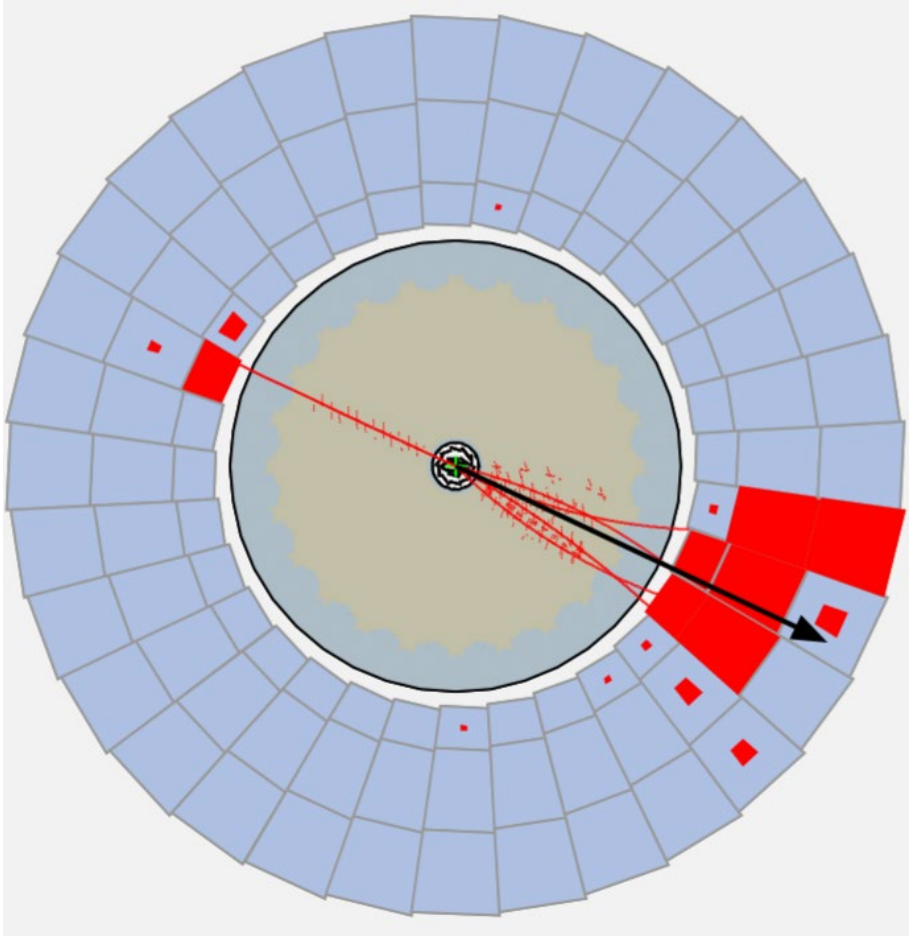
UCR plans for yellow report

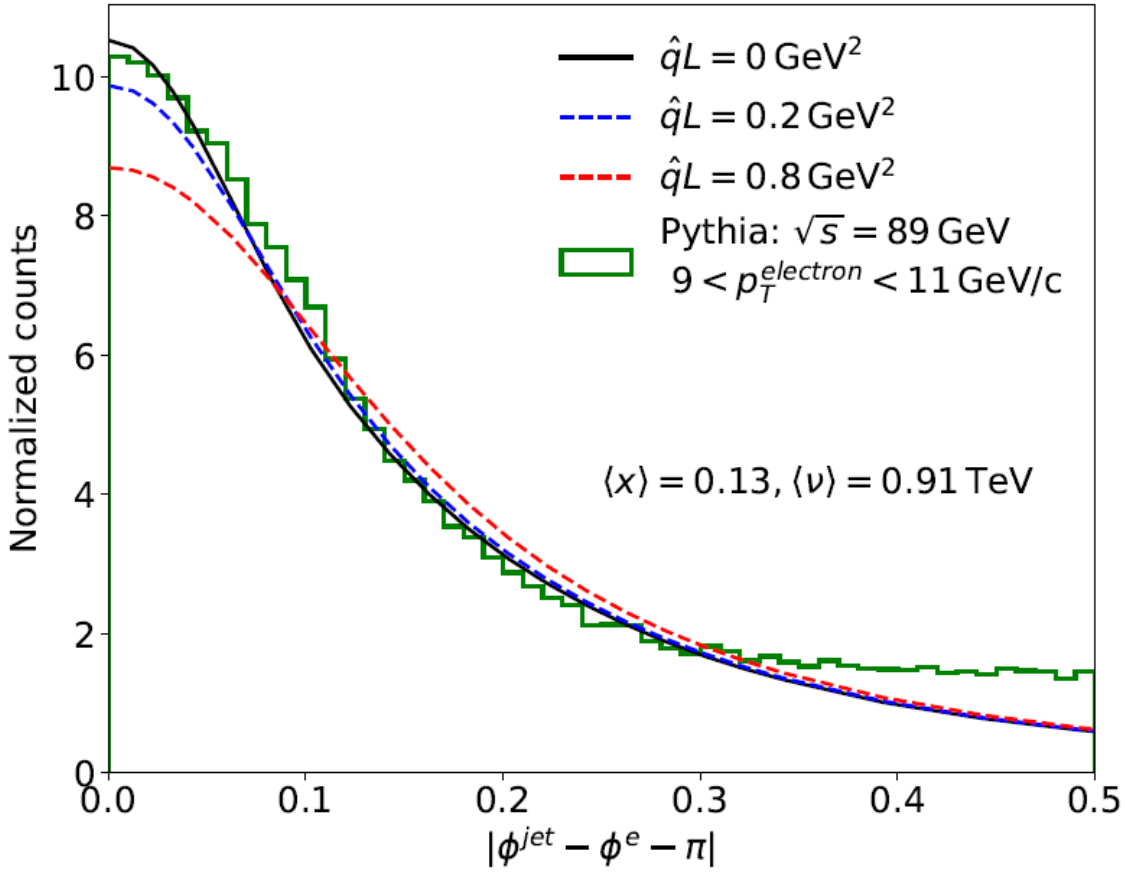


- Focus on electron-jet correlation measurements.
- We will use the “official software”,
  fast simulations.
- People:
  0.5 FTE postdoc (TBD) + Miguel
  Riley (undergrad), and possibly Chong (postdoc) + Rich
  Xilin (undergrad), and possibly William (grad) and Latif (postdoc) + Ken

