A Better Angle on Hadron TMDs at the EIC

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Constructing the new q_* observable for SIDIS

$$e^-(\ell) + N(P) \to e^-(\ell') + h(P_h) + X$$

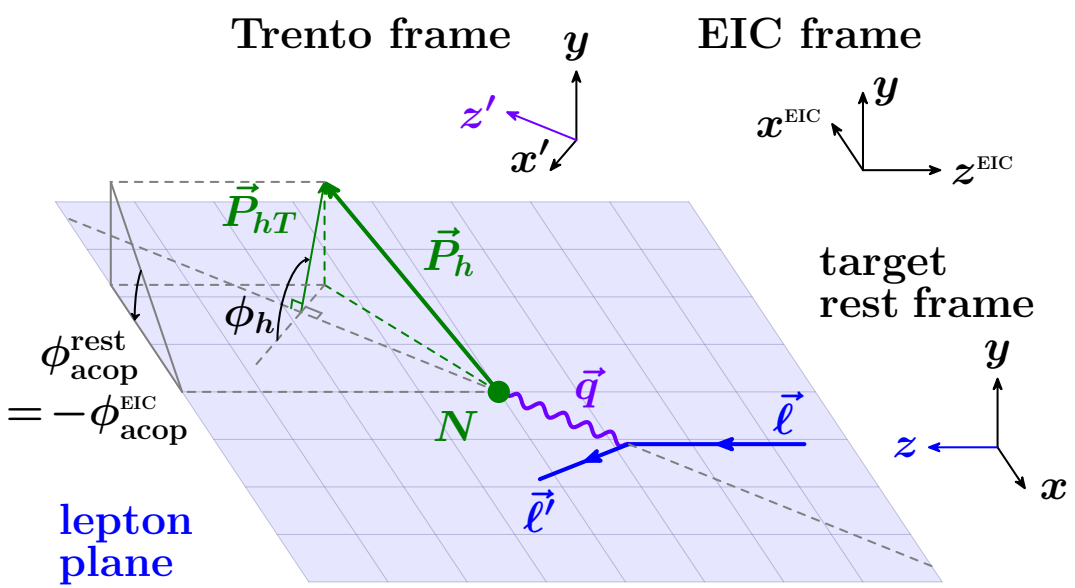
- Want to precisely measure P_{hT} in the TMD region $P_{hT} \sim \Lambda_{\rm QCD} \ll Q$

  $\Rightarrow$ Theoretically clean probe of 3D nucleon structure and hadronization

- Challenge: P_{hT} is defined w/r/t photon direction reconstructed from $\vec{\ell}'$

  $\Rightarrow$ Typical exp. resolution $|\vec{\ell}'| = (20 \pm 0.5)\,\text{GeV} \Rightarrow P_{hT} = (1 \pm 0.5)\,\text{GeV}$

- Idea: Construct TMD-sensitive observable q_* purely in terms of *lab-frame angles*



1. Use event acoplanarity:

$$\tan\phi_{\rm acop}^{\rm EIC} = -\frac{\sin\phi_h\, P_{hT}}{zQ\sqrt{1-y}}$$

2. Upgrade double-angle formula to all orders to cancel factors:

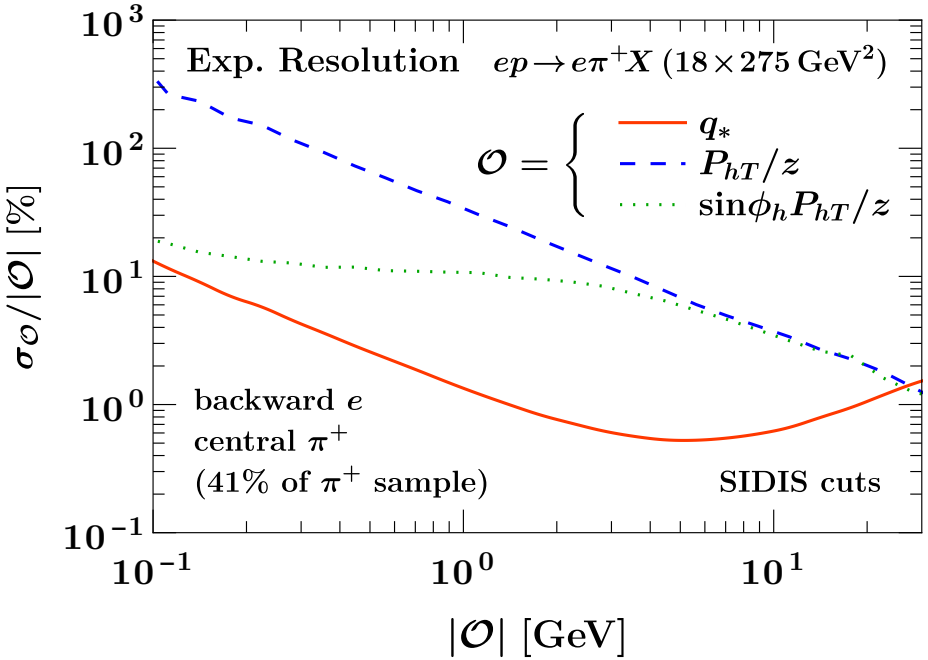
$$q_* \equiv 2E_N \frac{e^{\eta_h}}{1+e^{\Delta\eta}} \tan\phi_{\rm acop}^{\rm EIC}$$

Properties of the new q_* observable

- *Theory:* $q_* = -\sin\phi_h \, P_{hT}/z$ at small $q_* \ll Q$

  $\Rightarrow$ Cross section factorizes in terms of *standard TMD PDFs and FFs*

  $\Rightarrow$ Asymmetries $\mathrm{d}\sigma(q_* > 0) - \mathrm{d}\sigma(q_* < 0)$ give direct access to *spin correlations*



- *Experiment:* Superior resolution down into deep confinement regime
- Completely insensitive to momentum calibration by construction
- Statistical sensitivity and robustness against other sources of systematics are *on par* with P_{hT}

Conclusions – see [2209.11211] or get in touch for more details!

- q_* will help us break the resolution barrier in SIDIS TMD measurements.
- Bright prospects for mapping the 3D structure of hadronization and confinement!