Impact projections on uncertainty of transversity from EIC di-hadron channel

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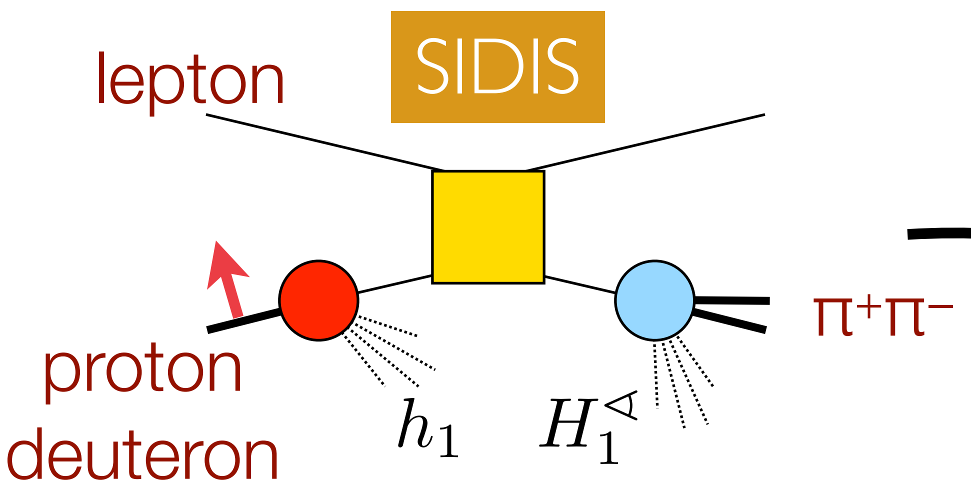
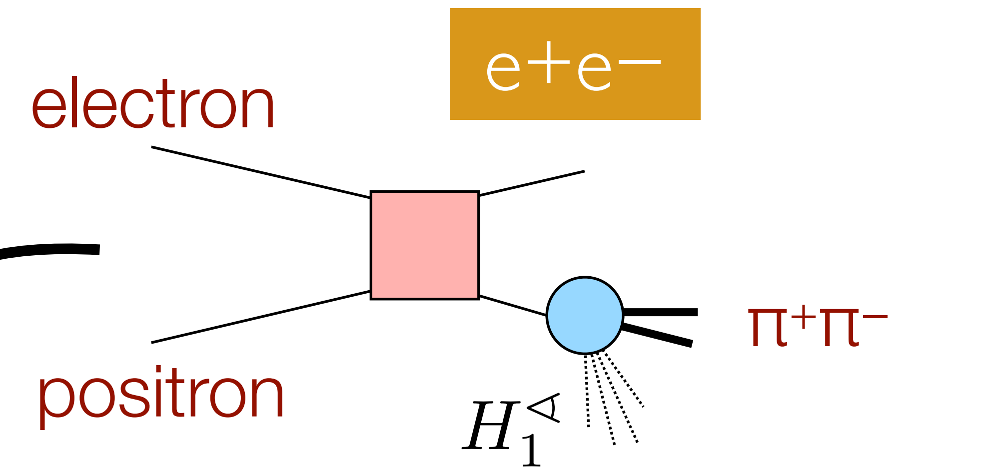
for the “Pavia group”

