Andrew's Notes from BHBT Polarimetery Meeting

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1 Summary of Status for Bethe-Heitler Beam-Target Polarimetery and Next Goals

Andrew Schick would like to extend his work on linear polarization of Bethe-Heitler pairs to circular polarization on a polarized target. The most immediate use for this method would be to assist in the determination of the fraction of polarization in Hall D's Real Gamma GDH Experiment (REGGE). A cursory investigation failed to uncover any publications on the analyzing power of the Bethe-Heitler reaction for the polarized beam with polarized target scenario, and so we have to obtain this result ourselves. In principle, the analyzing power could be quite sensitive to kinematics. The most direct way to access the analyzing power is to use Richard Jones' Bethe-Heitler generator which has the QED fully setup for circular polarization. Our goal is to run Richard's generator to produce two 10 billion event samples, one right handedly polarized, the other left handedly, and inject them unweighted into the GlueX simulation. From there, Andrew will bin the data in t and invariant mass to look for differences in rate and establish a suitable kinematic regime where the analyzing power is maximized.

2 Richard's Generator

2.1 Proposed Generator Configuration

- Two sets of 10 billion events, one left handed, one right handed.
- Initial photon energy between 3 and 12 GeV
- 100% longitudinal polarization and 100% target polarization.
- time-like form factors turned off (set to 0) for our initial investigation.
- Prior to simulation, a cut requiring θ_1, θ_2 of the e^+e^- pair be greater than $0.75°$.

2.2 Notes on the generator

There are 8 diagrams at tree level. The diagrams are organized by which form factors are relevant with increasing t.

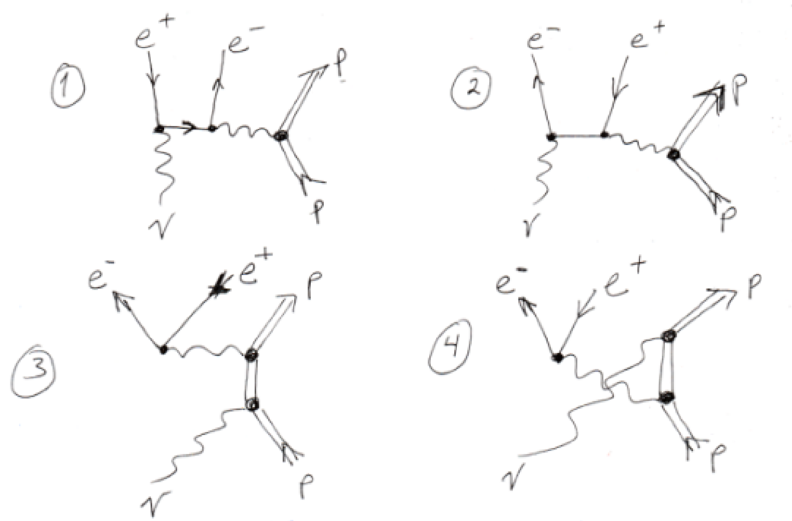

Figure 1: In case of triplet production, p in target becomes e^- in target, and $1 \to 5$, $2 \to 6$, $3 \to 7$, $4 \to 8$ where the two final state electrons are exchanged with an additional -1 sign.

Diagram 1 2 3 and 4, dominate at low t, where t is the difference between the momentum of the nucleon in the final state and the initial state (assuming it's a non-inelastic collision– proton in proton out same state.) The only hadronic physics input needed to calculate these diagrams (assuming nucleon target) are the standard electromagnetic form factors F_1 and F_2. We know how to calculate diagrams 1 through 4 at tree level, and they are all coded up as such in Richard's sub routine, with good parameterization up to 10 GeV.

At low enough t, you can have a simple modeling of the form factors as the fourier transformation of it's charge distribution. At higher t, the inelastic part becomes important, and you now have model dependence. In diagrams 5 and 6, (these are DVCS), the intermediate propagator is not on shell. You have photons probing partons at one point, and them probing partons at another point. The top vertex is time-like, and the bottom is space-like. The way Richard modeled it is to assume the leading order behavior is a Dirac vertex, and so he just put in a dirac F_1 and F_2. For the time-like vertex he needs to supply a model. There are 8 choices for the model that you can select in your control.in file when configuring his generator, which are accomplished by setting $F_1^{\text{timelike}}, F_2^{\text{timelike}}$ to 0 or 1, and optionally turning off the space-like form factors to isolate the compton diagrams.

Richard's generator takes interferences into account. The generator itself works with the amplitudes. The phase is embedded into the form factors and at higher t you can see it.

The raw output of Richard's generator has a weight attached to each event given by the differential cross section. Richard can then make the sample of events unweighted by performing an accept reject routine that moves the differential cross section into the population. It is the unweighted sample that will be used as input into HDGEANT4.