Target Spin Asymmetries measured at HERMES

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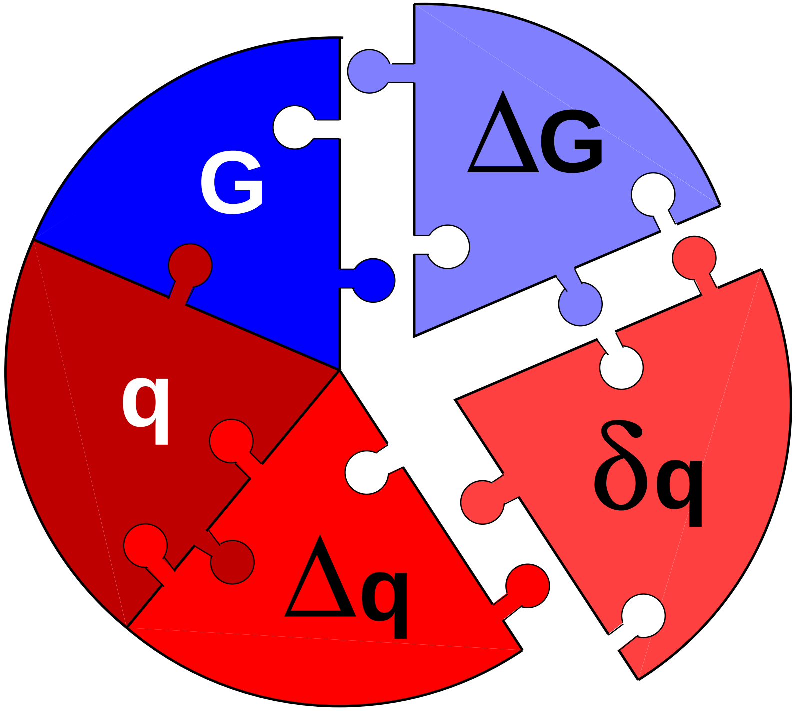
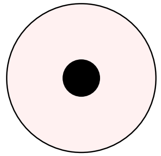
The last unknown twist-2 function: Transversity



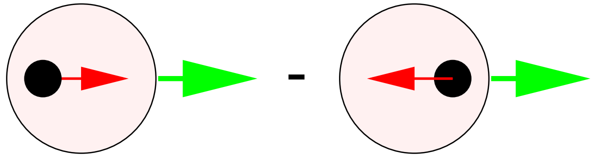
Complete description of the nucleon requires 5 twist-2 distributions

Structure functions:

f_1 =

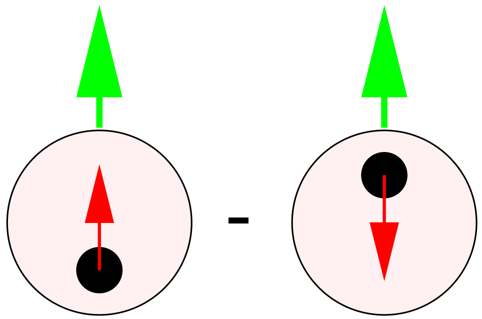


g_{1L} =



the last unknown . . .

h_1 =



Known: $f_1 \Rightarrow q(x)$; $\quad g_1 \Rightarrow \Delta q(x)$ Unknown: $h_1 \Rightarrow \delta q(x)$

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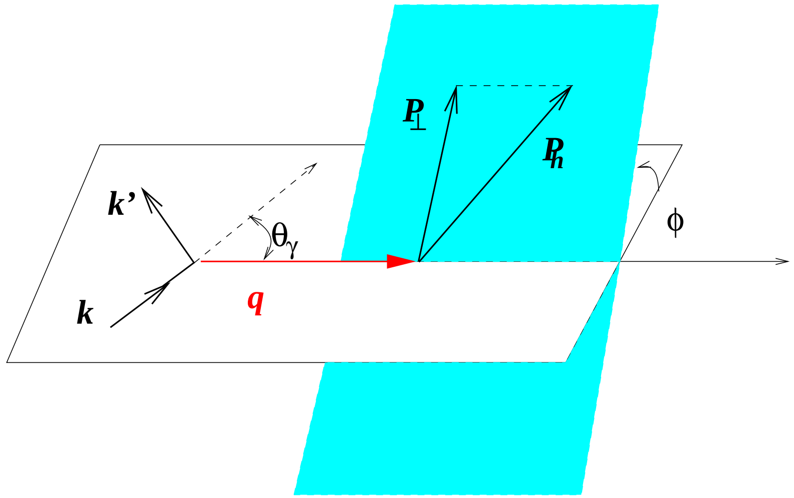
Accessing Transversity: the Collins effect

Collins effect:

- h_1 chiral odd quantity
- needs chiral odd counterpart

$\Rightarrow$ Collins fragmentation function $H_1^\perp$

- $A(\phi)_{UL}$ related to product of $H_1^\perp$ and h_1



Alternative explanation:

FSI of struck q
(Sivers effect)

