BSA from Deeply virtual π^0 electroproduction measurements with CLAS12

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Generalized Parton Distributions (GPDs)

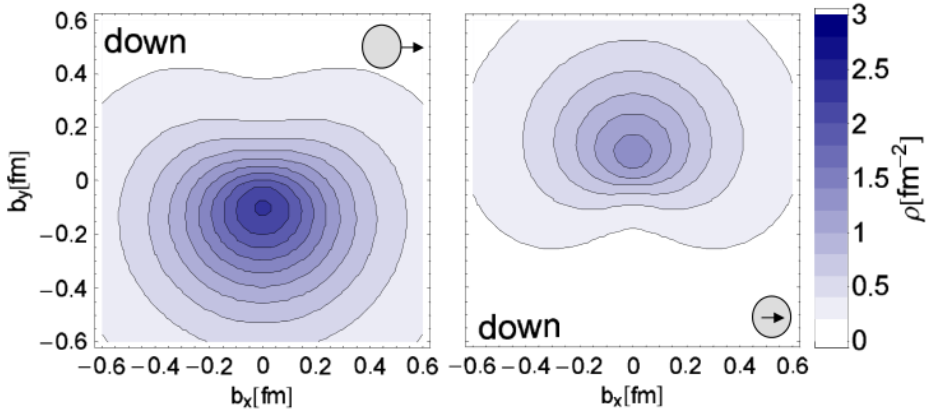
		Quark polarization		
		U	L	T
Nucleon polarization	U	H		$\bar{E}_T$
	L		$\tilde{H}$	
	T	E		H_T, $\tilde{H}_T$

Chiral even GPDs:

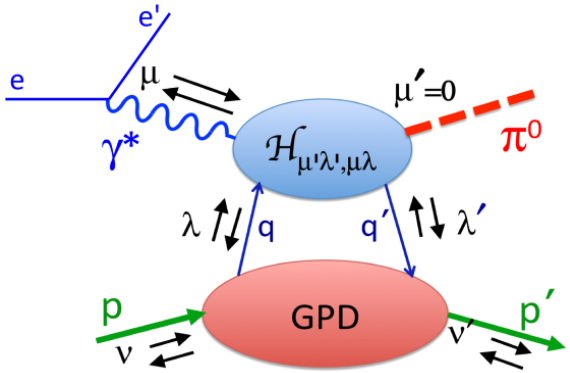
- DVCS on unpolarized and polarized targets with polarized beam by HERMES, JLAB and COMPASS

Chiral-odd GPD results:

- Deeply virtual meson production
- Lattice QCD by Göckeler *et al*



GPDs in deeply virtual exclusive reactions

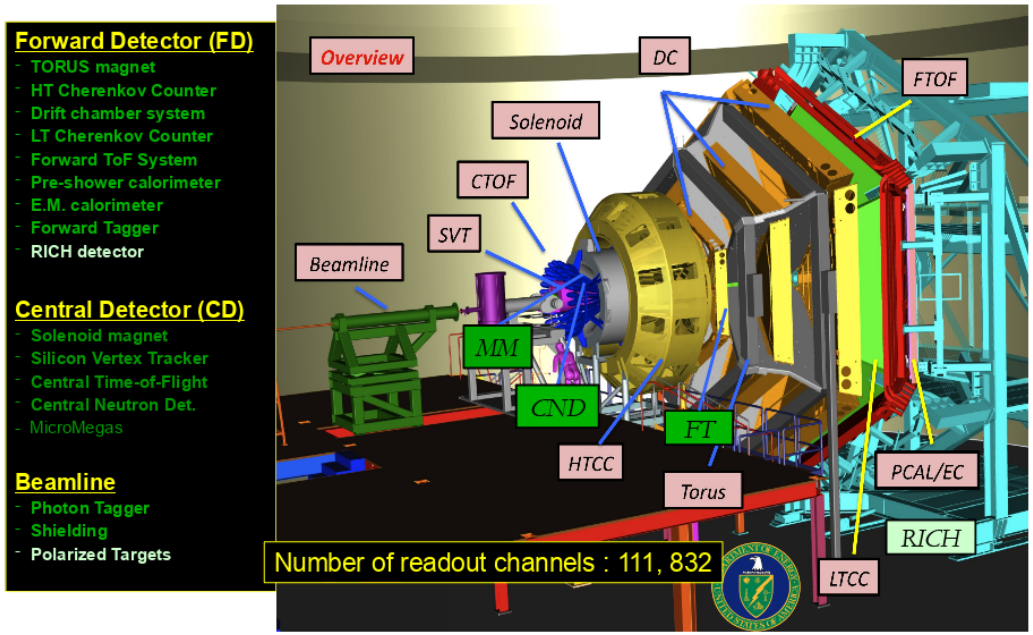


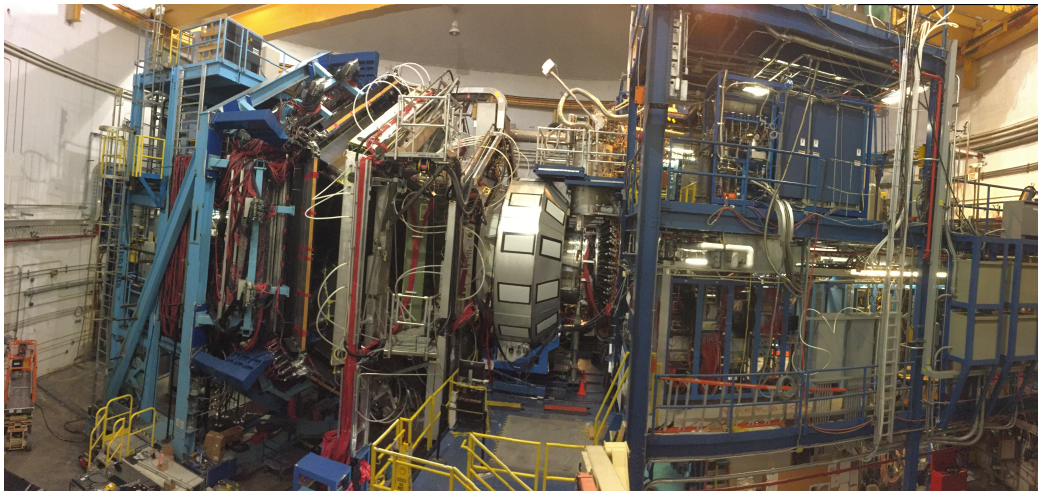
- $\langle F \rangle = \sum_\lambda \int_{-1}^{1} dx \mathcal{H}_{0\lambda,\mu\lambda}\left(x, \xi, Q^2, t\right) F\left(x, \xi, t\right)$

Generalized Form Factor (GFF) $\langle F \rangle$ is a convolution of hard subprocess with GPD F

- 4 parton helicity conserving (chiral even) GPDs: H, $\tilde{H}$, E, $\tilde{E}$
- 4 parton helicity flip (chiral odd) GPDs: H_T, $\tilde{H}_T$, E_T, $\tilde{E}_T$
- functions of three kinematic variables: x, ξ and t

Experimental setup





- CEBAF Large Acceptance Spectrometer
- 10.6 GeV longitudinally polarized electron beam
- 85% average polarization
- Liquid hydrogen target
- First CLAS experiment since 12 GeV Upgrade
- The analysis uses 3% of approved beam time

DVMP structure functions

$$\frac{2\pi}{\Gamma}\frac{d^4\sigma}{dQ^2 dx_B dt d\phi_\pi} =$$

unpolarized terms

$$\sigma_T + \epsilon\sigma_L + \epsilon\sigma_{TT}\cos 2\phi + \sqrt{\epsilon(1+\epsilon)}\sigma_{LT}\cos\phi$$

longitudinally polarized beam

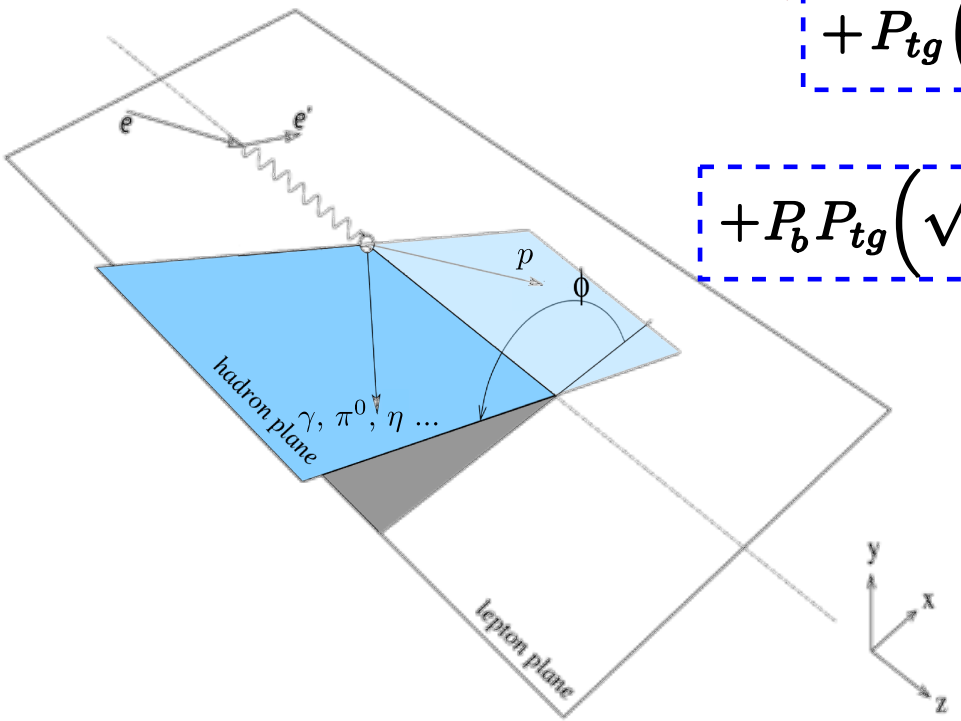
$$+P_b\sqrt{\epsilon(1-\epsilon)}\sigma_{LT'}\sin\phi$$

