Facts About n3He Beam Off Instrumental Asymmetry

M. McCrea

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1 Introduction

For the n3He experiment three sets of beam off instrumental asymmetries were taken during the summer maintenance period as shown in table 1. During the July 21 Friday meeting it was decided that it would be useful to make a list of known facts, and some conclusions based on those facts regarding the summer instrumental asymmetry data.

2 Facts

Things we know:

Fact 1. There are large average instrumental asymmetries on some of the summer runs, see figures 1 and 2.

The presence of this asymmetry implies some kind of 30 Hz signal getting into our DAQ system.

Fact 2. The spin flipper operates at a 30 Hz on-off cycle, as shown in figure 3, and is a possible source of the noise.

Fact 3. The sign of the average asymmetry changes on consecutive runs as shown in figures 1 and 2

Fact 4. The spin flipper sign is very consistent between runs, as is shown in figure 4, and does not correlate with the change in sign of the asymmetry.

This implies that it is not the spin flipper causing the asymmetry as the spin flipper state does not correlate with the sign of the measured instrumental asymmetry.

Fact 5. The size and shape for the average asymmetry is not the same for all wires, see figures 5, and 2.

The differences in the instrumental asymmetries calculated on the different wires and monitor implies that the asymmetry source is coupling to each object with a different strength, or there are multiple sources for the measured asymmetries.

Fact 6. The asymmetry is much larger in the M1 monitor, see figures 1 and 2.

This implies the coupling of the monitor to the asymmetry source is much larger than to the wires or that the different rate of sampling and time averaging between the monitor and target chamber DAQ is suppressing the asymmetry in the target chamber.

Fact 7. The M1 monitor is, by most measures, less electrically and mechanically isolated and shielded than the target chamber.

This implies either mechanical vibration or electrical noise from an unknown source, possibly originating up the beam pipe to which the M1 monitor is mounted causing the M1 monitor to be more strongly coupled to the noise than the target chamber.

Fact 8. The M1 monitor is located under the same shielding as the SMP.

Fact 9. The target chamber is located near the center of the cave on a metal stand from which is it electrically isolated.

This suggests that it is not microphonic pickup from vibrations in the air as the M1 monitor would probably be more shielded from those than the target chamber which sits in the open air.

Fact 10. The wire asymmetries calculated in a run have an averages in the range of 10^{-6}, but a spread of around 10^{-4}, see figure 8 .

This makes it hard to see, but the asymmetries across a run are relatively constant. Fitting a polynomial of form $a + bt$ to the asymmetries in a run supports this conclusion. This shows that the asymmetry is not changing over the course of a run from positive to negative, but is changing in a step-wise fashion between runs.

Fact 11. Examining the absolute size of the asymmetry indicates that it is changing consistently between most runs

Fact 12. The time between runs when the DAQ is resetting is not controlled.

As the time between runs is not controlled it likely has some variations in its length. This implies it is possible to have an constant frequency 30 Hz external noise source with a variable amplitude for which the relative phase to our data taking changes between runs causing the change in sign of the average asymmetry.

Fact 13. The size and sign of the average asymmetry per run changes depending on the time bin range used. See figures 11 and 12 for the beam monitor, and figure 7 for wire 0.

The diamond shapes that were seen in the wire and M1 asymmetry initially can change shape entirely being replaced by x's, v's, or parallel lines depending on the time bin range used from a pulse when calculating the asymmetry.

Fact 14. The asymmetry size calculated using all time bins in each pulse is smaller than any tested sub range.

Fact 15. Some sub ranges have opposite sign to their asymmetry.

This implies we are seeing a great deal of cancellation in the instrumental asymmetries when averaging the asymmetry for all time bins in a run.

This implies the 30 Hz noise is not a simple 30 Hz, but something with a substructure over the duration of a 1/60 second pulse that varies from positive to negative in value.

Fact 16. (that someone else should double check) The SNS runs at 60 Hz, but not coupled to 120 V AC line 60 Hz whose frequency can change by a few hertz depending on load.

