Additional Appendix to A_{zz}

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Abstract

A quick outline of drift effects in the measure of A_{zz}.

1 Drift effects in the Measurement of A_{zz}

To investigate the systematic differences in the time dependent components of the integrated counts we look at the effects from calibration, efficiency, acceptance, and luminosity between the two polarization states.

Fluctuations in luminosity due to target density variation can easily be kept to a minimum by keeping the material beads at the same temperature for both polarization states by control of the microwave and the LHe evaporation. The He vapor pressure reading can give accuracy of material temperature changes at the level of $\sim$0.1%.

Beam rastering can also be controled to a high degree. (more discussion needed!!)

The acceptance of each cup can only change as a function of time if the magnetic field changes. The capacity to set and reset and hold, set-ability, the target supper conducting magnet to a desired holding field is $\delta B/B$ =0.01%. This implies that like the cup length l and the acceptance $\mathcal{A}$ for each polarization states is the same.

In order to look at the change in A_{zz} do to changes in the drift in beam current measurement calibration and detector efficiency we rewrite A_{zz},

$$A_{zz} = \frac{2}{fP_{zz}} \left(\frac{N_1 Q_1 \varepsilon_1 l \mathcal{A}}{N Q \varepsilon l \mathcal{A}} - 1 \right). \tag{1}$$

We can then express Q_1 as the change in beam current measurement calibration that occurs in the time it take to collect data in one polarization state before switching such that $Q_1 = Q(1 - dQ)$. In this notation dQ is the fractional change as a function of time. A similar representation is used for drifts in detector efficiency leading to,

$$A_{zz} = \frac{2}{fP_{zz}} \left(\frac{N_1 Q(1 - dQ)\varepsilon(1 - d\varepsilon)}{N Q \varepsilon} - 1 \right). \tag{2}$$

which leads to,

$$A_{zz} = \frac{2}{fP_{zz}} \left(\frac{N_1}{N}(1 - dQ - d\varepsilon + dQ d\varepsilon) - 1 \right). \tag{3}$$

The term $dQ - d\varepsilon + dQd\varepsilon = d\xi$ is what has been previously studied in experiments like the JLAB transversity experiment in which the cumulative drift in current measurement combined with drift in HRS efficiency has been measured to be $\sim 1 \times 10^-4$ (source?? J.P.). To express A_{zz} in terms of the estimated experimental drifts in efficiency and current measurement we can write,

$$A_{zz} = \frac{2}{fP_{zz}}\left(\frac{N_1}{N} - 1\right) \pm \frac{2}{fP_{zz}}d\xi. \tag{4}$$

This leads to a contribution to A_{zz} on a scale smaller than 1×10^-3,

$$dA_{zz}^{drift} = \pm\frac{2}{fP_{zz}}d\xi = \pm 0.00061. \tag{5}$$

Though a very important contribution to the error this value allows a clean measurement of $A_{zz} = 0$ at $X = 0.45$ without overlap with the Hermes error bar. For this estimate we assume only two polarization state changes in a 12 hour period. If it is possible to increase that flip rate than dA_{zz}^{drift} decreases accordingly.

Naturally detector efficiency can drift for a variety of reasons, for example including fluctuations in gas quality, HV drift or drifts in spectrometer magnetic field. All of these types of variation can be realized both during the experiment though monitoring as well as systematic studies of data collection.

There can be difficult to know changes in luminosity however the identical condition of the two polarization states minimizes the relative changes in time. There are also checks on the consistancy of the cross section data that can be use ensuring the quality of each run used in the asymmetry analysis.

(This my make less sense in the morning!!!)