Beam Spin Asymmetry for Deeply Virtual Exclusive π^0 Electroproduction with CLAS12

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Generalized Parton Distributions (GPDs)

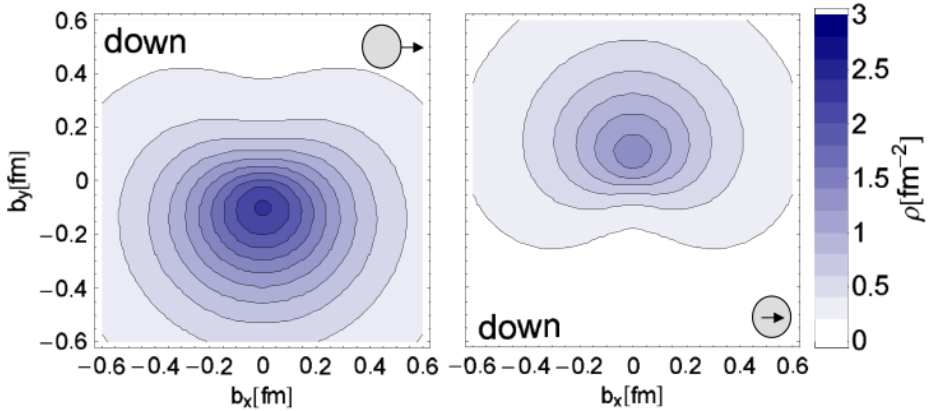
		Quark polarization		
		U	L	T
Nucleon polarization	U	H		$\bar{E}_T$
	L		$\tilde{H}$	
	T	E		H_T, $\tilde{H}_T$

Chiral-odd GPD results:

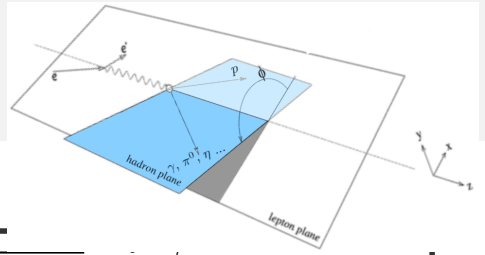
- Deeply virtual meson production
- Lattice QCD by Göckeler *et al*

Chiral even GPDs:

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

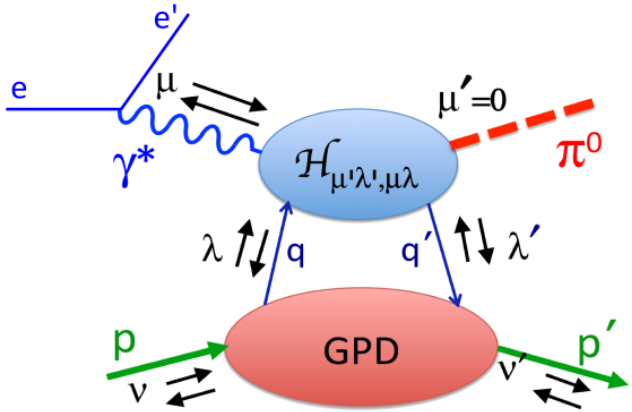


Access to the chiral-odd GPDs from experimental data



$$\sigma = \sigma_0 + \sqrt{2\epsilon(1+\epsilon)}\sigma_{LT}^{\cos\phi}\cos\phi + \epsilon\sigma_{TT}^{\cos 2\phi}\cos 2\phi + \lambda_e\sqrt{2\epsilon(1-\epsilon)}\sigma_{LT'}^{\sin\phi}\sin\phi$$

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



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

Goloskokov-Kroll model:

$$\sigma_L \sim \left\{ \left(1-\xi^2\right)\left|\langle \tilde{H} \rangle\right|^2 - 2\xi^2 \mathrm{Re}\left[\langle \tilde{H} \rangle^* \langle \tilde{E} \rangle\right] - \frac{t'}{4m^2}\xi^2\left|\langle \tilde{E} \rangle\right|^2 \right\}$$

$$\sigma_T \sim \left[\left(1-\xi^2\right)\left|\langle \boldsymbol{H_T} \rangle\right|^2 - \frac{t'}{8m^2}\left|\langle \bar{\boldsymbol{E}}_{\boldsymbol{T}} \rangle\right|^2 \right]$$