Note: To the best of my knowledge the SNS ran coupled to the line 120 V AC frequency for a significant period of time during NPDGamma running, but changed over to its own set 60 Hz clock before the end of NPDGamma running.

I am not sure how this small possible frequency difference could be relevant, but I thought I would bring it up.

A Tables and Plots

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

Table 1: Instrumental Asymmetries were taken during the SNS summer maintenance period in approximately 1 day intervals separated by periods of no data taking of 39 or 6 days.

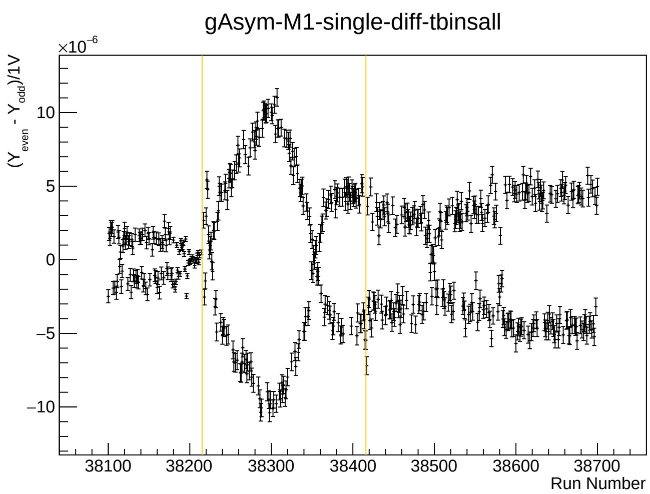

Figure 1: This M1 instrumental asymmetry calculated using all time bins in each neutron pulse. The central value is determined from the mean of the asymmetry values calculated for each pulse pair, and the error bars are calculated as the RMS width of the histogram plot of the values divided by the square root of the number of asymmetries, $\sqrt{12498}$.The orange lines show the transition points between different periods of summer data taking as shown in table 1.

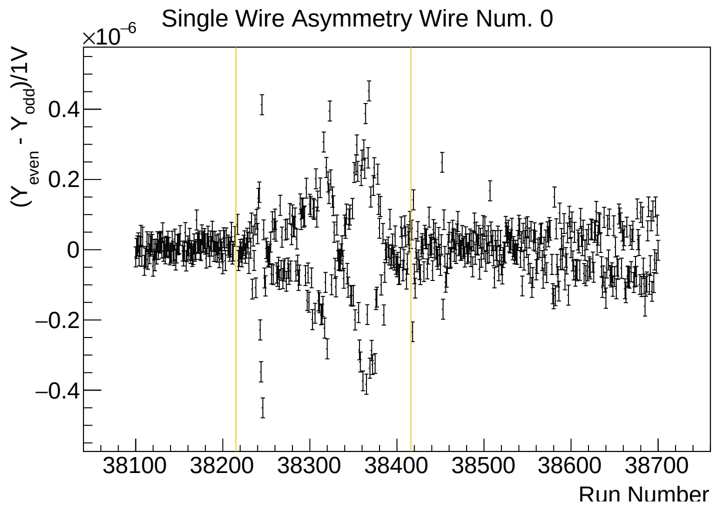

Figure 2: This wire 0 instrumental asymmetry calculated using all time bins in each neutron pulse. The run average value is determined from the mean of the asymmetry values calculated for each pulse pair, and the error bars are calculated as the RMS width of the histogram plot of the values divided by the square root of the number of asymmetries, $\sqrt{12498}$. The orange lines show the transition points between different periods of summer data taking as shown in table 1.

