Deeply Virtual Compton Scattering with Jefferson Lab's CLAS12 at 6.4 GeV Polarized Electron Beam

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Outline

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II. Experiment

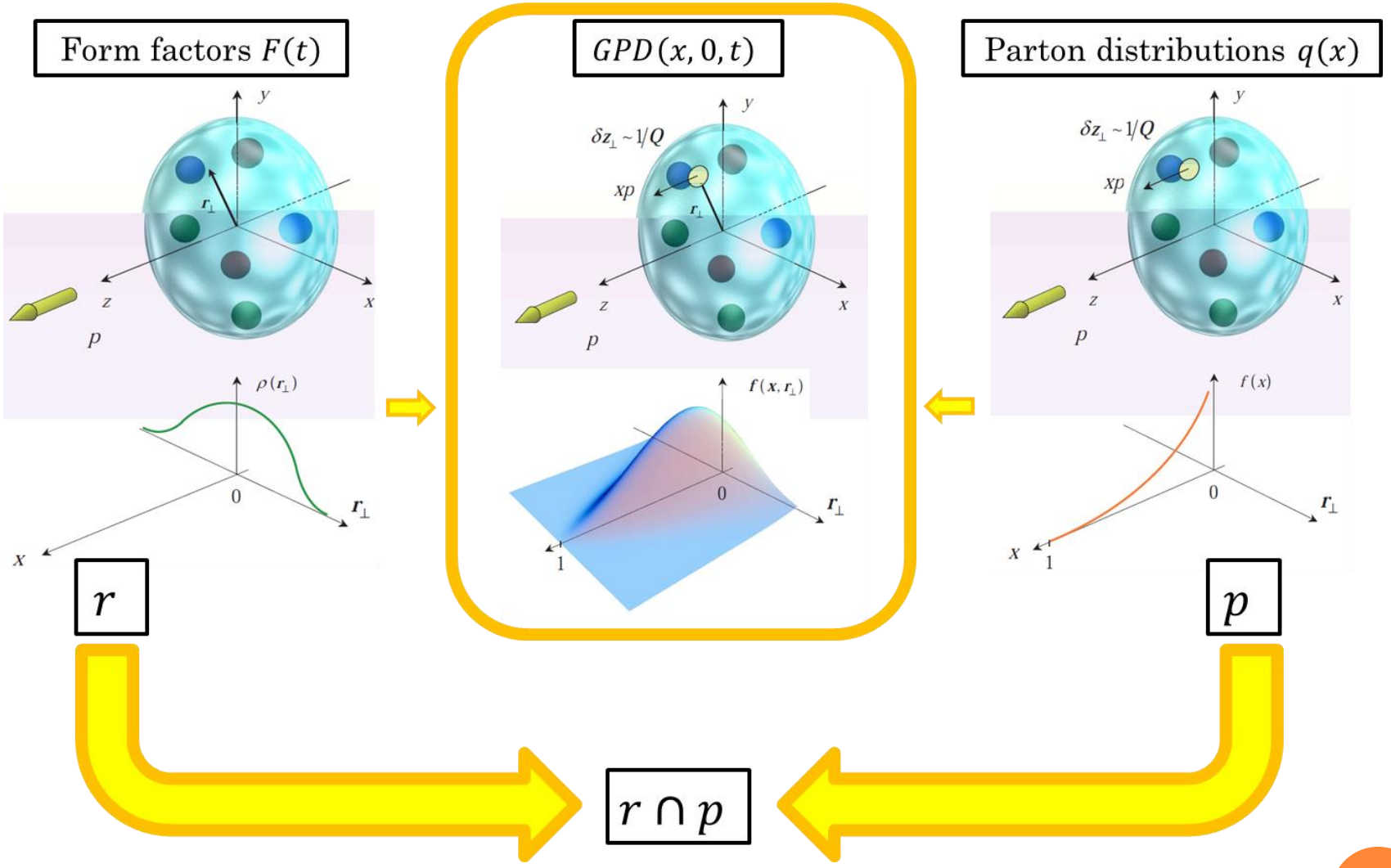
III. Analysis

IV. Results

V. Summary and Future Plans

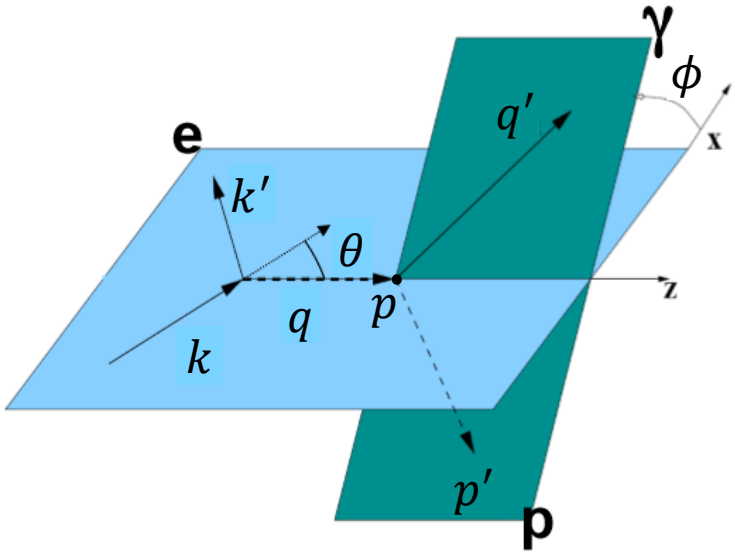
I. Introduction

Generalized Parton Distributions

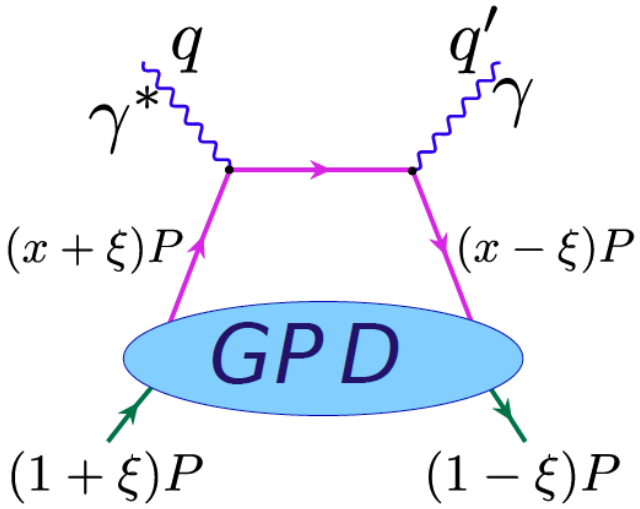


GPDs describe correlation between quark longitudinal momentum and transverse spatial distributions.

