Preliminary HERMES results from a combined beam charge and spin analysis of DVCS data

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for the hermes collaboration

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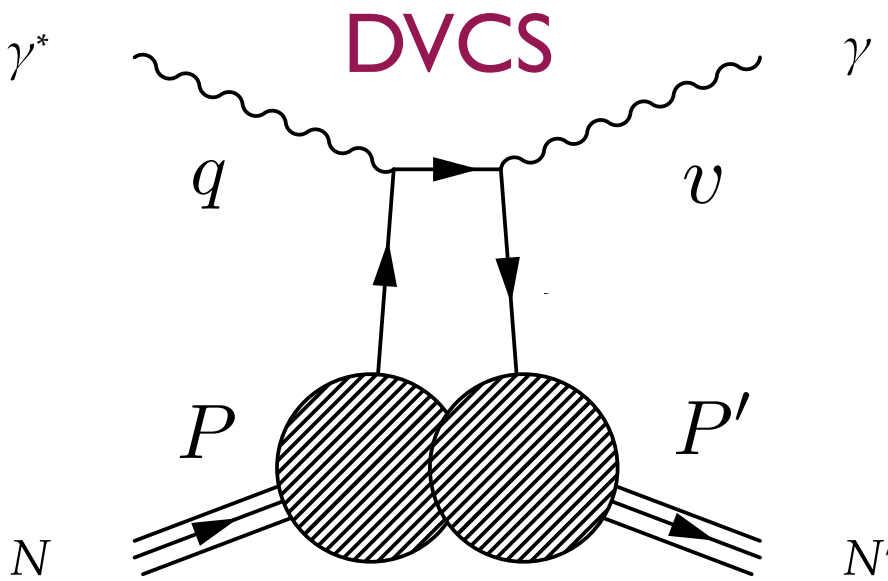
Deeply Virtual Compton Scattering