longitudinally polarized target

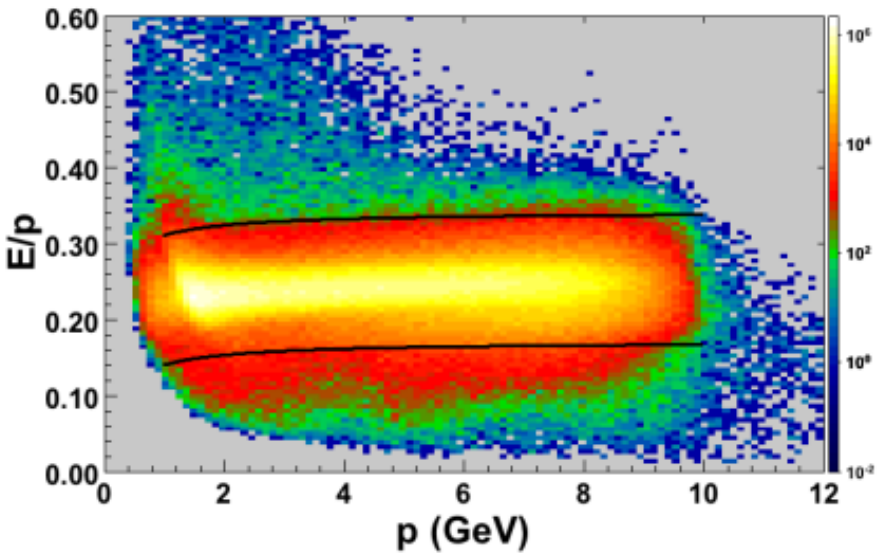
$$+P_{tg}\left(\sqrt{\epsilon(1+\epsilon)}\sigma_{UL}^{\sin\phi}\sin\phi + \epsilon\sigma_{UL}^{\sin 2\phi}\sin 2\phi\right)$$

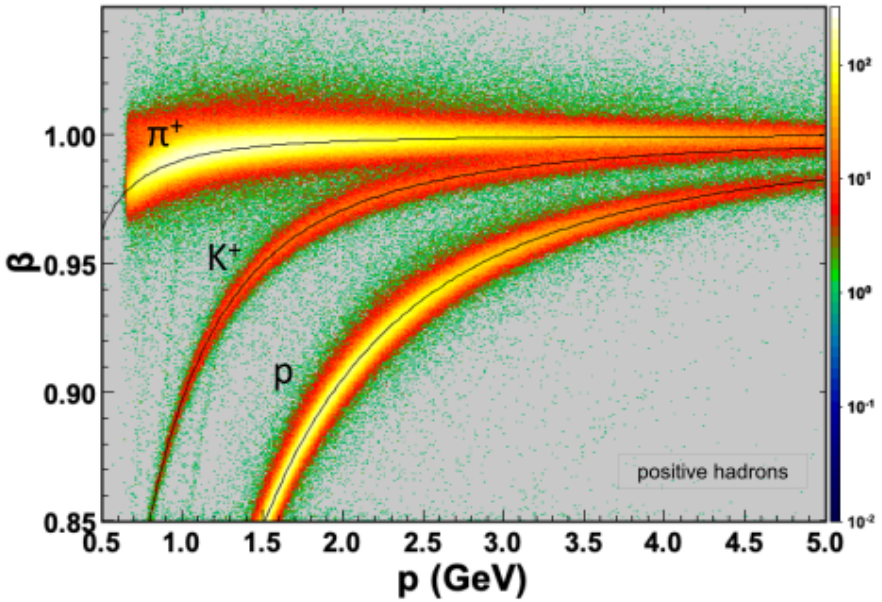
$$+P_b P_{tg}\left(\sqrt{1-\epsilon^2}\sigma_{LL} + \sqrt{\epsilon(1-\epsilon)}\sigma_{LL}^{\cos\phi}\cos\phi\right)$$

longitudinally polarized beam and longitudinally polarized target

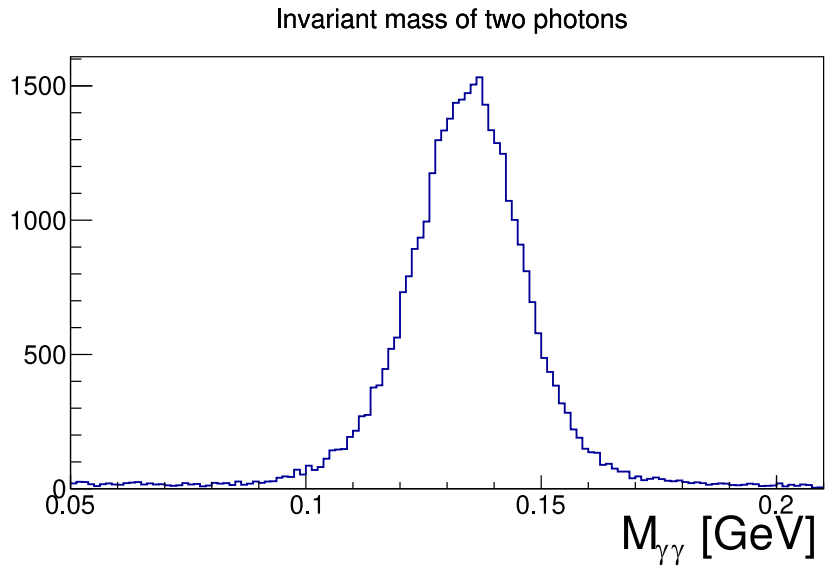


Particle identification





- All final state particles are detected: electron, proton and two photons from π^0 decay
- Invariant mass of two photons is used to select π^0 candidates



Exclusive event selection

With all final state particle detected we can consider multiple combinations which allow us to isolate clean exclusive event sample and reject background:

- $\vec{e}p \to epX$
- $\vec{e}p \to e\gamma\gamma X$
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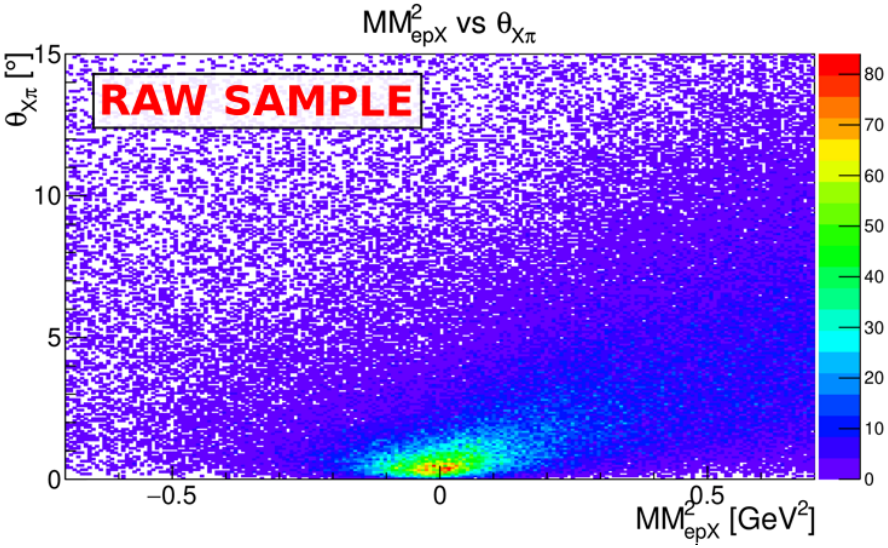