(published) reference situation





hermes

*Airapetian et al., JHEP **0806** (08) 017*

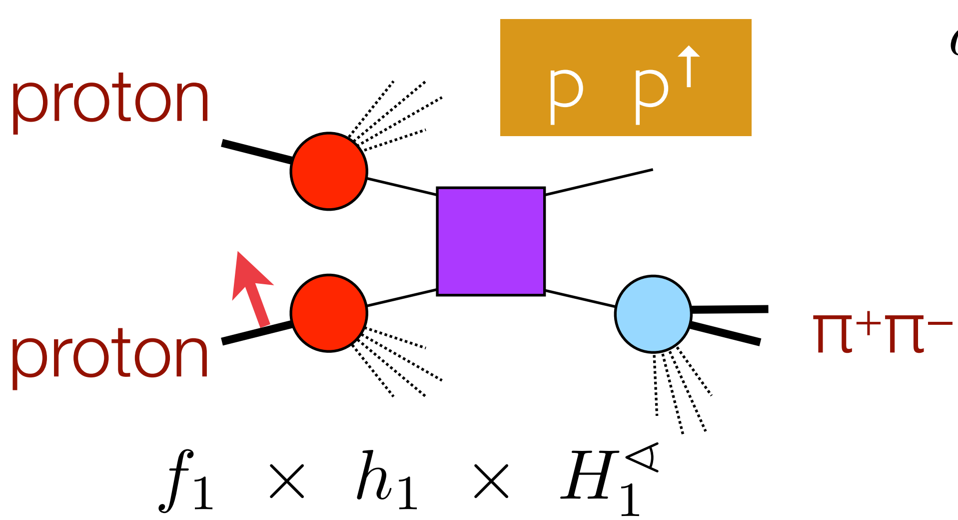
COMPASS

*Adolph et al., P.L. **B713** (12)*
*Braun et al., E.P.J. Web Conf. **85** (15) 02018*

$$A_{\rm SIDIS}^{\sin(\phi_R+\phi_S)}(x,z,M_h^2) \sim -\frac{\sum_q e_q^2\; h_1^q(x)\;\frac{|\boldsymbol{R}_T|}{M_h}\; H_{1,q}^{\sphericalangle}(z,M_h^2)}{\sum_q e_q^2\; f_1^q(x)\; D_{1,q}(z,M_h^2)}$$