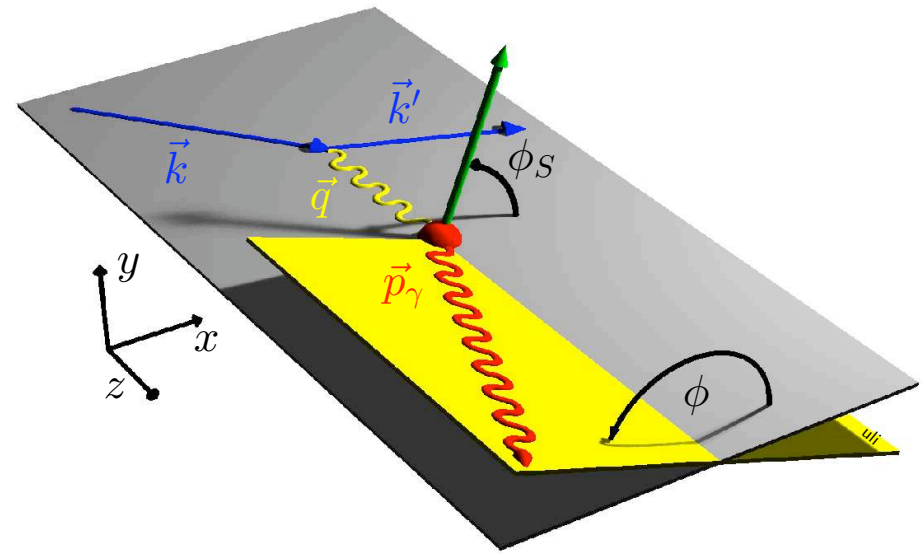


$$q^2 = -Q^2 = (k - k')^2$$

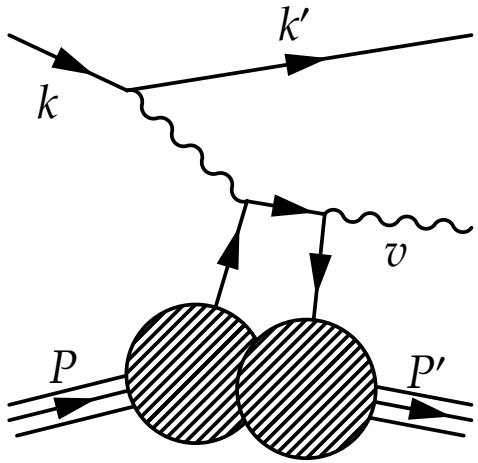
$$x_B = \frac{Q^2}{2P \cdot q}$$

$$t = \Delta^2 = (P' - P)^2$$

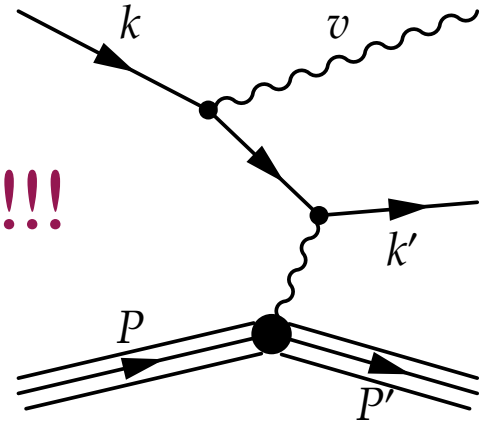
Two azimuthal angles describing the relative motion of the final state products.



Interference with Bethe-Heitler process



Same final state!!!



➡ The (differential) cross section: $\left(y = \frac{P \cdot q}{P \cdot k}\right)$

$$\frac{d\sigma}{dx_{\mathrm{B}}\, dQ^2\, dt\, d\phi\, d\phi_{\mathrm{S}}} = \frac{\alpha_{\mathrm{em}}^3 x_{\mathrm{B}} y}{16\pi^2 Q^2 e^6} \frac{|\mathcal{T}|^2}{\sqrt{1 + 4x_{\mathrm{B}}^2 M^2/Q^2}}$$

decomposes into the coherent sum of both processes:

$$|\mathcal{T}|^2 = |\mathcal{T}_{\mathrm{BH}}|^2 + |\mathcal{T}_{\mathrm{DVCS}}|^2 + \underbrace{\mathcal{T}_{\mathrm{DVCS}}\mathcal{T}_{\mathrm{BH}}^* + \mathcal{T}_{\mathrm{DVCS}}^*\mathcal{T}_{\mathrm{BH}}}_{\text{interference term}}$$

Combined analysis of proton data

Asymmetries are well suited observables:

$$\sigma_{\mathrm{LU}}(\phi; P_l, e_l) = \sigma_{\mathrm{UU}}(\phi) \cdot \left\{1 + P_l A_{\mathrm{LU}}^{\mathrm{DVCS}}(\phi) + e_l P_l A_{\mathrm{LU}}^{\mathcal{I}}(\phi) + e_l A_{\mathrm{C}}(\phi)\right\}$$

L : longitudinally polarized beam
U : unpolarized target

(signatures for different asymmetry amplitudes)

