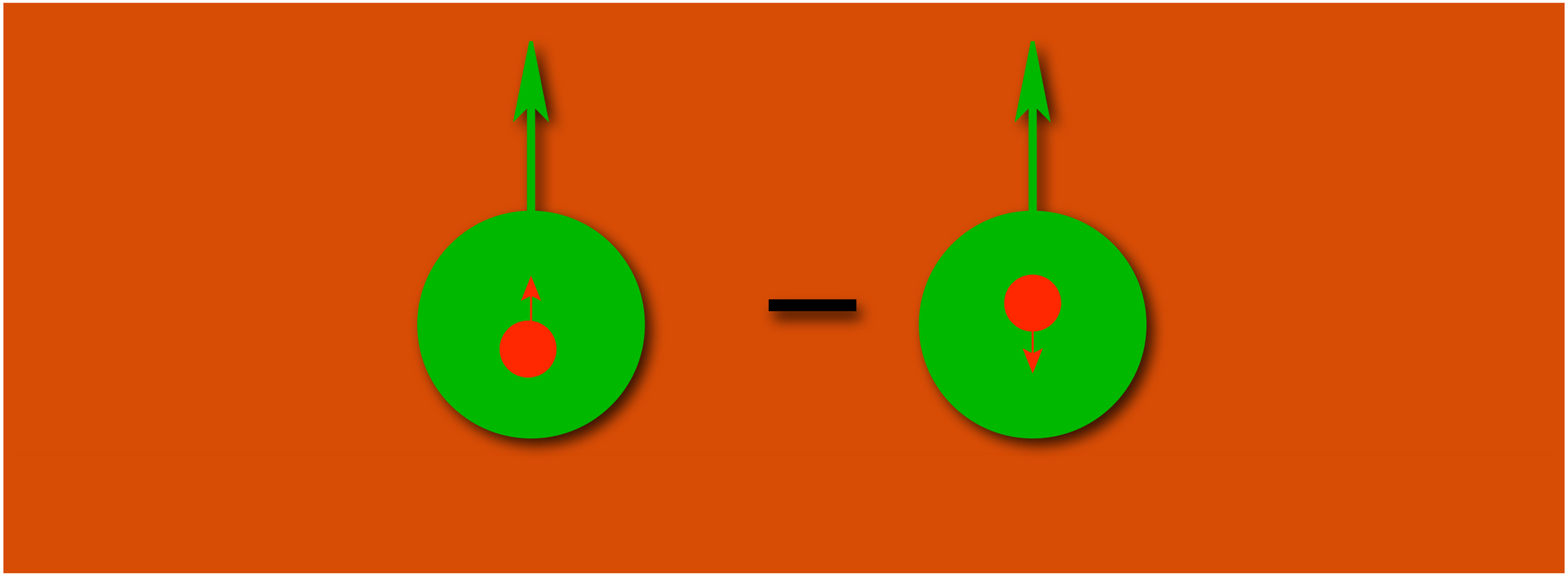
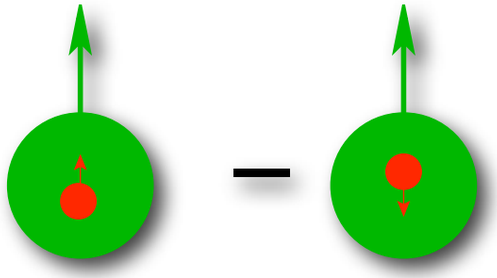


