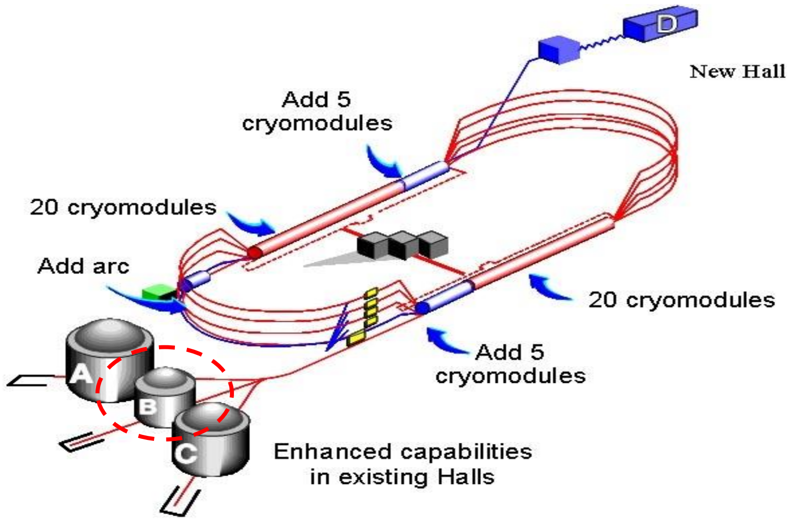


The JLAB 3D program at 12 GeV (TMDs+GPDs)

Silvia Pisano
Laboratori Nazionali di Frascati
INFN

GPDs&TMDs: 3D reductions of the Wigner functions

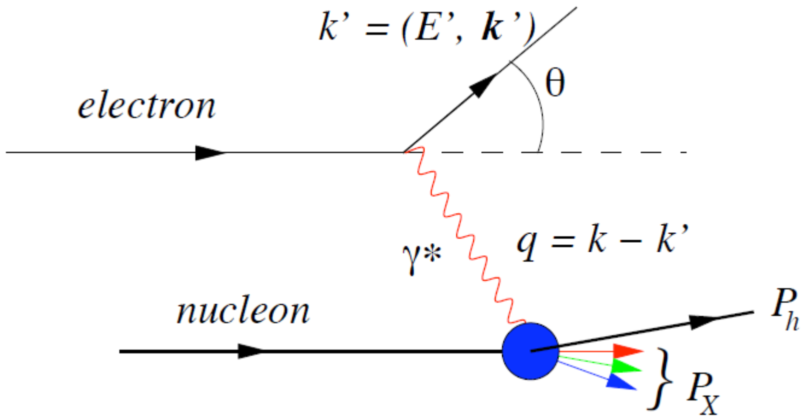
Wigner Functions: quantum phase-space quark distributions in the nucleon

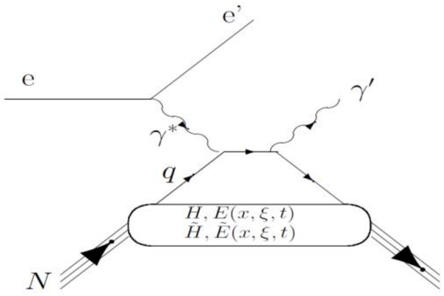
TMDs: 3D imaging in the momentum space
GPDs: 3D imaging in the coordinate space

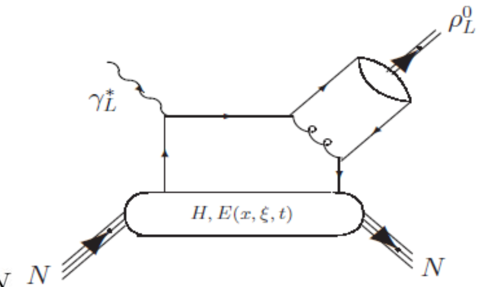
$$W_{\boldsymbol{\Gamma}}(\boldsymbol{r},\boldsymbol{k}) = \int \frac{dk^-}{(2\pi)^2} W_{\boldsymbol{\Gamma}}(\boldsymbol{r},k)$$

integrated over spatial coordinates:
Tranverse Momentum Distributions
→ accessed through ***Semi-Inclusive Deep Inelastic Scattering***

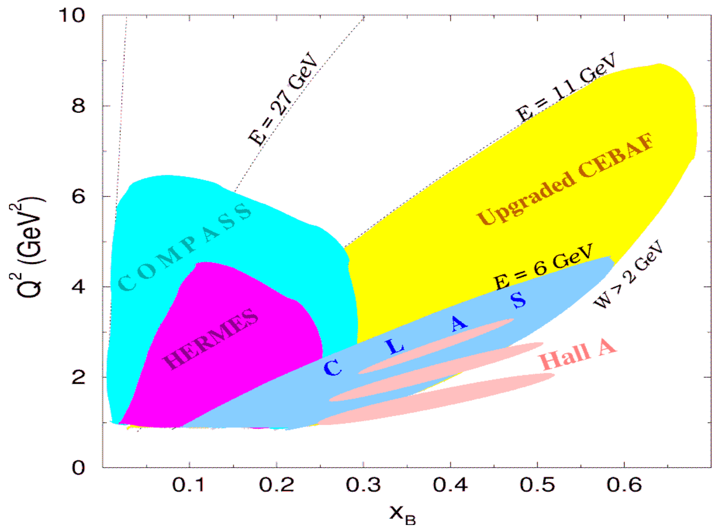
integrated over momentum space:
Generalized Parton Distributions
→ measured through ***exclusive reactions***



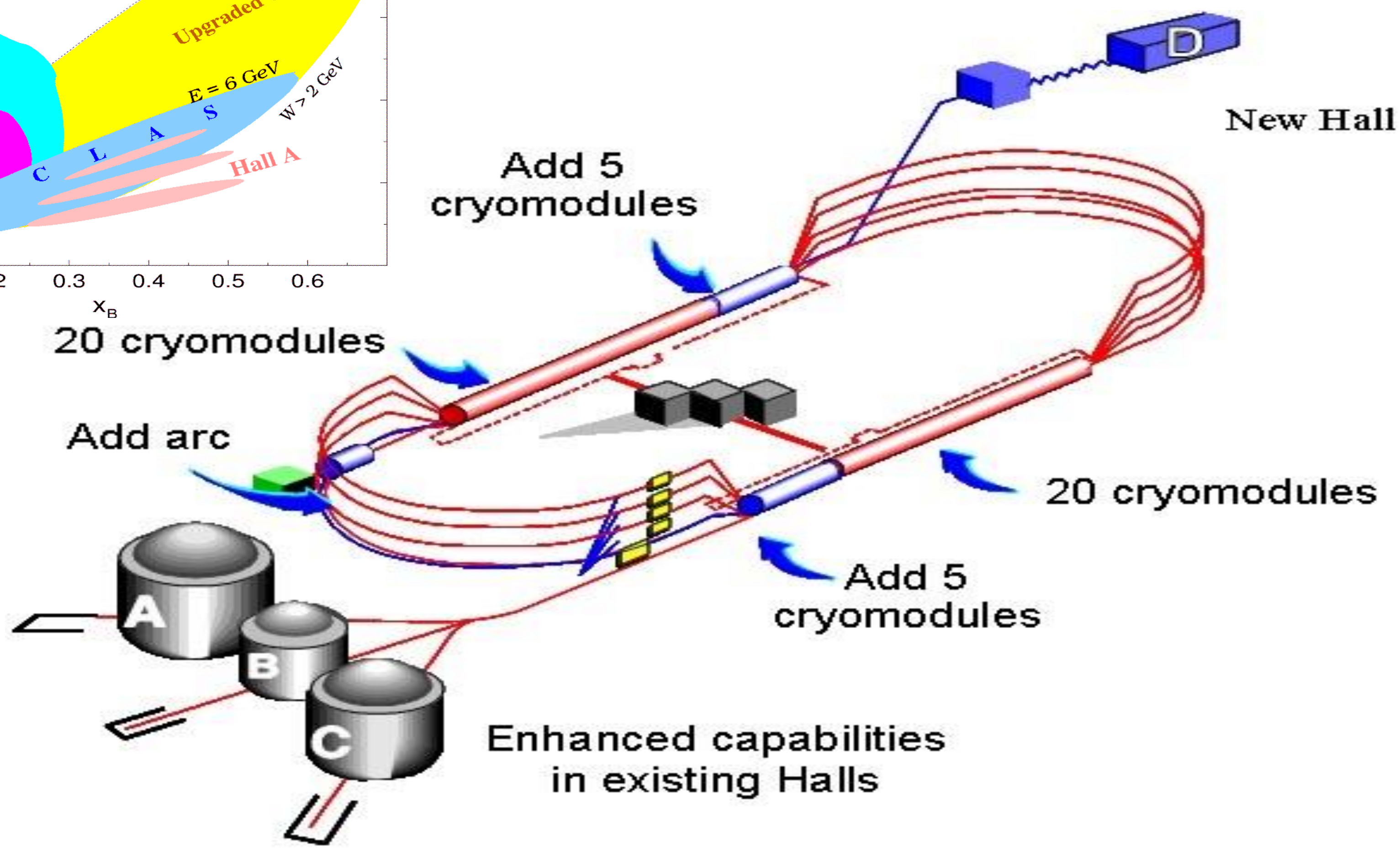




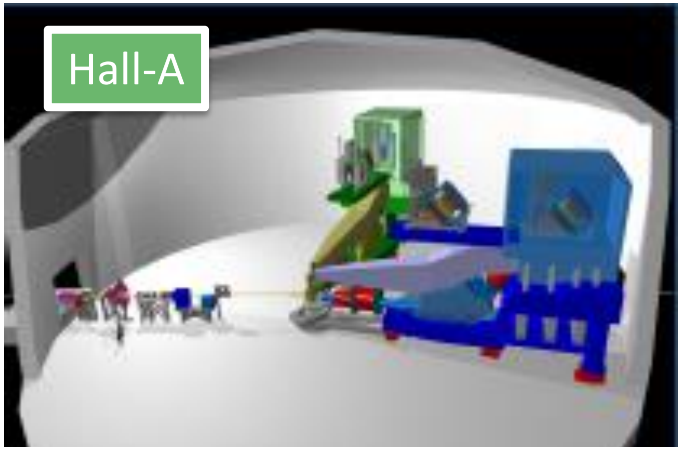
The 12-GeV upgrade



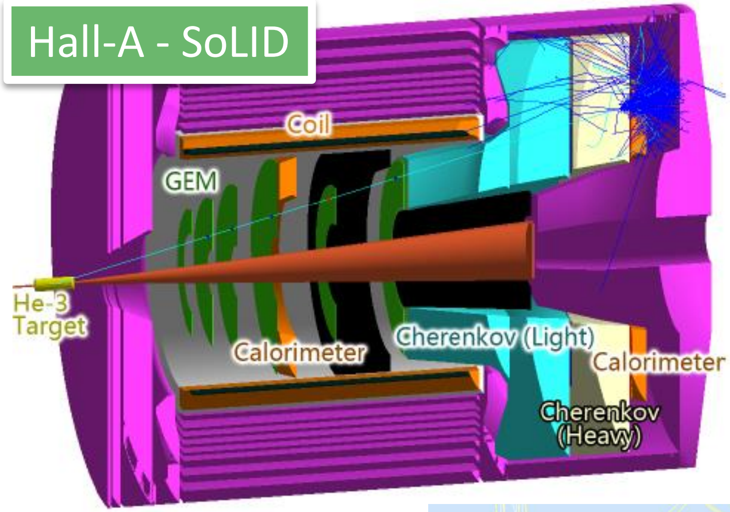
4 experimental halls with a longitudinally-polarized electron beam of E_{e^-} up to 12 GeV.