Deeply Virtual Compton Scattering



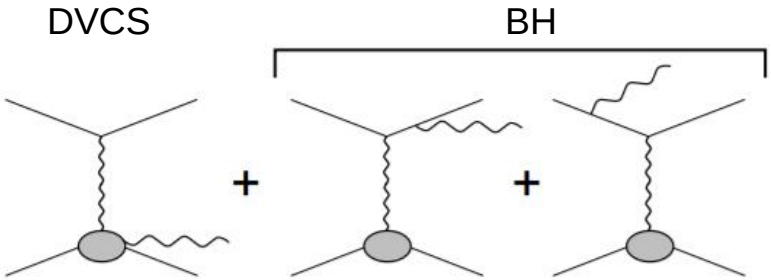
DVCS kinematics:
scattering plane (light blue)
and reaction plane (cyan)



DVCS accessing GPDs

Deeply virtual Compton scattering (DVCS) provides the cleanest access to chiral-even GPDs: H^q, $\tilde{H}^q$, E^q, and $\tilde{E}^q$.

DVCS and Bethe-Heitler



Amplitude of photon production:

$$\mathcal{T}^2 = |\mathcal{T}_{\mathrm{DVCS}} + \mathcal{T}_{BH}|^2 = |\mathcal{T}_{\mathrm{DVCS}}|^2 + |\mathcal{T}_{BH}|^2 + \mathcal{I}$$

Beam spin asymmetry for unpolarized target:

$$A_{\mathrm{LU}}(\phi) \propto s^{\mathcal{I}}_{1,\mathrm{unp}} \sin(\phi)$$

$$A_{\mathrm{LU}}(\phi) = \frac{d\sigma^{\uparrow}(\phi) - d\sigma^{\downarrow}(\phi)}{d\sigma^{\uparrow}(\phi) + d\sigma^{\downarrow}(\phi)} = \frac{1}{\varepsilon}\frac{N^{\uparrow}(\phi) - N^{\downarrow}(\phi)}{N^{\uparrow}(\phi) + N^{\downarrow}(\phi)}$$

$$A_{\mathrm{LU}}(\phi) \propto \Im\mathrm{m}\left\{F_1\mathcal{H} + \frac{x_B}{2 - x_B}(F_1 + F_2)\widetilde{\mathcal{H}} + \frac{t}{4M^2}F_2\mathcal{E}\right\}$$

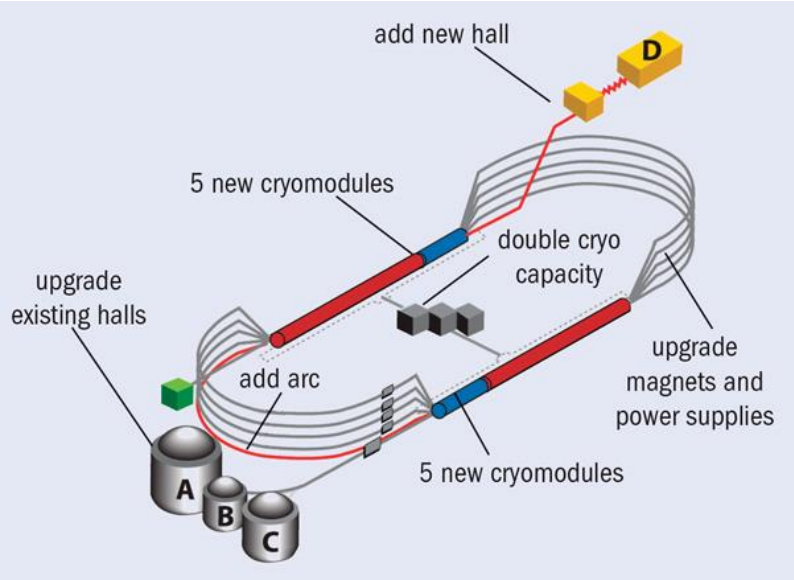
Compton form factors $\mathcal{H}$, $\widetilde{\mathcal{H}}$ and $\mathcal{E}$:

$$\{\mathcal{H}, \mathcal{E}\}(\xi, t, Q^2) = \sum_q \int_{-1}^{1} dx C_q^{(-)}(\xi, x)\{H^q, E^q\}(x, \xi, t, Q^2)$$

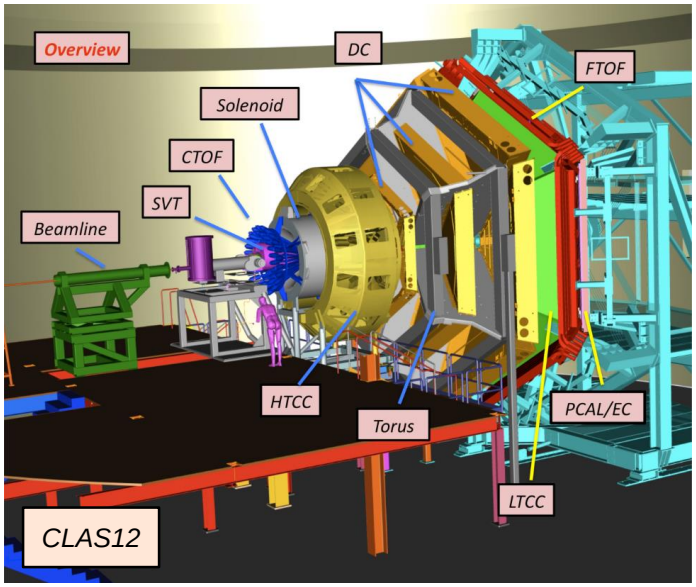
$$\widetilde{\mathcal{H}}(\xi, t, Q^2) = \sum_q \int_{-1}^{1} dx C_q^{(+)}(\xi, x)\widetilde{H}^q(x, \xi, t, Q^2)$$

