SIDIS status

16.3.2026 Early Science Workshop, Cosenza

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Anselm Vossen (Duke)

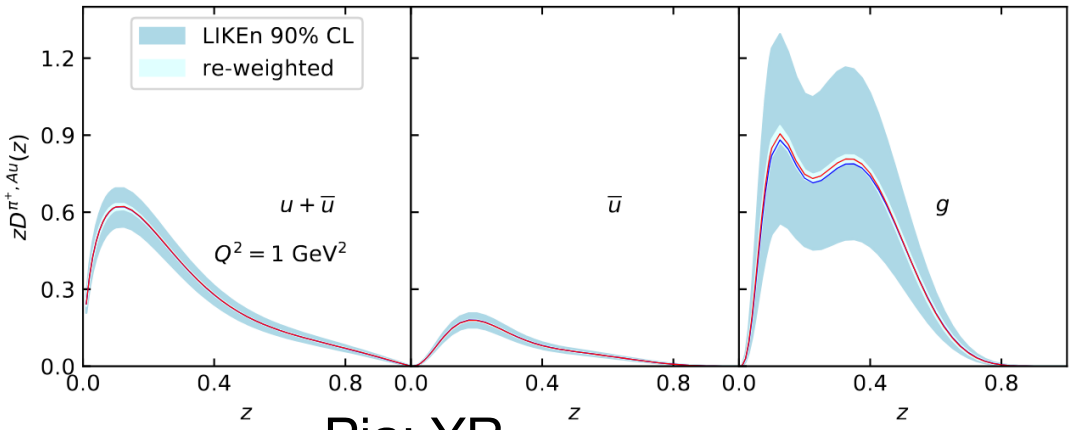
Topics

- Nuclear FFs and nPDFs
- Unpolarized PDF and TMD PDFs
- Sivers/Collins asymmetries
- Di-hadrons for low-x saturation
- Di-hadrons and D mesons for gluon TMDs, esp. Sivers

- Note: most of the current ESR figures are still from older studies and still need to be updated!

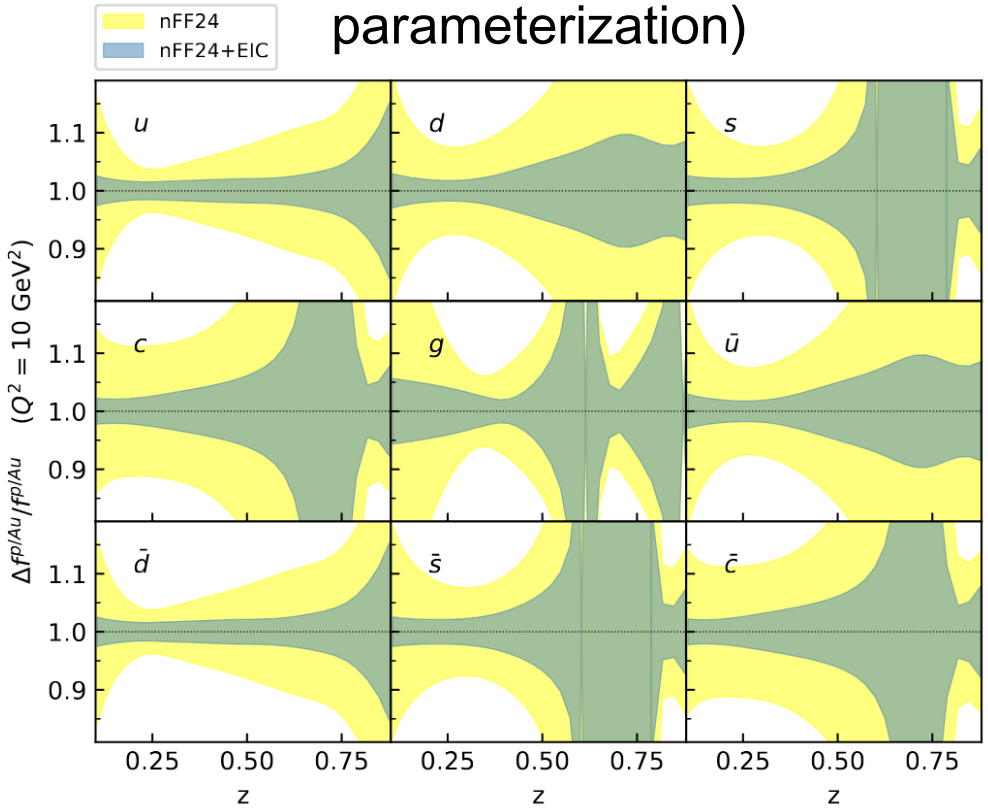
Nuclear FFs

- Revisiting YR impact studies on nFFs
- Start using the early science data: e+Cu and e+p at 10x100 used for now
- Need to look also e+Au 10x100 + e+p at 10x130 or 100
- Preference to have cross sections rather than R_{pA} s
- Some impact on nPDFs as well



