COMPASS results for Collins and Sivers asymmetries in K^0 -production from 2022 ^{6}LiD data

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On behalf of the COMPASS collaboration

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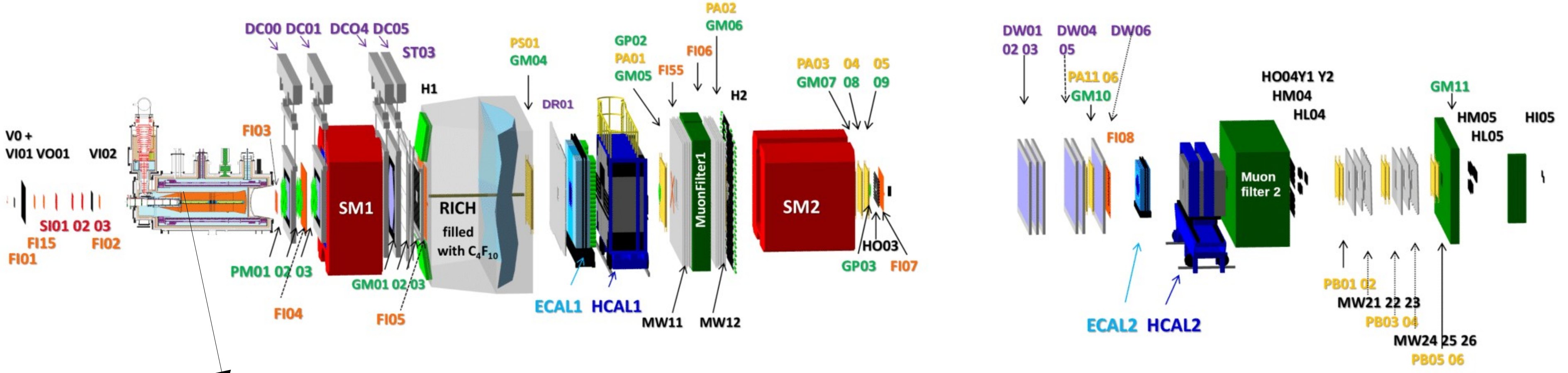
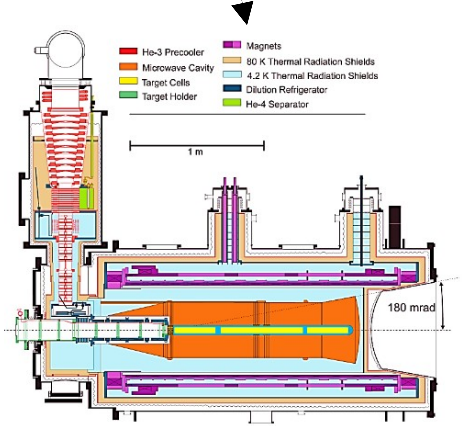
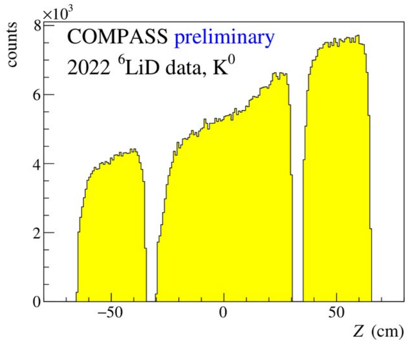
COMPASS collaboration
(COmmon Muon Proton Apparatus for Structure and Spectroscopy)





Target Material: ^{6}LiD or NH_3



Beam Properties:

Particle: μ^+

Polarization: 80%

Momentum: 160 GeV/c

SIDIS X-SECTION AND TMDS

$$\frac{d\sigma}{dx\,dy\,dz\,dP_{hT}^2\,d\varphi_h\,d\psi} = \left[\frac{\alpha}{xyQ^2}\frac{y^2}{2(1-\varepsilon)}\left(1+\frac{\gamma^2}{2x}\right)\right]\left(F_{UU,T}+\varepsilon F_{UU,L}\right)\times$$

