BigBite Analysis: Live Time Solved, 4/5 pass Asymmetries and Water Cal Update

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Outline

Live Time Calculation Problem

- During calculation of live time, beam trips are removed by applying beam trip cuts
- Beam trip cuts are defined using BigBite scalar clock
- Clock time of each start and stop of a beam trip are identified and removed
- When removing the beam trips, many runs have live times that are very low...

Live Time Calculation Example

Assume beam trip starts at BB clock time of 2s and ends at clock time of 4s

When calculating the live time, we want to remove events that occur at clock times between 2-4 s

```
if( (clock >= StartTrip) && (clock <= StopTime) ){
BeamTripped
}
if( !BeamTripped ){
Add these events to the live time
}
```

Event by event output:

Count Tripped (y/n)

0 n

1 n (counts = 2-0)

2 y

3 y

0 n (counts = 4-0)

4 y

5 n

6 n (counts = 6-4)

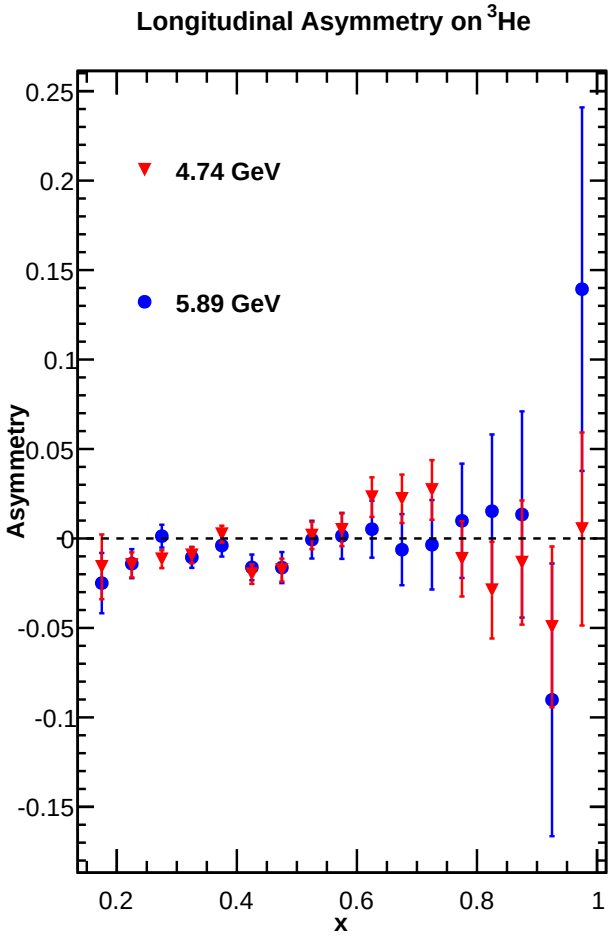
Live Time Summary

- For some reason scalar clock time drops to 0
- Scalar variables update every few events ($\sim$ 50-200 events)
- When clock drops to 0 it passes the beam trip cut
- The clock then goes back to its normal value
- Should be able to compute the live time by throwing out events where the clock went to 0

4.74 and 5.89 GeV Asymmetries

- Show preliminary asymmetries for beam energy of 4.74 GeV
  - Uses the scintillator to select electrons
  - N_2 dilution factor uses live time corrections
  - Propagate asymmetries to A_1,A_2,g_1,g_2
- Show preliminary asymmetries for beam energy of 5.89 GeV
  - N_2 dilution factor uses live time corrections (see talk from 3/22/2012)

Preliminary Longitudinal and Transverse Asymmetries



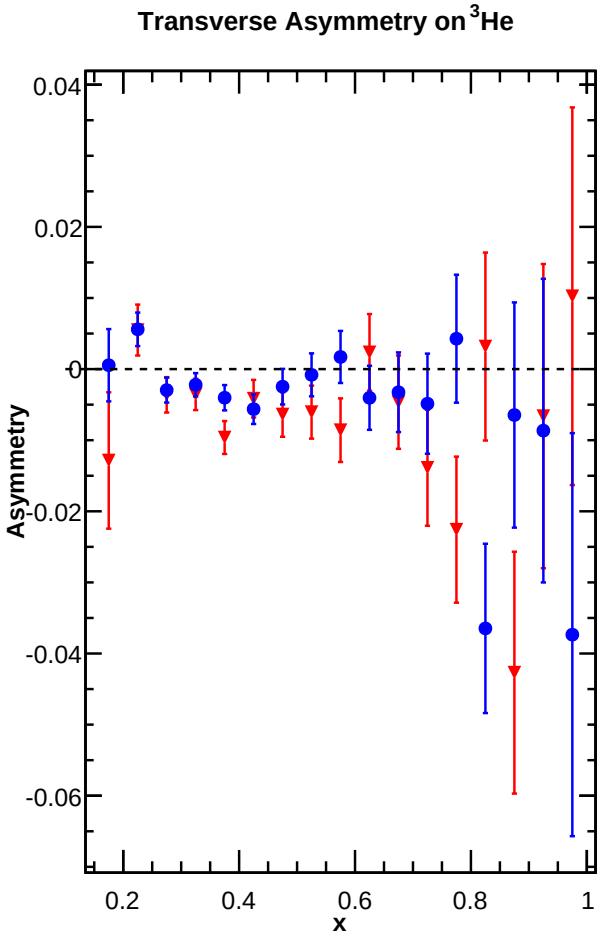


Figure: 5.89 GeV asymmetries are in blue and 4.74 GeV asymmetries are in red.