Pia: YR

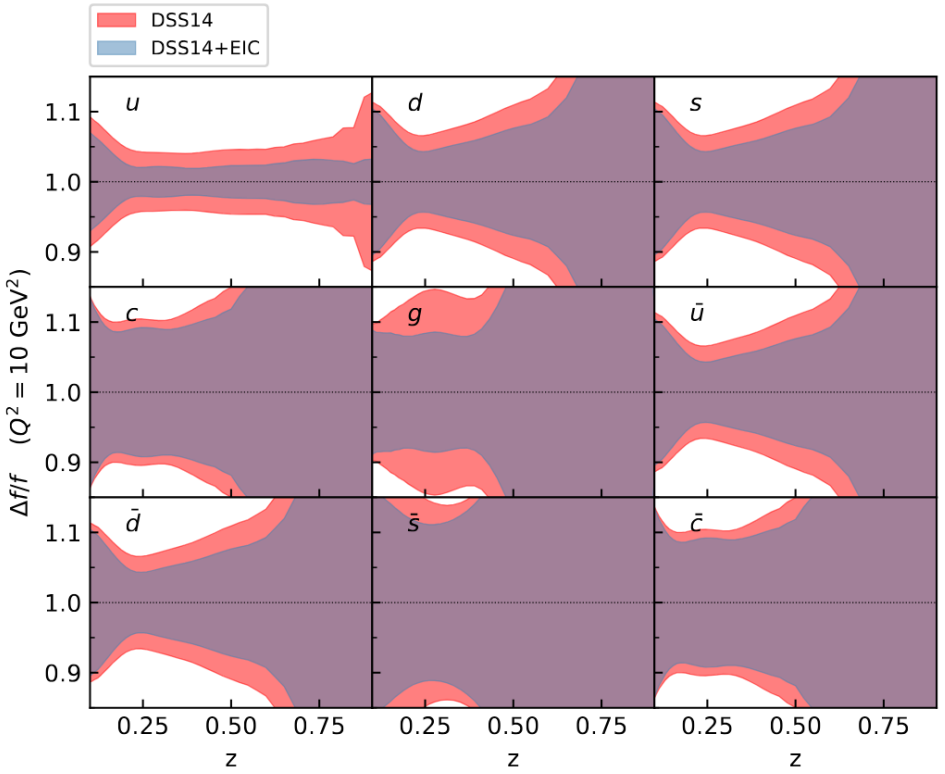
Early science e+Au (from parameterization)



Charlotte(exp)+Pia(pheno)

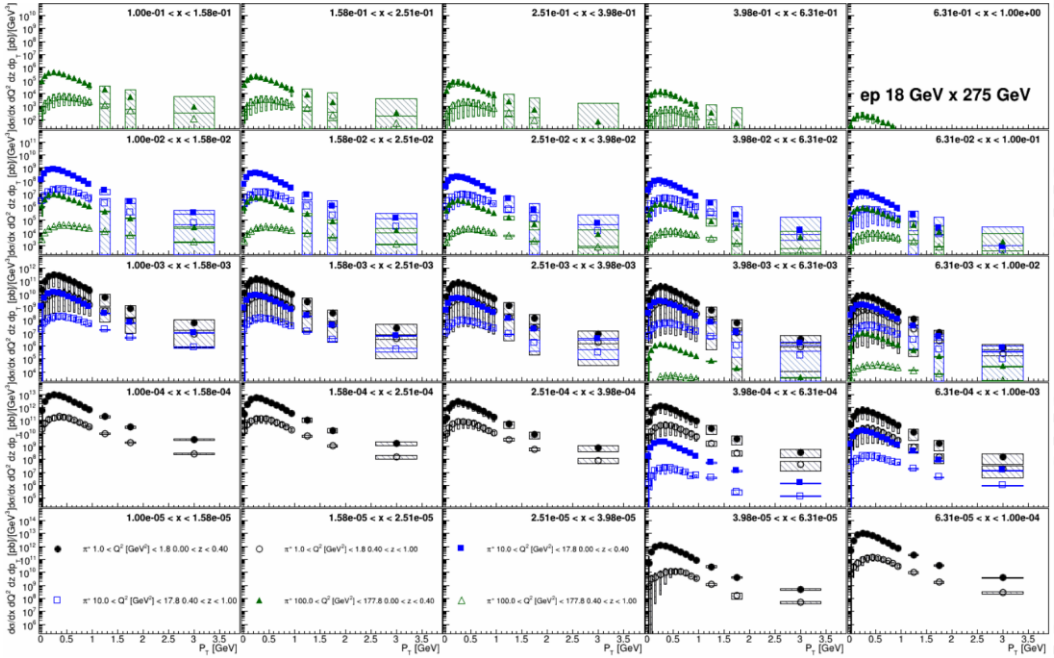
Fragmentation functions

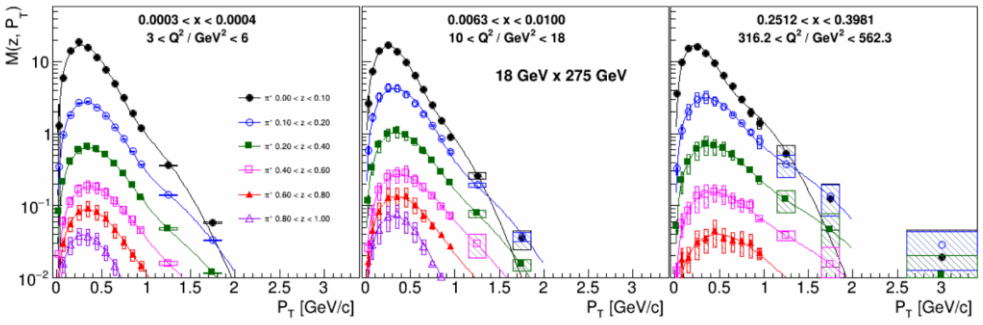
- Due to large amount of e^+e^-, fixed target SIDIS data, and some LHC data, not a huge impact expected from EIC data
- Nevertheless, some improvements for gluons and quarks at intermediate z visible
- Impact from combined PDFxFF global fit would be very important



Charlotte(exp)+Pia(pheno)