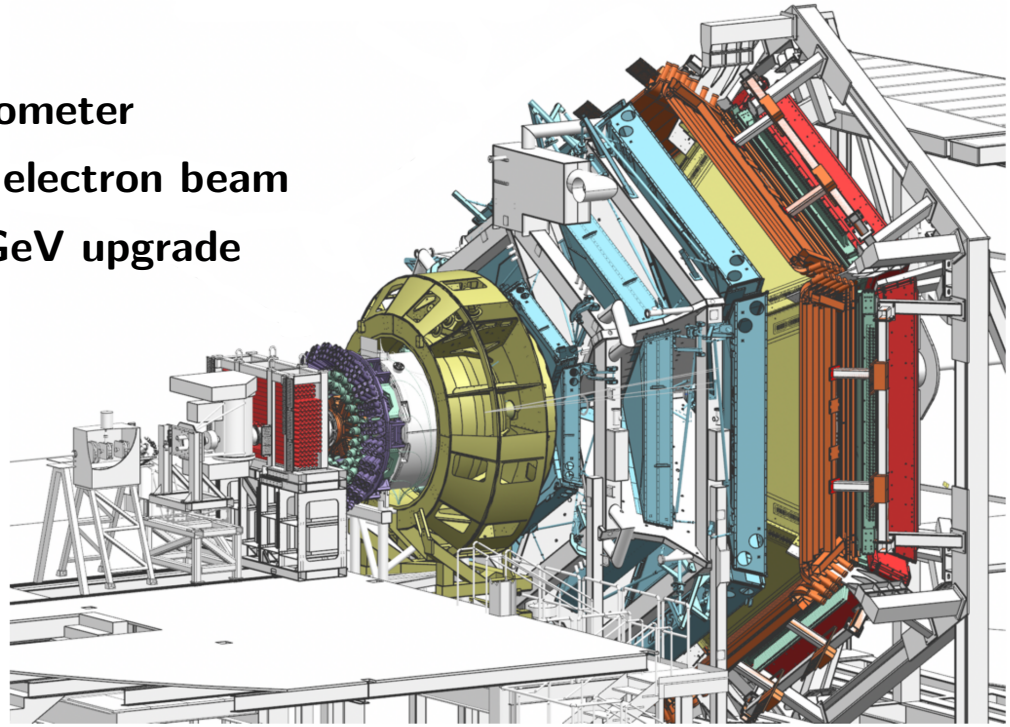
$$\sigma_{LT} \sim \xi\sqrt{1-\xi^2}\frac{\sqrt{-t'}}{2m}\,\mathrm{Re}\left[\langle \boldsymbol{H_T} \rangle^* \langle \tilde{\boldsymbol{E}} \rangle\right]$$

$$\sigma_{TT} \sim \frac{t'}{16m^2}\left|\langle \bar{\boldsymbol{E}}_{\boldsymbol{T}} \rangle\right|^2$$

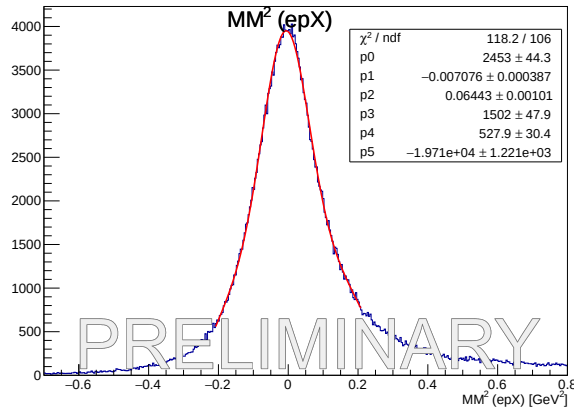
$$\sigma_{LT'} \sim \xi\sqrt{1-\xi^2}\frac{\sqrt{-t'}}{2m}\,\mathrm{Im}\left[\langle \boldsymbol{H_T} \rangle^* \langle \tilde{\boldsymbol{E}} \rangle\right]$$

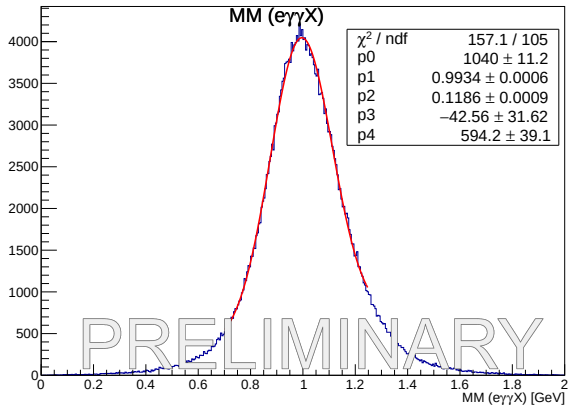
CLAS12 and exclusive π^0 electroproduction