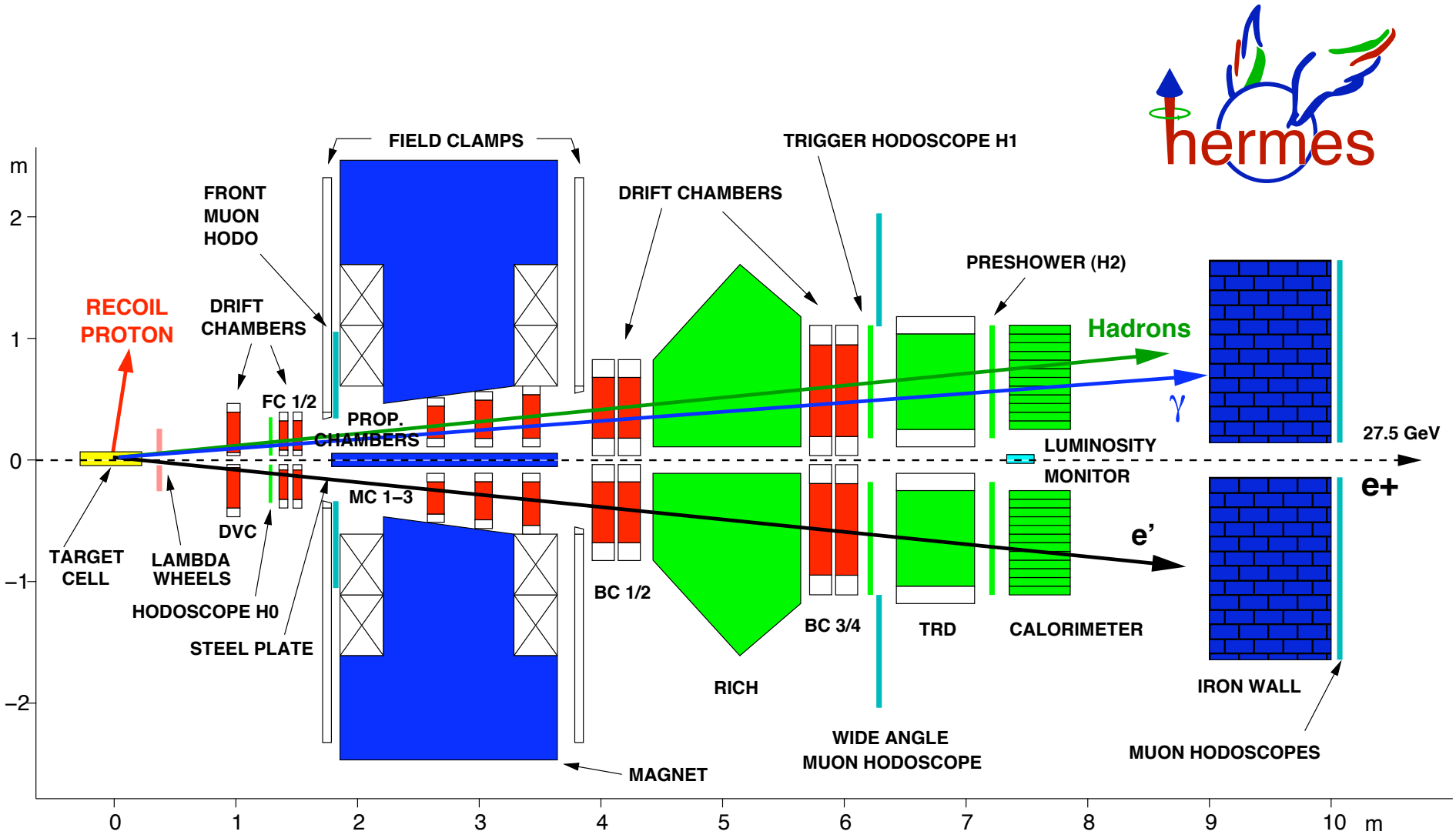
Effective asymmetry amplitudes:

$$A_{\mathrm{C}}(\phi) = -\frac{\frac{x_{\mathrm{B}}}{y}\sum_{n=0}^{3} c_n^I cos(n\phi)}{\frac{\sum_{n=0}^{2} c_n^{BH} cos(n\phi)}{(1+\epsilon^2)^2} + \frac{x_{\mathrm{B}}^2 t \mathcal{P}_1(\phi)\mathcal{P}_2(\phi)}{Q^2}\sum_{n=0}^{2} c_n^{DVCS} cos(n\phi)}$$

$$A_{\mathrm{LU}}^{\mathrm{DVCS}}(\phi) = \frac{\frac{x_{\mathrm{B}}^2 t \mathcal{P}_1(\phi)\mathcal{P}_2(\phi)}{Q^2} s_1^{\mathrm{DVCS}} sin\phi}{\frac{\sum_{n=0}^{2} c_n^{BH} cos(n\phi)}{(1+\epsilon^2)^2} + \frac{x_{\mathrm{B}}^2 t \mathcal{P}_1(\phi)\mathcal{P}_2(\phi)}{Q^2}\sum_{n=0}^{2} c_n^{DVCS} cos(n\phi)}$$