Unpolarized TMDs





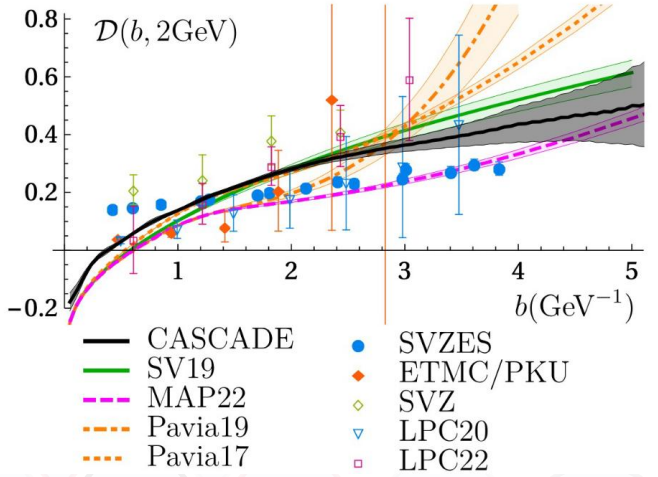
NIM A 1055 (2023) 168458

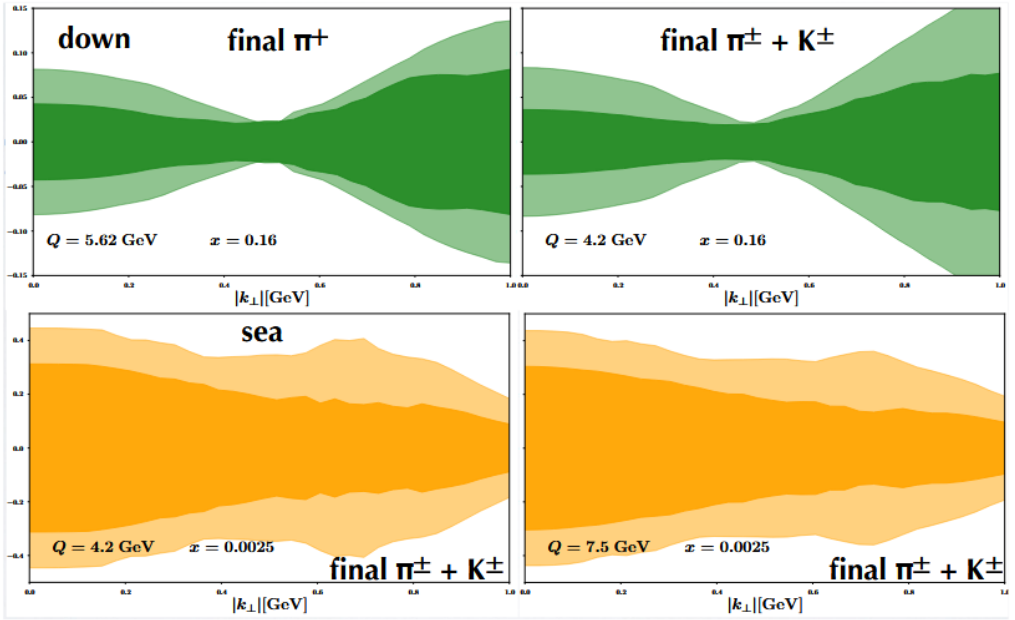
- Revisit the unpolarized TMD cross sections (x, Q^2, z and P_{hT} dependent) and multiplicities for light hadrons
- Start using the March campaign and early science energies

Susanna's group (exp)+Pavia group(pheno)

Impact on unpolarized TMDs

- Provide the March campaign pseudo-data to Pavia group (and others if possible) to obtain impact on unpol TMDs
- Need to discuss also how much current pheno analysis needs to be extended in terms of flavor dependence
- Still looking for a good way to highlight EIC impact on TMD evolution uncertainties (CS kernel)