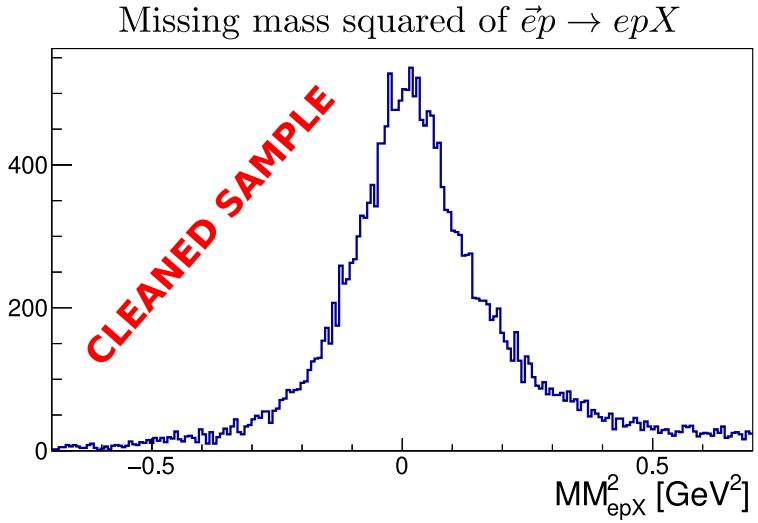
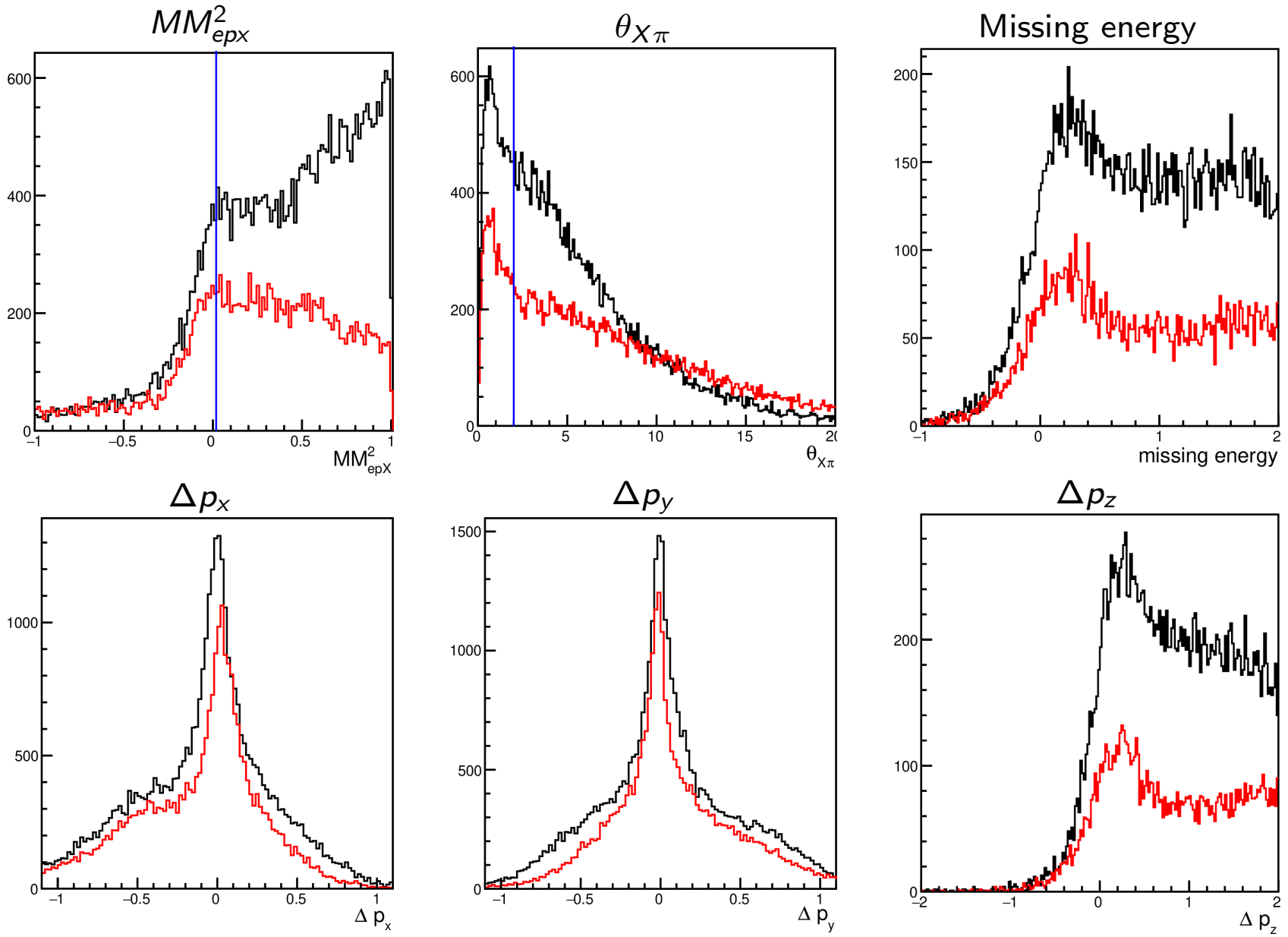
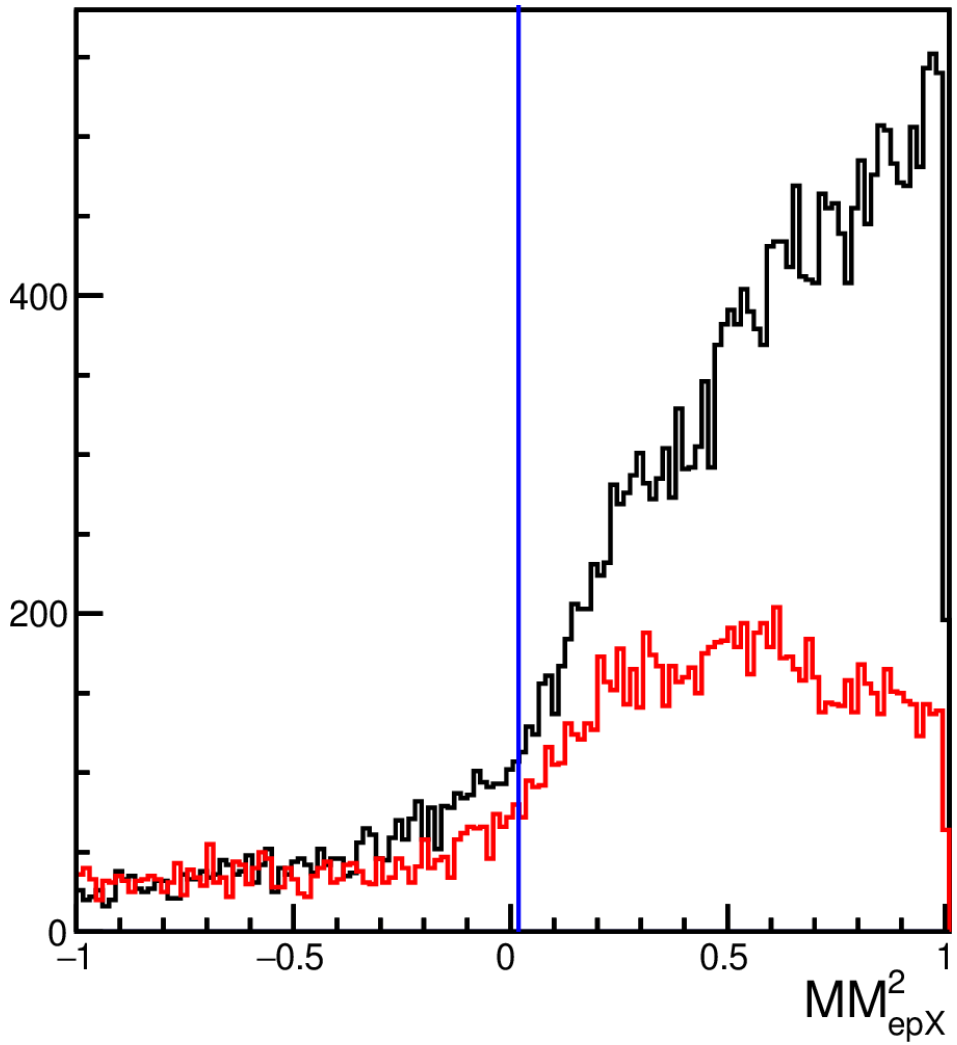