$\Rightarrow$ can be distinguished with transverse target

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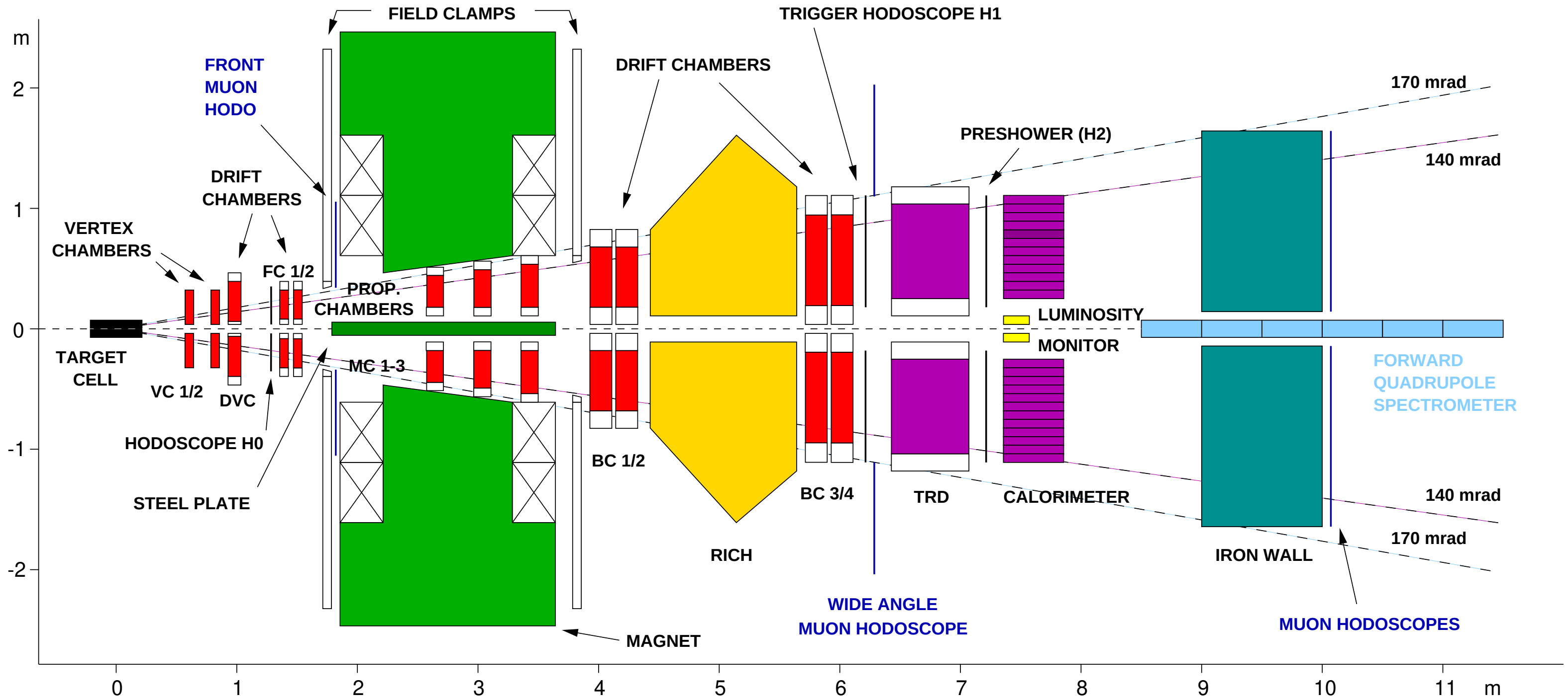
The HERMES Experiment