Preliminary A_1 and A_2 Asymmetries

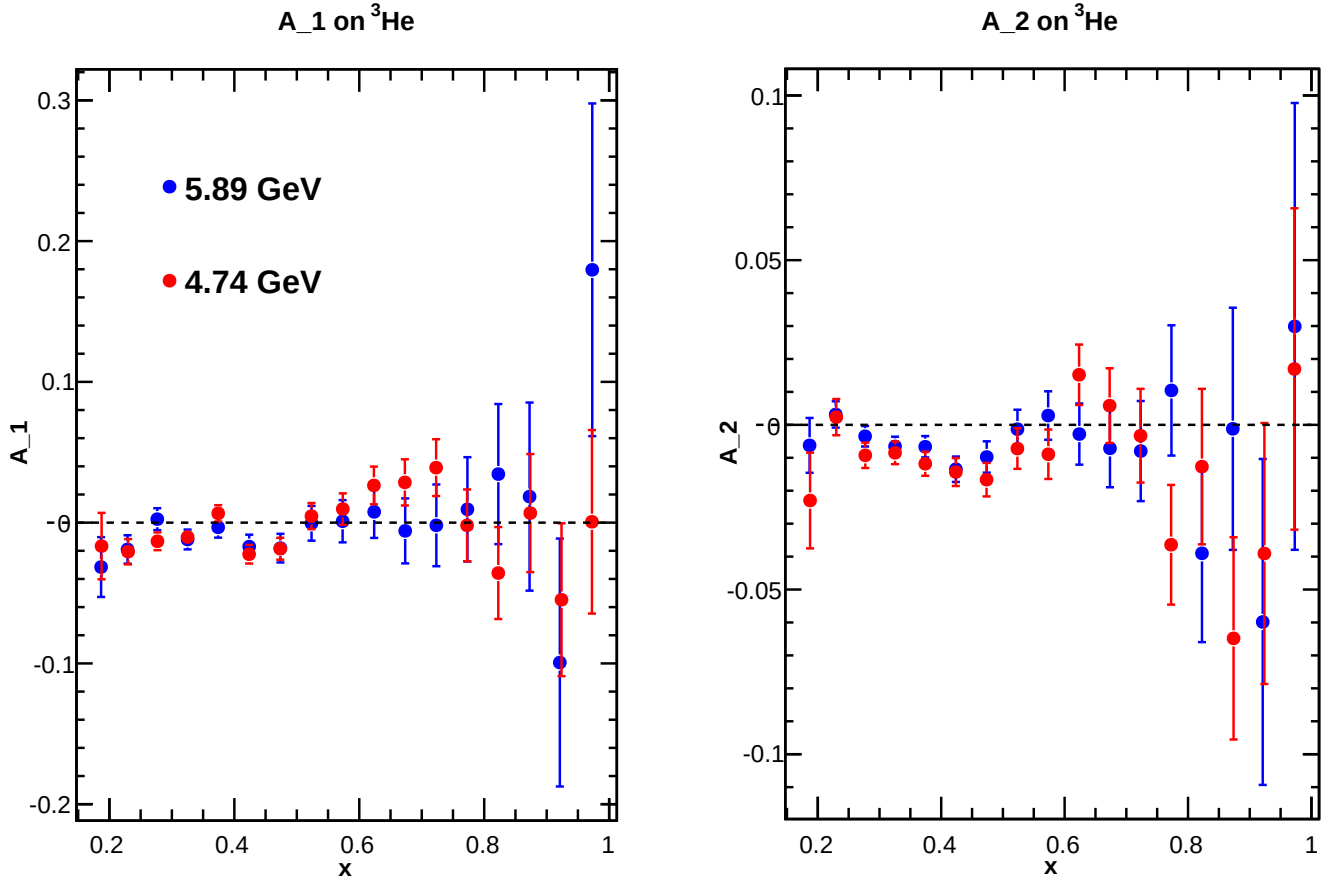


Figure: 5.89 GeV asymmetries are in blue and 4.74 GeV asymmetries are in red.

Preliminary x^2g_1 and x^2g_2 Asymmetries

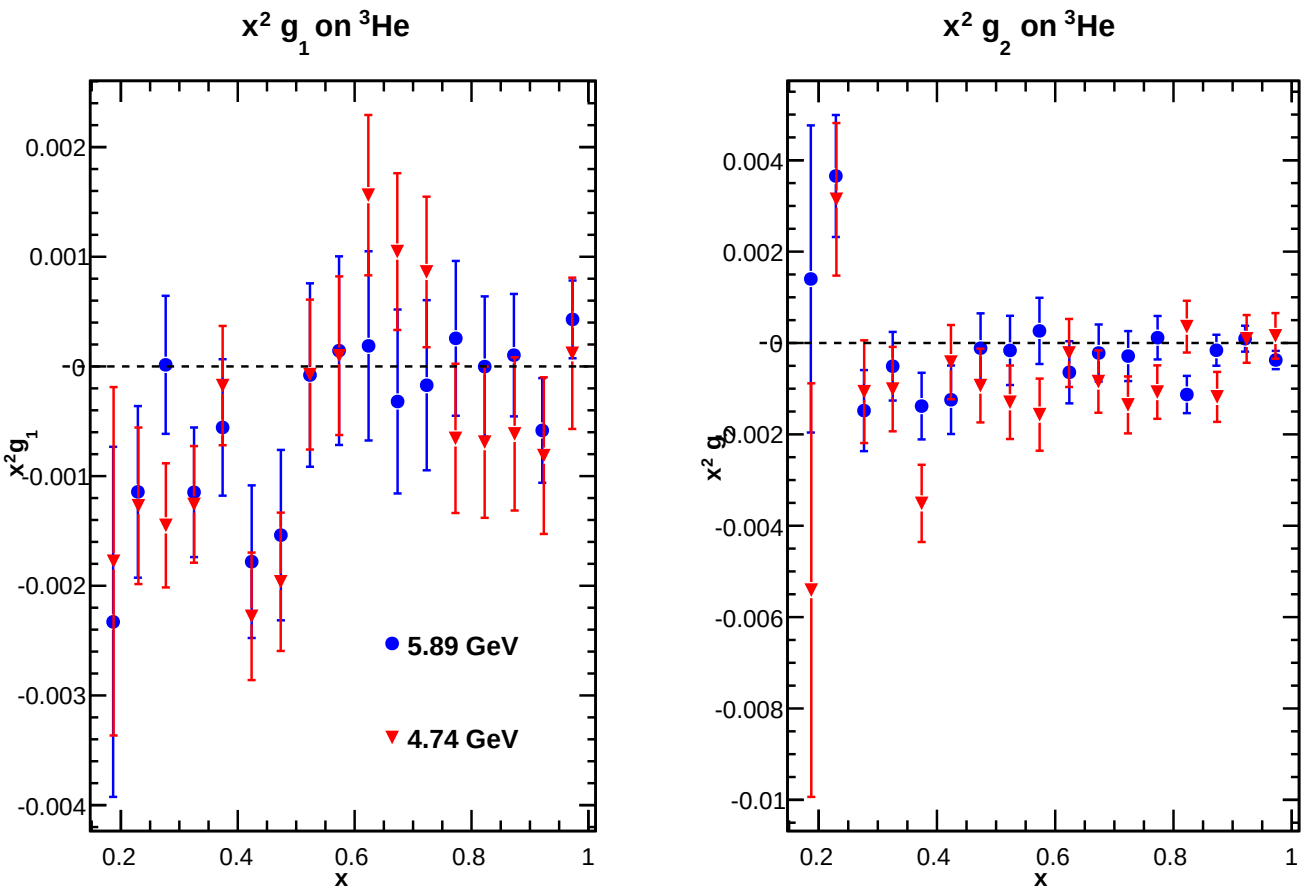
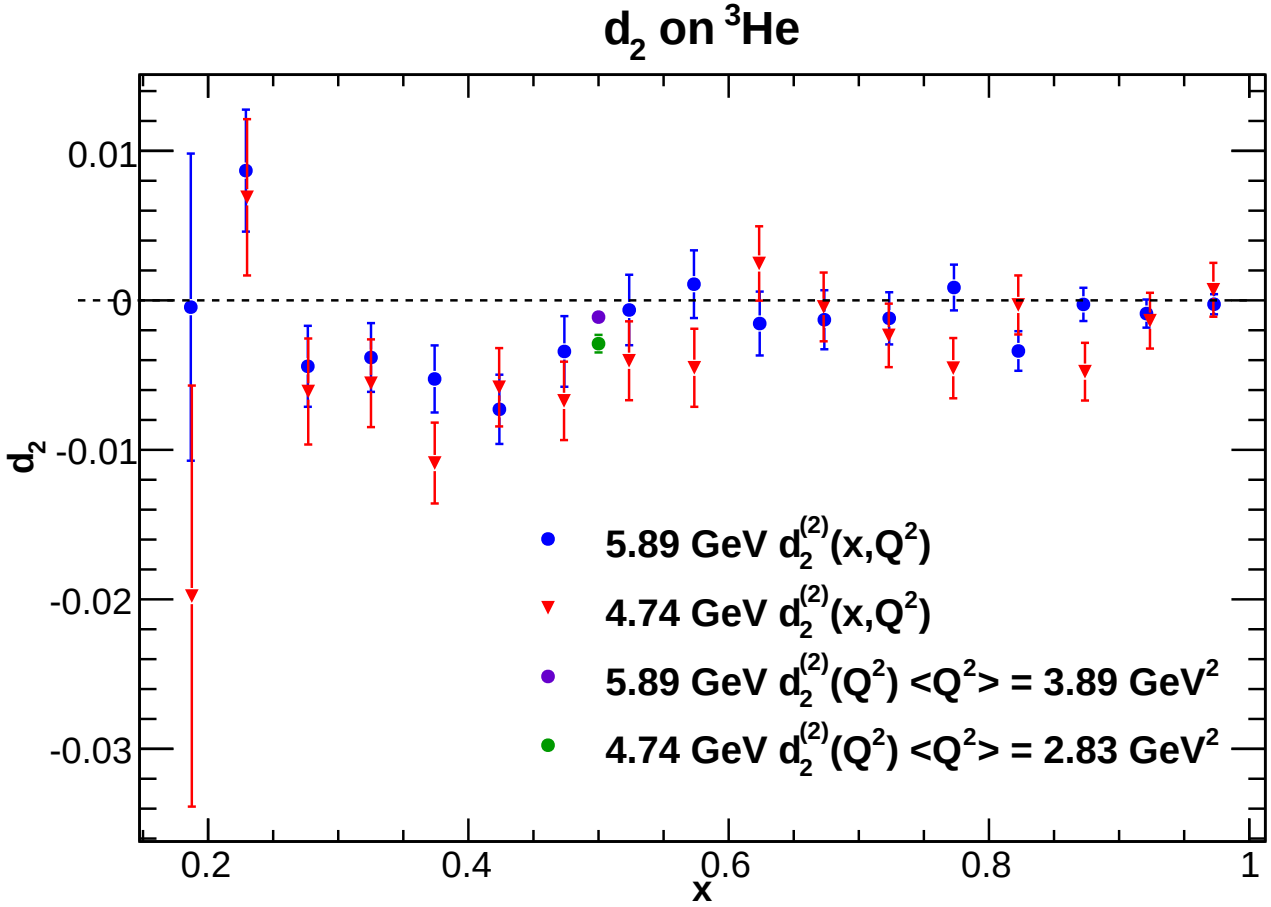


Figure: 5.89 GeV asymmetries are in blue and 4.74 GeV asymmetries are in red.

