Analysis Progress for d_2^n

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Beam Charge Asymmetry A_Q

- Helicity-dependent differences in beam steering and luminosity can lead to an asymmetry in the *beam charge*:

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

- Running the HAPPEX DAQ was supposed to keep A_Q in an acceptable range
- At Jin's request, I started looking at this in order to evaluate the relative helicity signs in our various DAQs

A_Q Monte Carlo

- We can compute Q and A_Q from the beam-current scalers (gain factors of x1, x3, x10)
- The scalers tick at 2000, 6000 and 20000 Hz/μA
- I simulated the baseline beam current with a Gaussian signal (σ~μ/50), adding a Poisson distribution for A_Q. How would each scaler report the asymmetry?

A_Q (ppm)

Central Value λ	*x1* scaler	*x3* scaler	*x10* scaler
500	522	492	486
250	236	229	243
50	49	32	41
25	16	-5	46

A_Q in BigBite

- In BigBite, we can measure A_Q from the gated scalers
  - Each scaler only counts when the beam helicity is in a certain direction
  - If the scaler count doesn't wrap back to zero over the course of the run, the final scaler readout corresponds to the total beam charge
- A_Q measurements (in ppm) for a randomly chosen BB run, on February 26:

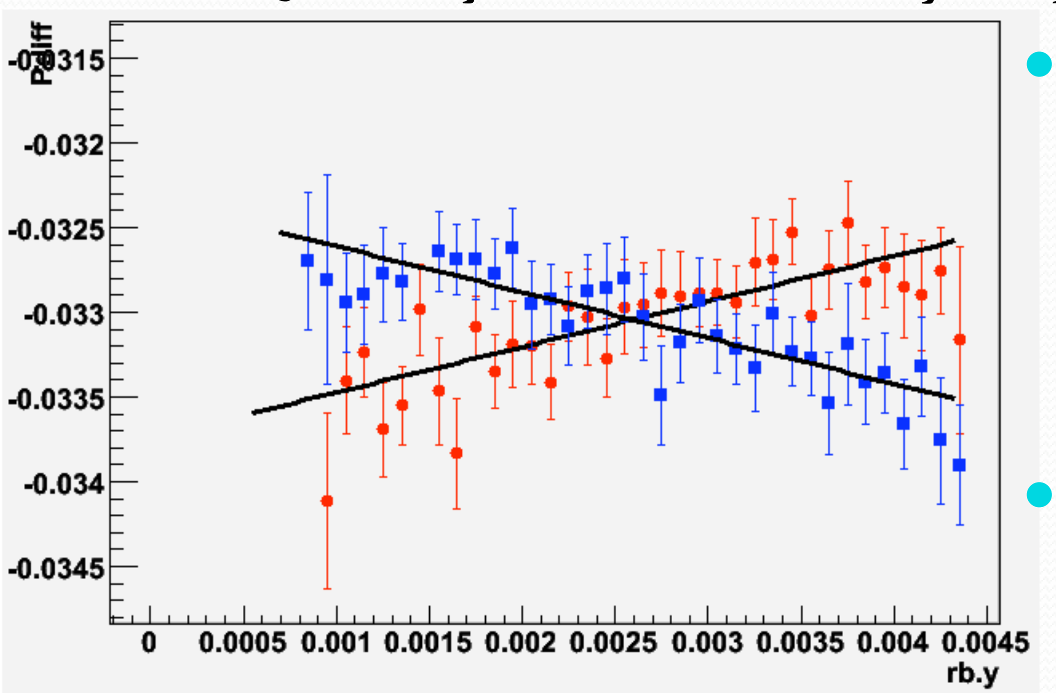
Gain Factor	Upstream A_Q	Downstream A_Q	Compton A_Q
x1	79	89	--
x3	30	37	34
x10	19	20	--

Problems with This A_Q Method

- Helicity gating adds an extra step
  - Is the timing of the gate really accurate on the level of 10 ppm?
  - Helicity sign in gated scalers may be flipped from ADC readout
    - Helicity signal has to be plugged into separate scaler input – one more opportunity for a sign flip
- Scaler information is not synchronous with helicity information in data stream …
- The value of this method might just be to tell us that A_Q is not large

Raster Correction

- Recall that the vertical raster position (*raster-y*) affects momentum reconstruction
- I looked at elastic runs (1-pass)
  - Compare p_{theory} to $p_{reconstructed}$
  - Quantify effect of *raster-y* on $p_{reconstructed}$



- Effect is very small at this LHRS momentum setting (0.87 GeV/c)
  - $\Delta p \sim 1$ GeV/c is within beam energy error bars
- Does this apply to other momentum settings?

LHRS Optics and the Raster

- Start with the first-order vertical position x in the focal-plane coordinate system:

$$x = a x_0 + b\theta_0 + c\,\frac{p - p_c}{p_c}$$

  - a, b, c are elements of the optics matrix
  - p_c is the central momentum setting of the LHRS
  - x_o, θ_o are coordinates at the target
- Gregg has a nice writeup of the math at https://hallaweb.jlab.org/wiki/images/2/25/HRSRasterCorrections_d2n.pdf
- We can solve for the error in Δp due to a displacement Δx (we neglect $\Delta\theta$, whose contribution is 10x less)

Size of the *raster-y* correction

$$\Delta p = \frac{a}{c} p_c \Delta x_0$$

- The correction Δp is linear in p_c, so it gets larger at higher momentum settings
- We can take Δx_0~4mm from our raster settings
- Taking a=-2.181 and c=11.905 to first-order from our optics matrix, we can predict the range of Δp for our kinematics

Momentum Setting p_c (GeV/c)	**Raster-y correction Δp (MeV/c)**
0.6	0.44
1.7	1.25

- It looks like this correction is not significant for us

What's Next?

- BigBite
  - ^{3}He quasi-elastics
  - Understanding particle ID
  - Acceptance simulation from G_E^n
- Compton
  - Systematic studies
  - Final (or semi-final) beam polarization numbers
- Raster
  - Raster-y corrections may not be necessary, but what about raster-x?