
2015-06-26	38125	38215
2015-08-03	38216	38301
2015-08-04	38302	38416
2015-08-10	38417	38493
2015-08-11	38494	38657
2015-08-12	38658	38769

Spin Flipper On/Off

A simple pulse sum is taken for pulse i in run j for the absolute value of the spin flipper:

$$x_{j,i} = \sum_{k=1}^{1624} abs(s_{sf,j,i}(k)), \tag{1}$$

which gives a distinct signal for spin flipper on and off signals.

Pulse Sum

For the beam monitor and wires a simple pulse sum is used pulse i in run j as:

$$w_{j,i} = \sum_{k=n}^{m} s_{w,j,i}(k), \tag{2}$$

$$q = \frac{n}{49}1624 \qquad r = \frac{m}{49}1624 \tag{3}$$

$$M1_{j,i} = \sum_{k=q}^{r} s_{M1,j,i}(k), \tag{4}$$

with 49 time bins for the target chamber wires n and m define a subset of that range from 0 to 49. The beam monitor has 1624 time bins and the fraction of its time bins used in the sum are chosen to match the a similar fraction of the total time bins as are used from the wires. k is the time bin index, and $s_{j,i}(k)$ is the recorded signal in time bin k, for run number j.

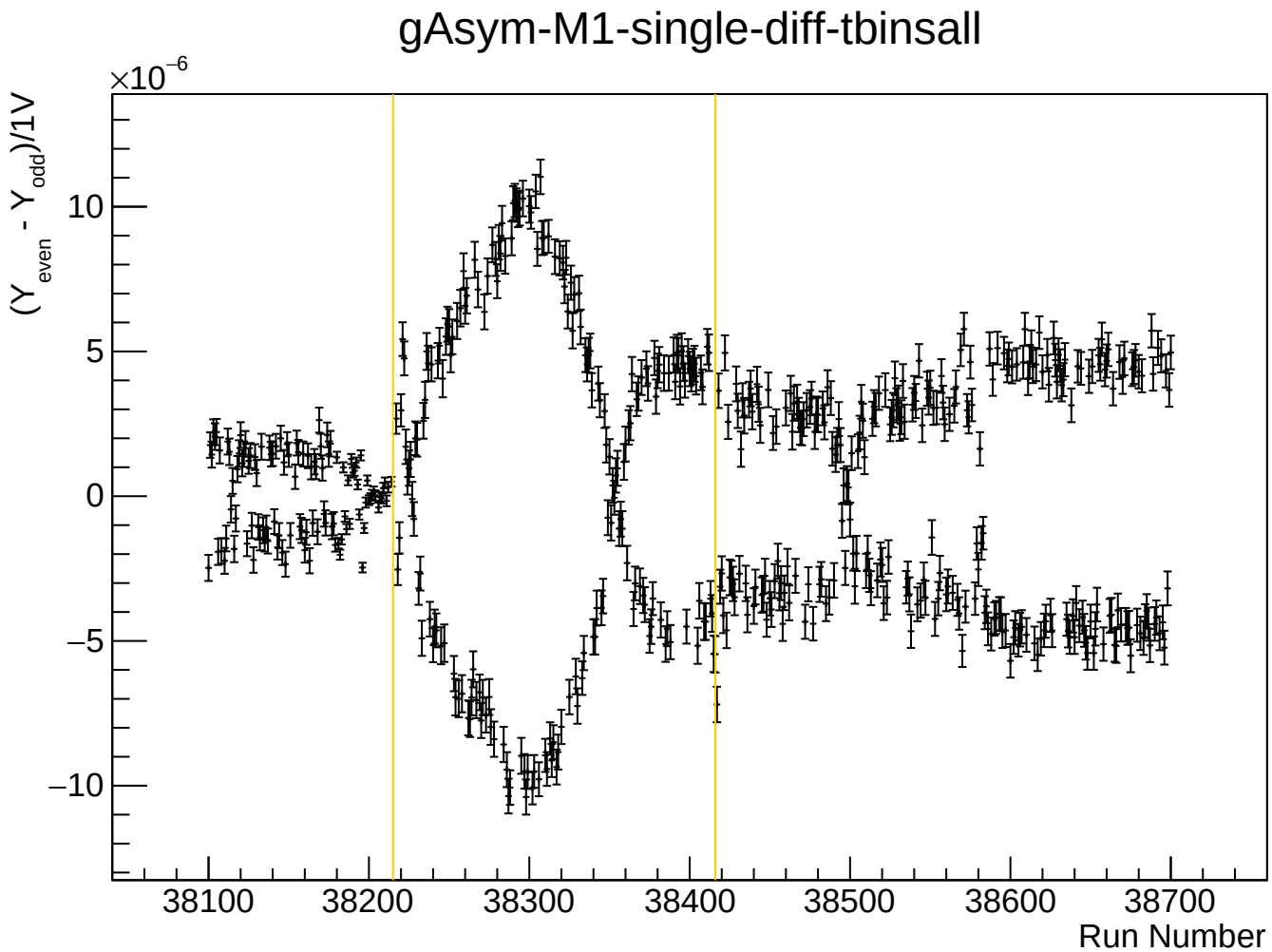
Beam Off Asymmetry Calculation

The single wire instrumental asymmetries were calculated using a simple difference formula normalized by one volt to render it unitless.

$$A = \frac{w_{j=\mathrm{even},i} - w_{j=\mathrm{odd},i}}{1V} \tag{5}$$

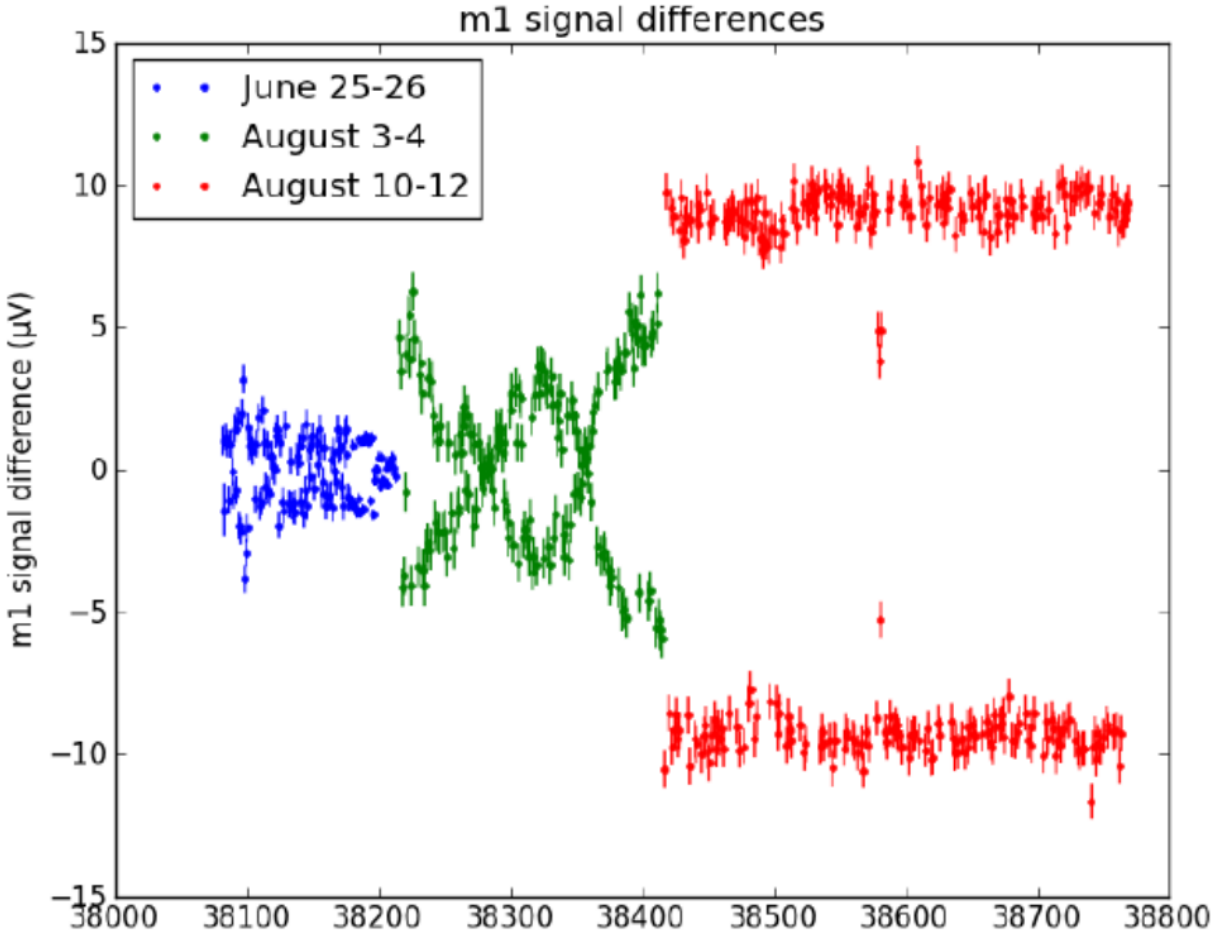
For comparison to the beam on signals and asymmetry a normalization comparable to average beam on signal for each wires can be used, but this has not been used in this analysis as we are mainly examining trends in the asymmetry behavior to try to find its origin.

