

Analysis of Coherent Deeply Virtual Compton Scattering off Deuteron

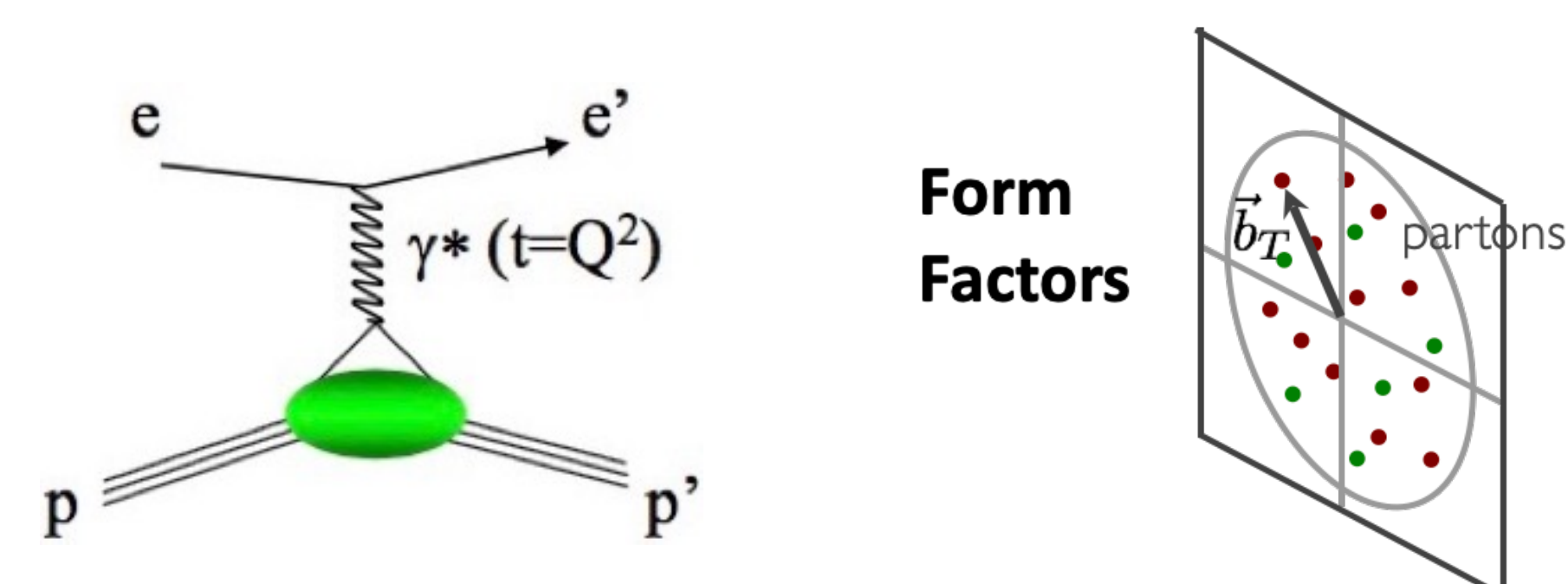
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Objectives

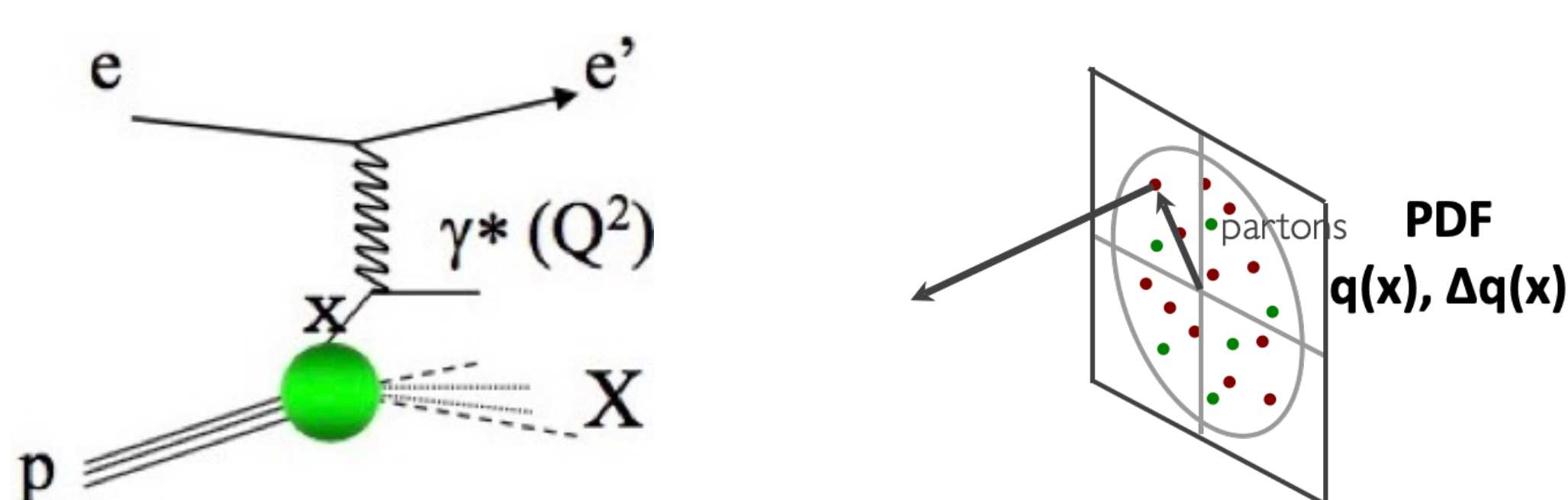
- Further refine analysis code to analyze Jefferson Lab data
- Study coherent deuteron DVCS process
- Use DVCS to study the 9 GPDs of the spin-1 Deuteron