*Vossen et al., P.R.L. **107** (11) 072004*

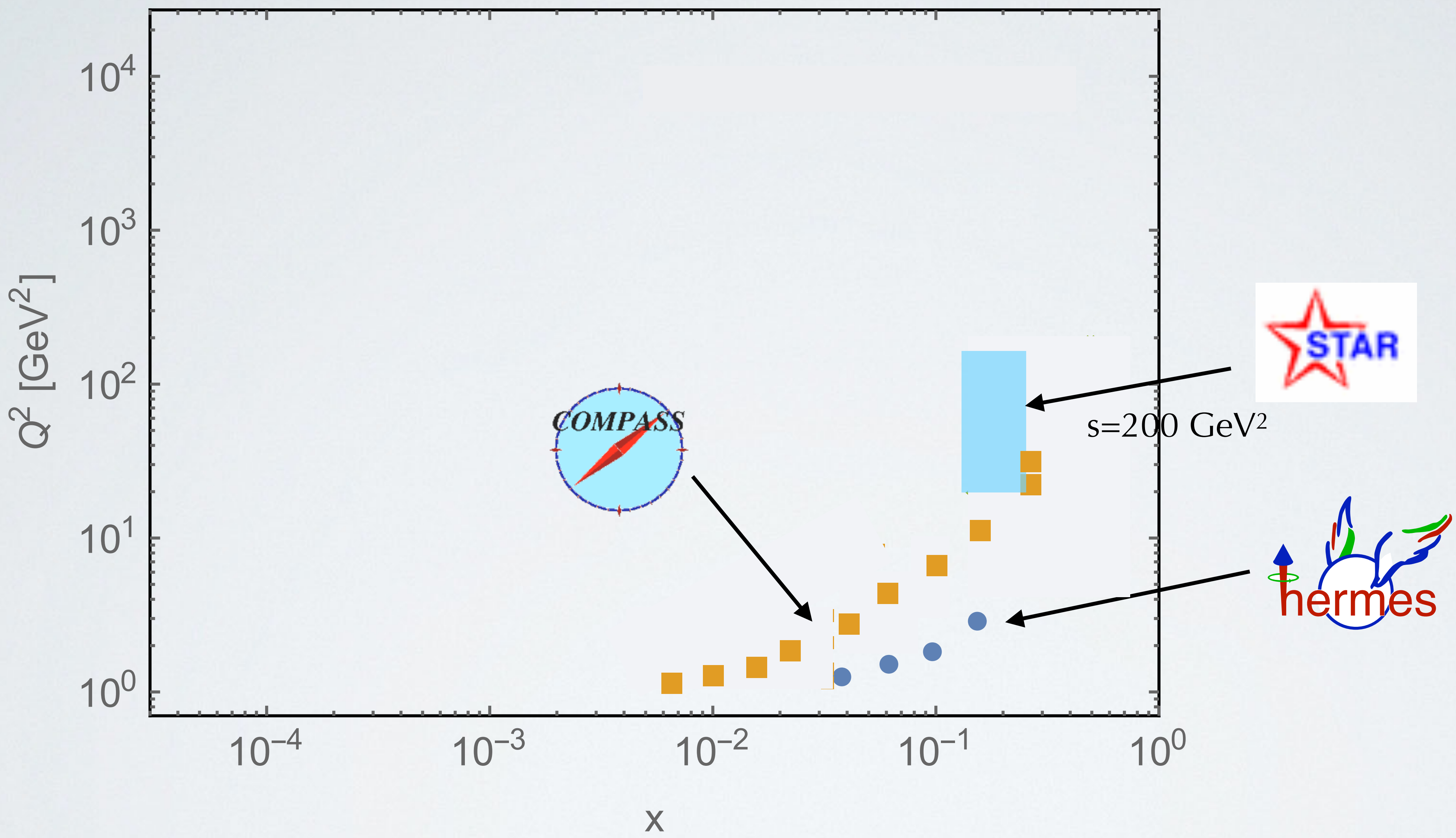
$$\frac{d\sigma_{UT}}{d\sigma_{UU}} \propto \frac{\sum_{a,b,c,d}\int \frac{dx_a dx_b}{8\pi^2\bar{z}}\; f_1^a(x_a)\, h_1^b(x_b)\; \frac{d\hat{\sigma}_{ab^\uparrow\to c^\uparrow d}}{d\hat{t}}\; H_1^{\sphericalangle\, c}(\bar{z},M_h)}{\cdots \qquad f_1^a \qquad f_1^b \qquad \frac{d\hat{\sigma}_{ab\cdot\to c\cdot d}}{d\hat{t}}\; D_1^c}$$