The Dihadron fragmentation functions way to Transversity

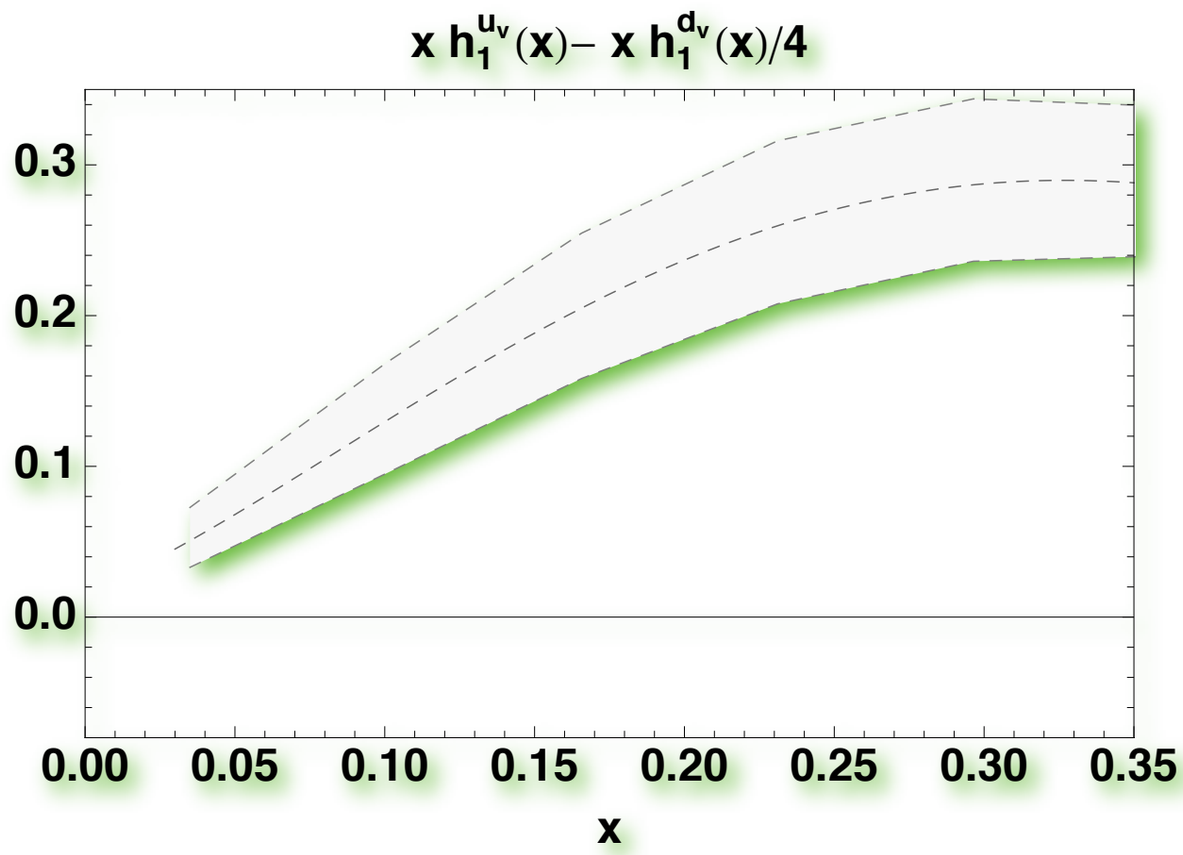
DIS 2011

Aurore Courtoy
INFN-Pavia

Outline



Transversity from pion pair production SIDIS off transversely polarized target



Torino group's transversity

in collaboration with Alessandro Bacchetta and Marco Radici in Pavia

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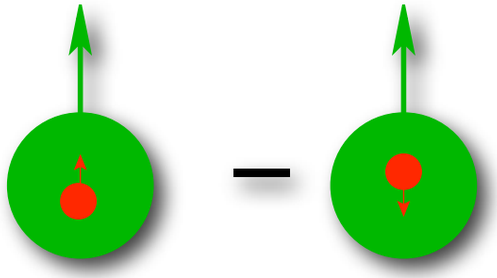
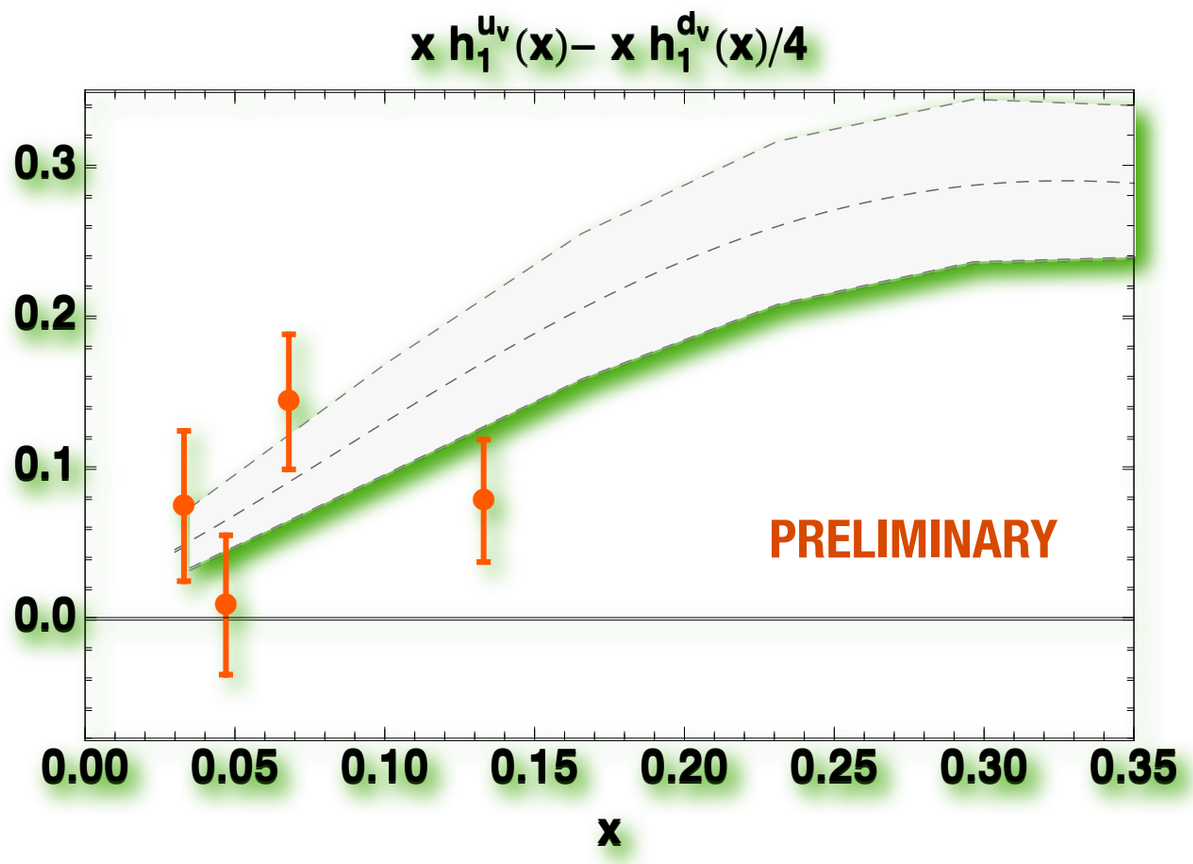


Transversity from pion pair production SIDIS off transversely polarized target

- from HERMES data
- DiFF analysis
  - from BELLE data
- $f_1(x)$ from MSTW



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Can Transversity Be Measured?