Background

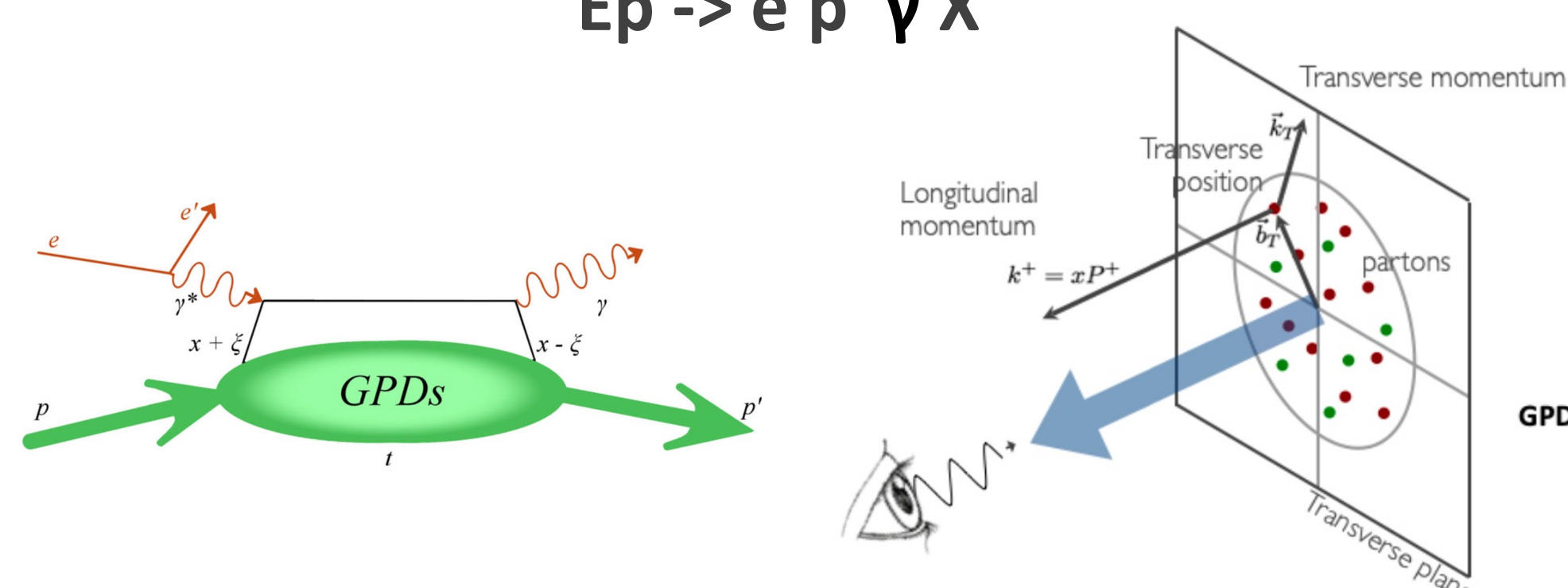
1950
Elastic Scattering
 $ep \rightarrow e'p'$