$$\begin{Bmatrix} 1+\cos\phi_h\left(\sqrt{2\varepsilon(1+\varepsilon)}A_{UU}^{\cos\phi_h}\right)+\cos 2\phi_h\left(\varepsilon A_{UU}^{\cos 2\phi_h}\right) \\ +\ \lambda\sin\phi_h\left(\sqrt{2\varepsilon(1-\varepsilon)}A_{LU}^{\sin\phi_h}\right) \\ +\ S_L\left[\sin\phi_h\left(\sqrt{2\varepsilon(1+\varepsilon)}A_{UL}^{\sin\phi_h}\right)+\sin 2\phi_h\left(\varepsilon A_{UL}^{\sin 2\phi_h}\right)\right] \\ +\ S_L\lambda\left[\sqrt{1-\varepsilon^2}A_{LL}+\cos\phi_h\left(\sqrt{2\varepsilon(1-\varepsilon)}A_{LL}^{\cos\phi_h}\right)\right] \\ +\ S_T\begin{bmatrix} \sin(\phi_h-\phi_S)\left(A_{UT}^{\sin(\phi_h-\phi_S)}\right) \\ +\sin(\phi_h+\phi_S)\left(\varepsilon A_{UT}^{\sin(\phi_h+\phi_S)}\right) \\ +\sin(3\phi_h-\phi_S)\left(\varepsilon A_{UT}^{\sin(3\phi_h-\phi_S)}\right) \\ +\sin\phi_S\left(\sqrt{2\varepsilon(1+\varepsilon)}A_{UT}^{\sin\phi_S}\right) \\ +\sin(2\phi_h-\phi_S)\left(\sqrt{2\varepsilon(1+\varepsilon)}A_{UT}^{\sin(2\phi_h-\phi_S)}\right) \end{bmatrix} \\ +\ S_T\lambda\begin{bmatrix} \cos(\phi_h-\phi_S)\left(\sqrt{(1-\varepsilon^2)}A_{LT}^{\cos(\phi_h-\phi_S)}\right) \\ +\cos\phi_S\left(\sqrt{2\varepsilon(1-\varepsilon)}A_{LT}^{\cos\phi_S}\right) \\ +\cos(2\phi_h-\phi_S)\left(\sqrt{2\varepsilon(1-\varepsilon)}A_{LT}^{\cos(2\phi_h-\phi_S)}\right) \end{bmatrix} \end{Bmatrix}$$

From 15 asymmetries we are interested in two of them

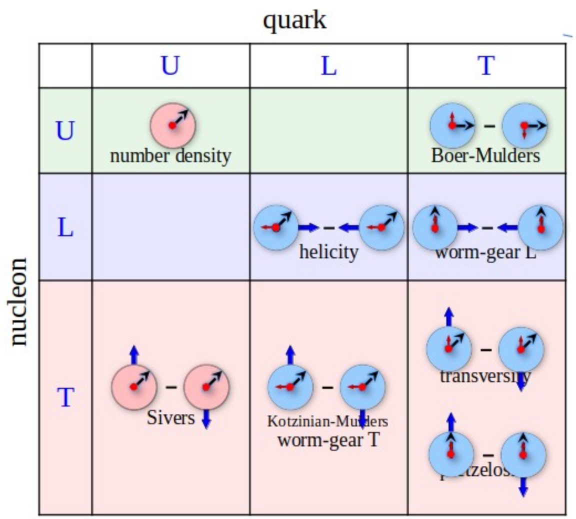
Collins

$$A_{UT}^{\sin(\phi_h+\phi_S)}(x) \simeq \frac{\sum_q e_q^2 h_1^q(x)\otimes H_1^{\perp,q\to h}}{\sum_q e_q^2 f_1^q(x)\otimes D_1^{q\to h}}$$

Sivers

$$A_{UT}^{\sin(\phi_h-\phi_S)}(x) \simeq \frac{\sum_q e_q^2 f_{1T}^{\perp,q}(x)\otimes D_1^{q\to h}}{\sum_q e_q^2 f_1^q(x)\otimes D_1^{q\to h}}$$

