LHRS Analysis for d_2^n

Data Quality, Trigger Variable, & Scintillator Studies

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Outline

1. A_1^n Statistical Error Projection
   - Sample Calculation
   - Comparison to World Data
2. Scintillator Calibration
   - S2m Time – S1 Time
3. Summary

A_1^n Statistical Error Projection (1)

Sample Calculation

- From the note, we have various quantities:
  - $N_p =$ Number of events that remain after a momentum cut only
  - $N_{\text{cut}} =$ Number of events that remain after all cuts
  - $N_{\text{raw}} =$ Number of events recorded for the sample run 2060
  - $N_T =$ Number of events recorded in parallel running over the run ranges 1530–1553 and 1702–1719
  - $N_{\text{eff}} = (N_{\text{cut}}/N_{\text{raw}})\, N_T =$ Effective number of events that would remain after all cuts are applied to all parallel data
- The momentum cut:
  - $\delta p_{i,i-1}/2 < p_i < \delta p_{i,i+1}/2$
    $\delta p_{i,j} = |p_i - p_j|,\ j = i-1, i+1$
  - For instance, if $p_i = 1.20, p_{i-1} = 1.13, p_{i+1} = 1.27$ (5-pass LHRS p settings)
    $\Rightarrow$ cut $= 1.165 < \texttt{BB.tr.p[0]} < 1.235$

A_1^n Statistical Error Projection (2)

Sample Calculation

- Utilizing all the good electron cuts (see the note), we obtain:
  - $N_p = 30386$
  - $N_{\text{cut}} = 4372$
  - $N_{\text{raw}} = 4681052$
  - $N_T = 214350416$
  - $\Rightarrow N_{\text{eff}} = 200199$
- The errors on the parallel asymmetry and A_1^n:

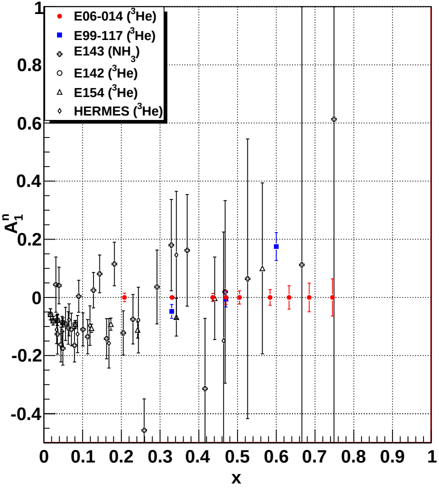
$$\Delta A_{\parallel}^{raw} = \frac{1}{\sqrt{N_{\text{eff}}}} = 0.223\%$$

$$\Delta A_1^n \approx \Delta A_{\parallel}^{phys} = \frac{1}{P_b P_t R D \sqrt{N_{\text{eff}}}} = 2.388\%$$

- Physics quantities:
  - $P_b \approx 0.65$ is the beam polarization
  - $P_t \approx 0.60$ is the target polarization
  - $R \approx 0.30$ is the ratio of ^{3}He to neutron structure functions
  - $D \approx 0.80$ is the dilution factor

A_1^n Statistical Error Projection (3)

E06-014 (5-pass Data) Compared to World Data



Scintillator Calibration (1)

Corrected S2m time — S1 raw time: Method

- With the S2m paddles calibrated, we now look to the S1 paddles
  - Look at the time difference between the two planes to see how to manipulate the time offsets for S1
  - The left-right (L-R) time offset for each paddle in S1 has already been done (and implemented in the DB)
- We consider the time difference between S2m (corrected) and S1 (raw) paddles :

$$\Delta t_{jk} = t_{\text{S2m}_j} - t_{\text{S1}_k}$$

  - From this, we determine what offset needs to be applied to both the L and R PMTs
  - We keep in mind the fact that the S2m paddles have each been calibrated to 61.15 ns
  - Choose $\Delta t_{jk} = 6$ ns

Scintillator Calibration (2)

Corrected S2m time — S1 raw time: Method

- There are only six time offsets to work with in the DB for the L and R PMTs
  - Utilize the average time difference for each paddle (in S1) in the quantity $\Delta t_{jk} \Rightarrow \Delta t_{jk,\text{avg}}$
  - This should be fine as long as the Δt_{jk}'s are consistent with one another for a given S1 paddle
- Each (L and R) S1 PMT acquires the offset (in the DB):

$$
\begin{aligned}
t^k_{\text{off},L} &= \delta t^k_L + f\delta t^k \\
t^k_{\text{off},R} &= \delta t^k_R + f\delta t^k \\
\delta t^k &= 6.00 - \Delta t_{jk,\text{avg}} \\
f &= 20 \text{ ch./ns}
\end{aligned}
$$

