Study of $-t$ dependence of Beam Asymmetry via η' photoproduction process off the proton at GlueX

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Meson Photoproduction & Beam Asymmetry

- Meson photo production plays crucial role in the studies of hadron spectrum and searches for exotic mesons.
- In order to hunt for new resonances, it requires to know quantum numbers first, which essentially constrains both decays and production mechanisms.
- Beam Asymmetry $(\Sigma_{\eta'}) = \frac{d\sigma_\perp - d\sigma_\parallel}{d\sigma_\perp + d\sigma_\parallel}$, $d\sigma_{\perp,\parallel} \equiv \frac{d\sigma_{\perp,\parallel}}{dt}(s,t)$ differential cross sections for photons polarized perpendicular or parallel to the reaction plane, s & t are Mandelstam variables.
- Beam Asymmetry is such an observable which helps to study production mechanism.
- Access of beam asymmetry at higher -t allows to identify whether ρ **and** ω mesons are still the dominant exchange mechanism during η' photo production process.

(Reaction Channels, η' decay modes for $\Sigma_{\eta'}$)

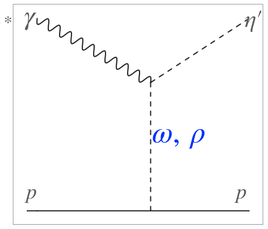
$\gamma p \to \eta' p$ $\quad \eta' \to \pi^+\pi^-\eta, \eta \to \gamma\gamma$ $\quad \Gamma_1{}^* \to (42.6 \pm 0.7)\%$

$\eta' \to \pi^0\pi^0\eta$ $\quad \eta \to \gamma\gamma$ $\quad \pi^0 \to \gamma\gamma$ $\quad \Gamma_2{}^* \to (22.8 \pm 0.8)\%$

Mass: 957.78±0.06 $(\mathrm{MeV/c^2})$ *

$I^G(J^{PC}) = 0^+(0^{-+})$

$\eta' : \frac{1}{\sqrt{(3)}}(u\bar{u} + d\bar{d} + s\bar{s})$



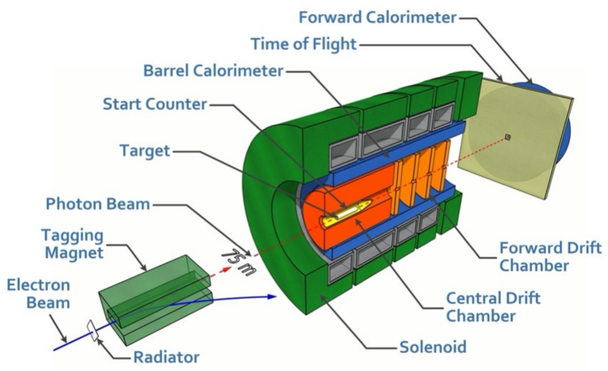
Natural Parity Exchange / Unnatural Parity Exchange

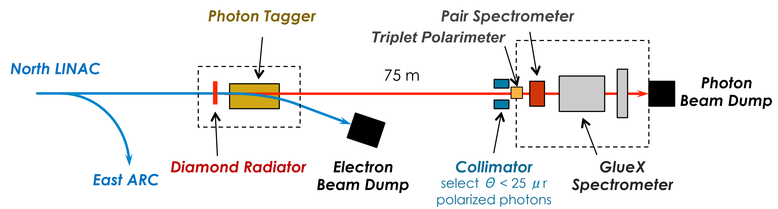
$$\Sigma = \frac{|\omega+\rho|^2 - |\mathbf{h}+\mathbf{b}|^2}{|\omega+\rho|^2 + |\mathbf{h}+\mathbf{b}|^2}$$

Σ =± 1 indicates vector meson/axial vector meson dominance

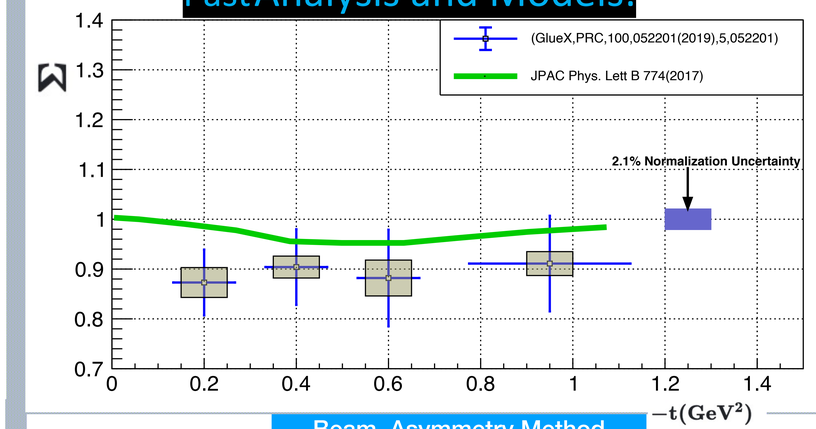
*M. Tanabashi et al. (Particle Data Group), Phys. Rev. D 98, 030001 (2018)

GlueX Detector and Beamline Setup





PastAnalysis and Models:



Beam Asymmetry Method

Photoproduction of pseudoscalar mesons: Linearly polarized photon beam and an unpolarized target, the polarized cross-section σ_{pol} is related to the beam asymmetry via the following equation:

$$\sigma_{pol}(\phi,\phi_\gamma) = \sigma_{unpol}[1 - P_\gamma \Sigma cos(2(\phi-\phi_\gamma))]$$