Re-creating Kabir's Asymmetry Results



Note: The orange lines indicate the transition between summer run series shown on slide 4.

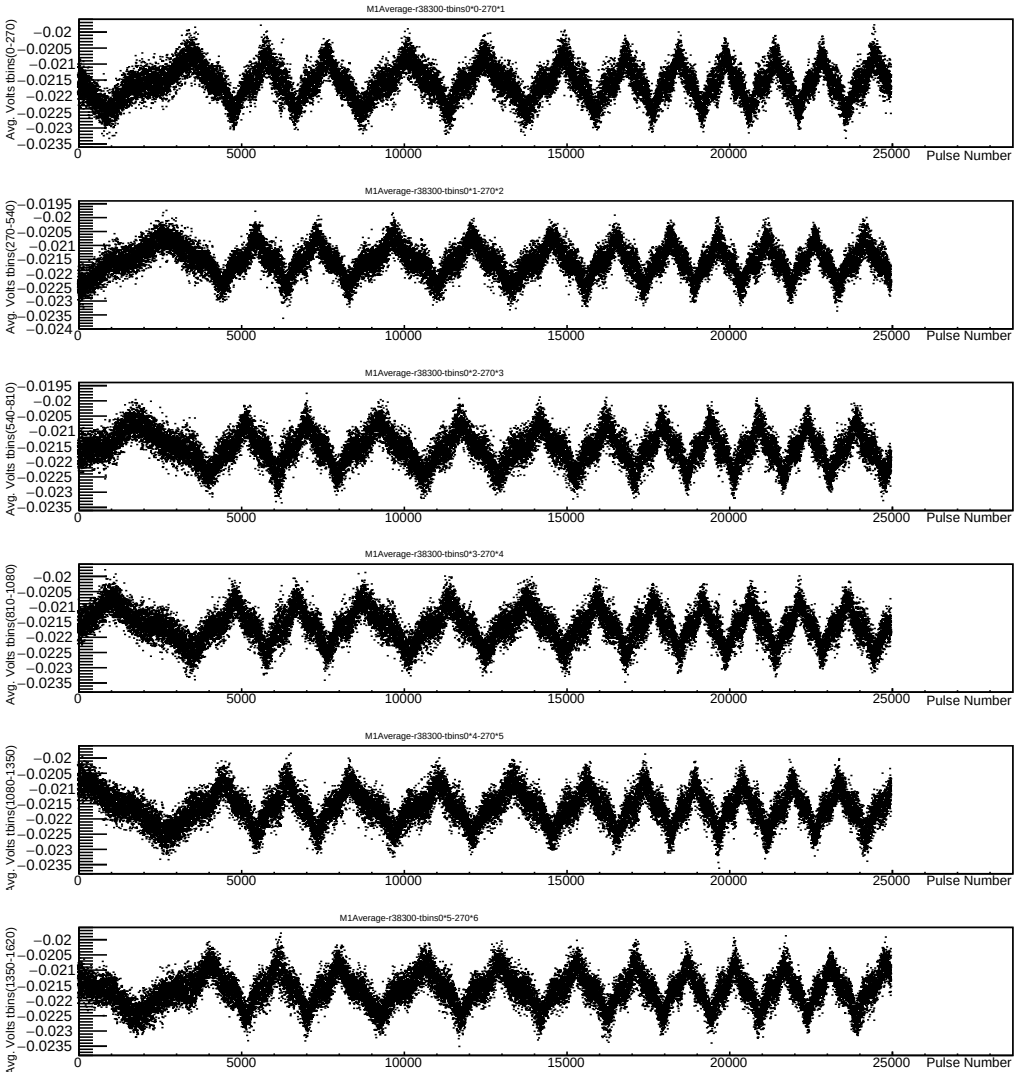
Effect of Changing Time Bin Range - 0-1300 (Rob's Analysis)



Rob's Asymmetry analysis present 2 weeks ago showed a different shape but similar magnitude to the asymmetry calculated by Kabir. Different colors show different data taking periods during the summer, that are separated by the orange lines on my plots.

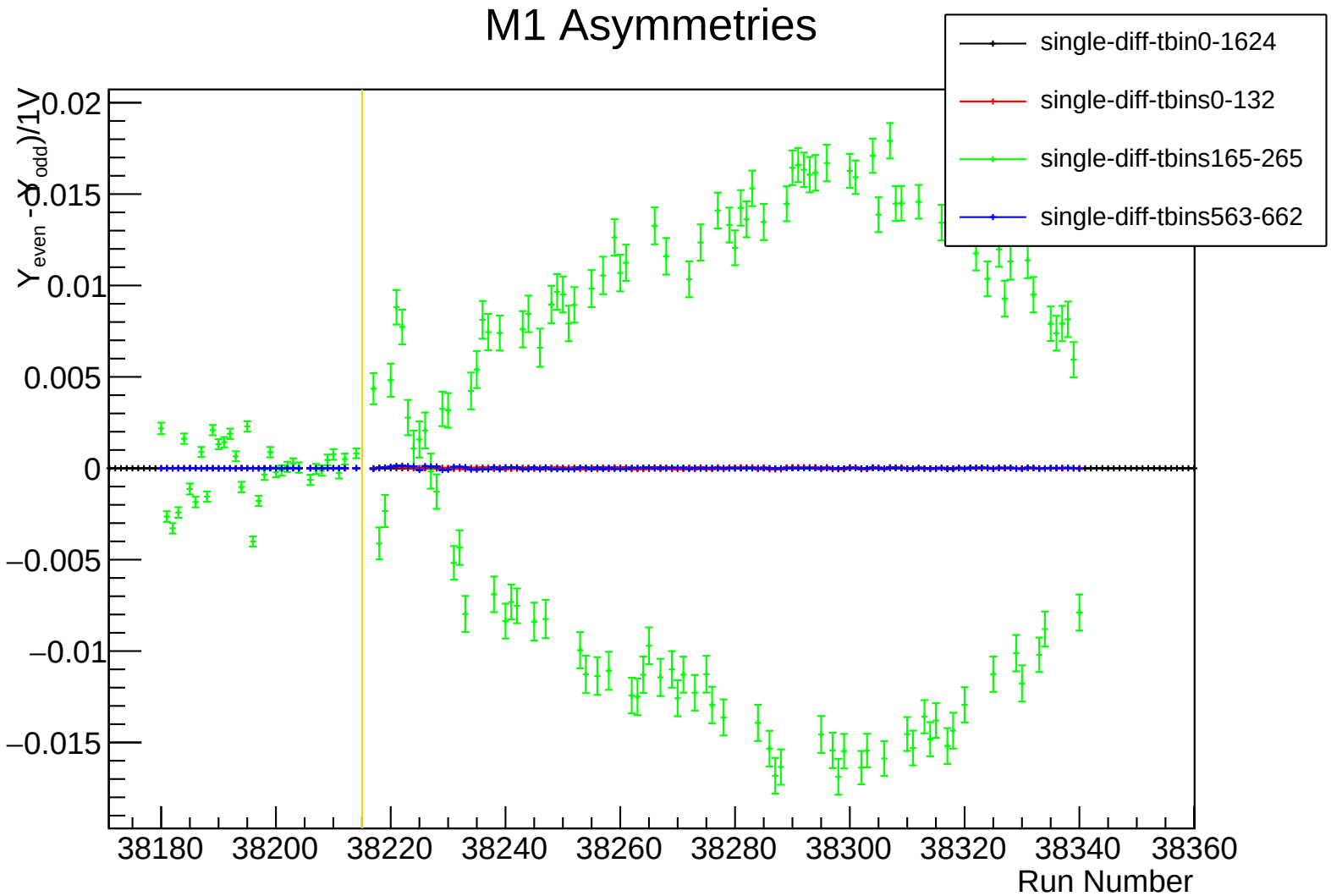
M1 Sequential Sums

Summing the m1 signal in groups of 270 time bins:



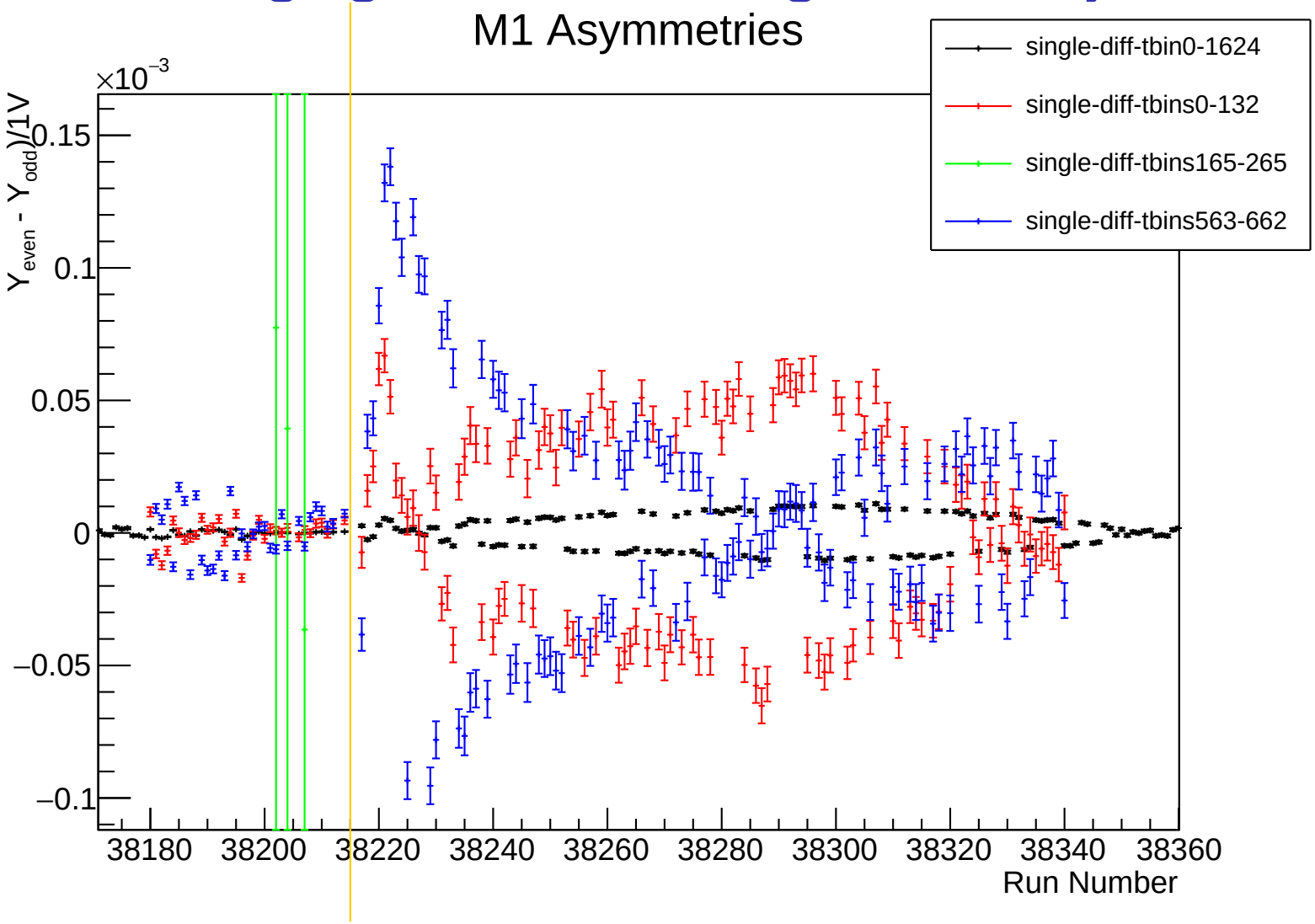
The sawtooth structure is similar for groupings the peaks are shifted depending what time bin range is used.

Effect of Changing Time Bin Range - Overlay



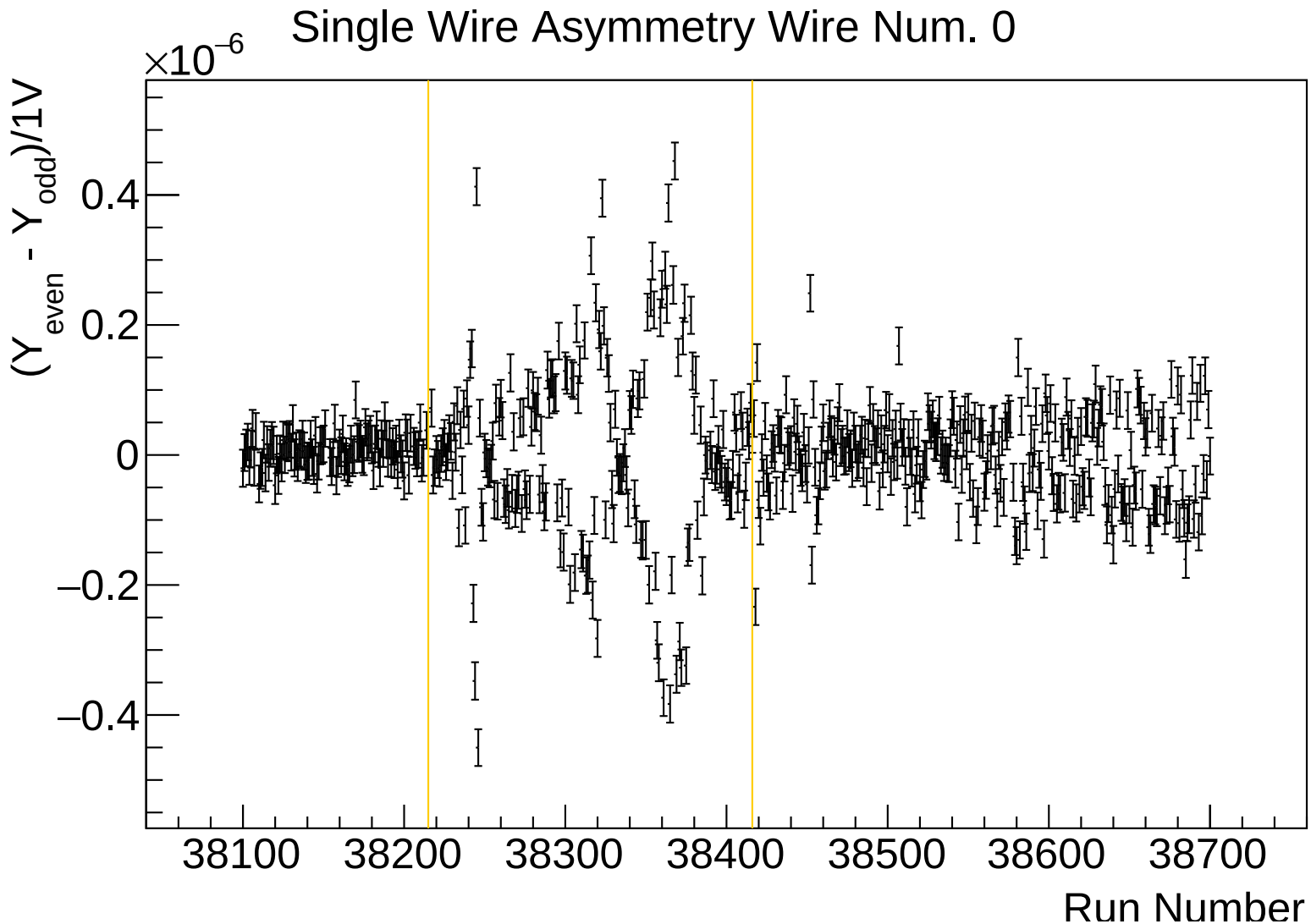
The orange line indicates the transition between time periods in the run list.

Effect of Changing Time Bin Range - Overlay Zoomed



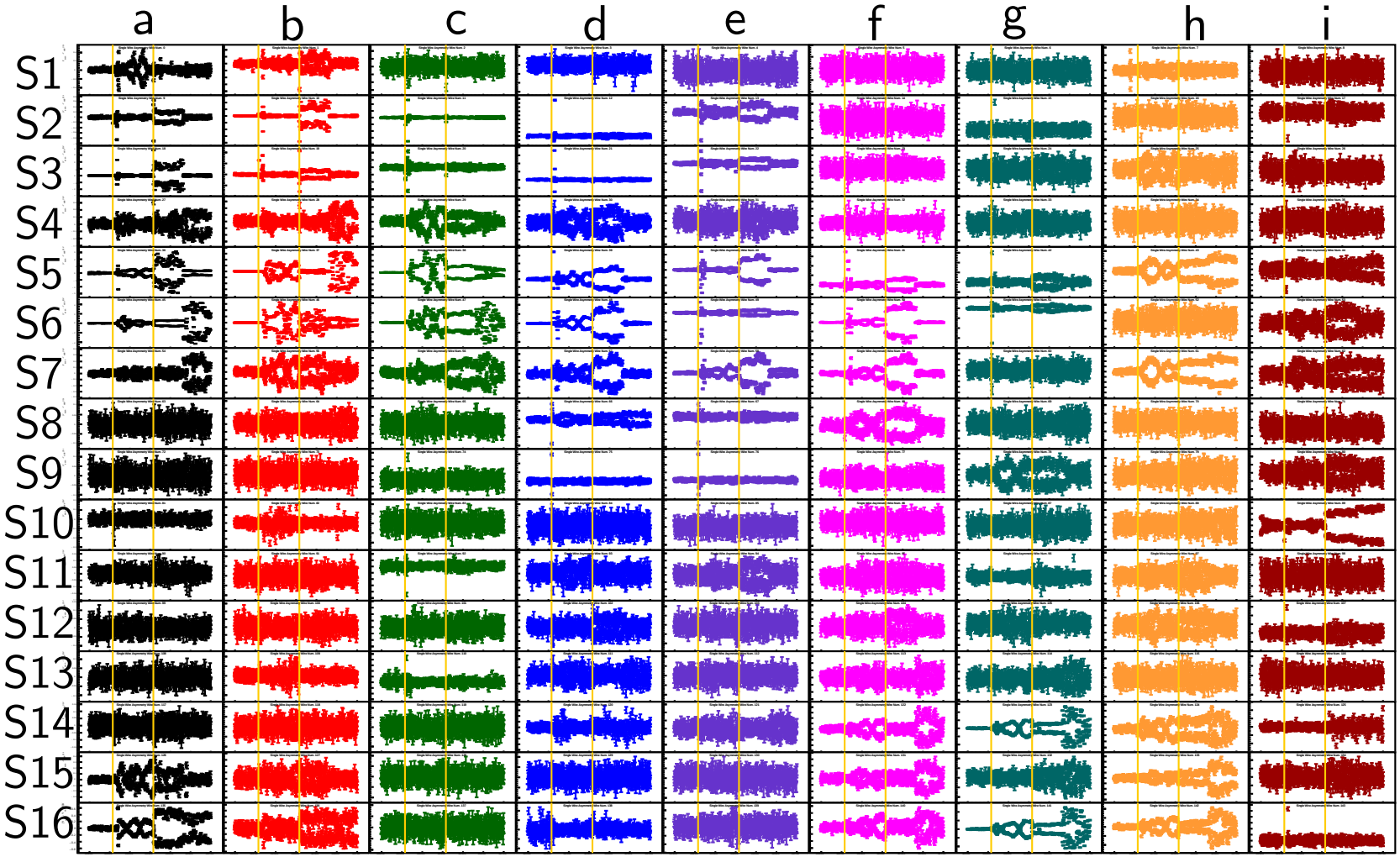
So while Kabir and Rob have different shapes for their asymmetry that is a result of their choice of time bins used in the asymmetry analysis, with different ranges giving different values.