Preliminary d_2 Statistical Precision

$\delta {d_2}^{stat.}$ = 0.00037 (5.89 GeV)
$\delta {d_2}^{stat.}$ = 0.00059 (4.74 GeV)



Asymmetry Corrections

- There are several corrections that need to be applied to the asymmetries:
  - Corrections for pion asymmetries
  - Corrections for positron asymmetries
  - Radiative corrections

Correcting for Pion Asymmetry (1)

- Pion contamination can be defined as:

$$A^e_{cont} = \frac{1}{f_{N_2} P_b P_t} \frac{\Delta N}{N_{tot}} = \frac{1}{f_{N_2} P_b P_t} \frac{\Delta N^e + \Delta N^\pi}{N^e_{tot} + N^\pi_{tot}}$$

- A^e_{cont}: electron asymmetry (parallel or perpendicular) contaminated by pions
- $\Delta N = N_- - N_+$
- $N_{tot} = N_- + N_+$
- $N^{e(\pi)}{}_{-(+)}$: Number of electrons (pions) with incident helicity -1 (+1)

Correcting for Pion Asymmetry (2)

- With $N^{\pi}_{tot} = RN^{e}_{tot}$, with R = the pion to electron ratio after PID cuts
- And with $\Delta N^{\pi} = f_{N_2} P_b P_t N^{\pi}_{tot} A^{\pi}$

$$A^{e}_{cont} = \frac{1}{f_{N_2} P_b P_t} \frac{\Delta N^{e} \left(1 + R f_{N_2} P_b P_t A^{\pi}\right)}{N^{e}_{tot} + R N^{e}_{tot}}$$

$$\Delta A^{e} = A^{e}_{cont} - A^{e}$$

- A^{π}: Pion asymmetry (parallel of perpendicular)
- A^{e}: Clean electron asymmetry