STAR
run 2006
(s=200 GeV[2])
*Adamczyk et al. (STAR), P.R.L. **115** (15) 242501*

efficient fit requires Mellin transform

the phase space



functional form fulfills Soffer bound

functional form whose Mellin transform can be computed analytically and complying with Soffer Bound at any x and scale Q^2

$$h_1^{q_v}(x;Q_0^2) = F^{q_v}(x) \left[\mathrm{SB}^q(x) + \overline{\mathrm{SB}}^{\bar{q}}(x)\right]$$

Soffer Bound

$$2|h_1^q(x,Q^2)| \leq 2\ \mathrm{SB}^q(x,Q^2) = |f_1^q(x,Q^2) + g_1^q(x,Q^2)|$$

MSTW08 DSSV

$$F^{q_v}(x) = \frac{N_{q_v}}{\max_x[|F^{q_v}(x)|]} x^{A_{q_v}} \left[1 + B_{q_v}\,\mathrm{Ceb}_1(x) + C_{q_v}\,\mathrm{Ceb}_2(x) + D_{q_v}\,\mathrm{Ceb}_3(x)\right]$$

$\mathrm{Ceb}_n(x)$ Cebyshev polynomial

10 fitting parameters

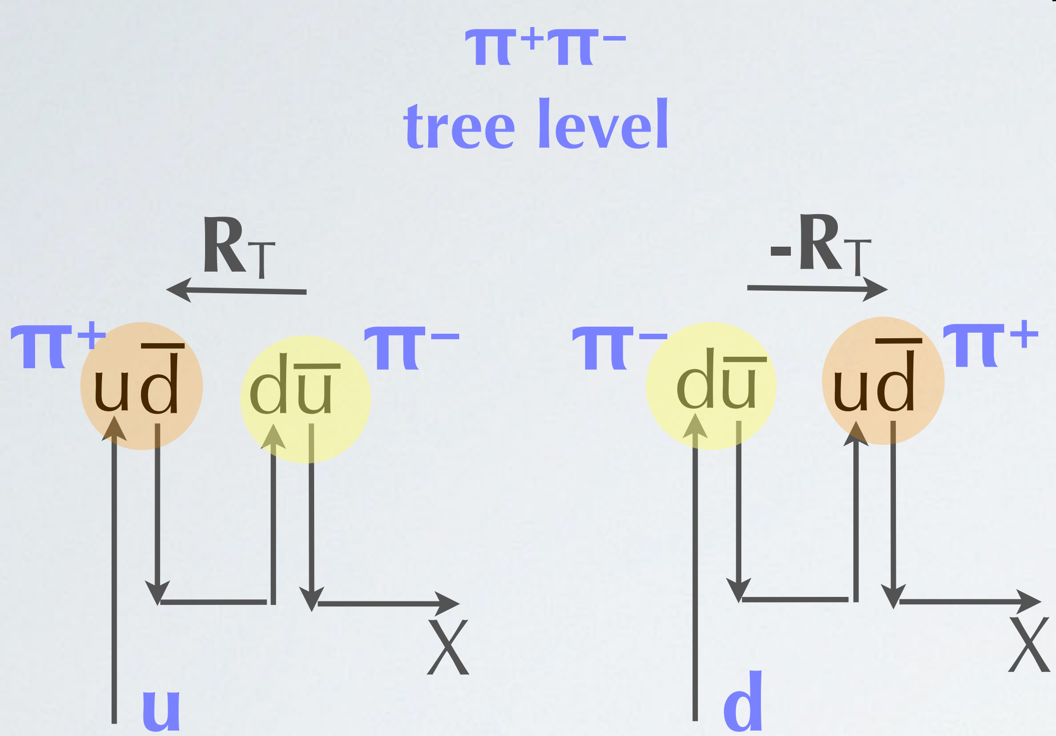
<u>constrain parameters</u>

$|N_{q_v}| \leq 1 \Rightarrow |F^{q_v}(x)| \leq 1$ Soffer Bound ok at any Q^2

$h_1^q(x) \overset{x\to 0}{\approx} x^{A_q + \mathrm{const}}$ such that tensor charge is finite

currently, only LO analysis

$$A_{UT}^{\sin(\phi_R+\phi_S)}(x,z,M_h^2) \propto -\frac{|\mathbf{R}|}{M_h}\,\frac{\sum_q e_q^2\, h_1^q(x)\; H_1^{\sphericalangle q}(z,M_h^2)}{\sum_q e_q^2\, f_1^q(x)\; D_1^q(z,M_h^2)}$$



$$\begin{aligned} H_1^{\sphericalangle u} &= -H_1^{\sphericalangle d} && \text{isospin symmetry} \\ H_1^{\sphericalangle q} &= -H_1^{\sphericalangle \bar{q}} \\ D_1^q &= D_1^{\bar{q}} \end{aligned}$$