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- Drell-Yan → h_1 h_1
- Final State Interaction:
  - Single-Particle Fragmentation → $h_1 \otimes H_1^{\perp}$
  - Two-Particle Fragmentation → h_1 $H_1^{<}$

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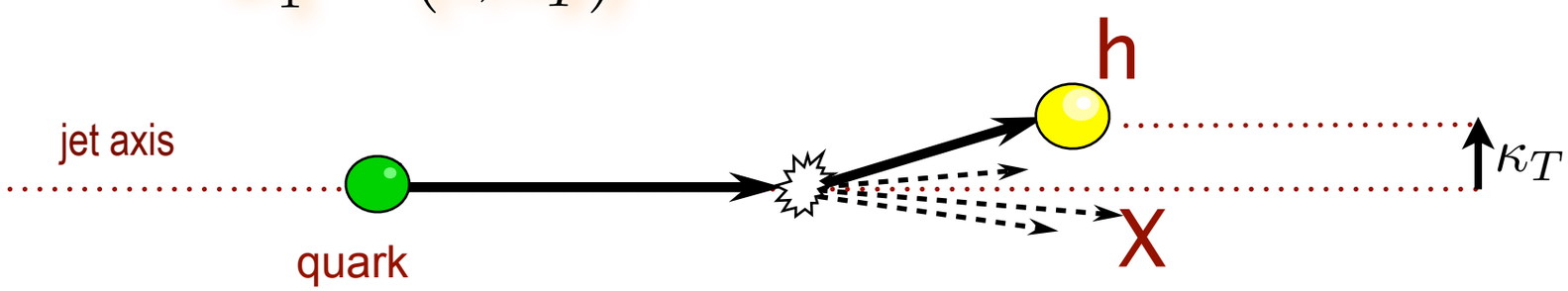
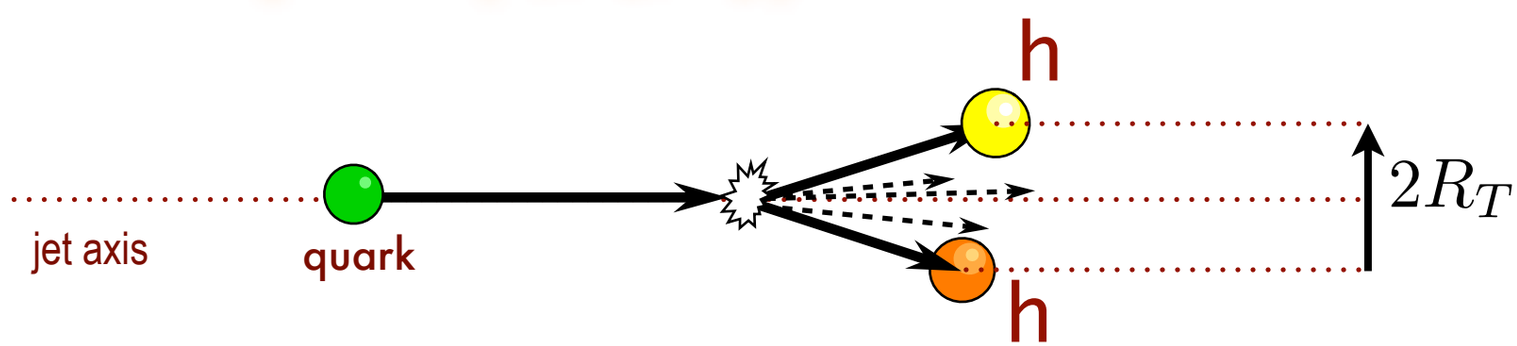
Transverse Correlations from Fragmentation Functions

✦ **TMD FF** $D_1^{q\to h}\left(z,\kappa_T^2\right)$



TMD factorization

✦ **DiFF** $D_1^{q\to h_1 h_2}\left(z_1,z_2,R_T^2\right)$



Collinear factorization

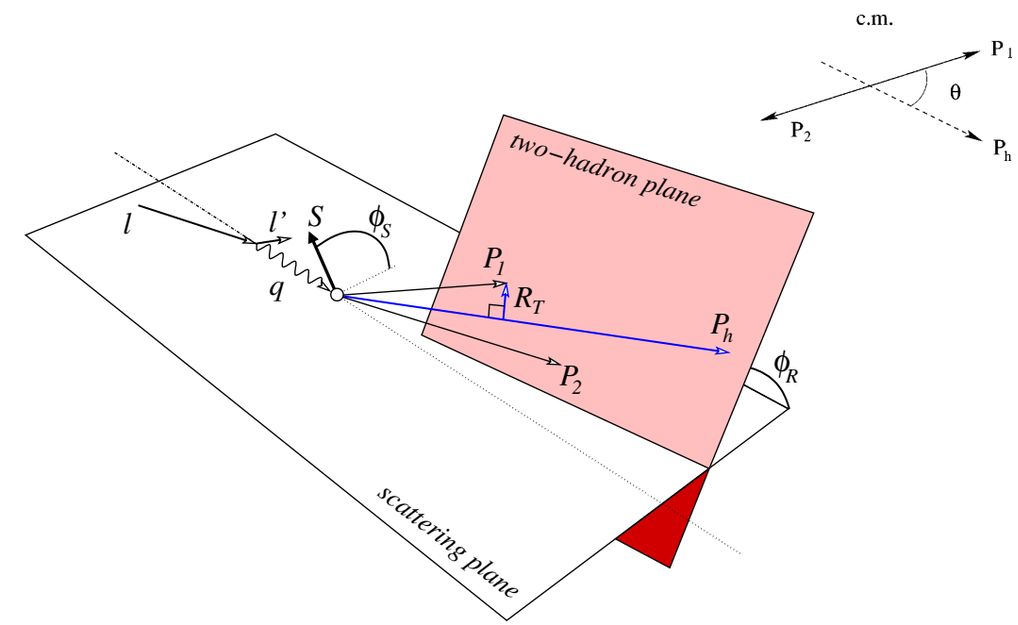
$A_{UT}^{\sin(\Phi_R+\Phi_S)\sin\theta}$:

$e\, p^{\uparrow} \to e'\, (\pi^+\pi^-)\, X$

Chiral-off DiFF:
Distribution of hadrons inside the jet

↓

Direction of
the transverse polarization of the fragmenting quarks



$$A_{\rm DIS}(x,z,M_h^2,Q^2) = -C_y\, \frac{\sum_q e_q^2\, h_1^q(x,Q^2)\, \frac{|\bar{R}|}{M_h}\, H_{1,sp}^{q\to\pi^+\pi^-}(z,M_h^2,Q^2)}{\sum_q e_q^2\, f_1^q(x,Q^2) \quad D_1^{q\to\pi^+\pi^-}(z,M_h^2,Q^2)}$$

$A_{UT}^{\sin(\Phi_R+\Phi_S)\sin\theta}$:

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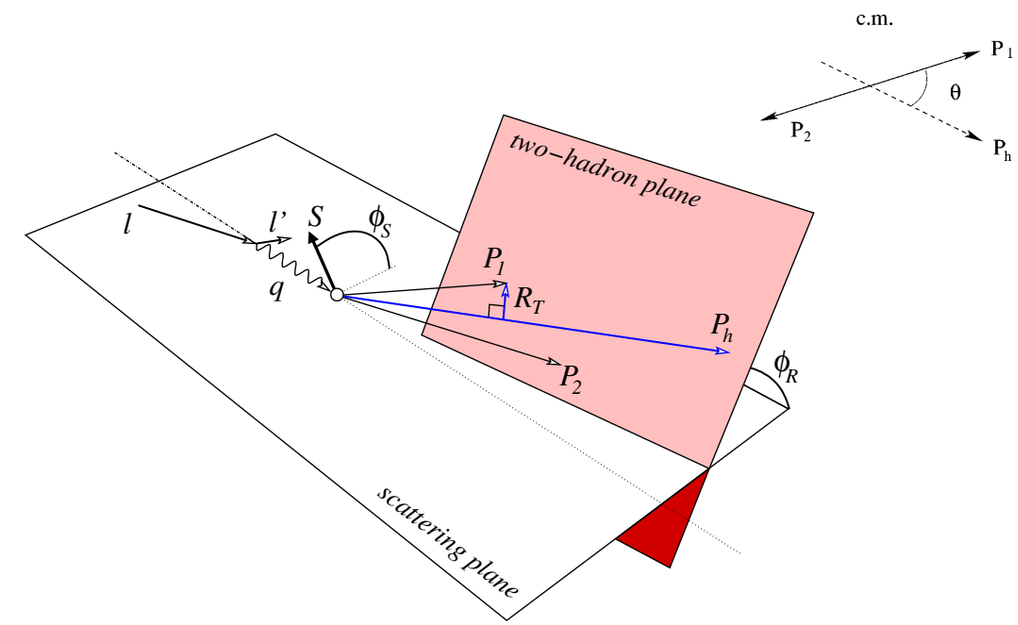
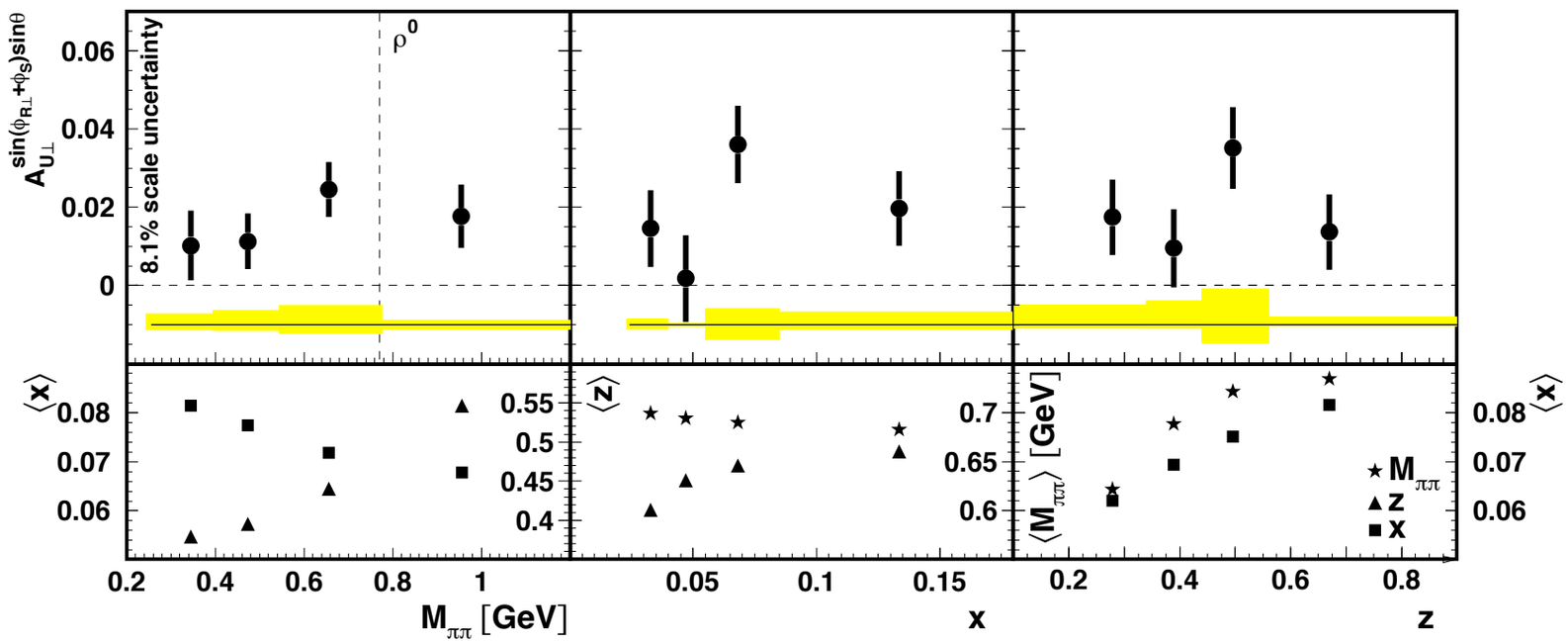


$$A_{\rm DIS}(x,z,M_h^2,Q^2) = -C_y \frac{\sum_q e_q^2\, h_1^q(x,Q^2)}{\sum_q e_q^2\, f_1^q(x,Q^2)} \frac{|\bar{R}|}{M_h} \frac{H_{1,sp}^{q\to\pi^+\pi^-}(z,M_h^2,Q^2)}{D_1^{q\to\pi^+\pi^-}(z,M_h^2,Q^2)}$$