Exclusive variables [sector 1]: e, p, π^0 detected and $MM^2_{epx} < 1$ GeV^2

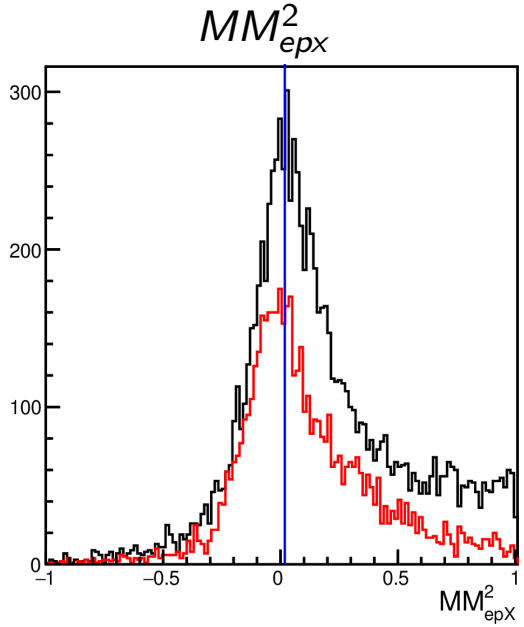


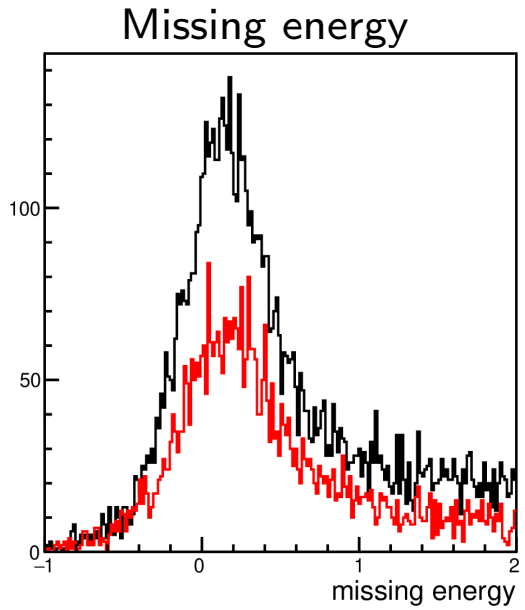
MM^2_{epx} for $\theta_{X\pi} > 2^\circ$

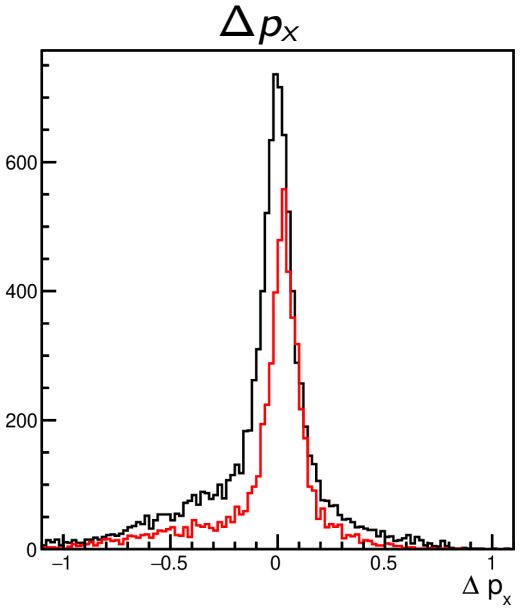


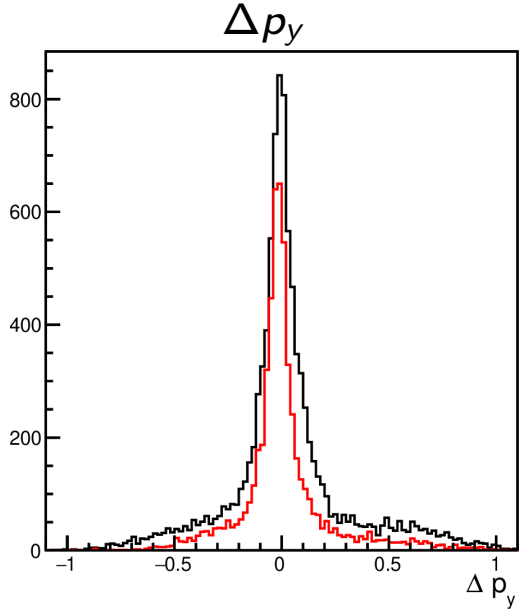
MM^2_{epx}

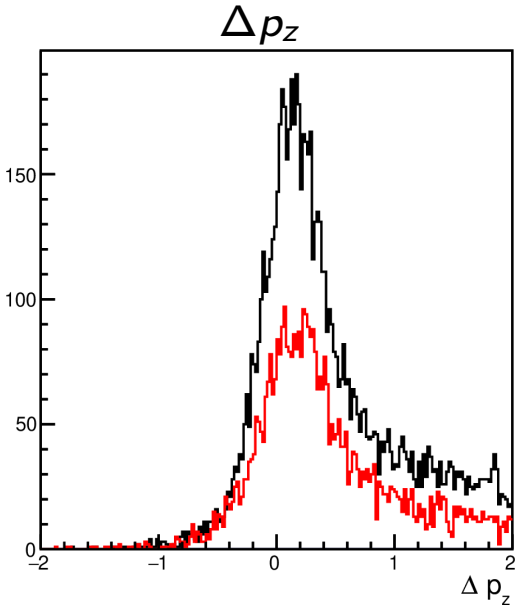
Exclusive variables [sector 1]: e, p, π^0 detected, $MM^2_{epx} < 1$ GeV^2, $\theta_{X\pi} < 2^\circ$



