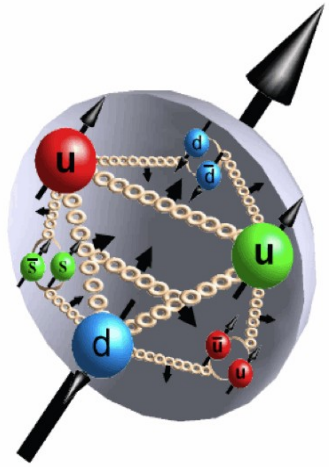
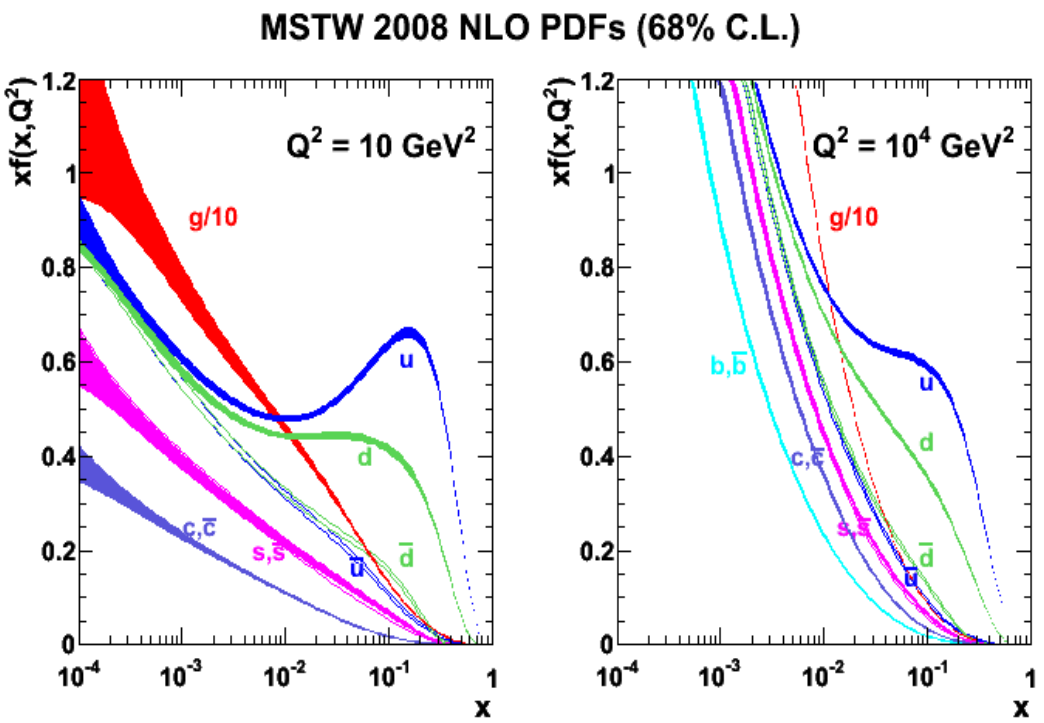
Key Future Measurements of TMDs at JLab and Other Facilities



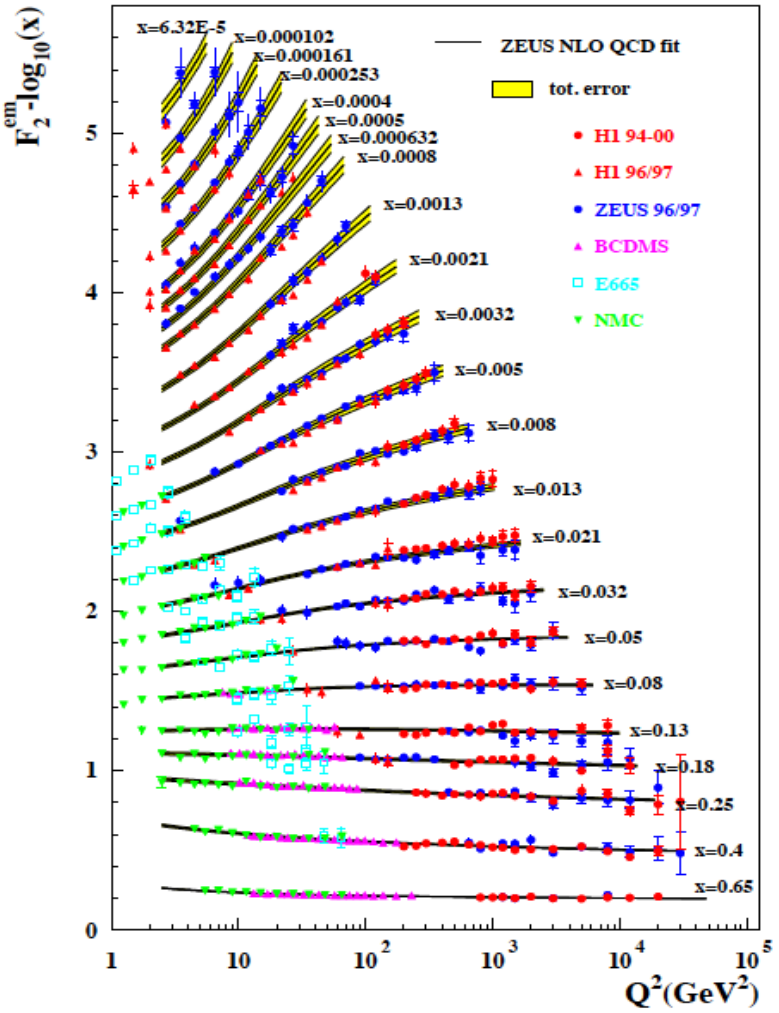
Kalyan Allada
Massachusetts Institute of Technology

SPIN 2014, Peking University, Beijing, China
20th - 24th October, 2014

Parton Distribution Functions Extracted in DIS



MSTW2008 NLO PDFs



- Unpolarized structure functions mapped to 5 orders of magnitude in x, Q^2 using inclusive DIS

Semi-Inclusive DIS

$$ep^{\uparrow} \rightarrow e'\pi X$$

$\nu = E - E'$
$x = Q^2/2M\nu$
$y = \nu/E$
$z = E_h/\nu$

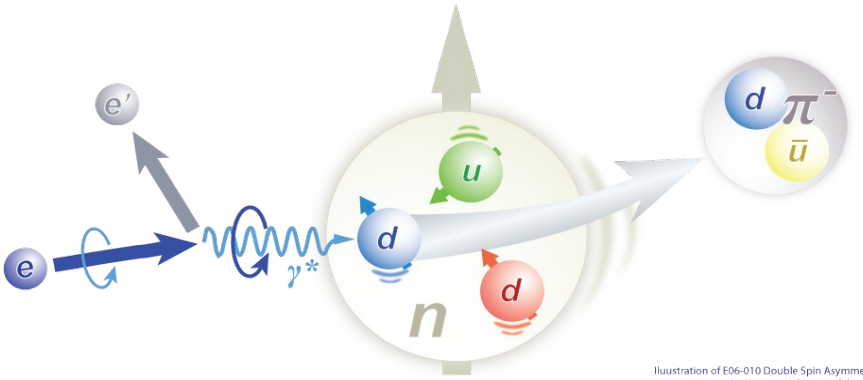
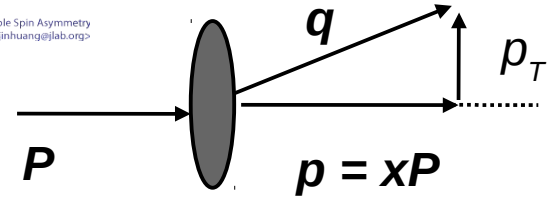


Illustration of E06-010 Double Spin Asymmetry
Jin Huang <jinhuang@jlab.org>



$$d\sigma^{\ell p \to \ell' h X}$$

$$= \sum_q \hat{f}_{q/p}(x, \boldsymbol{k}_\perp; Q^2) \otimes d\hat{\sigma}^{\ell q \to \ell q} \otimes \hat{D}_{h/q}(z, \boldsymbol{p}_\perp; Q^2).$$

- Detection of leading hadron provides access to TMDs:

Semi-Inclusive DIS

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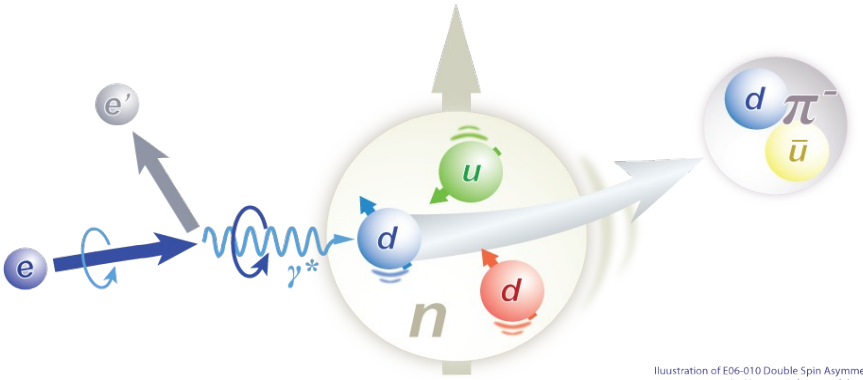
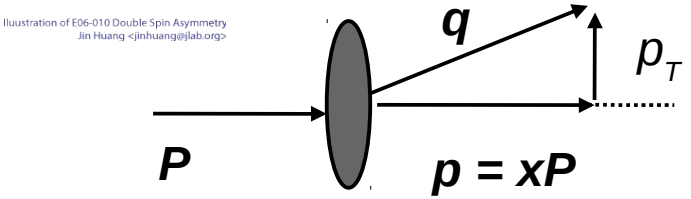


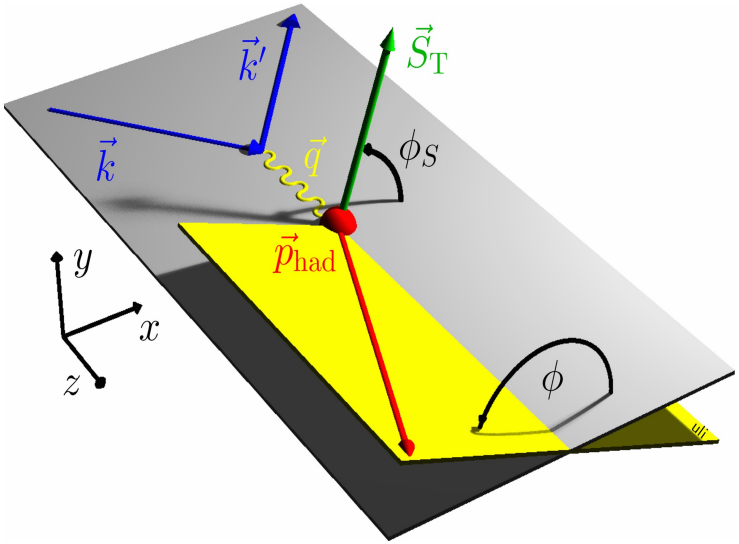


$$d\sigma^{\ell p \to \ell' h X} = \sum_q \hat{f}_{q/p}(x, \boldsymbol{k}_\perp; Q^2) \otimes d\hat{\sigma}^{\ell q \to \ell q} \otimes \hat{D}_{h/q}(z, \boldsymbol{p}_\perp; Q^2).$$

- Detection of leading hadron provides access to TMDs:
- Transverse Momentum Dependent PDFs
  - Links intrinsic parton motion($\boldsymbol{k}^q_T$) and parton spin($\boldsymbol{s}^q_T$), to nucleon spin ($\boldsymbol{S}^N_T$)
  - Provides access to quark OAM through spin-orbit correlations
  - Provides 3-D imaging of quarks in momentum space
  - Access to quark-gluon-quark correlations through higher-twist observables

Leading Twist TMDs

Eight leading twist TMDs accessible in SIDIS

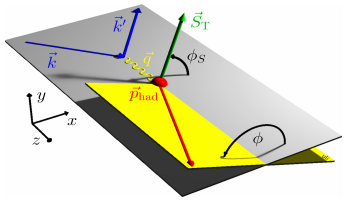


Leading Twist TMDs

Nucleon Spin Quark Spin

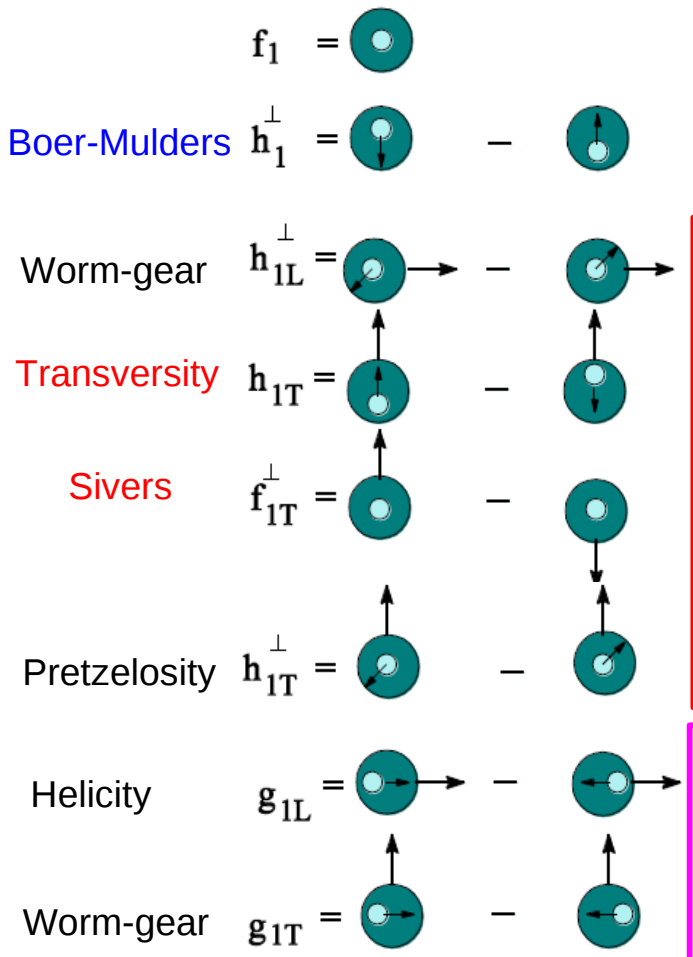
Nucleon Polarization	Quark Polarization: Un-Polarized (U)	Longitudinally Polarized (L)	Transversely Polarized (T)
U	f_1 =		$h_1^\perp$ = — Boer-Mulders
L		g_{1L} = — Helicity	$h_{1L}^\perp$ = —
T	$f_{1T}^\perp$ = — Sivers	$g_{1T}^\perp$ = —	h_1 = — Transversity $h_{1T}^\perp$ = —

Transverse Momentum Dependent Quark Distributions (TMDs)



$$d^6\sigma = \frac{4\pi\alpha^2 sx}{Q^4}\times$$

Accessible through Semi-inclusive DIS reaction



$$\{[1+(1-y)^2]\sum_{q,\bar{q}} e_q^2 f_1^q(x) D_1^q(z,P_{h\perp}^2)$$
$$+(1-y)\frac{P_{h\perp}^2}{4z^2 M_N M_h}\cos(2\phi_h^l)\sum_{q,\bar{q}} e_q^2 h_1^{\perp(1)q}(x) H_1^{\perp q}(z,P_{h\perp}^2)$$

Unpolarized

$$-|S_L|(1-y)\frac{P_{h\perp}^2}{4z^2 M_N M_h}\sin(2\phi_h^l)\sum_{q,\bar{q}} e_q^2 h_{1L}^{\perp(1)q}(x) H_1^{\perp q}(z,P_{h\perp}^2)$$
$$+|S_T|(1-y)\frac{P_{h\perp}}{zM_h}\sin(\phi_h^l+\phi_S^l)\sum_{q,\bar{q}} e_q^2 h_1^q(x) H_1^{\perp q}(z,P_{h\perp}^2)$$
$$+|S_T|(1-y+\frac{1}{2}y^2)\frac{P_{h\perp}}{zM_N}\sin(\phi_h^l-\phi_S^l)\sum_{q,\bar{q}} e_q^2 f_{1T}^{\perp(1)q}(x) D_1^q(z,P_{h\perp}^2)$$
$$+|S_T|(1-y)\frac{P_{h\perp}^3}{6z^3 M_N^2 M_h}\sin(3\phi_h^l-\phi_S^l)\sum_{q,\bar{q}} e_q^2 h_{1T}^{\perp(2)q}(x) H_1^{\perp q}(z,P_{h\perp}^2)$$

Polarized target

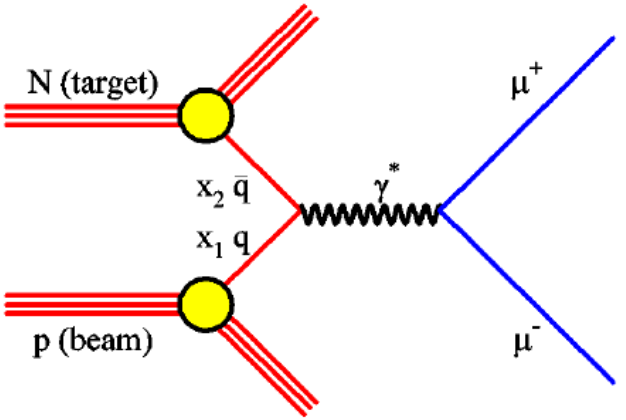
$$+\lambda_e|S_L|y(1-\frac{1}{2}y)\sum_{q,\bar{q}} e_q^2 g_1^q(x) D_1^q(z,P_{h\perp}^2)$$
$$+\lambda_e|S_T|y(1-\frac{1}{2}y)\frac{P_{h\perp}}{zM_N}\cos(\phi_h^l-\phi_S^l)\sum_{q,\bar{q}} e_q^2 g_{1T}^{(1)q}(x) D_1^q(z,P_{h\perp}^2)\}$$

