Contributions to measured Asymmetry

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The asymmetry measured during the experiment (A) is a combination of the desired physics asymmetry (A_{phys}), as well as instrumental effects. The observed asymmetry is assembled directly through the yields of events (N) with helicity + or −.

$$\begin{aligned} A &= \frac{N_+ - N_-}{N_+ + N_-} \\ N_\pm &= \mathcal{L}_\pm \sigma_\pm \eta_\pm d\Omega \\ \mathcal{L}_\pm &= Q_\pm T \\ \eta_\pm &= D_\pm \epsilon \\ \sigma_\pm &= \Sigma \pm P_B P_T \Delta \\ \Delta' &= P_B P_T \Delta \end{aligned}$$

where $\mathcal{L}_\pm$ is the helicity-dependent integrated luminosity, $Q_\pm$ is the accumulated charge per helicity state, T is the target density in nucleons per cm^2, $\eta_\pm$ is the helicity-dependent livetime constructed of the DAQ ($D_\pm$) and electronic ($\epsilon_\pm$) livetime fractions, and $\sigma_\pm$ is the helicity dependent cross-section that contains the actual asymmetry we wish to extract. The beam and target polarizations are given as P_B and P_T, respectively.

$$\begin{aligned} A &= \frac{\mathcal{L}_+\sigma_+\eta_+ - \mathcal{L}_-\sigma_-\eta_-}{\mathcal{L}_+\sigma_+\eta_+ + \mathcal{L}_-\sigma_-\eta_-} \\ &= \frac{Q_+\eta_+(\Sigma+\Delta') - Q_-\eta_-(\Sigma-\Delta')}{Q_+\eta_+(\Sigma+\Delta') + Q_-\eta_-(\Sigma-\Delta')} \\ &= \frac{\Sigma(Q_+\eta_+ - Q_-\eta_-) + \Delta'(Q_+\eta_+ + Q_-\eta_-)}{\Sigma(Q_+\eta_+ + Q_-\eta_-) + \Delta'(Q_+\eta_+ - Q_-\eta_-)} \\ &\quad \text{for clarity, assign } f = 1 - \frac{Q_-\eta_-}{Q_+\eta_+} \\ A &= \frac{\Sigma f + \Delta'(2-f)}{\Sigma(2-f) + \Delta' f} \end{aligned}$$

$$
\begin{aligned}
&= \frac{f + \frac{\Delta'}{\Sigma}(2-f)}{(2-f) + \frac{\Delta'}{\Sigma} f} \\
&\approx \frac{\Delta'}{\Sigma} + f, \text{ since } f \approx .01 \text{ and } \frac{\Delta'}{\Sigma} < .1.
\end{aligned}
$$

So the false asymmetry contributions, encapulased in f, contribute directly to the observed asymmetry and must be removed. Rewriting, to first order then in the corrections

$$
\begin{aligned}
f &= 1 - \frac{Q_- \eta_-}{Q_+ \eta_+} \\
&= 1 - (1 + (\frac{Q_-}{Q_+} - 1))(1 + (\frac{\eta_-}{\eta_+} - 1)) \\
&\approx (1 - (\frac{Q_-}{Q_+}) + (1 - \frac{\eta_-}{\eta_+}) \\
\frac{\Delta'}{\Sigma} &= A - f \\
&= A + (\frac{Q_-}{Q_+} - 1) + (\frac{\eta_-}{\eta_+} - 1)
\end{aligned}
$$

Table 1: Contributions to the observed asymmetry and their approximate uncertainties (when known).

term	value	uncertainty
$1 - Q_-/Q_+$	< 0.0002	
$1 - D_-/D_+$	0.001	
$1 - \epsilon_-/\epsilon_+$	0.01?	
A	0.04	0.005