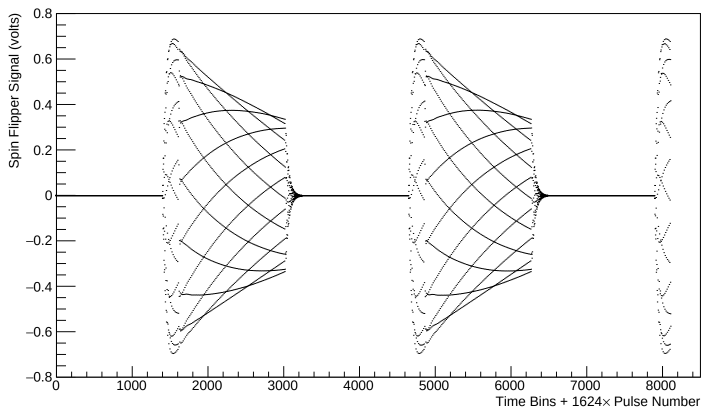

Figure 3: This plot shows the measured voltage applied to the spin flipper for the first 4 neutron pulses in a run.

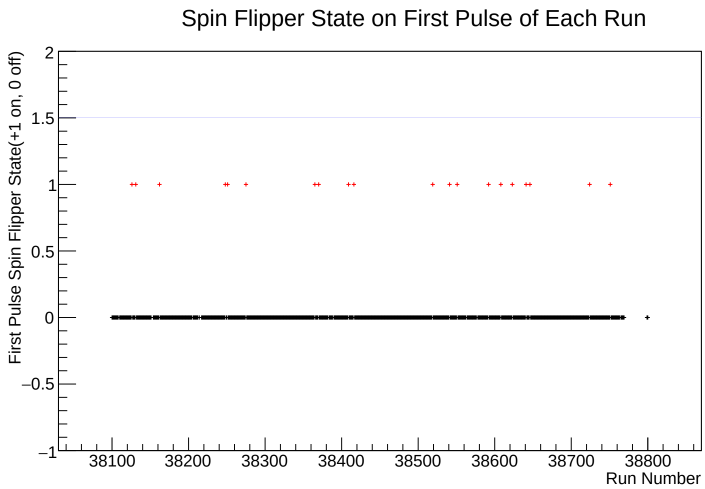

Figure 4: Runs marked at 0 in this plot shows that the spin flipper was off in the first pulse, while runs marked with +1 indicate the spin flipper was on in the first pulse.

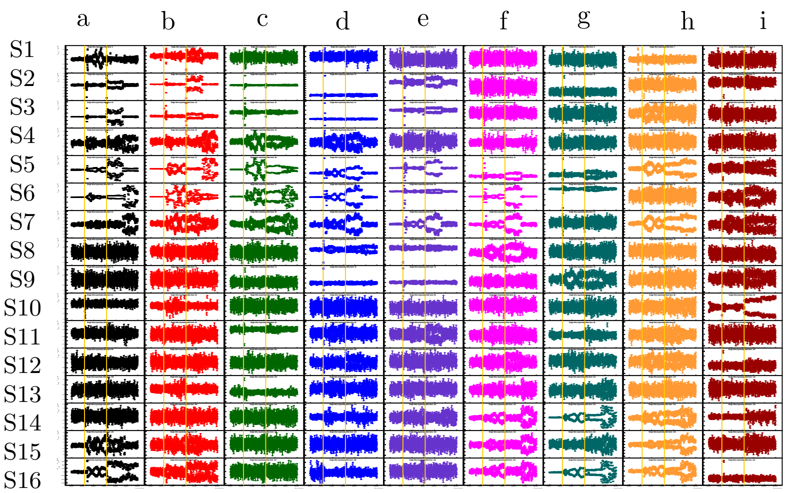

Figure 5: This panel plot shows the run average instrumental asymmetry of each wire over the runs 38100 to 38700. The vertical orange lines show the transition points between different periods of summer data taking as shown in table 1. Note: Each plot has an independent Y-axis that is not labeled due to space constraints.