Polarized beam and target

S_T and S_L are target polarization and λ_e is beam polarization

TMDs in Polarized Drell-Yan Process

- Clean probe to study hadron structure
- Access to to TMDs (Sivers, Boer-Mulders etc.)
- Convolution of PDFs, no fragmentation function involved
- No QCD final state interactions
- T-odd TMDs (Boer-Mulders and Sivers) are predicted to change sign



In single polarized DY, with transversely polarized target nucleons, the general expression of the cross-section (LO) is:

$$\frac{d\sigma}{d^4q d\Omega} = \frac{\alpha_{em}^2}{Fq^2}\hat{\sigma}_U\{(1 + D_{[\sin^2\theta]}A_U^{\cos 2\phi}\cos 2\phi)$$
$$+ |\vec{S}_T|[A_T^{\sin\phi_S}\sin\phi_S + D_{[\sin^2\theta]}(A_T^{\sin(2\phi+\phi_S)}\sin(2\phi+\phi_S)$$
$$+ A_T^{\sin(2\phi-\phi_S)}\sin(2\phi-\phi_S))]\}$$

S. Arnold *et al,* Phys.Rev. D79 (2009) 034005

A: azimuthal asymmetries
D: depolarization factor
S: target spin components
F: flux of incoming hadrons
σ_U: part of the cross-section surviving integration over φ and φ_S

φ_s : azimuthal angle of transverse target spin S_T in the target rest frame
φ : azimuthal angle of the lepton momenta in the Collins-Soper frame

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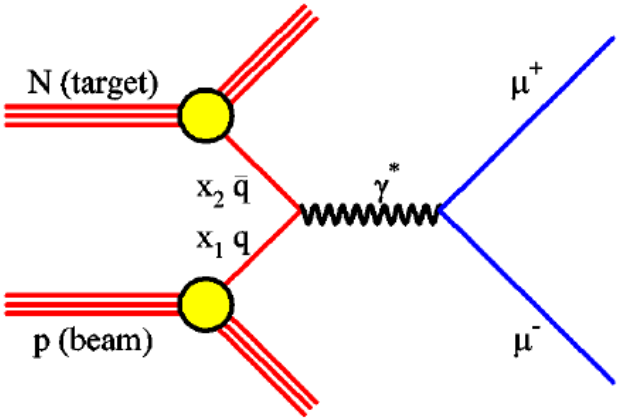

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$$+ \boxed{A_T^{\sin(2\phi-\phi_S)}}\sin(2\phi-\phi_S))]\}$$

S. Arnold *et al,* Phys.Rev. D79 (2009) 034005

$A_U^{\cos 2\varphi}$: Boer-Mulders function (B-M)

$A_T^{\sin 2\varphi_S}$: Sivers

$A_T^{\sin(2\varphi+\varphi_S)}$: B-M (beam) ⊗ Pretzelosity (target)

$A_T^{\sin(2\varphi-\varphi_S)}$: B-M (beam) ⊗ Transversity (target)

A: azimuthal asymmetries
D: depolarization factor
S: target spin components
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φ_S : azimuthal angle of transverse target spin S_T in the target rest frame
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Transversity PDF

Correlation between quark transverse spin ($\vec{s}_{\perp}^{\,q}$)
With nucleon transverse spin ($\vec{S}_{\perp}^{\,N}$)

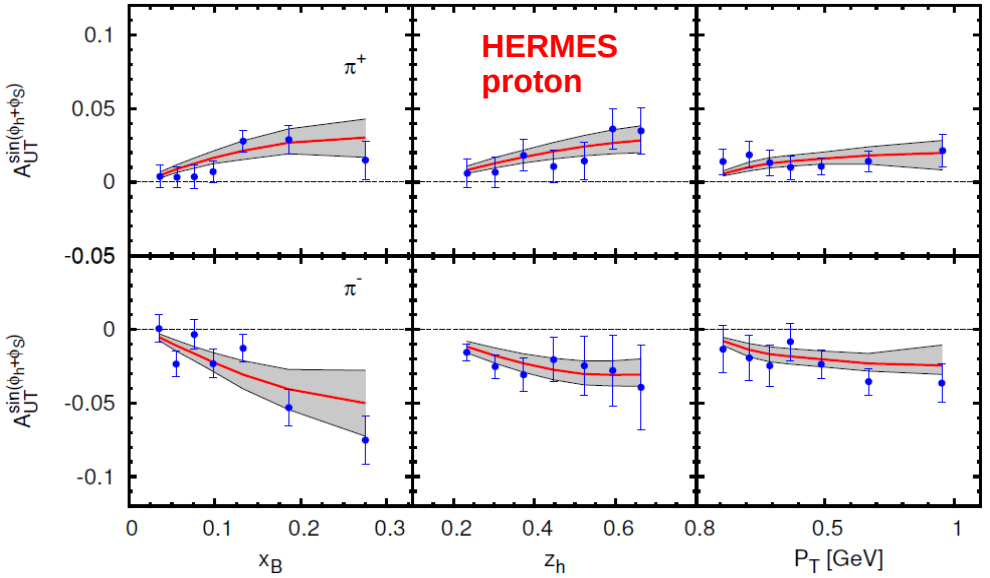
$$\sigma_{UT}^{SIDIS} \propto \sin(\phi_h + \phi_S)\; h_1 \otimes H_1^{\perp}$$

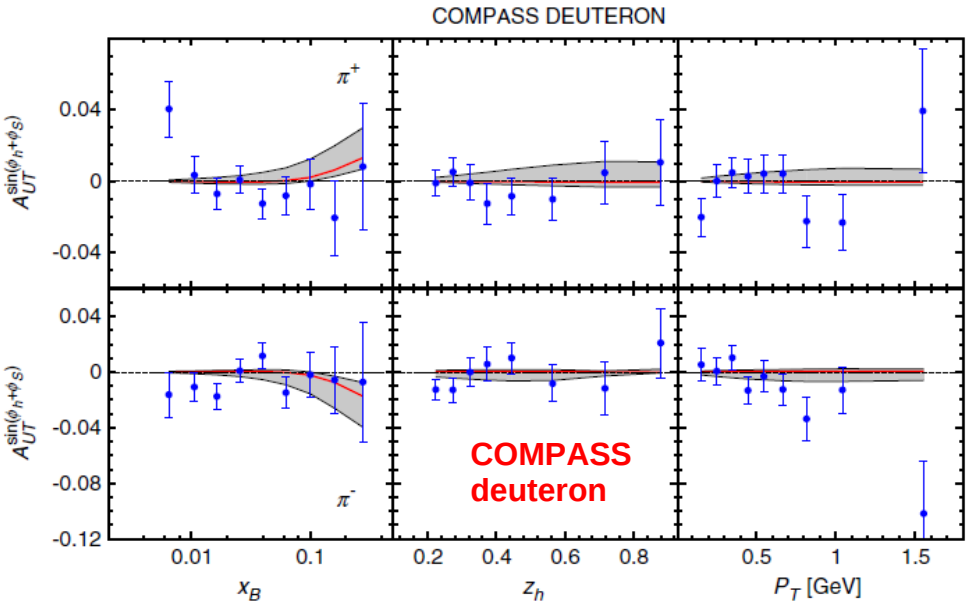
- Probes the relativistic nature of quark dynamics
- No contribution from the gluons
- Positivity bound $2\,|h_1| \leq q + \Delta q$ *Soffer, PRL 74 (1995)*
- First moments: tensor charge:

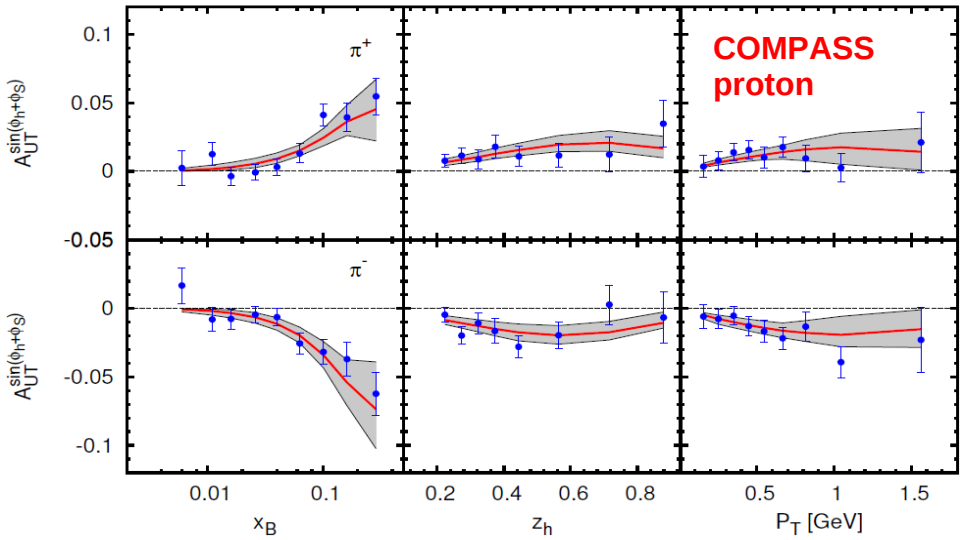
$$\delta q \equiv \int dx \left[h_1^q(x) - h_1^{\bar{q}}(x) \right]$$

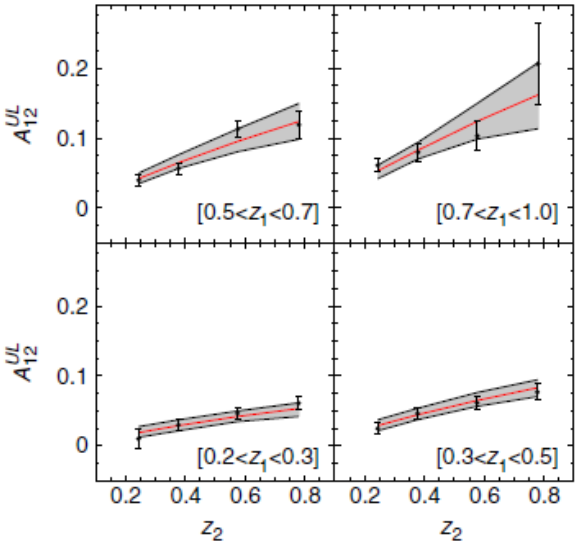
- Chiral-odd: decouples from inclusive DIS
- Accessible in
  - SIDIS (measurements done at HERMES, COMPASS, JLab)
  - Di-hadron production in SIDIS (measurements done at HERMES, COMPASS)
  - Polarized Drell-Yan $p^{\uparrow} + \bar{p}^{\uparrow} \longrightarrow l^{+} + l^{-} + X$ (cleanest process, not yet done)

Extraction of Transversity from SIDIS and Belle Data









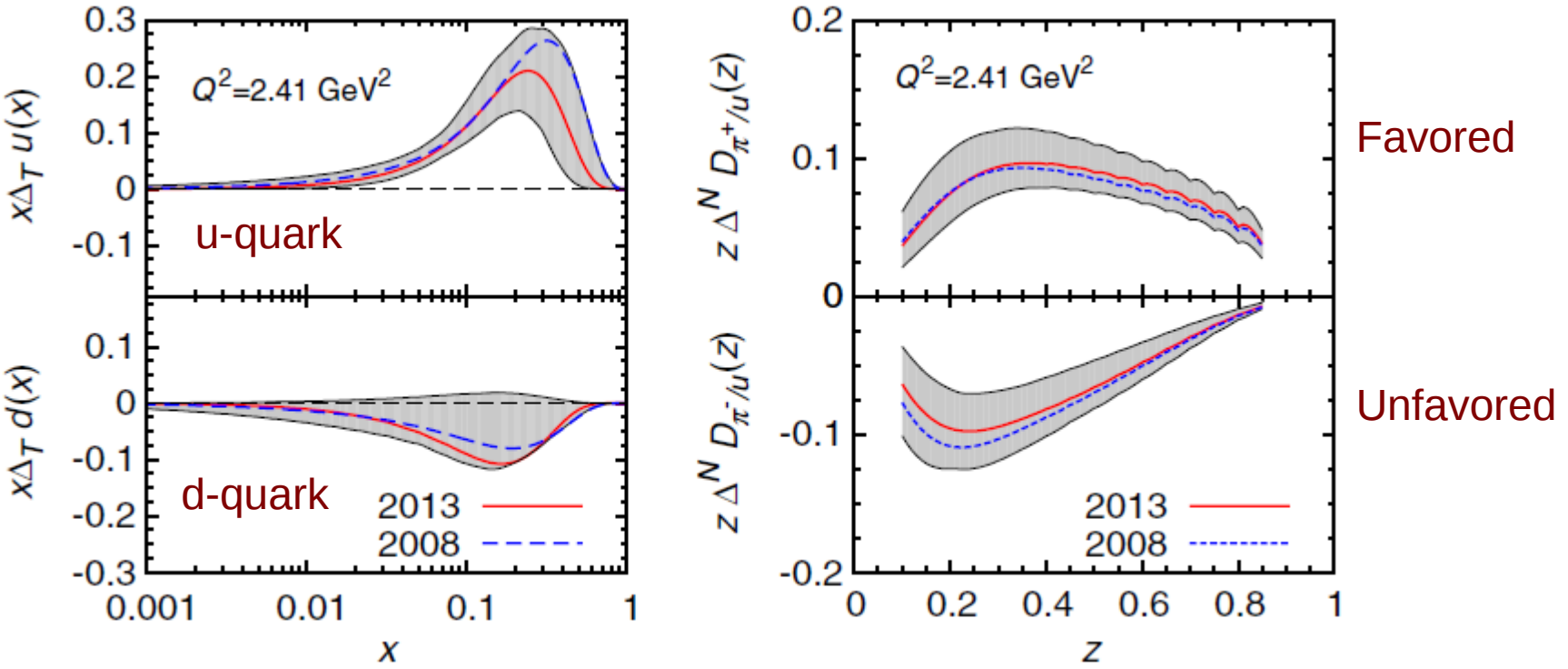
Belle e+/e- data

Anselmino *et al.* PRD 87, 094019 (2013)

Extraction of Transversity and Collins FF

Transversity

Collins FF



Anselmino *et al.*
PRD 87, 094019 (2013)

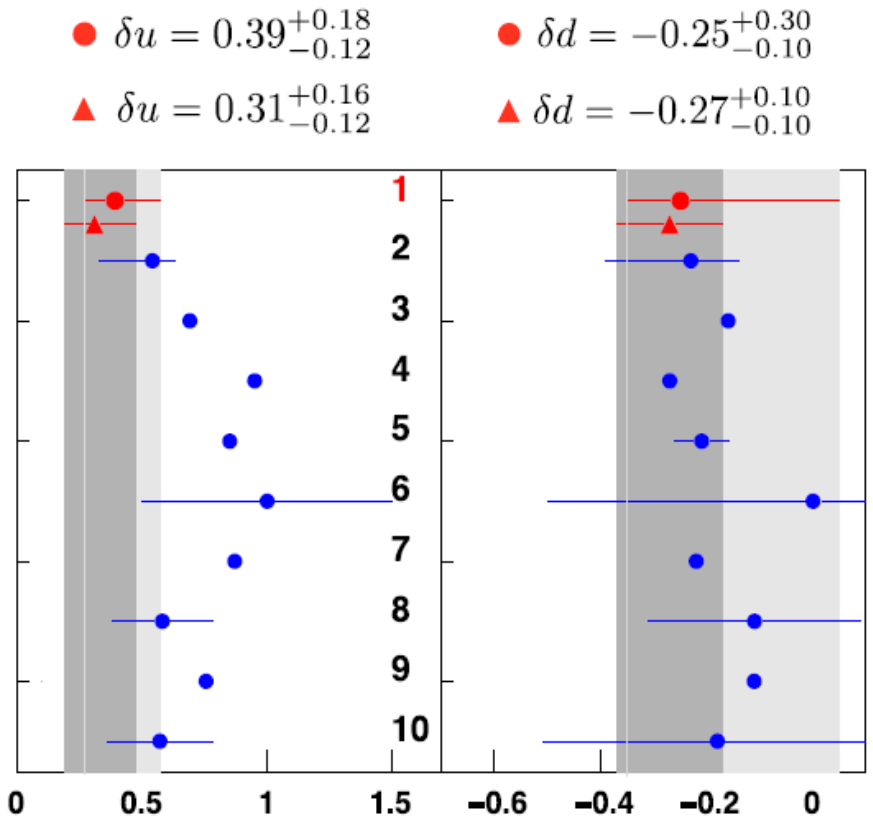
Extraction of Nucleon Tensor Charge

$$\delta q = \int_0^1 \left[h_1^q(x) - h_1^{\bar{q}}(x) \right] dx$$

1 : Extractions from global fits using two different Collins FF parameterizations

2-10: Predictions from various models, Lattice QCD

Large uncertainty in extracted results
Need precision data !