Mean Asymmetry Per Run - TBins 0-49 - wire 0



Note: Errors bars are RMS/$\sqrt{N}$, reduced run range 38180-38340

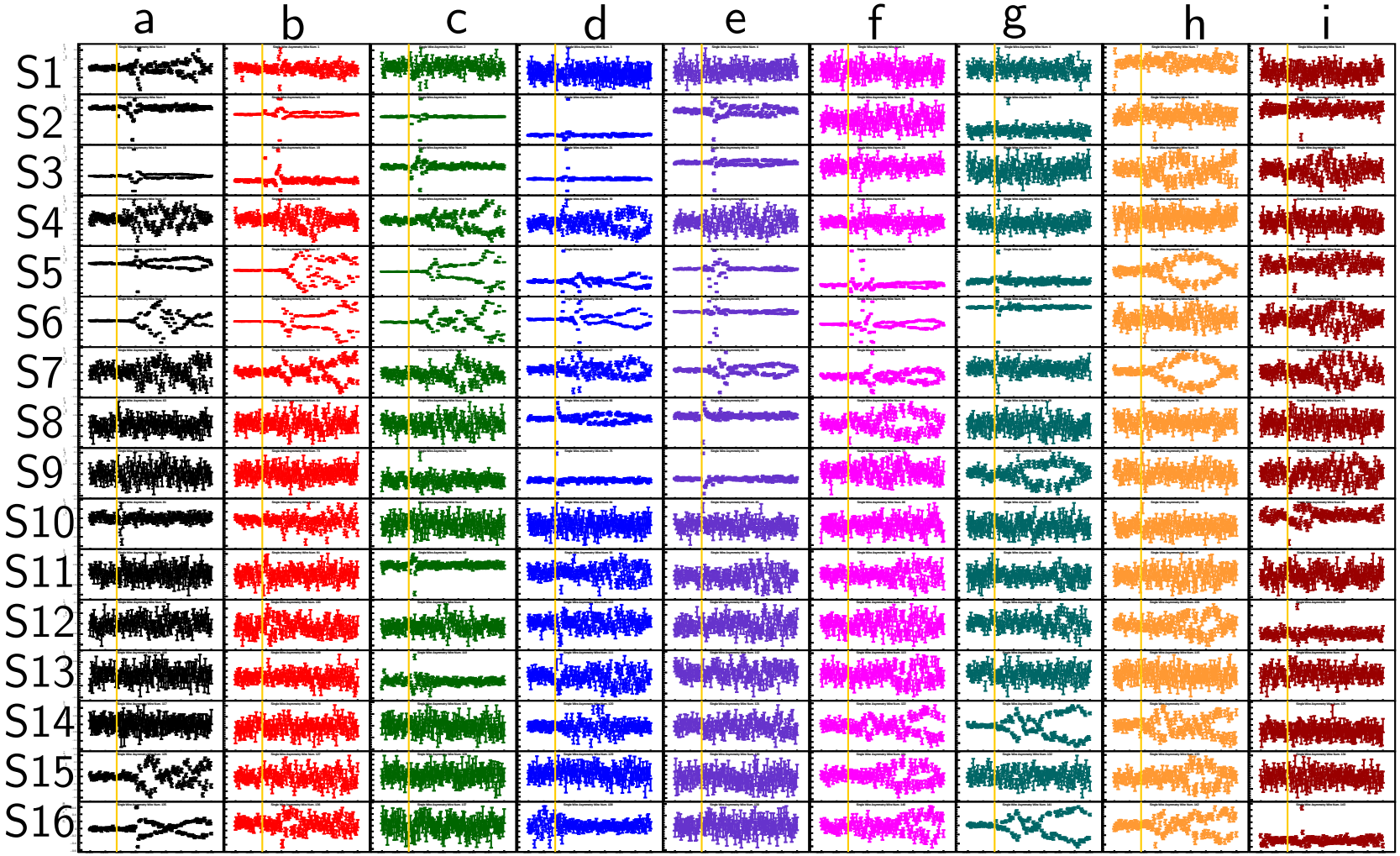
Mean Asymmetry Per Run - TBins 0-49



Note: Errors bars are RMS/$\sqrt{N}$.

Note: Vertical axis on all panel plot sub-plots are independent due to range of asymmetries that are being plotted.

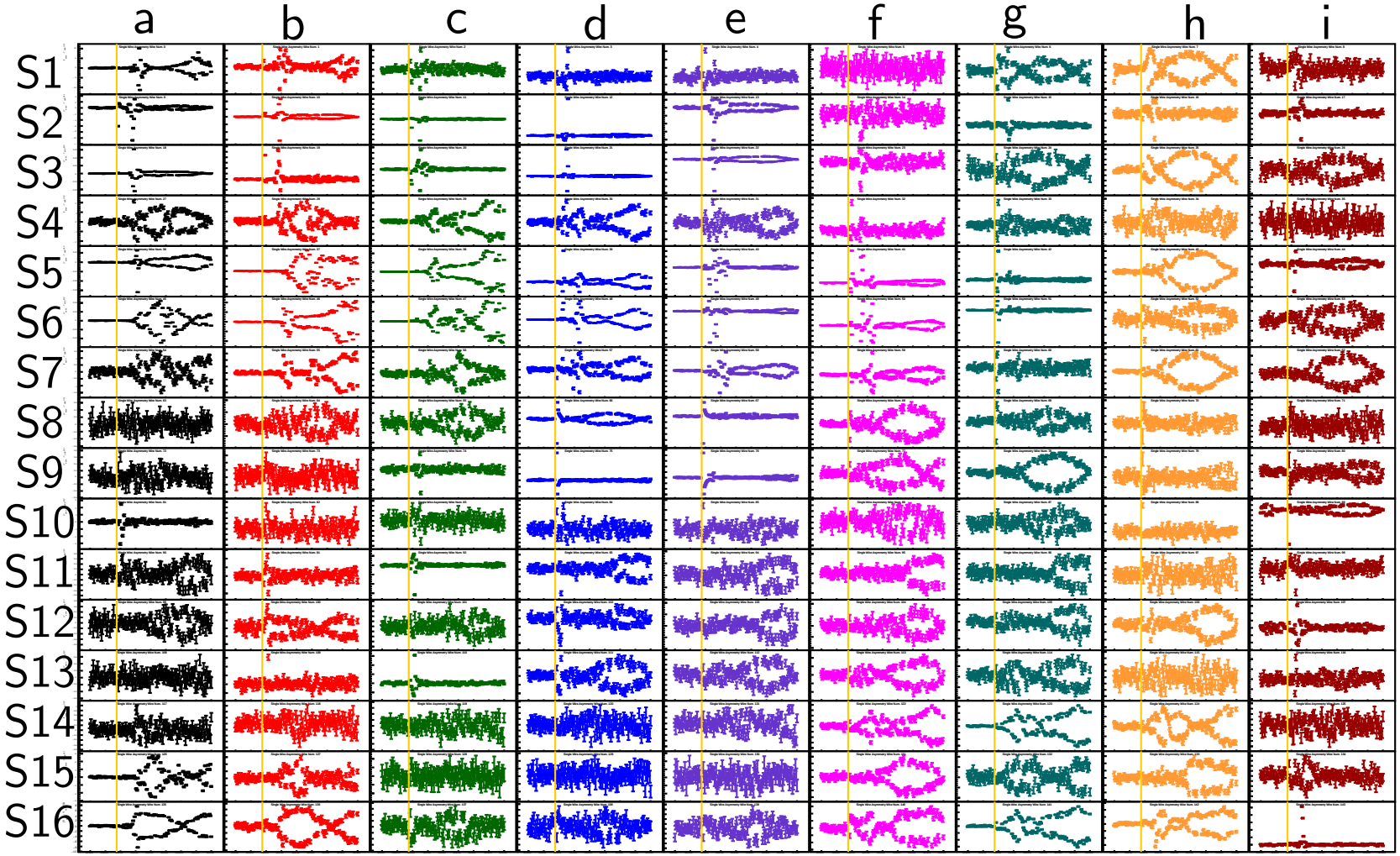
Mean Asymmetry Per Run - TBins 0-49



Note: Errors bars are RMS/$\sqrt{N}$, reduced run range 38180-38340

Note: Vertical axis on all panel plot sub-plots are independent due to range of asymmetries that are being plotted.