Jet transport in nuclei

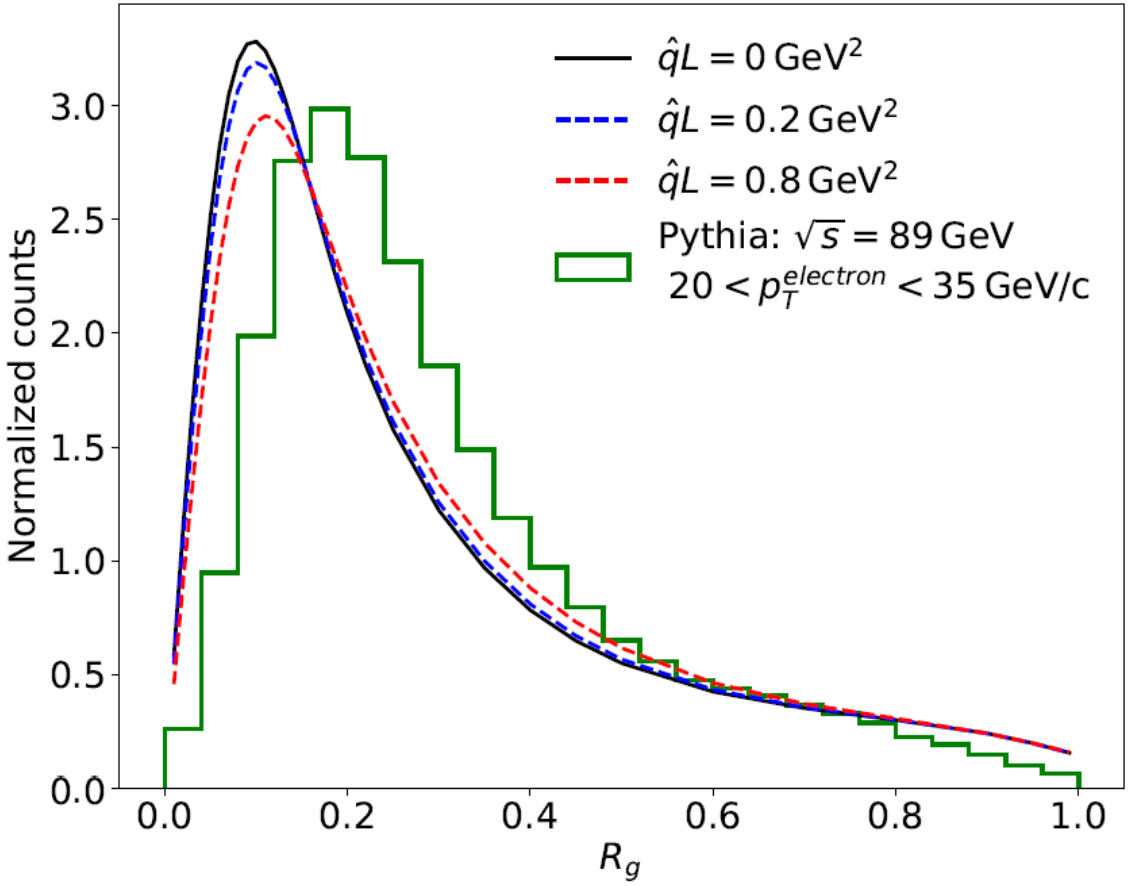
Traditional jet measurement

PRL 122 192003 (2019)



Jet substructure measurement

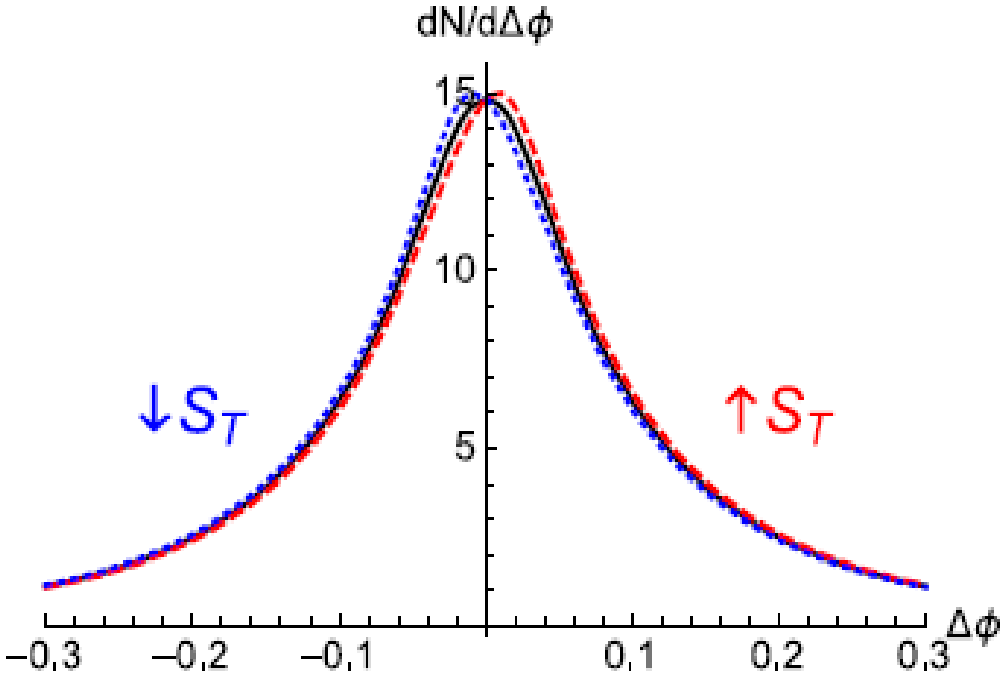
(arXiv:1912.05931)



- Clean and orthogonal channels to measure jet transport parameter in e-A.
- Look forward to collaborate with Berkeley on this.
- We also plan to work on the same observable but for polarized e-p

Direct measurement of Sivers effect with jets

Liu et al. PRL 122 192003 (2019)