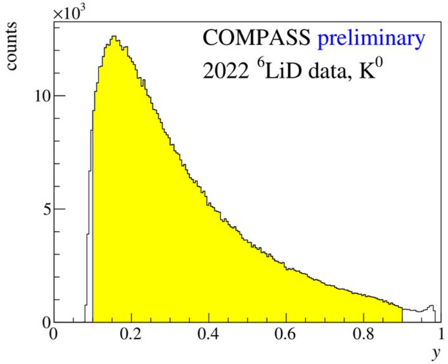
Twist 2 TMD PDFs

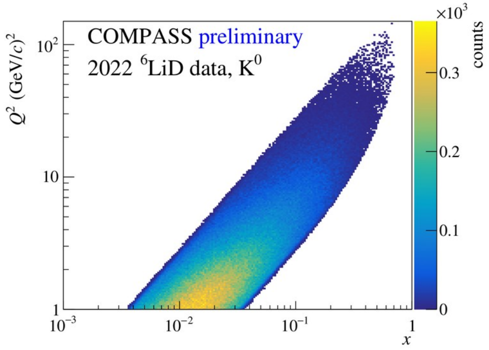


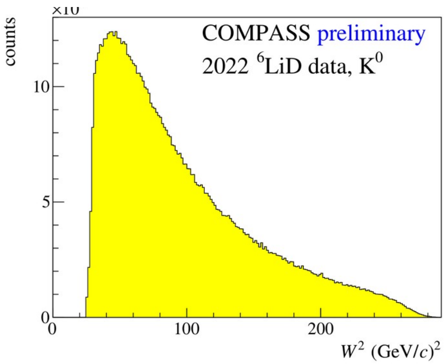
SIDIS Lepton kinematics

Standard Inclusive DIS cuts

$Q^2 > 1$ GeV^2
$0.003 < x < 0.7$
$0.1 < y < 0.9$
$W^2 > 25$ GeV$^2/c^2$

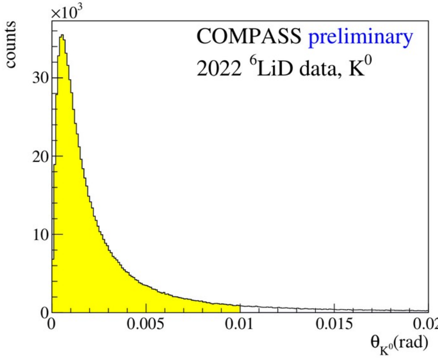


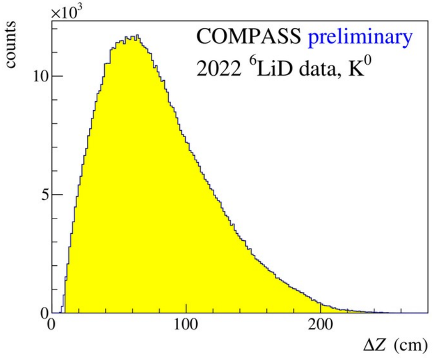




K^0 Selection

K^0 identified by h^+h^- pair





cuts on pointing angle and Vertex distance
$\theta < 0.01$ rad Vertex distance > 10 cm