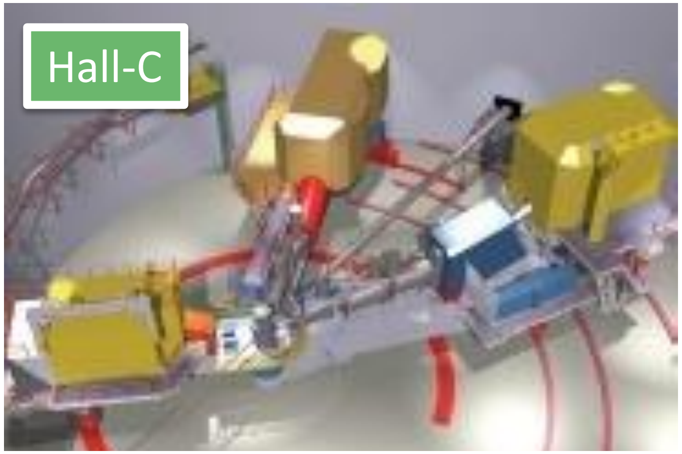


Upgraded halls@12 GeV

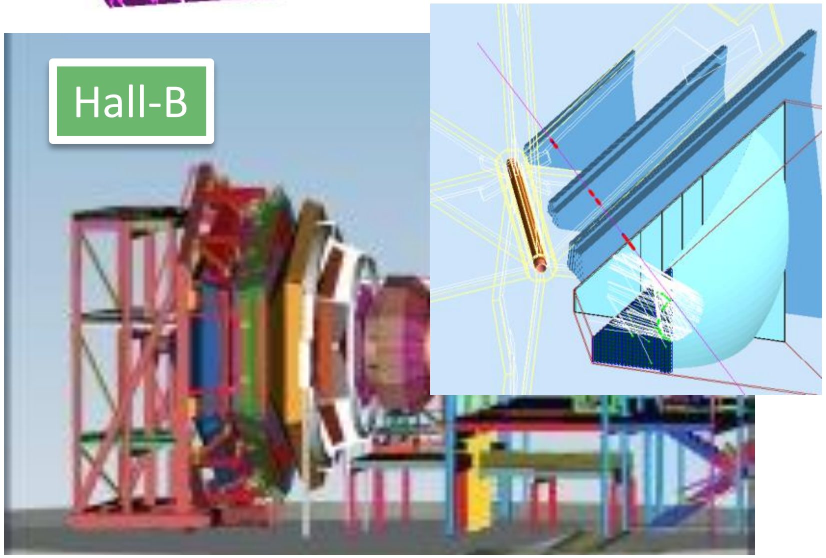


High Resolution Spectrometer (HRS) pair and specialized large installation experiments





Super High Momentum Spectrometer (SHMS) at high luminosity and forward angles

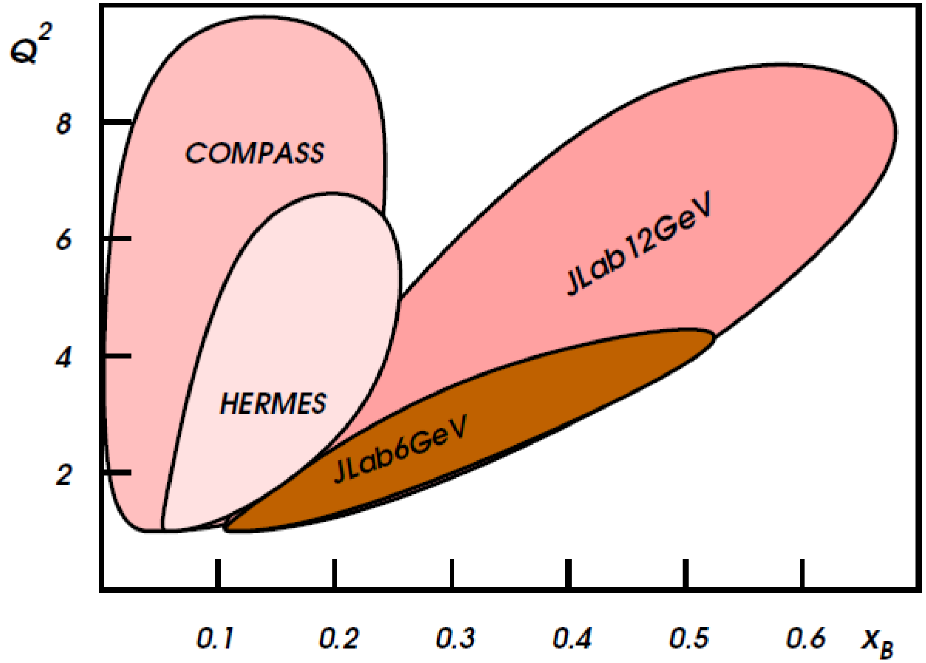


CLAS12: large acceptance, high luminosity

Deeply-Virtual Compton Scattering & GPD knowledge

DVCS data in the valence region

- Hall-A: unpolarized and beam-polarized cross-section
- Hall-B: beam-spin asymmetries, longitudinally-polarized target spin-asymmetries
- HERMES: beam-charge, beam-spin and target-spin asymmetries



All included in *CFFs* extractions

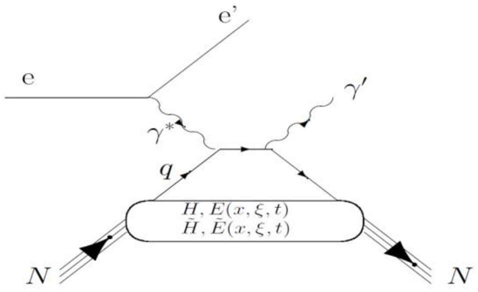
→ $H_{Im}CFF$ constrained at the level of 15%

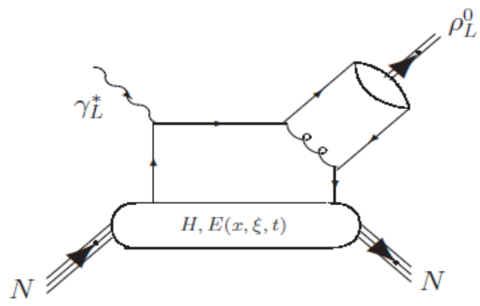
Wanted:
1. more observables
2. more precise data
3. larger phase-space coverage

- **COMPASS**: DVCS program (2016) → 160 GeV muon beam (recoil detector for full exclusivity): $x_B = 0.01 \div 0.1$ region explored
- **JLAB12**: Hall-A, B, C → high-statistics in a wide kinematics

12-GeV DVCS program

nucleon polarization	Sensitivity to GPDs	
unpolarized	$\boldsymbol{H}, \boldsymbol{\widetilde{H}}, \boldsymbol{E}$	E12-06-114: Hall-A, p E12-06-119: Hall-B, p E12-11-003: Hall-B, n E12-13-010: Hall-C, p PR12-06-108: Hall-B, p (DVMP - π^0, η)
longitudinally-polarized	$\boldsymbol{\widetilde{H}}, \boldsymbol{H}, \boldsymbol{E}$	E12-06-119: Hall-B, p (NH_3)
transversely-polarized	$\boldsymbol{E}, \boldsymbol{H}$	LOI12-11-105: Hall-B, p (HD)

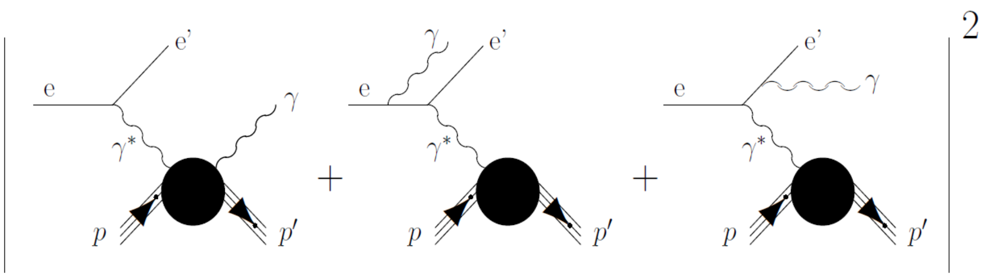




Good mapping in the $(x_B, Q^2, -t)$ bins → big impact in constraining $CFFs$

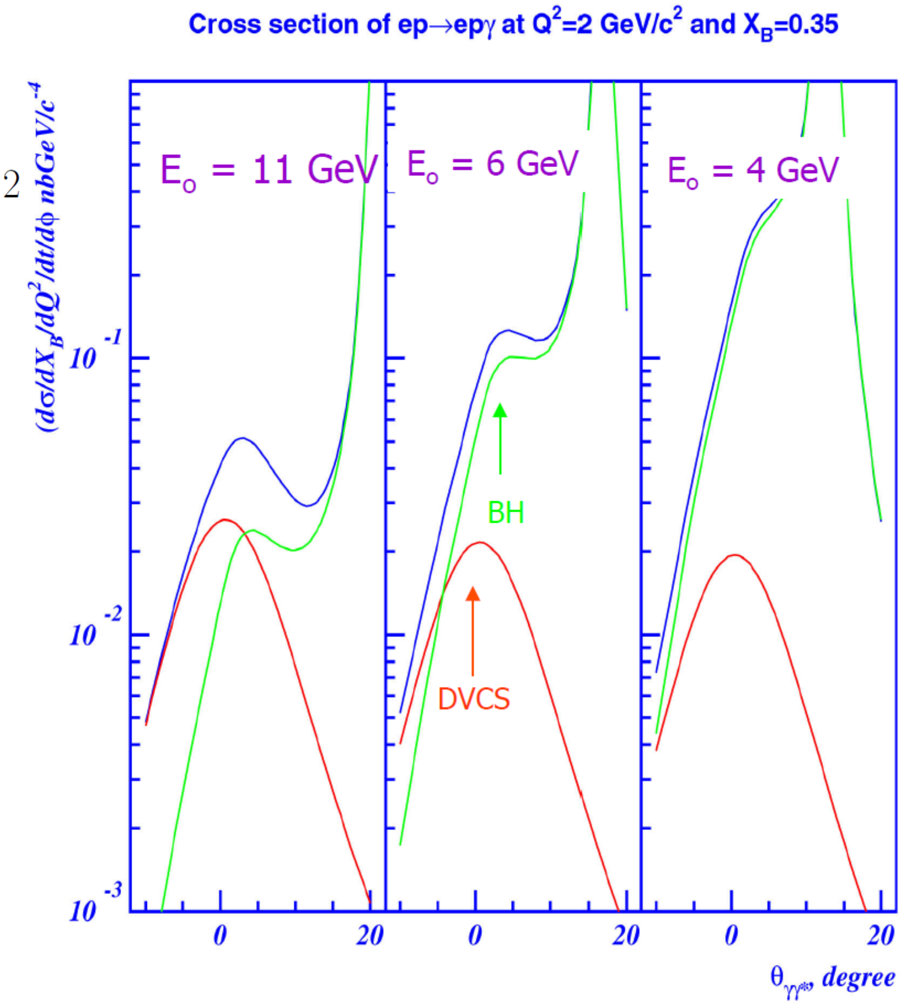
Deeply-Virtual Compton Scattering@12-GeV JLab

Two processes contribute to the same (e, p, γ) final state: Bethe-Heitler and Deeply-Virtual Compton Scattering.



