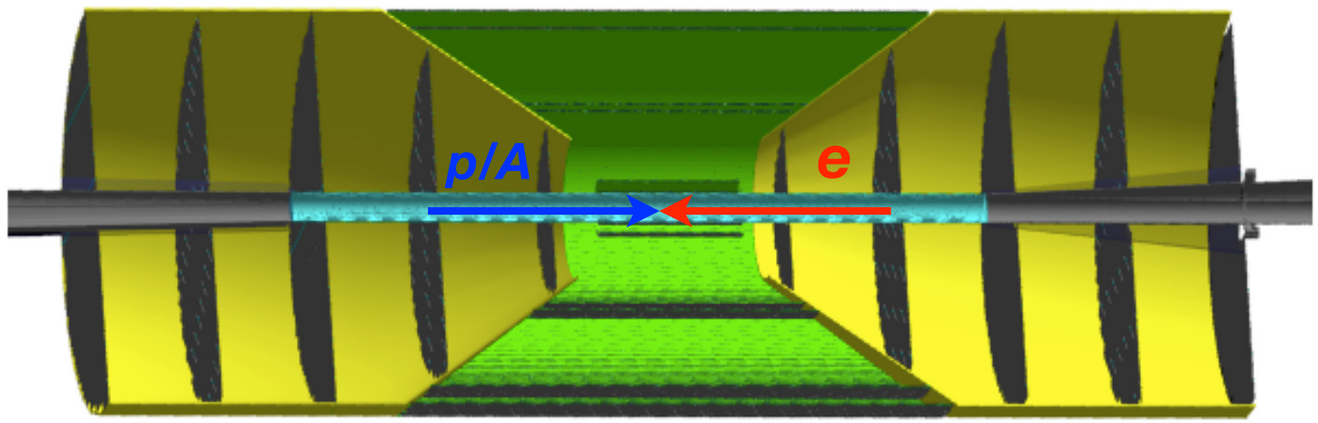
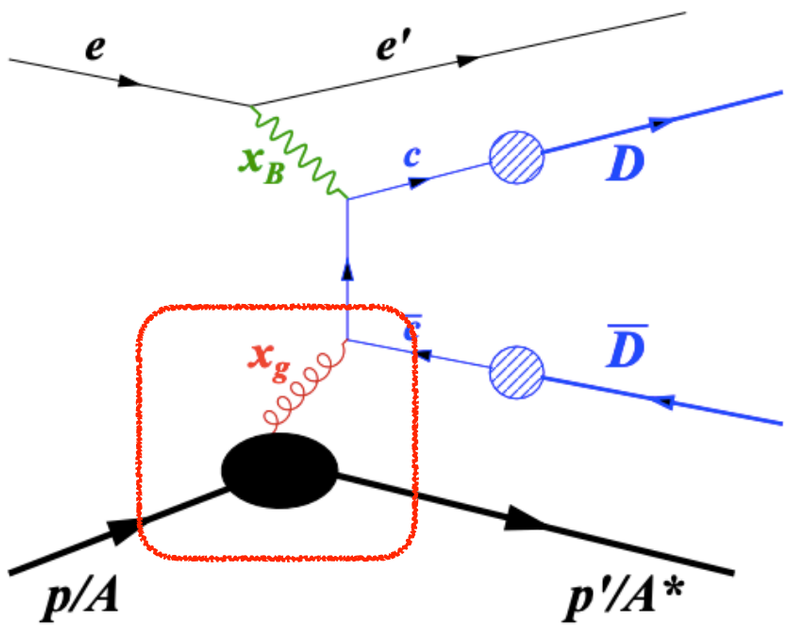
Probing Gluon Dynamics and Hadronization with Heavy Flavor Production at the Future Electron Ion Collider

Xin Dong (Lawrence Berkeley National Lab - LBNL)
Wenqing Fan (LBNL)
Yuanjing Ji (LBNL)
Matthew Kelsey (Wayne State Univ.)
Sooraj Radhakrishnan (Kent State Univ.)
Ernst Sichtermann (LBNL)
Yuxiang Zhao (Inst. of Modern Phys., Lanzhou)