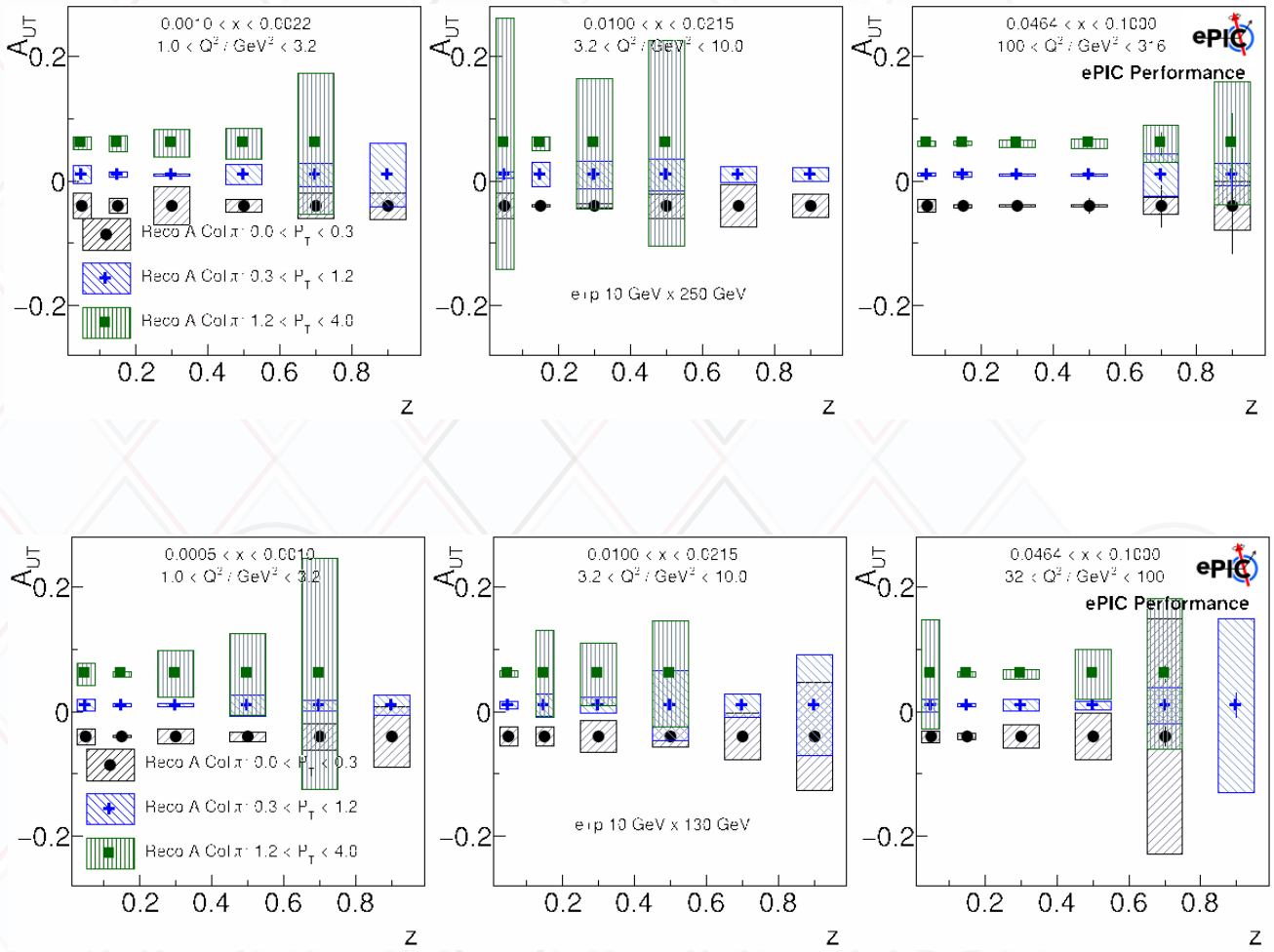




Susanna's group (exp)+Pavia group(pheno)

Collins/Sivers

- Infrastructure to extract Sivers/Collins pseudo-data for impact studies well established
- Need to adjust to early science energies and luminosities from March campaign (currently too low statistics)
- Try to implement more theoretical parameterizations and uncertainties to highlight impact directly on “measured” asymmetries (currently only fairly old Torino parametrizations available)

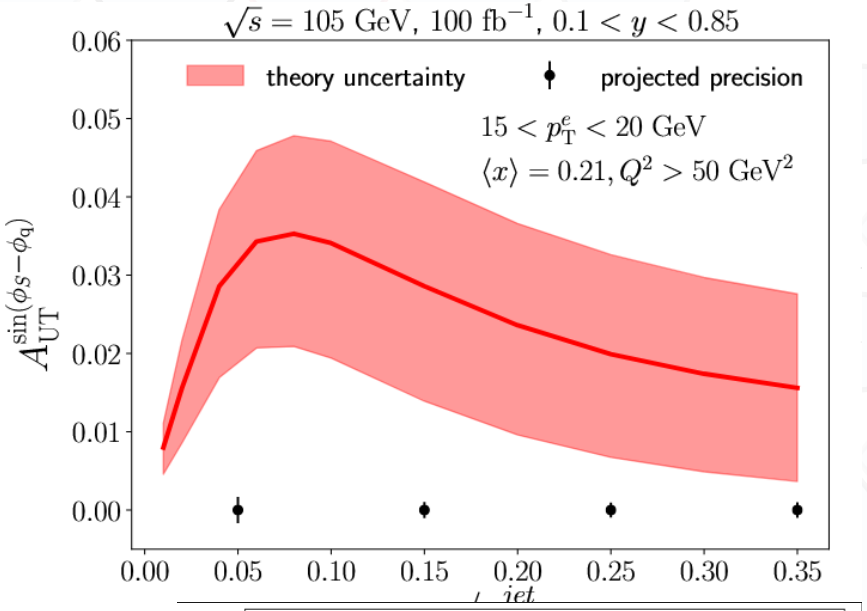


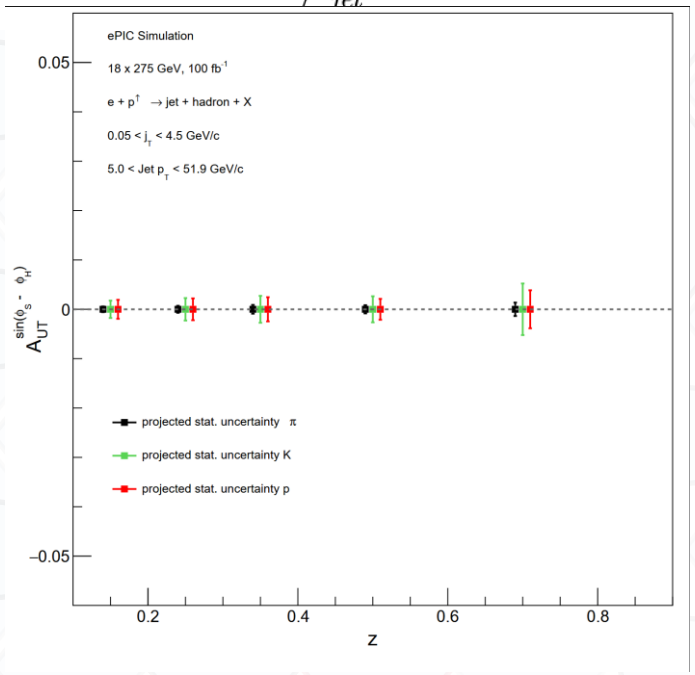
Currently 10 fb-1 assumed

Collins/Sivers in jets?

- Advantage of jets: no PDF - FF TMD convolution of transverse momenta
- Disadvantage: Flavor sensitivity generally lost
- Still important tool to add to global fits including SIDIS measurements – test how it improves TMD extractions