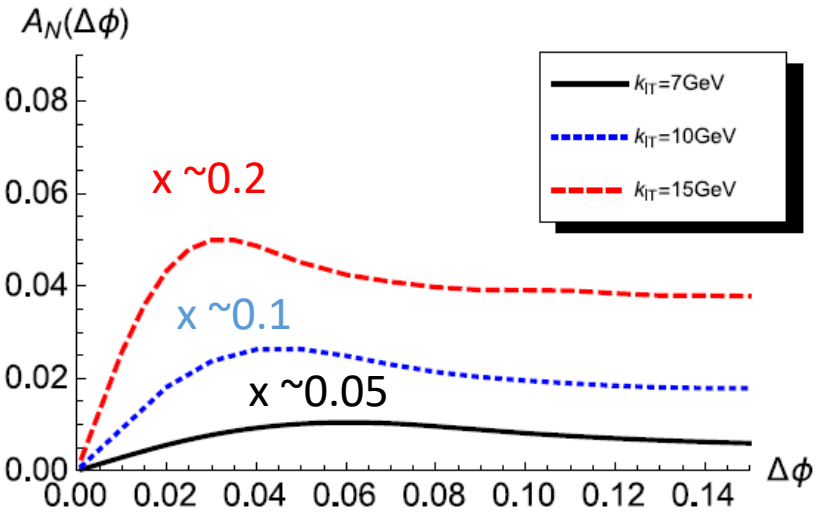
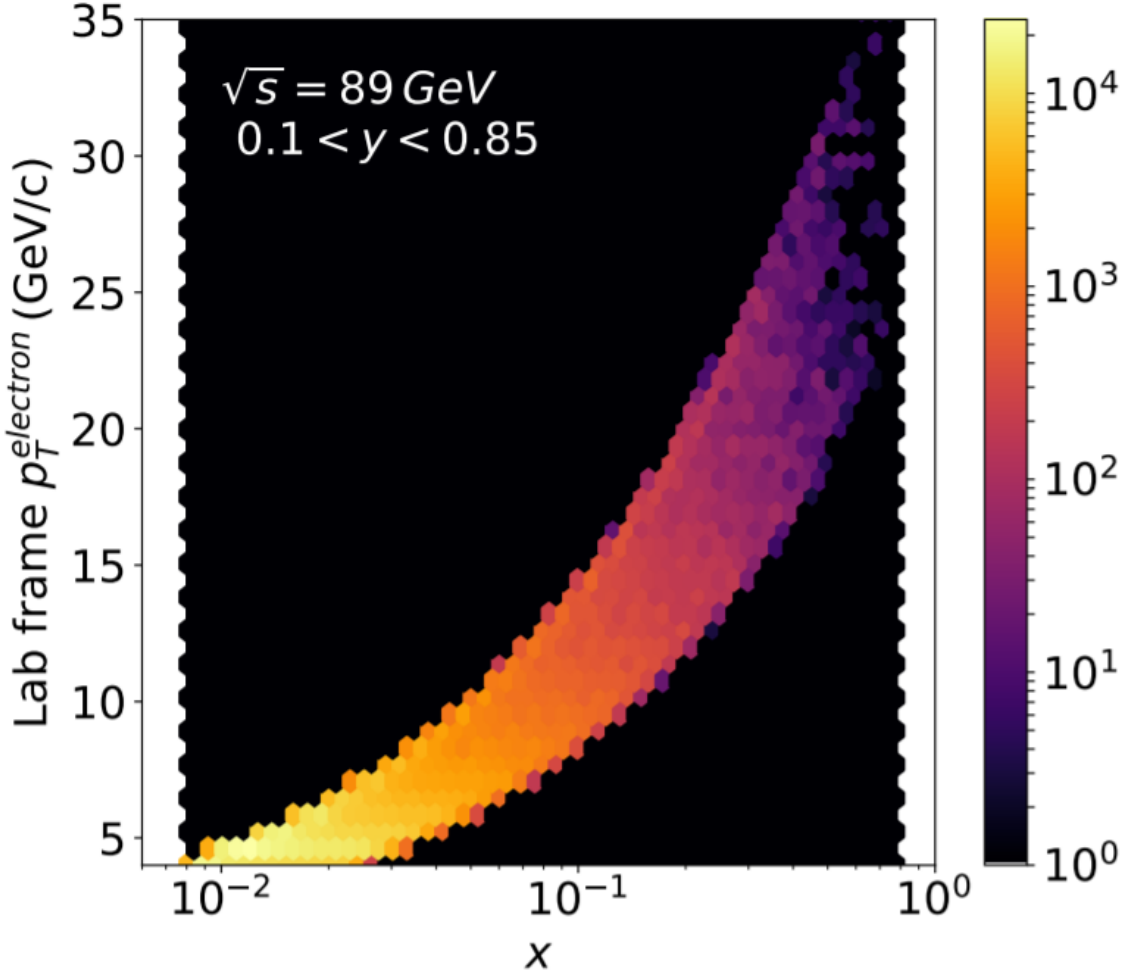
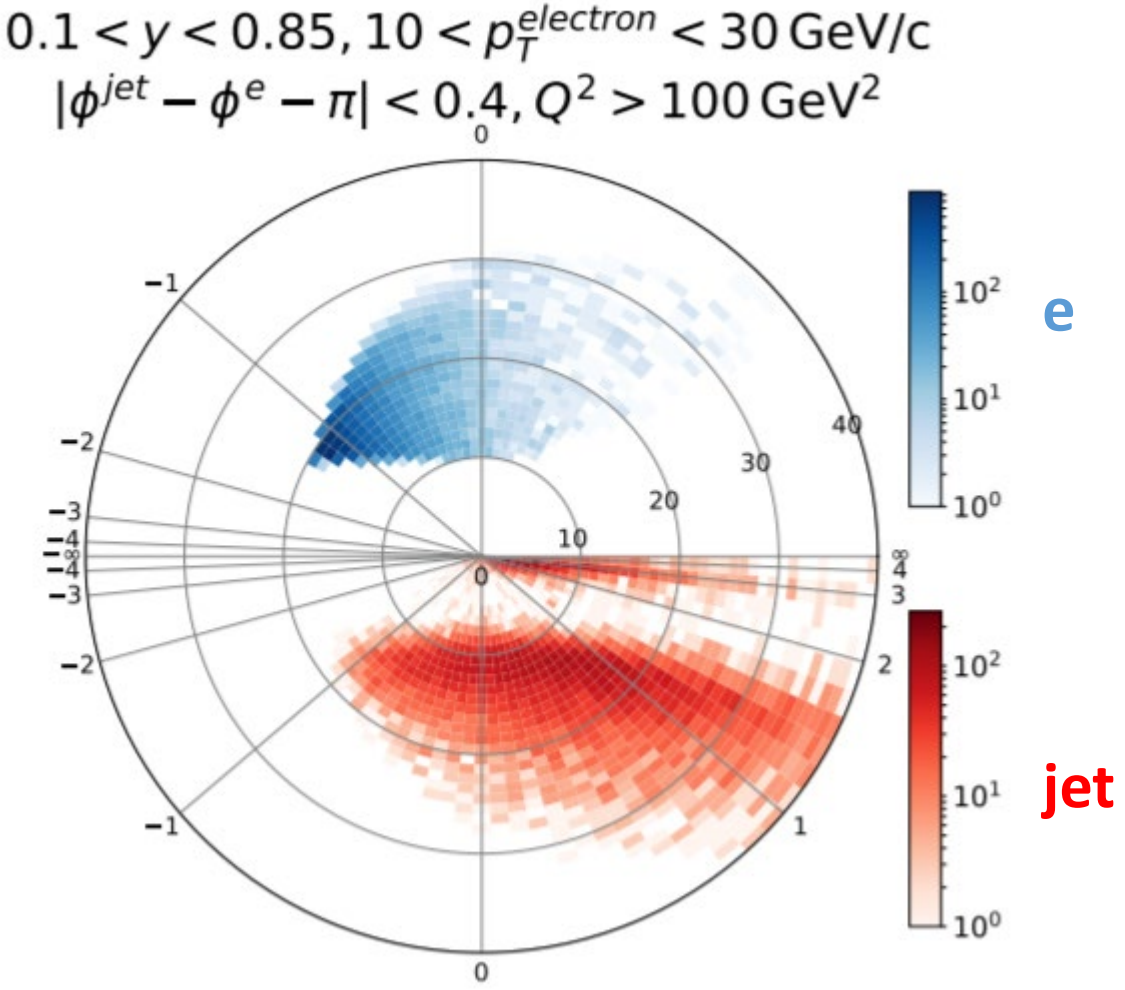