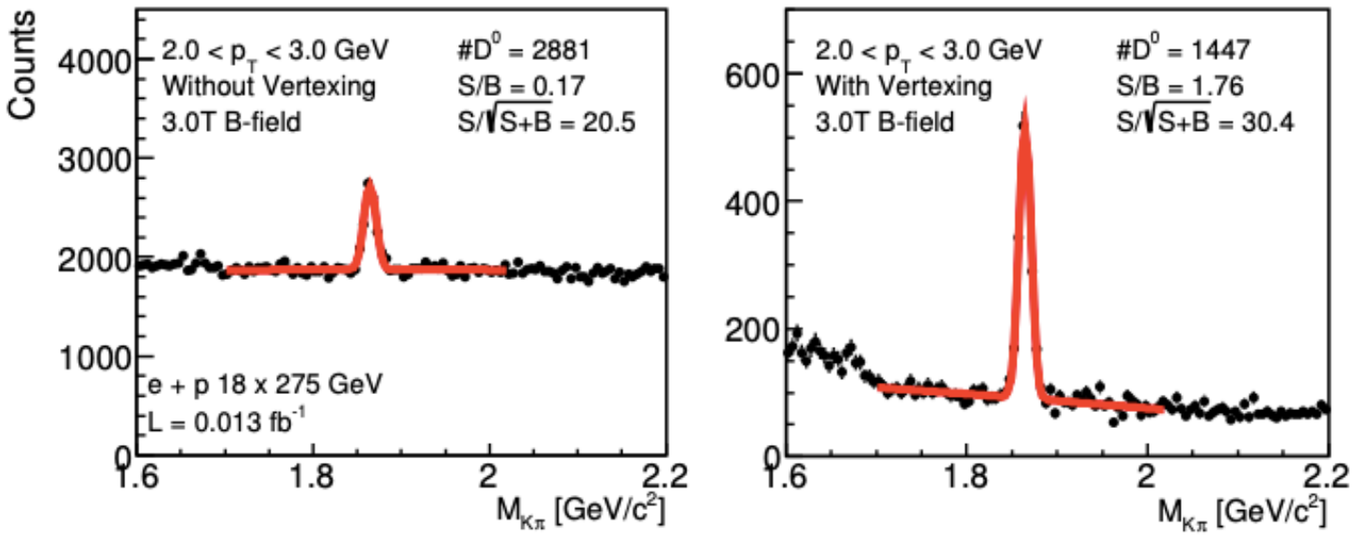
Si-tracker concept for EIC experiment



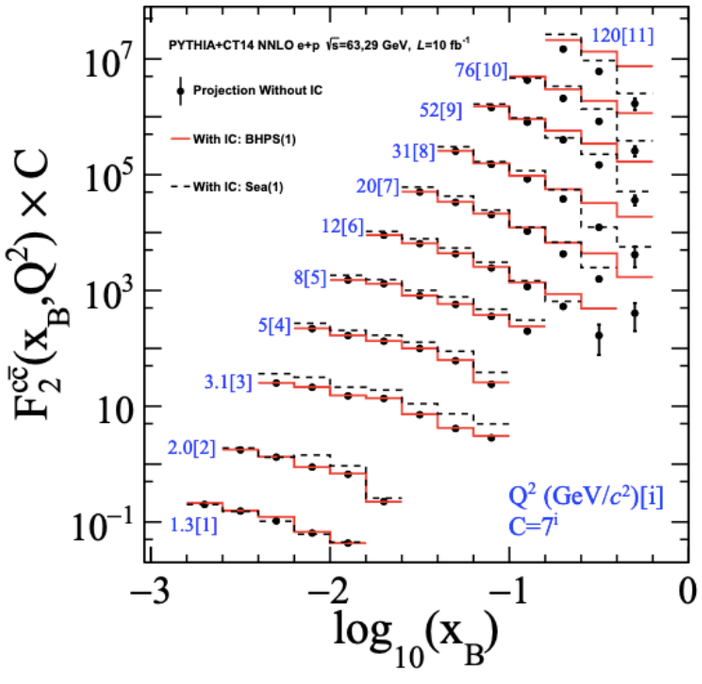
arXiv: 2102.08337



Simu. of topological recon. of D^0 in ep DIS

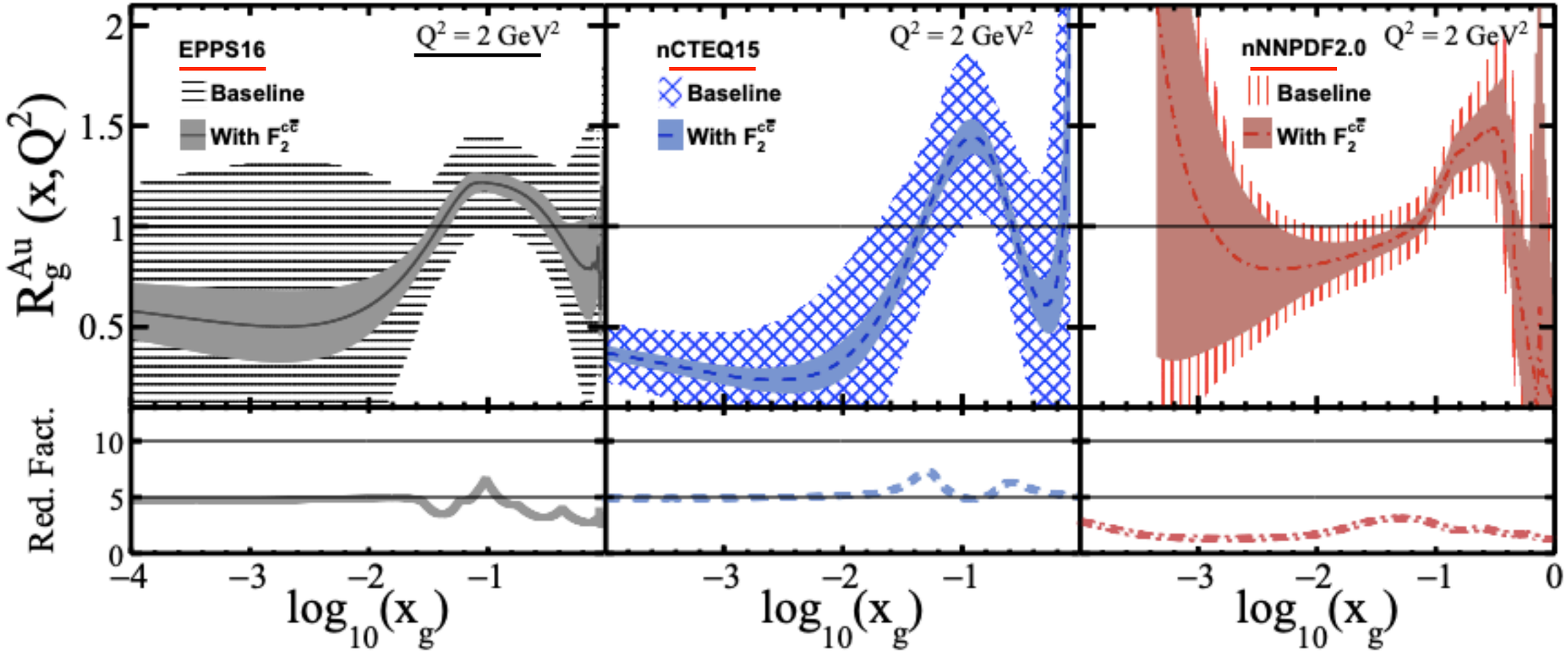