Knowledge on DiFFs leads to $h_1(x, Q^2)$

$A_{UT}^{\sin(\Phi_R+\Phi_S)\sin\theta}$ @ HERMES

[JHEP 06, 017 (2008)]



- integrated over 0.5<Mh<1GeV
- integrated over 0.2<z<1

$$n_q(Q^2) \quad = \int dz\, dM_h^2\, D_1^{q\to\pi^+\pi^-}(z, M_h^2, Q^2)$$

$$A_{\rm DIS}(x,Q^2) = -C_y \frac{\sum_q e_q^2\, h_1^q(x,Q^2)\, n_q^{\uparrow}(Q^2)}{\sum_q e_q^2\, f_1^q(x,Q^2)\, n_q(Q^2)}$$

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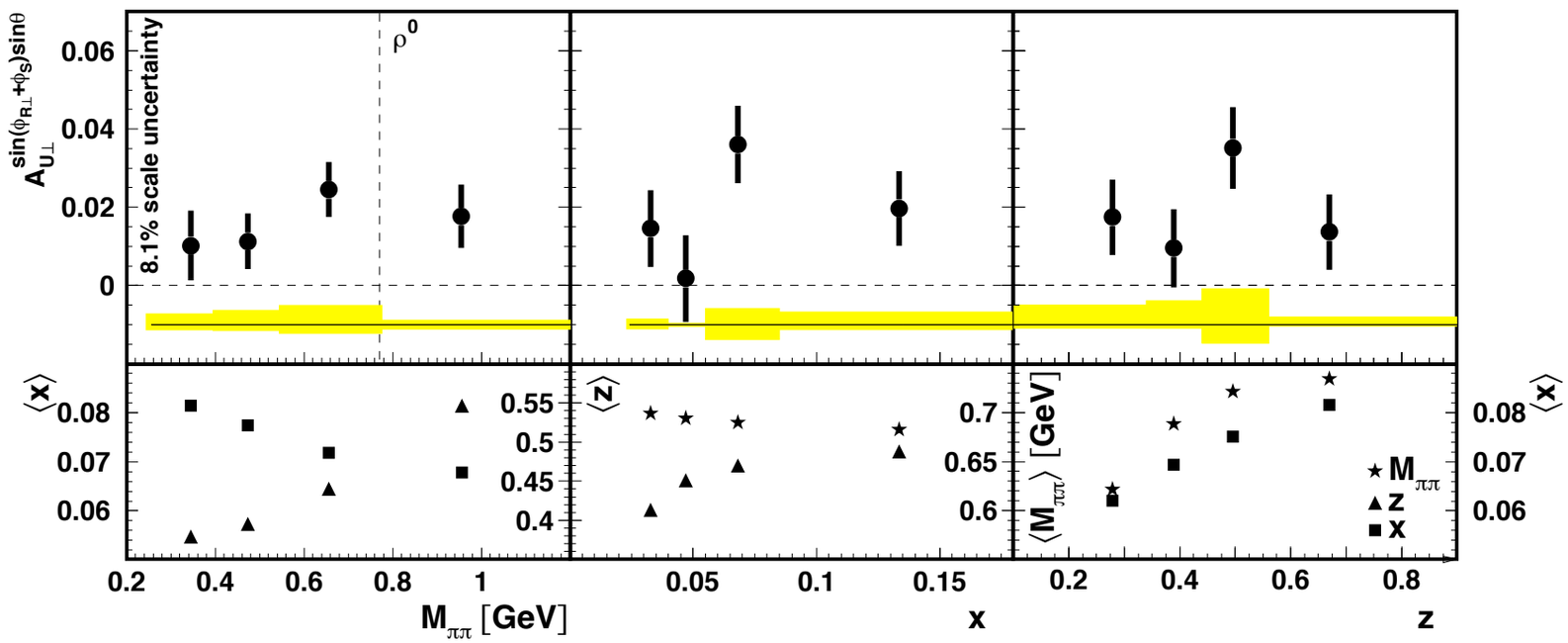