YR

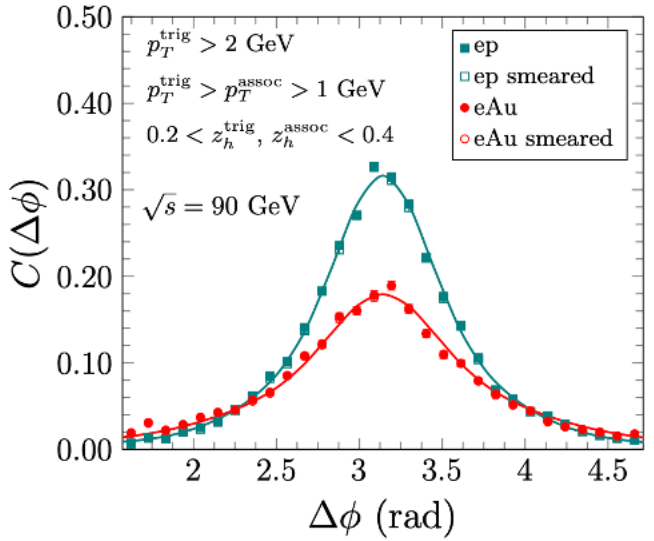


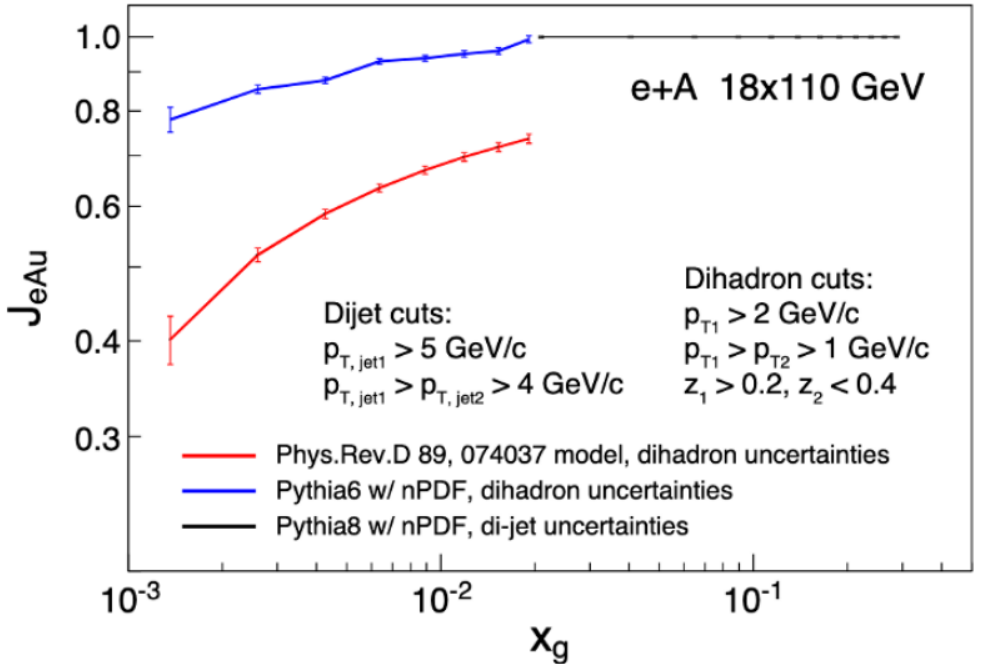


K.Adkins, pTDR

Di-hadrons for low x

- Revisit the di-hadron studies performed in the Yellow report:
- Back-to-back di-hadron broadening
- Reduction of di-hadron yield at low x expected

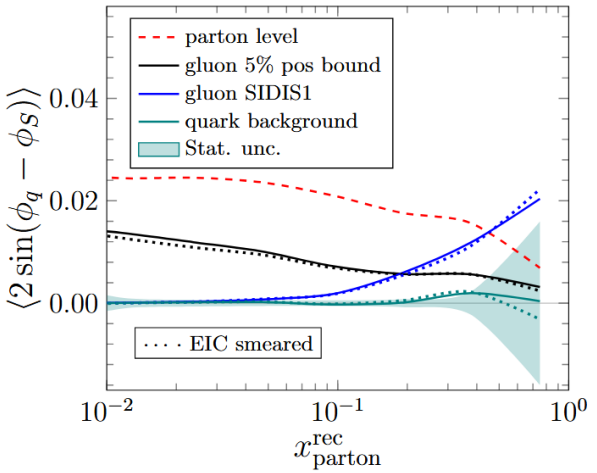




Athena proposal, based on *Zheng et al:* *PRD* 89 (2014) 074037

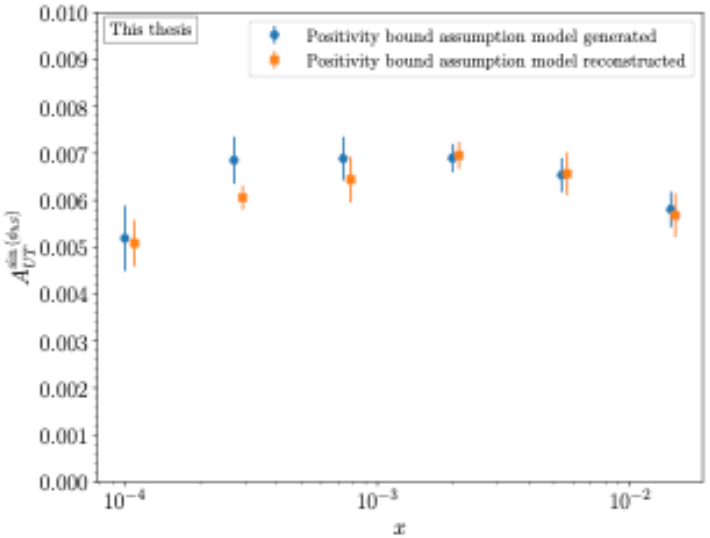
Di-hadrons and D^0 for Sivers

- Back-to-back di-hadrons have high likelihood to be produced from PGF, same for HF production
- Try to revisit di-hadron Sivers studies
- Use $D^0 \rightarrow K^-\pi^+$ as a clean probe of charm dynamics
- Access gluon transverse momentum distributions