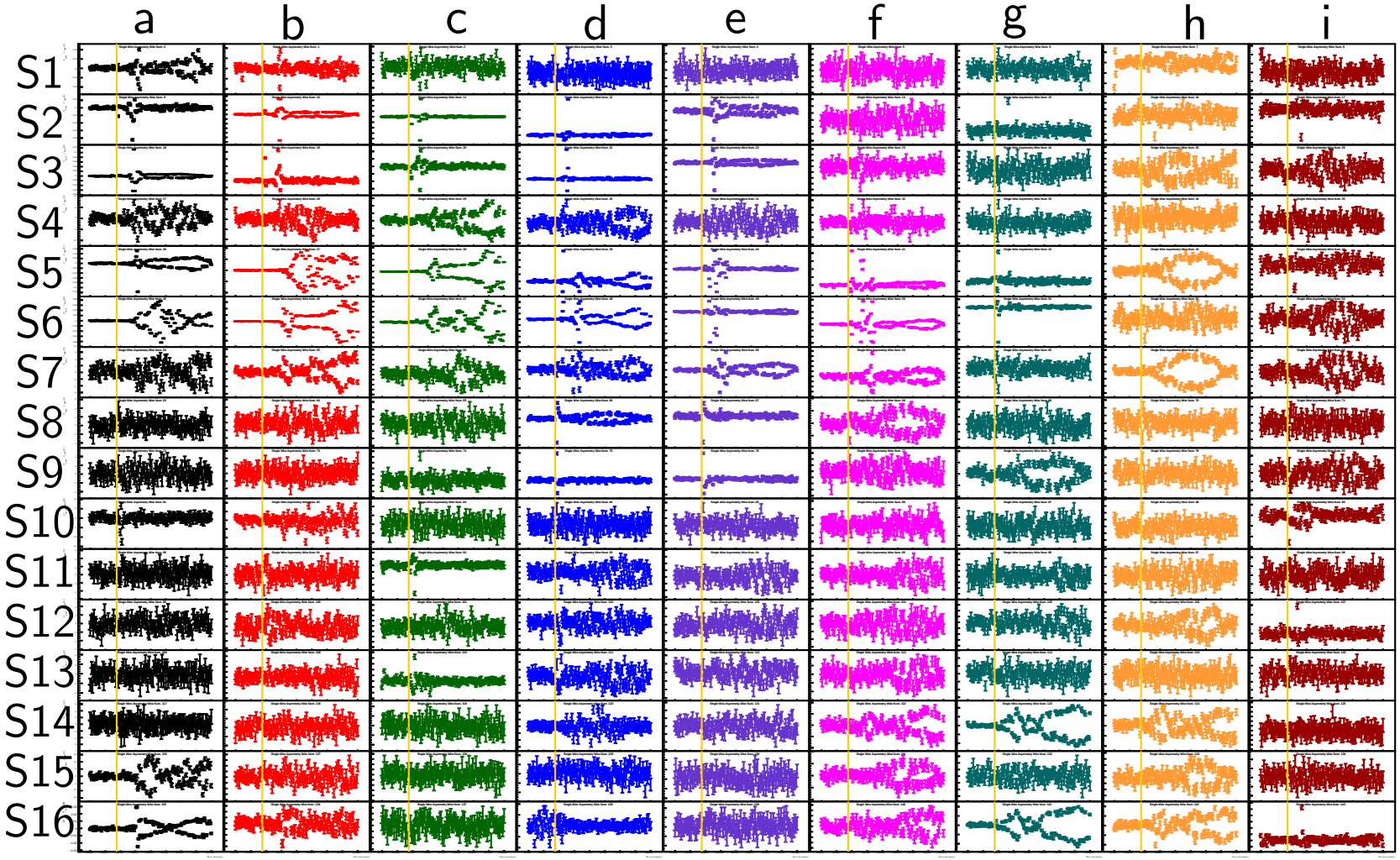
Mean Asymmetry Per Run - TBins 0-4



Note: Errors bars are RMS/$\sqrt{N}$, reduced run range 38180-38340

Note: Vertical axis on all panel plot sub-plots are independent due to range of asymmetries that are being plotted.

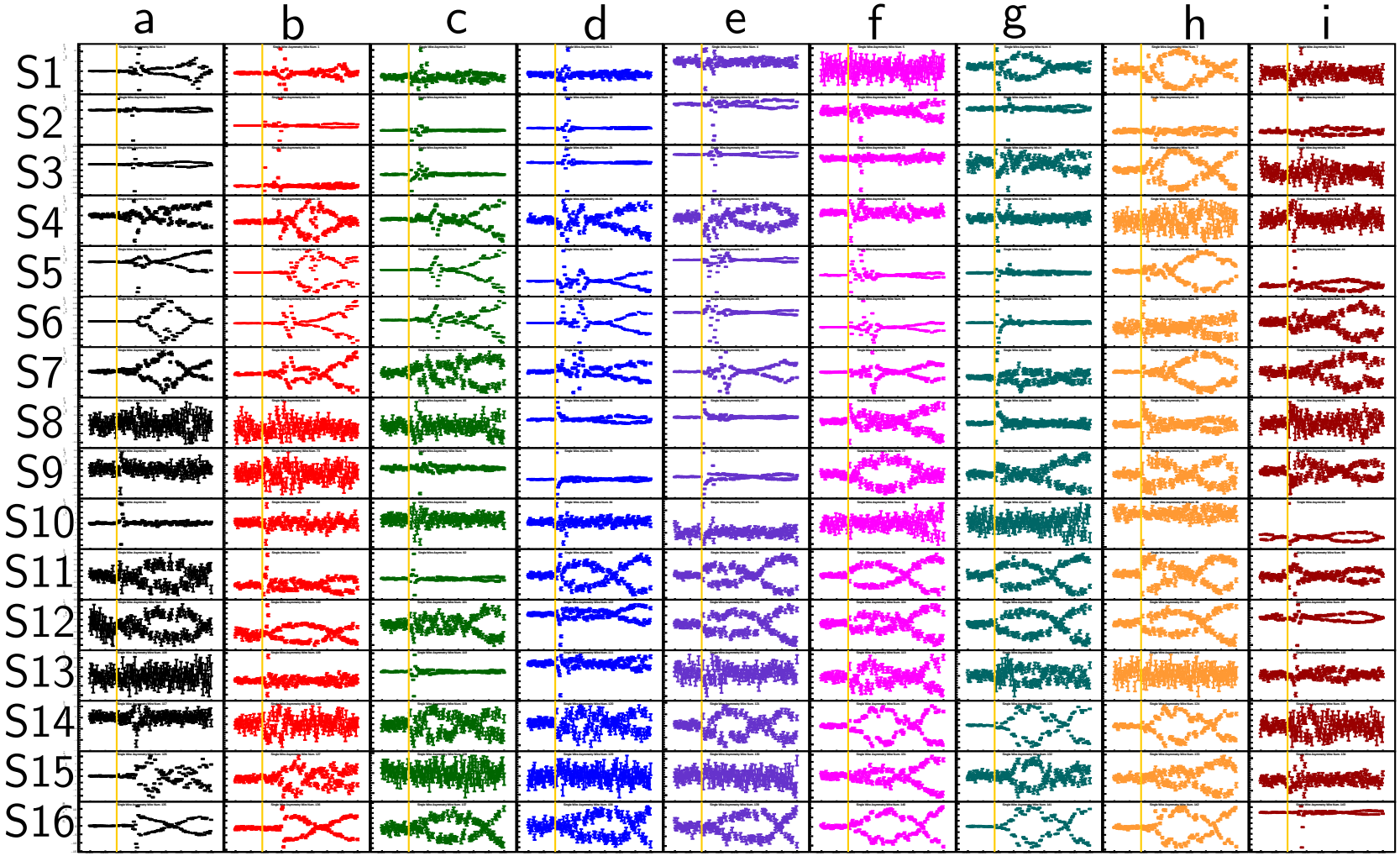
Mean Asymmetry Per Run - TBins 5-8



Note: Errors bars are RMS/$\sqrt{N}$, reduced run range 38180-38340

Note: Vertical axis on all panel plot sub-plots are independent due to range of asymmetries that are being plotted.