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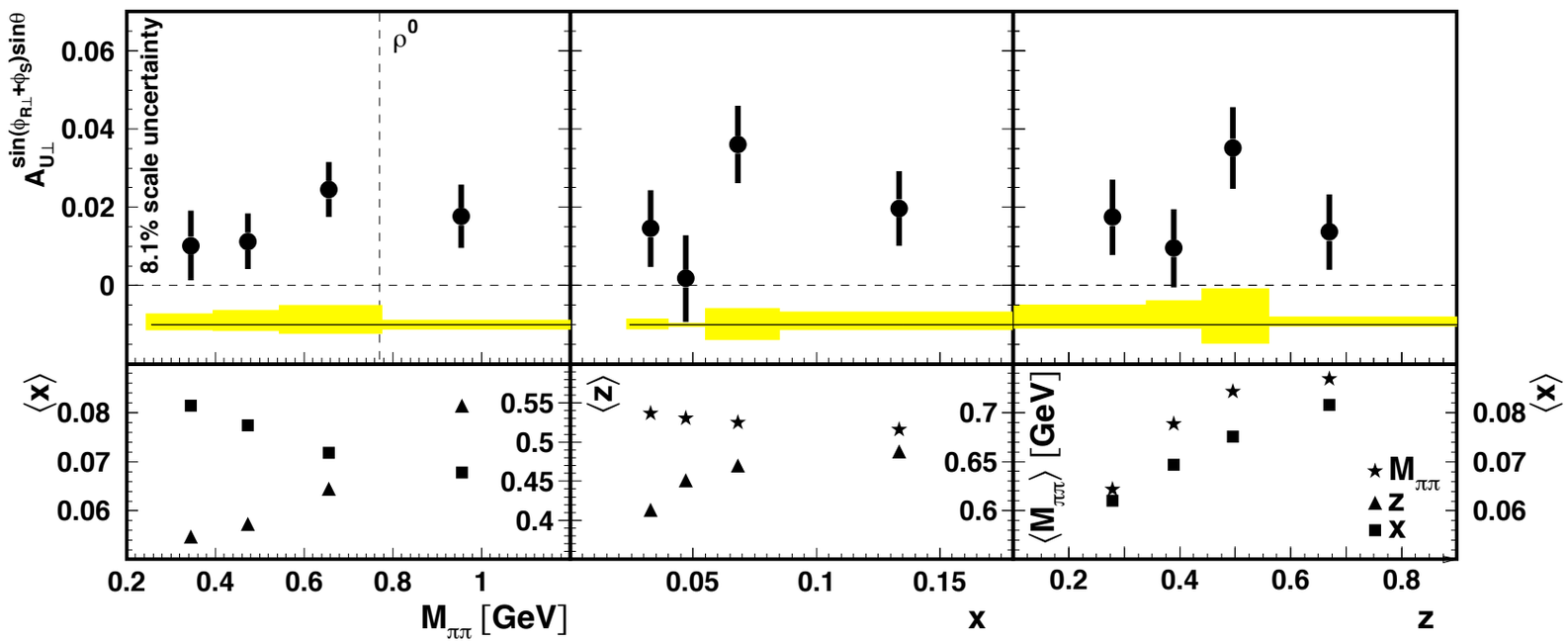

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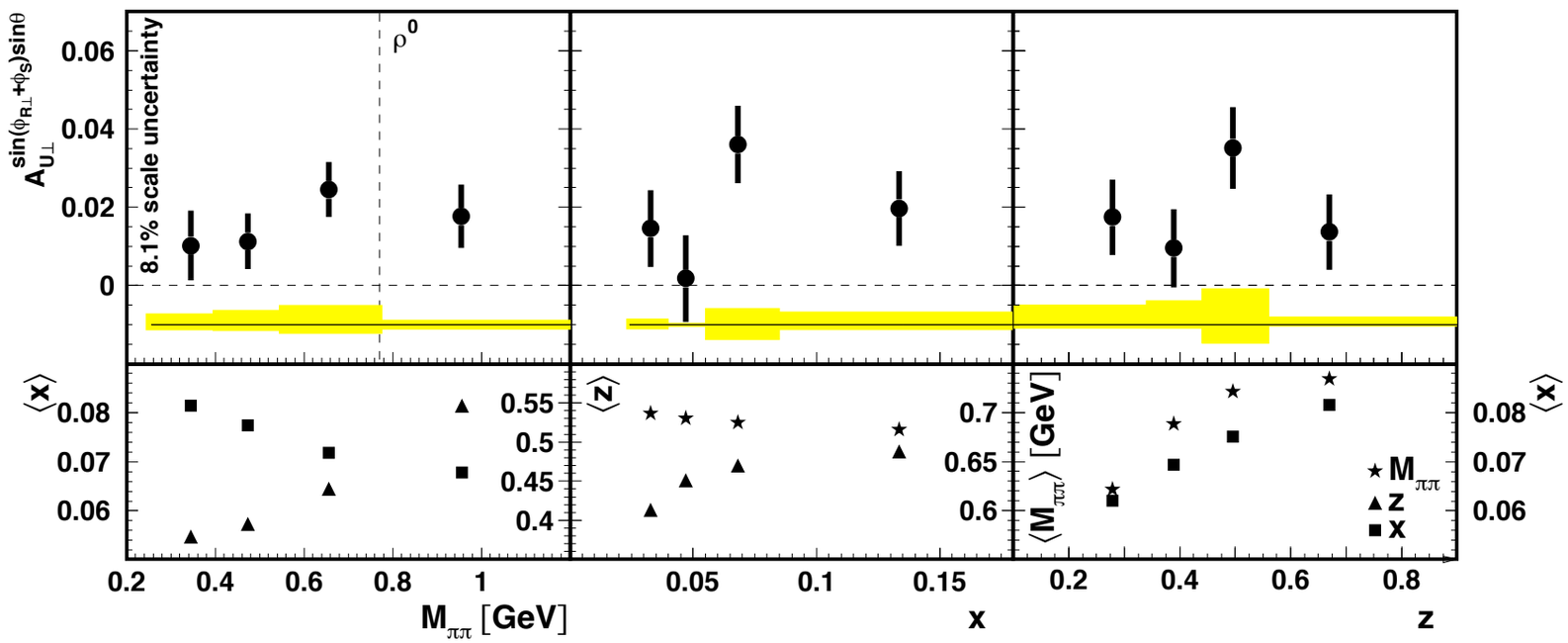

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$$x h_1^{u_v}(x,Q^2) - \tfrac{1}{4}\, x h_1^{d_v}(x,Q^2) = -C_y^{-1} \, A_{\rm DIS}(x,Q^2) \, \frac{n_u(Q^2)}{n_u^{\uparrow}(Q^2)} \sum_{q=u,d,s} \frac{e_q^2}{e_u^2} \, x f_1^{q+\bar{q}}(x,Q^2)$$