5.89 GeV Pion Asymmetry for X = 0.575

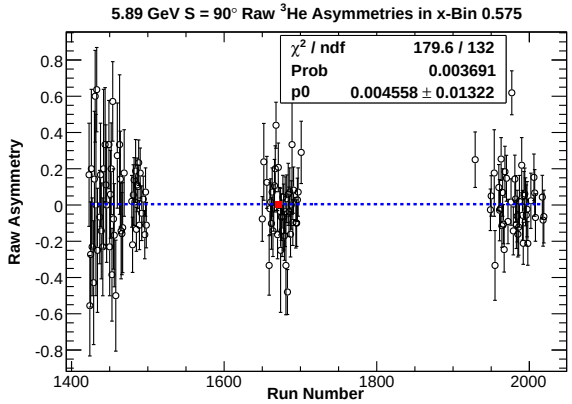


Figure: 5.89 GeV raw pion asymmetry per run for S=90 and x = 0.575

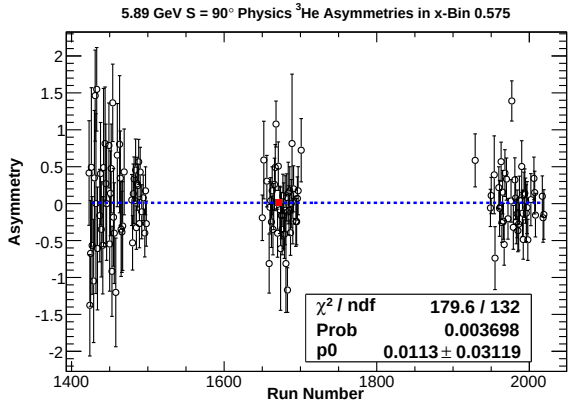


Figure: 5.89 GeV physics pion asymmetry per run for S=90 and x = 0.575

5.89 GeV Raw Pion Asymmetry

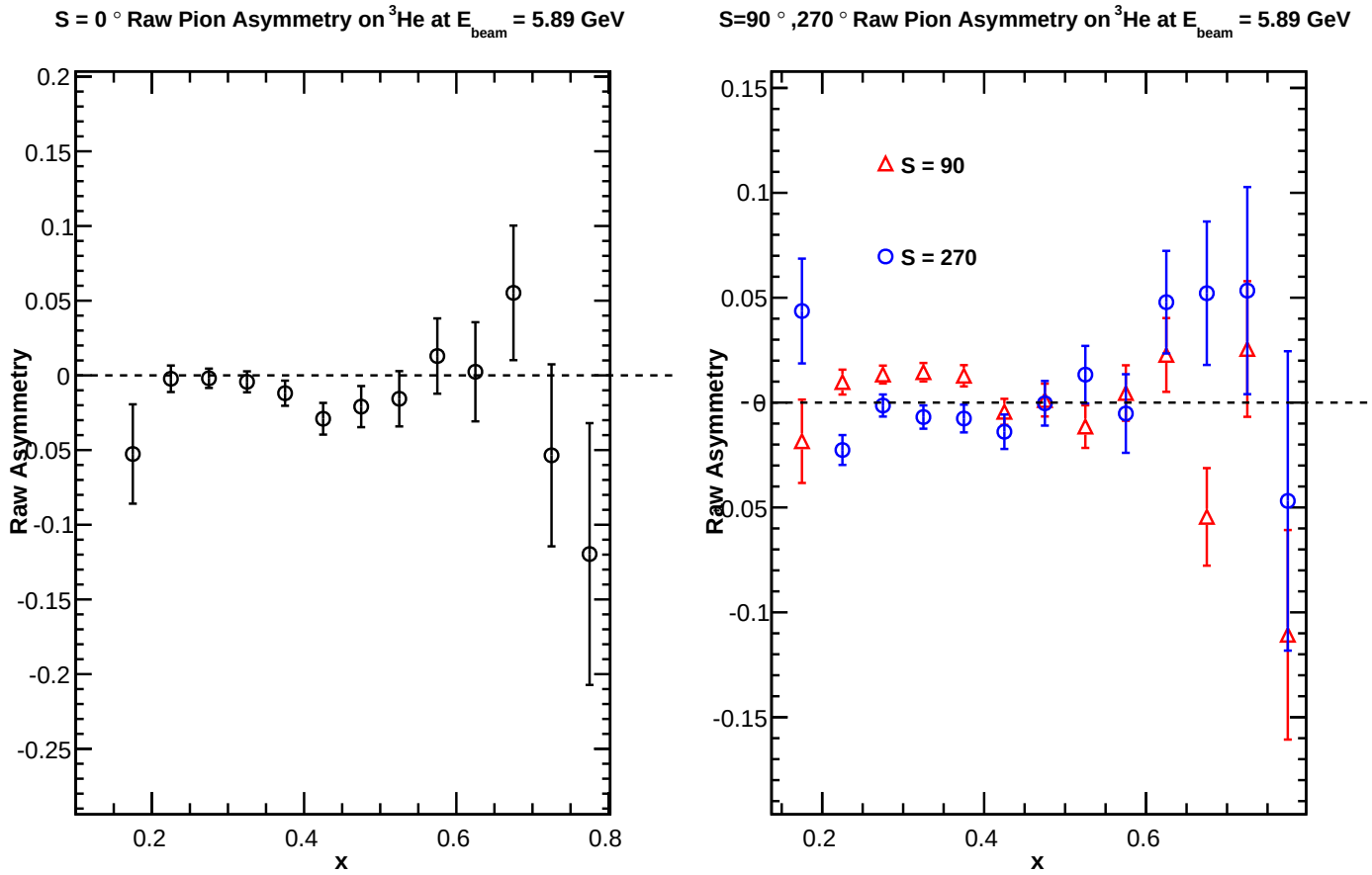


Figure: 5.89 GeV raw pion asymmetry

5.89 GeV Physics Pion Asymmetry

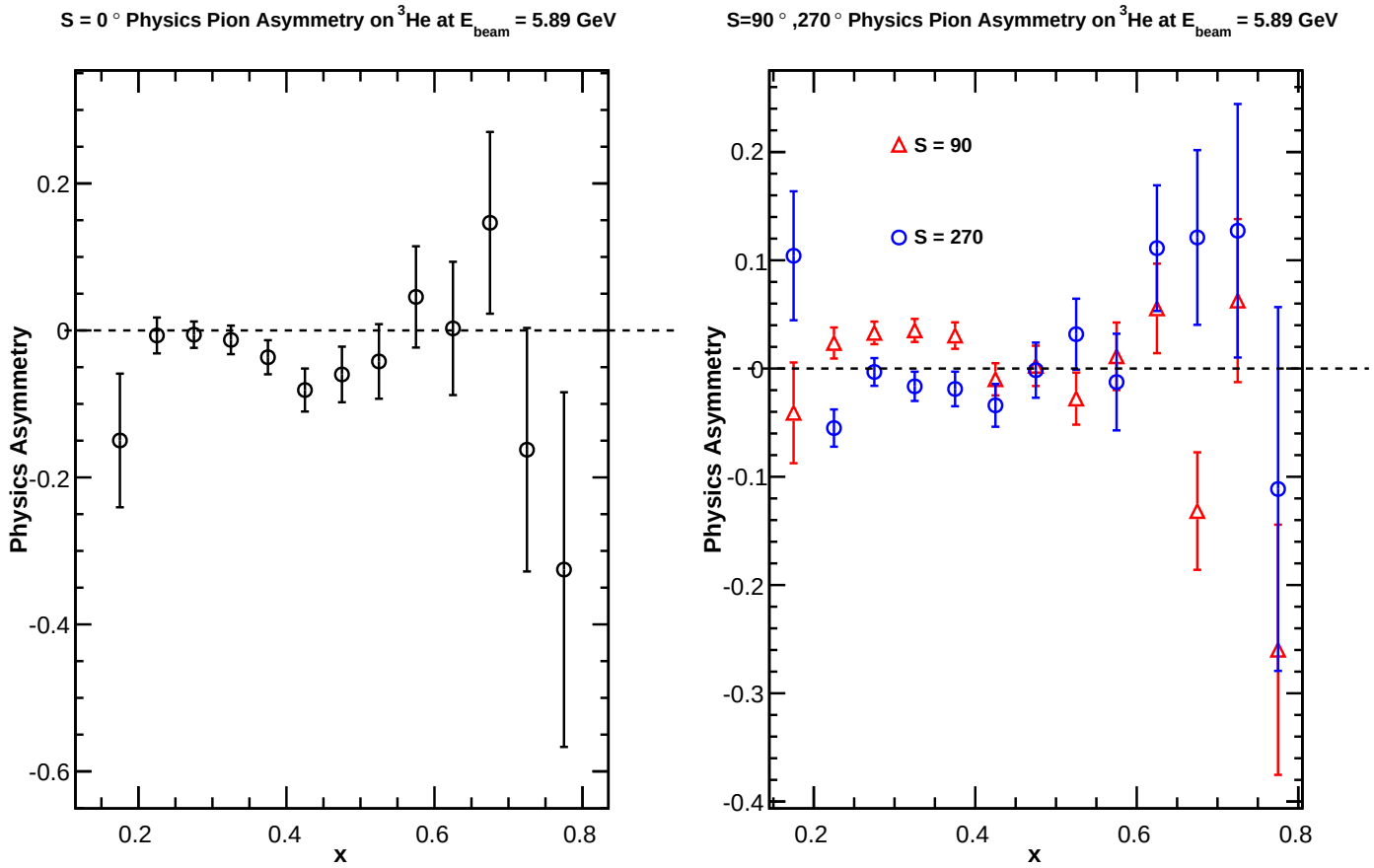


Figure: 5.89 GeV physics pion asymmetry

Pion Asymmetry Summary

- Need pion/electron ratio after PID cuts and pion asymmetry to apply pion corrections to electron asymmetries
- Found an error in the previous pion physics asymmetries that I was showing (3/14/2012)
- I was applying the wrong beam polarization

Correcting for Positron Asymmetry

- Much like the pion asymmetry correction, we would like to correct for the positron asymmetry
- We would like to apply the positron asymmetry correction run by run using the bend down particles
- There is an acceptance difference between the bend up and bend down particles that needs to be corrected:
  - Compare and understand LHRS and BigBite e+/e- ratios using negative and positive polarity to detect bend up particles
  - Correct the bend down particles in BigBite using the LHRS e+/e- ratios

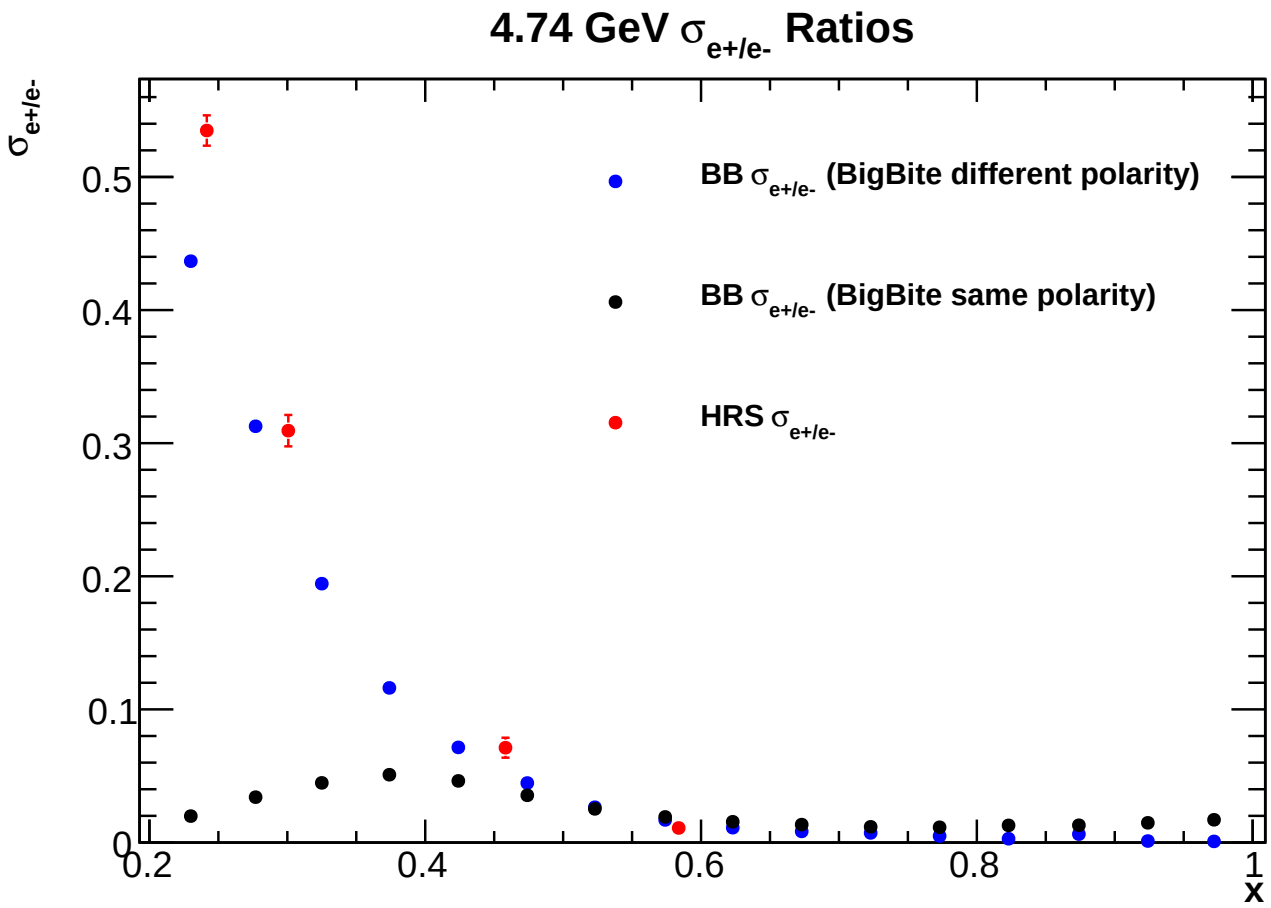


Figure: 4.74 GeV e+/e- ratios in the LHRS in red, bend down/bend up ratios in BB shown in black and e+/e- ratios using bend up particles in BB in blue