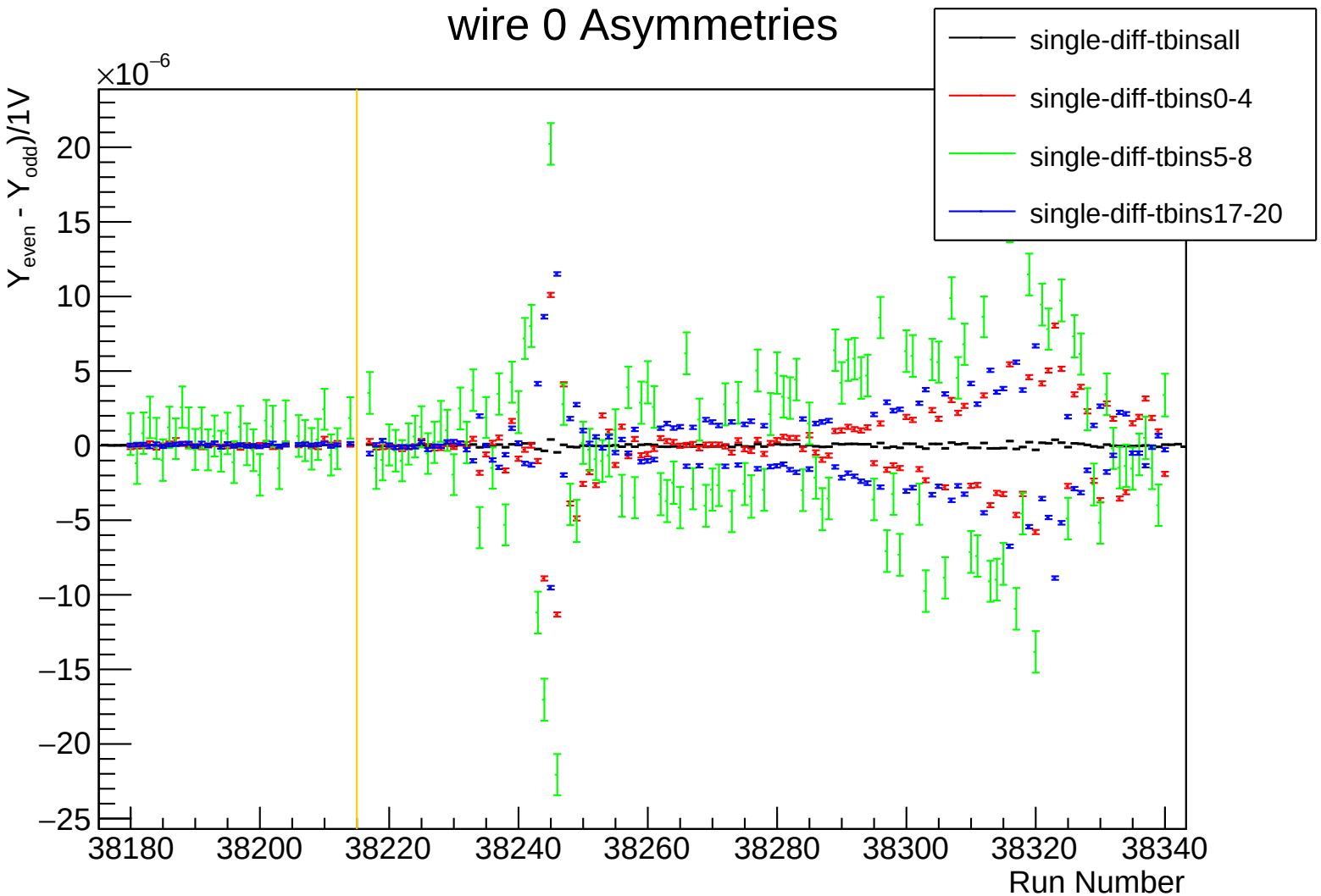
Mean Asymmetry Per Run - TBins 17-20



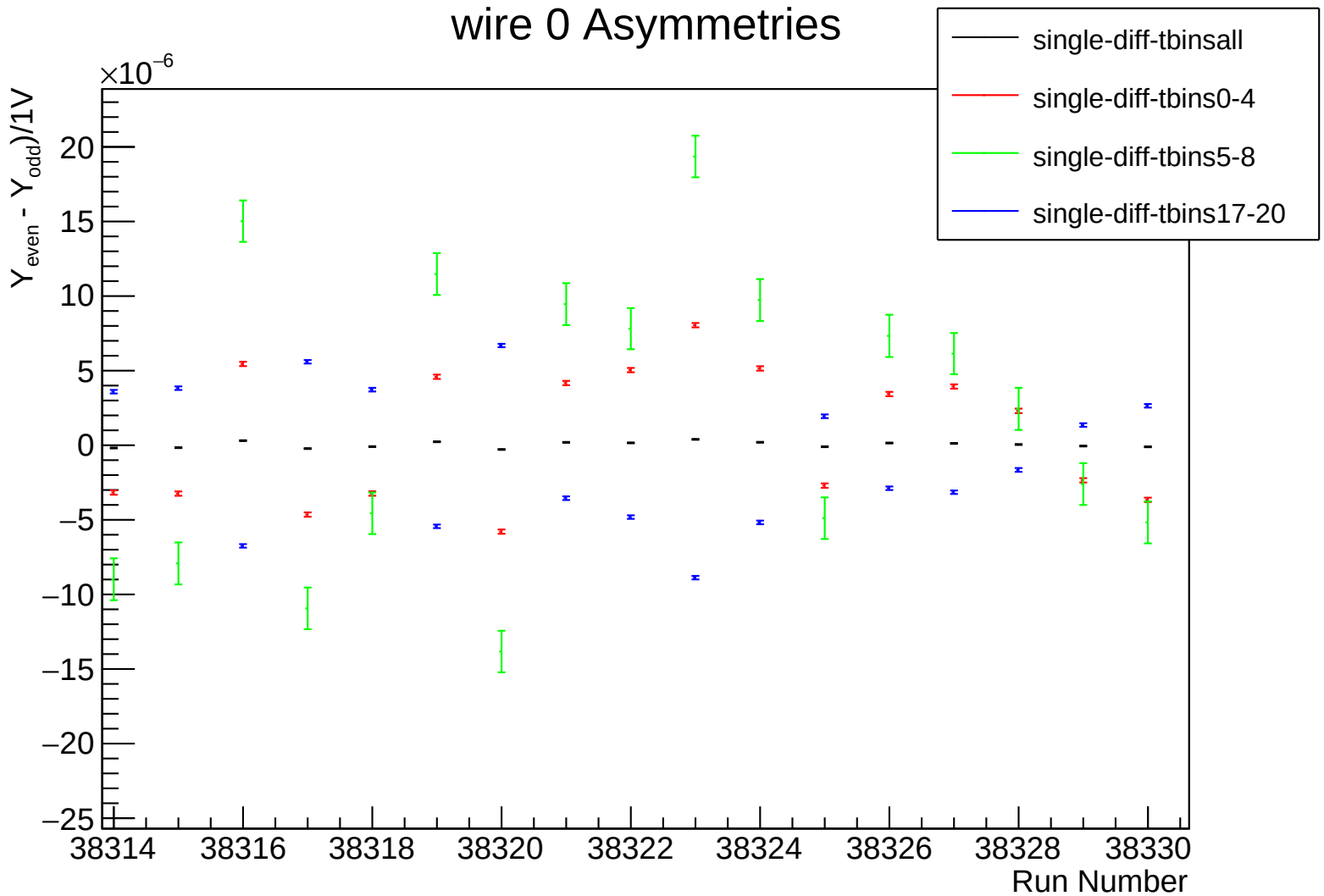
Note: Errors bars are RMS/$\sqrt{N}$, reduced run range 38180-38340

Note: Vertical axis on all panel plot sub-plots are independent due to range of asymmetries that are being plotted.