1967
Deep Inelastic Scattering
 $Ep \rightarrow e'X$

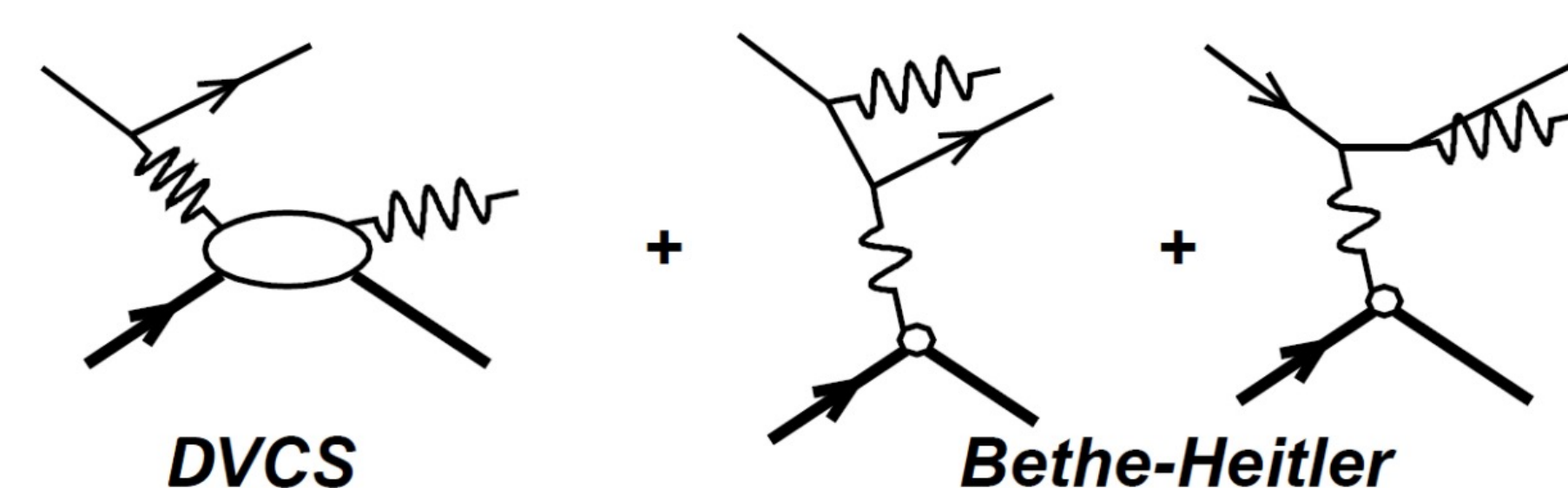


Today
Deeply Virtual Compton Scattering
 $Ep \rightarrow e'p' \gamma X$



Measuring an Asymmetry

DVCS and Bethe-Heitler



Experimentally Indistinguishable

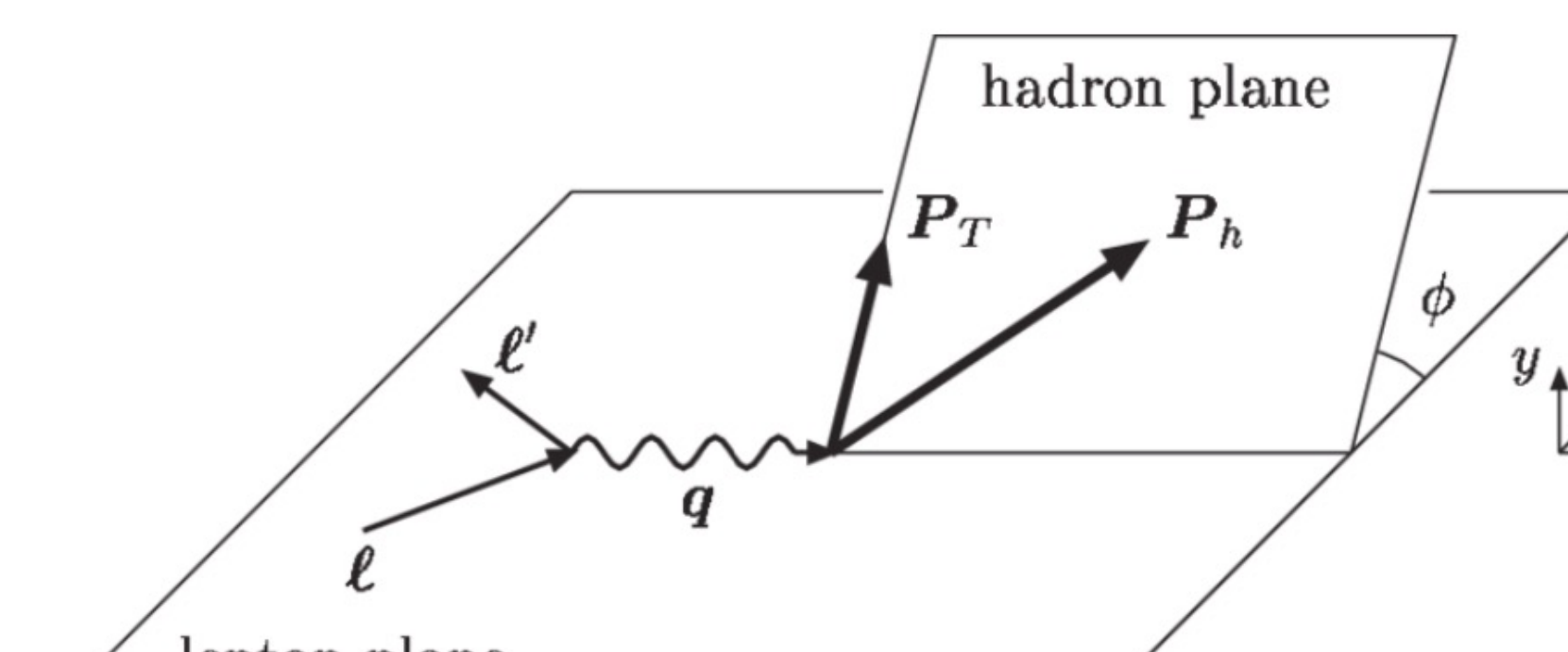
Cross Section

$$\frac{d^4\sigma}{dQ^2 dx_B dt d\phi} \propto |T_{DVCS} + T_{BH}|^2 = |T_{DVCS}|^2 + |T_{BH}|^2 + I$$