Anselmino *et al.*
PRD 87, 094019 (2013)

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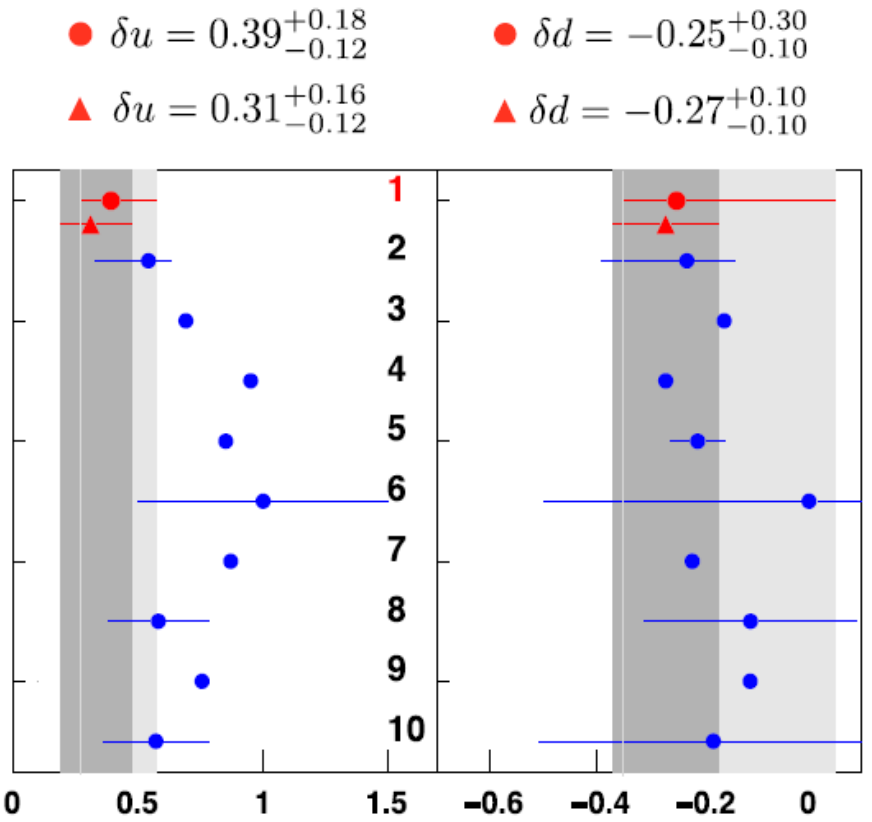
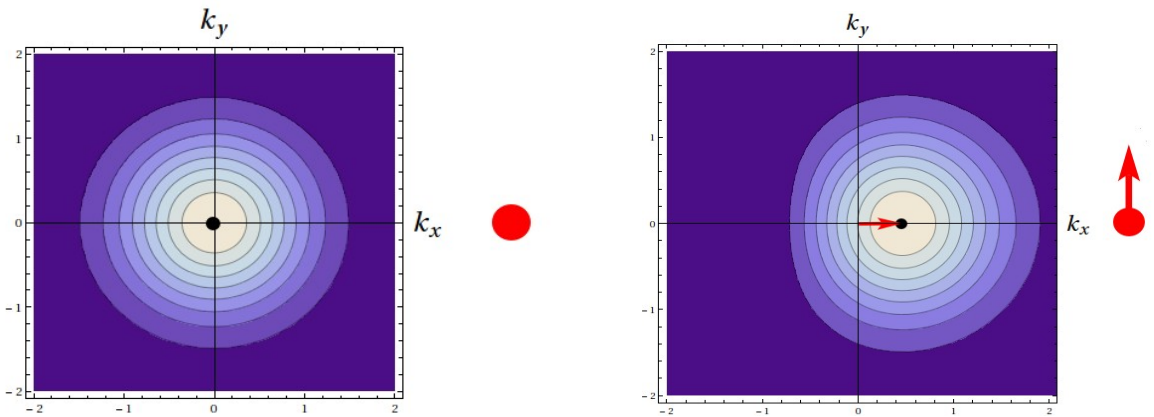


Anselmino *et al.*
PRD 87, 094019 (2013)

Some remaining issues:

- Transvesity extraction using
  - di-hadron production in SIDIS:
    first extraction using COMPASS/HERMES data
    (arXiv:1409.6607)
  - doubly polarized DY process (not yet done)
- How big is the sea quark transversity?
- Recent progress on lattice – possibility to calculate x-dependence of PDF ? (X. Ji, PRL 110, 2013)

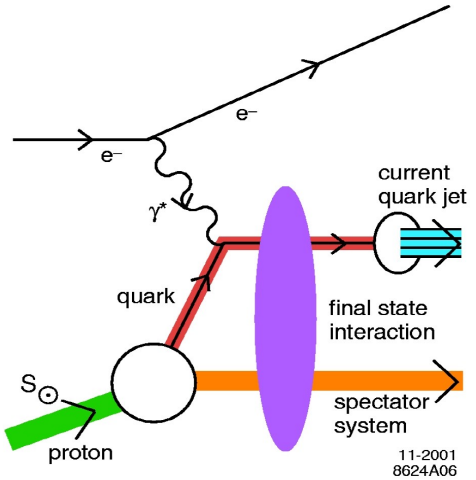
Sivers Effect



No polarization

Polarization S_y

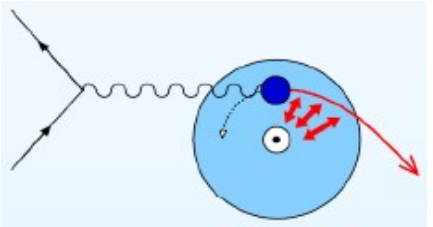
(plot courtesy, A. Prokudin)



S. Brodsky et al.,
Phys. Lett. B530, 99 (2002)

Correlation between transverse momentum ($\vec{k}_\perp^q$) of quark and transverse spin of the nucleon ($\vec{S}_\perp^N$)

- Requires non-zero quark OAM
- Final-state interactions => left-right asymmetry of hadrons
- Measured in SIDIS (HEMES, COMPASS, JLab Hall-A)
  - Limited precision, kinematics
- Accessible in Drell-Yan process (not yet done)
  - Naive time-reversal odd
  - QCD predicted sign change from SIDIS to DY
    (based on time-reversal argument involving FSI)

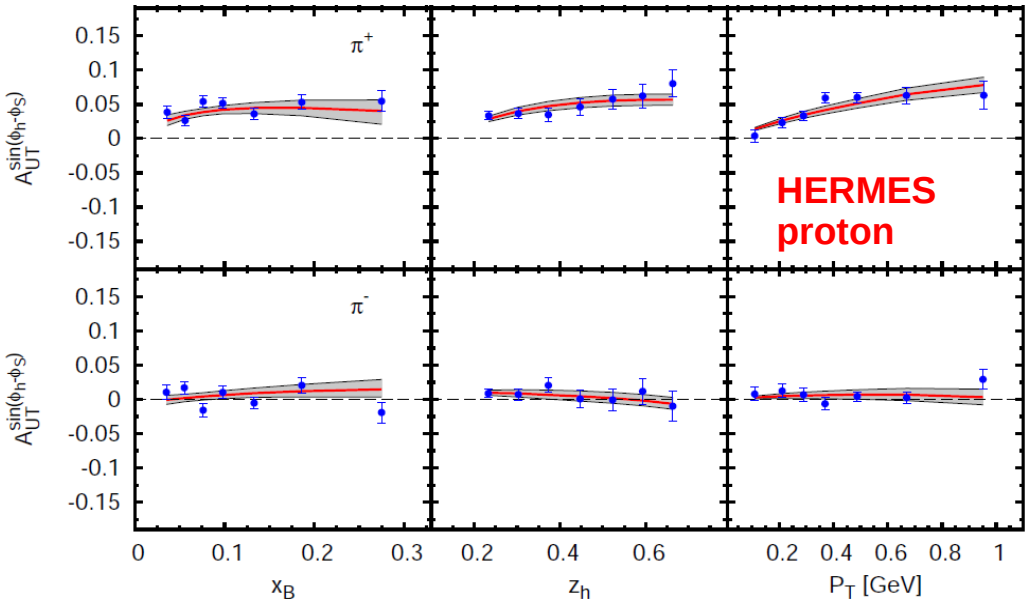


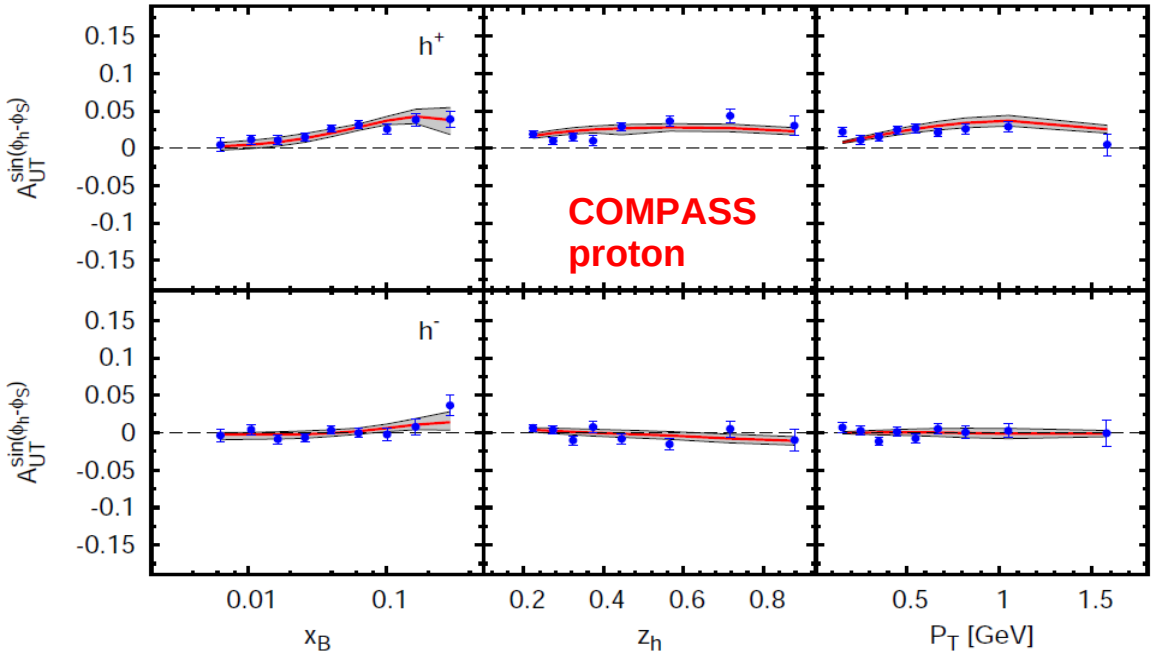
$$f_{1T}^{q}\left(x,p_T\right)_{SIDIS} = -f_{1T}^{q}\left(x,p_T\right)_{DY}$$

Transverse SSA in SIDIS: Sivers Moments

$e + p^{\uparrow} \longrightarrow e' + h + X$

$$\sigma_{UT}^{SIDIS} \propto \sin(\phi_h - \phi_S)\ f_{1T}^{\perp} \otimes D_1$$





Anselmino *et al.*
PRD 86, 014028 (2012)

Sivers Function

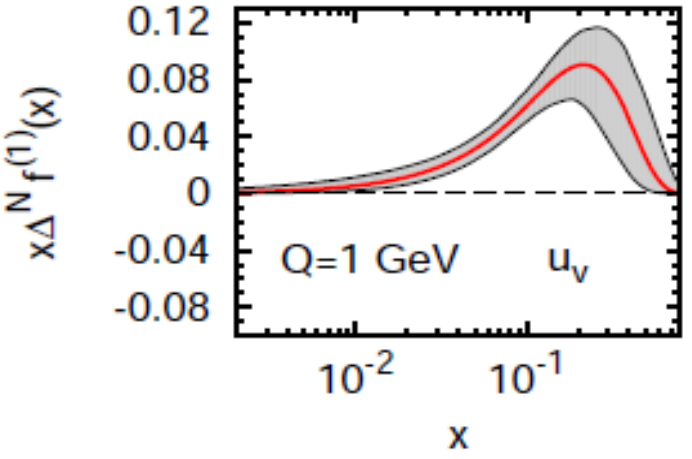
Initial model-dependent extraction of Sivers DF

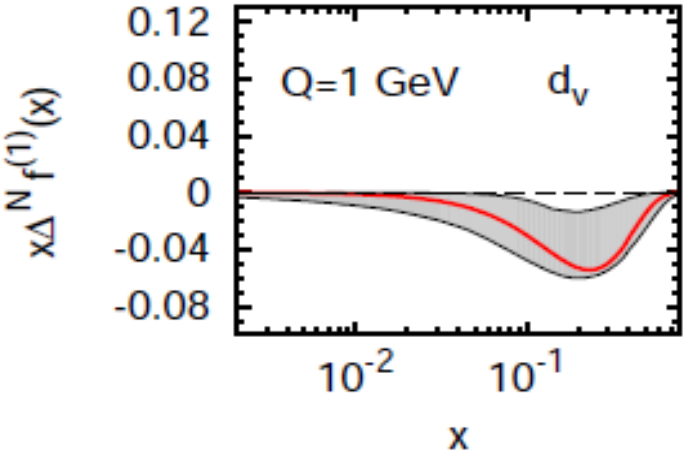
- Using global fit to HERMES and COMPASS data (Anselmino *et al.*)

Attempt to constrain quark OAM using GPD *E* and Sivers DF

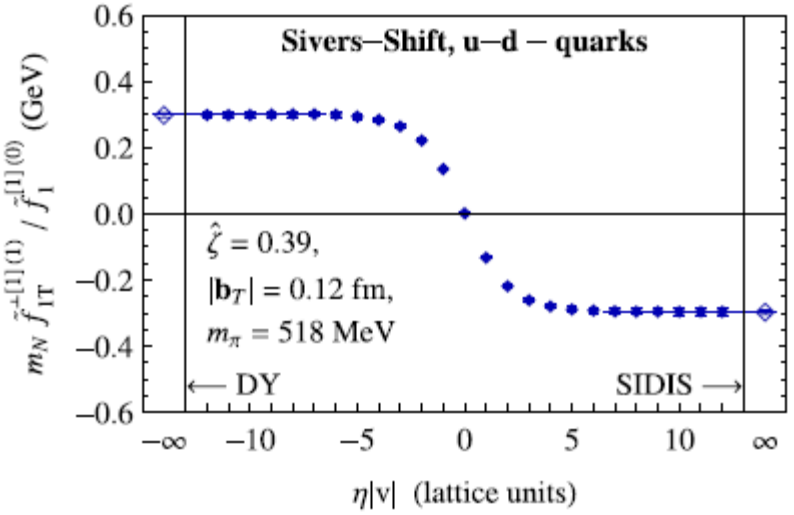
Bacchetta *et. al,* Phys. Rev. Lett. 107, 212001 (2011)

M. Anselmino *et al,*
PRD 86, 014028 (2012)





Lattice calculations of Sivers function



Musch, Haegler, Engelhardt, Negle & Schaeffer, PRD 85 (2012) 094510

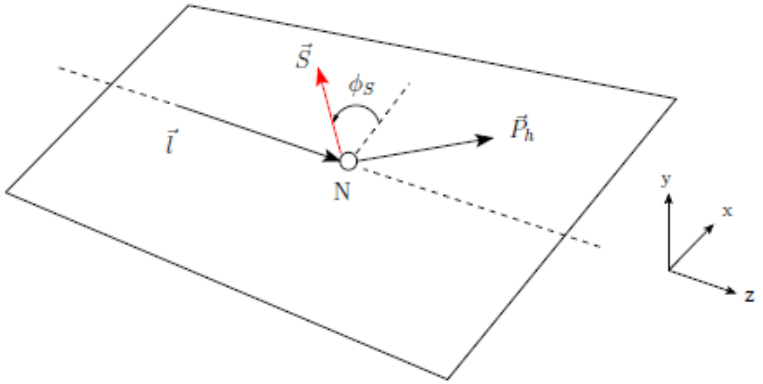
Inclusive Hadron SSA in Hall A

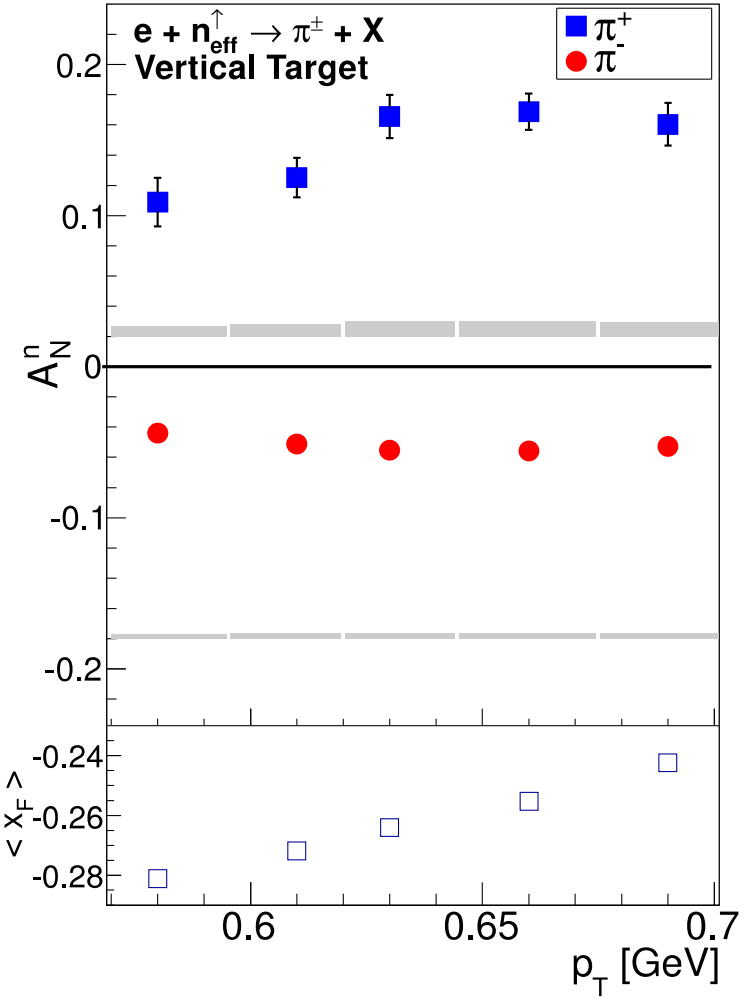
$e + n^{\uparrow} \longrightarrow \pi + X$