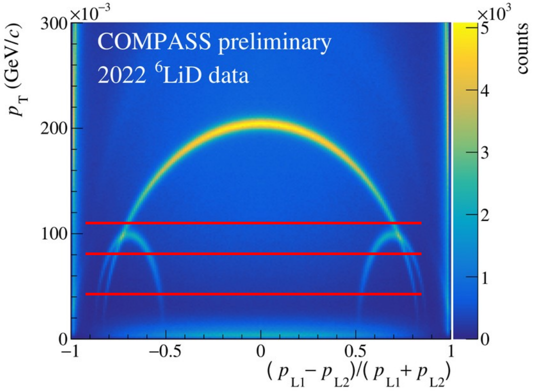
K^0 Selection

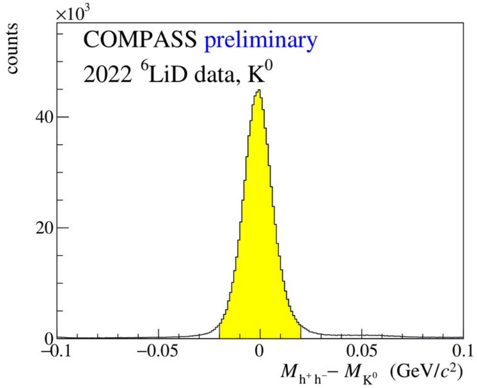
Armenteros Cuts

$\Lambda/\bar{\Lambda}$ exclusion: 80 MeV/c < P_T < 110 MeV/c

e^+/e^- background exclusion P_T > 40 MeV/c

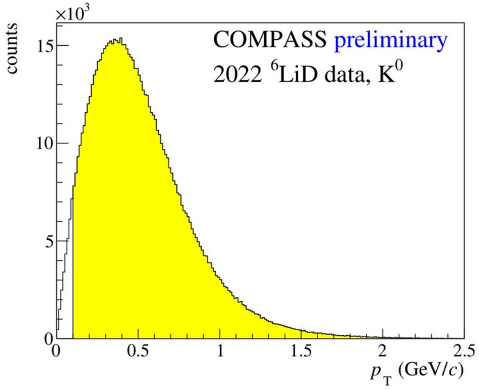
K^0 mass ± 20 MeV/c^2 of the PDG K^0 mass

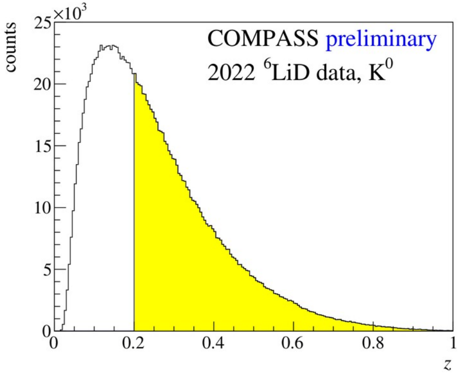




Estimated background **2%**

Hadronic Cuts





$0.2 < z < 1$ for the fractional photon energy transferred to the K^0

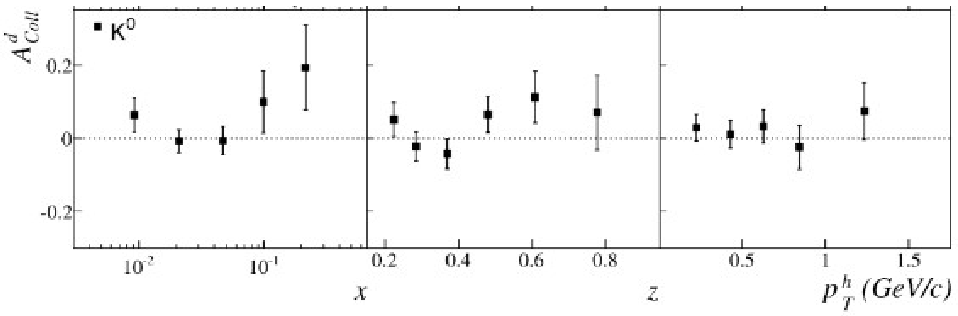
Transverse momentum P_T > 0.1 GeV/c

Final Statistics 780837

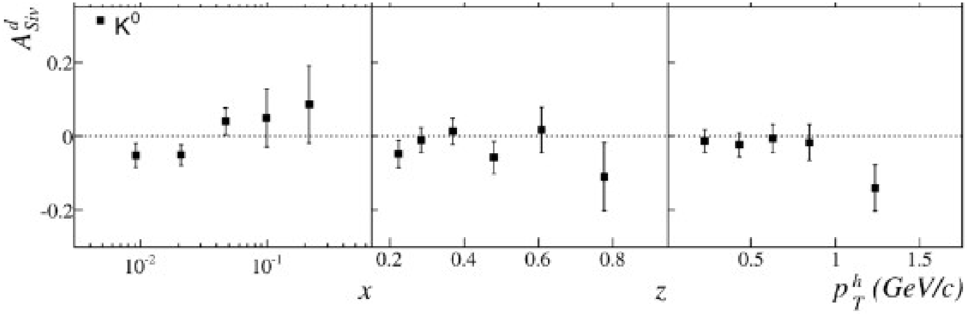
COLLINS AND SIVERS EFFECTS (DEUTERON 2002-2004)