FIG. 3. The single transverse spin asymmetry as a function of $\Delta\phi = \phi_J - \phi_\ell - \pi$ for different lepton transverse momenta $k_{\ell\perp} = 7$, 10, and 15 GeV, respectively, which illustrates the transverse momentum dependence of the quark Sivers function.

"The advantage of the lepton-jet correlation as compared to the standard SIDIS processes is that it does not involve TMD fragmentation functions.".

Focus on large jet pT, (large x) region.





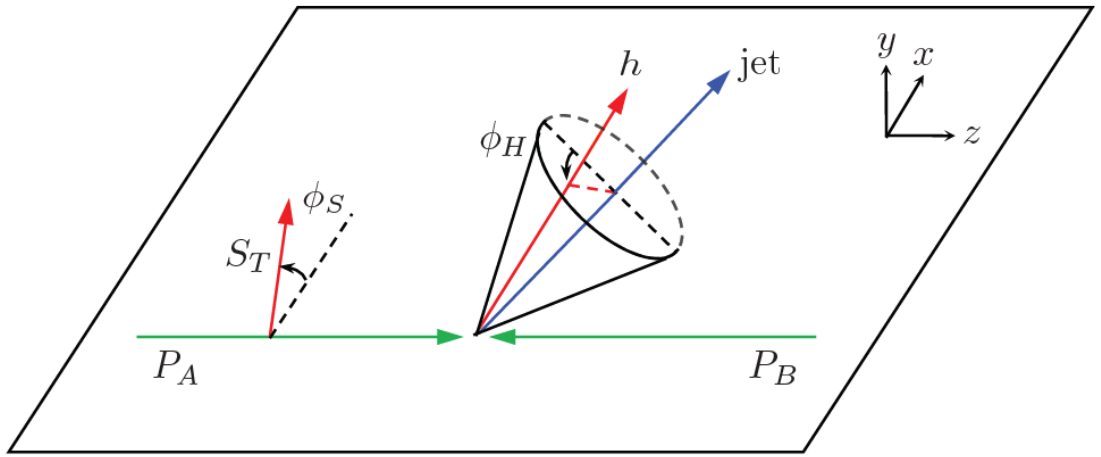
arXiv:1912.05931

Why bother with jets?

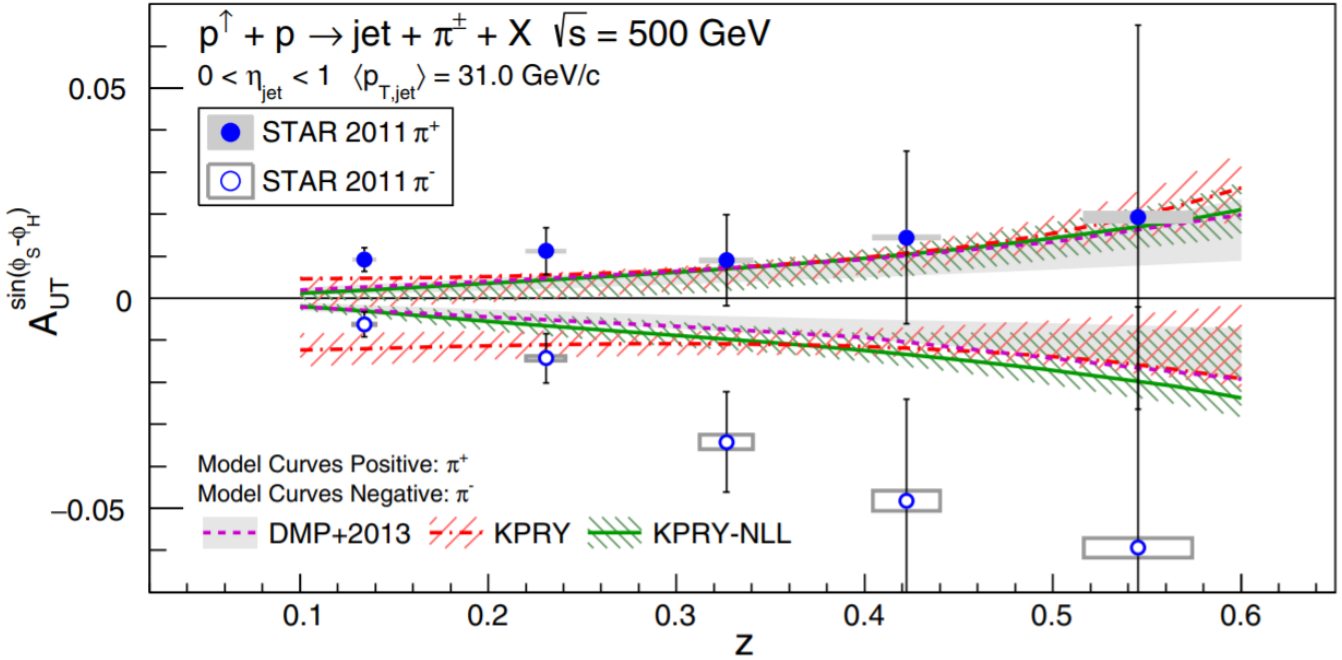
- Jets in DIS are an unprecedented tool for 3D imaging (not studied at HERA).
- Avoids convolution of TMD-PDF with TMD-FF.
  "direct" access to quark dynamics = cleaner theory interpretation.
- Brand-new, booming theory:
  "Transverse-Momentum-Dependent Distributions with Jets" PRL 121, 162001 (2018)
  "Lepton-Jet Correlations in Deep Inelastic Scattering at the EIC" PRL 122 192003 (2019)
- Opens up completely new field: jet substructure for 3D imaging, e.g:
  "Probing Transverse-Momentum Distributions **With Groomed Jets**" JHEP 1908 (2019) 161
- EIC polarization of nucleon and light nuclei will enable a whole suit of novel jet measurements.
- Unlike hadrons, no work exists on EIC projections. Uncrowded, green field.