II. Experiment

CEBAF AT 12 GEV AND CLAS12



CEBAF 12 GeV Upgrade

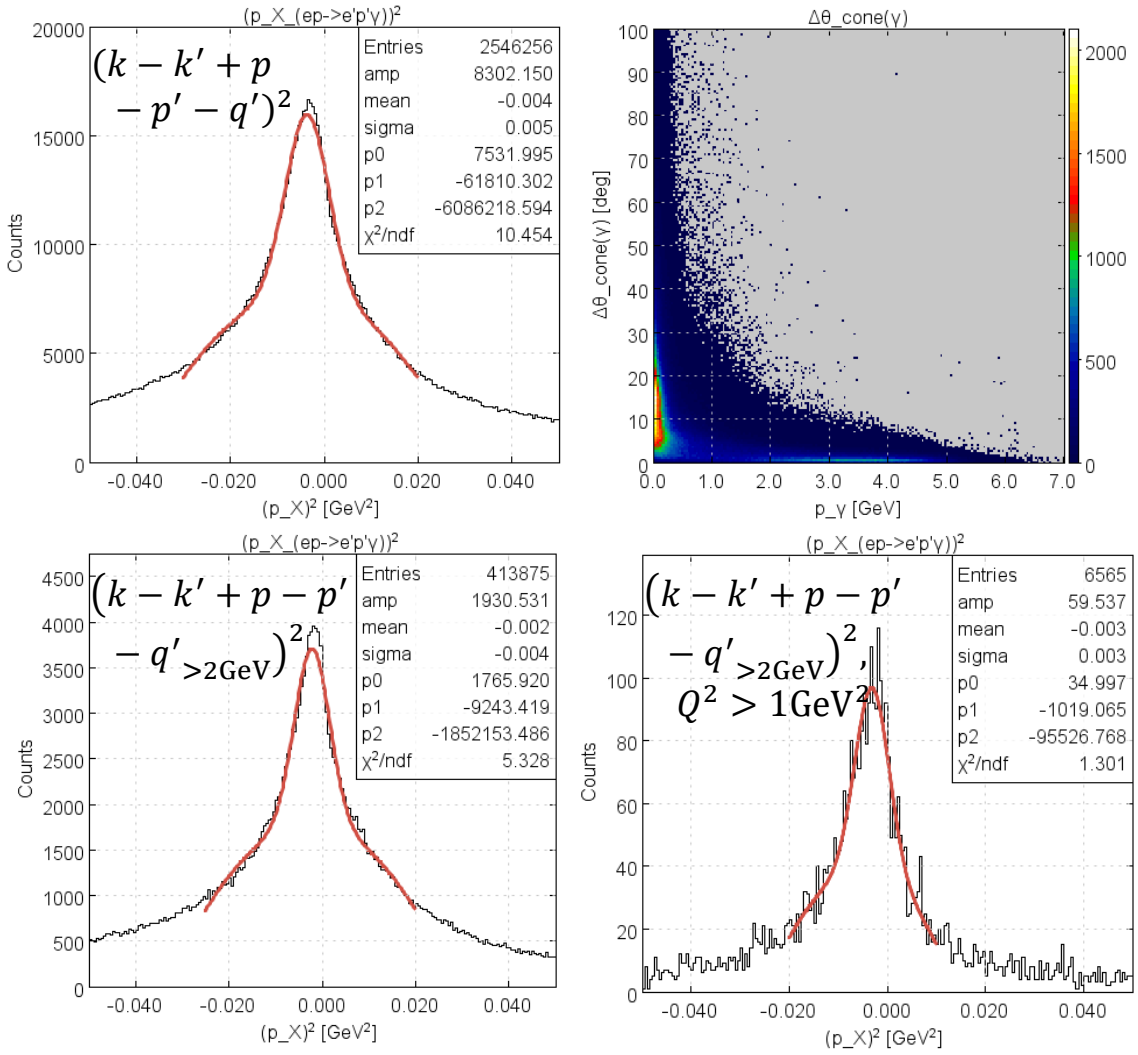


CLAS12 Detector System

First DVCS experiment with CLAS12 was performed in spring of 2018 at 6.4 GeV and 10.6 GeV polarized beam energies, employing liquid hydrogen as production target.

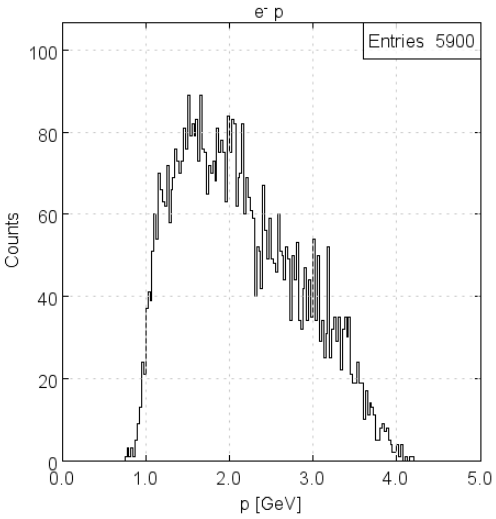
III. Analysis

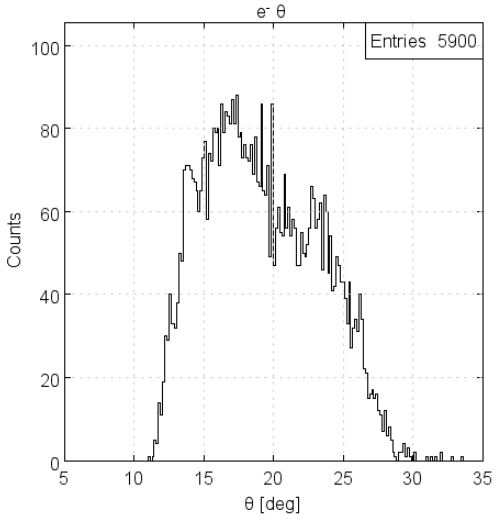
$ep \rightarrow e'p'\gamma$ Event Selection

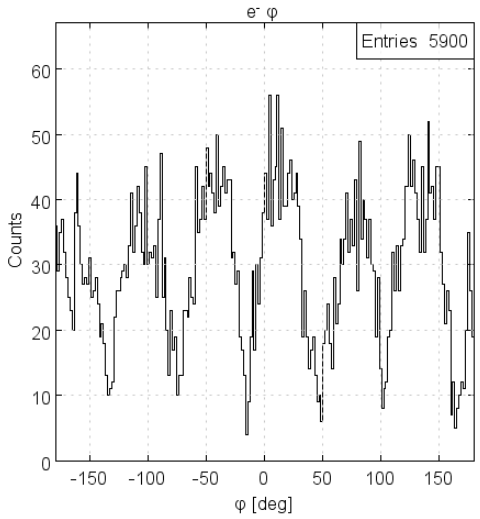


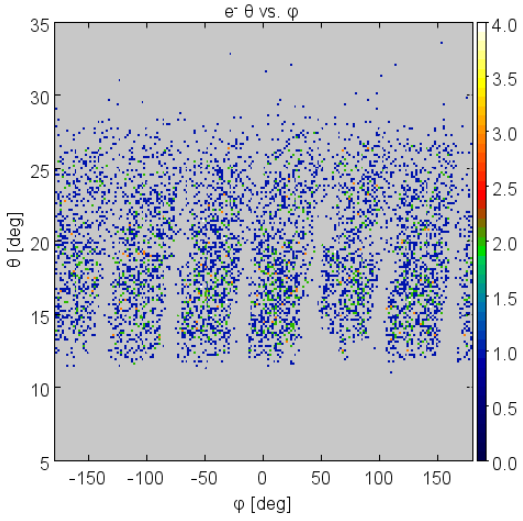
Exclusive events with 1 FD e, 1 CD p, and 1 γ were selected. 2 GeV cut on q' and 1 GeV^2 cut on Q^2 cleans up for single photoelectron events.