} charge conjugation

access only $q\text{-}\bar{q} = q_v$, q=u,d
valence flavors in SIDIS A_{UT}

theoretical uncertainties

unpolarized Di-hadron Fragmentation Function D_1

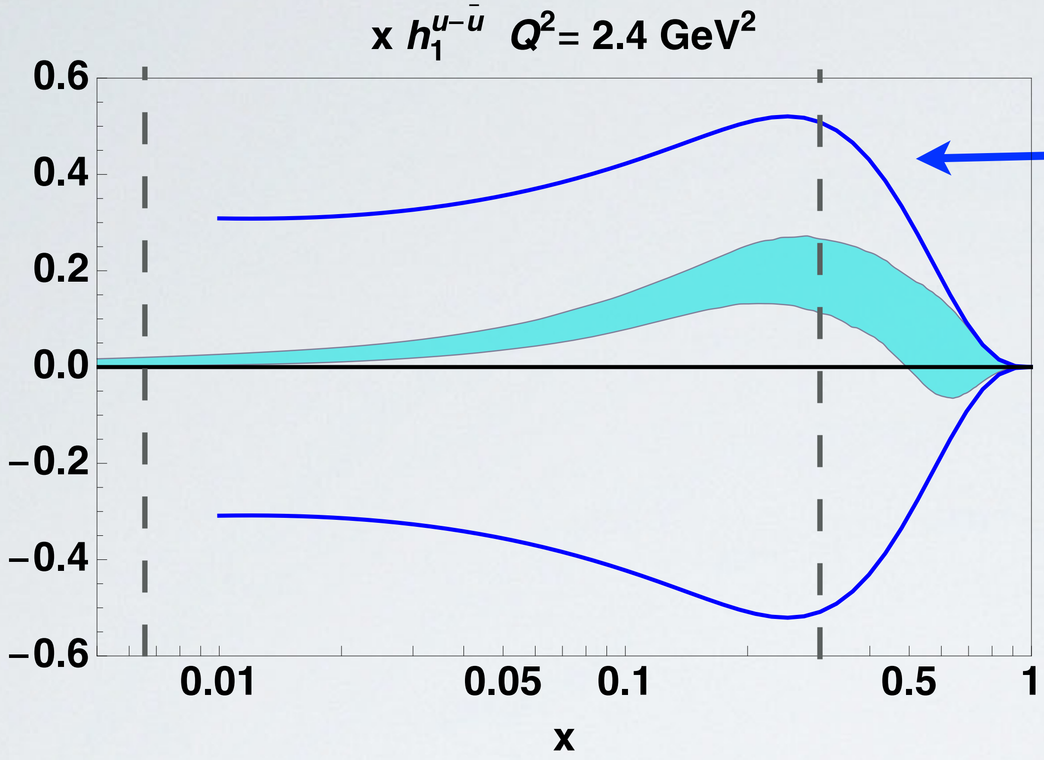
- **quark** D_1^q is **well** constrained by $e^+e^- \to (\pi^+\pi^-)\,X$ (Montecarlo)
- **gluon** D_1^g is **not** constrained by $e^+e^- \to (\pi^+\pi^-)\,X$ (currently, LO analysis)
- **no data** available yet for $p\,p \to (\pi^+\pi^-)\,X$

we don't know anything about the gluon D_1^g

our choice: set $D_1^g(Q_0) = \begin{cases} 0 \\ D_1^u(Q_0)/4 \\ D_1^u(Q_0) \end{cases}$ ← ~ 1-hadron $D_1^g(Q_0)$