Quantum Mechanical amplitudes Probabilities

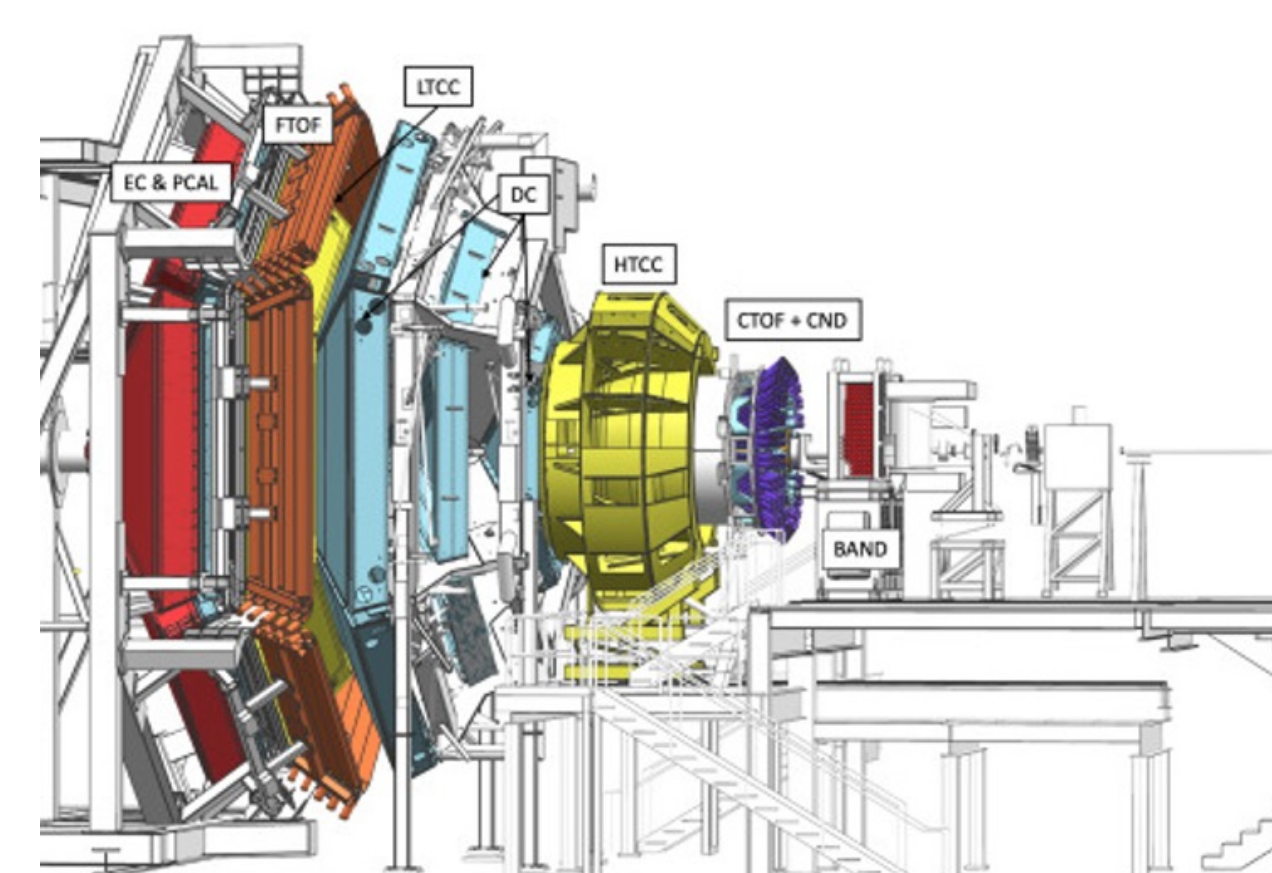
$$A = \frac{\sigma^+ - \sigma^-}{\sigma^+ + \sigma^-} \propto \frac{I}{|T_{DVCS}|^2 + |T_{BH}|^2 + I}$$

