Figure of Merit as a Function of NPOL Theta

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Abstract

During the collection of LH2 data, a significant number of protons were scattered to the extreme top and bottom of the front array. Some of these protons undergo small angle scattering with no asymmetry and therefore no polarization information. It has been pointed out by J. Kelly that these protons may make it to the rear array and along with the HMS arm, form a triple coincidence. We have studied the dilution effects that these protons have on ξ_+, ξ_-, and the Figure of Merit and made a cut based on the results.

1 Introduction

E93-038 was a triple coincidence experiment in which a front array hit and a rear array hit formed two parts of the triple coincidence with an HMS hit being the third. The arrangement of the polarimeter was such that a line of sight coul be drawn from the target, through the extreme top (or bottom) of the front array, and terminating in the upper (or lower) rear array. This situation poses a problem for LH2 data since protons incident on the front array toward the top or bottom could scatter through small angles and have no polarization dependence to their scattering. Such protons would continue on to the rear array and be detected there as well, thus completing the triple coincidence without manifesting any information on the polarization of the proton.[1] Protons scattered to small angles do not contribute to the $\xi_\pm$ asymmetries and in fact contribute to their dilution. This is true for protons which undergo multiple Coulomb scattering, which is independent of the protons polarization, and for protons that do undergo nuclear scattering to similarly small angles as the analyzing power for the reaction vanishes as the scattering angle goes to zero.

We are able to use a variable calculated in Analyzer2.x named *p_thetasc* to determine the scattering angle of a nucleon scattered in the front array.[2] In the detector frame of GENGEN, this angle is given by

$$\theta_{sc} = tan^{-1}\left(\frac{v_y}{v_x}\right) \tag{1}$$

where v_x and v_y are the x and y components of the nucleon's velocity after the scattering event in the front array. For the pathological protons described earlier, we estimate that the corresponding *p_thetasc* should fall between 5 and 10 degrees. The smaller angle is determined by the polarimeter's geometry and the larger angle, which is more uncertain, is determined by the root mean squared scattering angle for protons in plastic scintillators. The actual determination of the upper bound is described in the optimization section. By placing a minimum cut on *p_thetasc* it is feasible that these unwanted protons may be indentified and rejected.

2 Optimization

We based our optimization procedure on the sensitivity of the FOM to θ_{sc}. A set of four runs for each Charybdis polarity were analyzed and the average for each polarity was plotted as a function of the *p_thetasc* cut, see in Figure 1. It is clear that both positive and negative precession asymmetries grow larger in magnitude with increasing theta scattering angle until 10°. This shows that a minimum *p_thetasc* cut placed at 10° will eliminate dilution protons and we maximize the $\xi_\pm$ asymmetries.

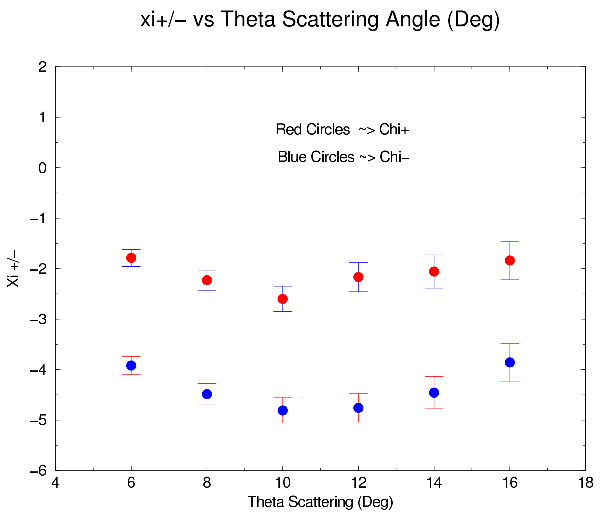

Figure 1: LH2 data with and without energy loss.

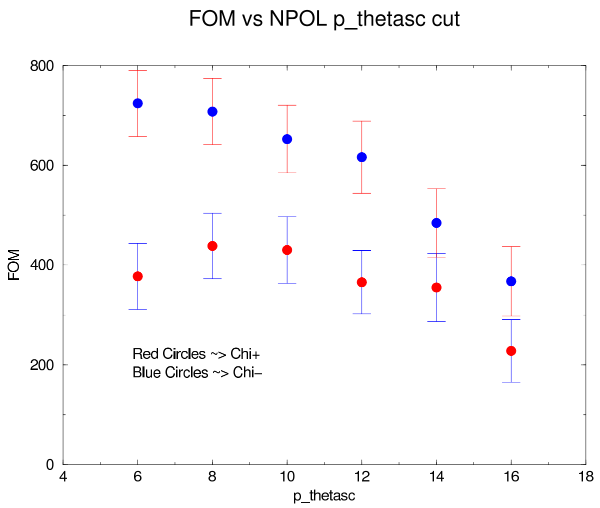

Figure 2: LH2 data with and without energy loss.

However, we must also include the effects such an angle cut has on the observed rate. The Figure of Merit (FOM) is given by,

$$FOM_{\pm} = \xi_{\pm}\sqrt{N} \tag{2}$$

where N is the number of events for The FOM, plotted for several different theta cuts, is shown in figure two.

It is clear that the Figure of Merit is optimized at a smaller angle, somewhere around 7 or 8 degrees.

3 Conclusion

We have examined the behavior of the scattering asymmetries, ξ_+, ξ_- and the FOM as effected by varying the minimum *p_thetasc* cut. We have found that both ξ_+ and ξ_- are maximized by choosing the minimum *p_thetasc* cut to be 10°. At this small angle, protons which contribute to the dilution of the asymmteries are identified and rejected. However, the FOM is optimized at a slightly smaller angle of 8°. We conclude that the *p_thetasc* cut be made 8°.

References

[1] Private communication with Jim Kelly.

[2] http://www.physics.umd.edu/enp/e93038/npol_calculations.htm