Wire 0 Asymmetry for Different Time Bin Ranges

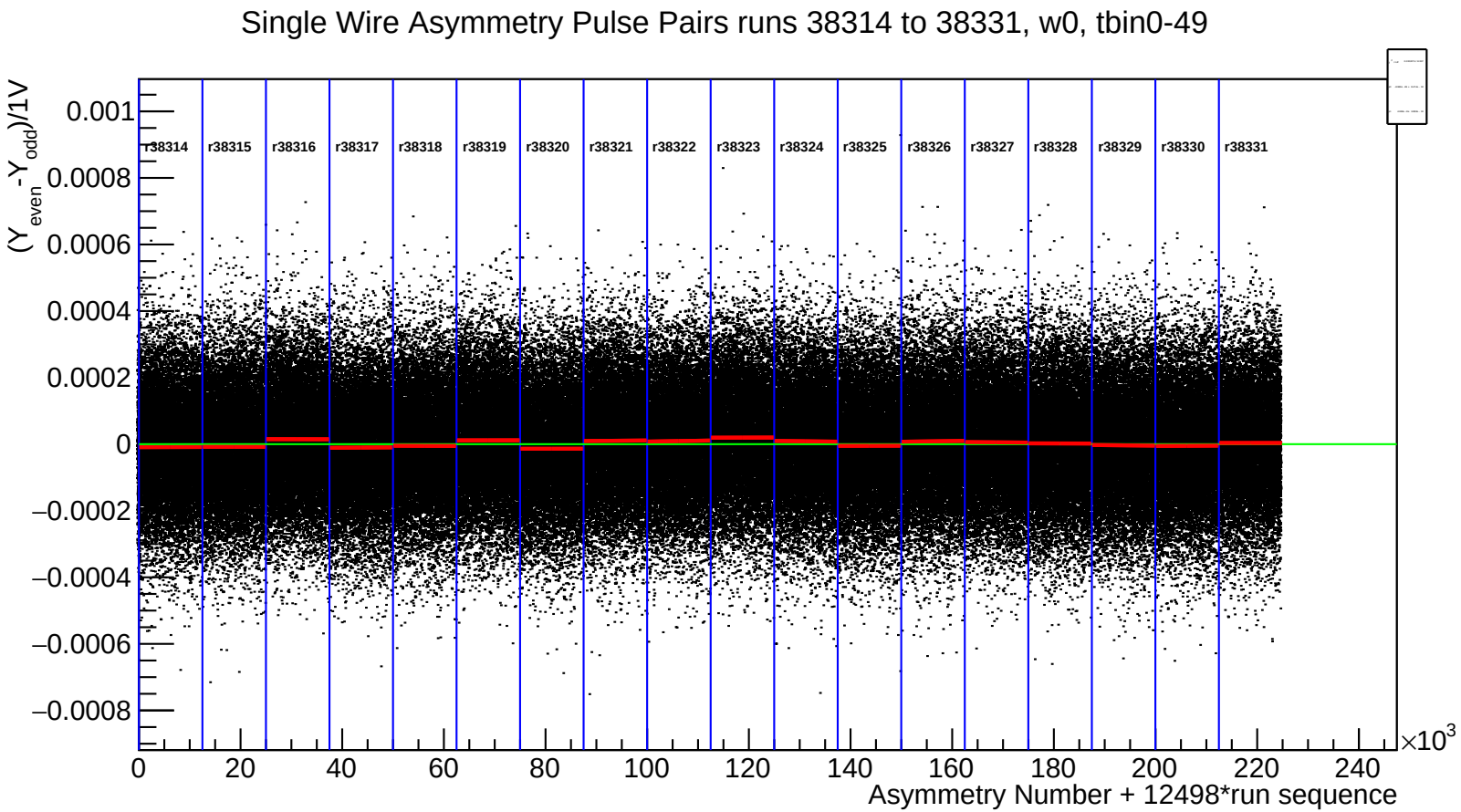


Wire 0 Asymmetry for Different Time Bin Ranges



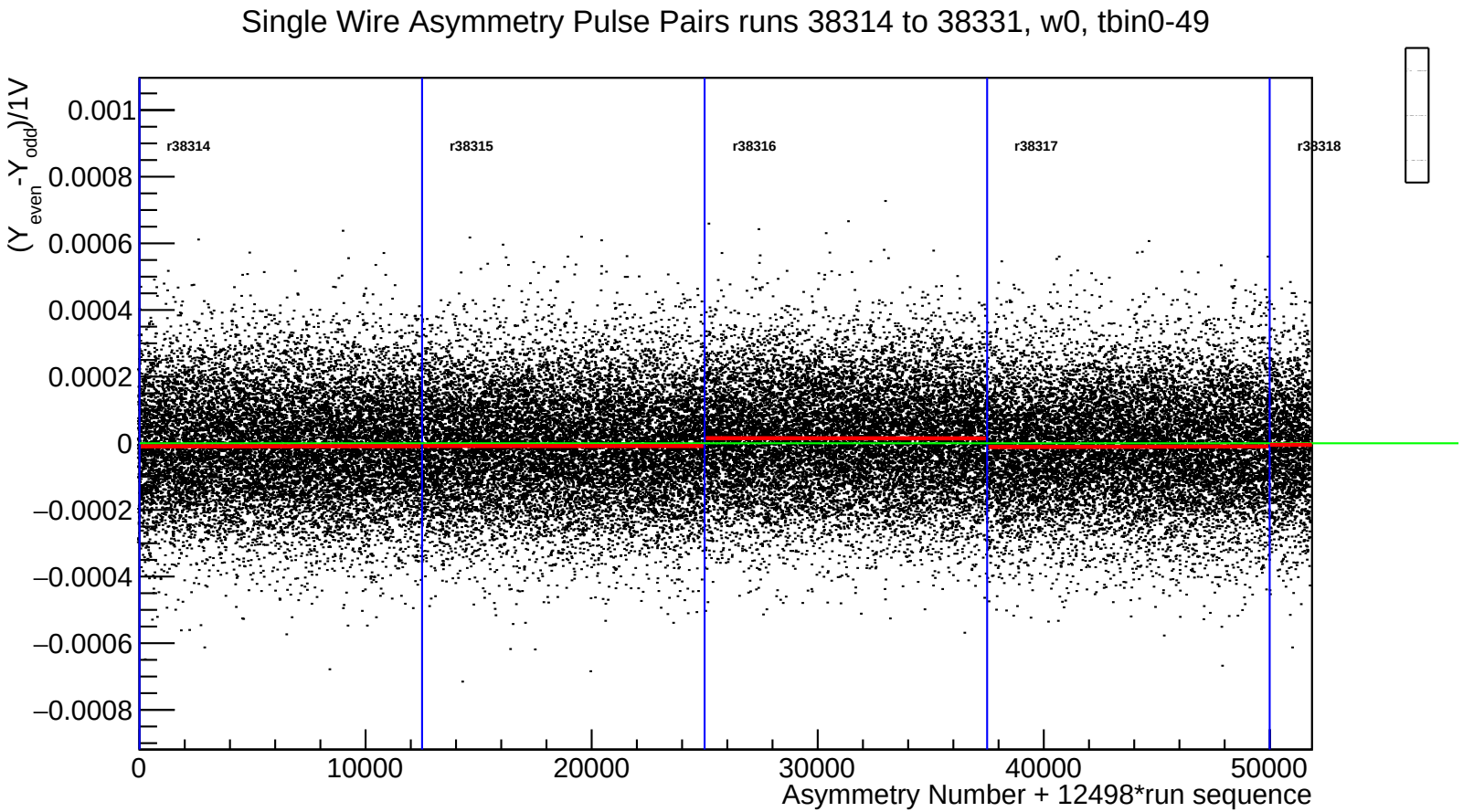
Note: The asymmetry from all time bins is smaller than a given sub-range, and the red and blue points are opposite each other.

Asymmetry Change Over Runs - wire 0

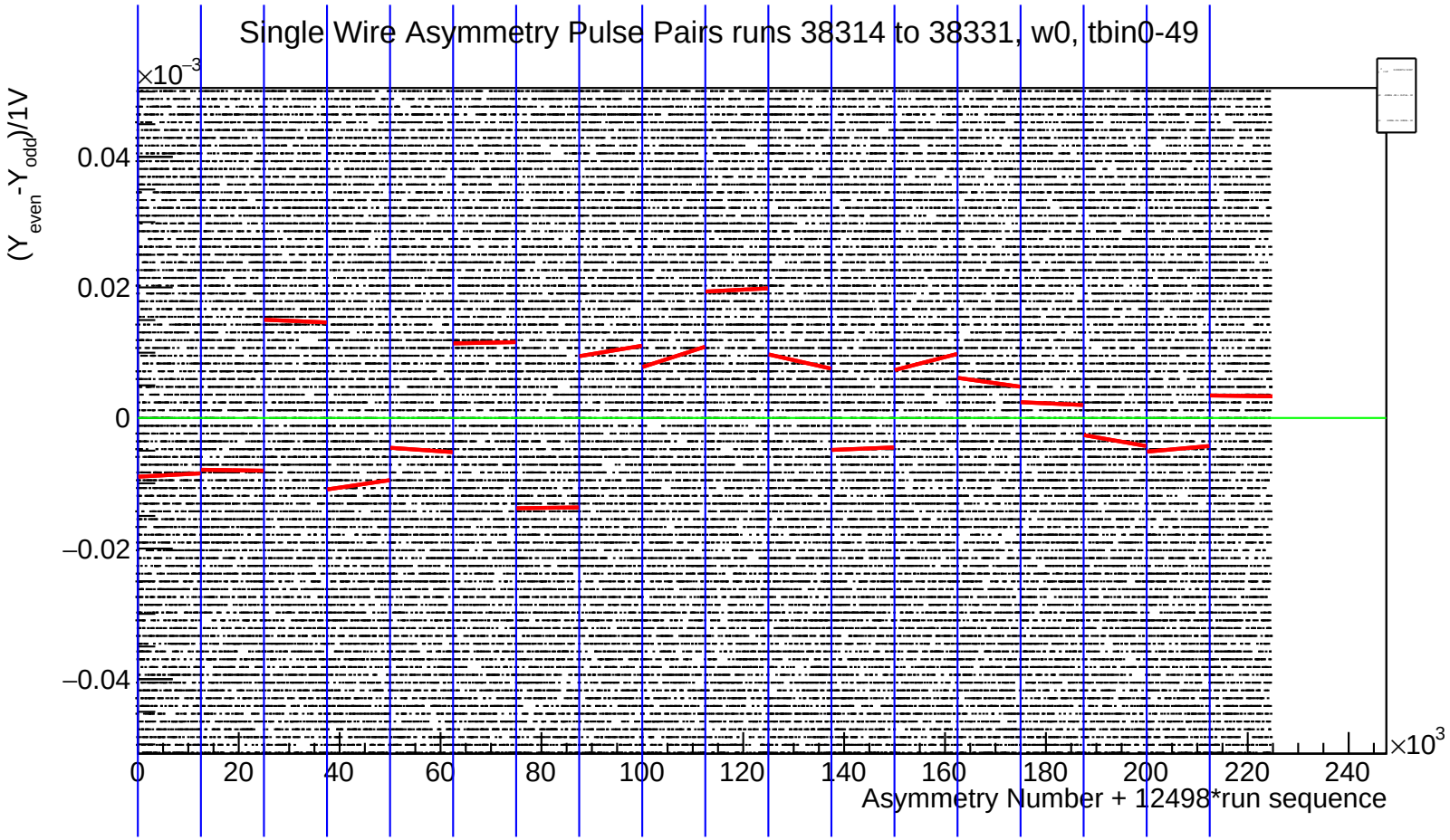


Blue lines are the separation between runs, red lines $a + bt$ fit to the asymmetry, and the green line is a horizontal line at 0.