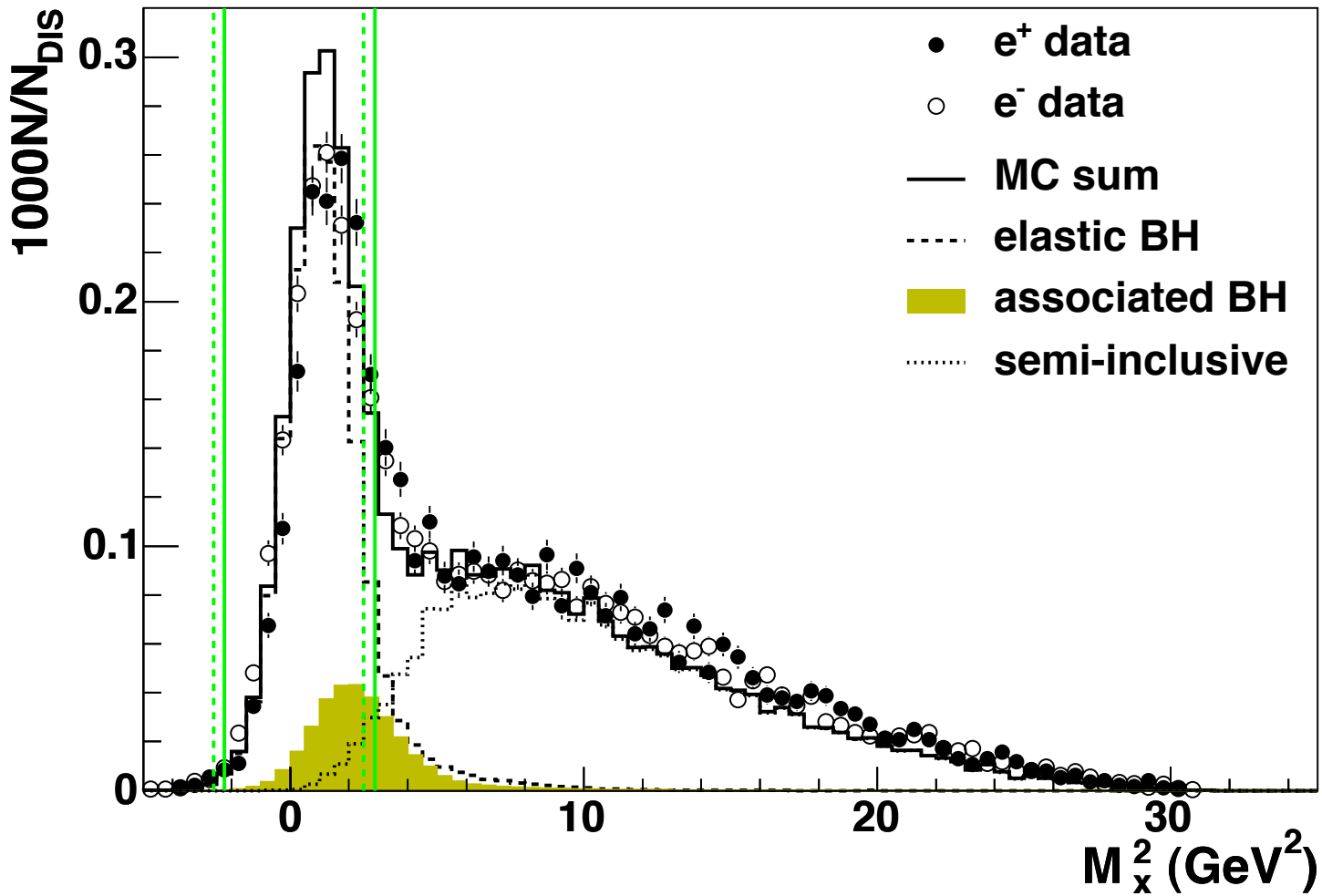
$$A_{\mathrm{LU}}^{\mathrm{I}}(\phi) = \frac{\frac{x_{\mathrm{B}}}{Q^2}\sum_{n=1}^{2} s_n^{\mathrm{I}} sin(n\phi)}{\frac{\sum_{n=0}^{2} c_n^{BH} cos(n\phi)}{(1+\epsilon^2)^2} + \frac{x_{\mathrm{B}}^2 t \mathcal{P}_1(\phi)\mathcal{P}_2(\phi)}{Q^2}\sum_{n=0}^{2} c_n^{DVCS} cos(n\phi)}$$

The HERMES experiment



DVCS with the HERMES spectrometer

Identification by missing mass technique: $(e + p \rightarrow e' + \gamma + X)$



Not possible to separate associated from elastic production.