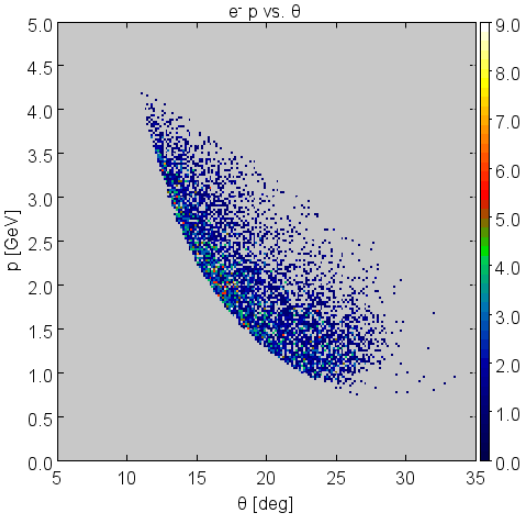
Reconstructed *e* Kinematics

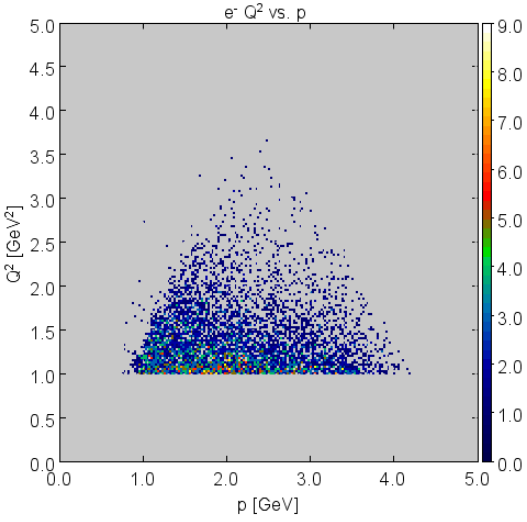






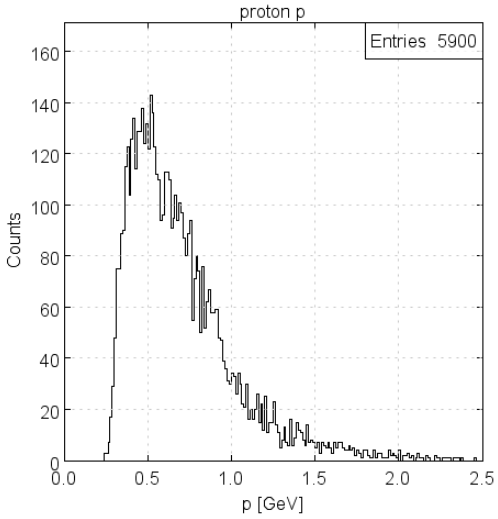


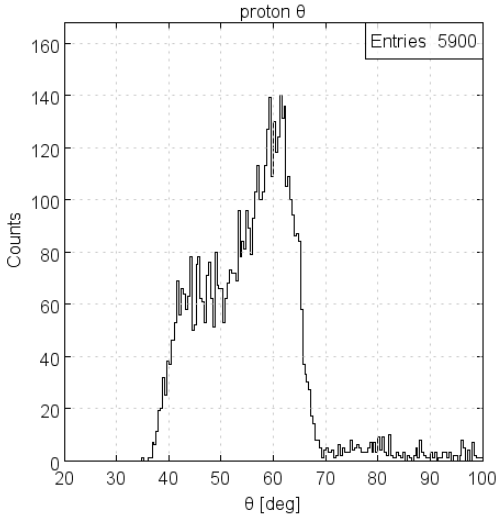


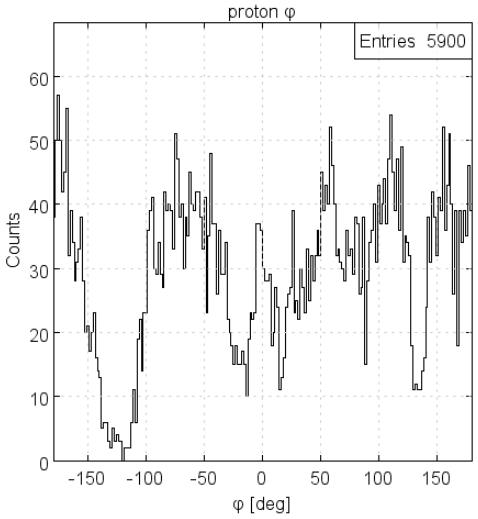


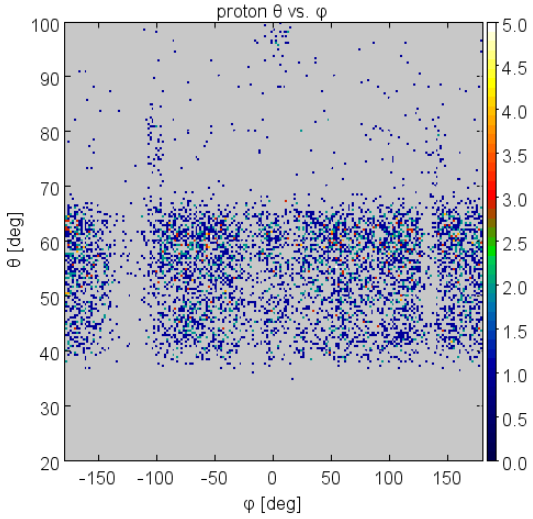
Electrons were selected from the forward detector subsystem. 2 GeV cut on *W* is implemented to exclude other processes.