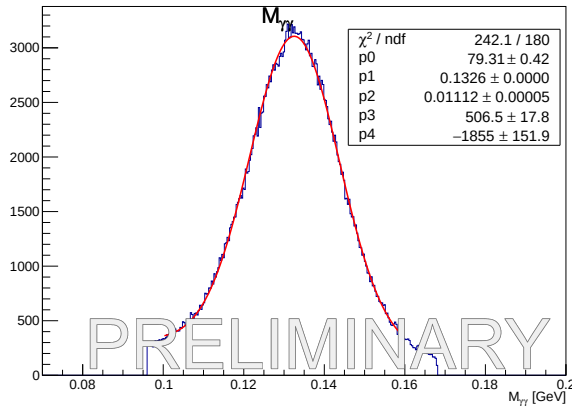
- **CEBAF Large Acceptance Spectrometer**
- **10.6 GeV longitudinally polarized electron beam**
- **First CLAS experiment since 12 GeV upgrade**
- **86% electron polarization**
- **Liguid hydrogen target**
- **All final state particles detected**
- **access Q^2 range up to 10 GeV^2**



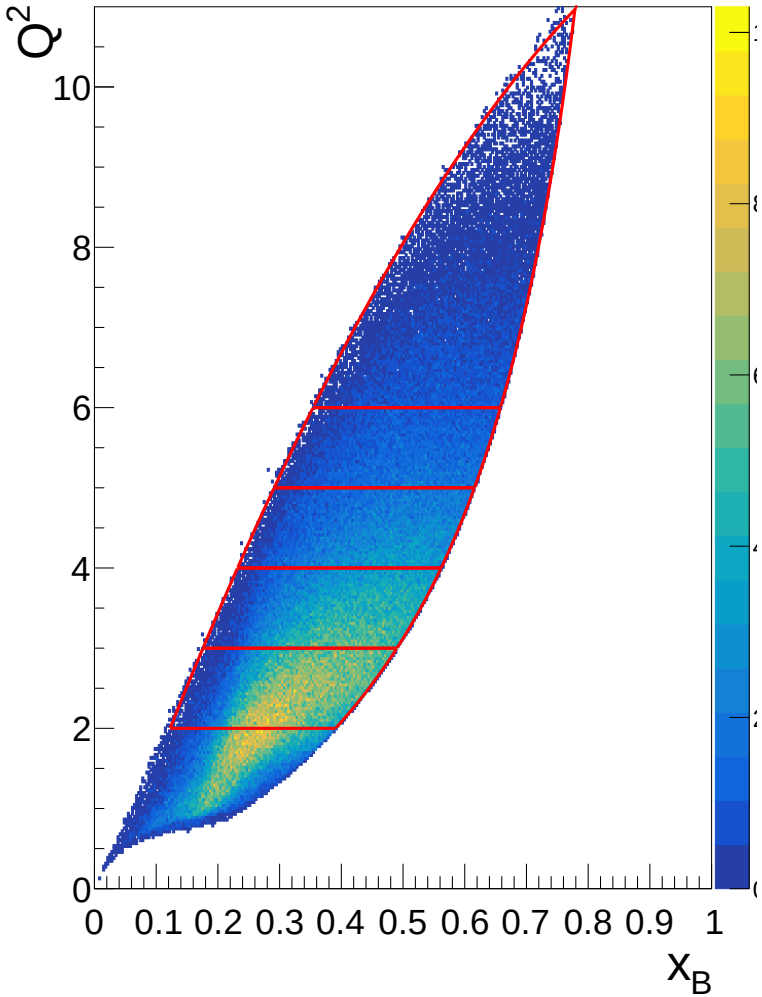
$ep \rightarrow ep\pi^0$ selection







Kinematic coverage, binning



CLAS12 allows:

- azimuthal dependence analysis
- multidimensional binning
- extended kinematic coverage