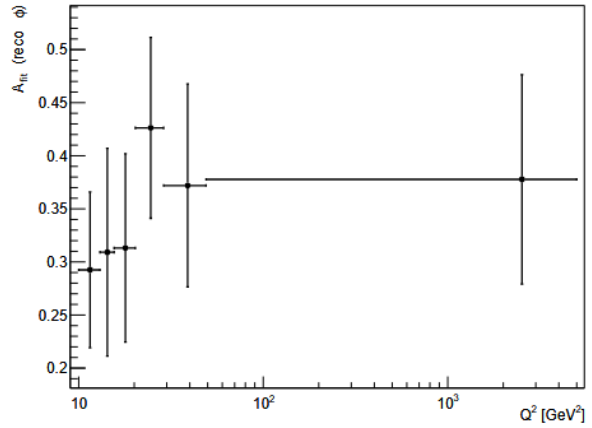


YR: Xiao

Jiménez López



Artificially introduced azimuthal asymmetry of 0.3

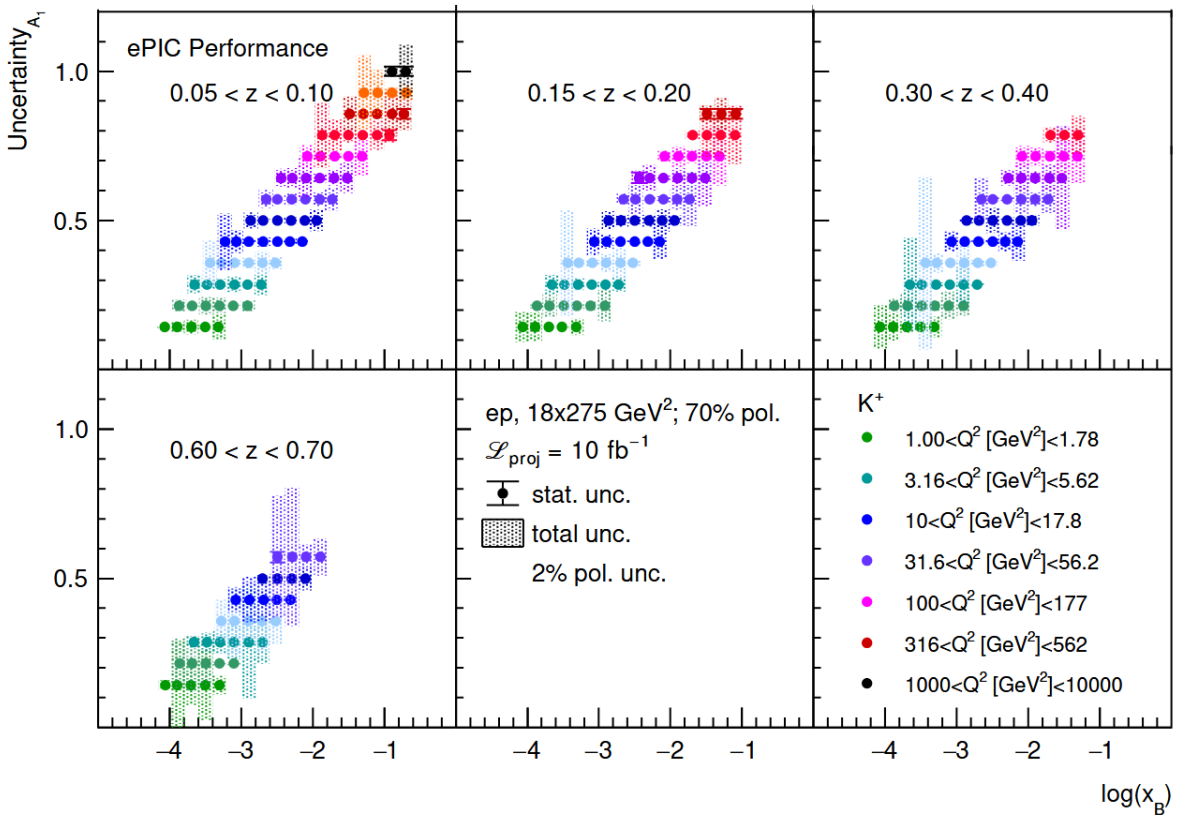


Extracted amplitude vs. Q^2.

Artur Hoghmrtsyan

Helicities

- Early science data should provide already a large part to the (sea)-quark helicity goals
- low x-Q2 region band will be accessed only at highest beam energies
- Overlap to fixed target data needs lowest proton beam energy
- impact of eD/e^{3}He for SIDIS asymmetries still needs to be evaluated