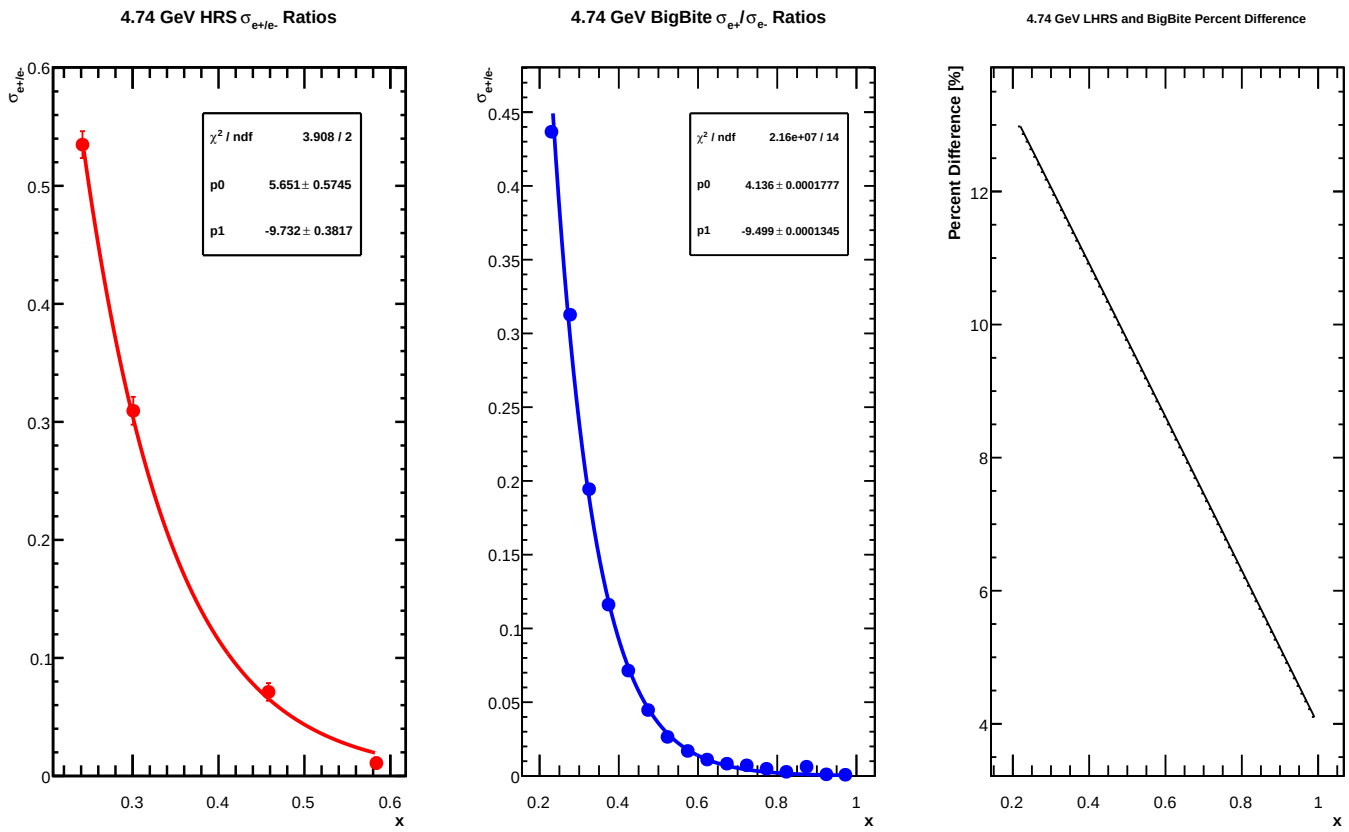


Figure: Left plot has the LHRS e+/e- ratio fitted with an exponential function, the center plot has the BB e+/e- measured using different polarities and fitted to an exponential function. The right most plots shows the percent difference between the LHRS and BB fits. There is a large disagreement at low x with agreement improving as x increases.

4.74 GeV BigBite Bend Down/Bend Up Target Direction

Look at target direction on ratios...

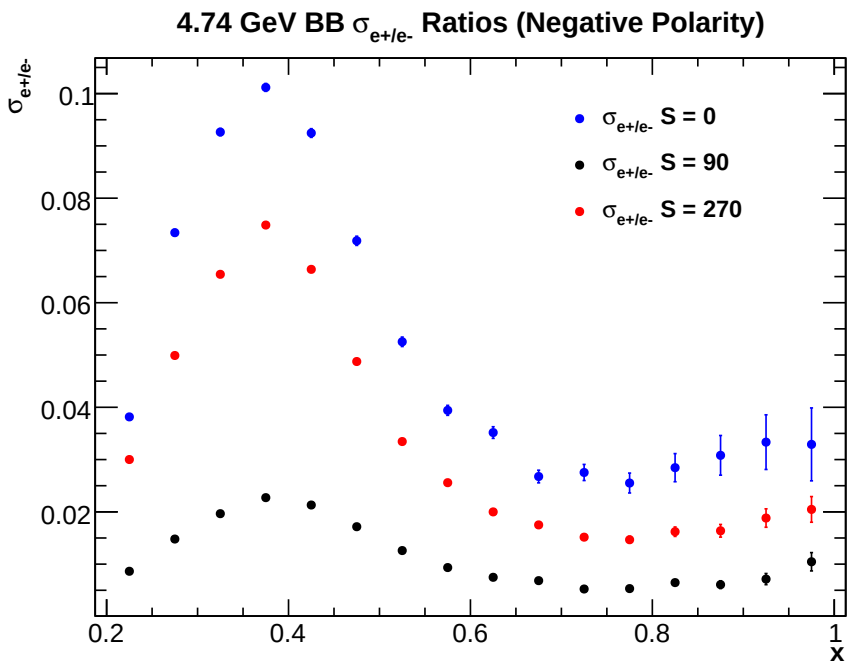


Figure: The bend down to bend up ratio in the BB is computed for each target state

4.74 GeV BigBite e+/e- Bend Up Target Direction

Look at target direction on ratios Note: All e+ measurements were done at S = 270 and LHRS not broken up into target directions