longitudinal polarised pure $\vec{p}, \vec{d}$ targets

long. pol. or helicity balanced $e^{\pm}$ beam

Kinematics: $Q^2 > 1$ GeV$^2, 0.03 < x < 0.3, 0.2 < z < 0.7$

RICH detector for π, K, p separation @ all momenta

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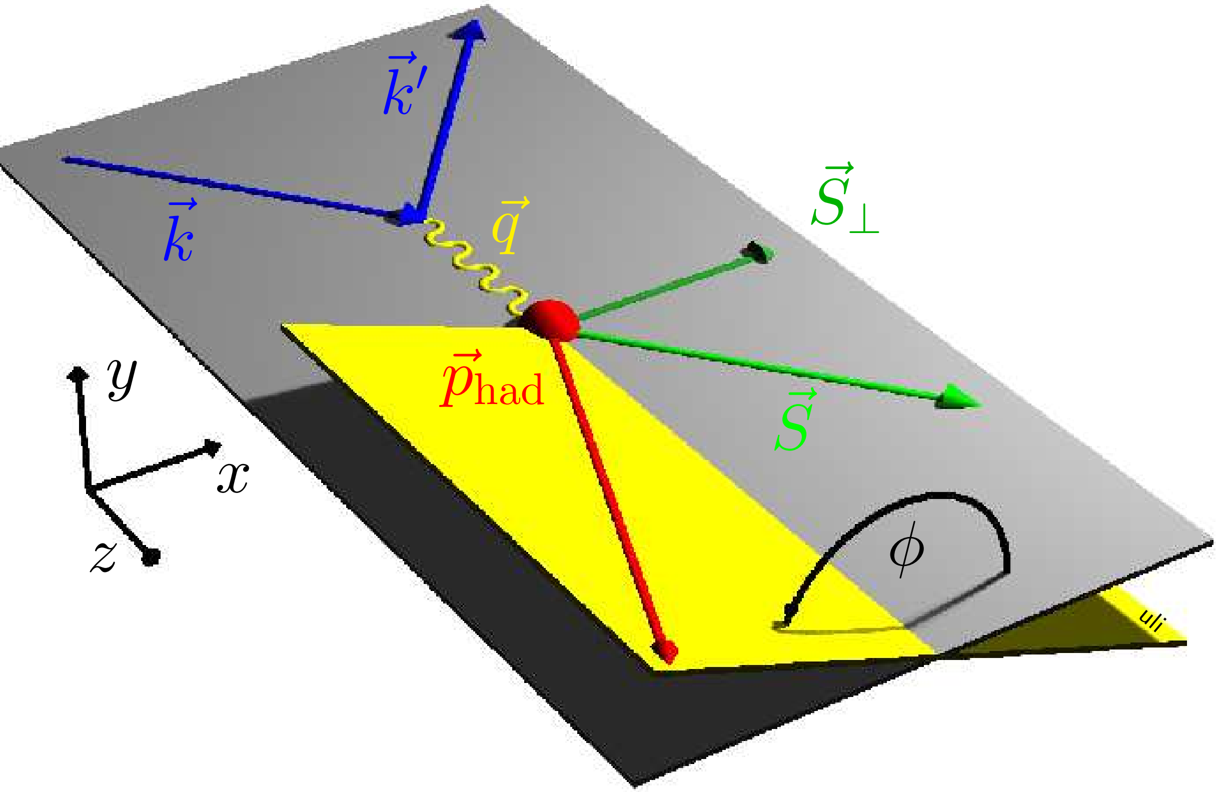
Transversity with longitudinal targets



HERMES kinematics:

$$S_\perp \simeq \frac{2MX}{Q}\sqrt{1-y} \approx 0.15$$

Target has transverse component wrt. photon

Measure Target Spin Asymmetry as function of ϕ

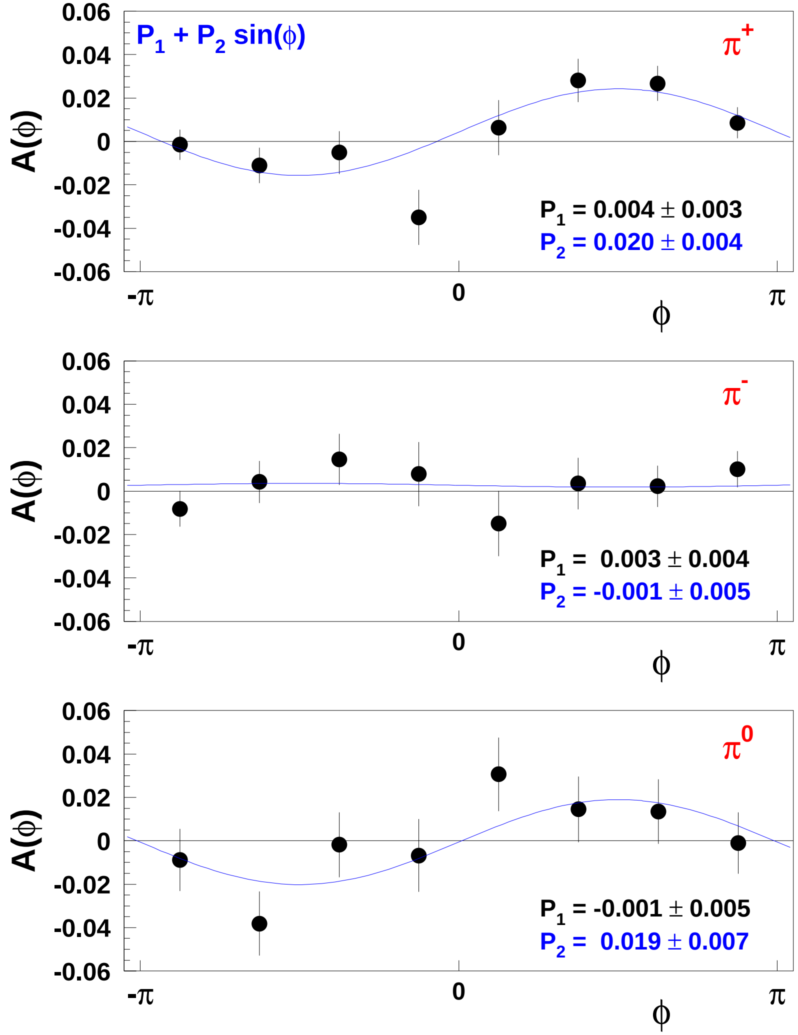
Since 2001: HERMES data taking with transverse target $\Rightarrow$ currently being analysed

Single Spin Asymmetries on the proton

in 1996/97 HERMES ran a long. pol. proton target.
Define TSA:

$$A(\phi)_{UL} = \frac{1}{\langle P \rangle} \frac{N^{+}(\phi) - N^{-}(\phi)}{N^{+}(\phi) + N^{-}(\phi)}$$

$+/-$ denote opposite target helicity states
UL Unpol. beam and Long. pol. target