$A_{UT}^{\sin(\Phi_R+\Phi_S)\sin\theta}$ @ HERMES

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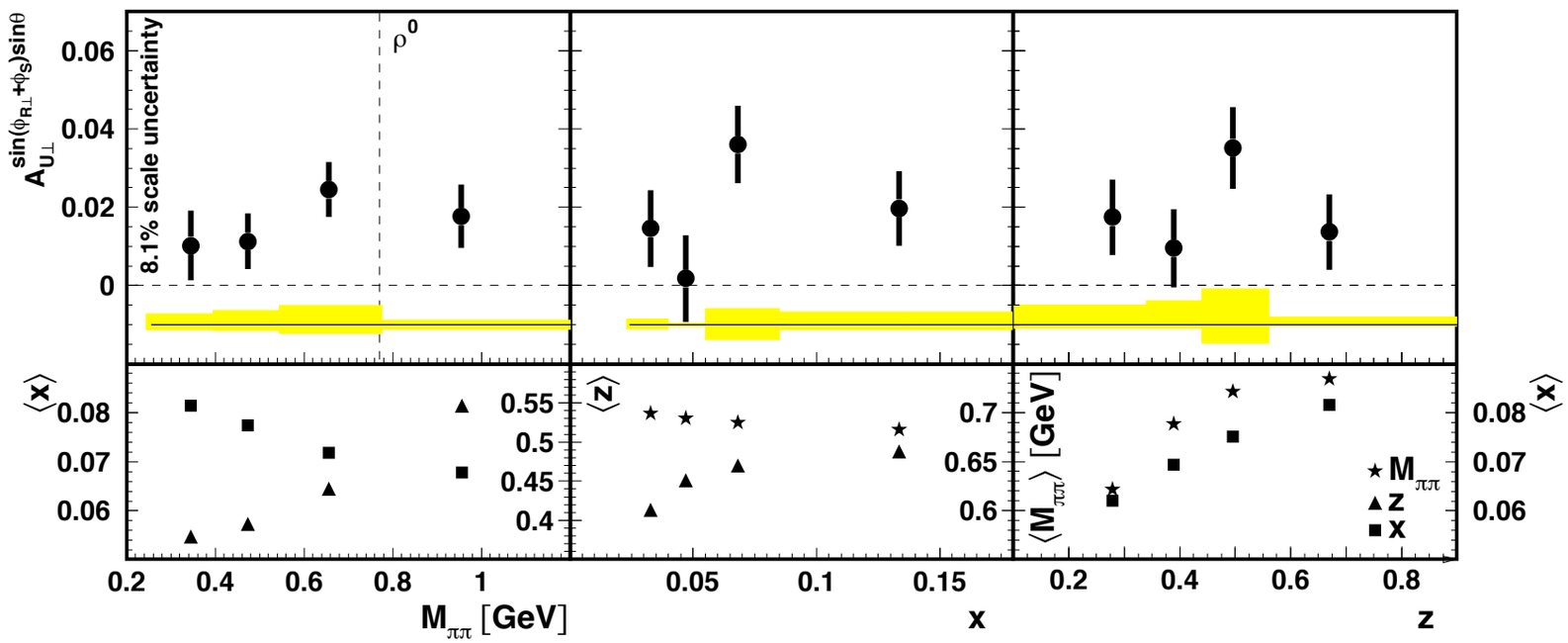

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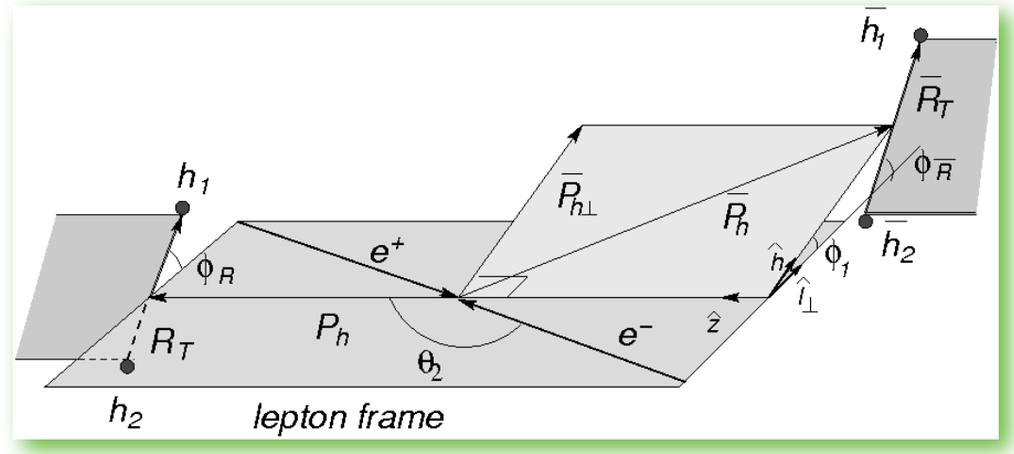
$A^{\cos(\Phi_R+\Phi_{\check{R}})}$

$e^+e^- \to (\pi^+\pi^-)_{jet1}\ (\pi^+\pi^-)_{jet2}\ X$ @ Belle

See A. Vossen's talk

[arXiv:1104.2425]



$$A_{e+e-}(z, M_h^2, \bar{z}, \bar{M}_h^2, Q^2)$$
$$= -\frac{\langle \sin^2\theta_2 \rangle}{\langle 1+\cos^2\theta_2 \rangle} \frac{\langle \sin\theta \rangle \langle \sin\bar{\theta} \rangle\, 5\, \frac{|\bar{R}|}{M_h}\, H_1^{\sphericalangle\, u}(z, M_h^2, Q^2)\, \frac{|\bar{\bar{R}}|}{\bar{M}_h}\, H_1^{\sphericalangle\, u}(\bar{z}, \bar{M}_h^2, Q^2)}{6\, D_1^u(z, M_h^2, Q^2)\, D_1^u(\bar{z}, \bar{M}_h^2, Q^2) + 4\, D_1^c(z, M_h^2, Q^2)\, D_1^c(\bar{z}, \bar{M}_h^2, Q^2)}$$