Charm Structure Function $F_2^{c\bar{c}}$ and Gluon nPDF



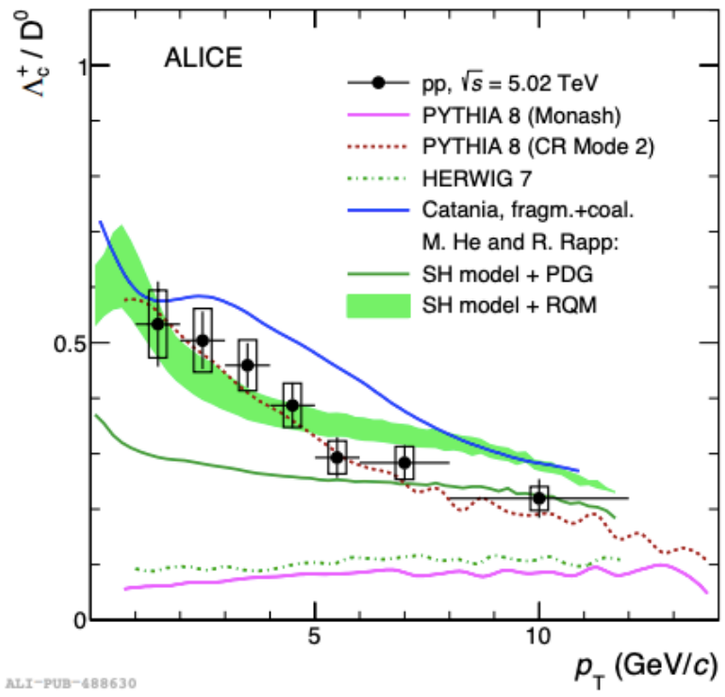
- Exclusive D-meson reconstruction with Si-tracker
- Extend HERA measurement to high x region
- Significant impact on gluon nPDF with ep/eA, especially at high x region