Does not depend on polarizations



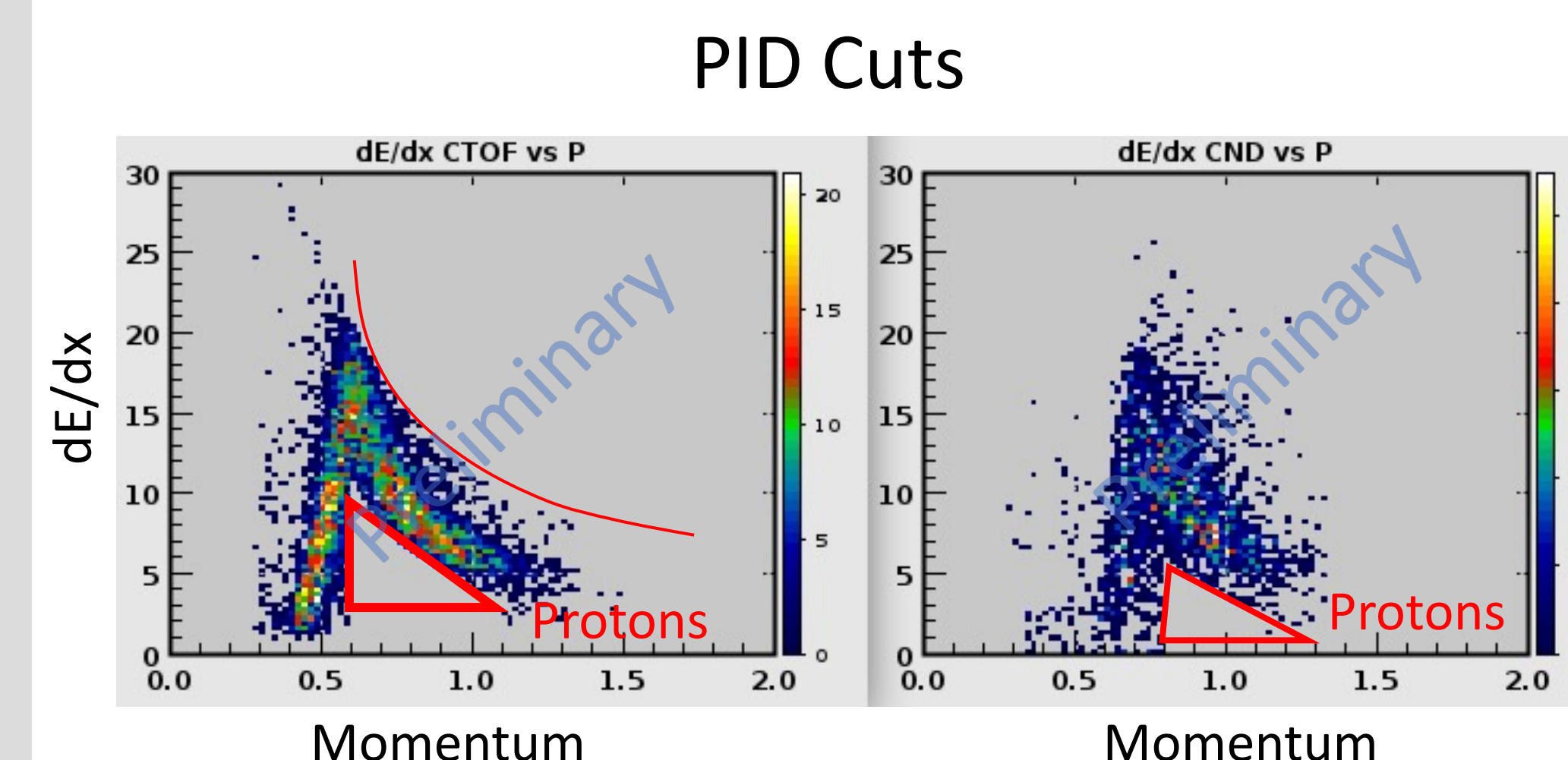
$$A_{LU}(\phi) = \frac{x_A(2-y)\sqrt{-\Delta^2(1-y)}}{2-2y+y^2} \times \Im m \frac{2G_1\mathcal{H}_1 + (G_1 - 2\tau G_3)(\mathcal{H}_1 - 2\tau\mathcal{H}_3) + \frac{2}{3}\tau G_3\mathcal{H}_5}{2G_1^2 + (G_1 - 2\tau G_3)^2} \times \sin(\phi)$$

JLab and CLAS12



- JLab CLAS12 data with beam energies of 10.4 GeV and 10.2 GeV (respectively for Fall 2019 and Spring 2019 RG-B runs) on liquid Deuteron target.