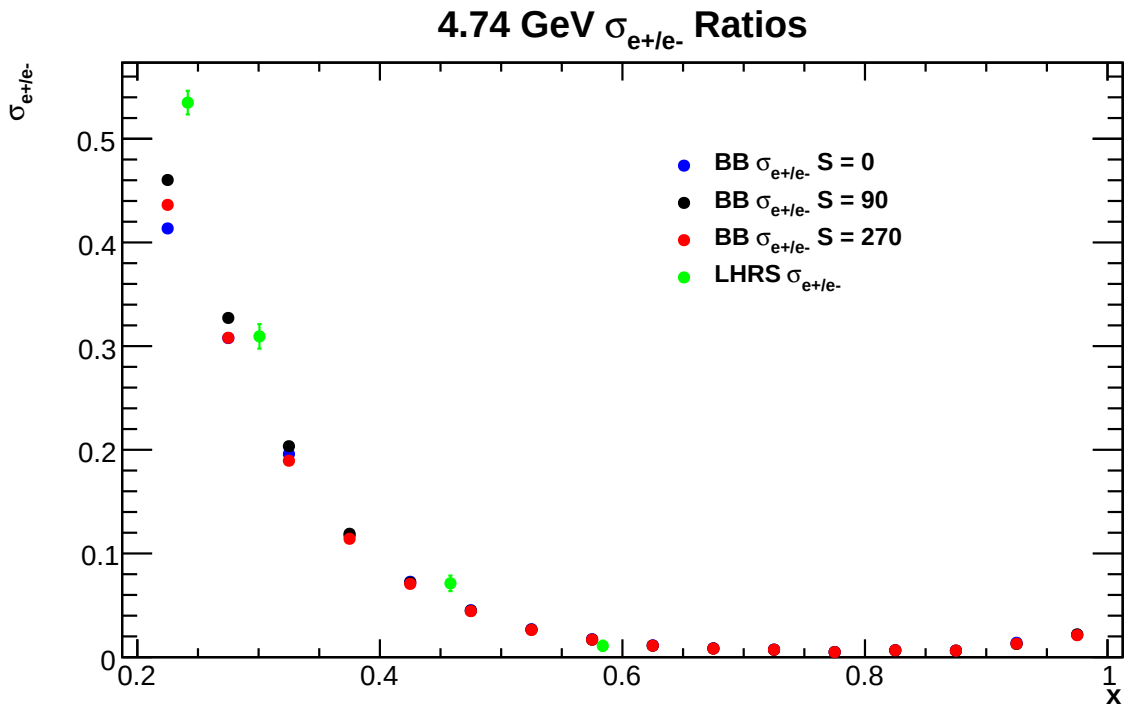


Figure: The e+/e- bend up ratio in the BB is computed for each target state. All the e+ events are at S=270 and LHRS is not broken down into target spin direction.

4.74 GeV BigBite Positron Bend Up and Bend Down Raw Asymmetries (S=270)

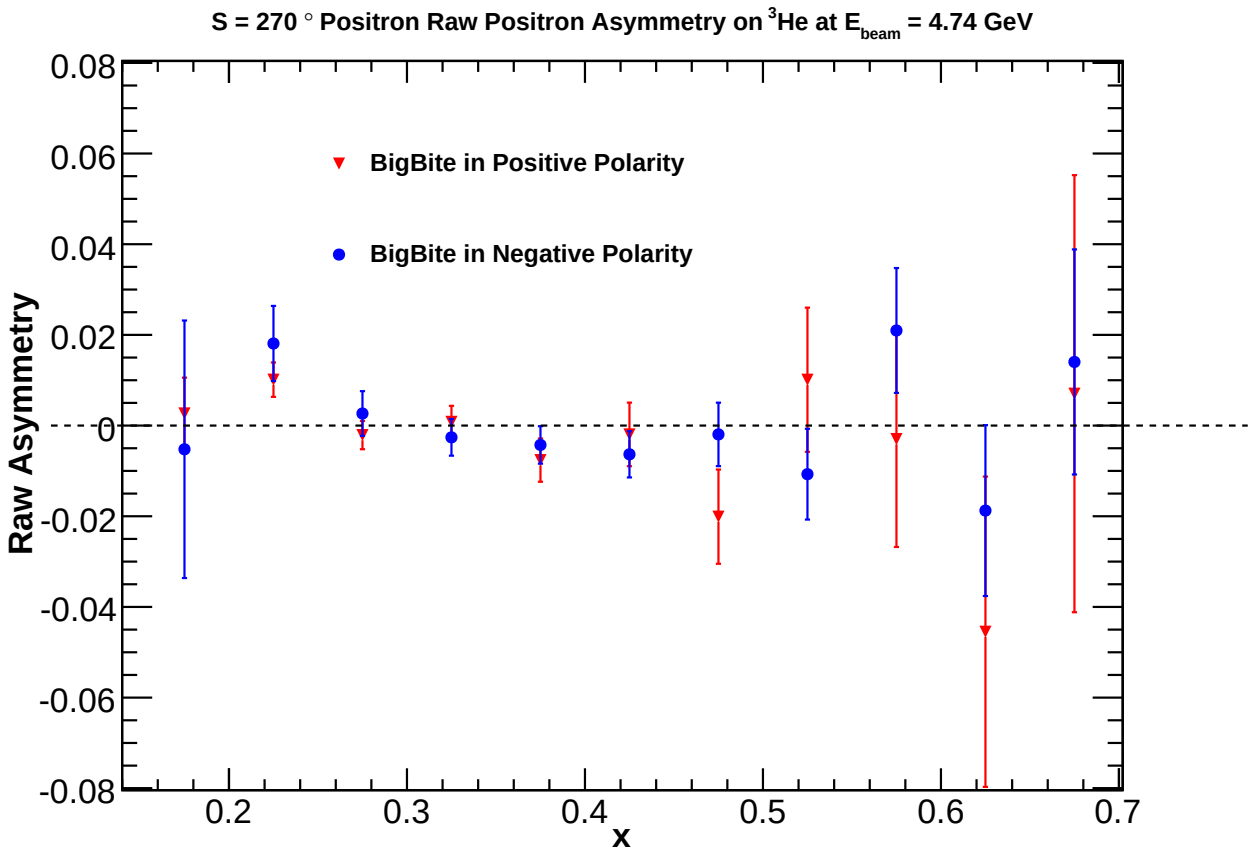
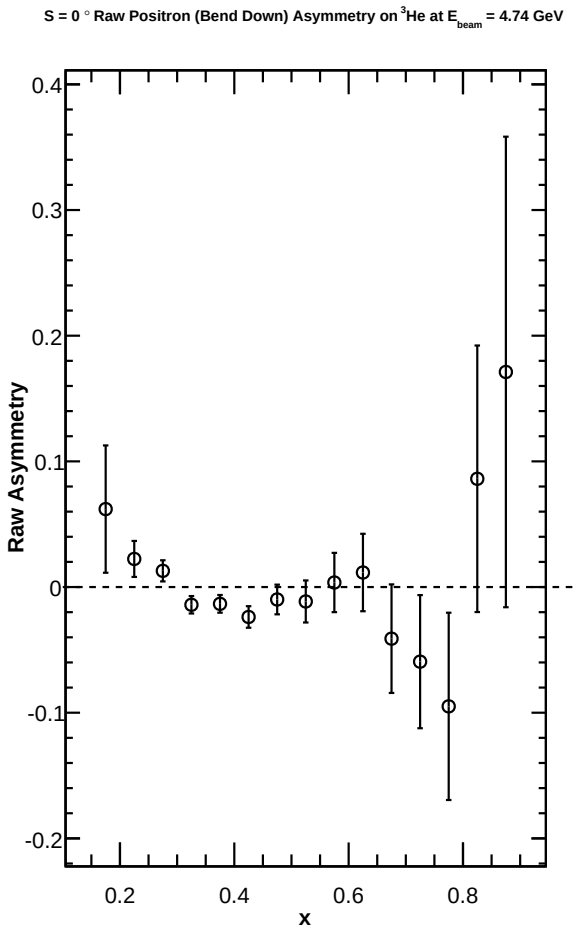
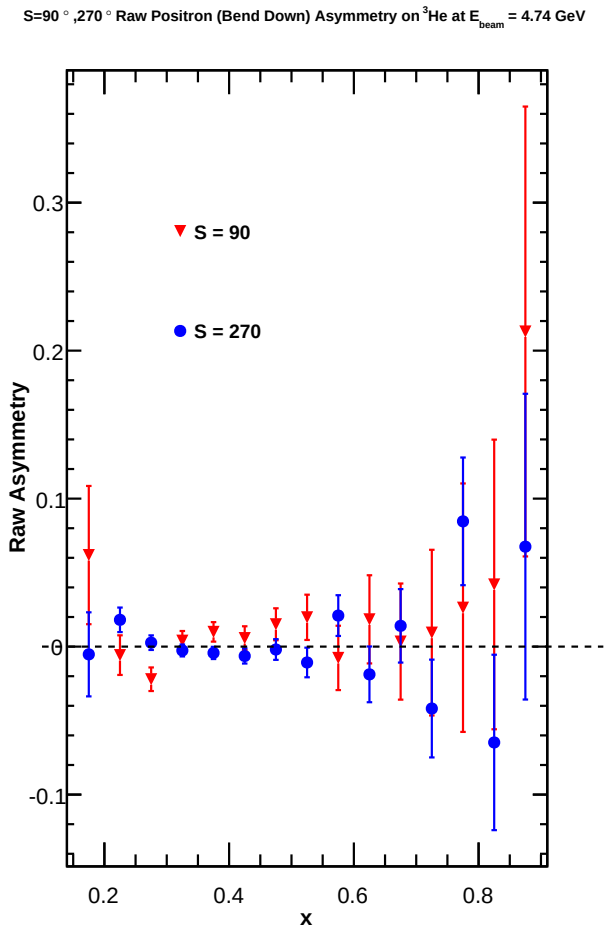