Hermes + Compass + STAR

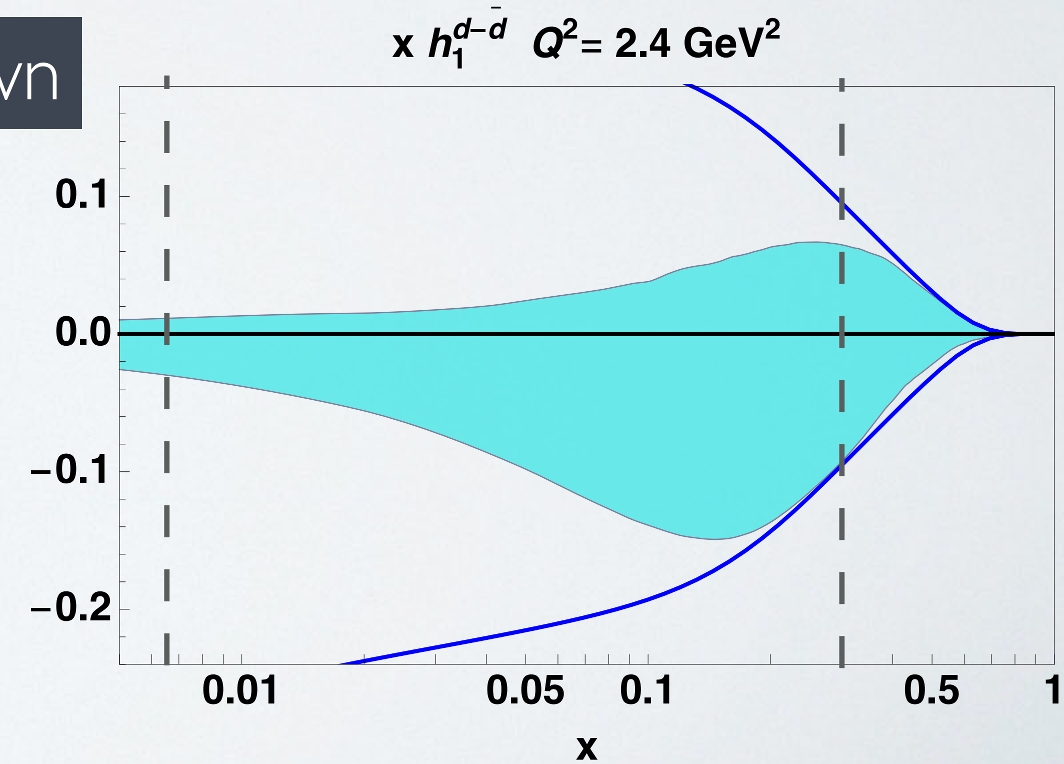
up



Soffer bound

uncertainty band from
90% of 600 replicas =
max uncertainty on $D_1^g(Q_0)$

down



assumptions for fit of EIC pseudodata

SIDIS

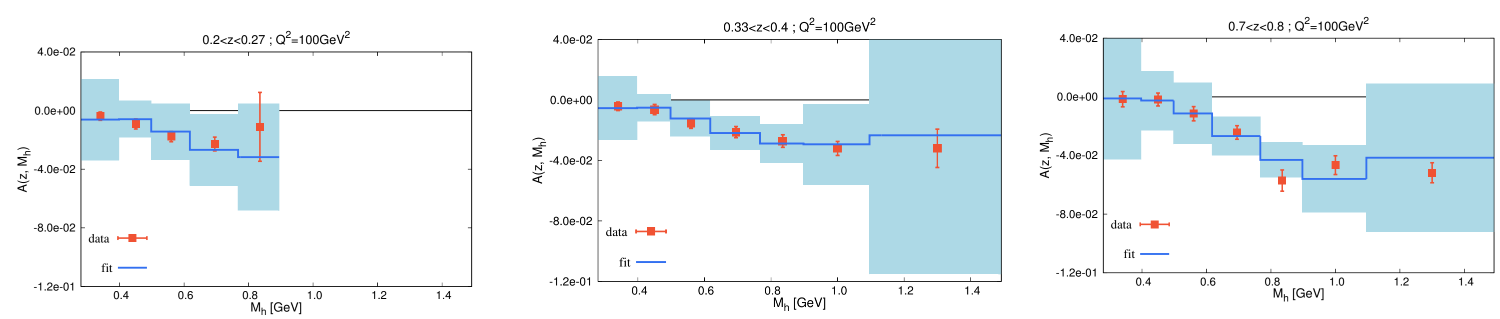
$$A_{\text{SIDIS}}^{\sin(\phi_R+\phi_S)}(x,z,M_h^2) \sim -\frac{\sum_q e_q^2\ h_1^q(x)\ \frac{|\boldsymbol{R}_T|}{M_h}\ H_{1,q}^{\sphericalangle}(z,M_h^2)}{\sum_q e_q^2\ f_1^q(x)\ D_{1,q}(z,M_h^2)}$$

- full analysis would require simultaneous fit of h_1 and D_1, $H_1^{\sphericalangle}$: not enough time by the Yellow Report deadline !

Alternative

- insert D_1, $H_1^{\sphericalangle}$ from published fit, interpolated in the (Q, z, $M_{\pi+\pi-}$) EIC grid, and fit EIC pseudodata with a variable functional form for h_1 only
- assume $\Delta f_1 = \Delta D_1 \sim 0$ (D_1 obtained by fitting Belle MC => unlimited precision) hence $\Delta h_1 \propto \Delta H_1^{\sphericalangle}$
- assume that precision of EIC pseudodata would reduce $\Delta H_1^{\sphericalangle}$ => 1/3 $\Delta H_1^{\sphericalangle}$ and compute projections on reduction of Δh_1