Using polarized ^{3}He target

$$A_{UT}^{\sin(\varphi_S)}\left(\varphi_S = 90^0\right)$$

K. Allada *et al*,
Phys. Rev. C 89, 042201(R), 2014





In the center-of-mass frame, viewed along the nucleon momentum direction

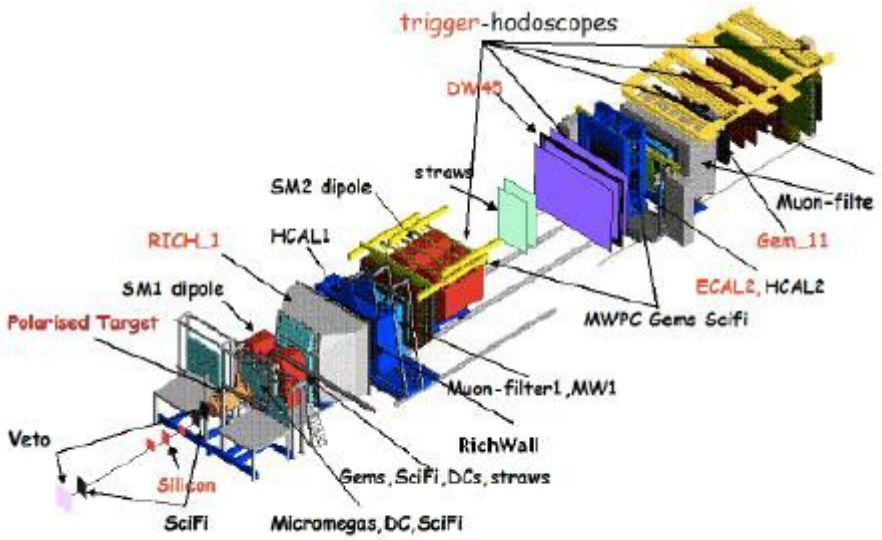
π^+ favors the right side of spin vector,

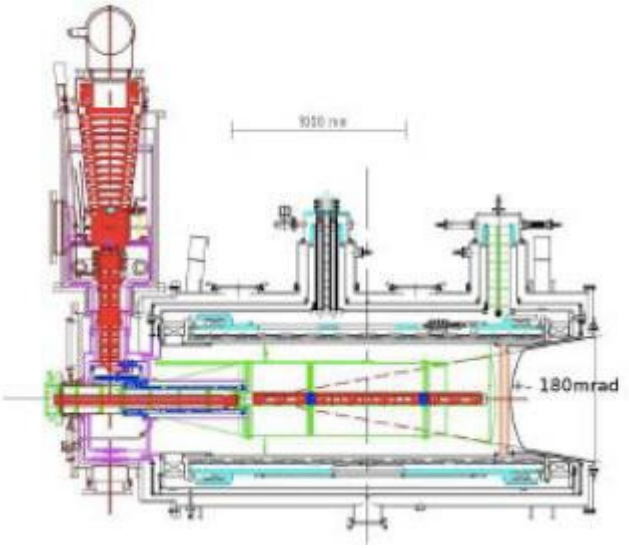
π^- favors the left side of spin vector.

Surprisingly similar behavior to fermilab E704 results from pp->hX

For a complete set of Hall-A transversity experiment results see Y. Zhao's talk parallel-V: S3

Sivers Function in Polarized Drell-Yan



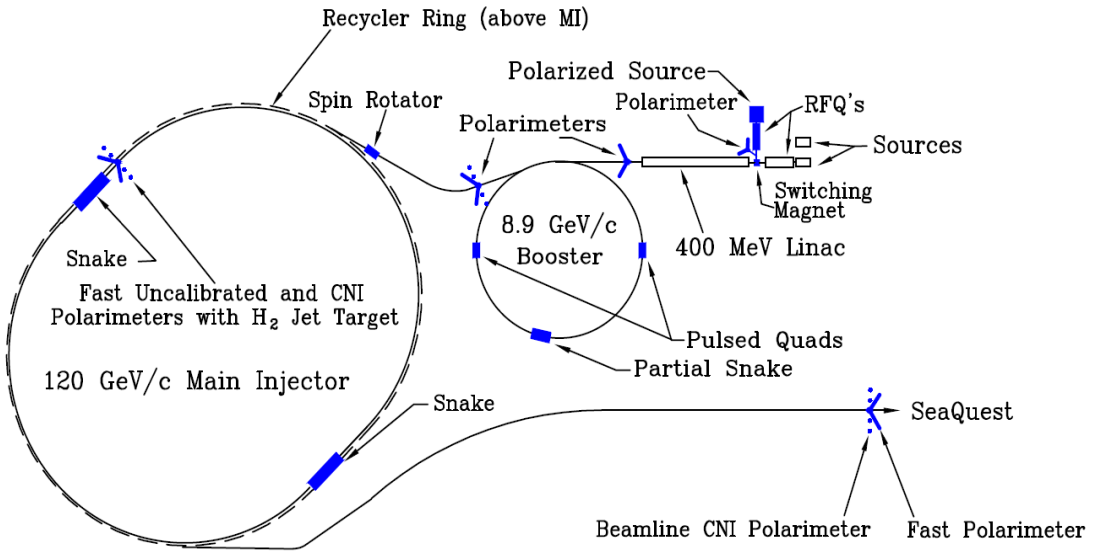


DY @ COMPASS $\pi^- + p^\uparrow \longrightarrow \mu^+ + \mu^- + X$

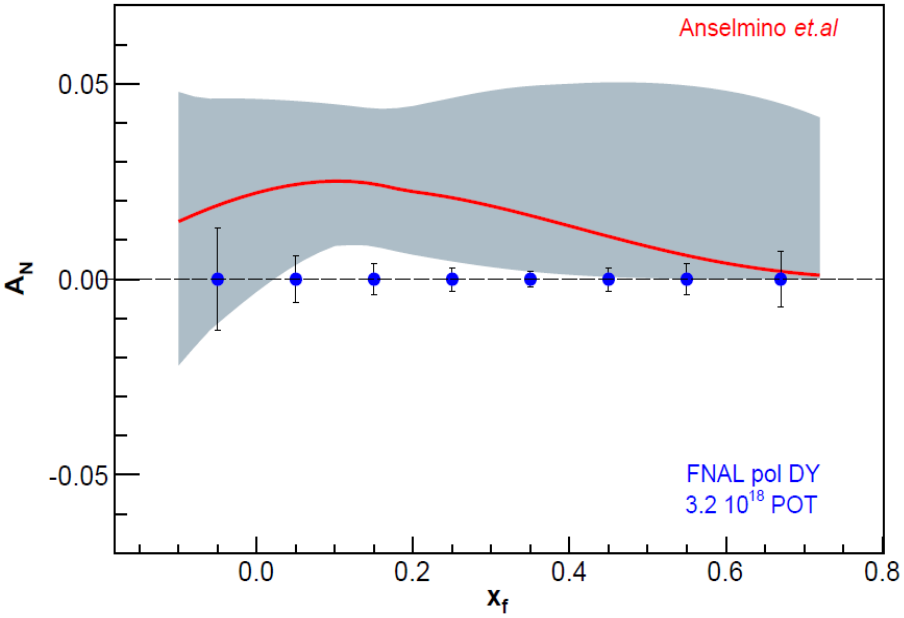
- 190 GeV/c π^- beam on a transversely polarized proton target (NH_3)
- Covers valence quark region
- Magnitude and sign of Sivers and Boer-Mulders asymmetry
- Expected to run in 2014-2015

See talk by B. Parsamyan (Parallel VIII: S11)

Sivers Function in Polarized Drell-Yan



W. Lorenzon et. al

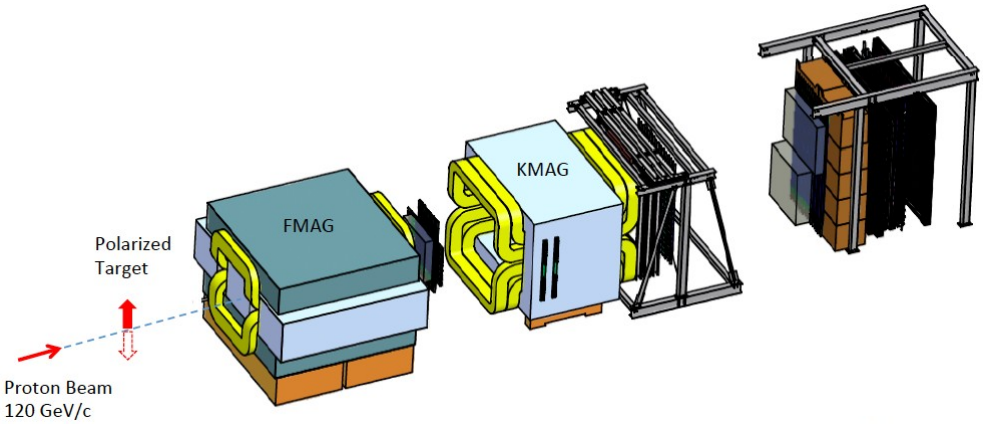


DY @ Fermilab (P-1027) $p^{\uparrow} + p \longrightarrow \mu^{+} + \mu^{-} + X$

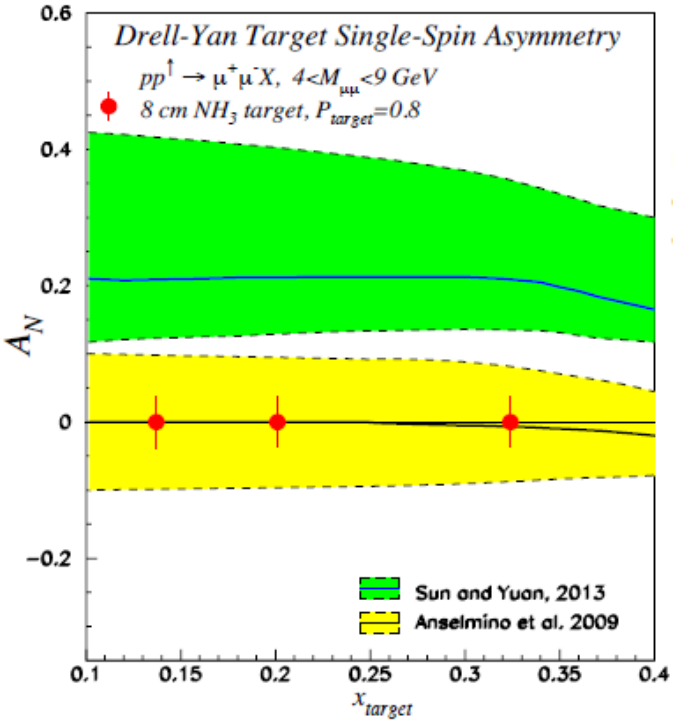
- 120 GeV/c transversely polarized proton beam on unpolarized proton target
- Covers valence quark region
- Magnitude of Sivers and Boer-Mulders asymmetry
- Beyond 2018

See W. Lorenzon's talk in parallel-VIII: S11

Sivers Function in Polarized Drell-Yan



$$A_N^{DY} \propto \frac{u(x_b) \cdot f_{1T}^{\perp,\bar{u}}(x_t)}{u(x_b) \cdot \bar{u}(x_t)}$$



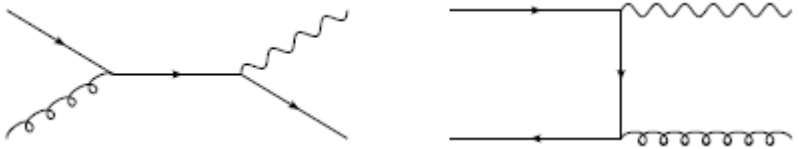
DY @ Fermilab (P-1039) $p + p^{\uparrow} \longrightarrow \mu^+ + \mu^- + X$ A. Klein, X. Jiang, et. al

- 120 GeV/c proton beam on a transversely polarized proton target (NH3)
- Sea quark Sivers asymmetry – both sign and magnitude
- Beyond 2016

See talk by M. Liu in parallel V-II: S10

A_N from Prompt Photon Production at PHENIX

$p^{\uparrow} + p \longrightarrow \gamma + X$



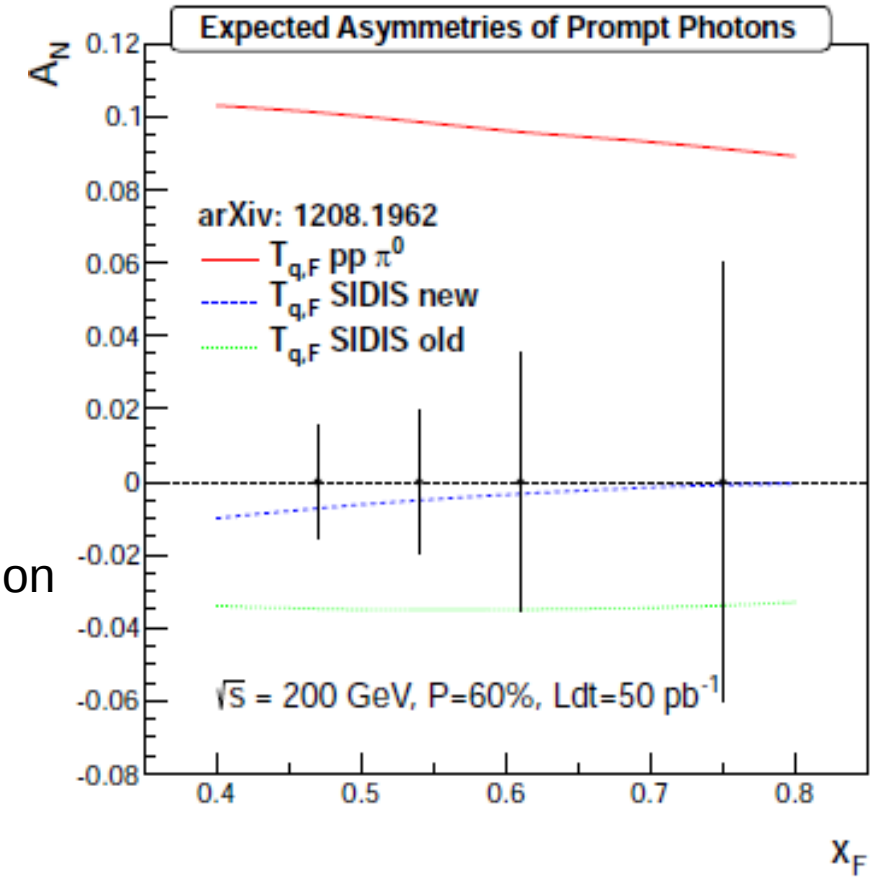
$qg \longrightarrow \gamma q$ $\quad$ $qq\text{-bar} \longrightarrow \gamma q$

Prompt photon A_N will measure Sivers effect

Check sign change between SIDIS and pp reaction

Plans to use PHENIX MPC-Ex detector to measure the prompt photon A_N

(plot courtesy – Xiaodong Jiang)