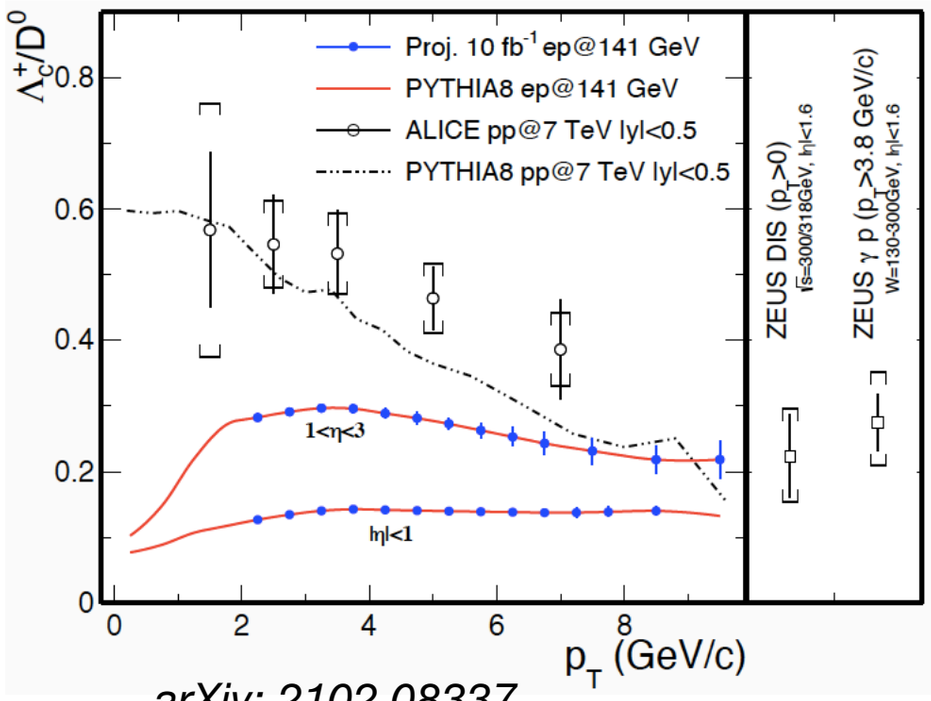
Projections with D-meson + DMT requirement $1\ fb^{-1}\ ep + 1\ fb^{-1}/A\ eAu$