$$\sigma = |BH|^2 + I(BH \cdot DVCS) + |DVCS|^2$$

$I(BH \cdot DVCS)$ gives rise to spin asymmetries, which can be connected to combinations of GPDs

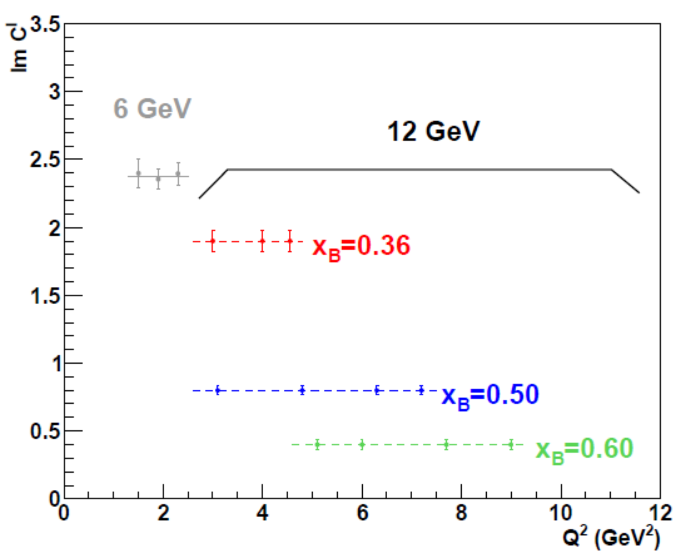


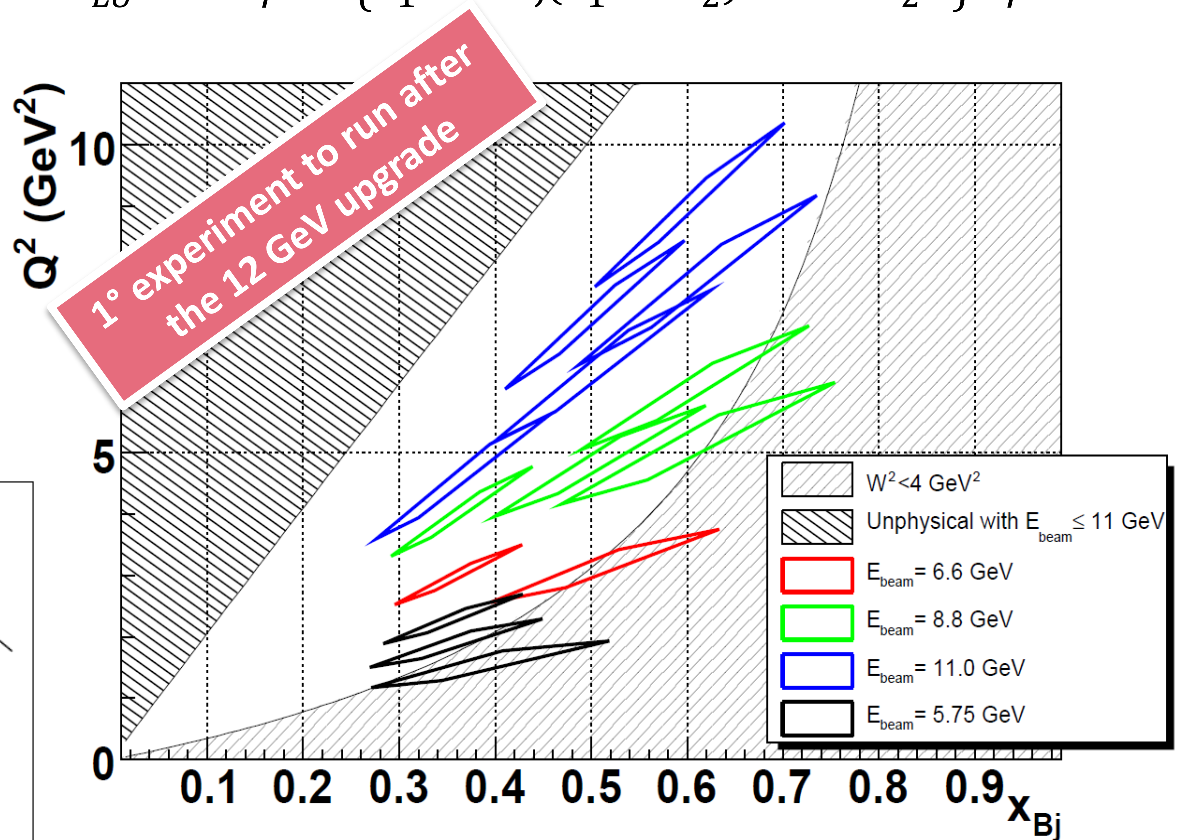
Hall-A@12 GeV: E12-06-114

$$\Delta\sigma_{LU} \propto \sin\varphi \, Im\{F_1\mathcal{H} + \xi(F_1 + F_2)\widetilde{\mathcal{H}} + kF_2\mathcal{E}\}d\varphi$$

Beam-polarized and unpolarized cross sections with high precision at three electron-beam energies to get:

- increased kinematic coverage
- Test of scaling → Q^2 dependence of $d\sigma$ at fixed x_B

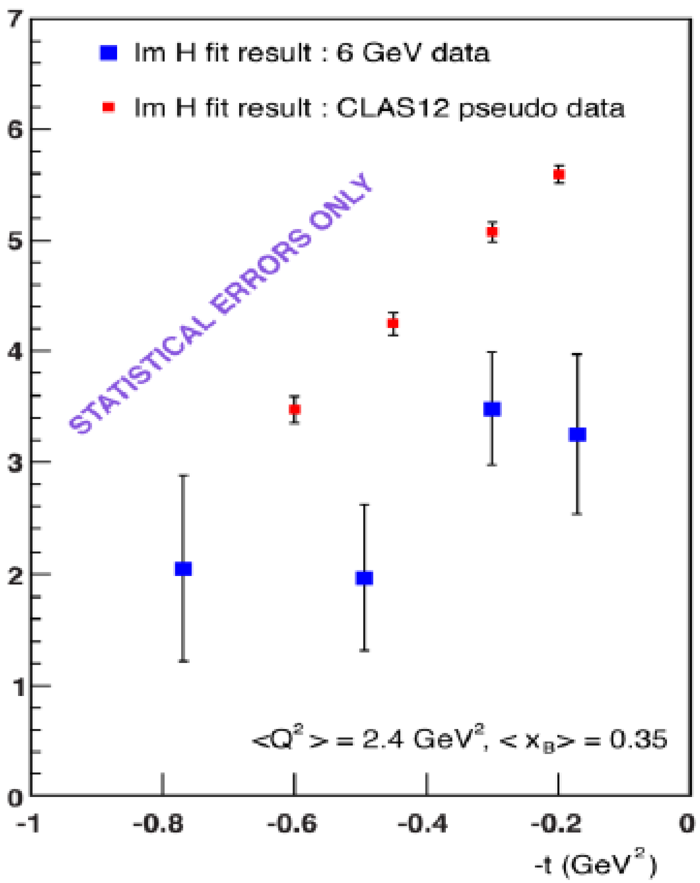


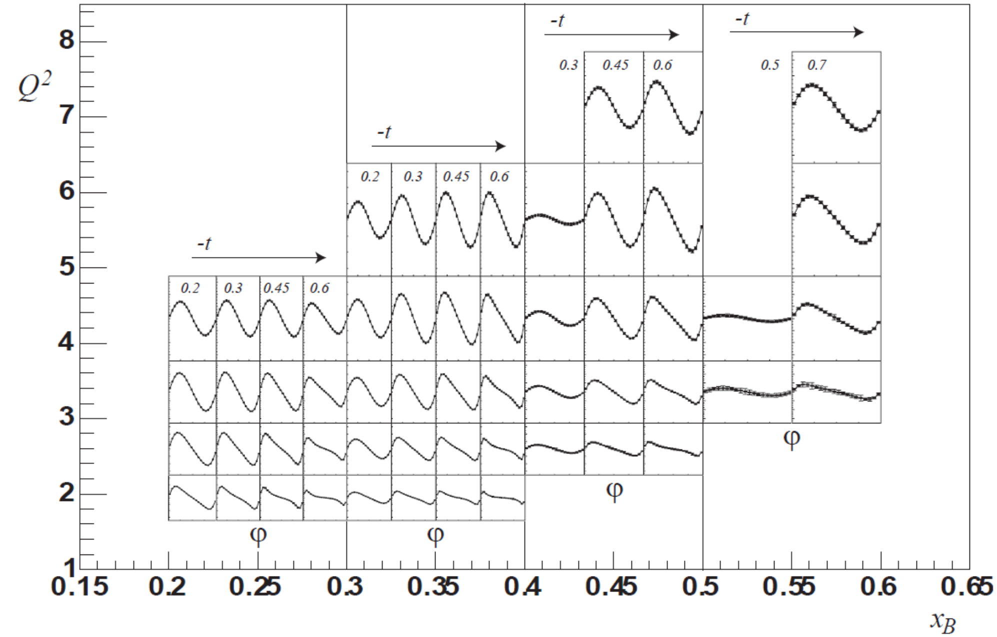


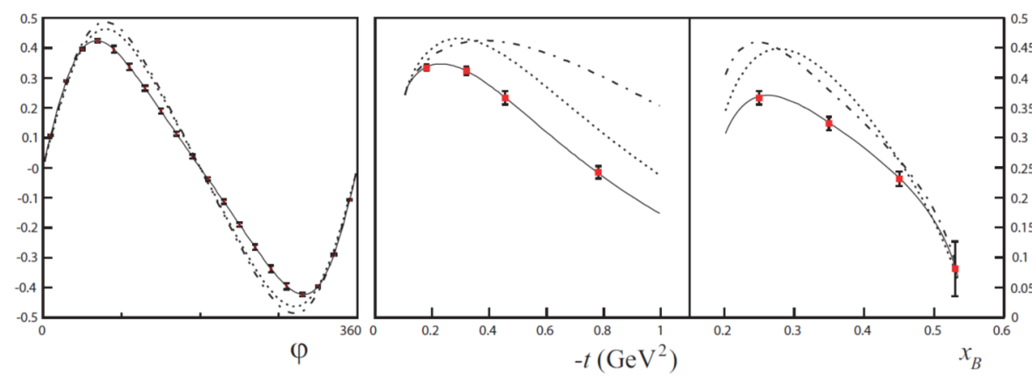
Large Q^2 region explored with high statistics

Hall-B@12 GeV: High-statistics BSA - E12-06-119

$$\Delta\sigma_{LU} \propto \sin\varphi \, Im\{F_1\mathcal{H} + \xi(F_1 + F_2)\widetilde{\mathcal{H}} + kF_2\mathcal{E}\}d\varphi$$



