

Exploring Sivers Asymmetries in SIDIS and DY at COMPASS

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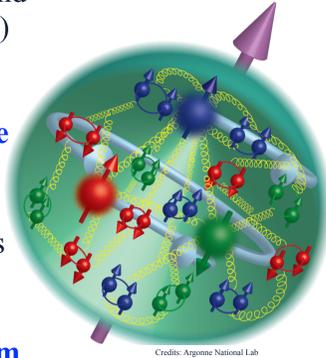
SPIN 2023 at Duke



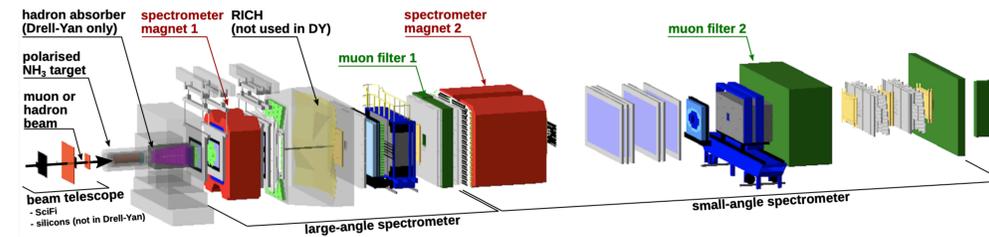
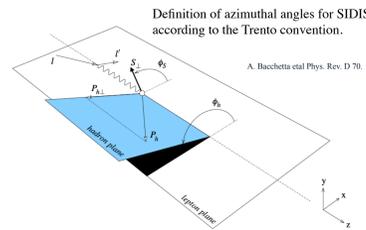
Unveiling the structure of the proton

Studying Sivers asymmetry in Drell-Yan (DY) and Semi-Inclusive Deep Inelastic Scattering (SIDIS) processes offers:

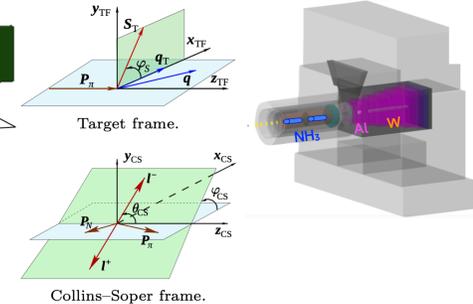
- a unique window into the **non-perturbative aspects of Quantum Chromodynamics (QCD)**,
- revealing hidden quark dynamics in protons and
- shedding light on the intricate **interplay between quark polarization and momentum**



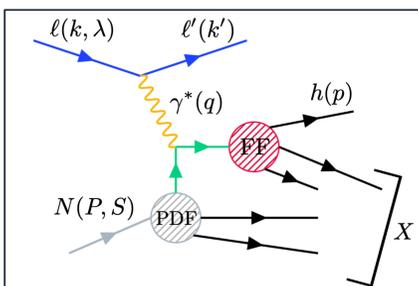
SIDIS at COMPASS



DY at COMPASS



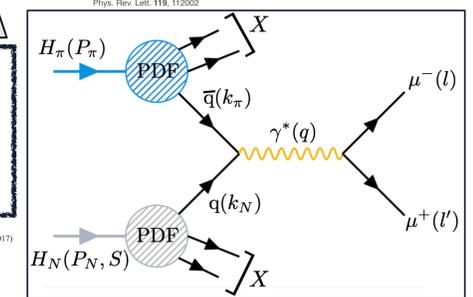
A sign change predicted for Sivers function between SIDIS and DY!



Structure function F_2 ,
 $F \propto PDF_{q,p} \otimes FF_{q \rightarrow h}$
 Particularly, $F_{UT}^{sin(\phi_h - \phi_s)} \propto f_{1T,p}^\perp \otimes D_1$

Structure function F_2 ,
 $F \propto PDF_{q,p} \otimes PDF_{q,\pi^-}$
 Particularly, $F_T^{sin\phi_s} \propto f_{1,\pi} \otimes f_{1T,p}^\perp$

$$f_{1T}^\perp |_{SIDIS} = -f_{1T}^\perp |_{DY}$$



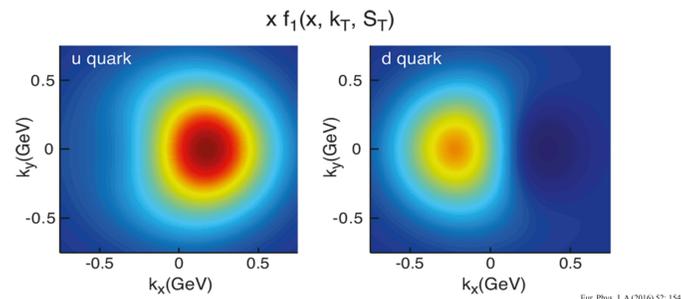
Sivers Function

The nucleon's soft non-perturbative structure is described by a set of eight Transverse Momentum Dependent (TMD) Parton Distribution Functions (PDFs), at leading twist.