Figure: Positron asymmetry at S = 270 measured by detecting bend up particles with BigBite in positive polarity (red markers) and bend down particles detected with BigBite in negative polarity (blue markers)

4.74 GeV BigBite Positron Bend Down Raw Asymmetries





Positron Correction Summary

- Disagreement between BB and LHRS e+/e- ranges from 12-4% depending on x
- Positron asymmetry measured from bend up particle with BB in positive polarity, and the bend down particle measured with BB in negative polarity seem to be in decent agreement
- Correct in run e+/e- ratios using LHRS
- Determin how to implement correction

Bloch Equation Results

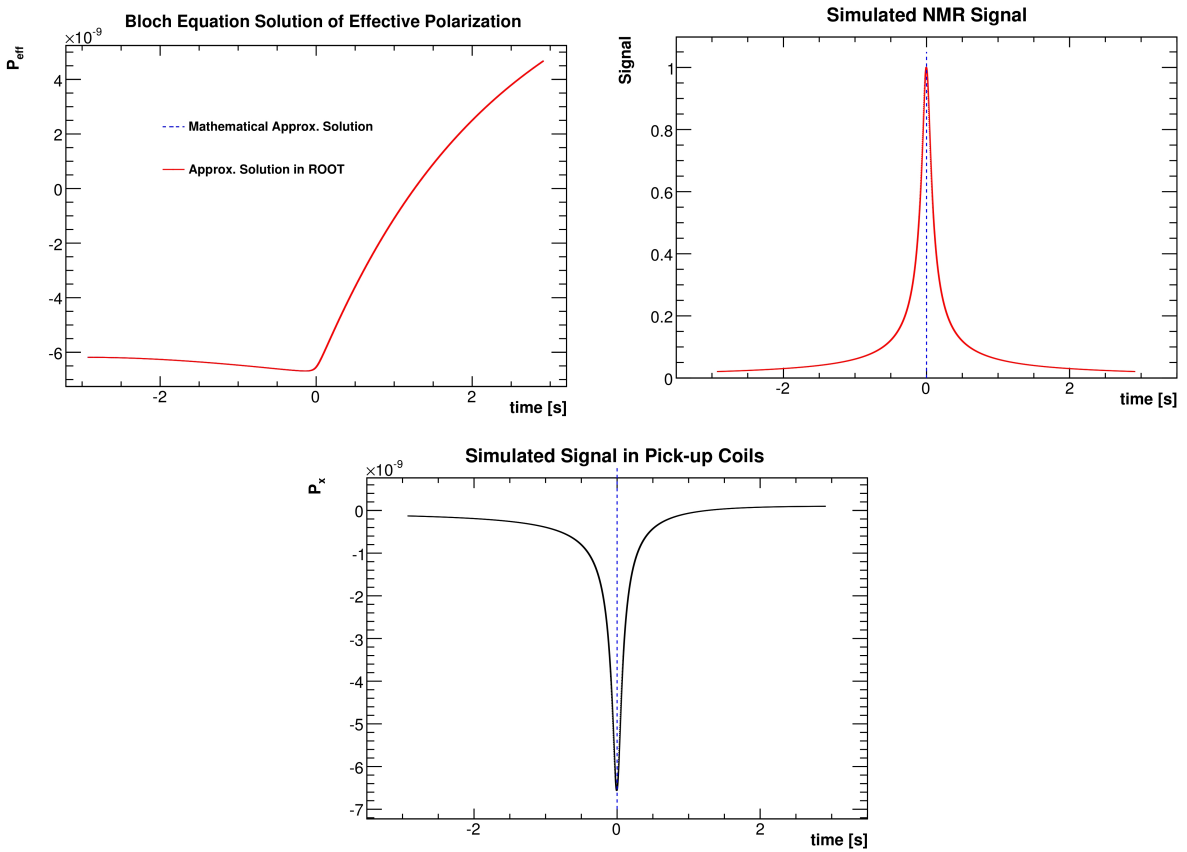


Figure: Top left plot shows the solution to the effective polarization. The top right plot shows the signal shape of the NMR signal. The bottom plot shows the simulated shape in the RF coils.

Fitting the Data

- The fit function is:

$$f(t) = a\frac{g(t)}{g(0)}\frac{H_1}{\sqrt{H_1^2 + \alpha^2 t^2}} + bt + c$$

- where we let H_1 and H_0 vary as fit parameters
- $g(t)$ is 3 piece function that is obtained by solving effective polarization (defined in talk from 3/22/2012)
- a,b,c are also fit parameters
- All parameters are minimized in Minuit and then fitted in ROOT

Fits to Down Stream Coil - Down Sweep Single Run Set (200 Sweeps)

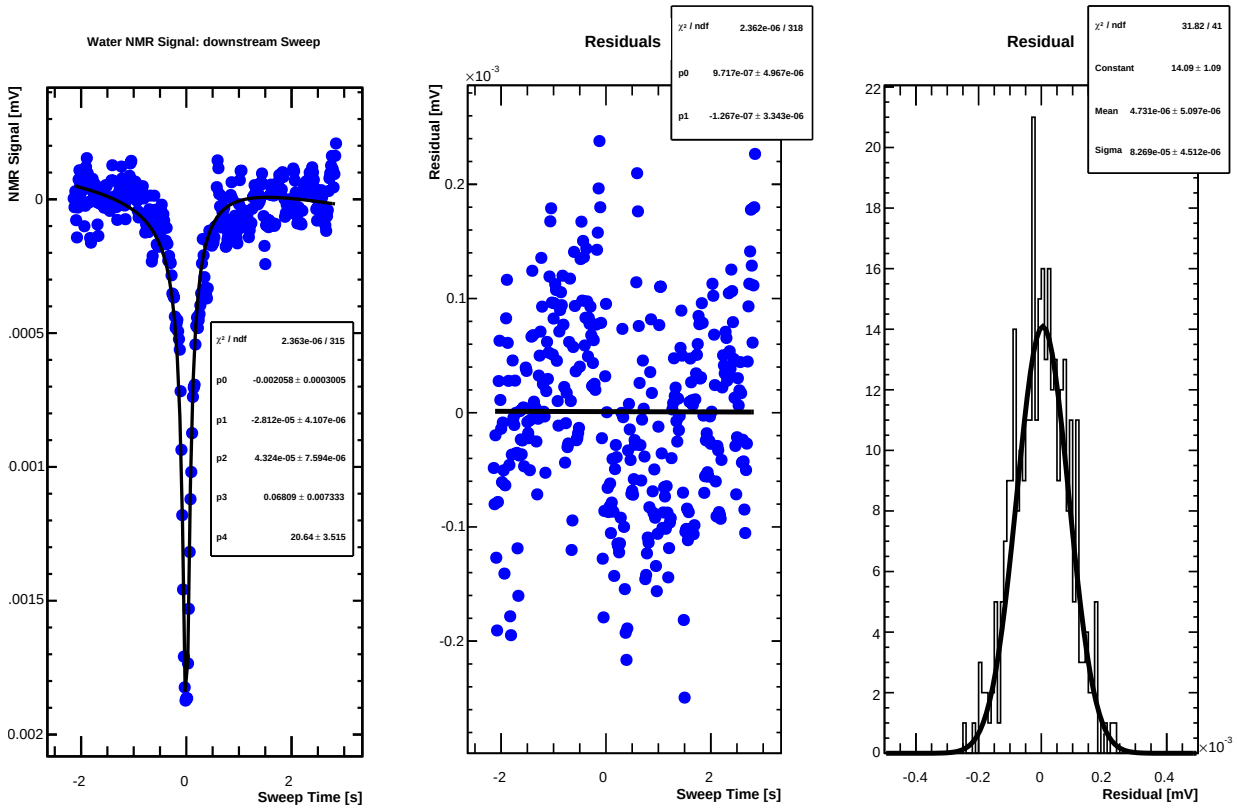


Figure: Left Plot shows the water NMR signal and fit. Center plot shows residual between data and fit with linear fit. The right plot shows residual histogram fitted with a Gaussian fit.