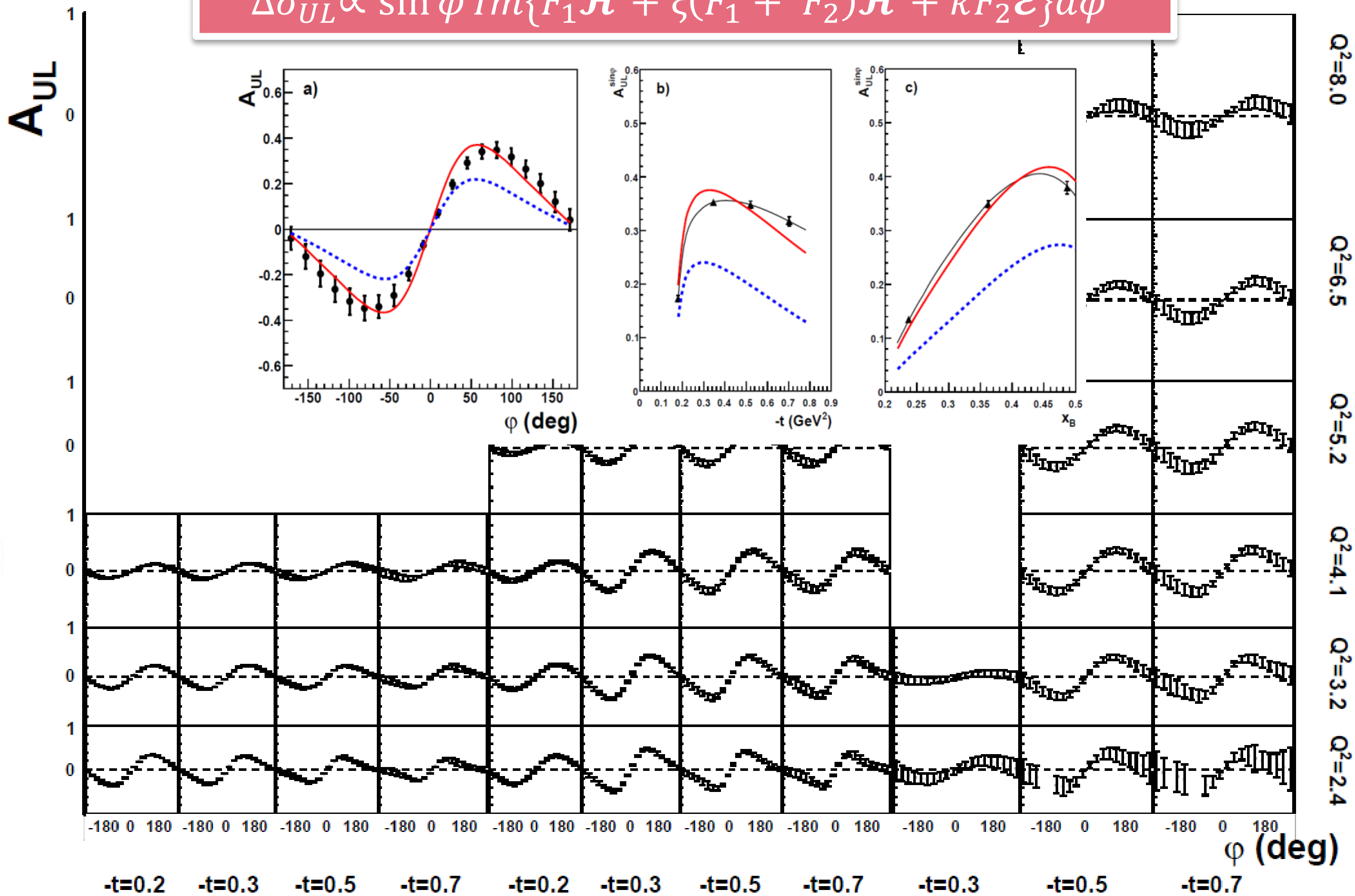




Longitudinal Target-Spin Asymmetry: E12-06-119

$$\Delta\sigma_{UL} \propto \sin\varphi \, Im\{F_1\widetilde{\mathcal{H}} + \xi(F_1 + F_2)\mathcal{H} + kF_2\mathcal{E}\}d\varphi$$

Dynamically-polarized NH_3 target



Quark orbital angular momentum & GPD E

$$J_q = \frac{1}{2}\int_{-1}^{+1} dx\, x\, [H^q(x,\xi,t=0) + E^q(x,\xi,t=0)]$$

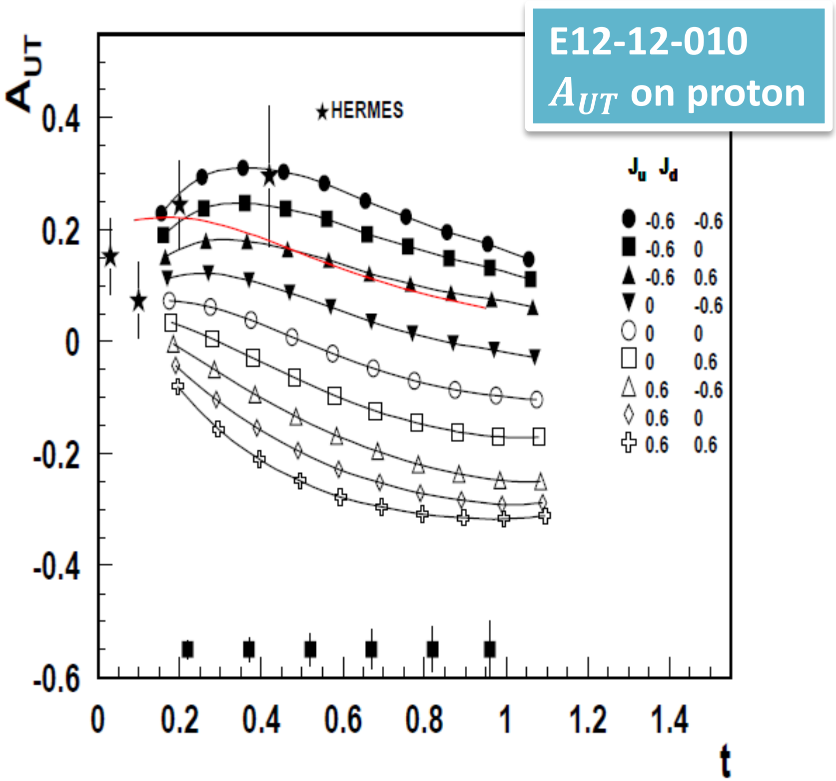
$$(H,E)_u(\xi,\xi,t) = {}^{9}/_{15}\left[4(H,E)_p(\xi,\xi,t) - (H,E)_n(\xi,\xi,t)\right]$$

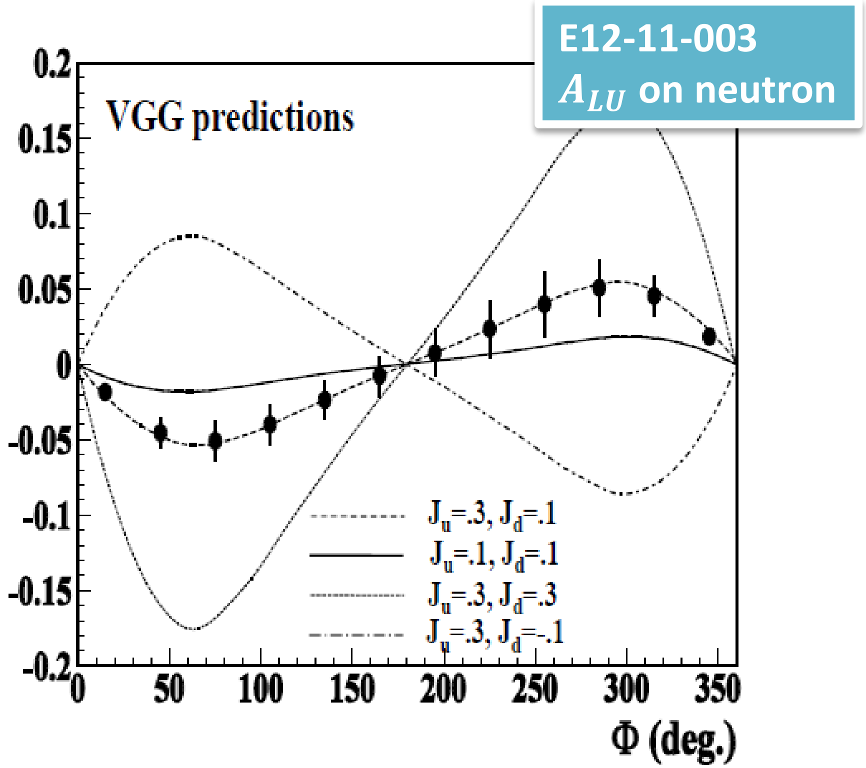
$$(H,E)_d(\xi,\xi,t) = {}^{9}/_{15}\left[4(H,E)_n(\xi,\xi,t) - (H,E)_p(\xi,\xi,t)\right]$$

To access $E_u \& E_d$ both $E_p \& E_n$ are needed.

Proton GPD E_p: $\cos\varphi$ modulation in σ_{UT} on proton

Neutron GPD E_n: A_{LU} on the neutron

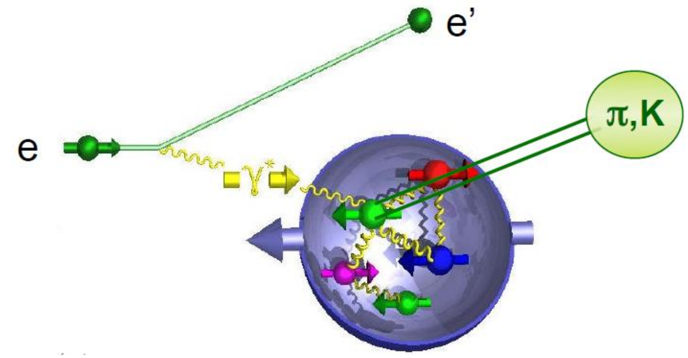




Semi-Inclusive DIS@JLab with 12 GeV

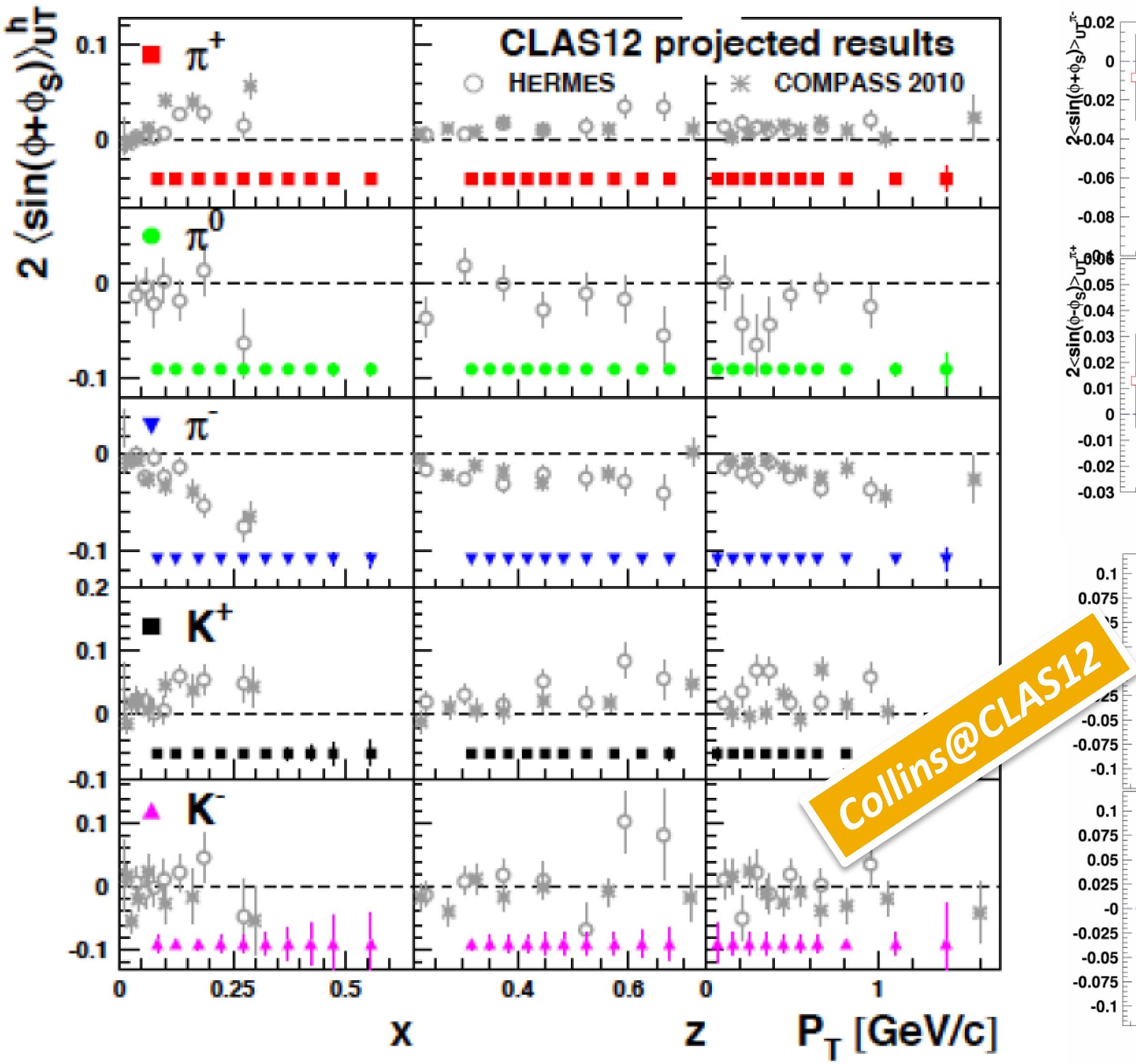
- Three halls involved
- ALL Beam/Target combinations explored
- Different targets for **FLAVOR SEPARATION**
- multi-D mapping