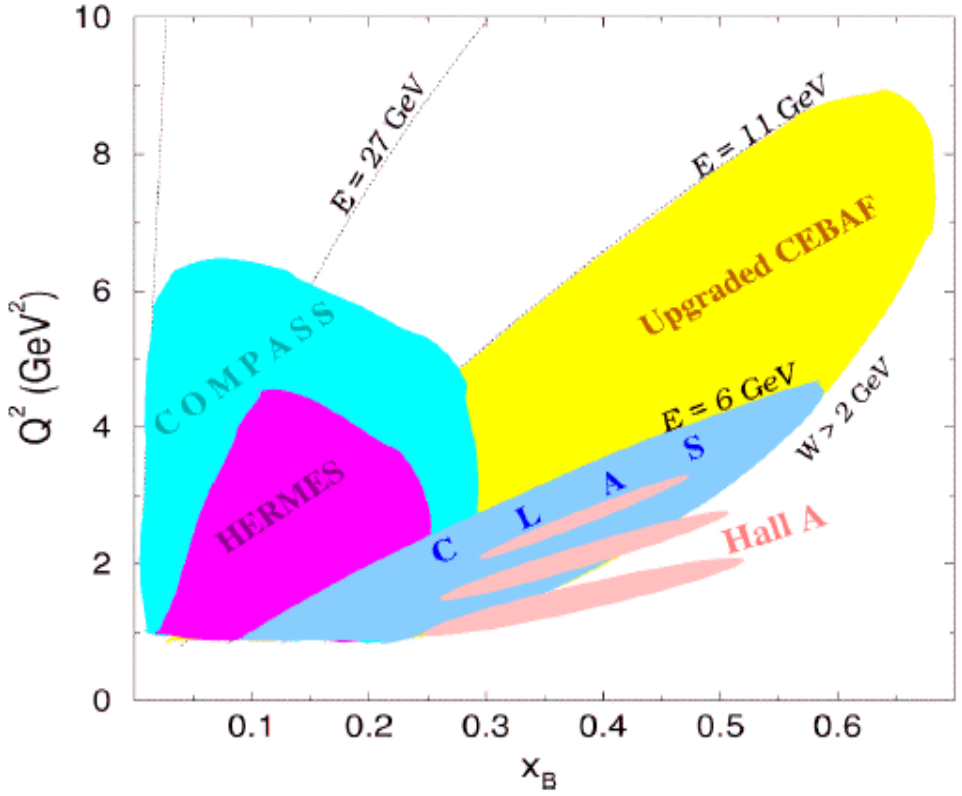


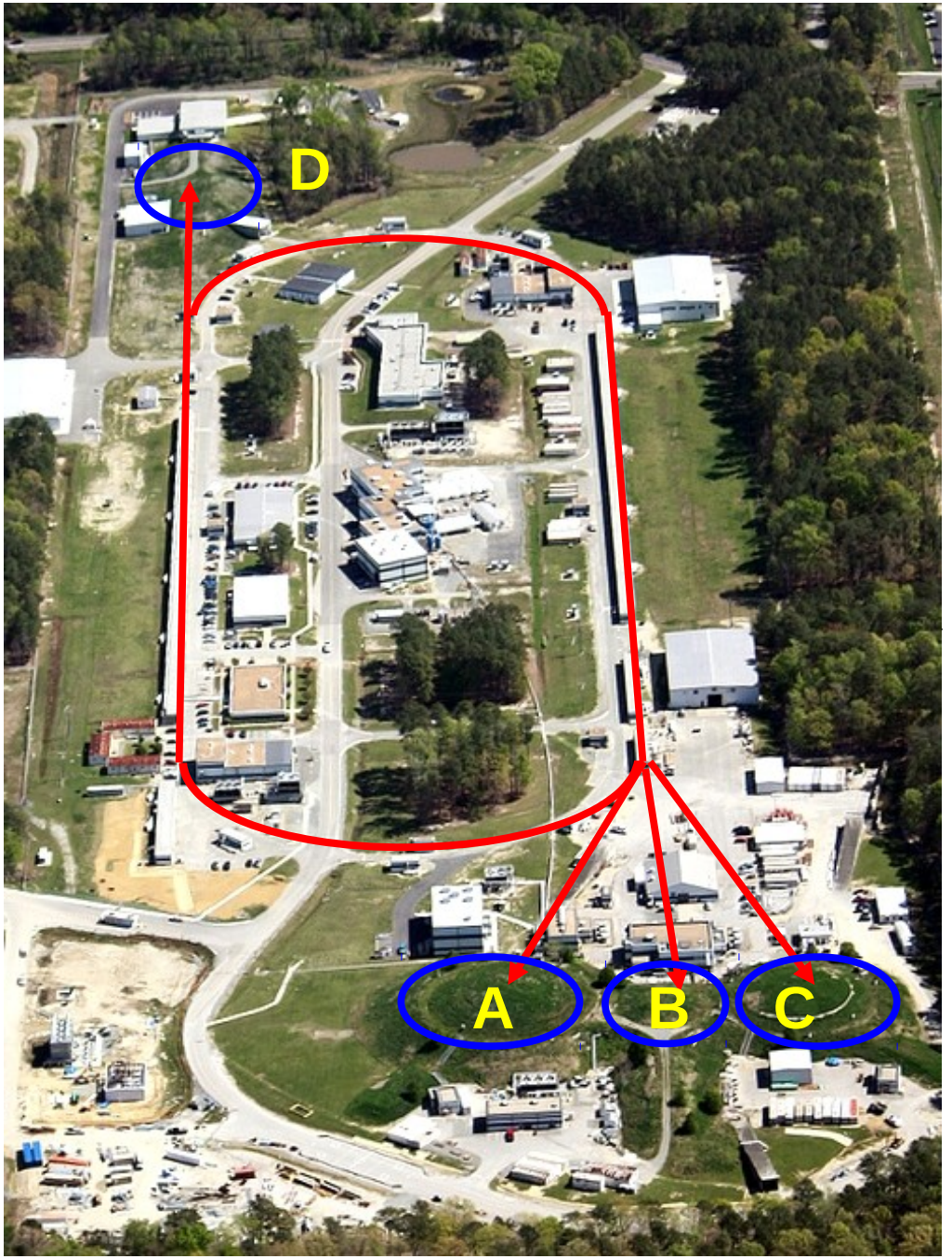
Kang, Qiu, Vogelsang and Yua, PRD 83 094001 (2011)
Gamberg and Kang, arXiv 1208.1962 (2012)

See X. Jiang's talk in Parallel-II: S5

Jefferson Lab 12 GeV

Polarized electron beam
Max energy = 6 GeV (12 GeV soon!)
Operations start in Oct 2014!

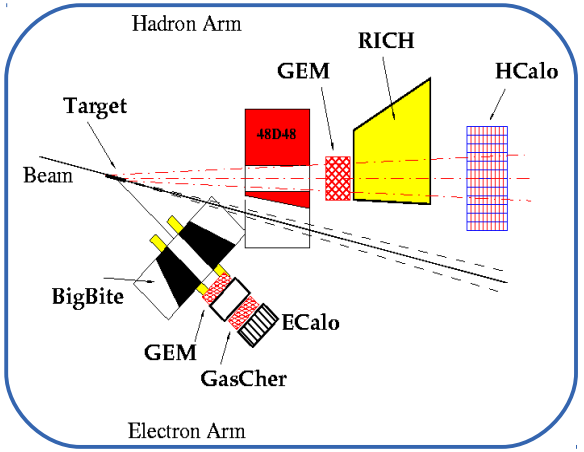




Multi-Hall SIDIS Program

Hall A Super BigBite

(SIDIS with ^{3}He: $\pi^{+/-}$, $K^{+/-}$)



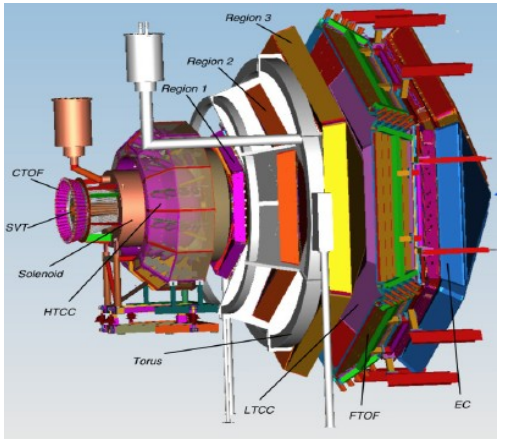
Leading Twist TMDs

: Nucleon Spin : Quark Spin

Nucleon Polarization	Quark polarization: Un-Polarized (U)	Longitudinally Polarized (L)	Transversely Polarized (T)
U	f_1 =		$h_1^\perp$ = – (Boer-Mulder)
L		g_1 = – (Helicity)	$h_{1L}^\perp$ = –
T	$f_{1T}^\perp$ = – (Sivers)	$g_{1T}^\perp$ = –	h_{1T} = – (Transversity); $h_{1T}^\perp$ = –

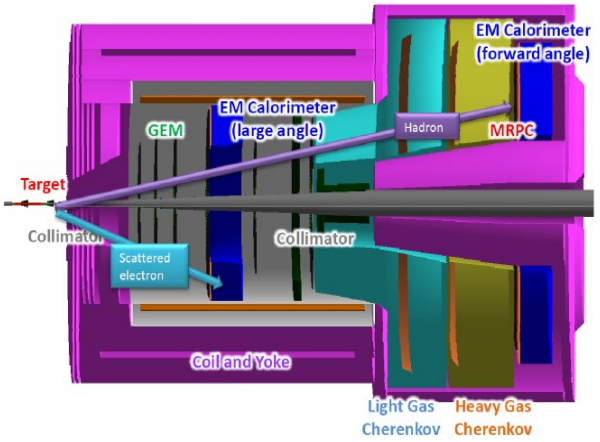
Hall B/CLAS12

(SIDIS with polarized H/D: $\pi^{+/-}$,$K^{+/-}$)
Comprehensive SIDIS program



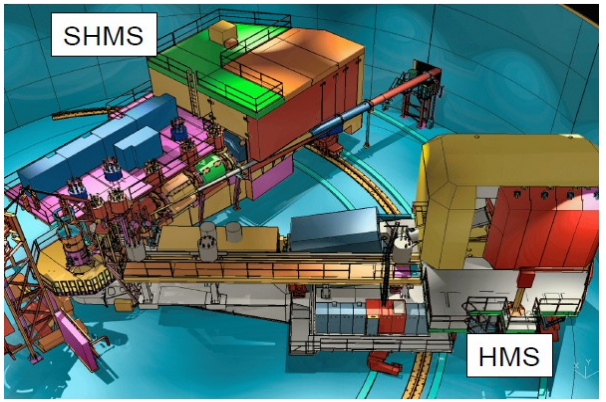
Hall A SoLID

(SIDIS with polarized ^{3}He/NH_3: $\pi^{+/-}$)
(precision 4D mapping)

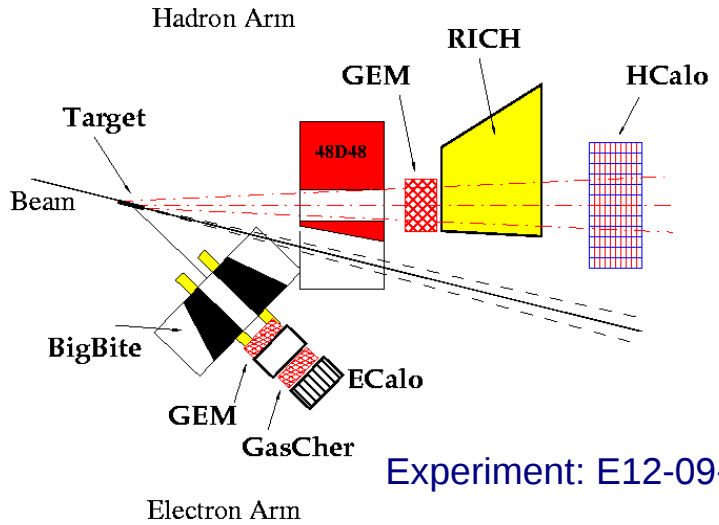


Hall C/SHMS

(SIDIS with unpolarized H/D) : L-T studies, precise π^+/π^- ratios, p_T dependence studies



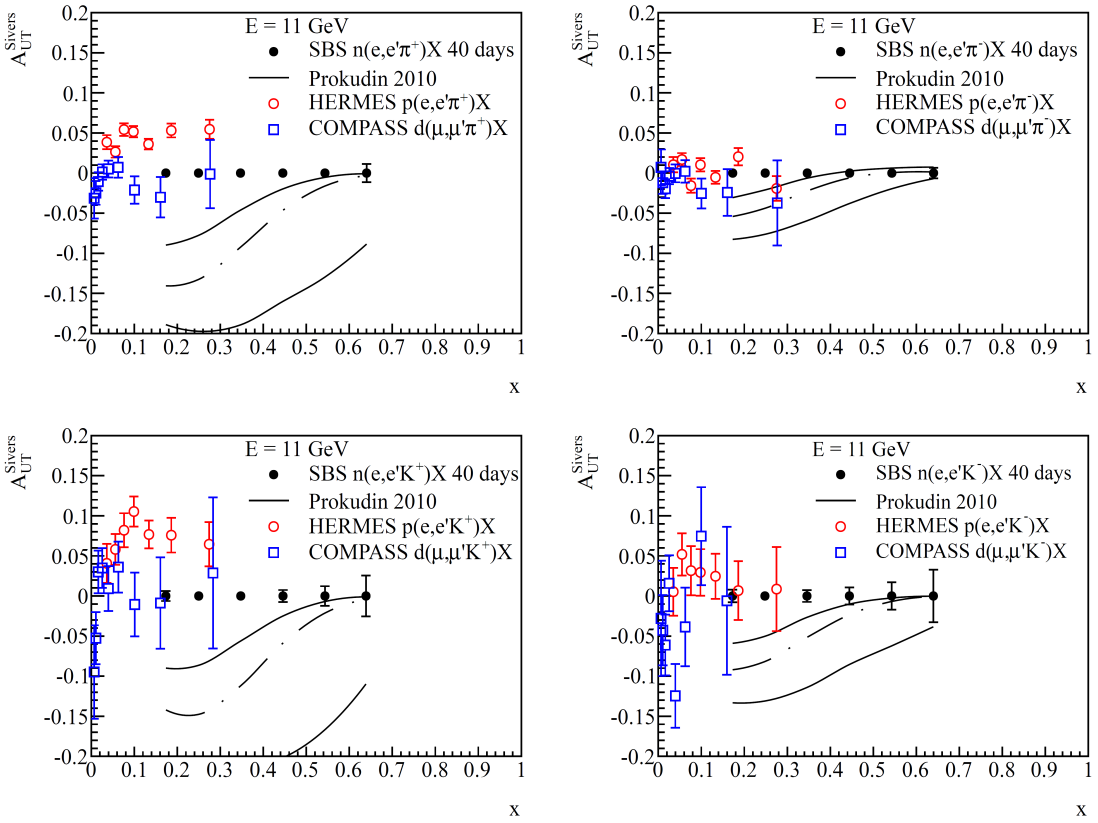
SIDIS with Super BigBite in Hall A



Experiment: E12-09-018

- Approved experiment
- BigBite as electron arm: DIS electrons at ~30 deg., 1 < p < 4 GeV
- SBS as hadron arm @ 14 deg.
- High-luminosity (10^{36} $cm^{-2}s^{-1}$) polarized ^{3}He target (with spin-flip)
- HERMES RICH detector as PID
- High-impact TMD physics
  - Collins/Sivers/pretzelosity
  - 100X higher statistical FOM than HERMES, high-x data.
- Will run after 2016

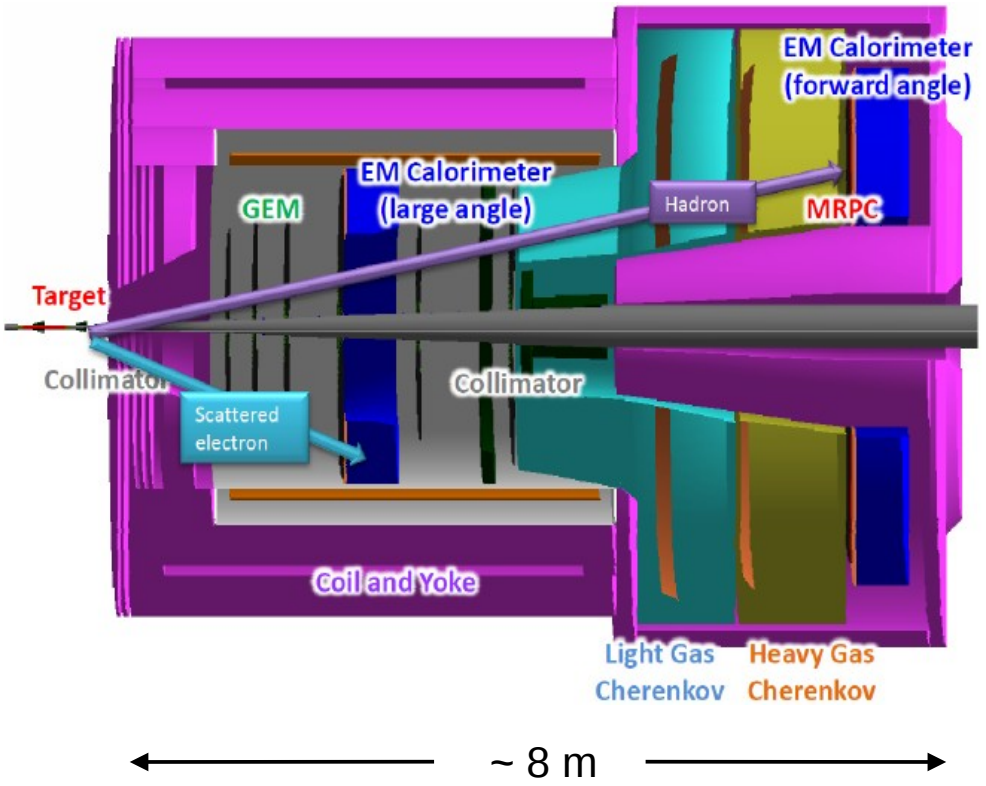
Sivers Asymmetry



Courtesy, A. Puckett

SoLID Spectrometer in Hall A

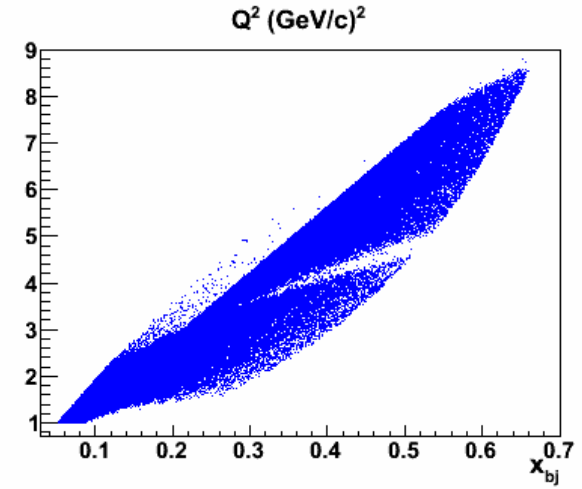
- Large acceptance, full azimuthal coverage
- High luminosity (10^{36}-10^{39} $cm^{-2}s^{-1}$)
- Longitudinal and transverse polarized targets
  - proton (NH_3) and neutron (^3He) targets
- Three SIDIS proposals approved
  - Longitudinal pol. ^3He target (E12-11-007)
  - Transverse pol. ^3He target (E12-10-006)
  - Transversely pol. NH_3 target (E12-11-108)
- Precision 4-D (x,Q^2,p_T,z) mapping of TMDs (Collins, Sivers, Pretzelosity etc.)