Initial Cuts Made

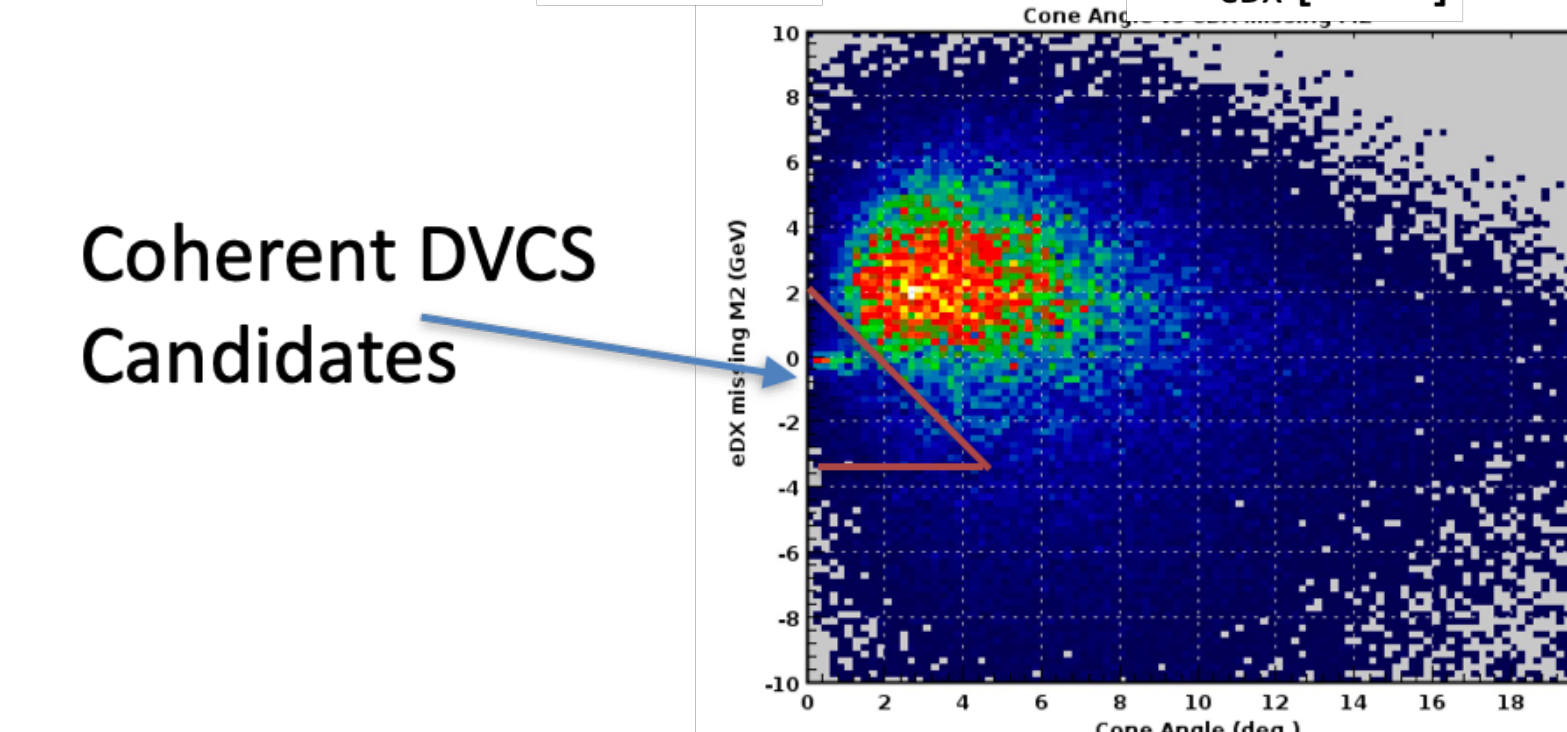
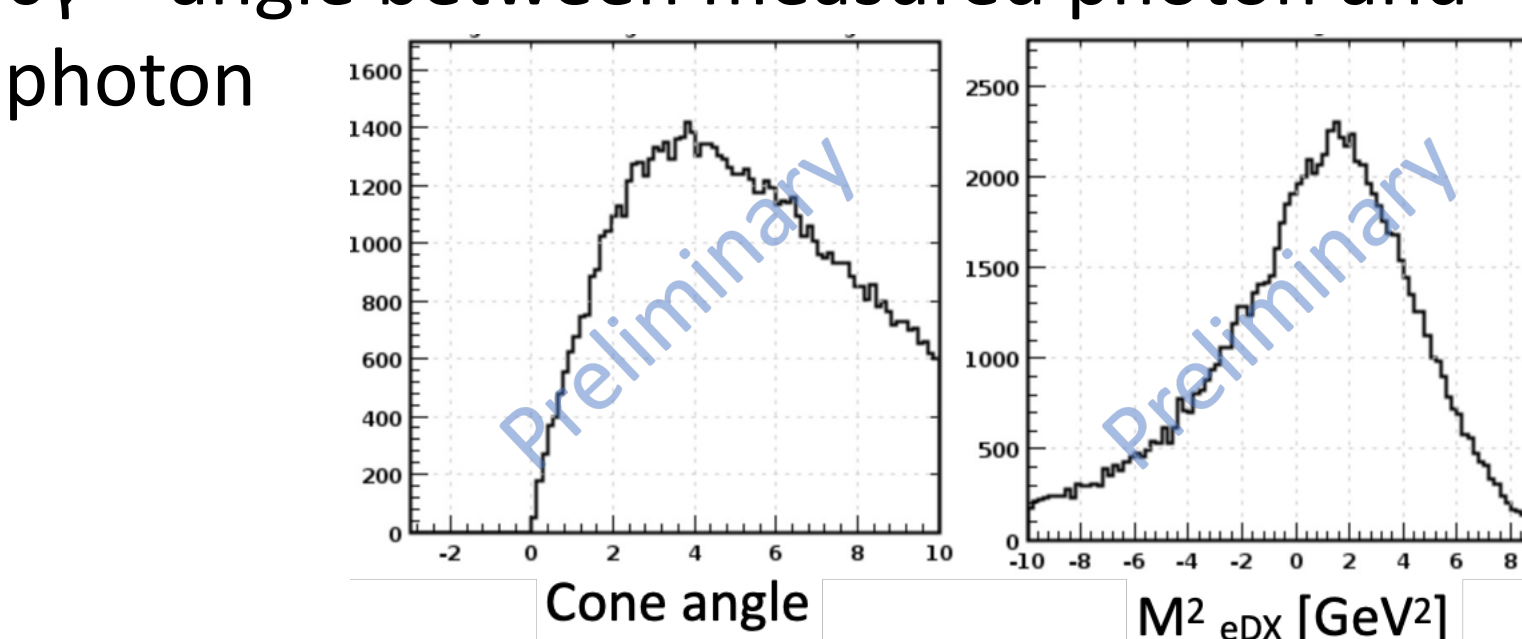


DVCS Cuts
• $Q^2 > 2 \text{ GeV}^2$ • $W > 1 \text{ GeV}$ • $E_e > 2 \text{ GeV}$ • $p_D < 2 \text{ GeV}$