DIS cuts: $Q^2 > 2$ GeV^2 and $W > 2$ GeV

- 5 $\{Q^2, x_B\}$ bins
- each $\{Q^2, x_B\}$ bin has 3 $-t$ bins
- each $\{Q^2, x_B, -t\}$ bin has 9 ϕ bins

in total: 135 $\{Q^2, x_B, -t, \phi\}$ bins

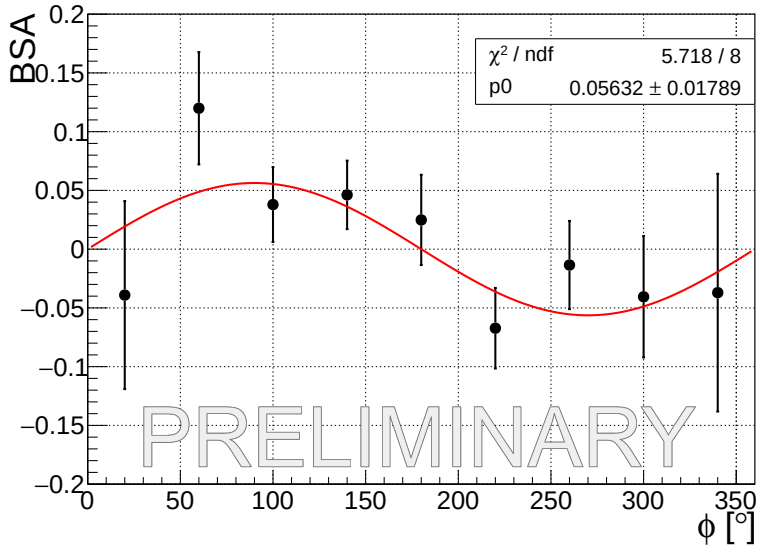
Beam spin asymmetry

$$\text{BSA} = \frac{1}{P_b}\frac{n^+ - n^-}{n^+ + n^-},$$ where P_b is an average electron beam polarization

$$\sigma = \sigma_0 + \sqrt{2\epsilon(1+\epsilon)}\sigma_{LT}^{\cos\phi}\cos\phi + \epsilon\sigma_{TT}^{\cos 2\phi}\cos 2\phi + \lambda_e\sqrt{2\epsilon(1-\epsilon)}\sigma_{LT'}^{\sin\phi}\sin\phi$$

$$BSA = \frac{d\sigma^+ - d\sigma^-}{d\sigma^+ + d\sigma^-} \propto A_{LU}^{\sin\phi}\sin\phi$$

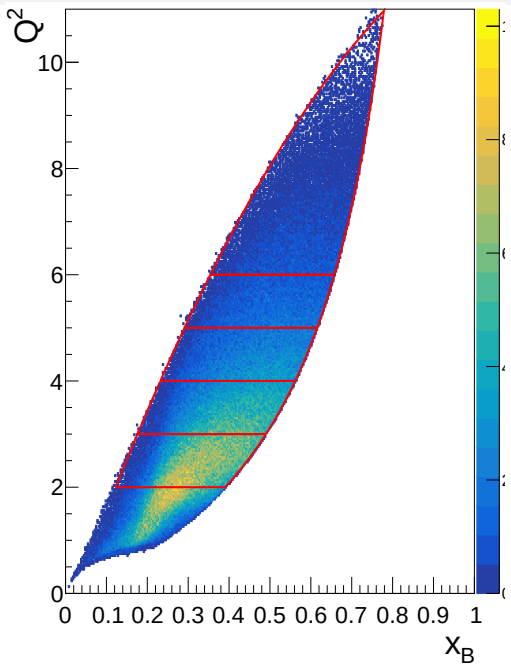
$$A_{LU}^{\sin\phi} = \sqrt{2\epsilon(1-\epsilon)}\frac{\sigma_{LT'}^{\sin\phi}}{\sigma_0}$$



The Beam Spin Asymmetry as a function of ϕ for one of the kinematic bins

Preliminary $\frac{\sigma_{LT'}}{\sigma_0}$ from CLAS12 first experiment data

- the results are compared with theoretical calculations based on Goloskokov-Kroll (GK) model



Summary

- CLAS12 and polarized electron beam enables the extraction of BSA moments for exclusive π^0 electroproduction
- 10.6 GeV electron beam extends our reach to the higher Q^2 kinematic regions
- $\frac{\sigma_{LT'}}{\sigma_0}$ is positive and large, compatible with previously observed BSA moments
- These data will provide further insight into chiral-odd GPDs and constrain their parameterizations