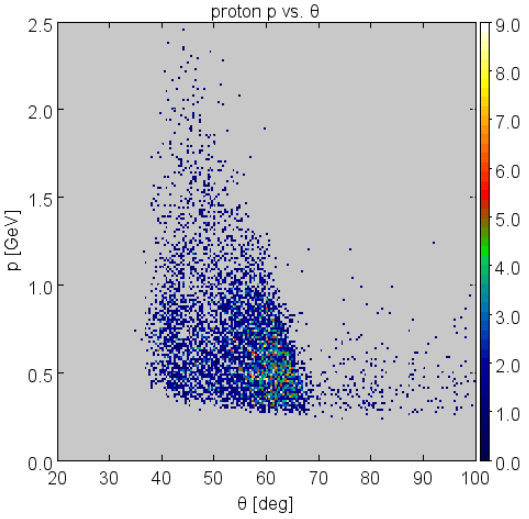
Reconstructed p Kinematics

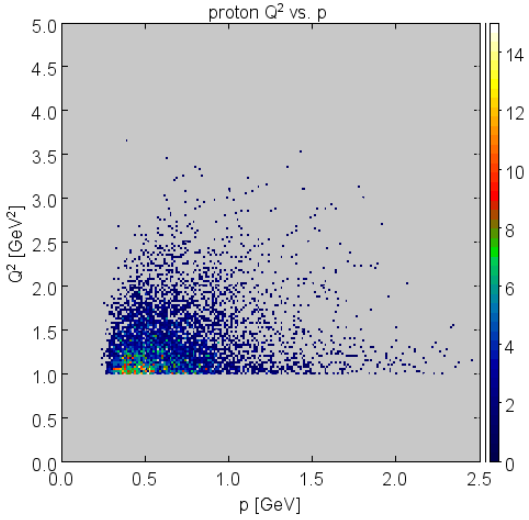






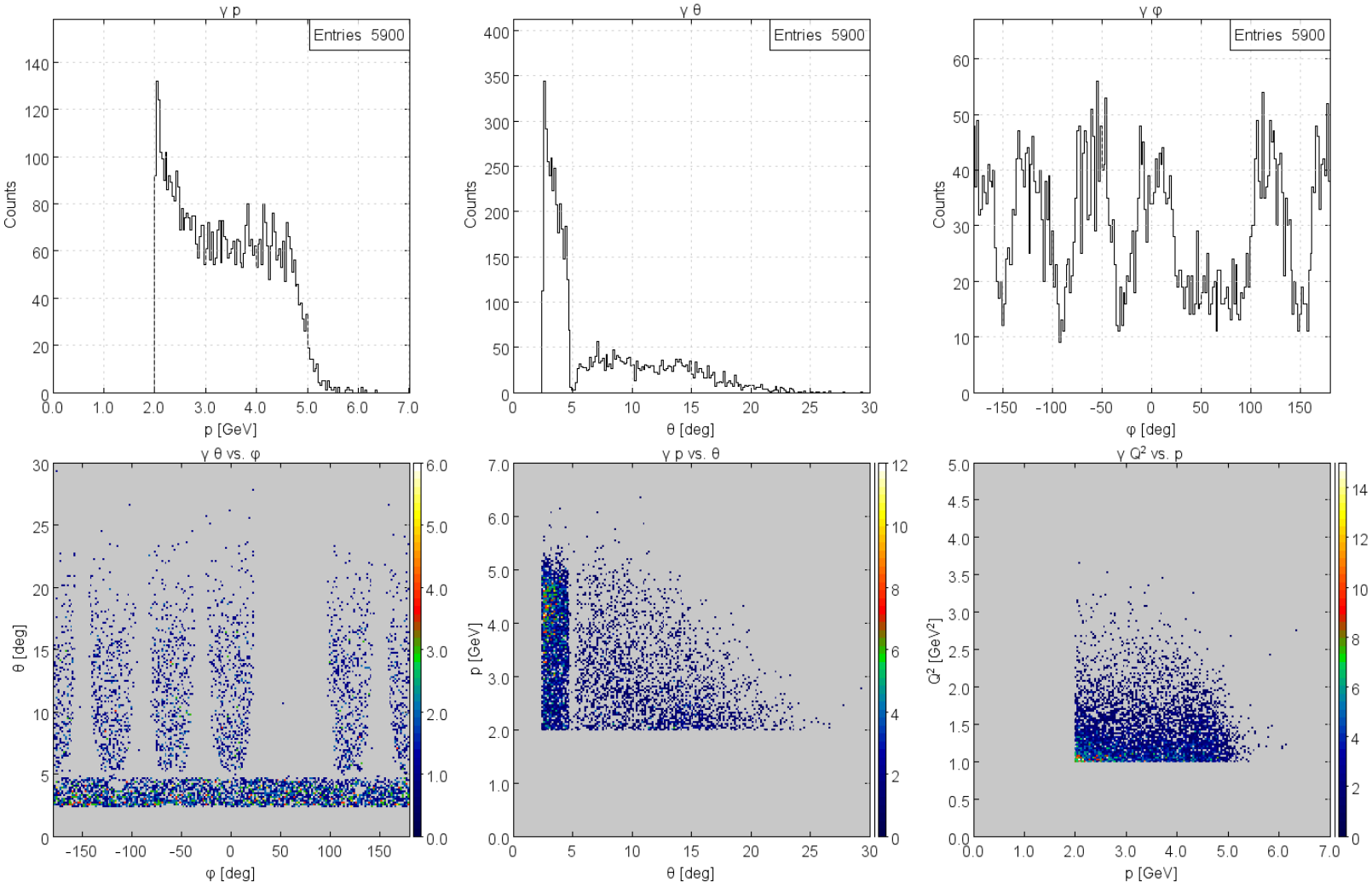






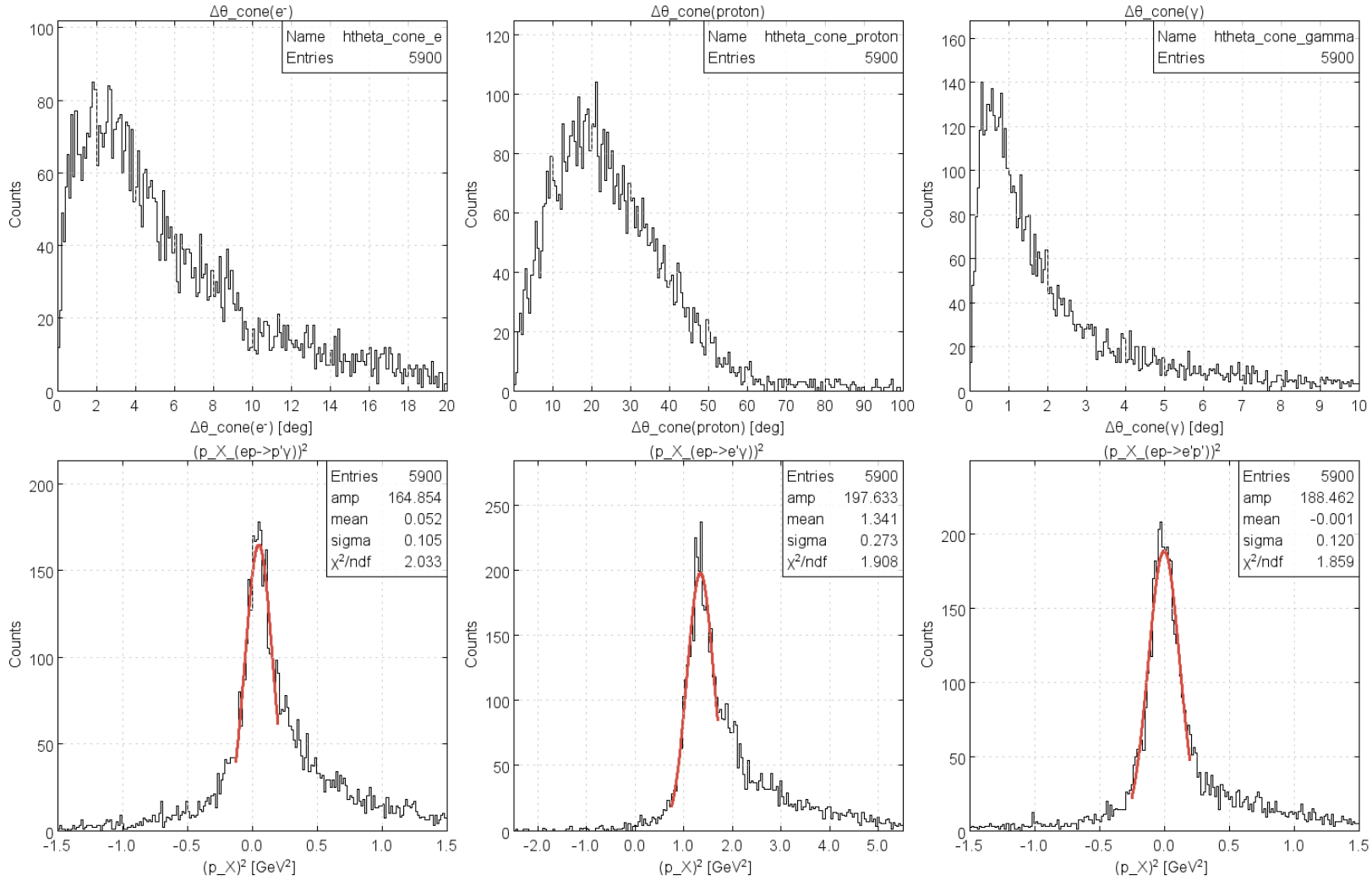
Protons were selected from the central detector subsystem.

Reconstructed γ Kinematics