Fits to Down Stream Coil - Down Sweep Run Set 01 ($\sim$ 3000 Sweeps)

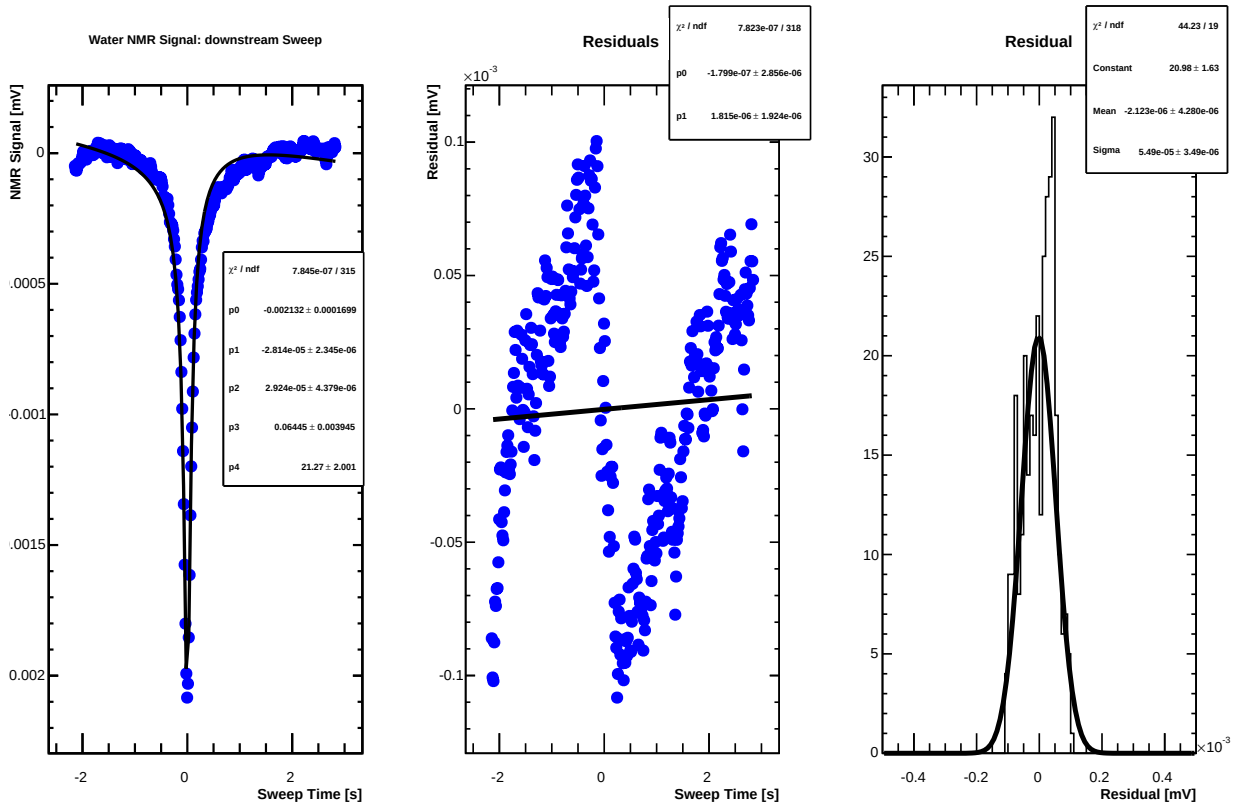


Figure: Left Plot shows the water NMR signal and fit. Center plot shows residual between data and fit with linear fit. The right plot shows residual histogram fitted with a Gaussian fit.

Fits to Down Stream Coil - Down Sweep All Runs (∼ 6000 Sweeps)

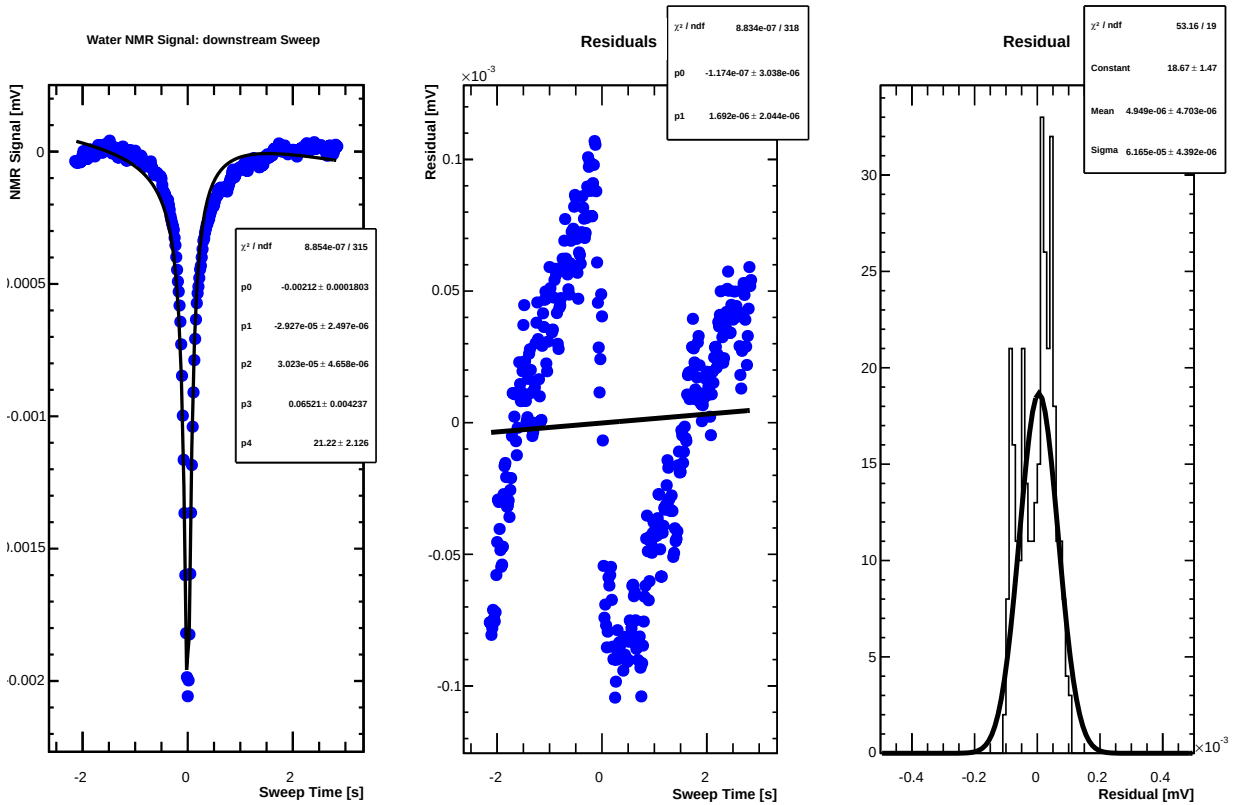


Figure: Left Plot shows the water NMR signal and fit. Center plot shows residual between data and fit with linear fit. The right plot shows residual histogram fitted with a Gaussian fit.

Water Calibration Summary

- Fits are missing some of the NMR structure
- Try to remove bad runs by looking at every 100 sweeps and plot χ^2,peak width,height and location

What's Next

- Look more into in-plane angle shift
- Formulate positron asymmetry correction
- Finalize pion refection factor for pion asymmetry corrections
- Water NMR fit