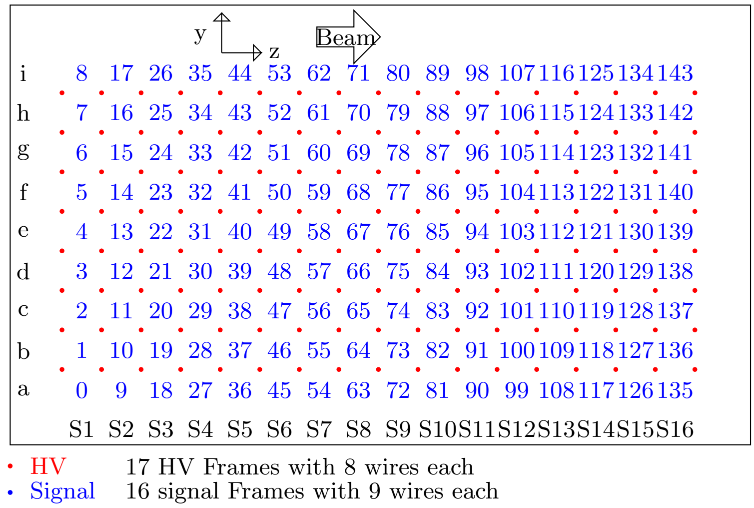

Figure 6: Wire, wire frame, and row numbering conventions. Wires are number 0-143, row from a-i, and planes from S1 to S16 as shown.

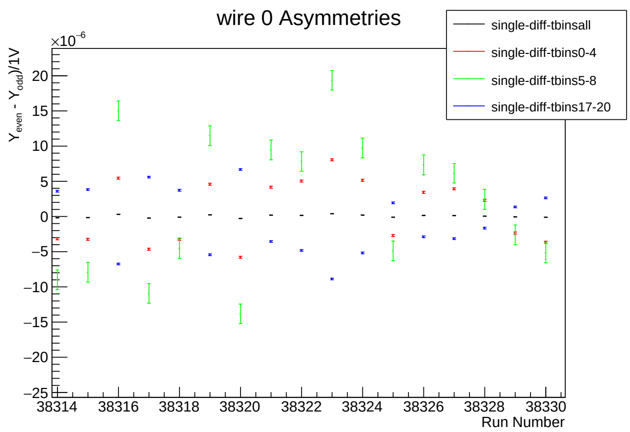

Figure 7: Sub-set of the run average single wire instrumental asymmetries for wire 0 calculated using all time bins that was shown in figure 2 compared with different time bin sub-ranges.

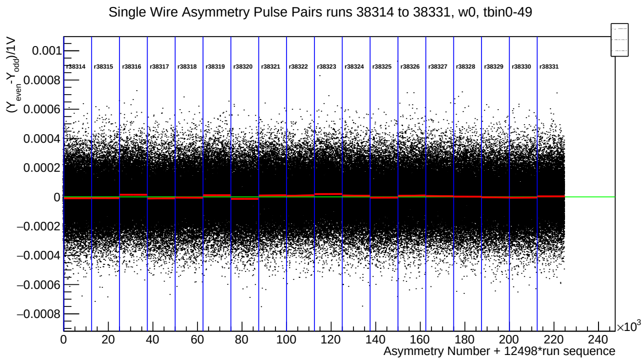

Figure 8: Single wire instrumental asymmetries over each run. Blue lines indicate separations between runs, red lines are linear fits to the data, and green line is a horizontal line at 0. The asymmetries were calculated using a single wire subtracting odd numbered pulses from the preceding even numbered pulse, so the asymmetry for pulse pair in run number j is calculated as i in run $A + i, j = Y_{i,j}^{even} - Y_{i,j}^{odd}/1V$. Pulse numbering starts at 0, so the first pulse in a run is pulse 0 and is even, then the second pulse is pulse number 1 and is odd, and sum of the pulse 1 time bins would be subtracted from the sum of the pulse 0 time bins to form the asymmetry pair number 0. Pulse numbers 2 and 3 would be subtracted to form asymmetry number 1. See figures 9 and 10 for fit details.