➡ Possible with Recoil Detector for 2006/2007 data.

Corrections and systematic uncertainties

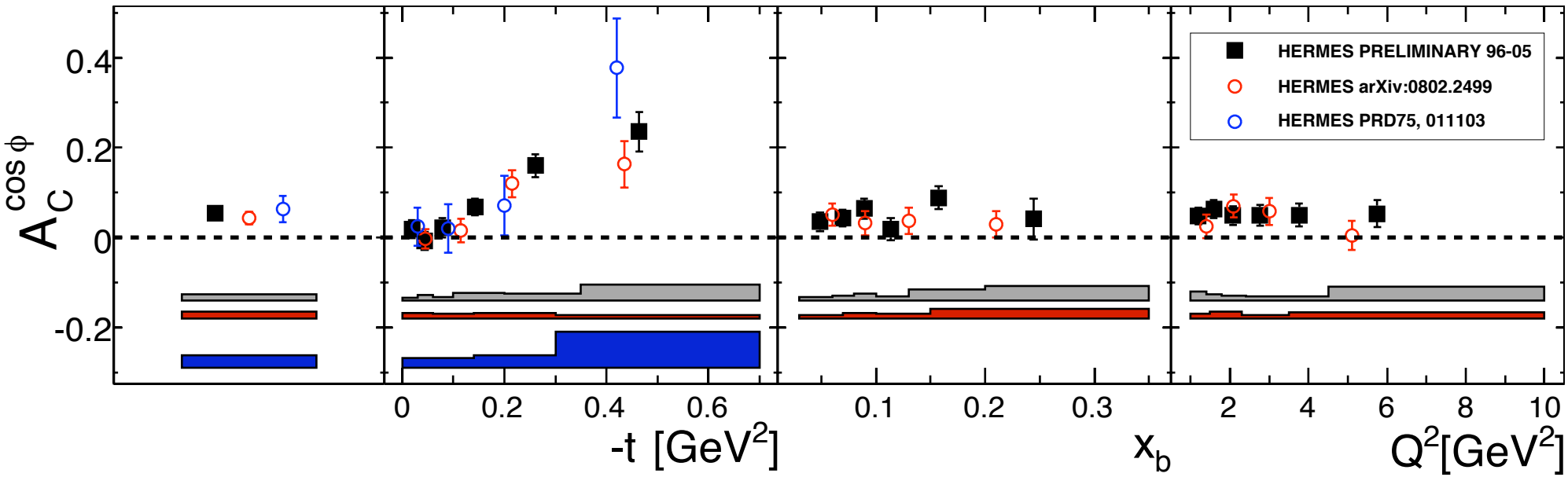
- Systematic uncertainty due to shifted exclusive M_x peak positions for different beam charges.

- Background correction for semi-inclusive π^0 production. Fractional contributions are obtained from MC. Asymmetries are taken from data.

$$A_{\mathrm{excl.}} = \frac{1}{1 - f_{\mathrm{i}}} \left[A_{\mathrm{meas.}} - f_{\mathrm{i}} A_{\mathrm{i}} \right]$$

- MC study for bin-width, acceptance, smearing and mis-alignment effect using various input models.

Beam charge asymmetries



Changes in the new analysis:

- 2.5 times the statistics in the former publications.
- 6 bins in all kinematic variables.
- The systematic error includes new model-dependent studies.

→ Results agree with former publications with higher statistical precision.

GPD Models

VGG model: **(Vanderhaeghen, Guichon, Guidal 1999)**

★ Based on double distributions.

★ Includes a D-term to restore full polynomiality.

★ Includes a Regge inspired and a factorized t-ansatz.

★ Skewness depending on free parameters b_{val} & b_{sea}.

★ Includes twist-three contributions.