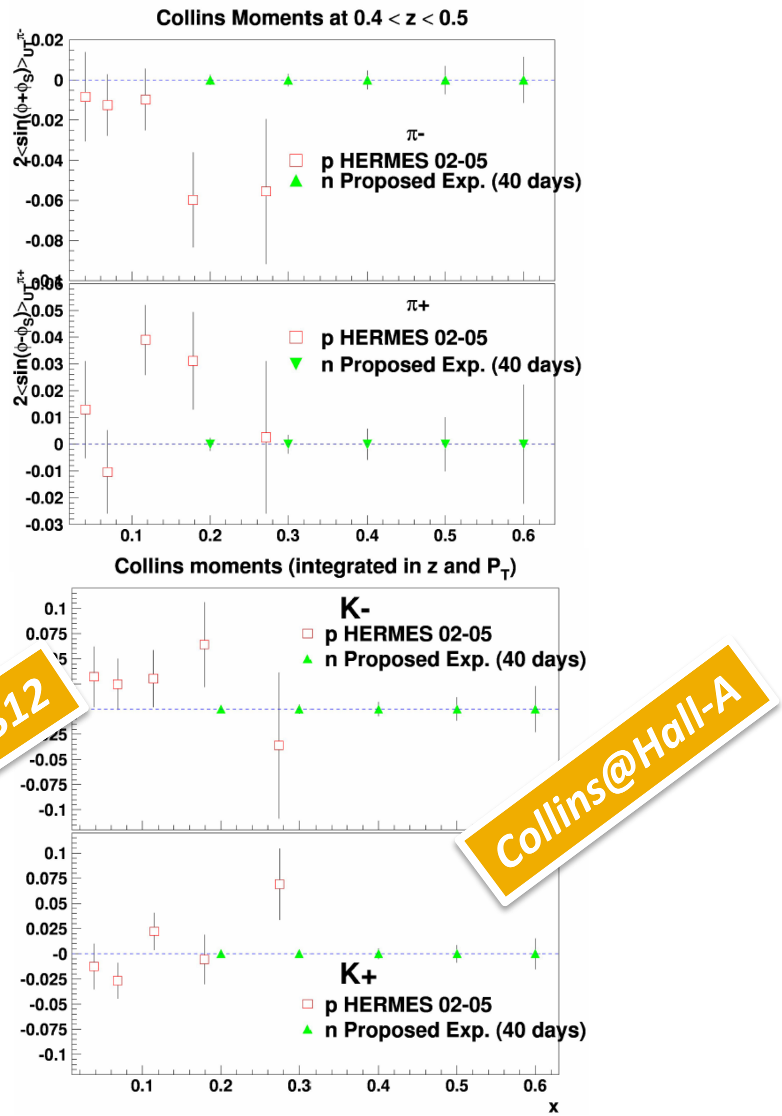
N/q	U	L	T
U	f_1		$h_1^{\perp}$
L		$\mathbf{g_1}$	$h_{1L}^{\perp}$
T	$f_{1T}^{\perp}$	g_{1T}	$\mathbf{h_1}, h_{1T}^{\perp}$



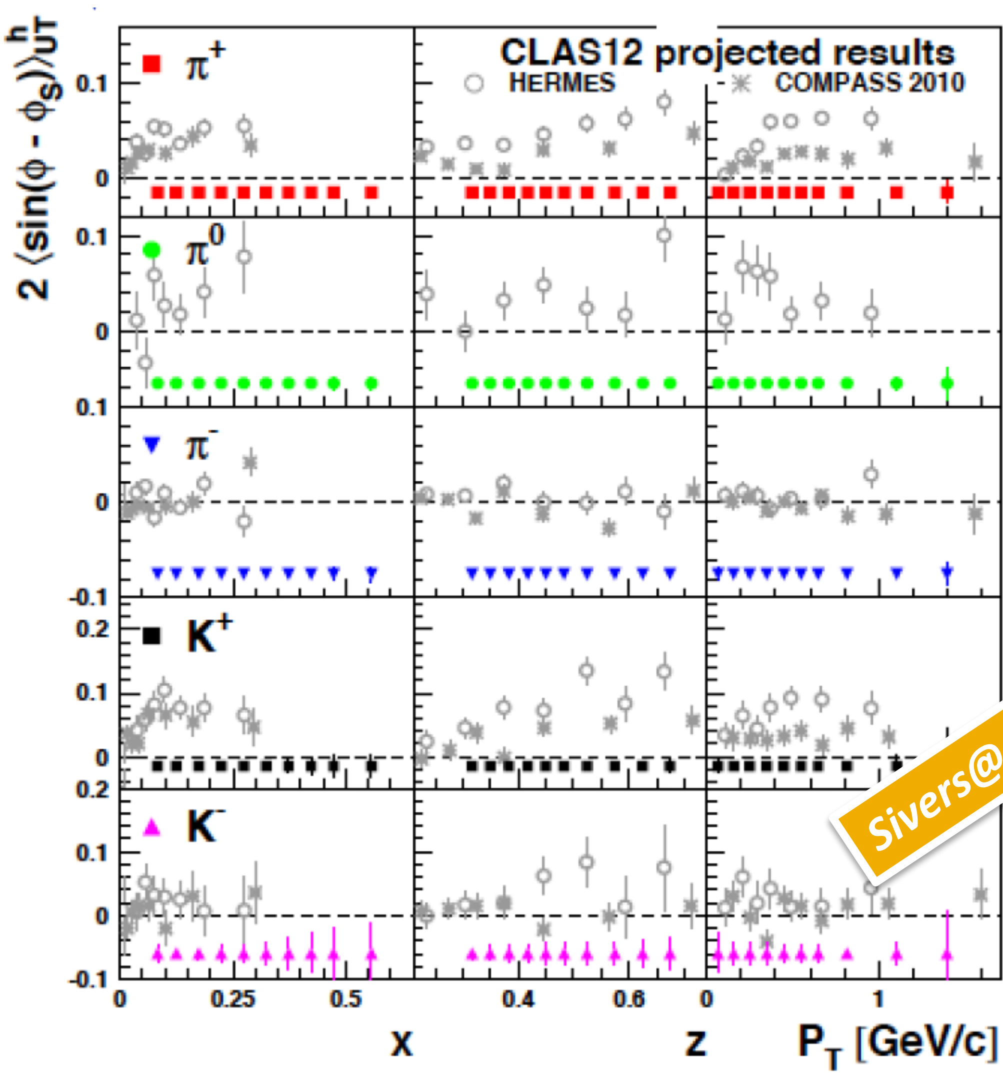
proton (H_2, NH_3, HD)	deuterium (D_2, ND_3)	helium (^3He)
E12-06-112: π^+, π^-, π^0 E12-09-008: k^+, k^-, k^0 E12-09-017: π^+, π^-, k^+, k^- C12-11-102: π^0	E12-09-08: $\pi^+, \pi^-, \pi^0, k^+, k^-, k^0$ E12-09-017: π^+, π^-, k^+, k^- C12-11-102: π^0	
E12-06-112: π^+, π^-, π^0 E12-09-008:k^+, k^-, k^0	E07-107: π^+, π^-, π^0 E09-009: k^+, k^-, k^0	E12-07-007: π^+, π^-
C12-11-108 (SoLID) PR12-11-111: $\pi^+, \pi^-, \pi^0, k^+, k^-, k^0$ PR12-12-009: di-hadron SIDIS		E10-006: π^+, π^-(SoLID) E12-09-018: π^+, π^-, k^+, k^-(SBS)

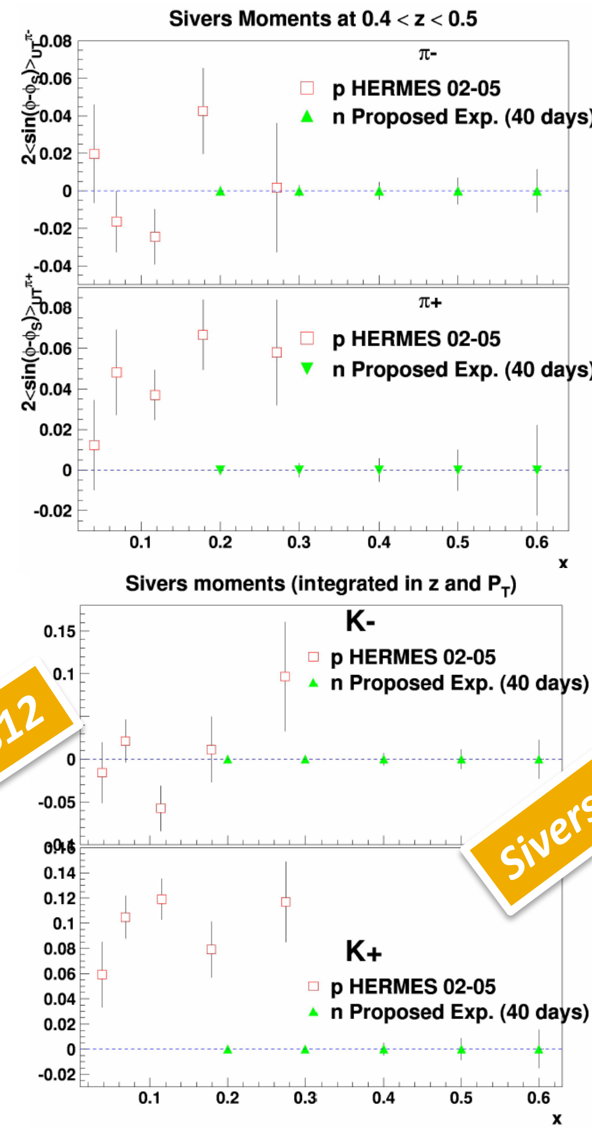
Collins@JLab12: Hall-A (neutron) & Hall-B (proton)





Sivers@JLab12: Hall-A (neutron) & Hall-B (proton)