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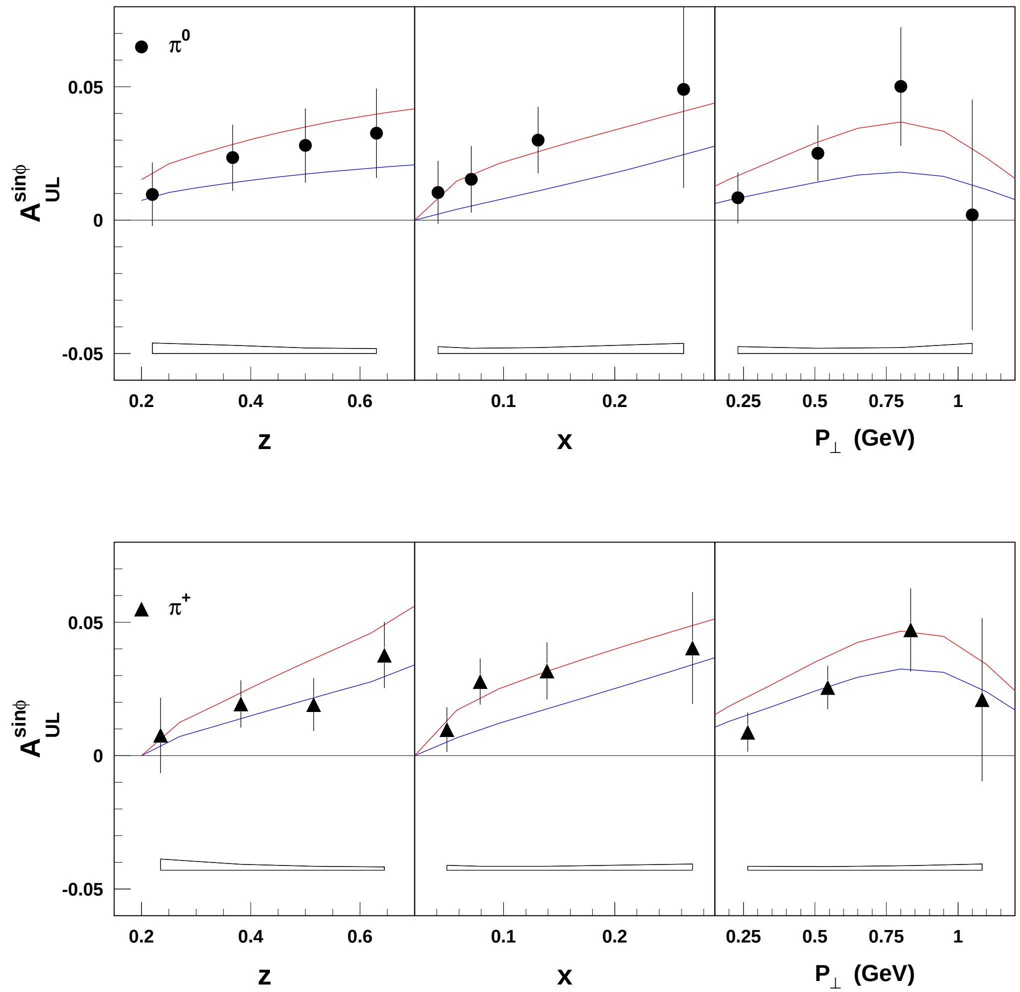
Model calculations for $A_{UL}^{\sin\phi}$ on p



Soffer inequality
upper limit:

$$h_1 = (f_1 + g_1)/2$$

non-relativistic
lower limit:

$$h_1 = g_1$$

'Collins guess' for $H_1^\perp$

Oganessyan et al., PLB 483 (2000) 69

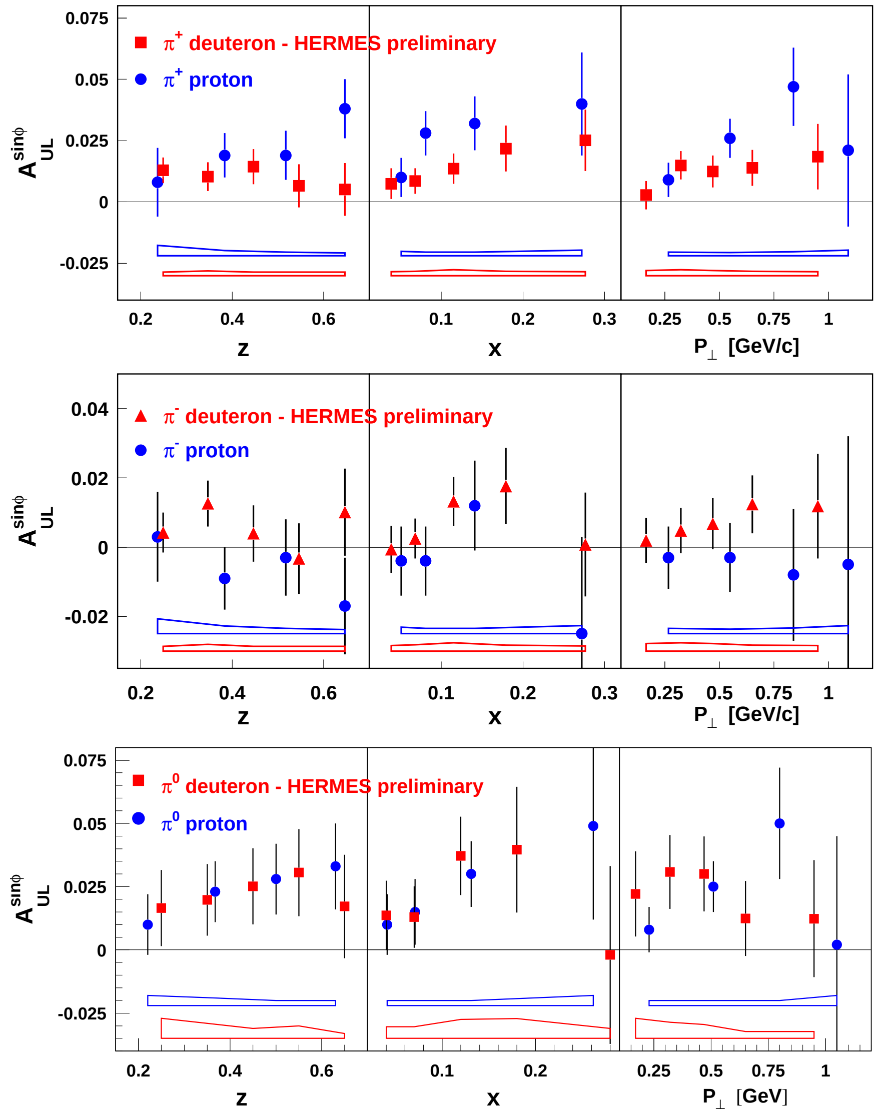
Target Spin Asymmetries on the deuteron

effect should peak in valence region ($x \approx 0.3$)

stronger for π^+ (u-Quark dominance)

grow with $p_\perp$ and peak for $p_\perp \approx 1$ Gev^2

$A_{UL}^{\pi^+}$ on $p > A_{UL}^{\pi^+}$ on d
$A_{UL}^{\pi^\circ}$ similar for p and d
$A_{UL}^{\pi^-} > 0$ only for d



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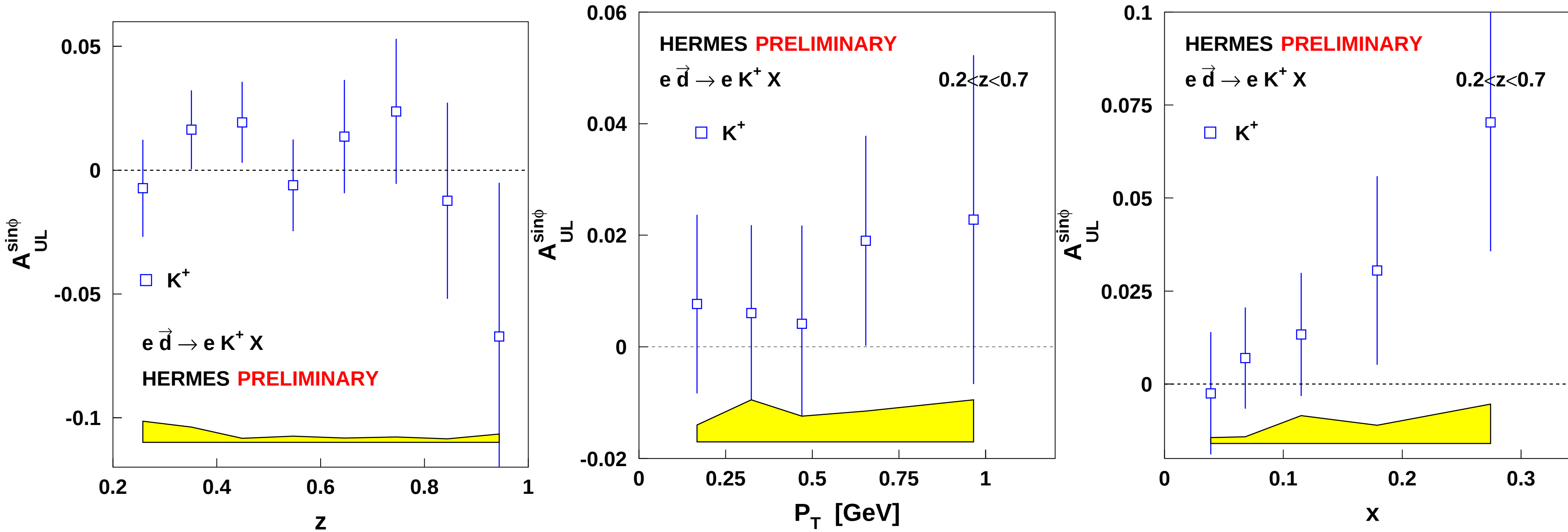
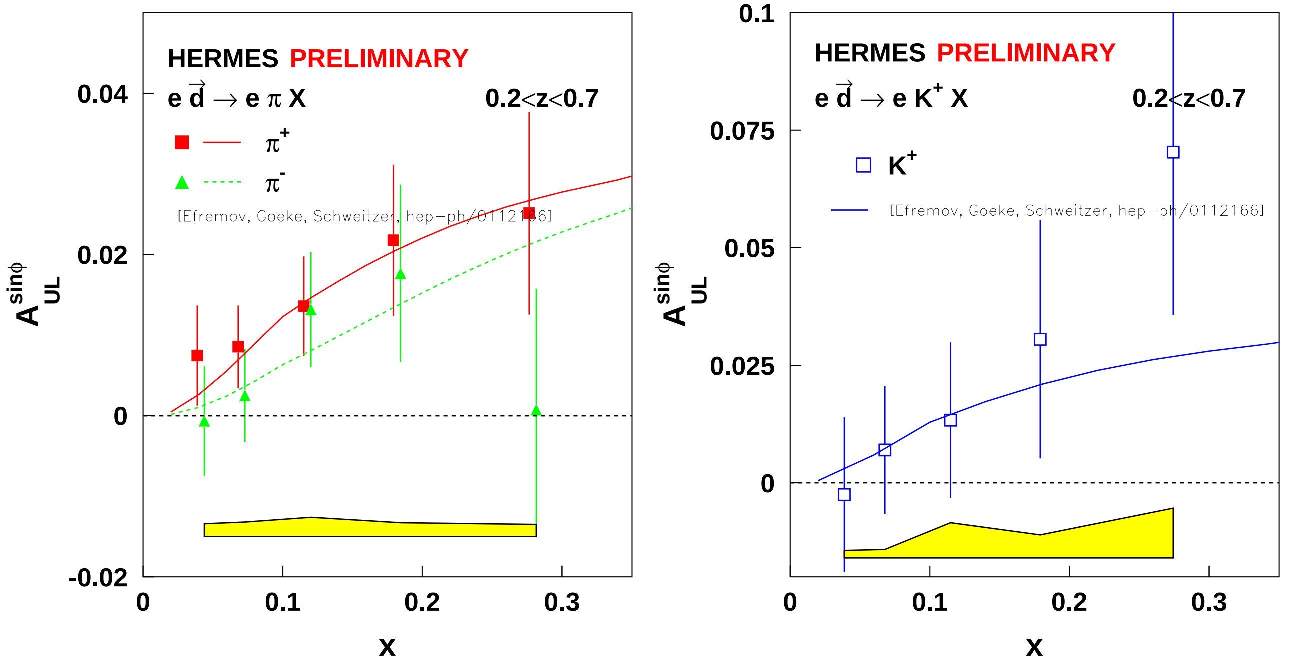
Getting strange . . . Kaon TSA