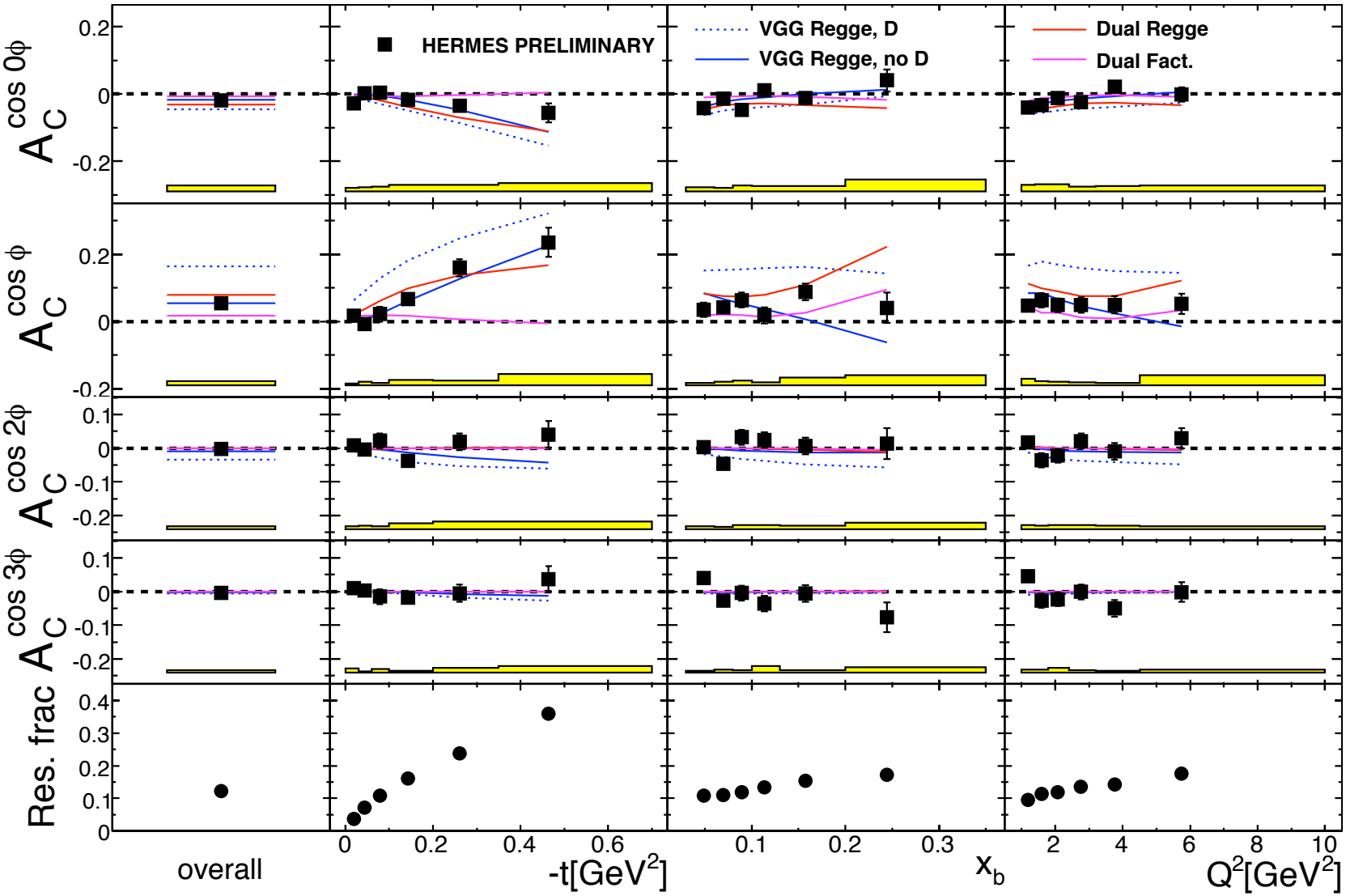
Dual model: **(Guzey, Teckentrup 2006)**

★ GPDs based on an infinite sum of t-channel resonances.

★ Includes a Regge inspired and a factorized t-ansatz.

★ Does not include twist-three.