- Asymmetries consistent with zero
- 1st deuteron measurements (the only existing transverse deuteron target data up to 2022)

Collins



Sivers



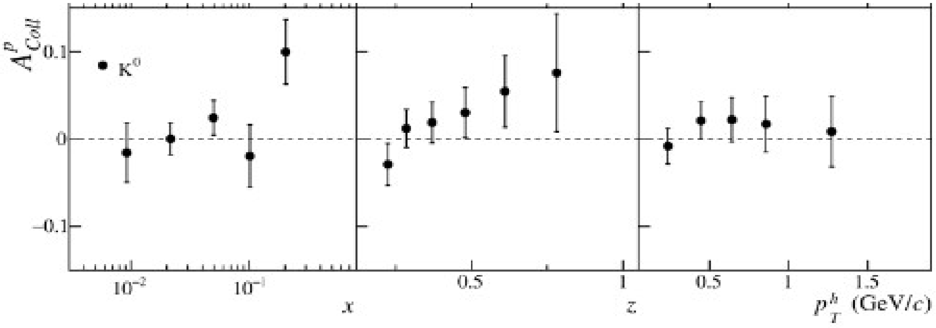
COMPASS PLB 673 (2009) 127

Final Statistics 250000

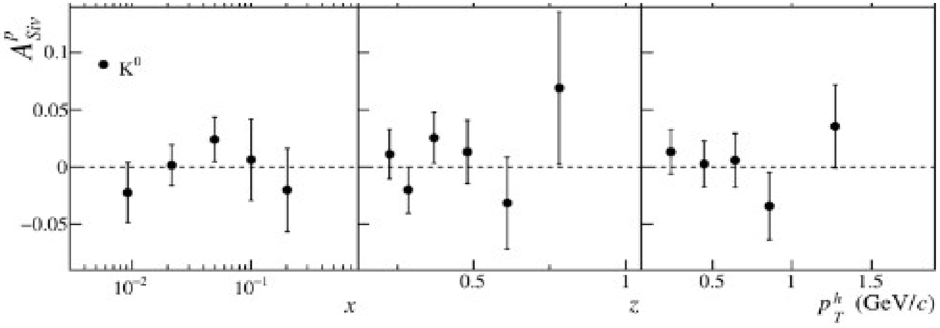
COLLINS AND SIVERS EFFECTS (PROTON-2010)

- Positive trend for collins asymmetries for increased z
- Average asymmetries positive but compatible with zero