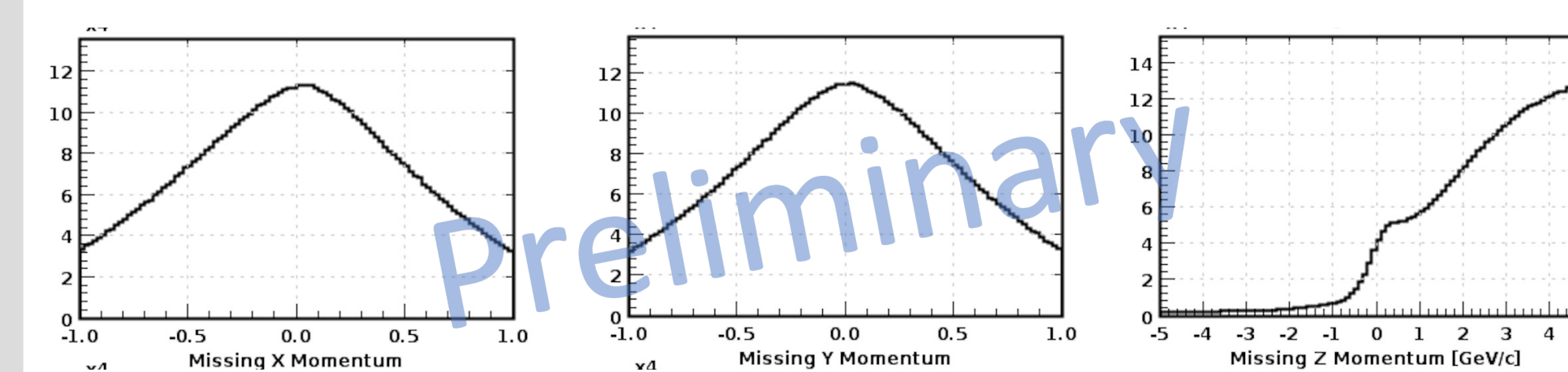
Exclusivity Cuts (Forward Tagger)

Exclusivity Cuts

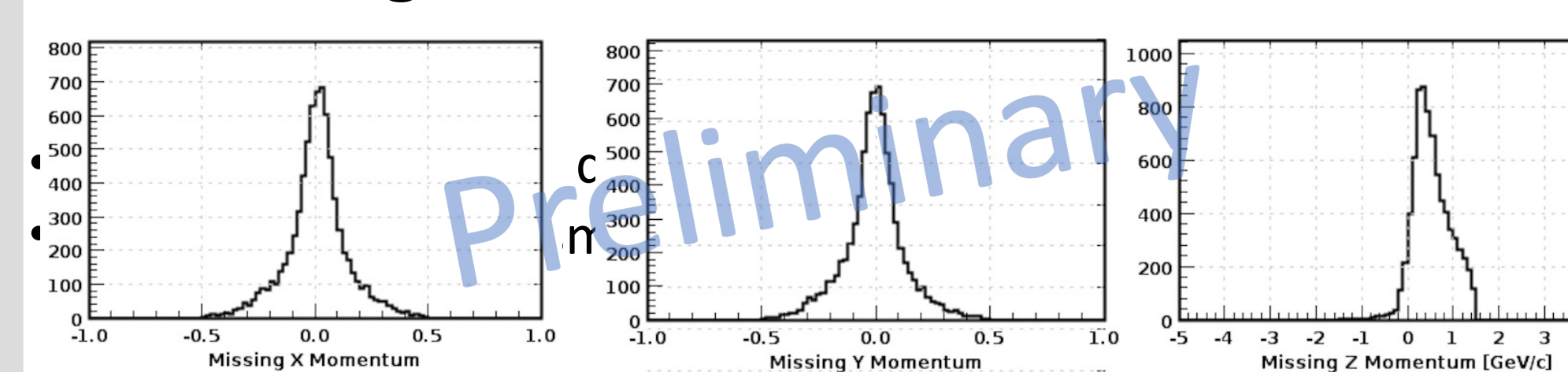
- $M_x^2(eD \rightarrow e'D'\gamma) < 2 \text{ (GeV/c}^2\text{)}^2$
 - $p_t < 0.5 \text{ GeV/c}$
 - $M_x^2(eD \rightarrow e'D') < -1.5 * \theta_\gamma, x+2$
- θ_γ = angle between measured photon and "missing" photon



