Possible Q^2 Points for A_y Based on Acceptable Rates and Errors

Joe Katich
College of William and Mary

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Abstract

Experiment E05-015 is a Hall-A at Jefferson Lab that will measure a target single spin asymmetry (SSA) of electrons scattering from a vertically polarized ^{3}He target. The experiment is approved to run for 7 PAC days (plus one day of commissioning). The proposal calls for measurements at $Q^2 \simeq 0.5$ and 1.0 (GeV/c)^2, but the extreme forward angle settings of the spectrometers (and thus very high event rates) could allow us to measure a third intermediate Q^2 point. Results of rate and error calculations will be presented.

1 Introduction

The E05-015 proposal calls for measurements at $Q^2 \simeq 0.5$ and 1.0 (GeV/c)^2 with rates of 405×10^6 and 28.6×10^6 events per day ($\sim$ 4.0 kHz & 0.3 kHz) respectively. These rates have since been recalculated using a more sophisticated QFS code, and errors calculated to go with them. The goal is to measure a third intermediate Q^2 point by reducing the amount of time spent on the stated points while maintaining a comparable level of statistical accuracy. In the following sections the method of calculation will be explained and results will be shown.

2 Calculations

Rates were calculated using the formula:

$$Rate = L \times \Delta\Omega \times \sigma_{rad} \tag{1}$$

where L is luminosity of the beam, $\Delta\Omega$ is the solid angle acceptance of the spectrometers and σ_{rad} is the radiated cross section calculated using the QFS code.

Errors were calculated using:

$$\delta A_y^n = \frac{\frac{1}{\sqrt{N}}}{P_T \times \eta} \tag{2}$$

where N is the total number of events (rate in kHz $\times$ 3600 $\times$ 24 $\times$ number of days running that particular Q^2 point), P_T is the target polarization and η is the dilution factor correcting for scattering from the protons in ^{3}He and from unpolarized nitrogen in the polarized target system.

3 Results

Rates and errors were calculated for hundreds of different configurations with the variables being Q^2, scattering angle and number of hours to run in the given configuration. Values of Q^2 ran from 0.50 to 1.05 $(GeV)^2$ with an increment of 0.05 $(GeV)^2$, while values of scattering angle ranged from 12.80° to 19.15° incremented by 0.05°. The most likely candidates for the run plan are listed in the tables below.

Run Plan 1:
In this configuration, the Q^2 = 0.50 & 0.65 points would use only the LHRS. The Q^2 =1.00 point would use both arms.

Possible Q^2 and Errors

$\boldsymbol{Q^2}$	θ_{lab}	Rate(kHz)	Run Time(hr)	Error
0.50	12.85	4.00	10.0	1.35×10^{-3}
0.65	14.90	1.43	20.0	1.64×10^{-3}
1.00	19.15	0.19	138.0	1.21×10^{-3}

Run Plan 2:

In this configuration, the Q^2 = 0.50 & 0.70 points would use only the LHRS. The Q^2 =1.00 point would use both arms.

Possible Q^2 and Errors				
Q^2	θ_{lab}	Rate(kHz)	Run Time(hr)	Error
0.50	12.85	4.00	10.0	1.35×10^{-3}
0.70	15.55	1.02	24.0	1.77×10^{-3}
1.00	19.15	0.19	134.0	1.23×10^{-3}

Run Plan 3:

In this configuration, the Q^2 = 0.50 & 0.75 points would use only the LHRS. The Q^2 =1.00 point would use both arms.

Possible Q^2 and Errors				
Q^2	θ_{lab}	Rate(kHz)	Run Time(hr)	Error
0.50	12.85	4.00	10.0	1.35×10^{-3}
0.75	16.15	1.02	36.0	1.68×10^{-3}
1.00	19.15	0.19	122.0	1.29×10^{-3}

It would probably be nicest to have the Q^2=0.75 point, and the calculations show that this could be done while losing little statistical accuracy in the other two Q^2 points. Of course, the run time for each Q^2 point could be manipulated in order to shift more statistics into one point or the other.