Direct measurement of Collins effect with jets

"Collins azimuthal asymmetries of hadron production inside jets",
Phys. Lett. B 774, 635 (2017), Kang et al.
"The transverse momentum distribution of hadrons within jets"
JHEP 1711 (2017) 068, Kang et al.



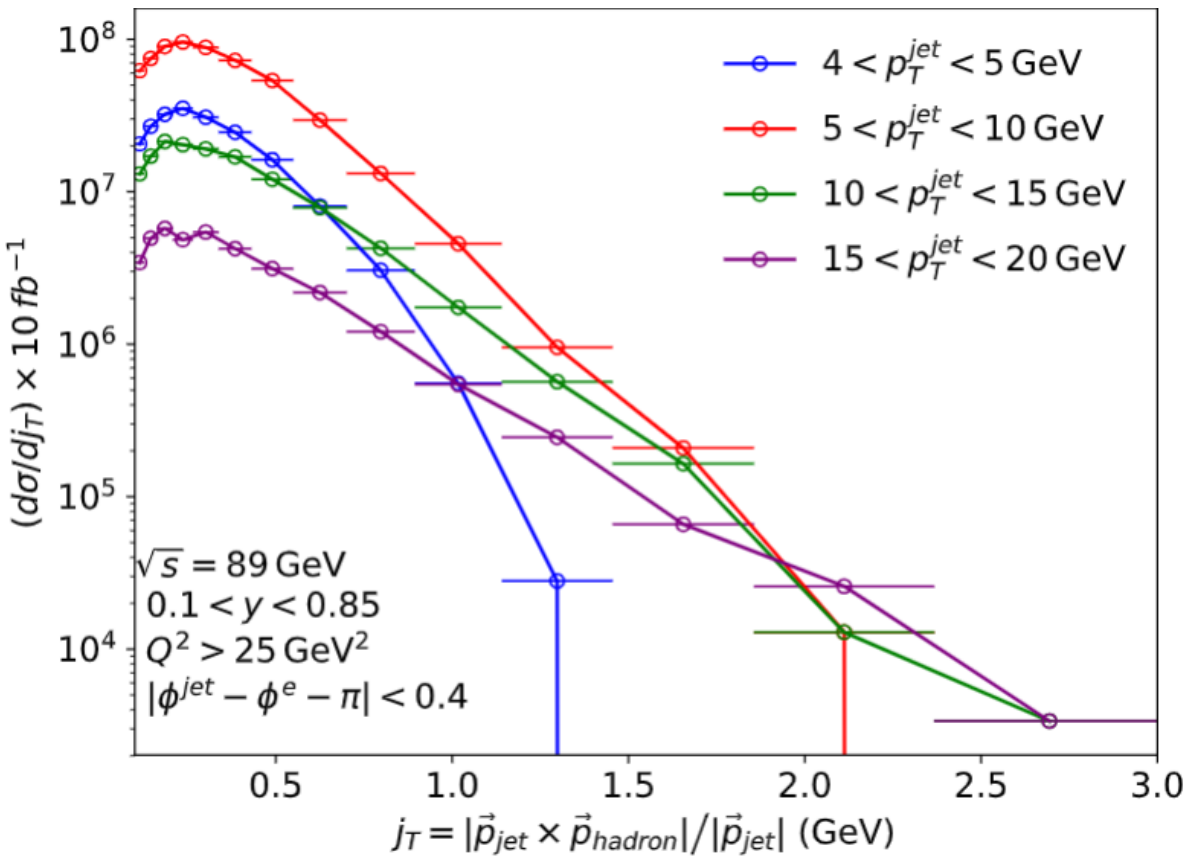
STAR Collaboration, Phys. Rev. D 97, 032004 (2018)

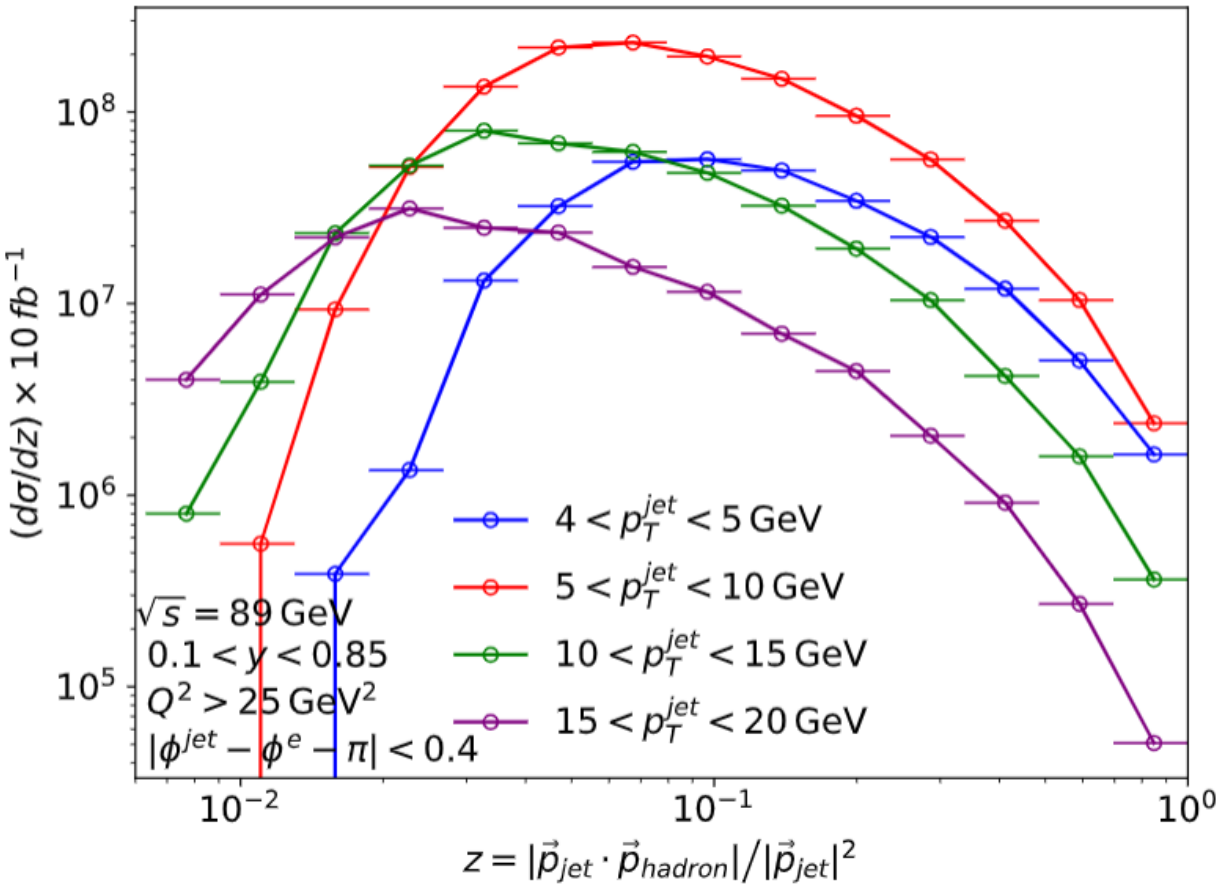


- At EIC, we could explore TMD evolution & universality with much higher precision, kinematic control.

