Analysis Progress

for the d_2^n analysis meeting

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1. Helicity in the Datastream

2. Beam Charge Asymmetry
   - Introduction
   - Beam Charge Asymmetry Measured by the Compton
   - Beam Charge Asymmetry from BigBite, LHRS

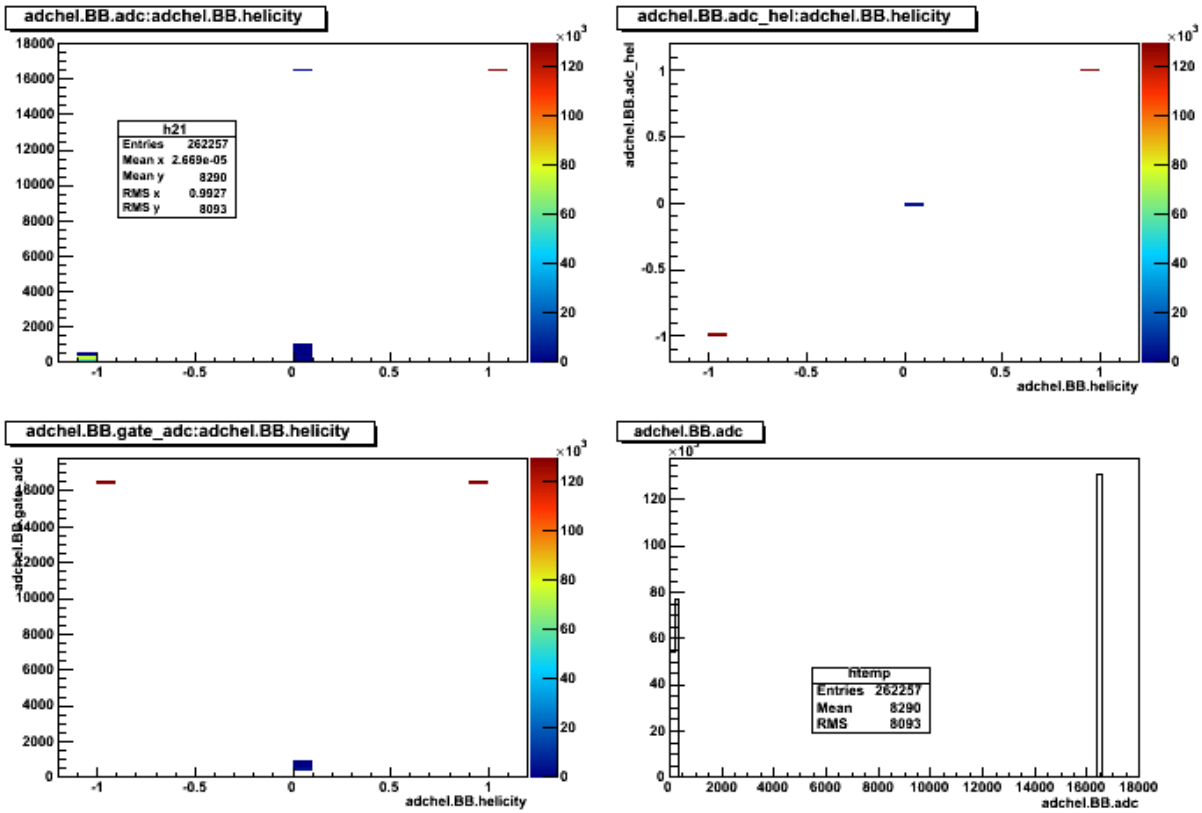
3. What's Next?

Helicity Signals: Quick Intro

- d_2^n ran with a **prompt** helicity signal, meaning no delay (what we see in the DAQ is what MCC is providing)
- Helicity signals go to
  1. ADCs (pedestal = -, saturation = +) read out with each event
  2. Scalers (as an input bit to gate the scalers)
- We have two copies of the helicity available in our main T tree:
  - adchel
  - adchel2
- These copies are redundant: they should not give different results

Using the Helicity Signals

- Each adchel block has four variables:
  1. adc = *ADC readout (either pedestal or saturation)*
  2. adc_hel = *Helicity determination based on ADC readout*
  3. gate_adc = *MPS gate (blanks out 500 μs during helicity flip)*
  4. helicity = *Final helicity determination*