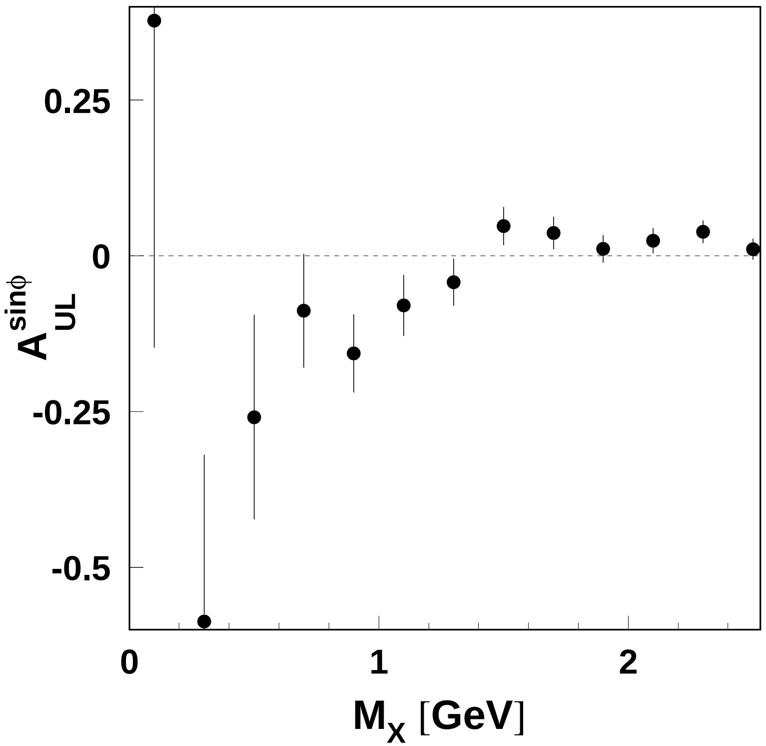
K^+ results similar to $\pi^+ \Rightarrow$ u–quark dominance in fragmentation