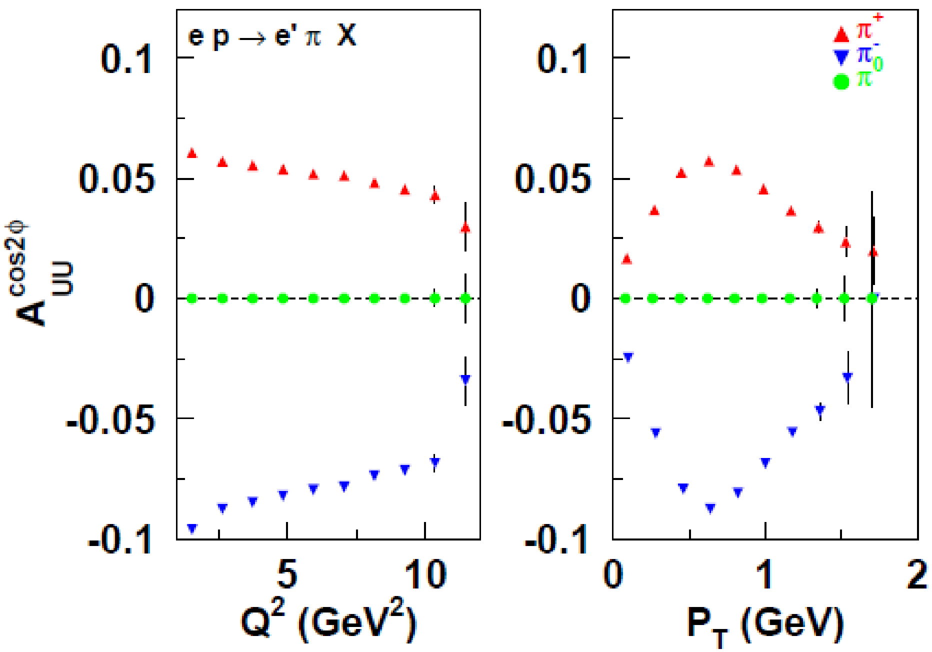
A_{UU}: spin-orbit corr. for pions@Hall-B – E12-06-112

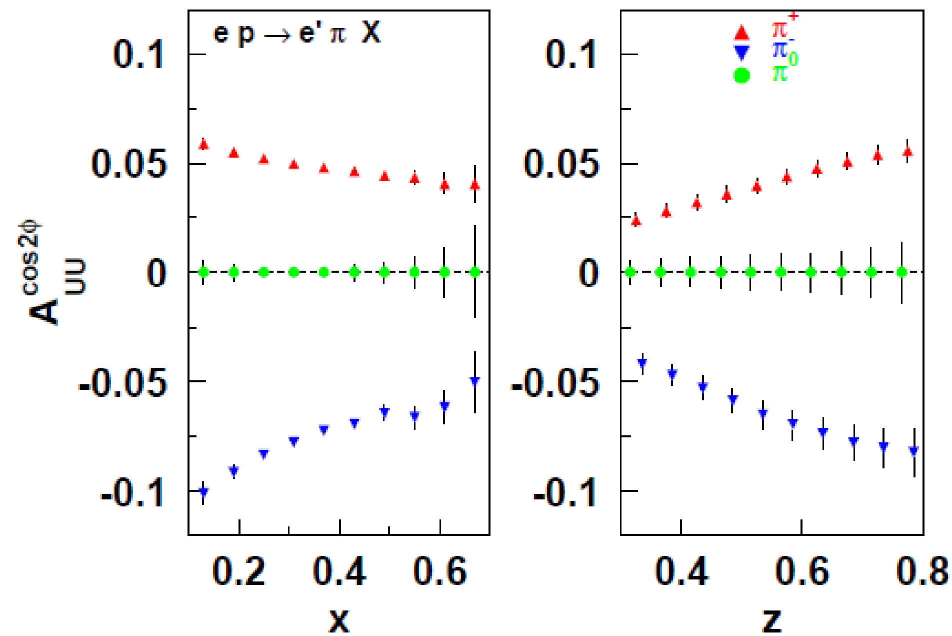
Tranversely-polarized quark in an unpolarized proton

→$\cos 2\varphi_h$ modulation

Wide $x\&p_T$ range to map quark 3D momentum phase space

N/q	U	L	T
U	f_1		$h_1^{\perp}$
L		g_1	$h_{1L}^{\perp}$
T	$f_{1T}^{\perp}$	g_{1T}	$\mathbf{h_1}, h_{1T}^{\perp}$



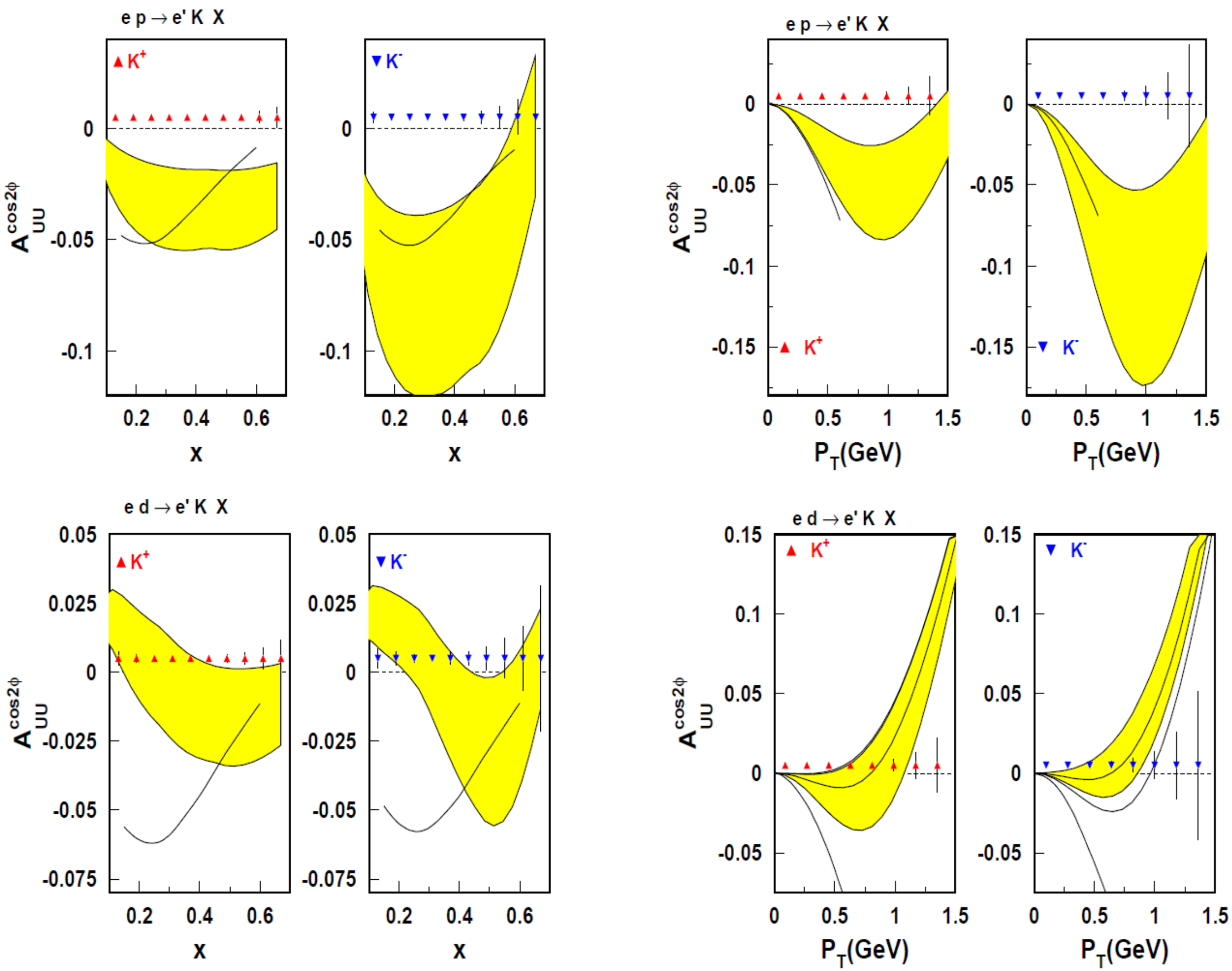


Spin-orbit correlations for kaons@Hall-B – E12-09-008

N/q	U	L	T
U	f_1		$h_1^{\perp}$
L		g_1	$h_{1L}^{\perp}$
T	$f_{1T}^{\perp}$	g_{1T}	$h_1, h_{1T}^{\perp}$

Boer-Mulders asymmetry in kaon SIDIS

→ Collins fragmentation function for kaons – KAON PUZZLE

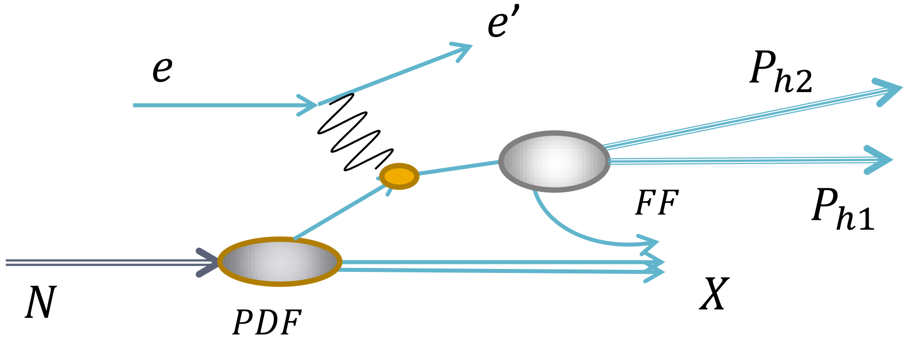


Transversity through di-hadron – Hall-B&Hall-A (SoLID)

Access through **single-hadron SIDIS**: $h_1{}^q \otimes H_1{}^{\perp q} \rightarrow h_1{}^q(x, k_\perp, Q^2)$

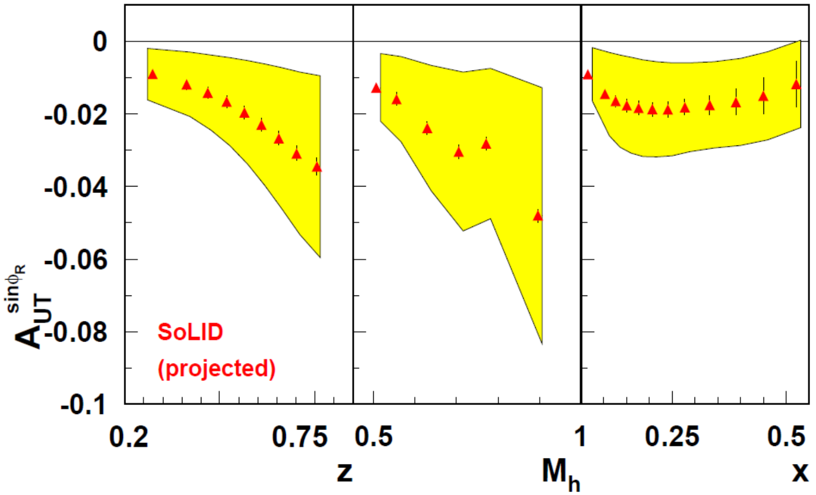
Access through **di-hadron SIDIS**: $A_{UT} \propto h_1{}^q \cdot H_1{}^{\sphericalangle q} \rightarrow h_1{}^q(x, Q^2)$