An Introduction to the Beam Charge Asymmetry

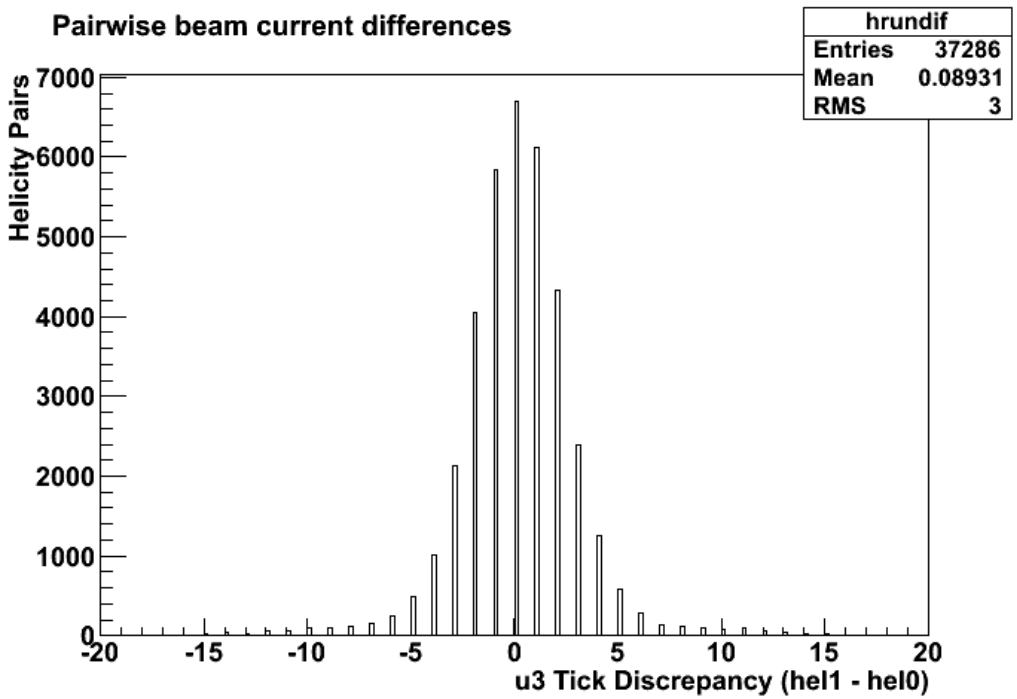
- In an ideal world, a flip in the beam helicity ($\uparrow\uparrow \leftrightarrow \uparrow\downarrow$) changes only one thing: the beam helicity
- In the real world, there may be other changes, e.g. in steering or luminosity ("false asymmetries")
- The **beam charge asymmetry** quantifies the difference in delivered beam charge for the two helicity states:

$$A_Q = \frac{Q^{\uparrow} - Q^{\downarrow}}{Q^{\uparrow} + Q^{\downarrow}} \tag{1}$$

- Charge feedback from the HAPPEx DAQ is supposed to reduce charge asymmetry, but a nonzero A_Q will contribute to our systematic errors
- We can compute this asymmetry over individual helicity pairs or on the cumulative charge over an entire run

Measuring A_Q with the Compton

- To determine the signs of the helicity signals in the primary DAQs, we decided to compare A_Q in the LHRS, BigBite, and Compton
- The CMU Compton DAQ has one beam current signal: a copy of u3
- Out of $\sim$ 3300 ticks per MPS, the pairwise A_Q is a few ticks:



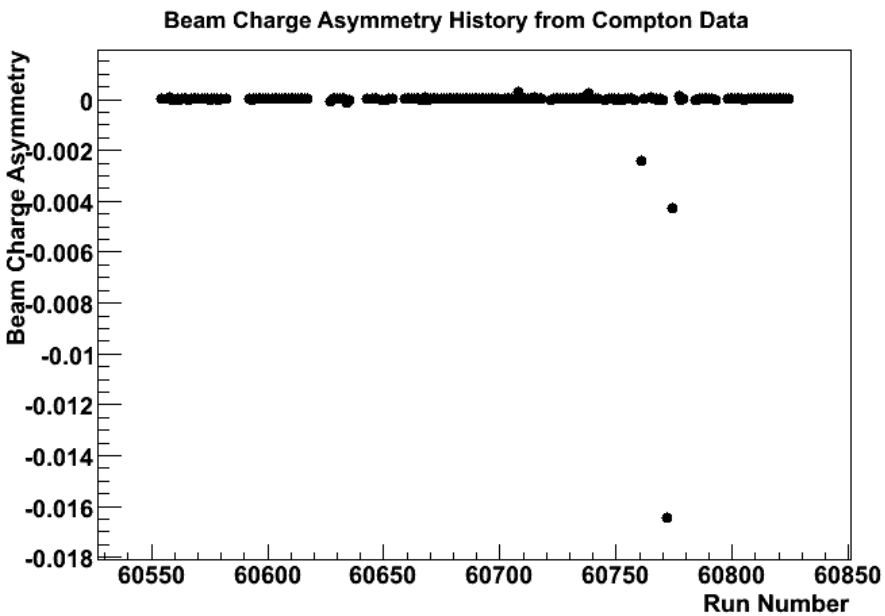
- We get a total A_Q of about 15 ppm, but the resolution is not very good!

A_Q Behavior from the Compton DAQ (i)

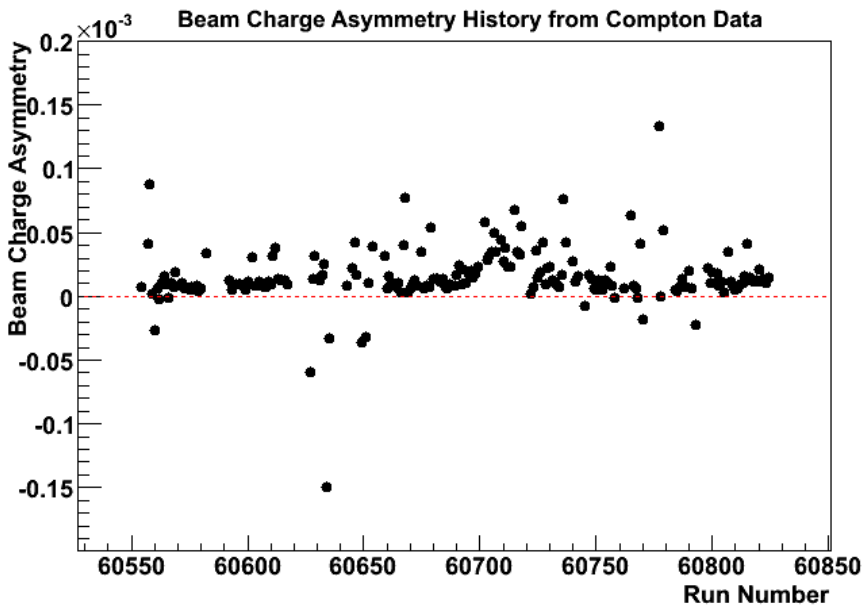
Questions:

- Is A_Q more or less stable over time?
- How large does A_Q get?

Total A_Q History



Zoom on Central Region



A_Q Behavior from the Compton DAQ (ii)

- We see a few large excursions, but asymmetry is mostly under 100 ppm
- Strong bias toward positive asymmetry
  - Doesn't quite fit a real asymmetry in, say, spin-dependent steering
  - Otherwise, we would expect a sign flip when the insertable half-wave plate is changed
- These are rough – can't read too much into them yet
  - Low resolution on BCM signal
  - Strong dependence on how current cut is defined

Progress on A_Q in BigBite, LHRS

- There are a few complications in a direct comparison of a Compton run to a detector run:
  - Different timing (Compton runs $\sim$ 2 hours, detector runs $\sim$ 30 min)
  - Making sure the beam current cuts are equivalent
- Presently, I'm extracting asymmetries roughly 1 order of magnitude larger than in the Compton.
- Once agreement is closer, the sign will be much more trustworthy.

What's Next?

- Beam charge asymmetry
  - Establish asymmetry algorithm that gives consistent results between Compton, detector stacks
  - Confirm helicity signs in detectors
- Beamline
  - Quantify raster effects on physics quantities of interest (e.g. reconstructed momentum)
  - Compton systematic errors
- Caveat
  - Cross-country moves slow a body down