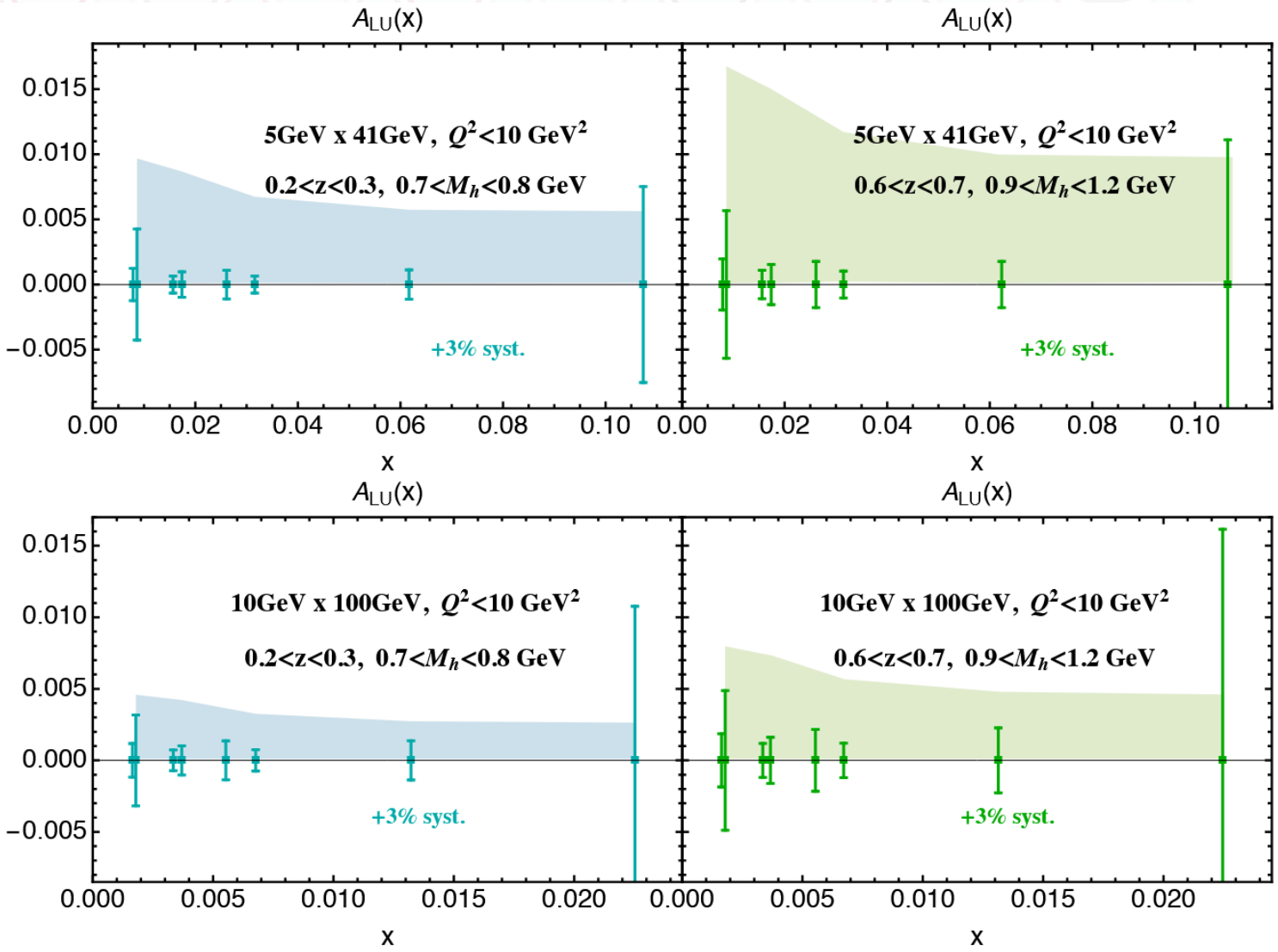
Charlotte

Other early science studies not covered

- Λ polarization transfer and polarizing FFs
- Higher twist TMDs and Boer-Mulders (will require excellent understanding acceptance), e, gT, etc
- Single Hadron inclusive A_Ns (similar to RHIC)
- Some suggestions to look at nPDFs and nFFs also in single hadron inclusive production (Watanabe, Qiu)

Higher twist function e

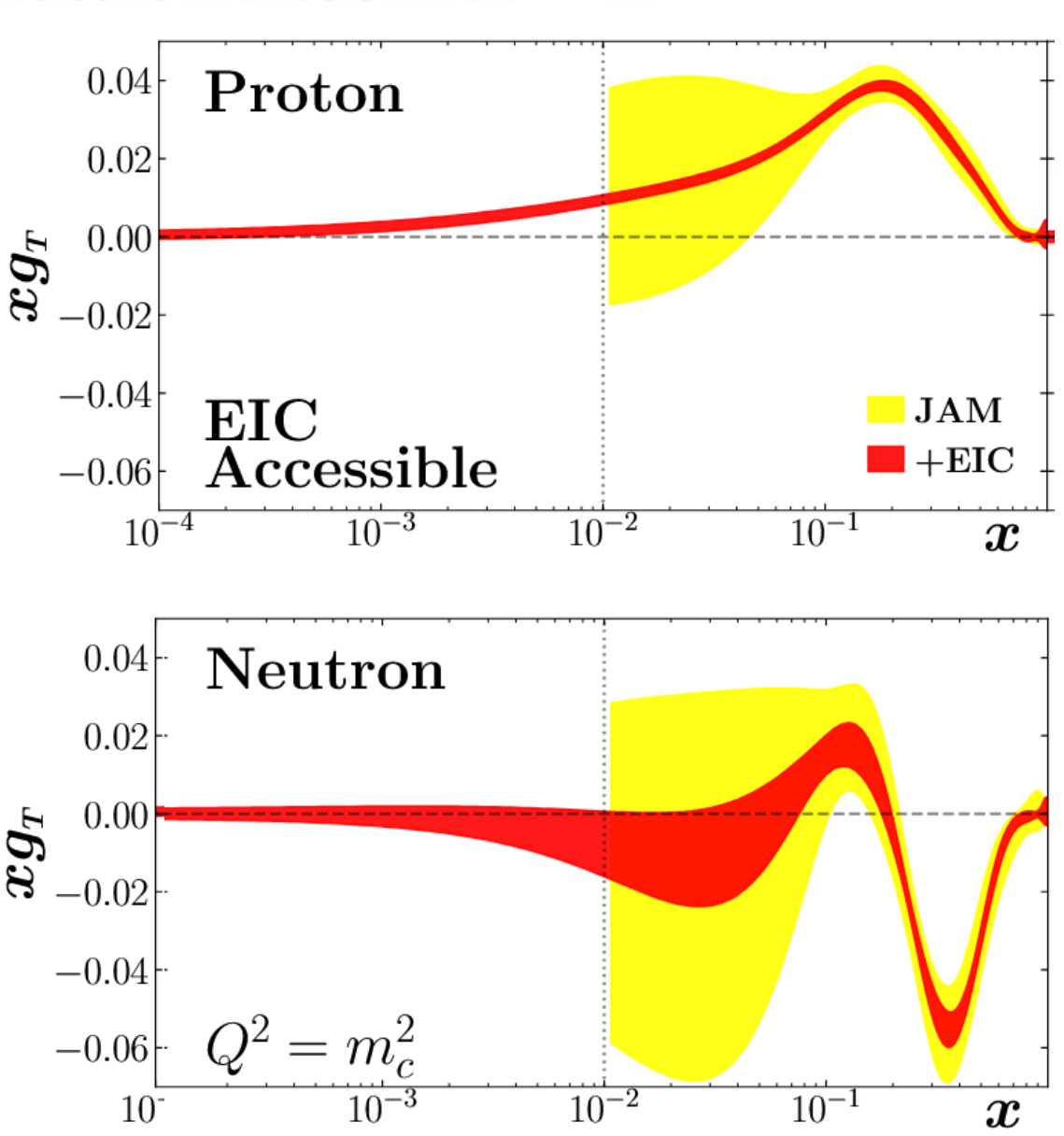
- Significant theoretical interest in HT function e(x)