Collins



Sivers



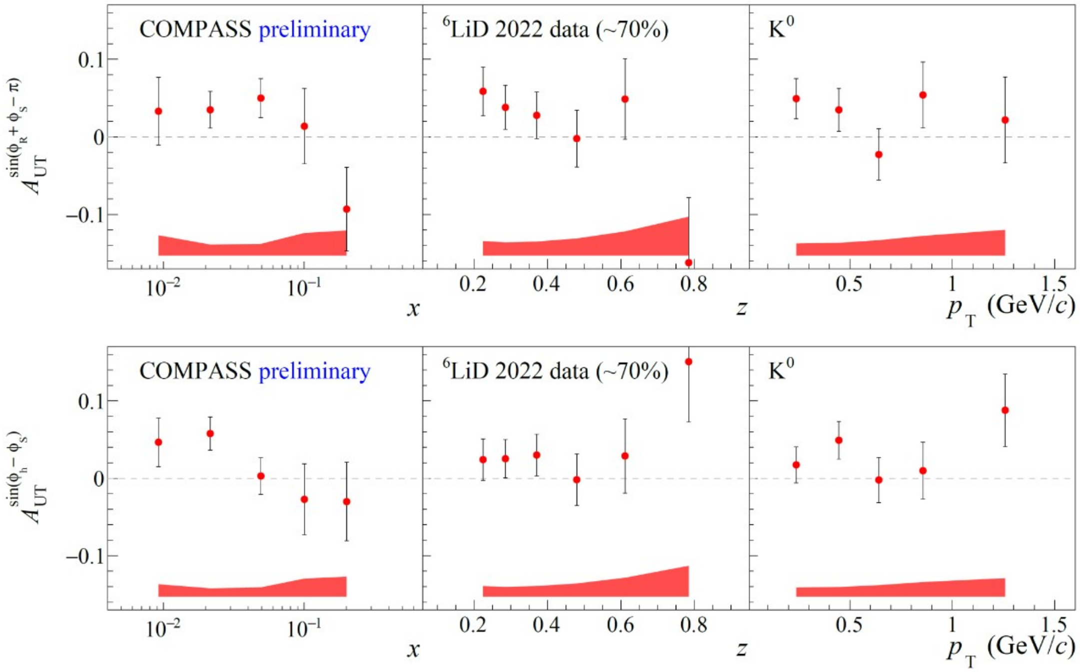
COMPASS PLB 744(2015)250

Final Statistics 1000000

Collins and Sivers TSAs 2022 results

NEW!

~70% of 2022 Data



Overall positive trend is observed for both Collins and Sivers asymmetries

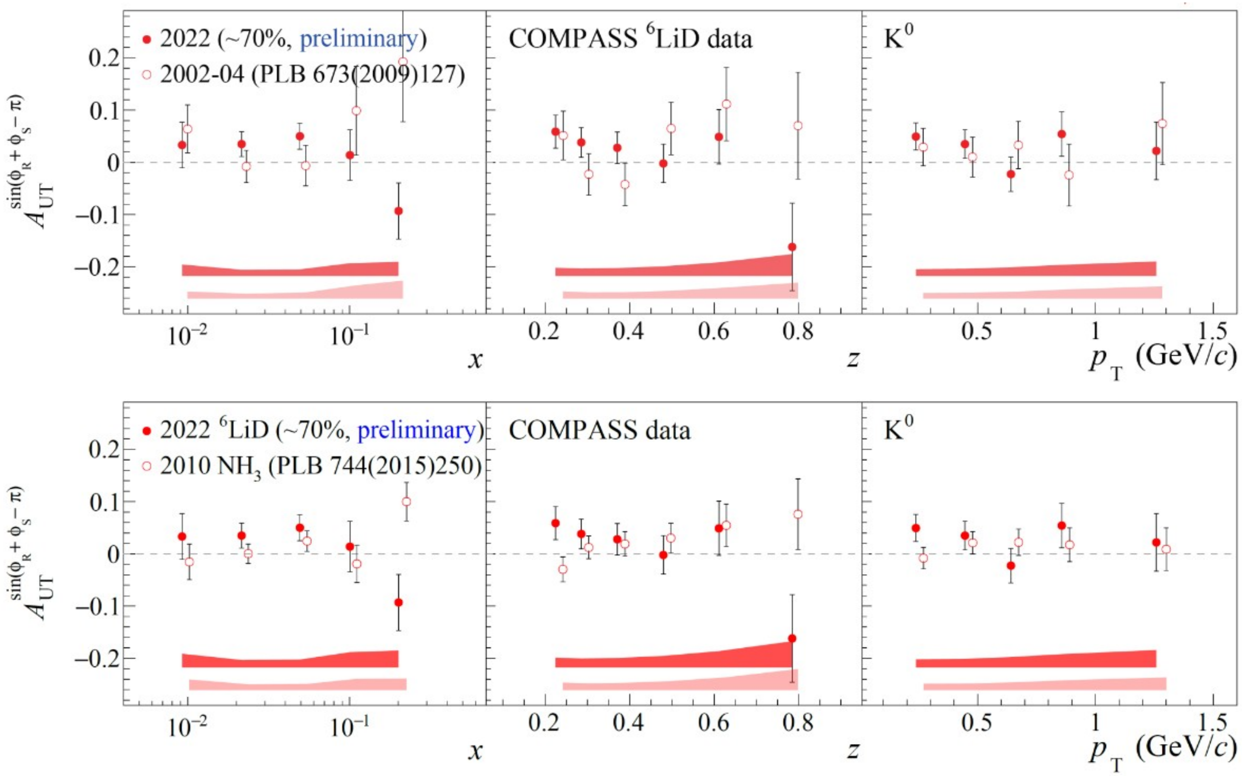
Amplitudes are consistent with zero within the errors for both asymmetries