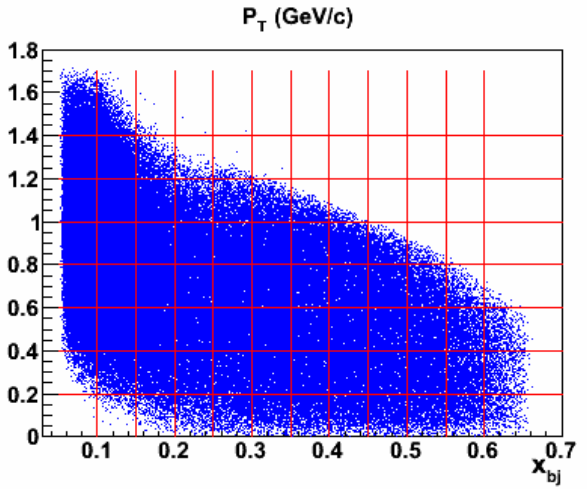


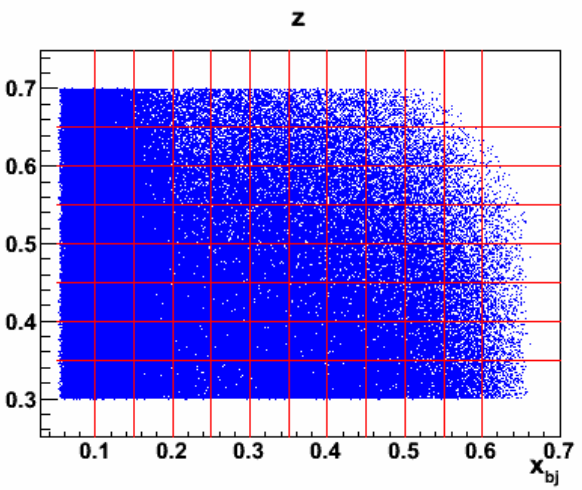
Planned physics with SoLID include parity violation DIS, SIDIS, di-hadron, J/ψ production, etc.
(See talk by J.P.Chen in parallel-VII: S11)

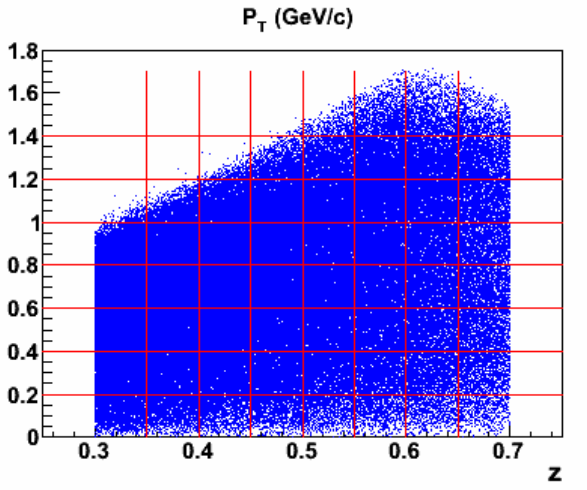
SoLID Phase Space Coverage

- x_B = 0.05 – 0.68
- Q^2 = 1.0 – 8.0 (GeV/c)^2
- P_T = 0 – 1.8 GeV/c
- z = 0.3 – 0.7
- W > 2.3 GeV





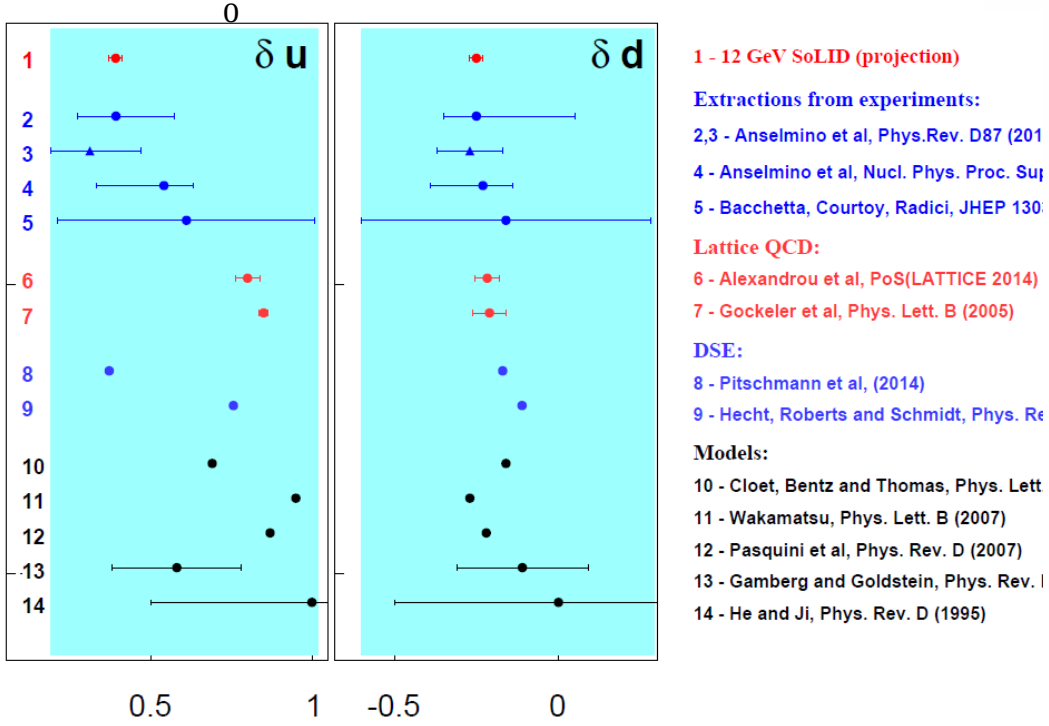




SoLID Projections : Collins Asymmetry

- Covers large-x region
- Essential for transversity distribution, tensor charge extraction
- SoLID proton/neutron data will allow extraction of tensor charge

$$\delta q = \int_0^1 \left[h_1^q(x) - h_1^{\bar{q}}(x) \right] dx$$



1 - 12 GeV SoLID (projection)

Extractions from experiments:

2,3 - Anselmino et al, Phys.Rev. D87 (201

4 - Anselmino et al, Nucl. Phys. Proc. Su

5 - Bacchetta, Courtoy, Radici, JHEP 130

Lattice QCD:

6 - Alexandrou et al, PoS(LATTICE 2014)

7 - Gockeler et al, Phys. Lett. B (2005)

DSE:

8 - Pitschmann et al, (2014)

9 - Hecht, Roberts and Schmidt, Phys. Re

Models:

10 - Cloet, Bentz and Thomas, Phys. Lett

11 - Wakamatsu, Phys. Lett. B (2007)

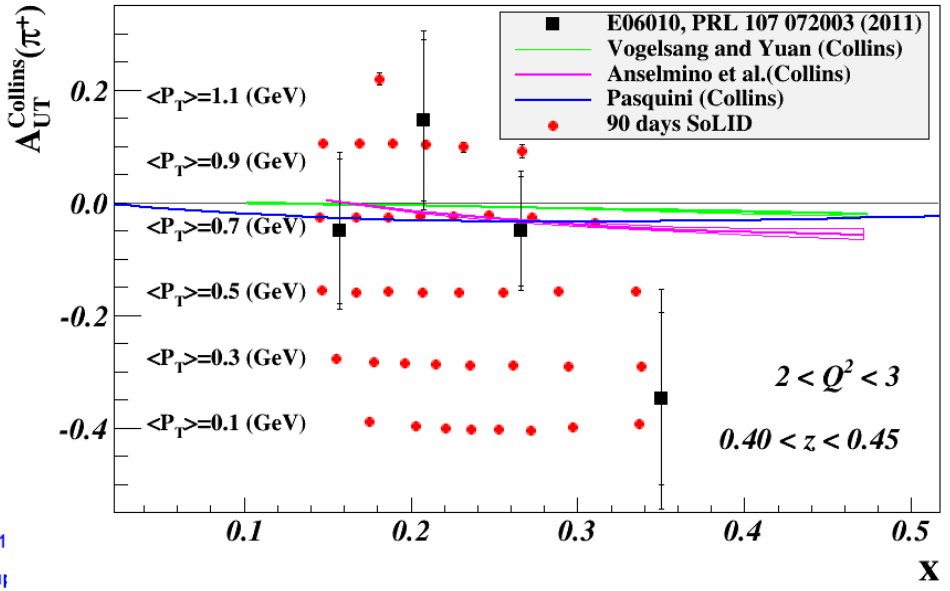
12 - Pasquini et al, Phys. Rev. D (2007)

13 - Gamberg and Goldstein, Phys. Rev.

14 - He and Ji, Phys. Rev. D (1995)

Courtesy, A. Prokudin

Collins Asymmetry



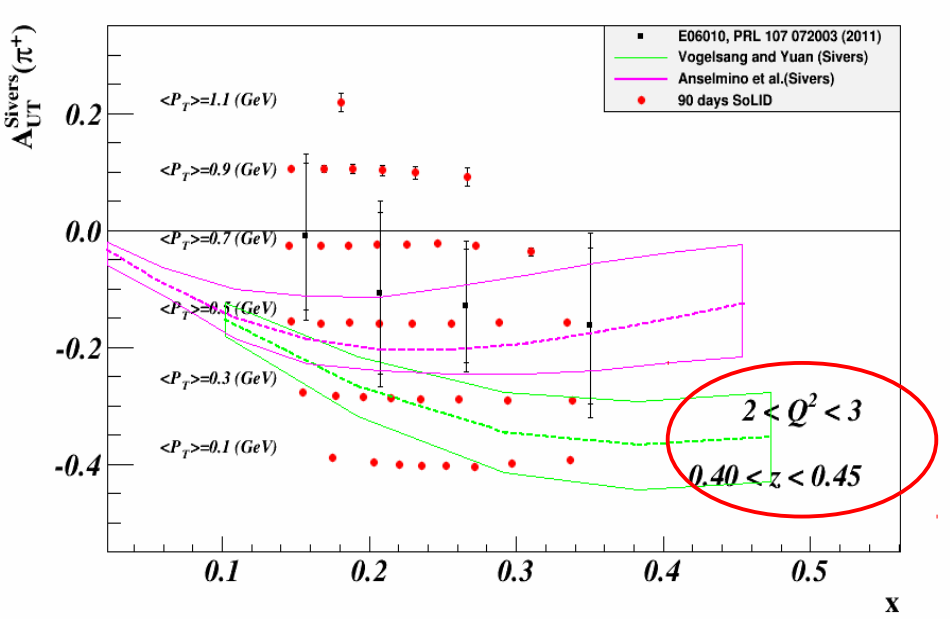
A total of more than 1000 bins

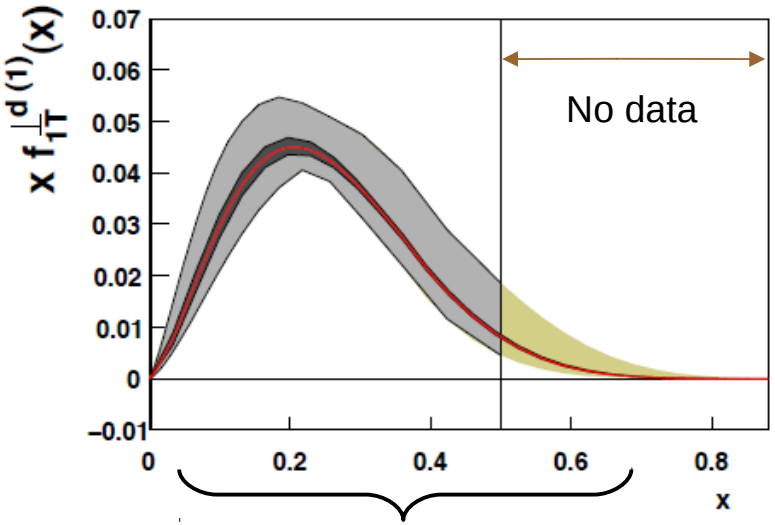
Only statistical uncertainties included in the fit
Systematic (model) uncertainties not included

SoLID Projections : Sivers Asymmetry

- Covers valence quark region
- Relatively large p_T range
  - Important for testing TMD approach
- Relatively large Q^2 range (evolution studies)
- Access higher-twist terms by direct fitting of SSA

Sivers Asymmetry (π^+)