One of them, the **Sivers function**, describes the correlation between parton (q) transverse momentum (k_\perp) and nucleon spin \vec{S} .

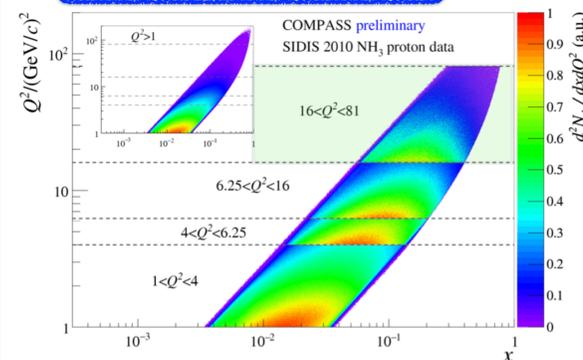
$$f_{q/h^\dagger}(x, \vec{k}_\perp, \vec{S}) = f_{q/h}(x, k_\perp^2) - \frac{1}{M} f_{1T}^\perp(x, k_\perp^2) \vec{S} \cdot (\hat{P} \times \vec{k}_\perp)$$

Spin independent Spin dependent

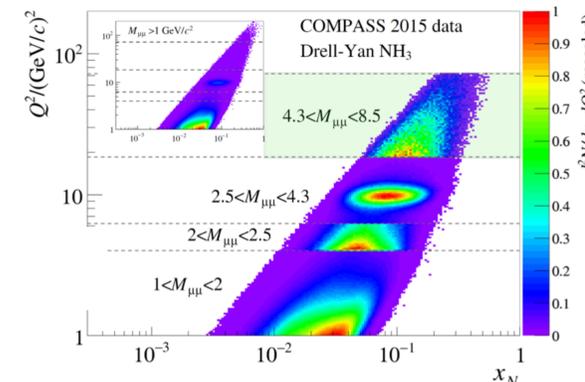


Internal motion of quarks is correlated with the spin of the proton!

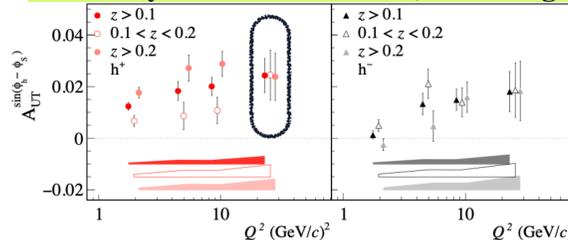
Results from SIDIS



Results from DY



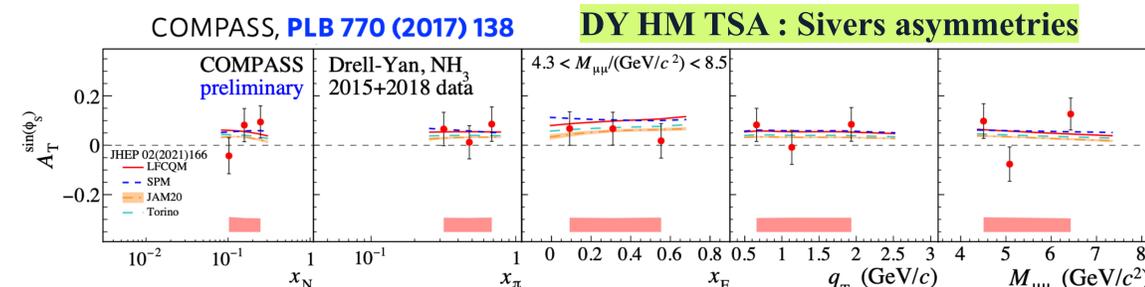
Sivers asymmetries in SIDIS, HM range



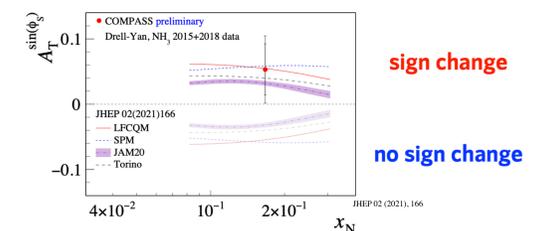
- Comparable $x:Q^2$ kinematic coverage leads to minimization of possible Q^2 evolution effects
- Unique experimental environment to test the TMD universality and the sign change of Sivers function
- Sivers from SIDIS in HM range shows a non-zero signal for h^+

COMPASS at CERN: TMDs on the proton

- Fixed target experiment located in the north area at CERN (SPS, M2 beam line)
- DY with 190 GeV π^- beam on a transversely polarized proton target (2015/2018)
- SIDIS with 160 GeV μ^+ beam on transversely polarized proton target (2007/2010)



Effect on Sivers Sign Change



Summary

TSSA in pion-induced DY at COMPASS

- Sign change between DY and SIDIS at 2- σ level (compatible with zero at 1- σ level)
- Unique facility offered by COMPASS to measure SIDIS and DY in overlapping phase space with essentially the same apparatus
- Publication of combined 2015 and 2018 data in preparation

Acknowledgments

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