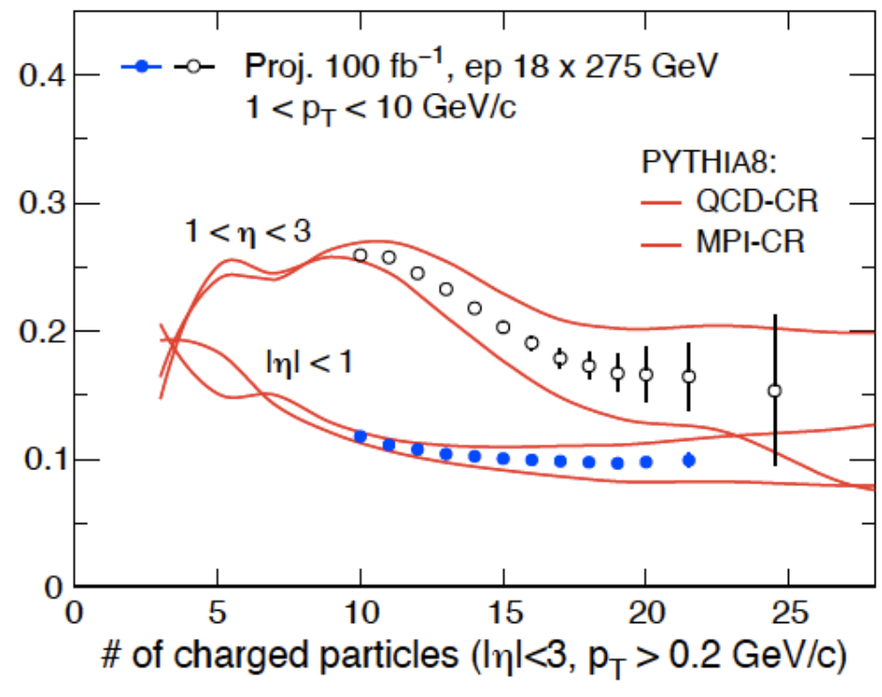
M. Kelsey et al, PRD 104 (2021) 054002

Fragmentation/Hadronization/Cold Nuclear Matter Effect

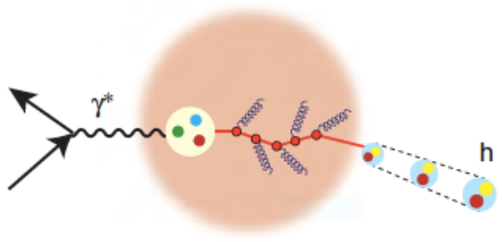


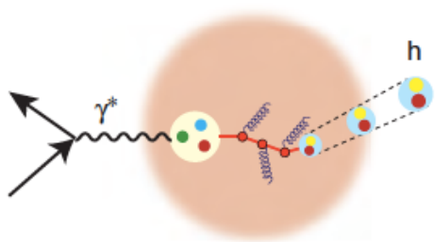


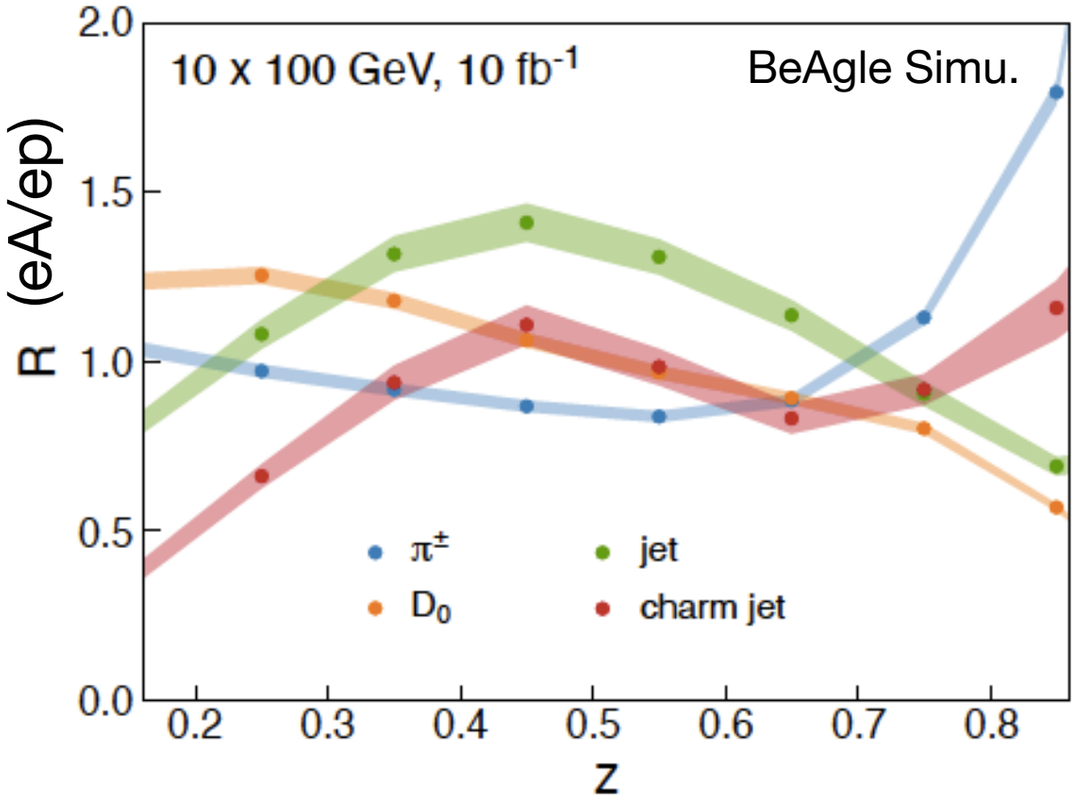
arXiv: 2102.08337



- Systematic measurement of charm baryons
  - multi-differential (p_T, multiplicity etc)
- Charm/light fragmentation measurement in ep/eA
  - fragmentation/cold nuclear matter effect