Region covered by SoLID

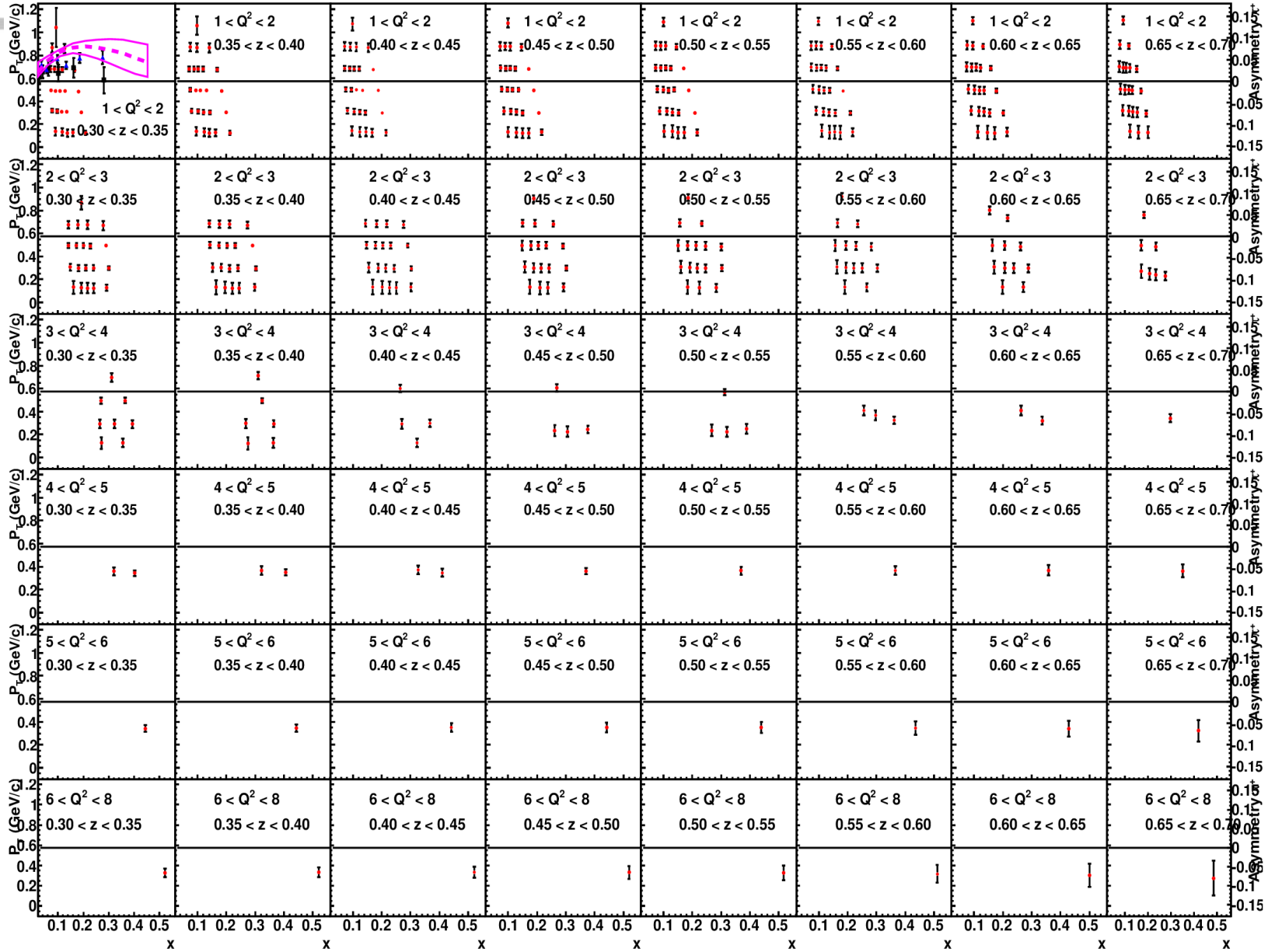
Current experimental uncertainties

Projected uncertainties with SoLID

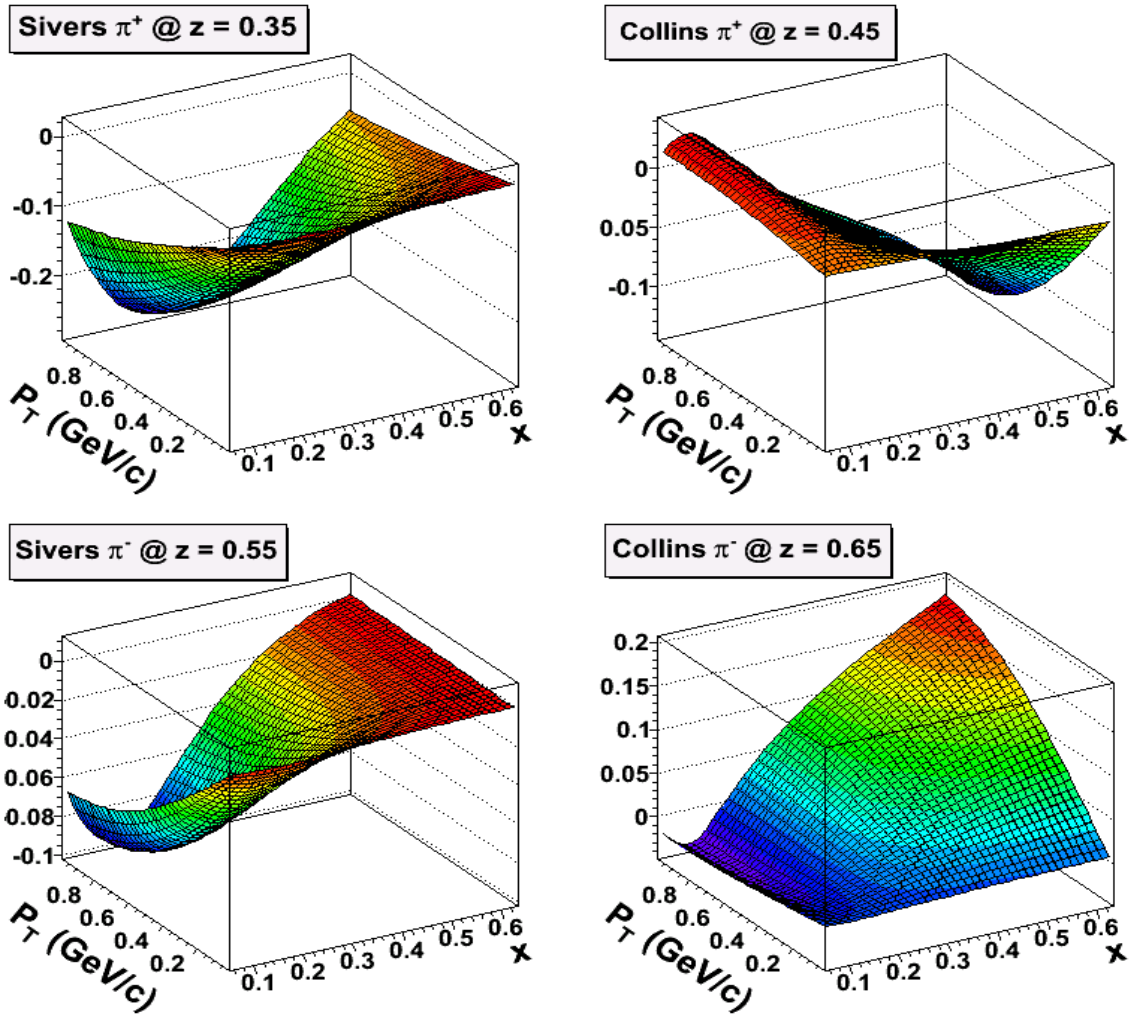
Only statistical uncertainties included in the fit
Systematic (model) uncertainties not included:
Assumption in extraction:

- k_T dependence, Q^2 evolution, TMD FF are known

Sivers Moment Projections in Multi-dimensions



Impact of SoLID Data on the Extraction of TMDs

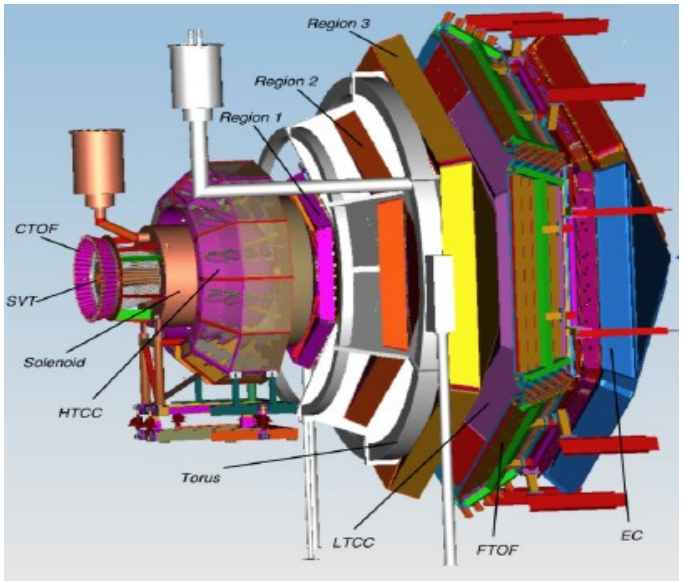


High precision SoLID data will allow
Multi-dimensional mapping of SSA

CLAS 12 TMD Program

CLAS12 detector

- Luminosity up to 10^{35} $cm^{-2}s^{-1}$
- High polarized electron beams (~85%)
- H and D polarized target
- Broad kinematic range



Leading Twist TMDs

: Nucleon Spin : Quark Spin

Nucleon Polarization	Quark polarization: Un-Polarized (U)	Longitudinally Polarized (L)	Transversely Polarized (T)
U	f_1 =		$h_1^\perp$ = – (Boer-Mulder)
L		g_1 = – (Helicity)	$h_{1L}^\perp$ = –
T	$f_{1T}^\perp$ = – (Sivers)	$g_{1T}^\perp$ = –	h_{1T} = – (Transversity); $h_{1T}^\perp$ = –

E12-06-112: Pion SIDIS
E12-09-008: Kaon SIDIS

E12-07-107: Pion SIDIS
E12-09-009: Kaon SIDIS

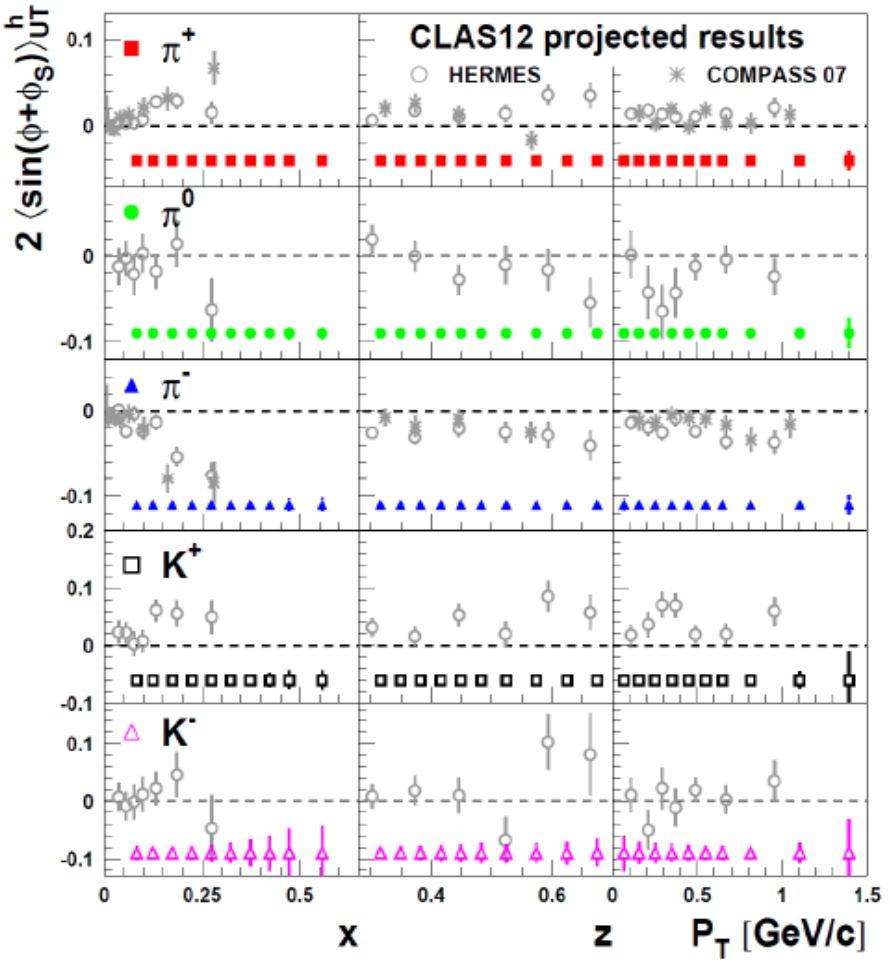
PR12-11-111: Pion/Kaon SIDIS
PR12-12-009: Pion/Kaon SIDIS

Courtesy, L.L. Pappalardo

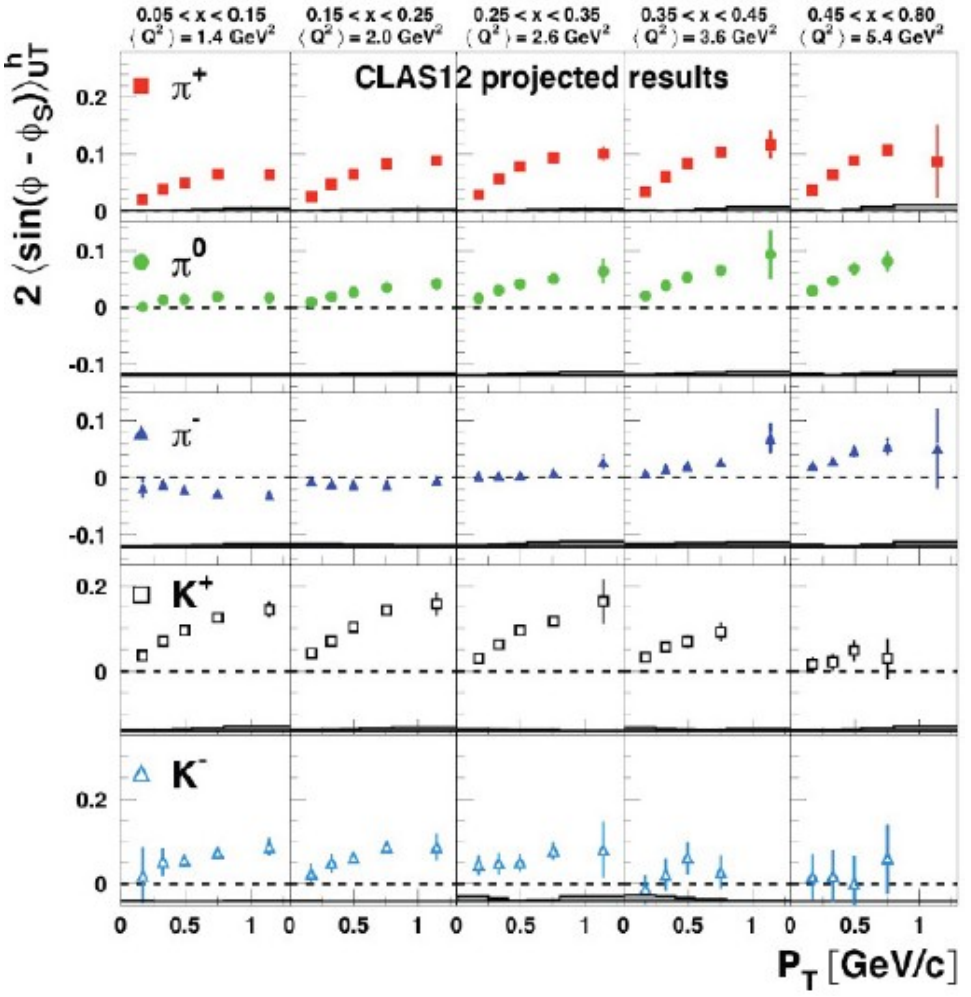
CLAS 12 Projections: Collins and Sivers

100 days @ L = 5x10^{33} cm^{-2}s^{-1}, HD-Ice target (60% H pol, f = 1⁄3), RICH dectector

Collins



Sivers

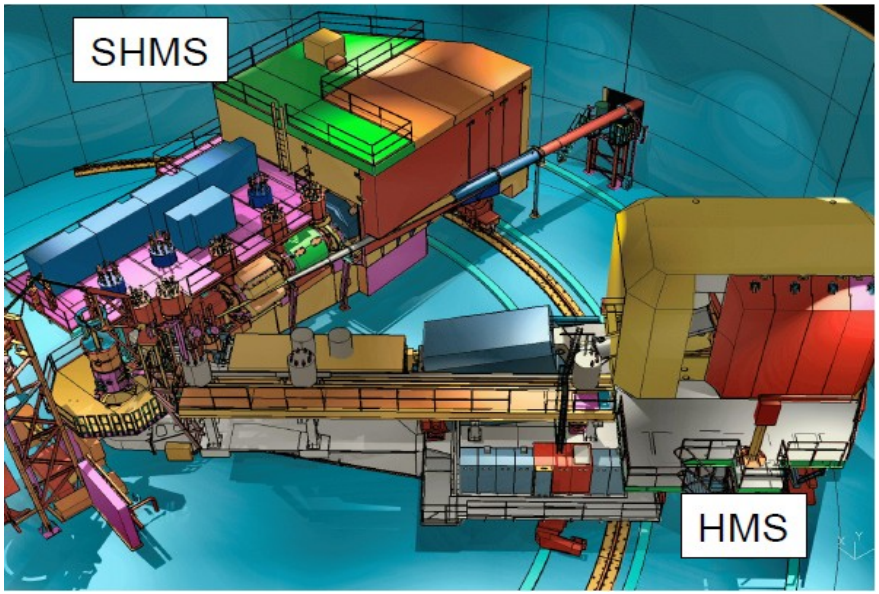


Courtesy, Silvia Pisanos

SIDIS with Super HMS in Hall-C

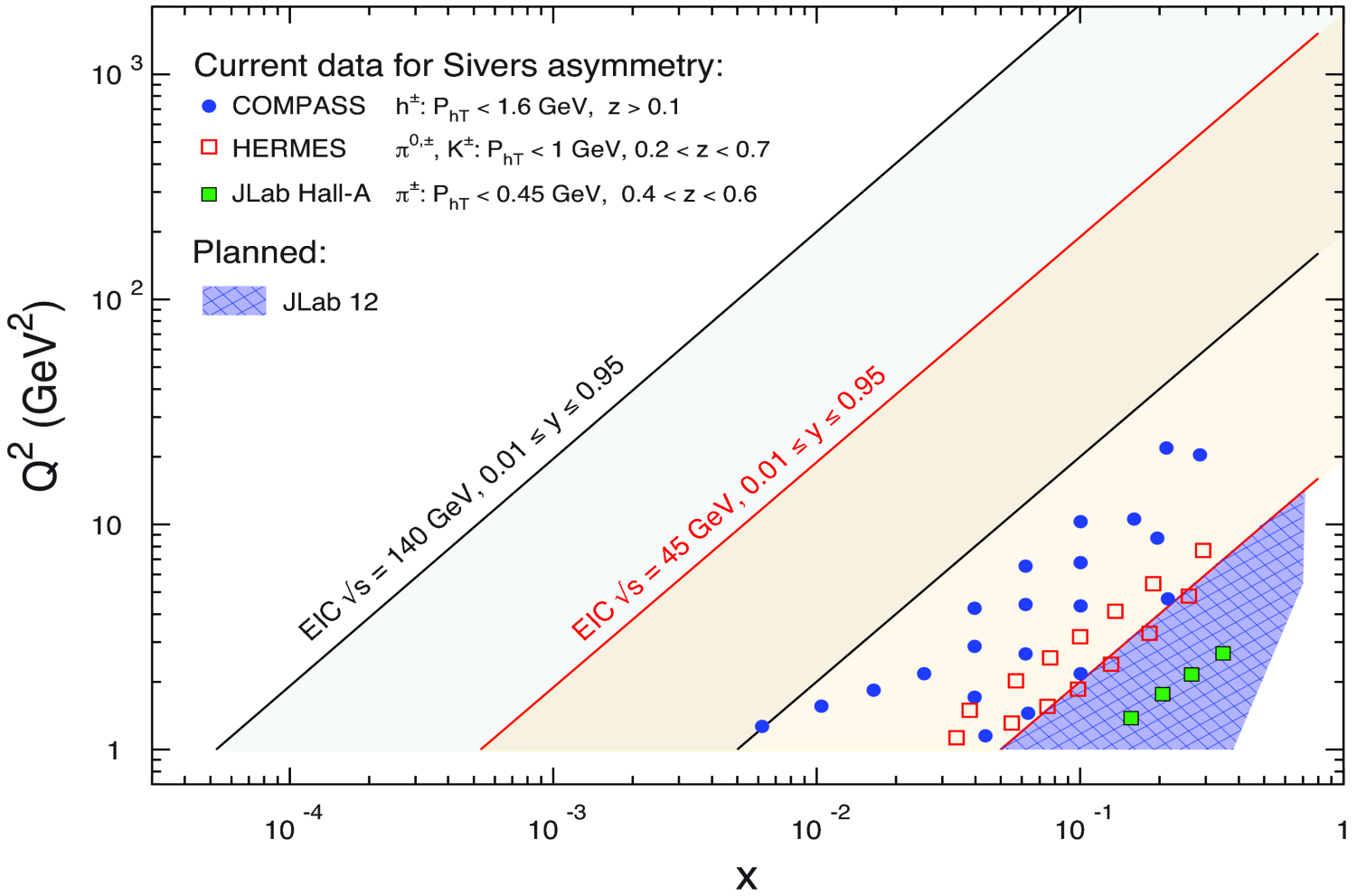
High Momentum Spectrometer (HMS)
dΩ ~ 6 msr, P_0= 0.5 – 7 GeV/c
θ_0=10.5 to 80 degrees

