Measurement of the t-dependence of the beam asymmetry of photoproduced η at GlueX

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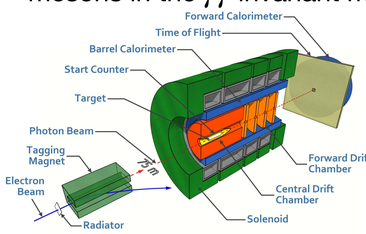
Introduction

We are studying the photoproduction mechanisms of η mesons at the GlueX experiment in Hall-D at Thomas Jefferson National Laboratory in Newport News, VA. These particles are produced by a linearly polarized photon beam at energies between 8.2 and 8.8 GeV incident on a liquid hydrogen target.

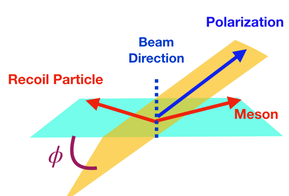
Azimuthal (ϕ) angular distributions for the η with respect to the direction of the polarized photon facilitate the extraction of the beam asymmetry Σ for the reaction $\gamma p \rightarrow \eta p$. Σ, derived as a function of four-momentum transfer –t, quantitatively denotes contributions from natural and unnatural parity exchanges in η photoproduction. Compared with previous GlueX results [1,2], new data using 100% of the allocated GlueX-I runtime produced approximately 6 times more statistics, thereby allowing to extend these measurements to values well beyond the previous limitation of $-t \leq 1.1$ (GeV/c)^2. Preliminary results will be shown for events reconstructed from the decay of $\eta \rightarrow \gamma\gamma$.

Experiment

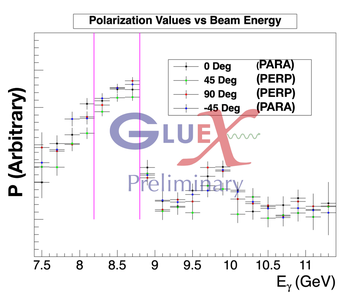
An 11.6 GeV electron beam from the CEBAF accelerator is directed onto a diamond radiator, producing coherent, polarized bremsstrahlung. This photon beam is transported to the GlueX experiment. Drift chambers track charged particles through the magnetic field, providing momentum and angle measurements. The energy and direction of photons from the η decay are measured with calorimeters. Full reconstruction of the final state allows identification of η mesons in the $\gamma\gamma$ invariant mass.



Detector schematic

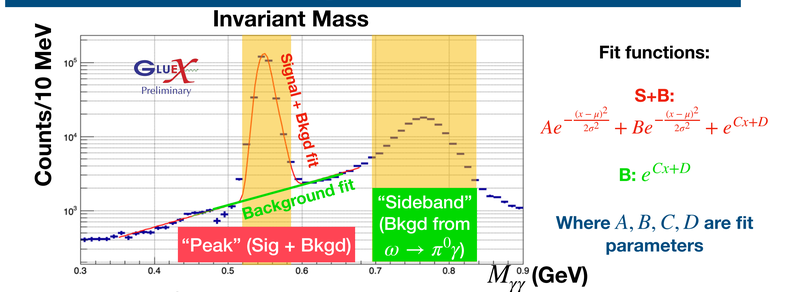


Production schematic



Triplet polarimeter values (statistical errors only) for the analyzed data. Photons can be polarized either parallel or perpendicular to the floor in a 0/90 degree pair or a -45/45 degree pair.

Preliminary Distributions



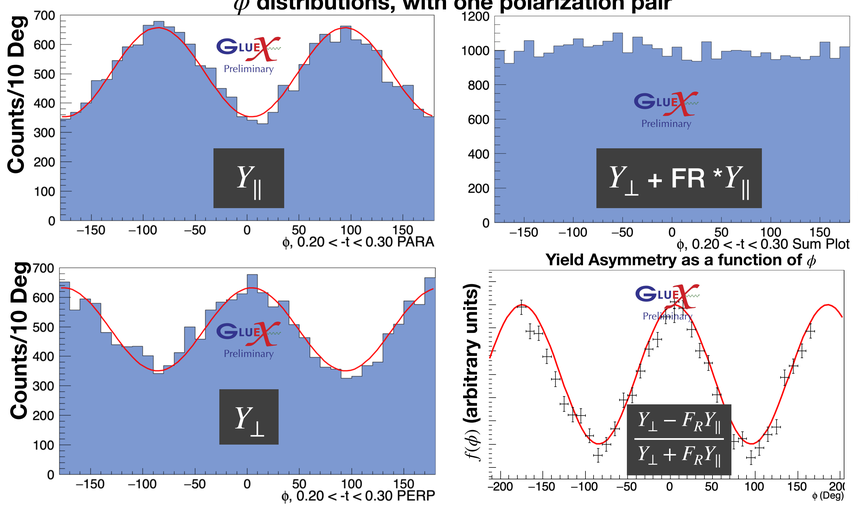
Fit functions:

S+B: $Ae^{-\frac{(x-\mu)^2}{2\sigma^2}} + Be^{-\frac{(x-\mu)^2}{2\sigma^2}} + e^{Cx+D}$

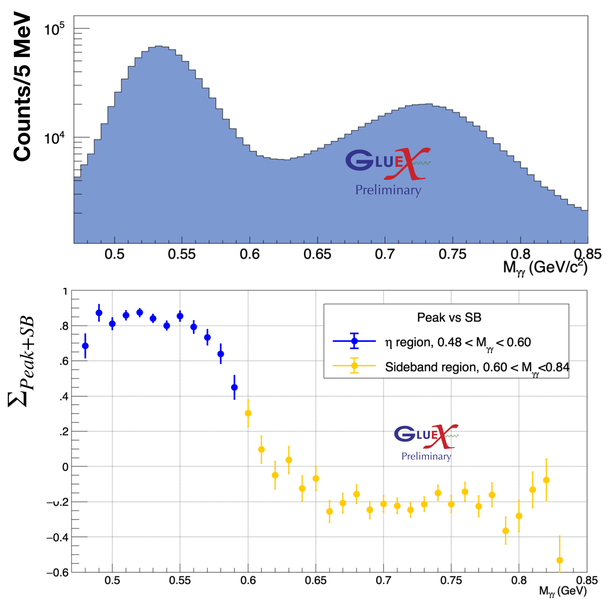
B: e^{Cx+D}

Where A, B, C, D are fit parameters

ϕ distributions, with one polarization pair



Peak and sideband region Σ vs Invariant Mass (All -t)



Method

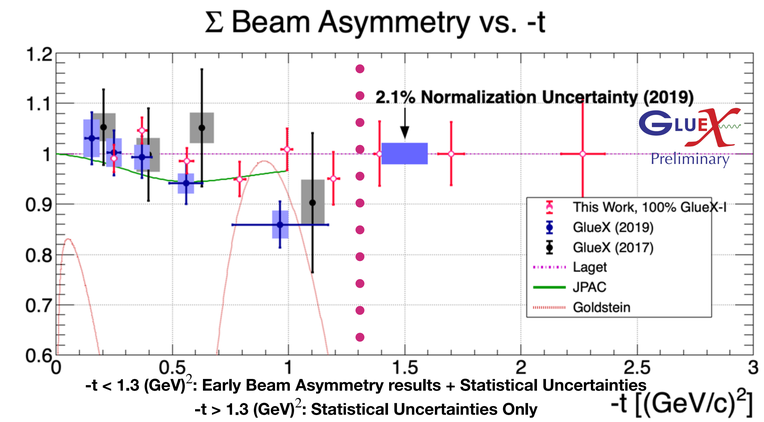
Azimuthal yields were used to obtain the yield asymmetry $f(\phi) = \frac{Y_\perp - F_R Y_\parallel}{Y_\perp + F_R Y_\parallel}$,

where F_R is the photon flux ratio obtained from a given run period.

Σ was extracted from fits to $f(\phi) = \frac{(P_\parallel + P_\perp)\Sigma\cos(2\phi - 2\phi_0)}{2 + (P_\perp - P_\parallel)\Sigma\cos(2\phi - 2\phi_0)}$, where $P_\parallel$ and $P_\perp$ are corresponding polarization values, ranging from 32-35%.

We correct for the background using a sideband asymmetry subtraction:
$\Sigma = \frac{\Sigma_{peak} - f\Sigma_{SB}}{1 - f}$, where dilution factor $f = \frac{B}{S+B}$

Preliminary Results



Outlook & Acknowledgements

We are in the process of applying systematic corrections for the beam asymmetry result. Also, Monte-Carlo simulations are being performed to better understand the data and better determine the signal and background. We also expect to achieve similar progress in the $\eta \rightarrow \pi^+\pi^-\pi^0$ decay.

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References

[1] S. Adhikari et al. Beam asymmetry Σ for the photoproduction of η and η' mesons at Eγ =8.8 GeV. Physical Review C, 100(5), Nov 2019.
[2] H. Al Ghoul et al. Measurement of the beam asymmetry Σ for π0 and η photoproduction on the proton at Eγ =9 GeV. Physical Review C, 95(4), Apr 2017.