Scintillator Calibration (3)

Corrected S2m time — S1 raw time: Before

Scintillator Calibration			
S1 Paddle	S2m Paddle	Δt_{jk} (ns)	$\Delta t_{\mathrm{jk,avg}}$ (ns)
0	0	17.21	17.27
	1	17.36	
	2	17.25	
1	3	15.59	15.56
	4	15.55	
	5	15.55	
2	5	7.93	7.93
	6	7.92	
	7	7.91	
3	8	8.05	8.05
	9	8.07	
	10	8.04	
4	10	6.92	6.92
	11	6.92	
	12	6.91	
5	13	4.23	4.21
	14	4.18	
	15	4.23	

Scintillator Calibration (4)

Corrected S2m time — Corrected S1 time: After

- Most Δt_{jk} are consistent
- Is it S1 or S2m yielding the discrepancy?
- Is the discrepancy too small to fix?

Scintillator Calibration			
S1 Paddle	S2m Paddle	Δt_{jk} (ns)	$\Delta t_{\text{jk,avg}}$ (ns)
0	0	5.99	5.99
	1	5.98	
	2	6.02	
1	3	5.95	5.96
	4	5.96	
	5	5.96	
2	5	5.98	5.99
	6	6.01	
	7	6.00	
3	8	6.02	6.02
	9	6.04	
	10	6.01	
4	10	5.99	5.99
	11	5.99	
	12	5.98	
5	13	5.99	5.99
	14	6.01	
	15	5.99	

Scintillator Calibration (5)

Corrected Time Averages

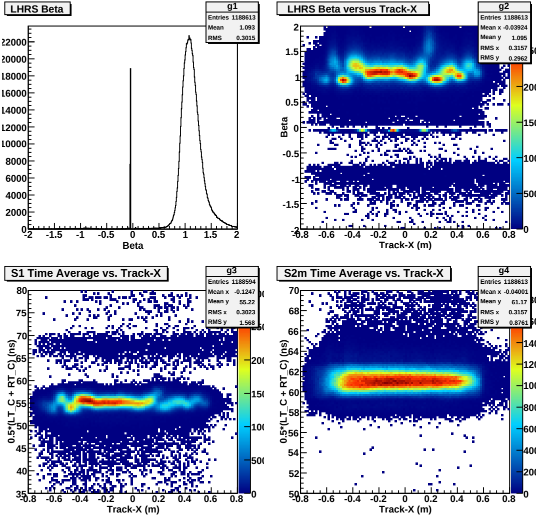
- Fairly good agreement
- TDC resolution is 0.05 ns/ch.

S1 Time Averages	
Paddle	t_{avg} (ns)
0	55.17
1	55.19
2	55.18
3	55.15
4	55.18
5	55.15

S2m Time Averages	
Paddle	t_{avg} (ns)
0	61.17
1	61.15
2	61.19
3	61.15
4	61.15
5	61.15
6	61.19
7	61.19
8	61.17
9	61.19
10	61.16
11	61.17
12	61.15
13	61.15
14	61.16
15	61.14

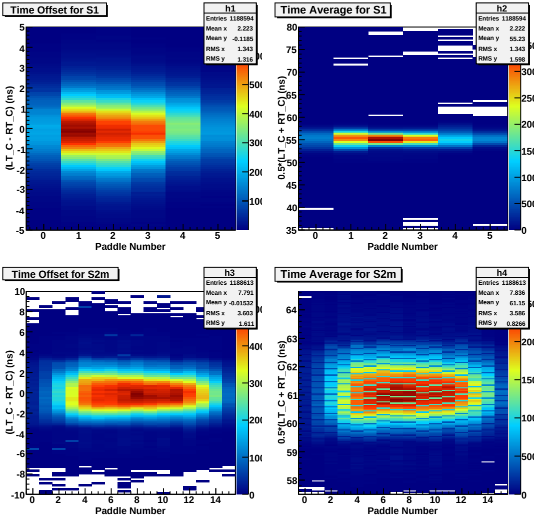
Scintillator Calibration (6)

β Distribution



Scintillator Calibration (7)

S1, S2m Distributions



Summary

- The projected statistical error on A_1^n is promising
  - Will provide a direct test on the JLab E99-117 result
  - Extend the precision data coverage to large-x
- Δt_{jk} adjusted to $6\ \mathrm{ns}$ for appropriate S2m, S1 paddle combinations
  - β still displays significant jitter — is it due to the ~ 0.01–$0.04\ \mathrm{ns}$ differences in S2m, S1 paddle times — or is this time difference too small to fix?
  - Didn't get a chance to fine tune these numbers yet. . .

What's Next?