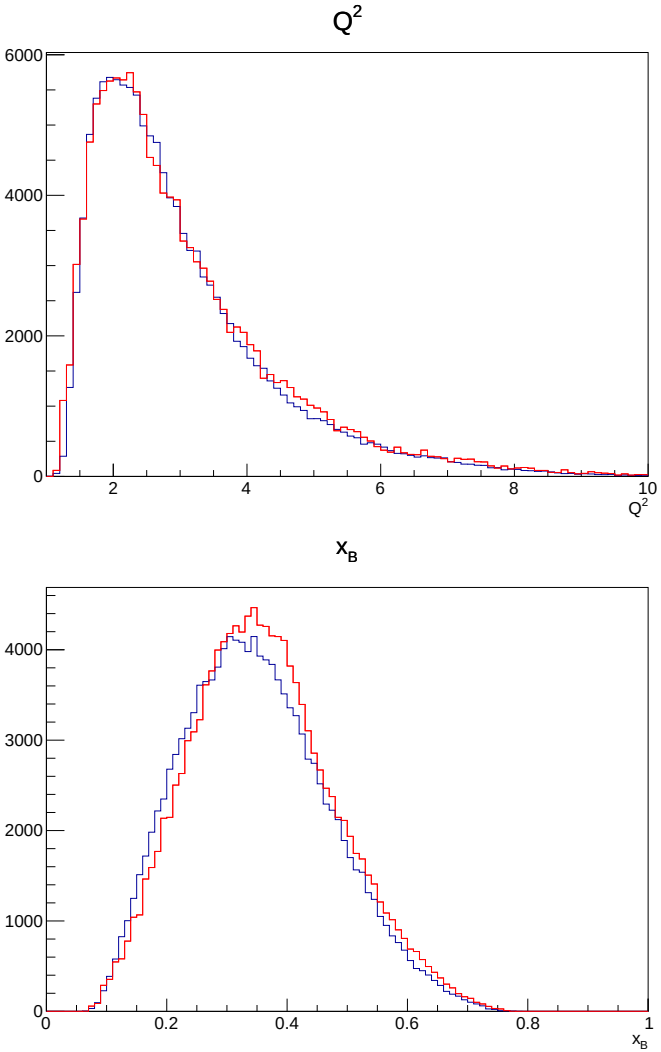


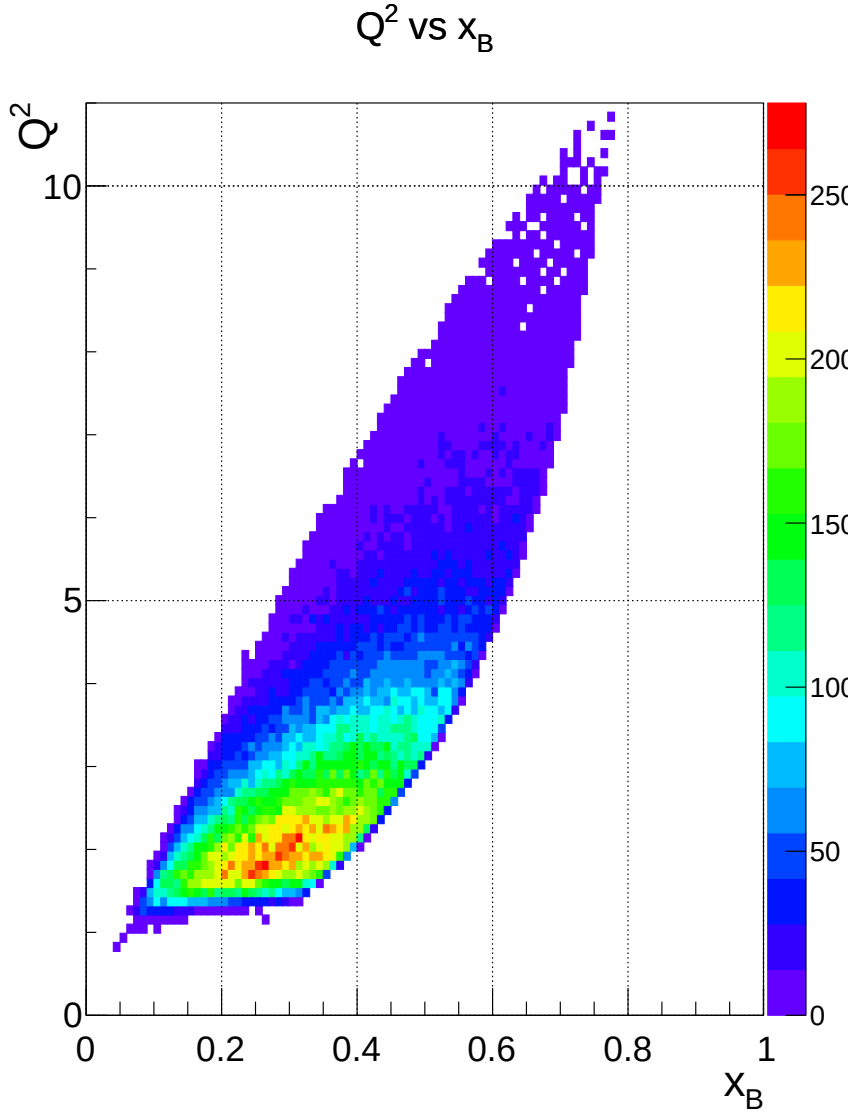




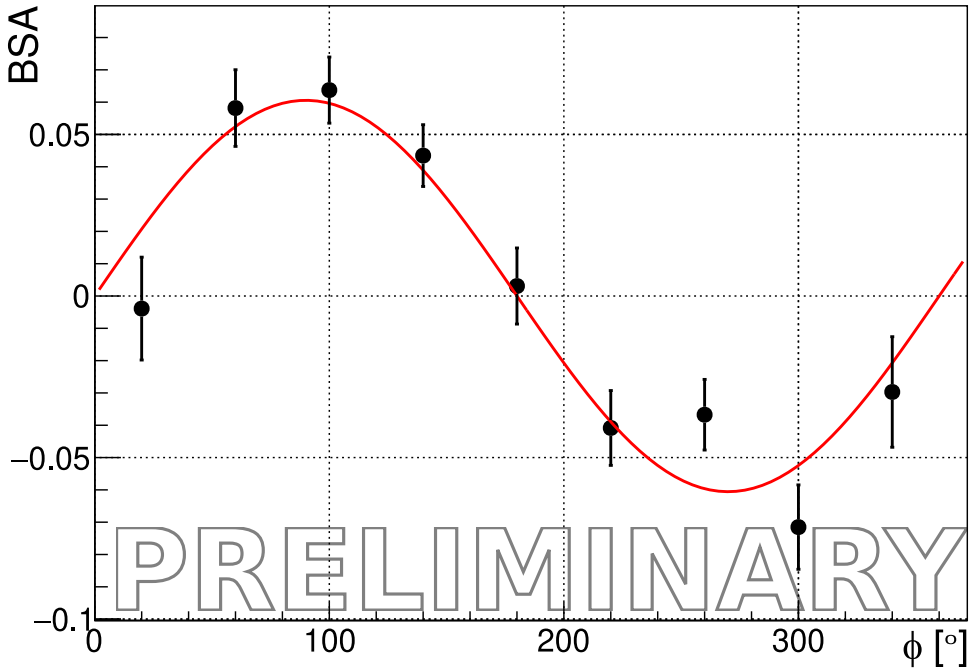


π^0: Kinematic coverage: $W > 2$ GeV, $Q^2 > 1$ GeV^2





Beam spin asymmetry



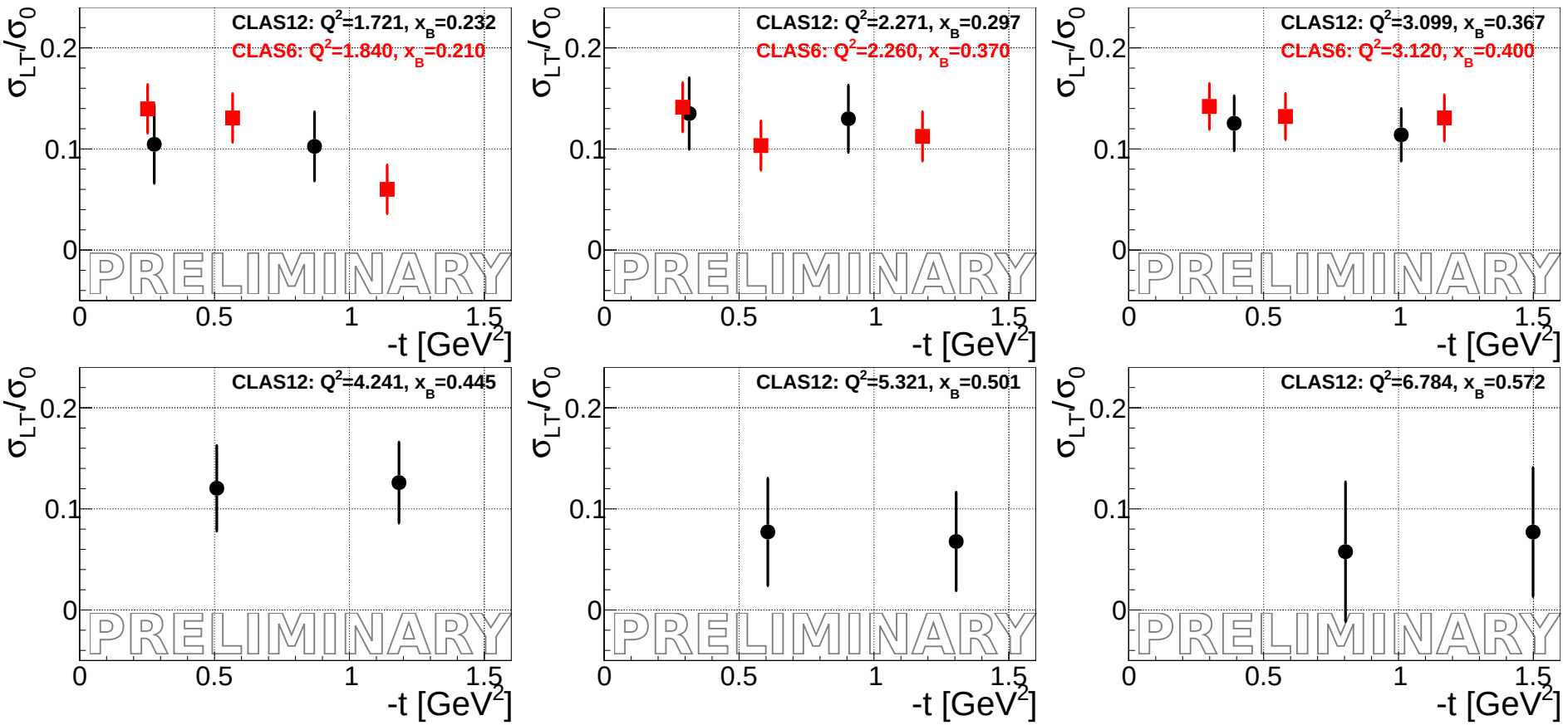
$$BSA = \frac{1}{P_b}\frac{N^+ - N^-}{N^+ + N^-}$$

where $P_b = 85\%$ is an average beam polarization

$$BSA = \sqrt{2\epsilon(1-\epsilon)}\frac{\sigma_{LT'}}{\sigma_0}$$

- Statistically significant beam spin asymmetry was observed

$\sigma_{LT'}/\sigma_0$ in Q^2,x_B bins



- The preliminary results are compatible with previous measurements

Summary

- CLAS12 preliminary results indicate a promising future for Deeply Virtual π^0 Electroproduction measurements
- 10.6 GeV electron beam extend our reach to the higher kinematic regions
- 85% beam polarization allows us to extract the beam spin asymmetry moments
- These data will provide further insight into chiral-odd GPDs and constrain their parameterizations