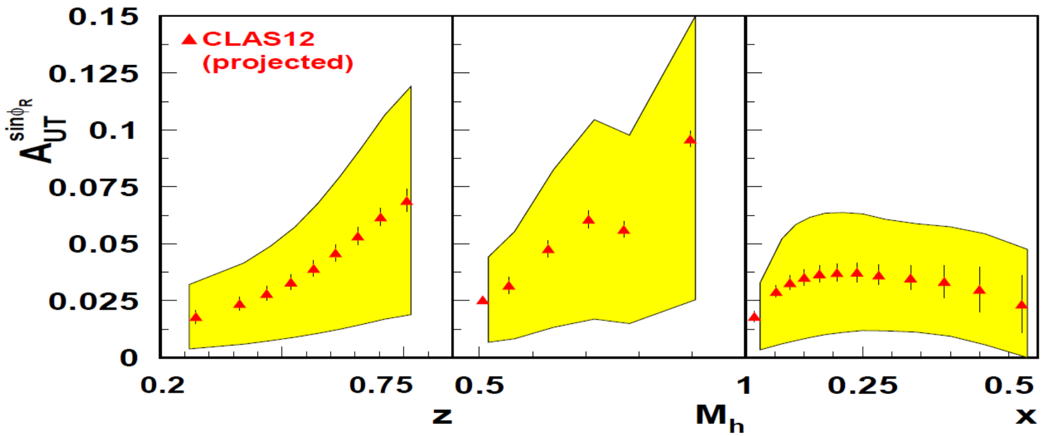
→ **Complementary measurements on p and n** in Hall-A (by SoLID) & Hall-B (C12-12-009)



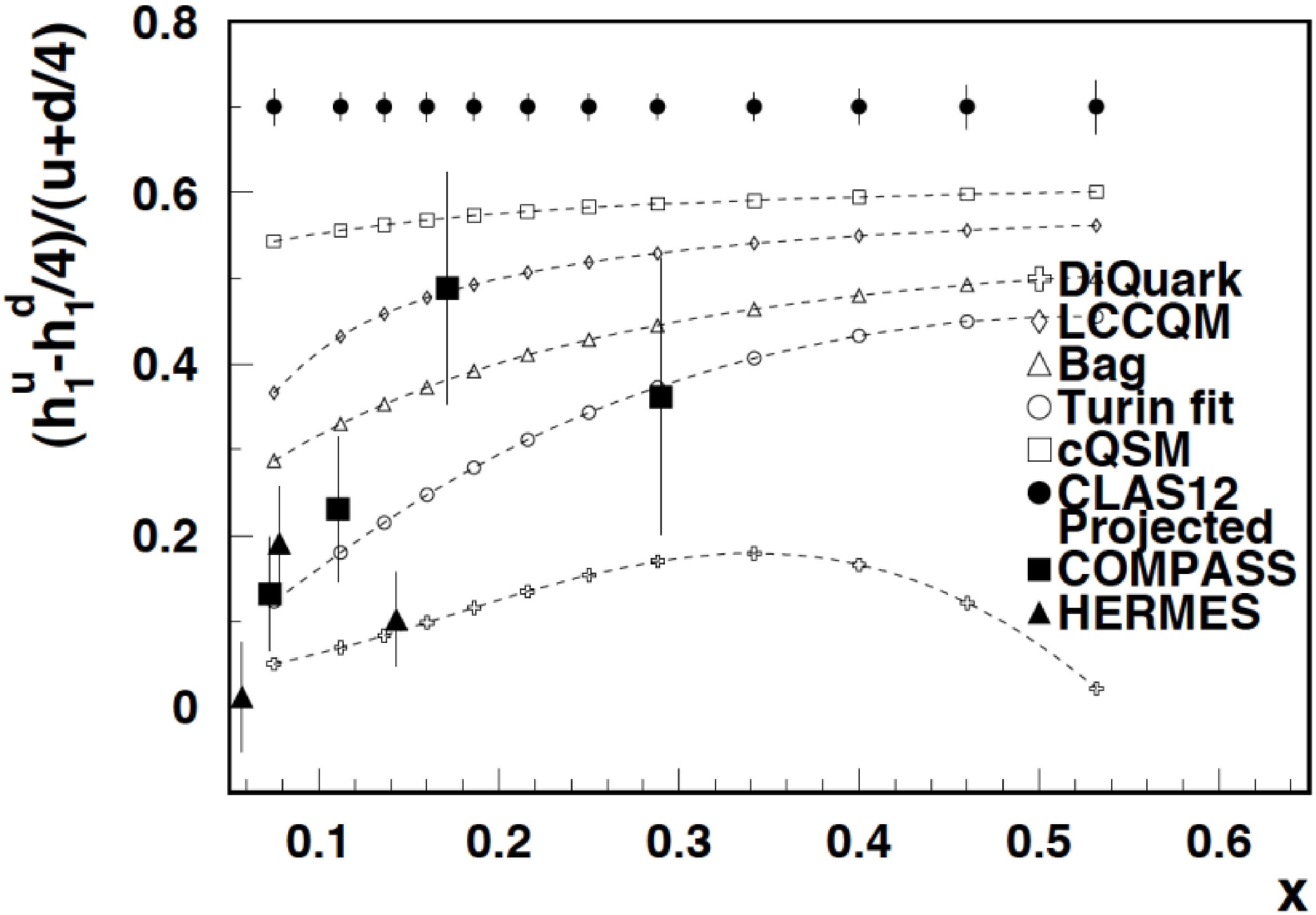
$$A_{UT,n}^{\sin(\phi_R+\phi_S)\sin\theta}(x,y,z,M_{\pi\pi},Q) = -\frac{B(y)}{A(y)}\frac{|\boldsymbol{R}|}{M_{\pi\pi}}\frac{H_{1,sp}^{\sphericalangle,u}(z,M_{\pi\pi})\left[4\,h_1^{d-\bar{d}}(x) - h_1^{u-\bar{u}}(x)\right]}{D_1^u(z,M_{\pi\pi})\left[f_1^{u+\bar{u}}(x) + 4\,f_1^{d+\bar{d}}(x)\right] + D_1^s(z,M_{\pi\pi})\,f_1^{s+\bar{s}}(x)}$$

$$A_{UT,p}^{\sin(\phi_R+\phi_S)\sin\theta}(x,y,z,M_{\pi\pi},Q) = -\frac{B(y)}{A(y)}\frac{|\boldsymbol{R}|}{M_{\pi\pi}}\frac{H_{1,sp}^{\sphericalangle,u}(z,M_{\pi\pi})\left[4h_1^{u-\bar{u}}(x) - h_1^{d-\bar{d}}(x)\right]}{D_1^u(z,M_{\pi\pi})\left[4f_1^{u+\bar{u}}(x) + f_1^{d+\bar{d}}(x)\right] + D_1^s(z,M_{\pi\pi})\,f_1^{s+\bar{s}}(x)}$$





Impact of JLab data on the valence region



Higher-twist PDF: E12-06-112B

Proposal just submitted to PAC42

→ di-hadron SIDIS A_{LU}&Multiplicities on hydrogen and deuterium (56 days @ $\mathcal{L} = 10^{35} cm^{-2} s^{-1}$)

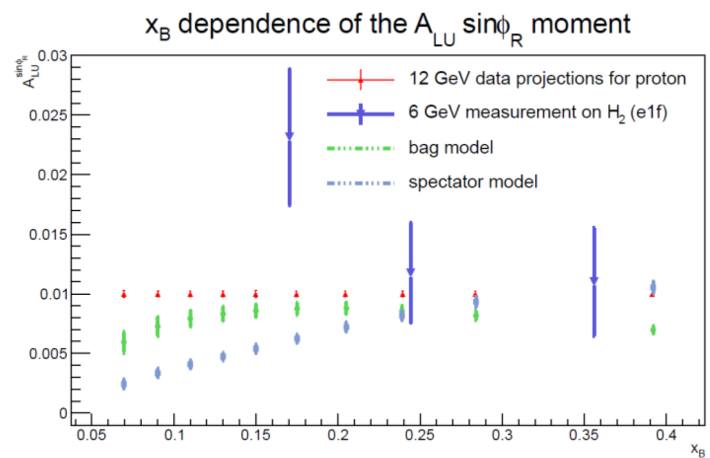
→ access to the higher-twist PDF $e(x)$

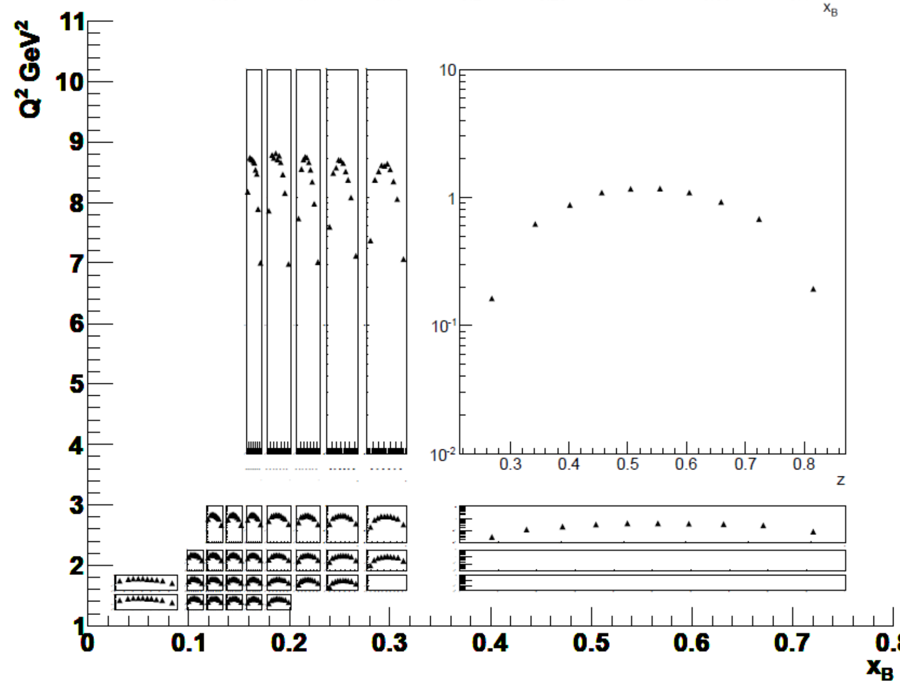
$$F_{LU}^{\sin\phi_R} = -x\frac{|\boldsymbol{R}|\sin\theta}{Q}\left[\frac{M}{M_h}\, x\, e^q(x)\, H_1^{\sphericalangle q}(z,\cos\theta,M_h) + \frac{1}{z}\, f_1^q(x)\, \widetilde{G}^{\sphericalangle q}(z,\cos\theta,M_h)\right]$$

Also ***unpolarized multiplicities*** will be extracted in 10x10x10x5 $(x_B, z, m_{\pi^+\pi^-}, Q^2)$ bins

$$M^h(z, m_{\pi\pi}, x; Q^2) = \frac{\sum_q e_q^2\, f_1^q(x;Q^2)\, D_1^q(z, m_{\pi\pi}; Q^2)}{\sum_q e_q^2\, f_1^q(x;Q^2)}$$

cfr. Marco Radici's talk





Summary&Conclusions

- ***JLab@12 GeV will perform high-precision measurements in the valence region for both TMDs&GPDs.***

- By analyzing all the target/beam polarization combinations on both neutron and proton target, and thanks to a good hadron identification, a huge amount of asymmetries will be extracted and the flavour separation wil be performed

- Many modulations will be extracted in more than one experimental hall, equipped with complementary performing detectors