Beam Charge Asymmetries



$\propto -A_C^{cos\phi}$

$\propto \mathrm{Re}[F_1\mathcal{H}]$

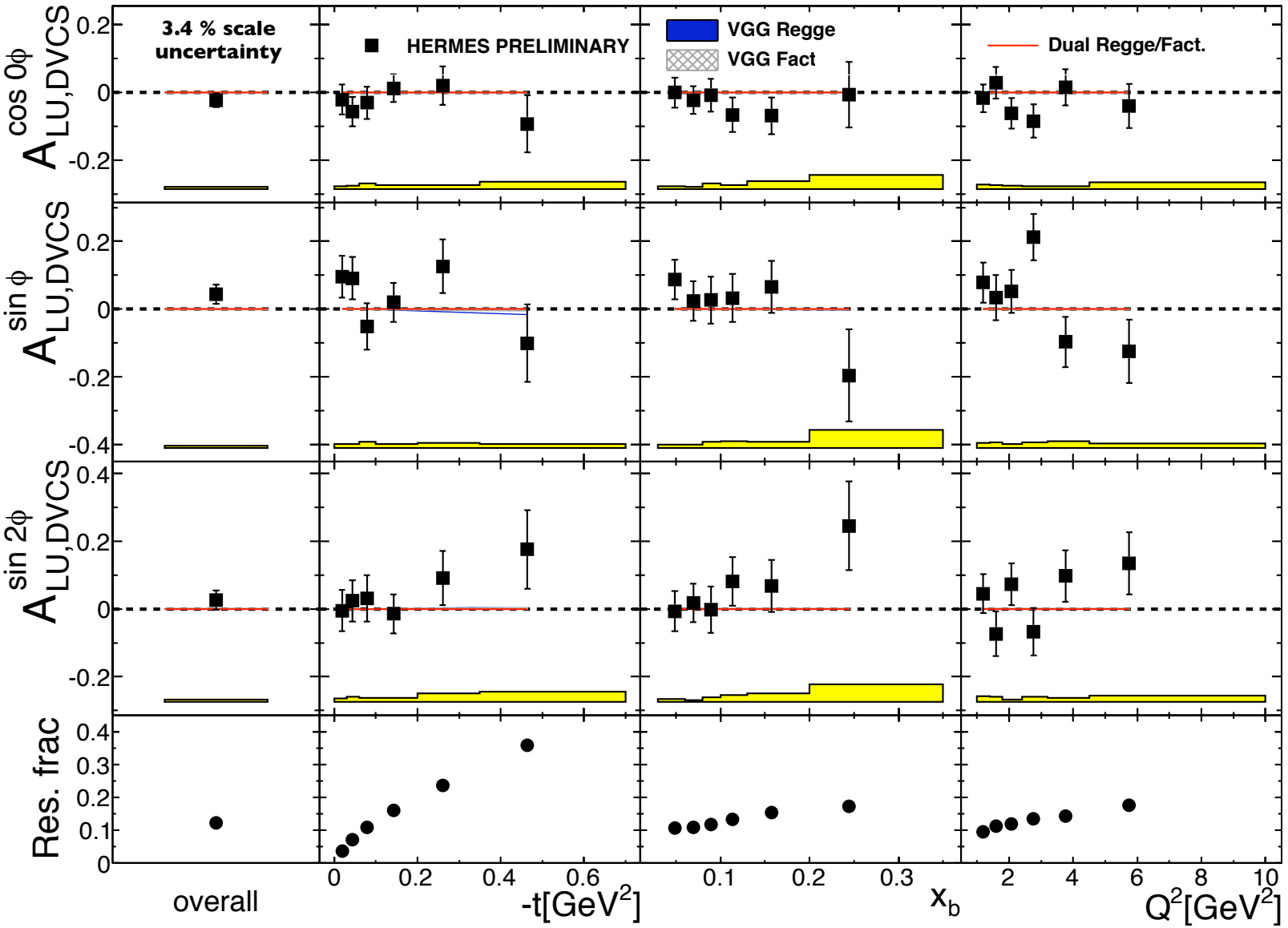
(higher twist)

(higher twist)

Bin-wise fractions of associated production.

The factorized ansatz and the VGG variant with the D-term is dis-favored by the beam charge asymmetry.