Gluon Helicity $\Delta g/g$

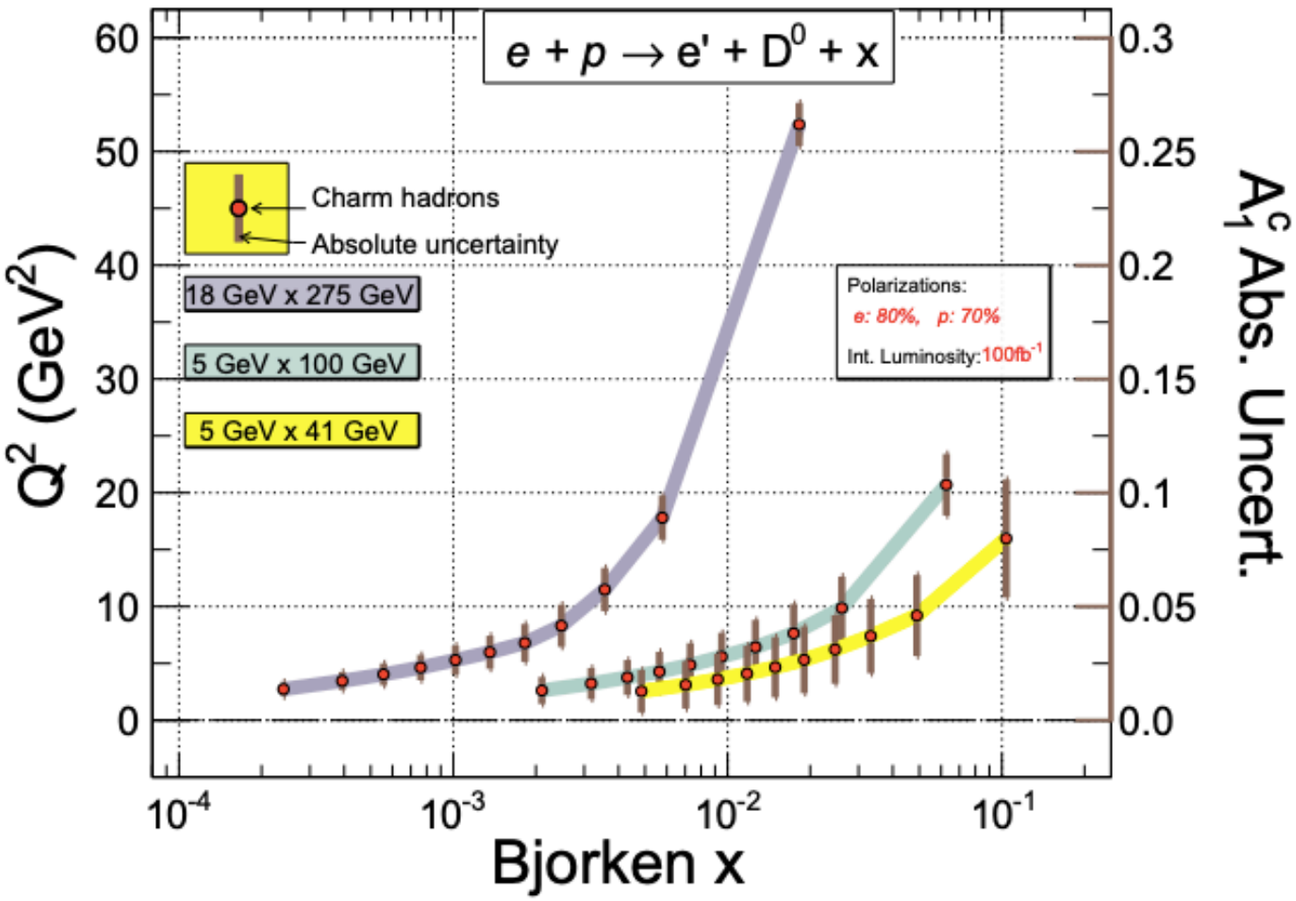
Understanding proton spin is one of the EIC science goals

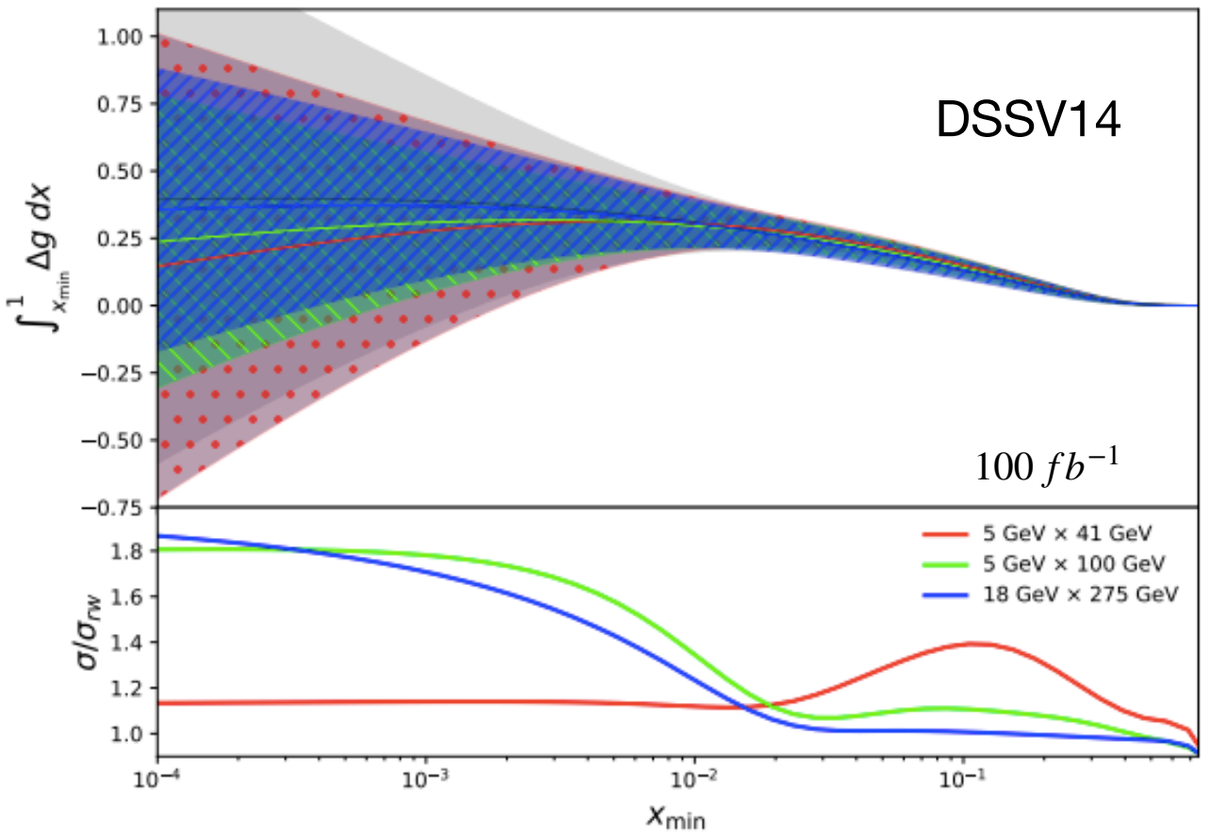
HF - better sensitivity to the gluon dynamics
- complementary to the inclusive measurement
- direct access to $\Delta g/g$ LO $A_{LL} \propto \hat{a}_{LL} \times \Delta g/g$