Missing Momentum in X,Y,Z Before Cuts



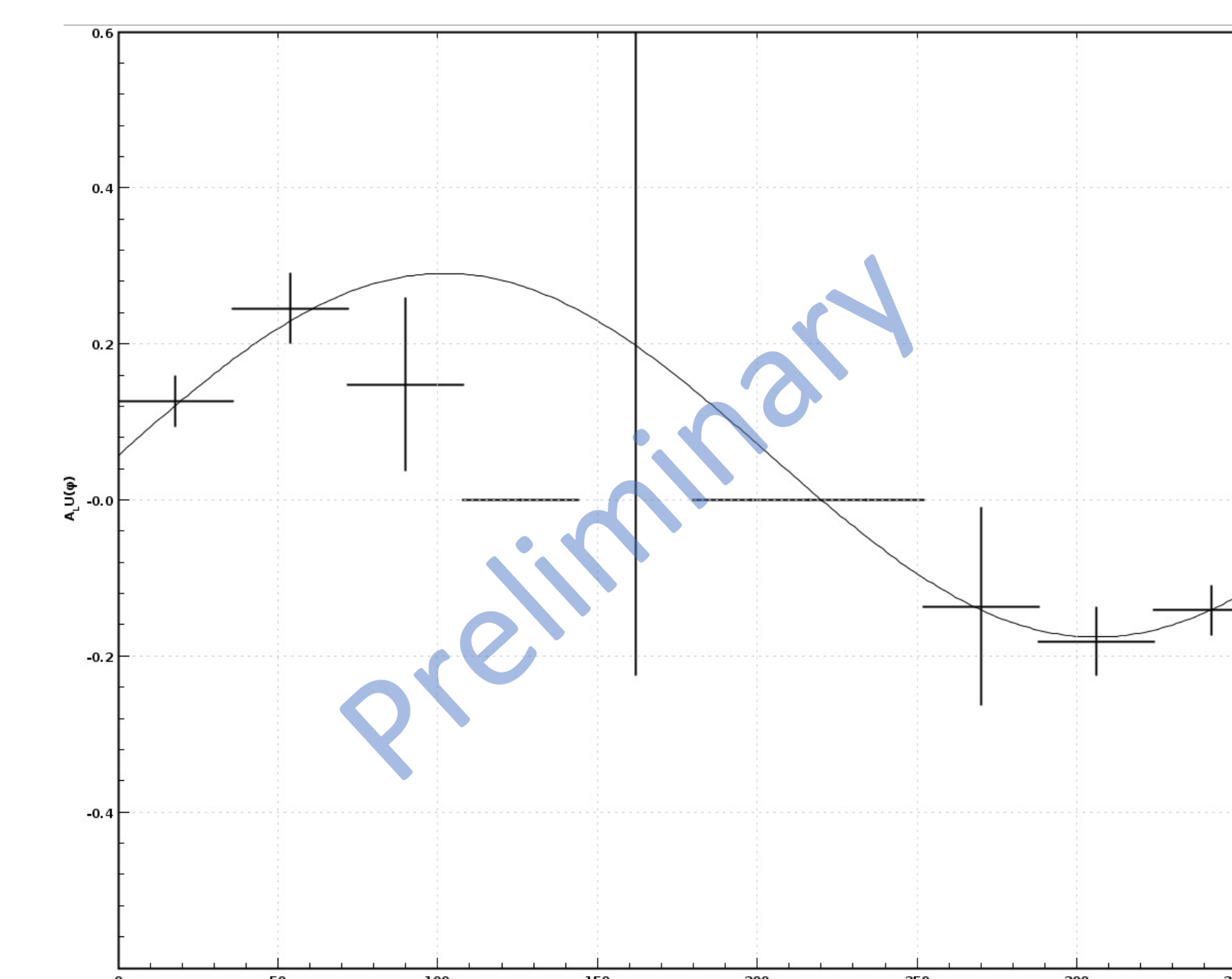
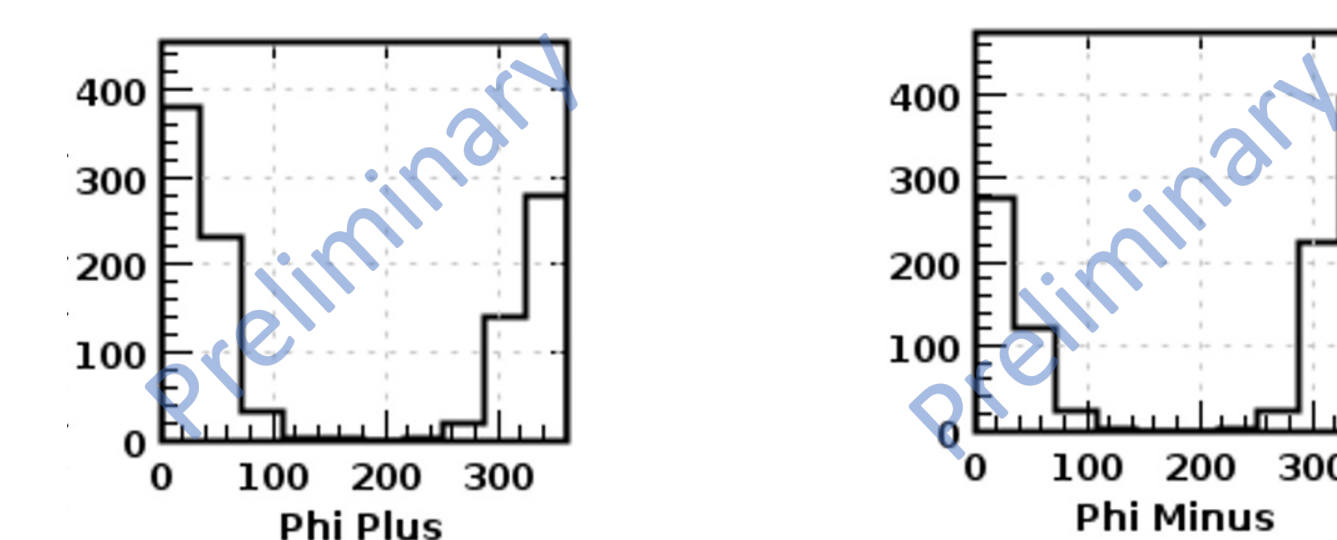
Missing Momentum in X,Y,Z After All Cuts



Results and Conclusions

- Preliminary Beam Spin Asymmetry for the Deuteron
- Clear $\sin(\phi)$ dependence
- Close to 30% amplitude in for photons in Forward Tagger

$$A = \frac{\sigma^+ - \sigma^-}{\sigma^+ + \sigma^-}$$



Future Work

- MC Simulation to learn new trends
- Using the MC Events as training set to do machine learning particle identification
- As we learn more, we can refine the cuts further, increasing efficiency of code on smaller number of events
- Binning of $\sin(\phi)$ dependence on $-t, Q^2, x_b$

Acknowledgments

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