Hadrons-in jet @ EIC

Plots by Youqi





Questions we want to answer this year

- What tracking and calorimeter specs we need to make electron-jet correlation measurements?
- What x range can we cover with these jet measurements?
- What would be the optimum center-of-mass energy to make these measurements?
- What can we test and learn from overlap with 12 GeV JLab and forward STAR?

We plan to aim for papers or reports outside the yellow report umbrella:

- Projection of key jet-TMD measurements (Sivers, Collins) and theory predictions **(need theorist)**
- Standalone contributions to yellow report focused on "JLab Science" **(with JLEIC group, ongoing)**
- MRPI report ???

Other plans (Miguel)

- Setup up lab at UCR.
  - 750 sq.ft + 400 sq.ft, class 7 cleanroom + startup funds for new equipment (~280 k)
  - Aim at EIC R&D activities and other projects. Focus on silicon.
- “EIC pathfinder” research at JLab with CLAS focused on e-A

- e-A Di-hadron correlations
- e-A SIDIS with polarized electron, DIS and SIDIS with polarized Lithium-7.

Backup slides

According to the white paper, this is an EIC flagship measurement

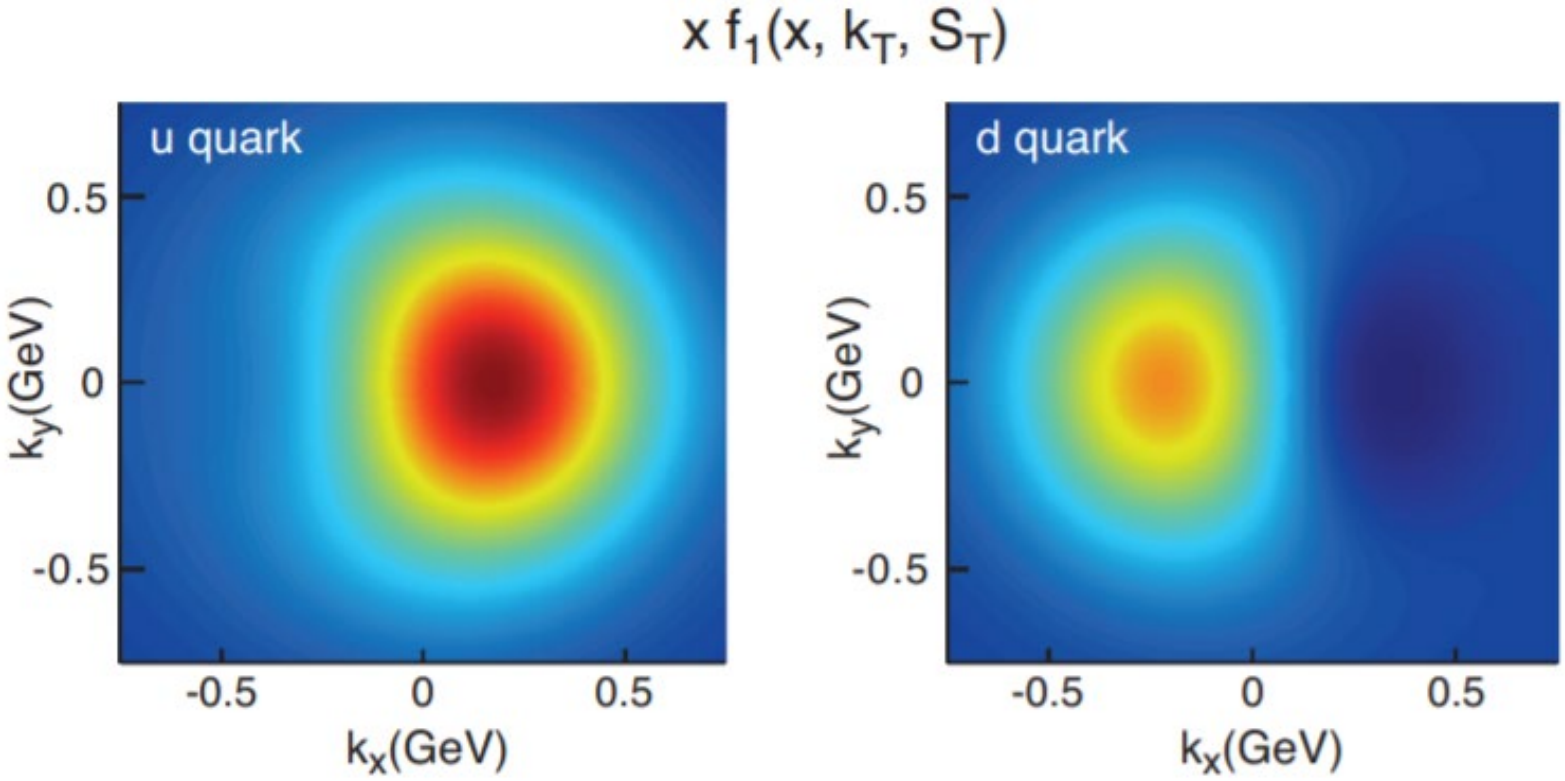
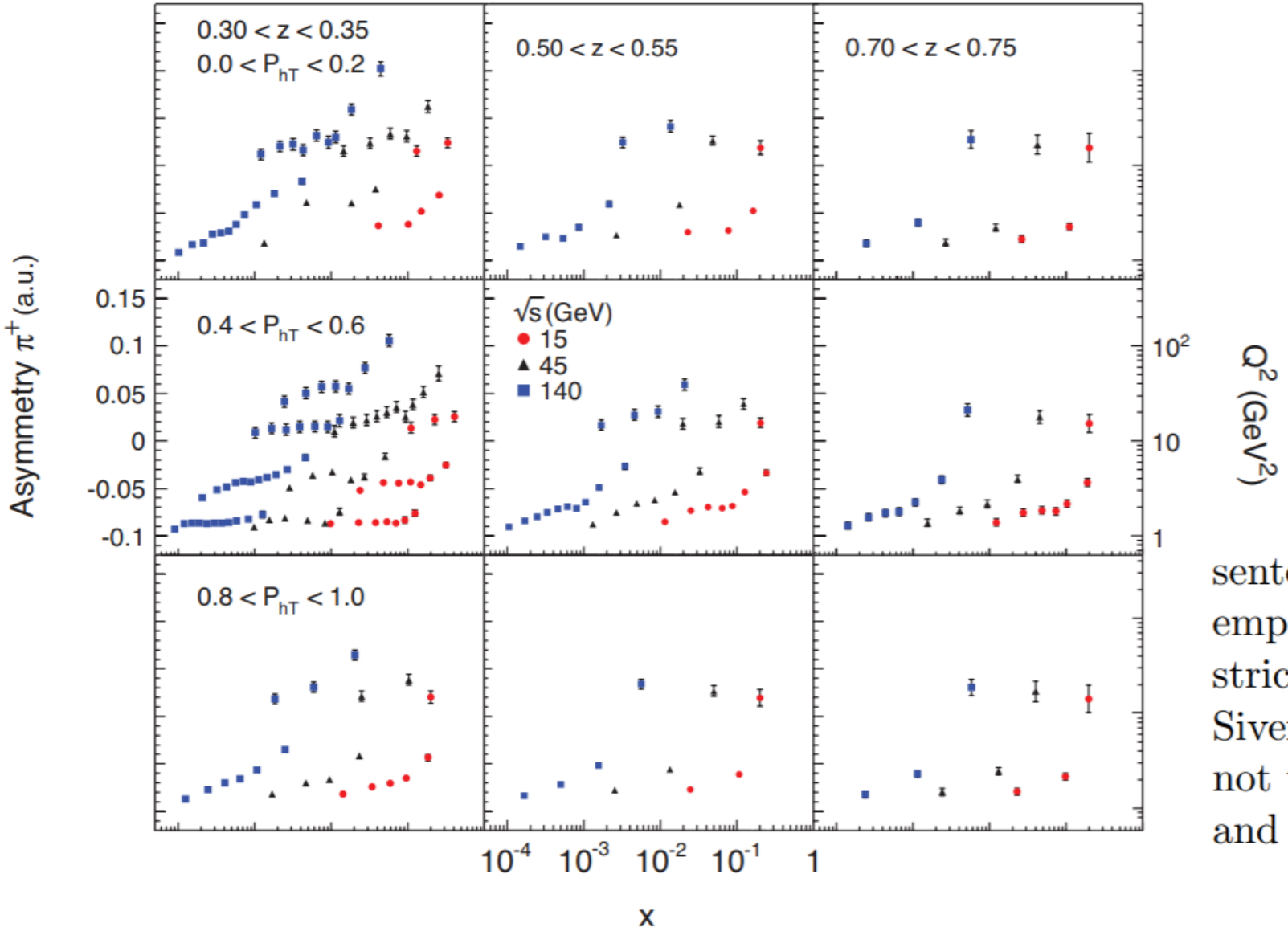