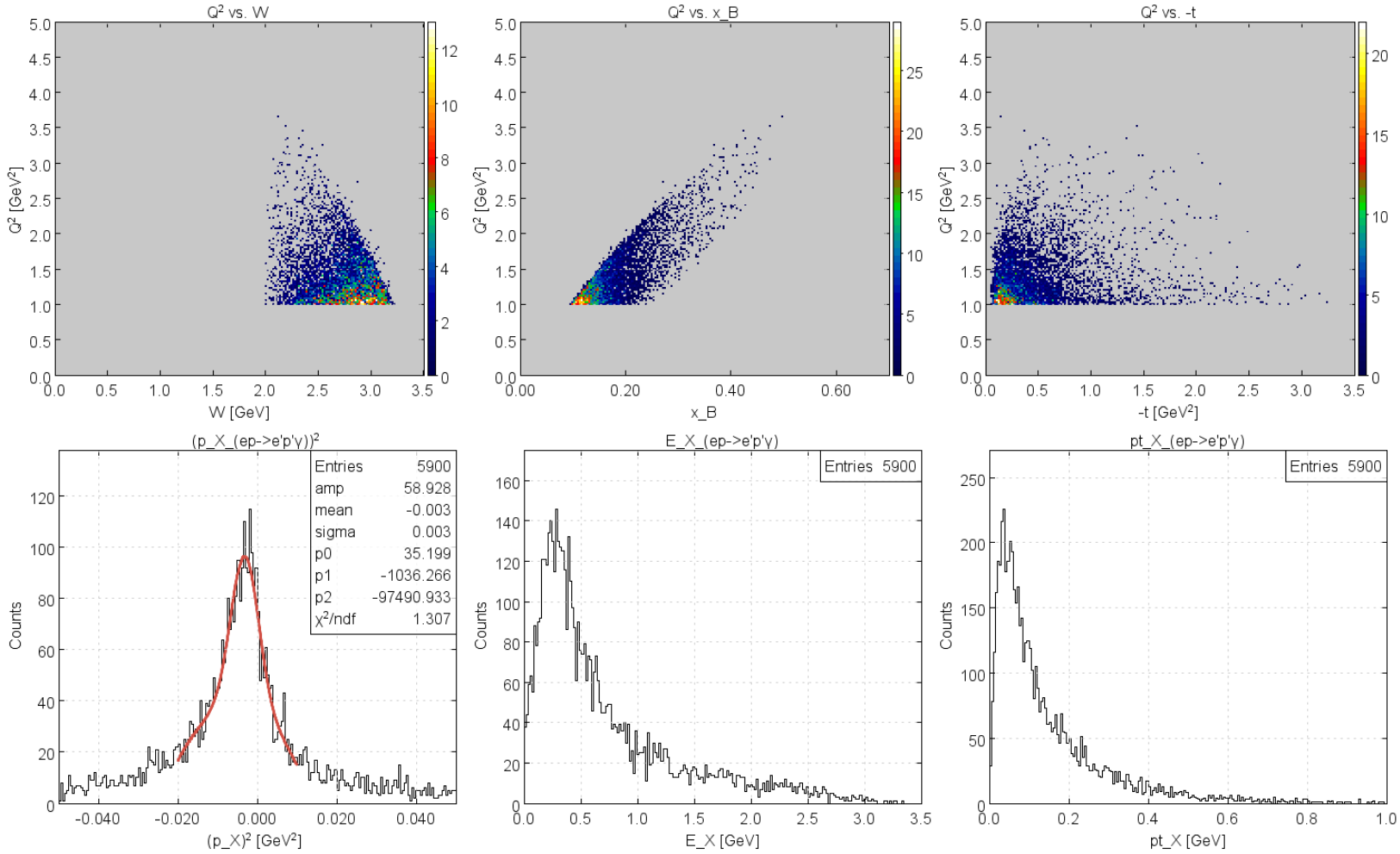
A significant portion of photons were detected from the forward tagger.

e, p, AND γ AND X_e, X_p, AND X_γ



The absence of $ep \rightarrow e'p'\gamma$ missing mass cut results to background i n the $\Delta\theta_{cone}$, X_e, X_p, and X_γ distributions.