- 2 hemispheres
- azimuthal modulation between the 2 hemispheres

$A^{\cos(\Phi_R+\Phi_{\check{R}})}$

$e^+e^- \to (\pi^+\pi^-)_{jet1}\ (\pi^+\pi^-)_{jet2}\ X$ @ Belle

From Belle data (in particular M_{h1}-M_{h2} asymmetries):

0.871

-0.0307±0.0011

$$(A_{e+e-})_H = -\frac{\langle \sin^2\theta_2 \rangle}{\langle 1+\cos^2\theta_2 \rangle}\,\frac{\langle \sin\theta \rangle \langle \sin\bar{\theta} \rangle\, 5\,(n_u^{\uparrow})^2}{6\,(n_u)^2 + 4\,(n_c)^2}$$

$4\,n_c^2/6\,n_u^2=0.415$

0.753

PRELIMINARY

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$$\frac{n_u^{\uparrow}(Q^2)}{n_u(Q^2)} = -0.276 \pm 0.007_{\rm exp} \pm 0.006_{\rm theo}$$

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PRELIMINARY

Evolution effects :

Hermes'scale

$$\frac{n_u^{\uparrow}(Q^2)}{n_u(Q^2)} = -0.304 \pm 0.008_{\rm exp} \pm 0.021_{\rm theo}$$

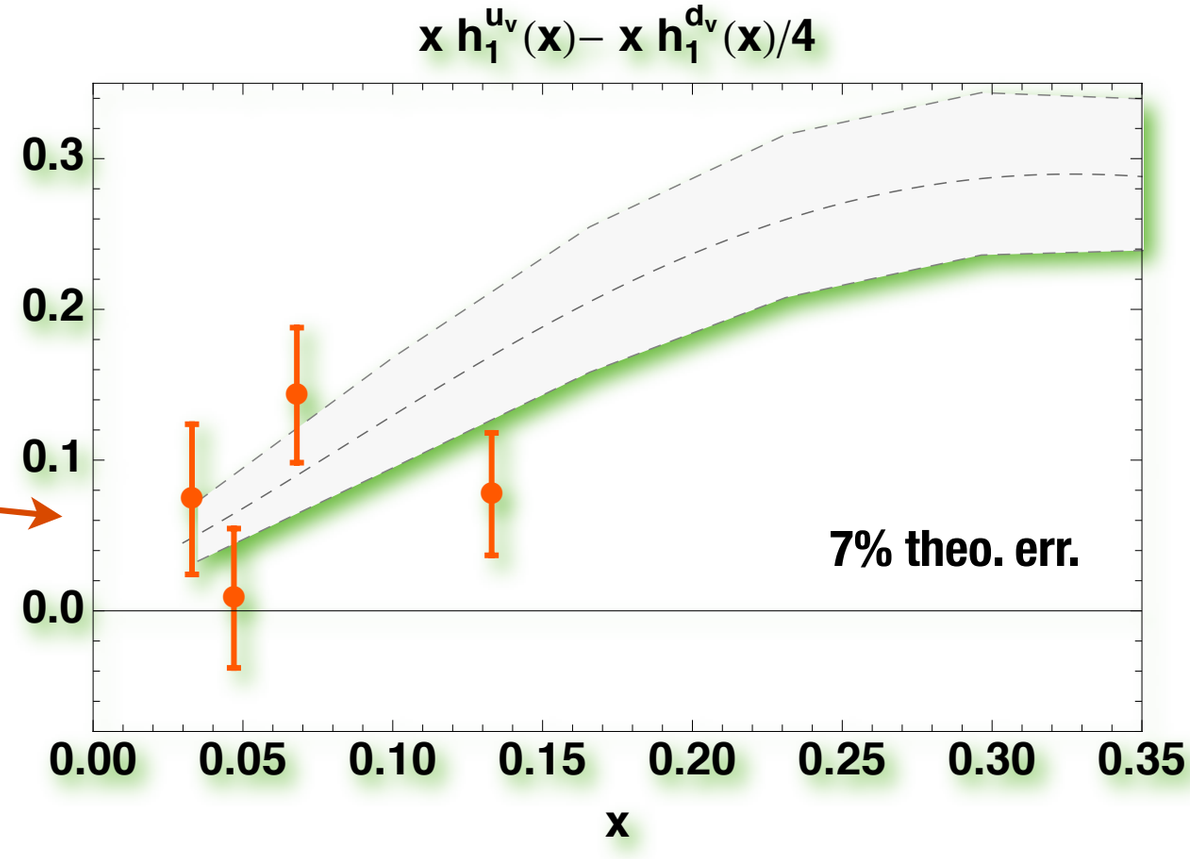
needs analytical expression and gluon DiFF

Transversity from e p$^{\uparrow}$ → e' ($\pi^+\pi^-$) X @ HERMES

$$xh_1^{u_v}(x,Q^2) - \tfrac{1}{4}\,xh_1^{d_v}(x,Q^2) = -C_y^{-1}\,A_{\rm DIS}(x,Q^2)\,\frac{n_u(Q^2)}{n_u^{\uparrow}(Q^2)}\sum_{q=u,d,s}\frac{e_q^2}{e_u^2}\,x f_1^{q+\bar{q}}(x,Q^2)$$

-0.304^{-1} (± 7% theo. err.) from BELLE

1st extraction
in
collinear factorization
framework



Anselmino *et al.*

PRELIMINARY

Outlook

- **Transversity via DiFF**
  - **COMPASS** data for pion pair production in DIS off transversely pol. target

    to be published soon ?

  - **CLAS12** ππ, Kπ, KK production in DIS off ***transversely*** pol. target **?**

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- **Higher-twist PDFs via DiFF**
  - **CLAS** ππ, Kπ, KK production in DIS