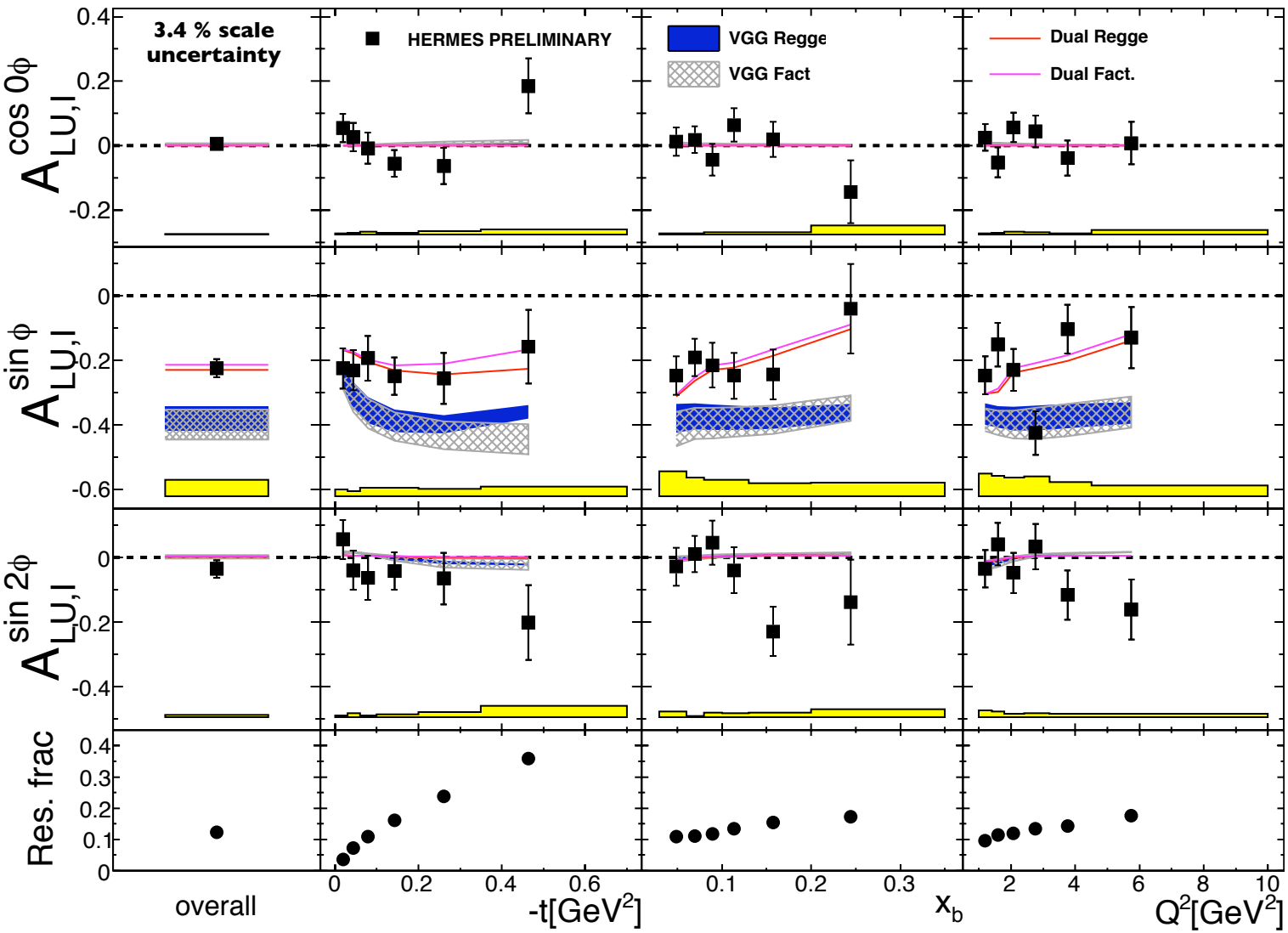
Beam Spin Asymmetries



(higher twist)

Pure DVCS squared asymmetries are compatible with zero, in agreement with model assumptions.

Beam Spin Asymmetries



$\propto Im[F_1\mathcal{H}]$

(higher twist)

Result agrees with Dual model predictions, but fractions of associated productions are not corrected for.

Summary

- HERMES released new preliminary results on BCA and BSA from a combined analysis on the proton with much more statistics than in previous publications.
- The BCA clearly disfavors all factorized model variants and the inclusion of a D-term in VGG.
- The BSA needs to be accounted for the associated production. The statistical precision allows for strong constraints on GPDs.
- In the 2006/2007 data the associated process can be separated with the information from the Recoil Detector.