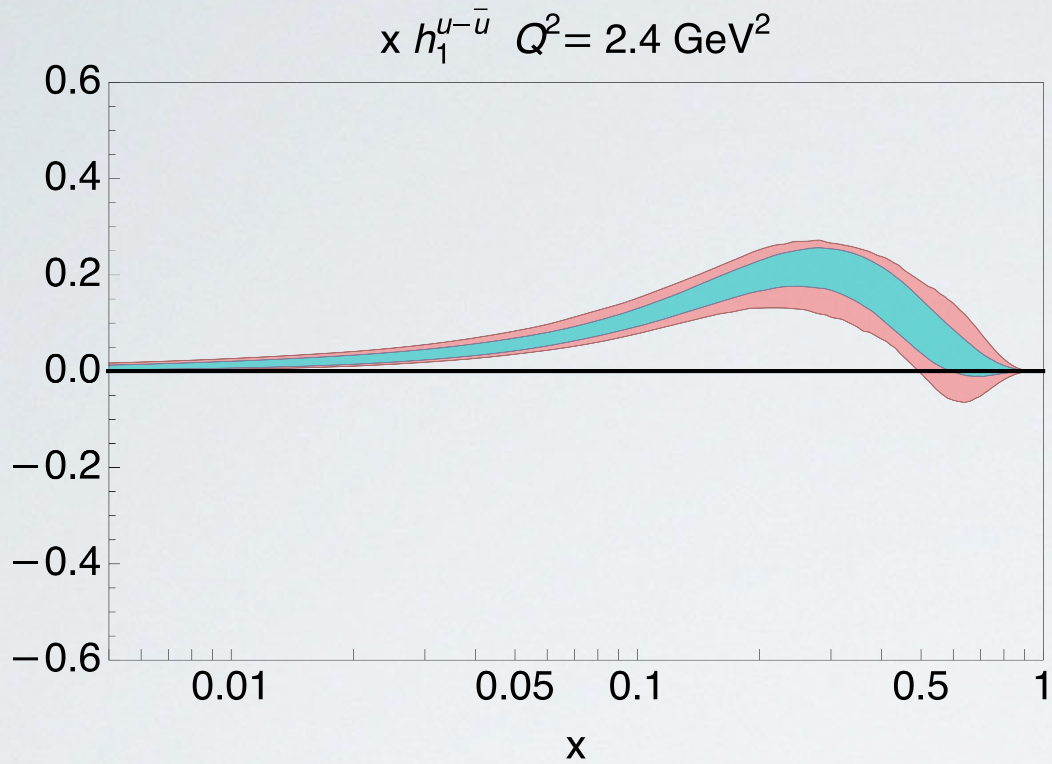
$\Delta H_1^{\sphericalangle}$ ($M_{\pi+\pi-}$) for various z bins



*Courtoy et al., P.R. D**85** (12) 114023*

Hermes + Compass + STAR + EIC 10x100 proton

up



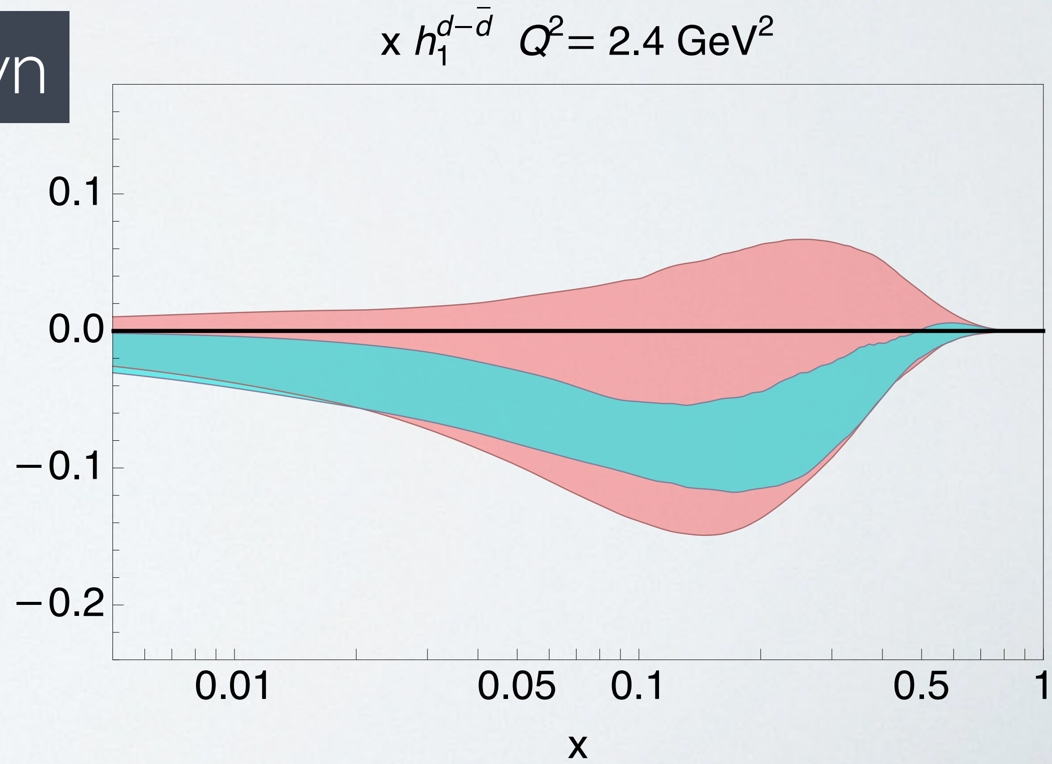
uncertainty band from
90% of 600 replicas =
max uncertainty on $D_1^g(Q_0)$