data placed at each measured (x_B, Q^2) position

error bars - uncertainty of A_1^c

$$A_1^c \equiv \frac{g_1^c(x,Q^2)}{F_1^c(x,Q^2)} = \frac{1}{D(y)} \frac{1}{P_e P_p} \frac{N^{++} - N^{+-}}{N^{++} + N^{+-}}$$





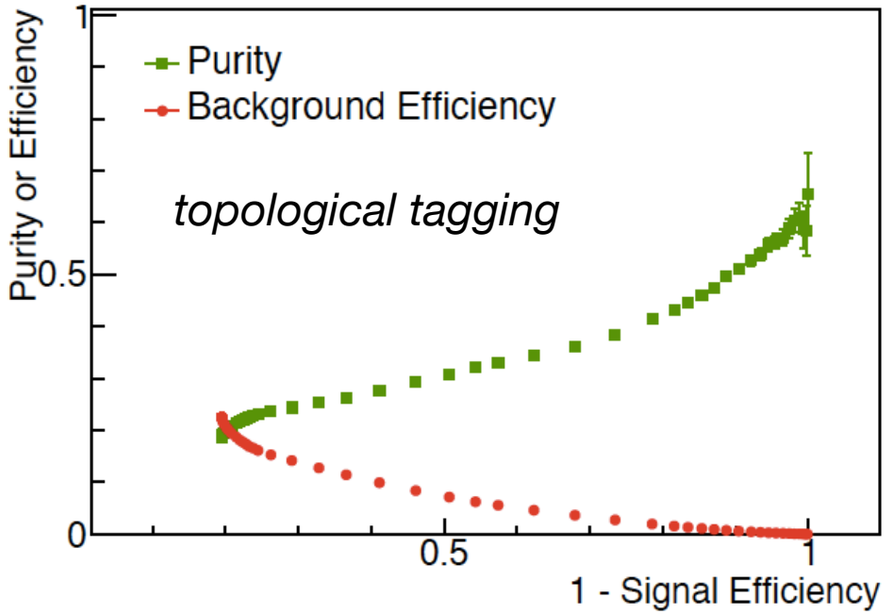
D.P. Anderle et al, PRD 104 (2021) 114039

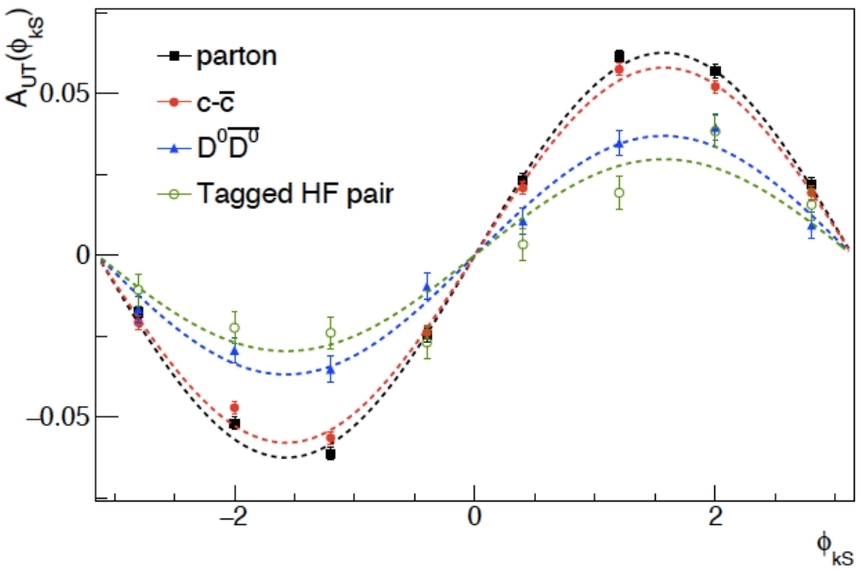
grey - original uncert.
colored - w/ EIC charm data at different energies