Figure 2.13: The density in the transverse-momentum plane for unpolarized quarks with $x = 0.1$ in a nucleon polarized along the $\hat{y}$ direction. The anisotropy due to the proton polarization is described by the Sivers function, for which the model of [77] is used. The deep red (blue) indicates large negative (positive) values for the Sivers function.

From White paper:



sented by the light grey band. It should be emphasized that our current knowledge is restricted to only a qualitative picture of the Sivers function and the above analysis did not take into account the model dependence and the associated theoretical uncertainties.

When using hadrons, one gets convolutions of the form:

$$C[wfD] = x_B \sum_q e_q^2 \int d^2\boldsymbol{p}_T\, d^2\boldsymbol{k}_T\, \delta^{(2)}(\boldsymbol{p}_T - \boldsymbol{k}_T - \boldsymbol{P}_{h\perp}/z)\, w(\boldsymbol{p}_T, \boldsymbol{k}_T)\, f^q(x_B, p_T^2)\, D^q(z, k_T^2), \quad (3.106)$$

with the unit vector $\hat{\boldsymbol{h}} = \boldsymbol{P}_{h\perp}/|\boldsymbol{P}_{h\perp}|$, where $w(\boldsymbol{p}_T, \boldsymbol{k}_T)$ is an arbitrary function.

Sivers

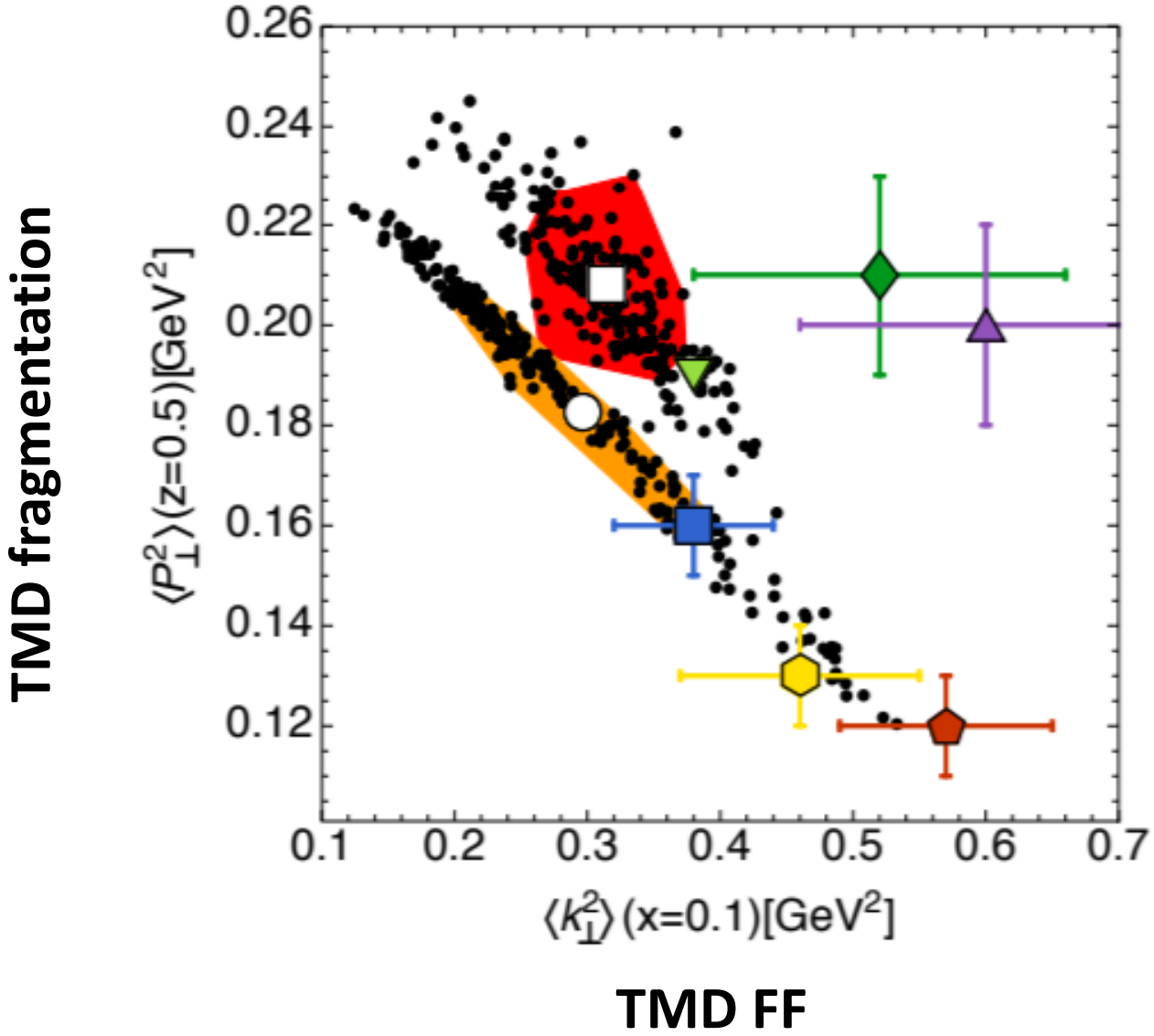
$$F_{UT,T}^{\sin(\phi_h - \phi_S)} = C\left[-\frac{\hat{\boldsymbol{P}}_{h\perp} \cdot \boldsymbol{p}_T}{M} f_{1T}^{\perp} D_1\right]$$