published fit

+ EIC 10x100 proton

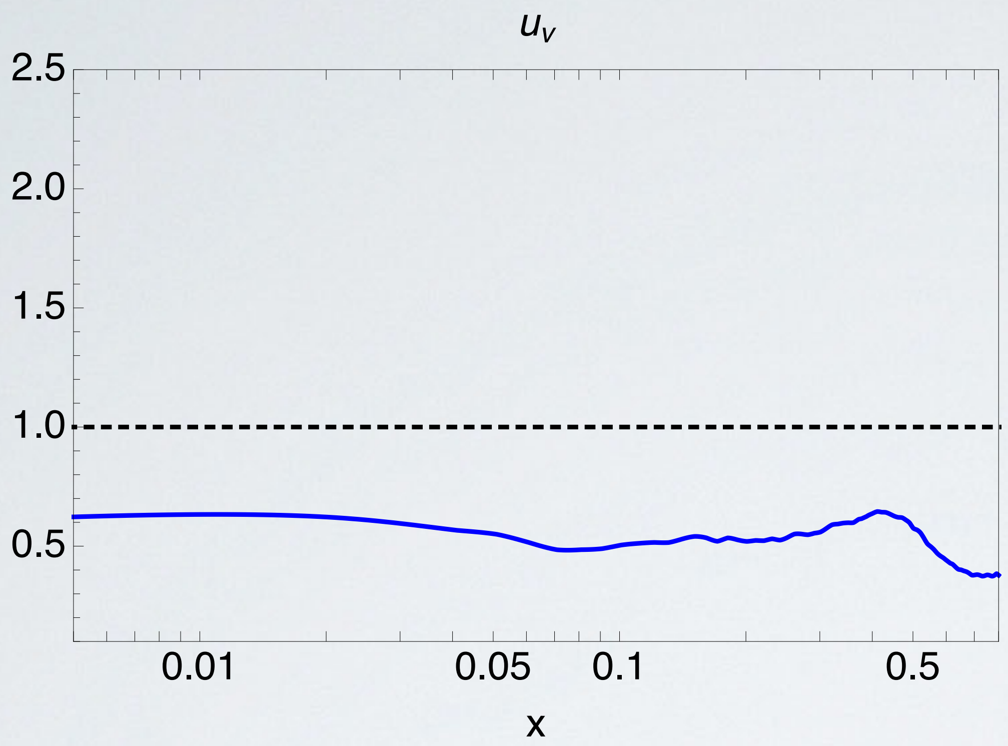
EIC 10x100 ^{3}He
is running…

down



Hermes + Compass + STAR + EIC 10x100 proton

up



$\Delta H_1^{\ast}$ => 1/3 $\Delta H_1^{\ast}$

Δh_1 => ~1/2 Δh_1

width (+ EIC 10x100 proton)

width (published fit)

down