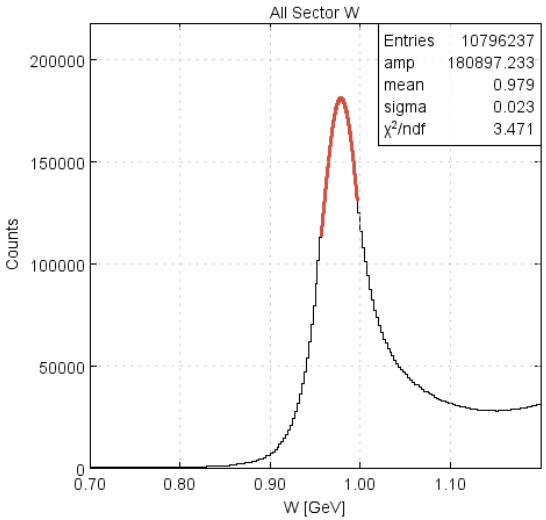
Kinematic Variables



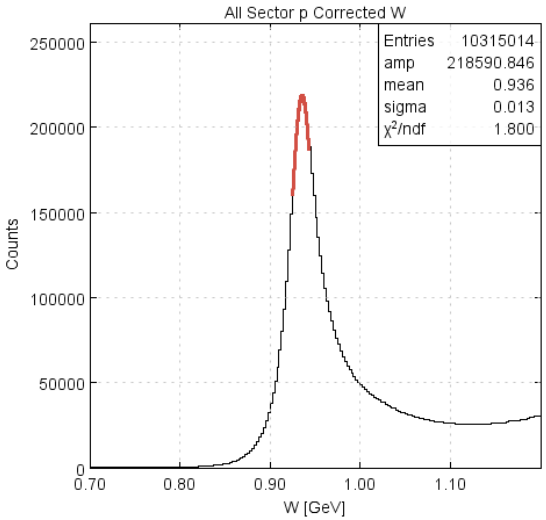
The missing mass distribution shows that in the data set used $E_\gamma >$ 3 GeV implies $|\vec{p}_{e'}| > 1$ GeV and $Q^2 > 1$ GeV².

e Momentum Correction

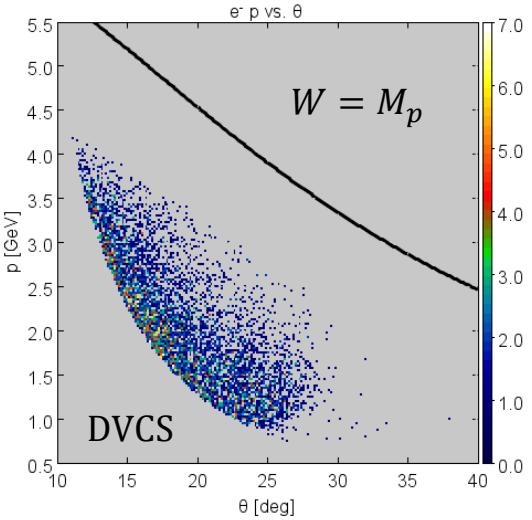
Before correction



After correction



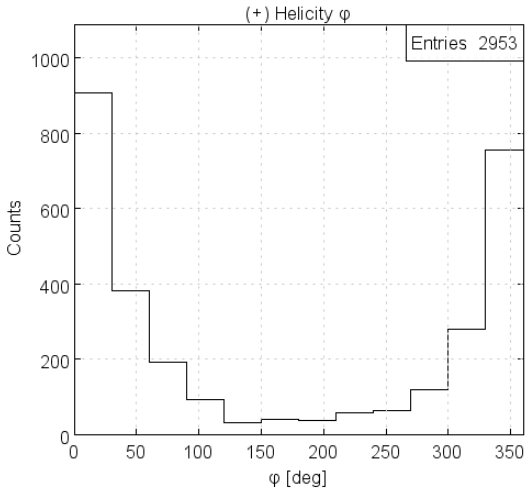
Elastic peak: k' vs. θ

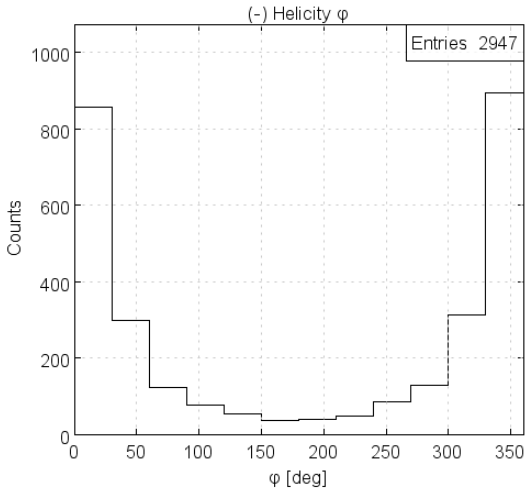


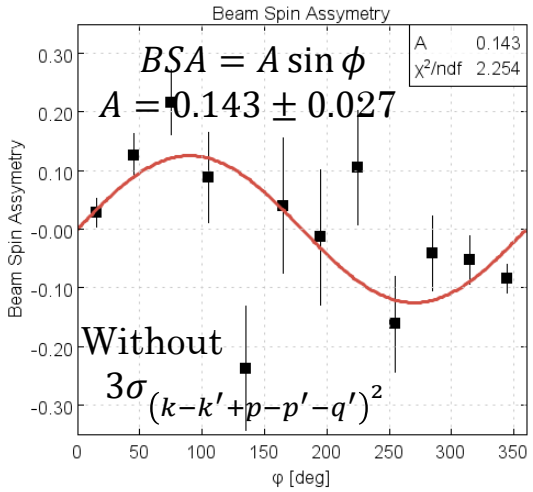
Electron momentum correction based on the elastic peak is expected to improve the missing mass distribution.