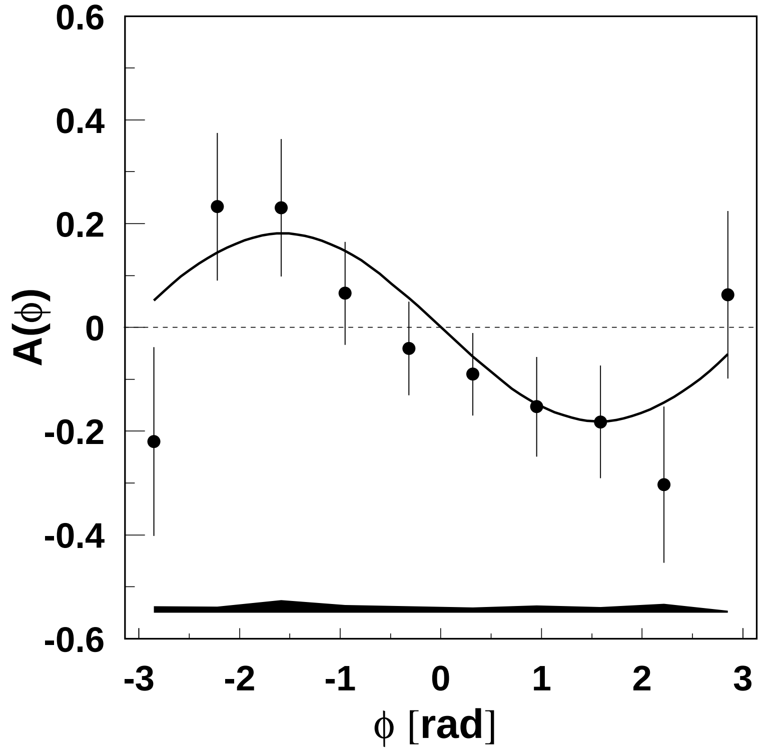
What does theory say ?



- transversity distribution calculated in χQSM
- K^+ curve predicted, data are described reasonably well
- …also by models based on SU(6) quark–diquark or pQCD

Target Spin Asymmetry: $ep \rightarrow e'\pi^+ n$





- Unpol. beam on Long. pol. target
- exclusivity by missing mass and subtraction method
- precacious scaling expected from GPD framework
- no theoretical prediction available

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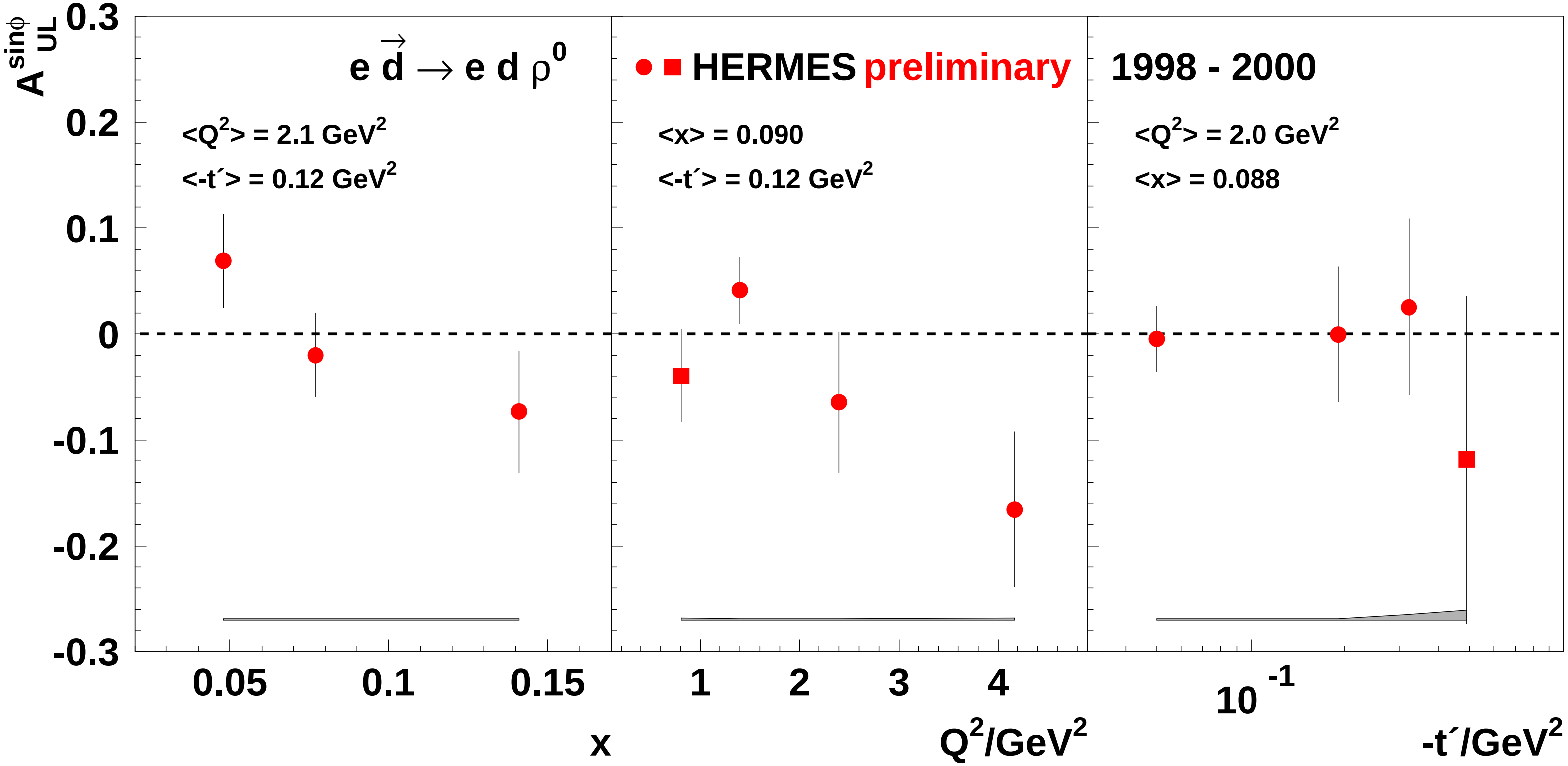
TSA in exclusive ρ° production