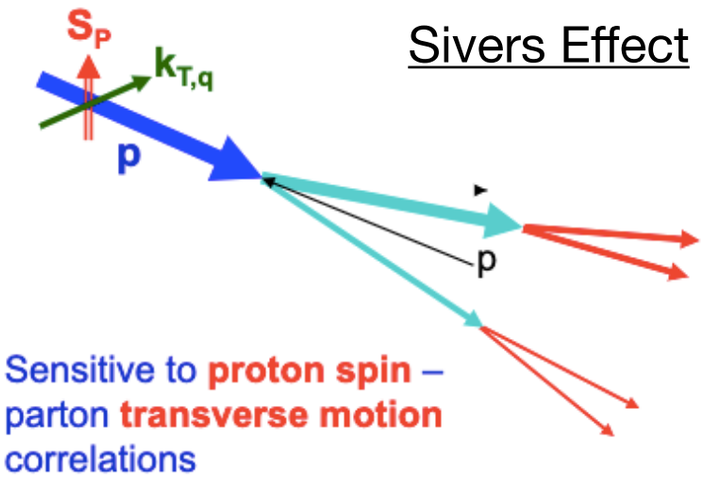
Heavy Flavor Pair - Probe Gluon TMDs

Charm/anti-charm pair in transverse polarized exp.
- gluon Sivers functions

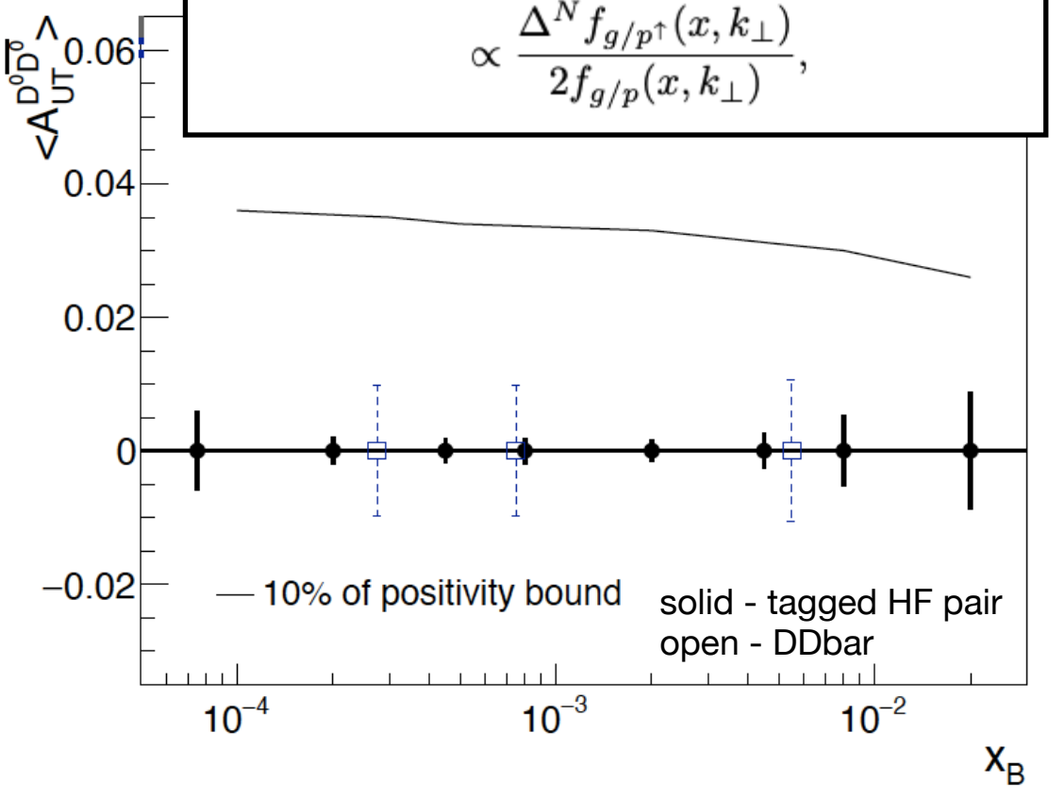
L. Zheng et. al., PRD 98 (2018) 034011







$$A_{UT}(\phi_{kS}, k_T) = \frac{d\sigma^{\uparrow}(\phi_{kS}, k_T) - d\sigma^{\downarrow}(\phi_{kS}, k_T)}{d\sigma^{\uparrow}(\phi_{kS}, k_T) + d\sigma^{\downarrow}(\phi_{kS}, k_T)} \propto \frac{\Delta^N f_{g/p^{\uparrow}}(x, k_{\perp})}{2 f_{g/p}(x, k_{\perp})},$$



Tagged HF pair - probe gluon TMDs to uncovered kinematic region at EIC