Super-HMS:
dΩ ~ 5 msr, P_0= 1 – 11 GeV/c
θ_0=5.5 to 40 degrees



- Main program: Precise measurements of absolute SIDIS cross-sections
- Approved SIDIS proposals:
  - E12-09-002: π^+/π^- ratios on H/D targets
  - E12-06-104: $R_{SIDIS} = \sigma_L/\sigma_T$ on H/D targets
  - E12-09-017: p_T dependence studies in SIDIS
  - E12-13-007: π^0 production

Future Electron Ion Collider Kinematics



EIC white paper, arXiv:1212.1701

Projections for an EIC

Three Options:

$\sqrt{s}$ = 140 GeV (20 x 250)
= 50 GeV (11 x 60)
= 15 GeV (3 x 20)

Integrated luminosity in each case: 30 fb^{-1}
(about 1 month running with 10^{34}/cm^2/s)

- $0.8 > y > 0.05$
- Polarization: 70%
- Overall efficiency : 50%
- z = 12 bins (0.2 – 0.8)
- P_T = 5 bins (0 – 1 GeV)

How important are sea quarks TMDs?

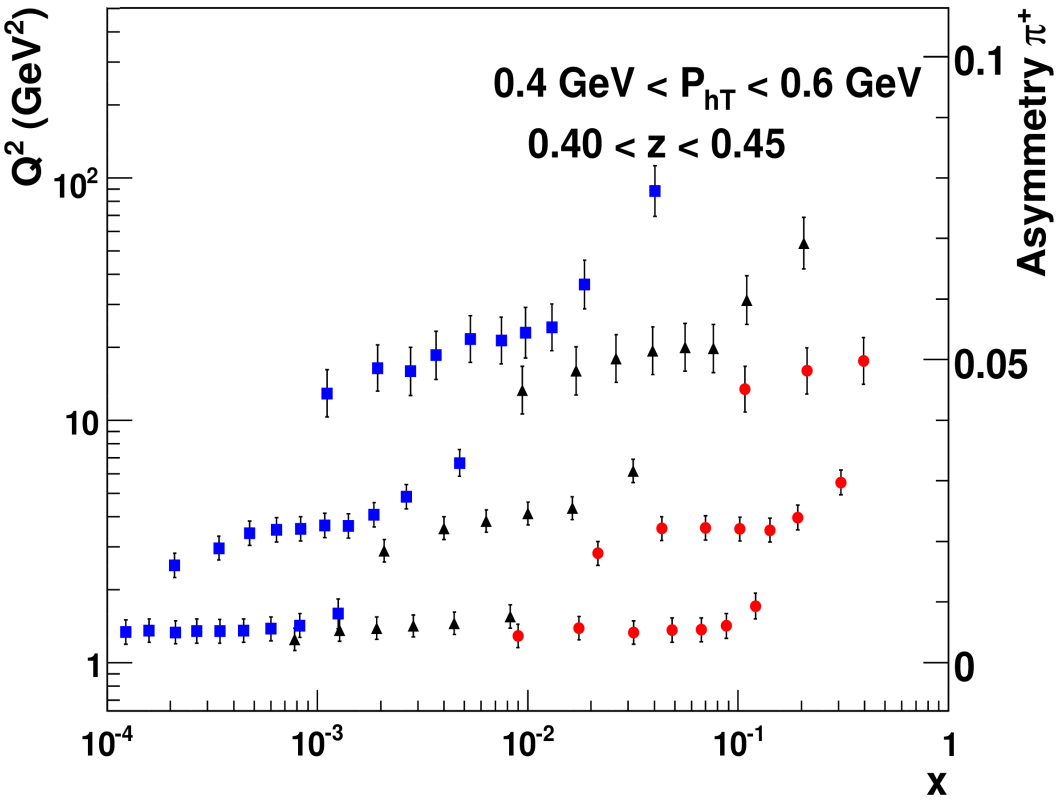
What about gluon TMDs?

- Eg: *J/psi* production ($\gamma g \rightarrow c\bar{c}$)

$$e + p^{\uparrow} \rightarrow e + J/\psi + X$$

Godbole, et al.
PRD **85**, 094013 (2012)

Projection of π^+ SSA on proton



1 out of 60 bins of (P_T,z)

(plot by M. Huang, Duke Univ.)

Summary

- Study of TMDs through SIDIS at JLab
  - Moving from exploration to precision measurements
  - Study spin-orbit corrections, P_T dependence, factorization, flavor dependence, higher twist terms etc.

- In near future, Drell-Yan experiments will perform crucial measurements
  - Measure magnitude and sign of T-odd Sivers and Boer-Mulders functions
  - Explore sea quark TMDs
  - COMPASS, Fermilab, RHIC, NICA, FAIR (PAX) etc.

- JLab 12 GeV experiments will provide high precision SIDIS data allowing for:
  - Multi-dimensional study of TMDs valence region (Hall A/B)
  - Tensor charge extraction (Hall A/B)
  - Strange quark distributions from kaon measurements (Hall A/B)
  - Study of quark-gluon correlation from higher-twist terms (Hall A/B)
  - High precision SIDIS cross-sections (Hall C)

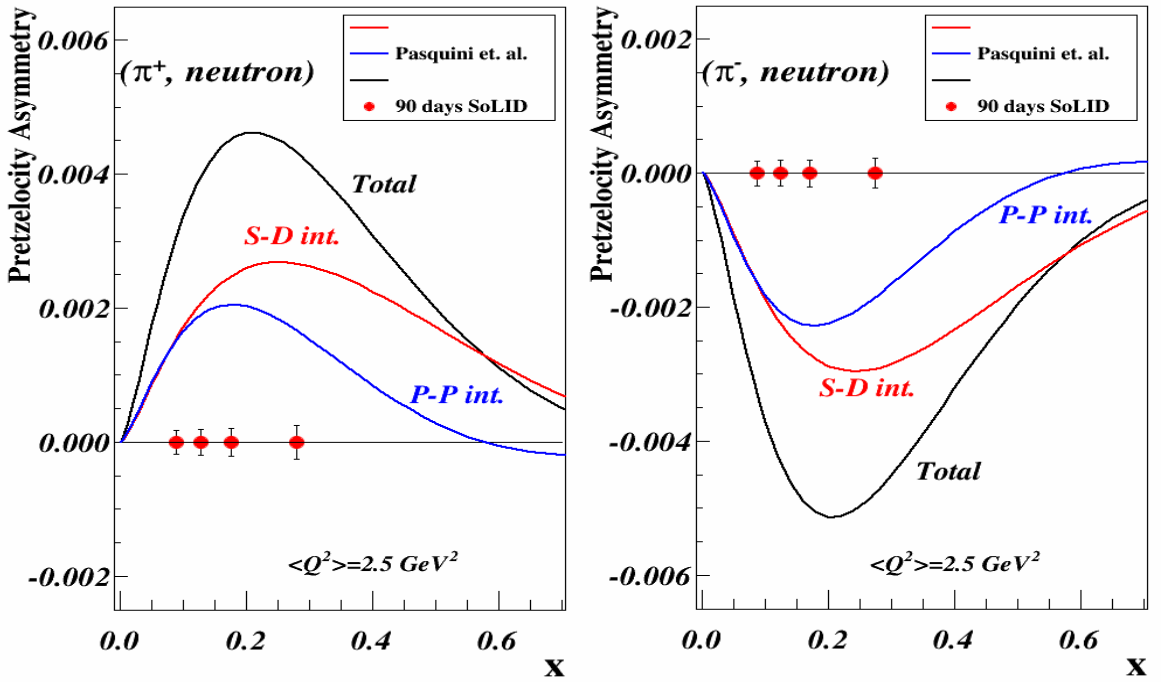
- A future EIC will explore sea quark and gluon TMDs – a bright future for TMDs!

Spare Slides

SoLID Projections : Pretzelosity Asymmetry

$$A_{UT}^{\sin(3\phi-\phi_S)} \sim \frac{h_{1T}^{\perp} \otimes H_1}{f_1 \otimes D_1}$$

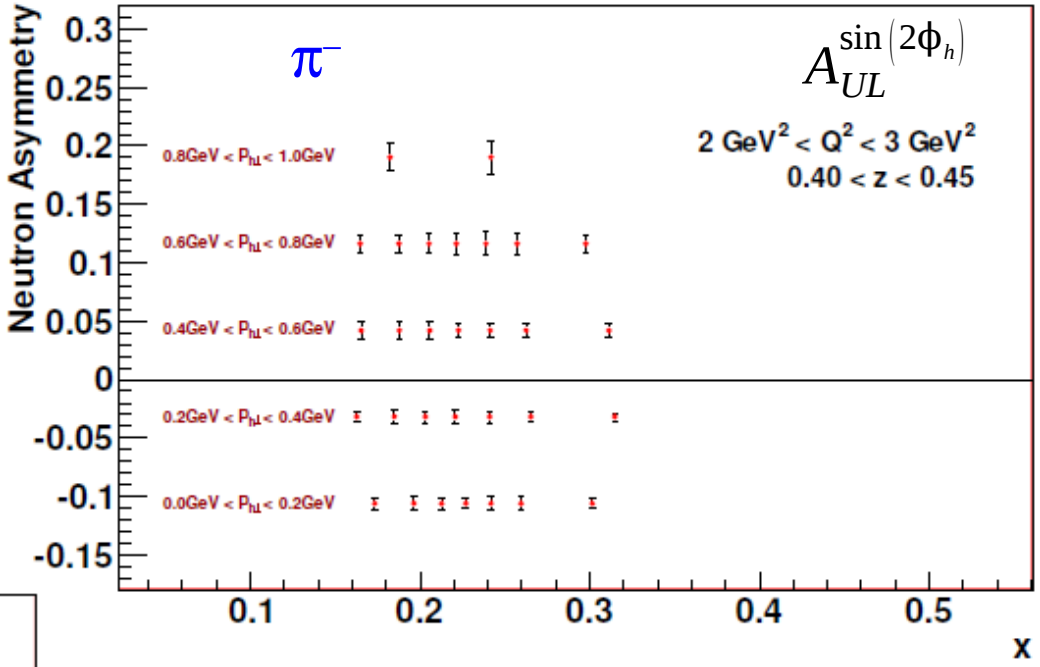
- Pretzelosity: ΔL=2 (L=0 and L=2 interference , L=1 and -1 interference)

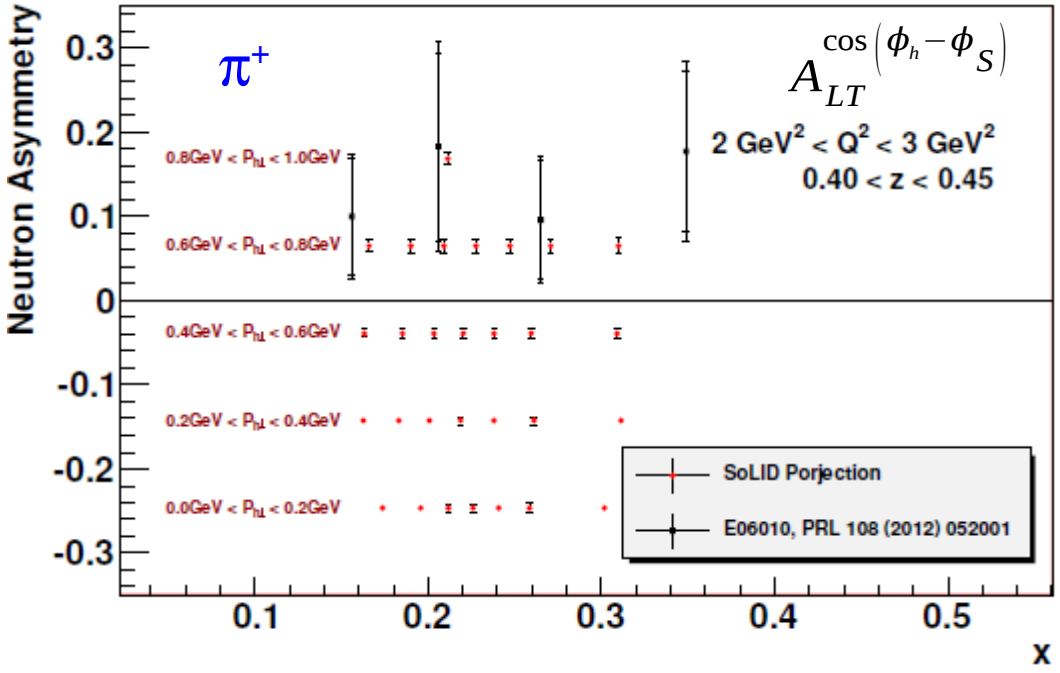


Boffi, Efremov, BP, Schweitzer, PRD 79 (2009)

SoLID Projections of A_{LT} and A_{UL}

- Clean extraction of g_{1T} and h_{1T} possible





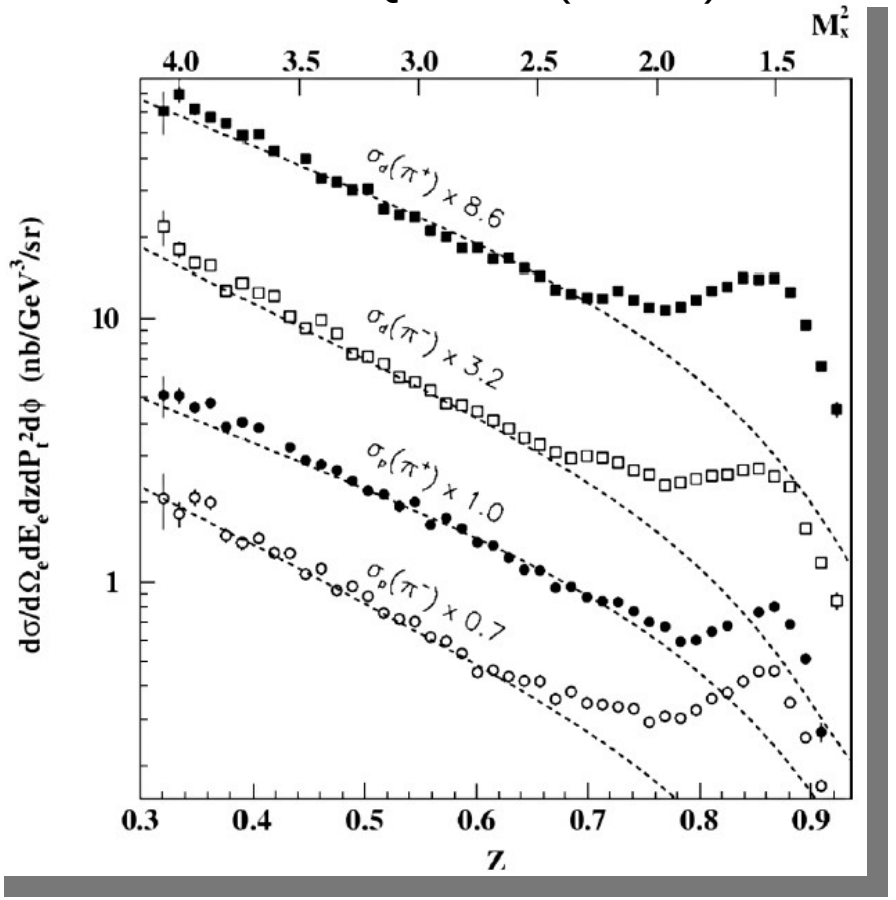
Projections for ^{3}He target

Hall-C SIDIS cross-section

$$\frac{dN}{dz} \sim \sum_q e_q^2 q(x, Q^2) D_{q\to\pi}(z, Q^2)$$

T. Navasardyan et al. PRL 98, 022001 (2007)

$x \sim 0.3$, $Q^2 \sim 2.3$ (GeV/c)^2



$z = E_h/\nu$