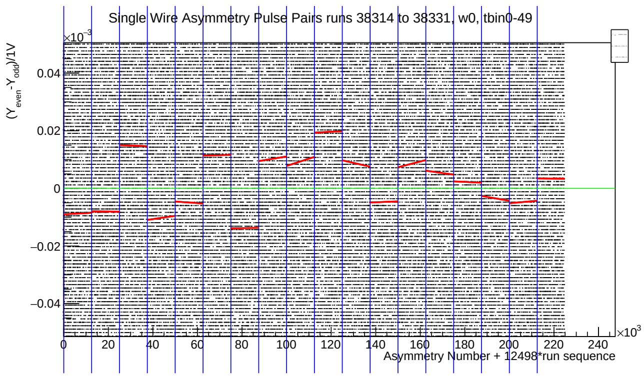

Figure 9: Close up view of the fit lines from the plot in figure 8.Blue lines indicate separations between runs, red lines are linear fits to the data, and green line is a horizontal line at 0.

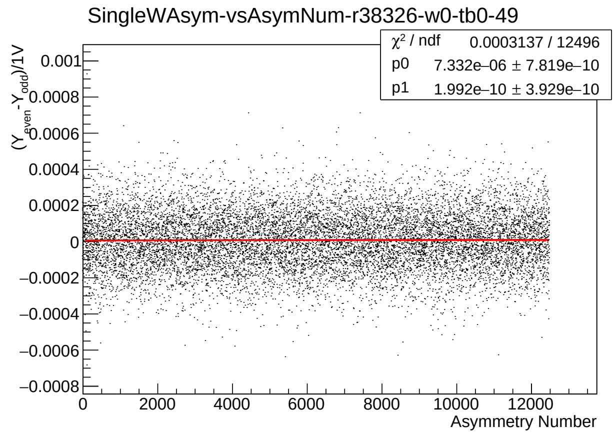

Figure 10: Example fit parameters for a single run from figures 8 and 8.

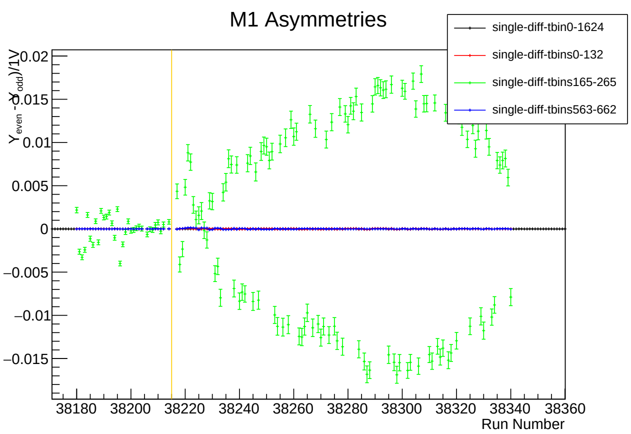

Figure 11: Run average asymmetries for subtracting the sum of different time bin ranges of the M1 monitor.

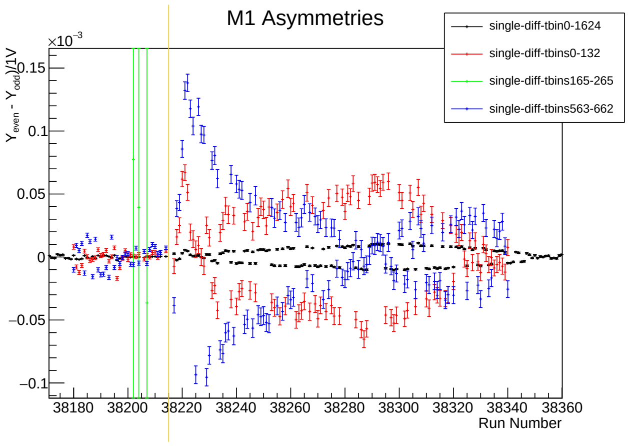

Figure 12: Run average asymmetries for subtracting the sum of different time bin ranges of the M1 monitor zoomed in on the smaller asymmetries from figure 11.