- first data on TSA in excl. ρ°, sensitive to $2J^u + J^d$
- qualitative agreement with Goecke *et al.*, Prog. Part. Nucl. Phys. 47 (2001) 401

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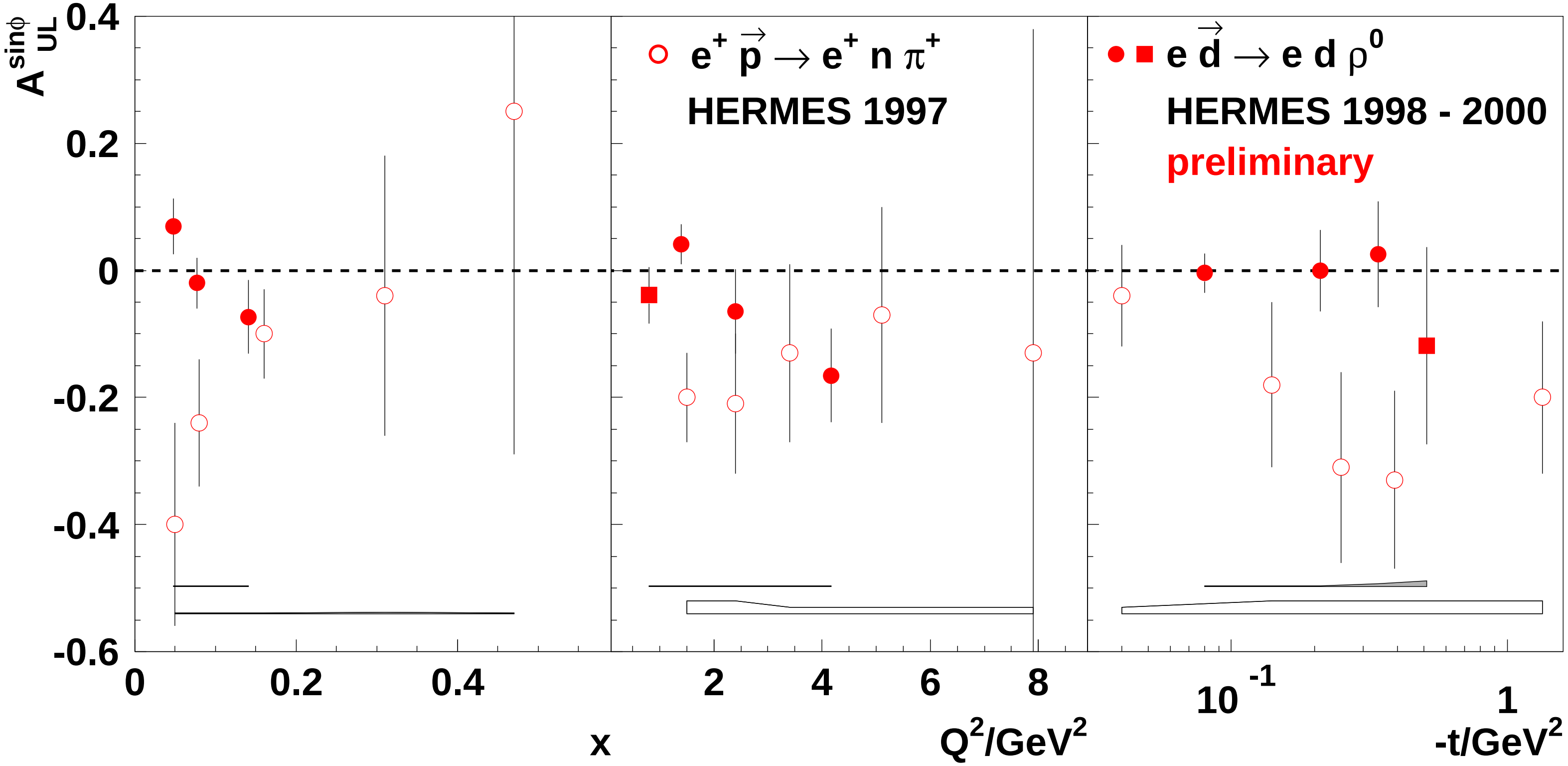
. . . compared to excl. π^+



- π^+ kinematics as expected from GPDs
- first data on TSA in excl. ρ°, qualitative agreement with GPD expectation, detailed studies will follow

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Summary & Outlook

- TSA for $\pi^{\pm}, \pi^{\circ}$ measured on long. pol. proton as function of $x, z, p_{\perp}$
- TSA for $\pi^{\pm}, \pi^{\circ}, K^{+}$ measured on long. pol. deuteron as function of $x, z, p_{\perp}$
- two possible explanations: Collins effect or Sivers effect
- if Collins: transversity distributions non–zero
- data with a transverse target will disentangle Collins and Sivers effect

Data using transversely pol. p on tape, analysis ongoing . . . stay tuned