Collins

$$F_{UT}^{\sin(\phi_h + \phi_S)} = C\left[-\frac{\hat{\boldsymbol{P}}_{h\perp} \cdot \boldsymbol{k}_T}{M_h} h_1 H_1^{\perp}\right],$$

Leads to ambiguity due to large correlations….

https://arxiv.org/pdf/1703.10157.pdf

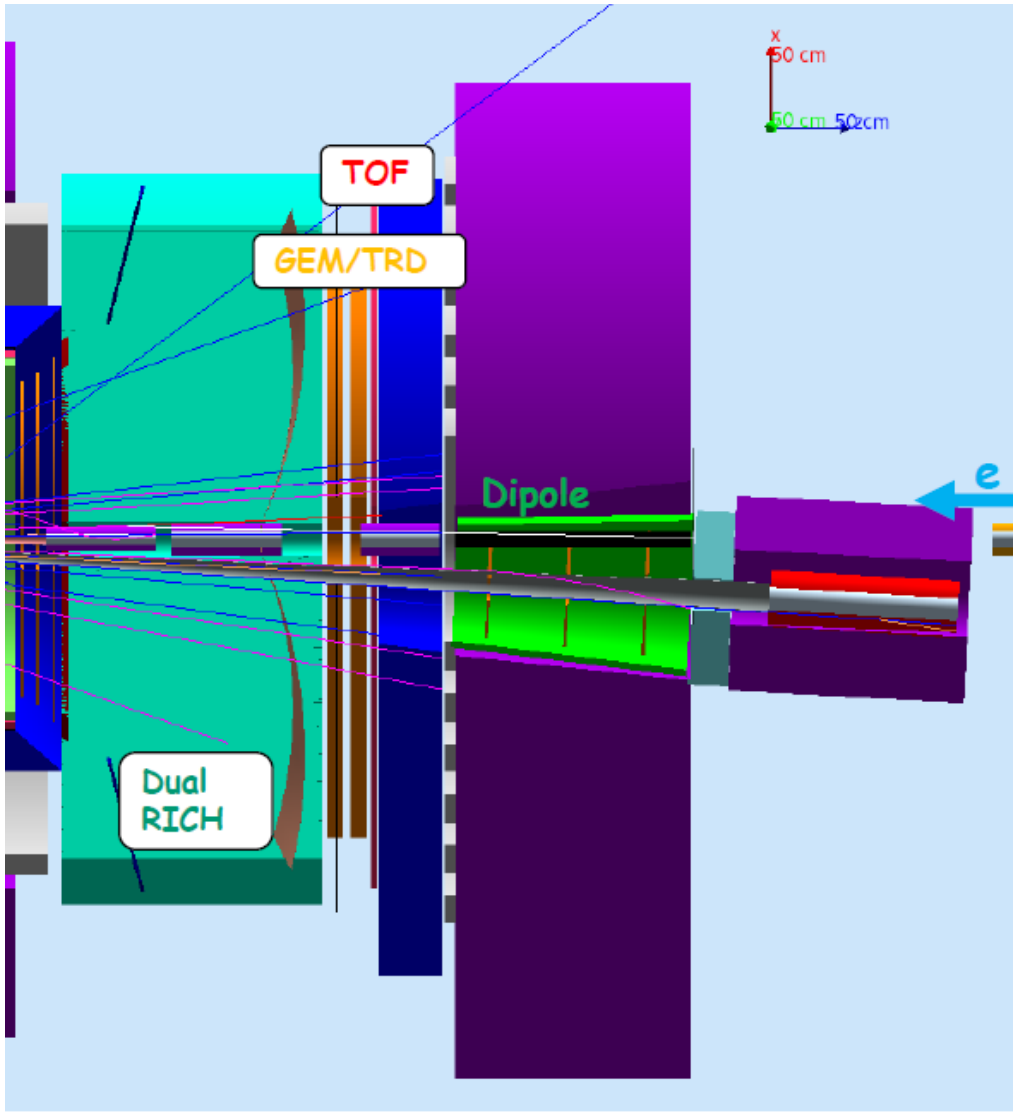


Plus, many other assumptions:

- $D^q(z, k_T^2)$ factorizes
- Is Gaussian in kT
- No flavor dependence
- Scale assumptions
- Etc, etc…

Other possibilities, plenty of room for UC collaboration

This configuration (similar for other EIC designs) will be a first for colliders



- As Oleg mentioned in our first UC consortium meeting, it might be possible to improvement HCAL jet response with leading-hadron PID info.
- PID for jet substructure and jet tagging (strange jets?)
- Measurements of “beam-remnant jet” with forward HCAL, correlations.