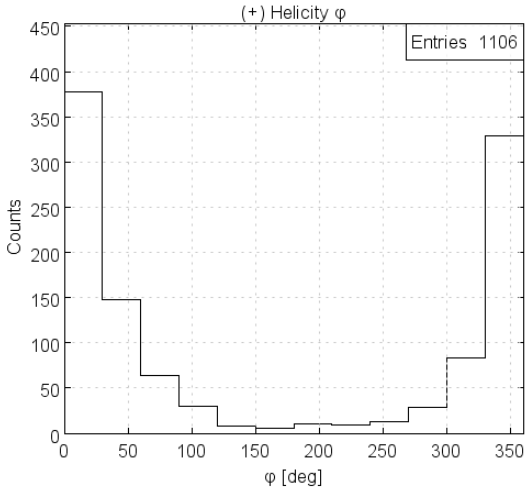
IV. Results

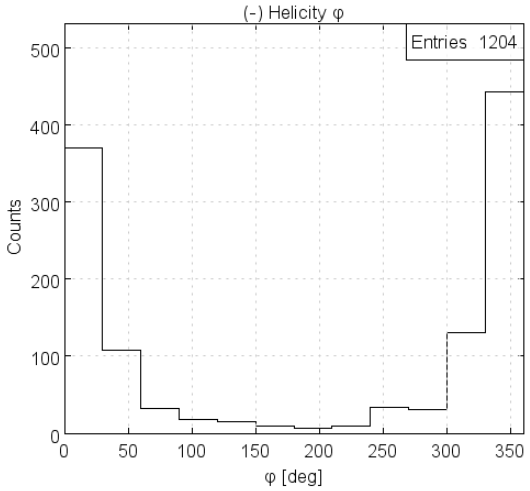
Beam Spin Asymmetry

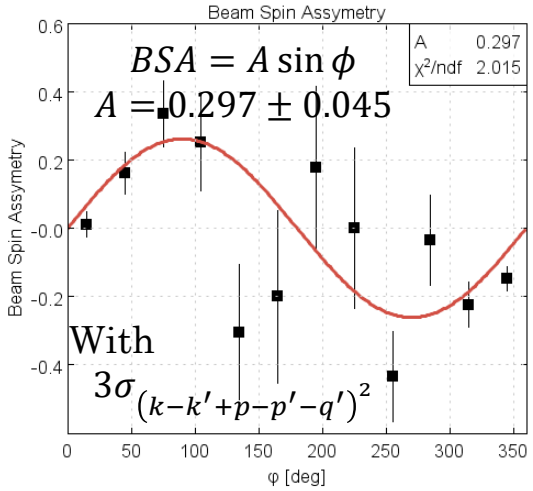






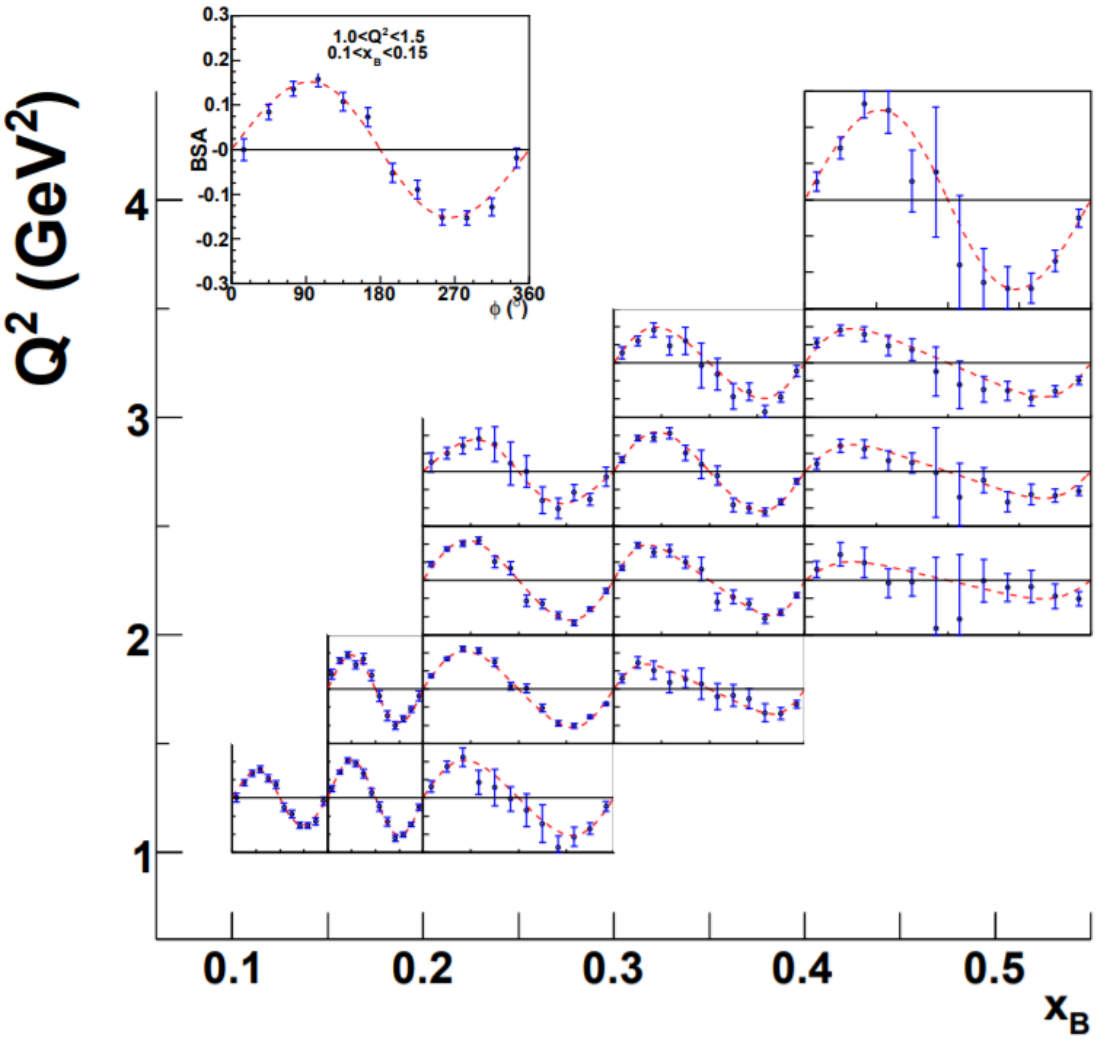






With the available statistics, missing mass cut decreases the qualit y of the fit (bottom).

Beam Spin Asymmetry from CLAS DVCS



F. X. Girod. PhD Thesis, SPhN-Saclay, (2006).

V. Summary and Future Plans

Summary and Future Plans

The discussions presented can de summarized as follows.

- Beam spin asymmetry from DVCS interfering with BH provides access to the GPDs H^q, $\widetilde{H}^q$ and E^q.
- First DVCS experiment with CLAS12 were performed at 6.4 GeV and 10.6 GeV polarized electron beam, employing unpolarized liquid hydrogen target.
- Exclusive events were selected and photon energy and Q^2 cuts significantly lowered the background of single photoelectron events.

The following steps will be performed in the near future:

- Kinematic corrections and combinatorics in event selection will be implemented.
- Perform DVCS and DVπ^0P simulation-reconstruction chain for further corrections.
- Beam spin asymmetry will be extracted for various kinematic bins.

Thank You!!!