YR Fig 7.28

HT function g_T

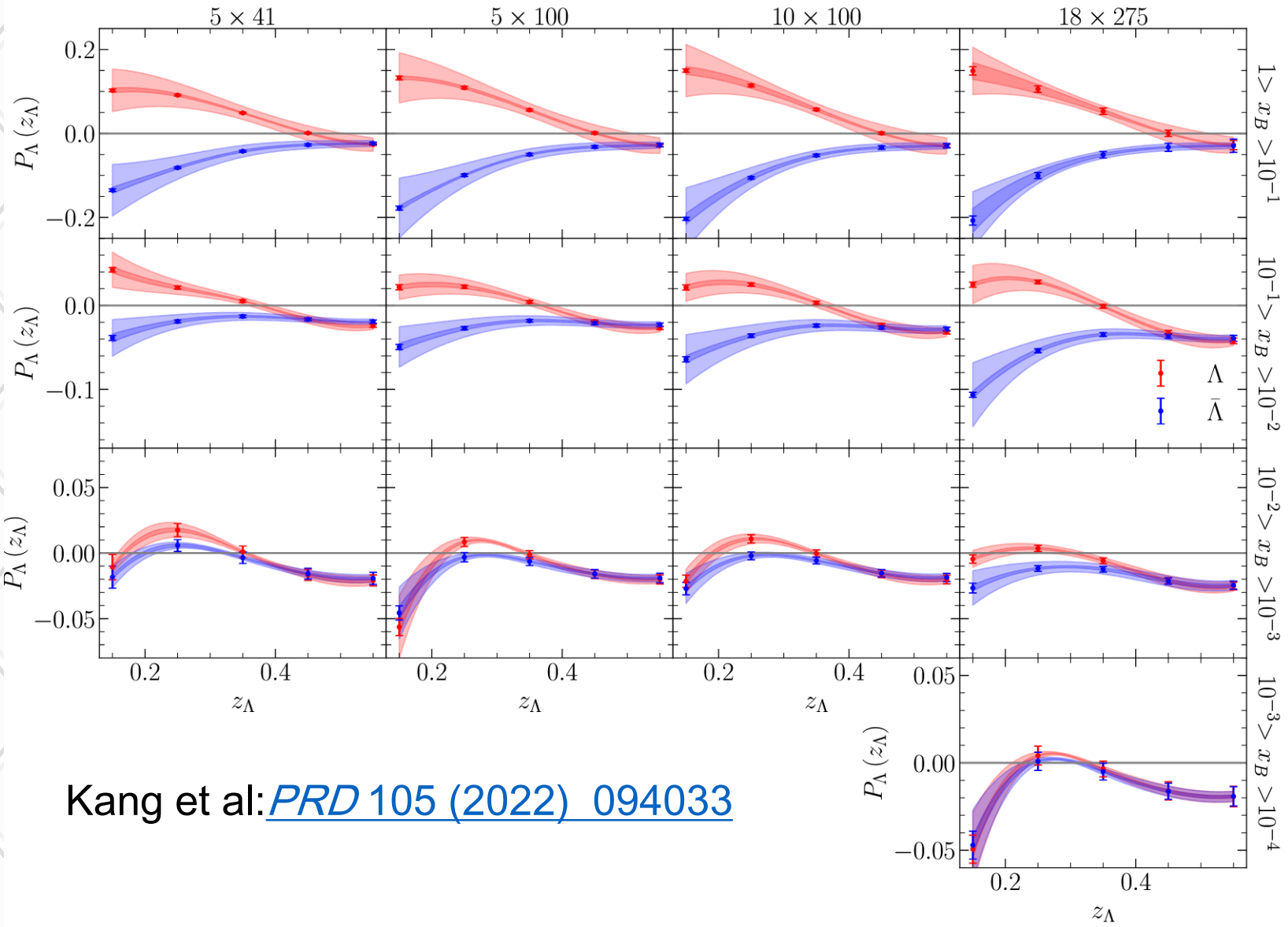
- Multi-parton correlations related to the structure function g2



YR Fig 7.27: JAM study

Lambda polarization

- Λ polarization estimates at with 40fb-1 of EIC data
- Mechanisms from polarizing TMD fragmentation funciton



Kang et al: *PRD* 105 (2022) 094033

Early science matrix

SIDIS uses fragmentation functions to add flavor, spin and transverse momentum sensitivity to DIS measurements

➔prerequisites: DIS + hadron momentum reconstruction + PID

➔Kinematic variables x,Q2,z,(P_{hT},ϕ_S,ϕ_h) ➔higher dimensional binnings required

Observable	DIS kine	species	energies	e/h pol	Z	P_{hT}	ϕ_s, ϕ_h	Lumi	ES grade	
nPDFs+nFFs PDFs+ FFs		e+A, (e+p/d)	10 x ~100	U/U		N	N	~fb^{-1}	****	Year 1+2
Unpol TMDs (start)		e+p	10 x ~100	U/U			N	~fb^{-1}	***	Year 2
HT A_Ns		e+p	10 x 100	U/T				~fb^{-1}	***	Year 3
TMD Evolution		e+p	10x100, (5x41, 18x275)	U/U				~fb^{-1}	***	Year 3+4
Sivers/Collins/IFF		e+p, (e+^{3}He)	10x100, (5x41, 18x275)	U/T				~ 10 fb^{-1}	**	Year 3+4
Helicities		e+p, (e+^{3}He)	10x100, (5x41, 18x275)	L/L				~ 10 fb^{-1}	**	
Di-hadrons (g Sivers/saturation)		e+p, e+A	18x275, (10x100)	U/(T)				~ 10 fb^{-1}	*	