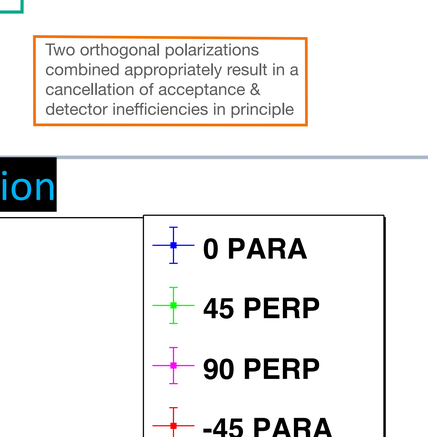
$$\Sigma = \frac{\sigma_\perp - \sigma_\parallel}{\sigma_\perp + \sigma_\parallel}$$

$$Y_\parallel(\phi, \phi_\gamma = 0) \; \alpha N_\parallel[\sigma_0 A(\phi)(1 - P_\parallel \Sigma cos2\phi)]$$

$$Y_\perp(\phi, \phi_\gamma = 90) \; \alpha N_\perp[\sigma_0 A(\phi)(1 + P_\perp \Sigma cos2\phi)]$$

Yield Asymmetry (YA) $= \frac{Y_\perp - F_R Y_\parallel}{Y_\perp + F_R Y_\parallel} = \frac{(P_\perp + P_\parallel)\Sigma cos2(\phi-\phi_0)}{2 + (P_\perp - P_\parallel)\Sigma cos2(\phi-\phi_0)}$

$F_R = \frac{N_\perp}{N_\parallel}$ $\quad \phi_0$ is the diamond misalignment offset



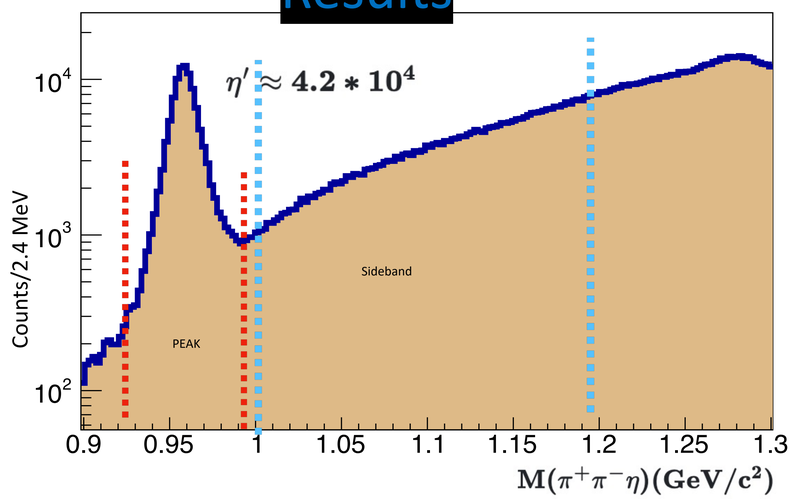
Two orthogonal polarizations combined appropriately result in a cancellation of acceptance & detector inefficiencies in principle

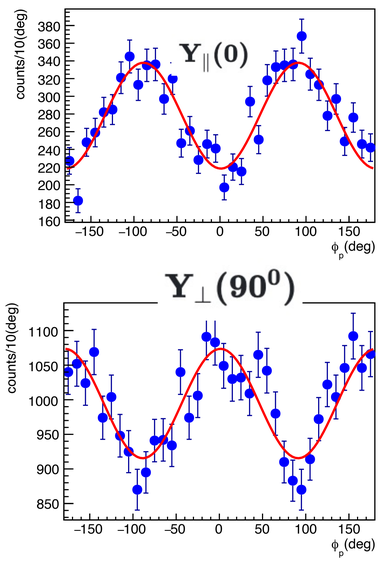
Polarization

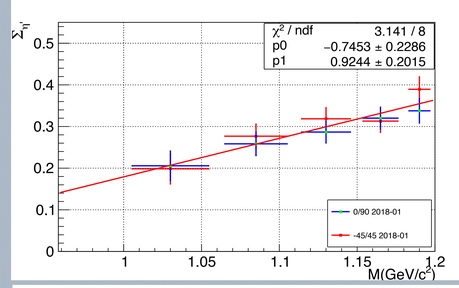
Fig. TPOL measurements for the four different polarizaton orientations with average polarization of approximately 35%.

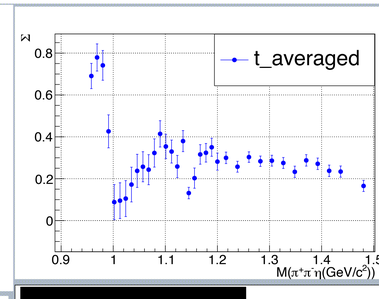
Acknowledgement: I want to greatly acknowledge GlueX collaboration, FIU and all computing facilities at Jlab and beyond .

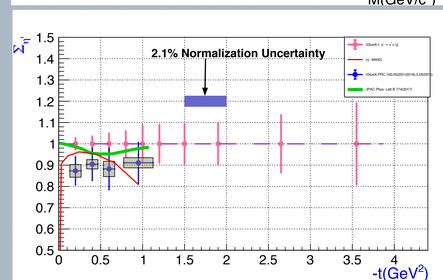
Results











Next Steps:

1)Extraction of Dilution factor
2)Sideband and Background corrected asymmetries
3) Systematic studies
4) Bggen MC study for background reactions channels