Collins TSAs vs Old Data

$$A_{UT}^{\sin(\phi_h+\phi_s)} \propto h_1^q \otimes H_{1q}^{\perp h}$$

New results are consistent within the errors with previous 2002-04 results, with a higher precision

New results are consistent with previously published 2010 proton data



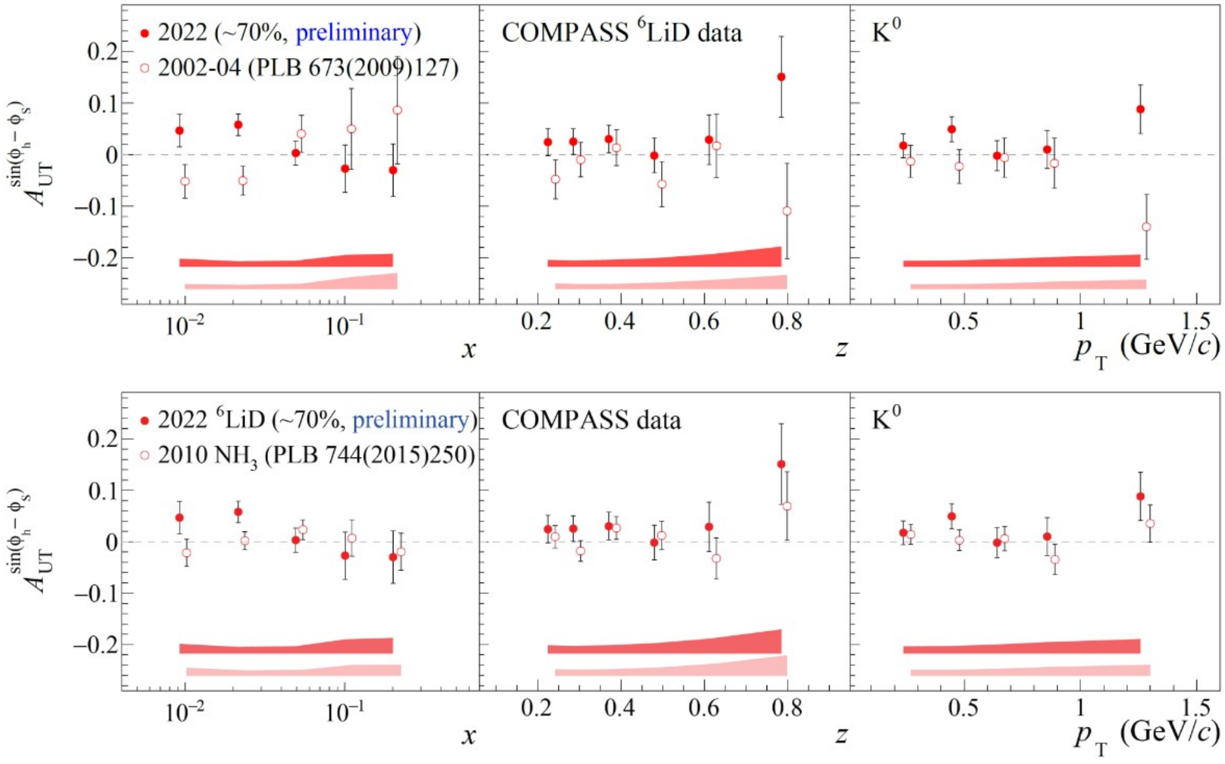
Sivers TSAs vs Old Data

$$A_{UT}^{\sin(\phi_h-\phi_s)} \propto f_{1T}^{\perp q} \otimes D_{1q}^{h}$$

New results are consistent with previously published 2002-2004 data

Differences are observed at small x

Amplitudes are consistent with previously published 2010 proton data



Conclusions

- Measured from part (~70%) of the SIDIS data collected in 2022
- The asymmetries are evaluated as a function of x, z and P_T
- Significant precision improvement as compared to the old 2002-04 data
- comparable accuracy when confronted to the proton 2010 results
- both Collins and Sivers K^0 TSAs appear to be compatible with zero within the uncertainties, but with overall tendency to positive values
- Looking forward for PID analysis

Thank You