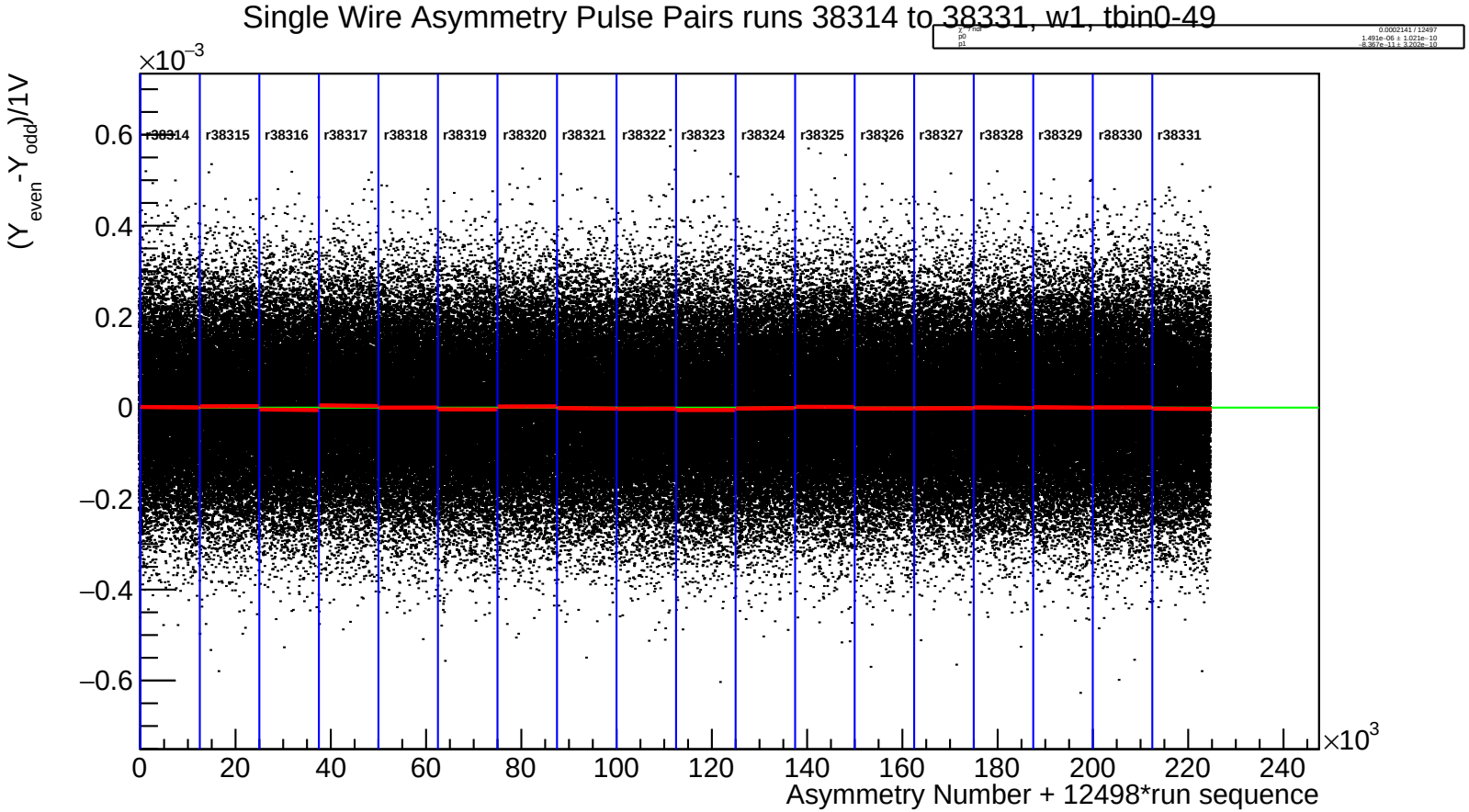
Asymmetry Change Over Runs - wire 0



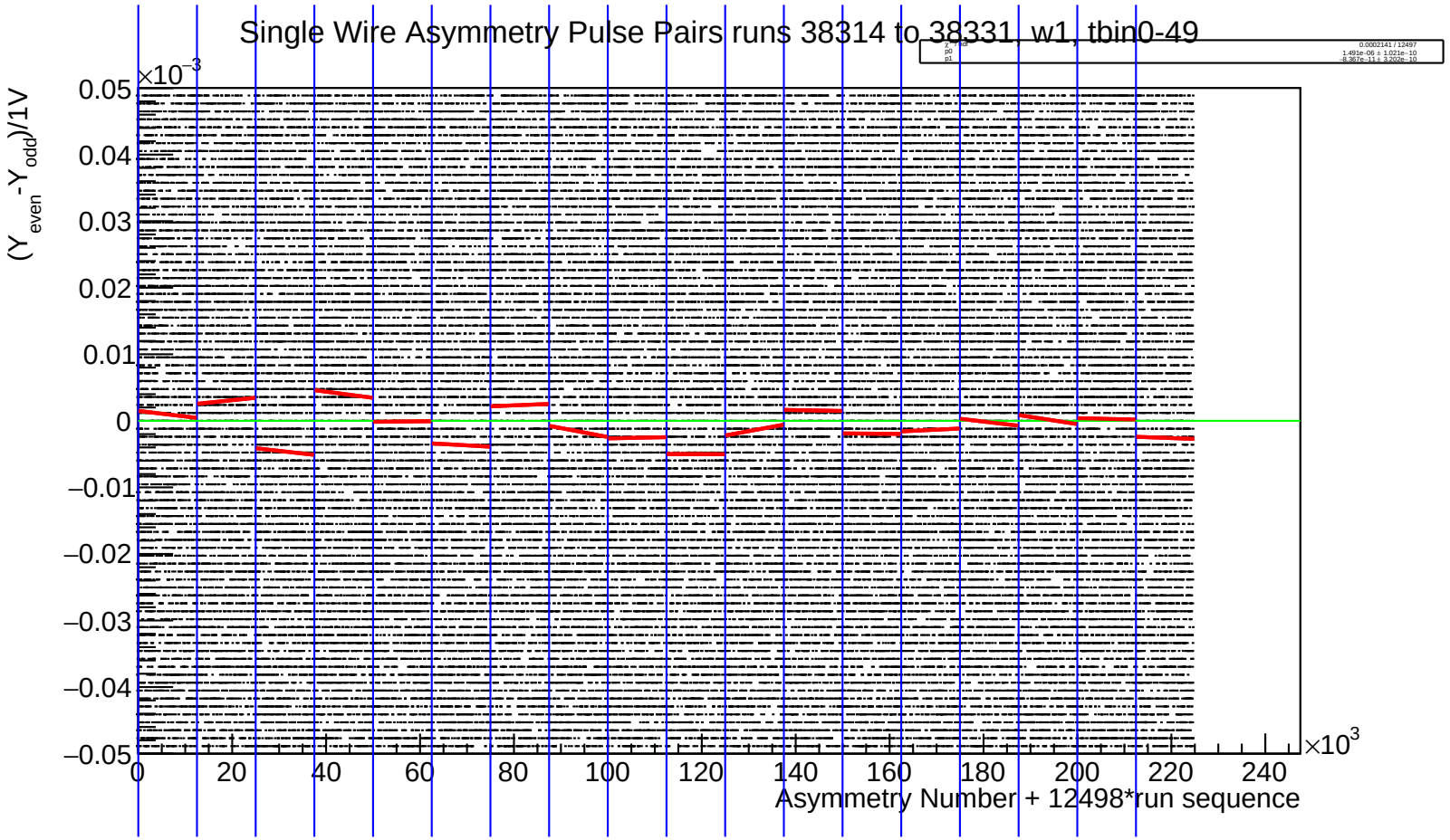
Asymmetry Change Over Runs - wire 0 zoomed



Asymmetry Change Over Runs - wire 1



Asymmetry Change Over Runs - wire 1 zoomed



Continuing Analysis

- What t0 signals were used for triggering during the beam off running?
  - Was it the same between summer and Tuesday runs?
- Create plots for two wire asymmetries, 3 possible kinds
  - Can use Two wire difference:

$$A_{diff} = \frac{(w_{j,i}^{even} - w_{j,i}^{odd}) + (v_{j=,i}^{odd} - v_{j,i}^{even})}{1V} \tag{6}$$

  - two wire ratio:

$$R^{even/odd} = \frac{w_{j,i}^{even/odd}}{v_{j,i}^{even/odd}} \tag{7}$$

$$A_{ratio} = R^{even} - R^{odd} \tag{8}$$

  - Alternative Ratio:

$$\alpha = \frac{w_{j,i}^{even}}{w_{j,i}^{odd}} \frac{v_{j,i}^{even}}{v_{j,i}^{odd}} \tag{9}$$

$$A_{NPDG} = \frac{\sqrt{\alpha} - 1}{\sqrt{\alpha} + 1} \tag{10}$$