- **Important impact on a wide physics case** → spin-orbit correlations, strange quark content in the nucleon, fragmentation, GPDs in the valence region

- JLab 12-GeV operations will start in few months!

backup

Physics Program@Hall-B in the 12-GeV era

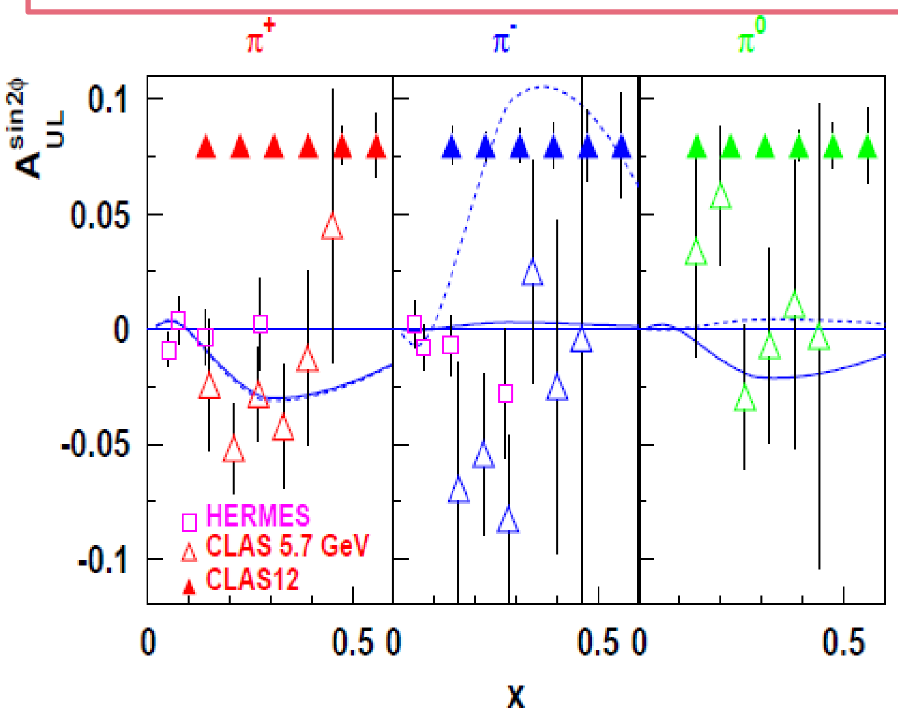
Proposal	Physics	Contact	Rating	Days	Group	New equipment	Energy	Run Group	Target
E12-06-108	Hard exclusive electro-production of π^0, η	Stoler	B	80	139	RICH (1 sector) Forward tagger	11	**A** **F. Sabatié**	liquid H_2
E12-06-112	Proton's quark dynamics in SIDIS pion production	Avakian	A	60					
E12-06-119	Deeply Virtual Compton Scattering	Sabatie	A	80					
E12-09-003	Excitation of nucleon resonances at high Q^2	Gothe	B+	40					
E12-11-005	Hadron spectroscopy with forward tagger	Battaglieri	A-	119					
E12-12-001	Timelike Compton Scatt. & J/ψ production in e+e-	Nadel-Turonski	A-	120					
E12-12-007	Exclusive φ meson electroproduction with CLAS12	Stoler, Weiss	B+	60					
PR12-12-008	Photoproduction of the very strangest baryon	Guo	--	80					
E12-07-104	Neutron magnetic form factor	Gilfoyle	A-	30	90	Neutron detector RICH (1 sector) Forward tagger	11	**B** **K. Hafidi**	liquid D_2 target
PR12-11-109 (a)	Dihadron DIS production	Avakian	-	-					
E12-09-007a	Study of partonic distributions in SIDIS kaon production	Hafidi	A-	56					
E12-09-008	Boer-Mulders asymmetry in K SIDIS w/ H and D targets	Contalbrigo	A-	TBA					
E12-11-003	DVCS on neutron target	Niccolai	A	90					
E12-06-109	Longitudinal Spin Structure of the Nucleon	Kuhn	A	80	170	Polarized target RICH (1 sector) Forward tagger	11	**C** **S. Kuhn**	NH_3 ND_3
E12-06- 119(b)	DVCS on longitudinally polarized proton target	Sabatie	A	120					
E12-07-107	Spin-Orbit Correl. with Longitudinally polarized target	Avakian	A-	103					
PR12-11-109 (b)	Dihadron studies on long. polarized target	Avakian	-	-					
E12-09-007(b)	Study of partonic distributions using SIDIS K production	Hafidi	A-	110					
E12-09-009	Spin-Orbit correlations in K production w/ pol. targets	Avakian	B+	103					
E12-06-106	Color transparency in exclusive vector meson production	Hafidi	B+	60	60		11	**D**	Nuclear
E12-06-117	Quark propagation and hadron formation	Brooks	A-	60	60		11	**E**	Nuclear
E12-10-102	Free Neutron structure at large x	Bueltman	A	40	40	Radial TPC	11	**F**	Gas D_2
TOTAL approved run time (PAC days)				1491	**559**				

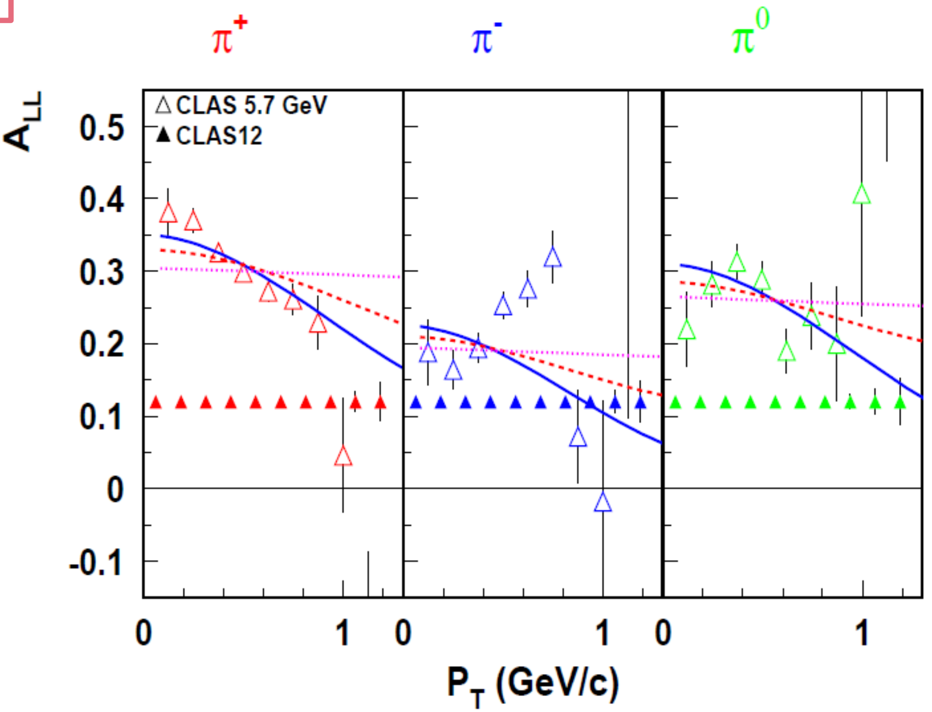
A_{UL}&A_{LL} for pions on proton@Hall-B – E12-07-107

Longitudinal Target-Spin Asymmetry: Kotzinian-Mulder function → tranversely-polarized quark in a longitudinally-polarized proton

Longitudinal Double-Spin Asymmetry: difference in the k_T distribution of quark with spin || or anti-|| to the proton spin

N/q	U	L	T
U	f_1		$h_1^{\perp}$
L		$\mathbf{g_1}$	$h_{1L}^{\perp}$
T	$f_{1T}^{\perp}$	g_{1T}	$\mathbf{h_1}, h_{1T}^{\perp}$





A_{UL}&A_{LL} for pions on ^3He@Hall-A (SoLID) – E12-11-007

N/q	U	L	T
U	$\boldsymbol{f}_1$		$h_1^{\perp}$
L		$\mathbf{g_1}$	$h_{1L}^{\perp}$
T	$f_{1T}^{\perp}$	g_{1T}	$\mathbf{h_1}, h_{1T}^{\perp}$

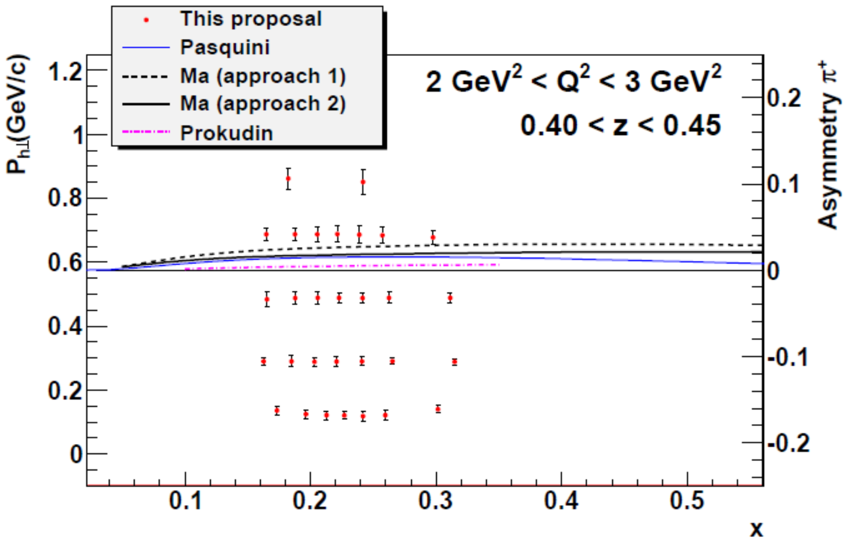
Measurement on NEUTRON

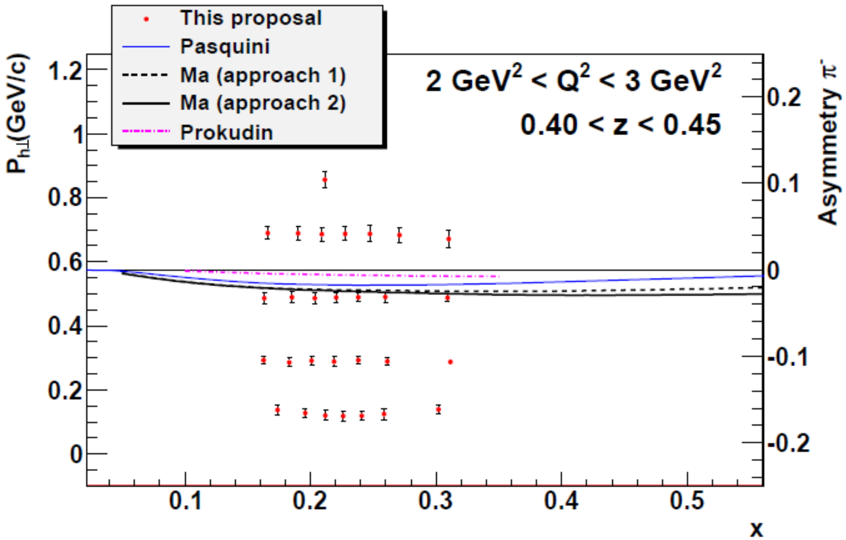
→ Can be combined with the Hall-B measurement on proton

Measurement on longitudinally and transversely polarized ^3He target.

Combining the A_{LL} on neutron → constrain the flavour decomposition of the quark helicity distribution

4D binning in $(x, z, p_{\perp}, Q^2)$

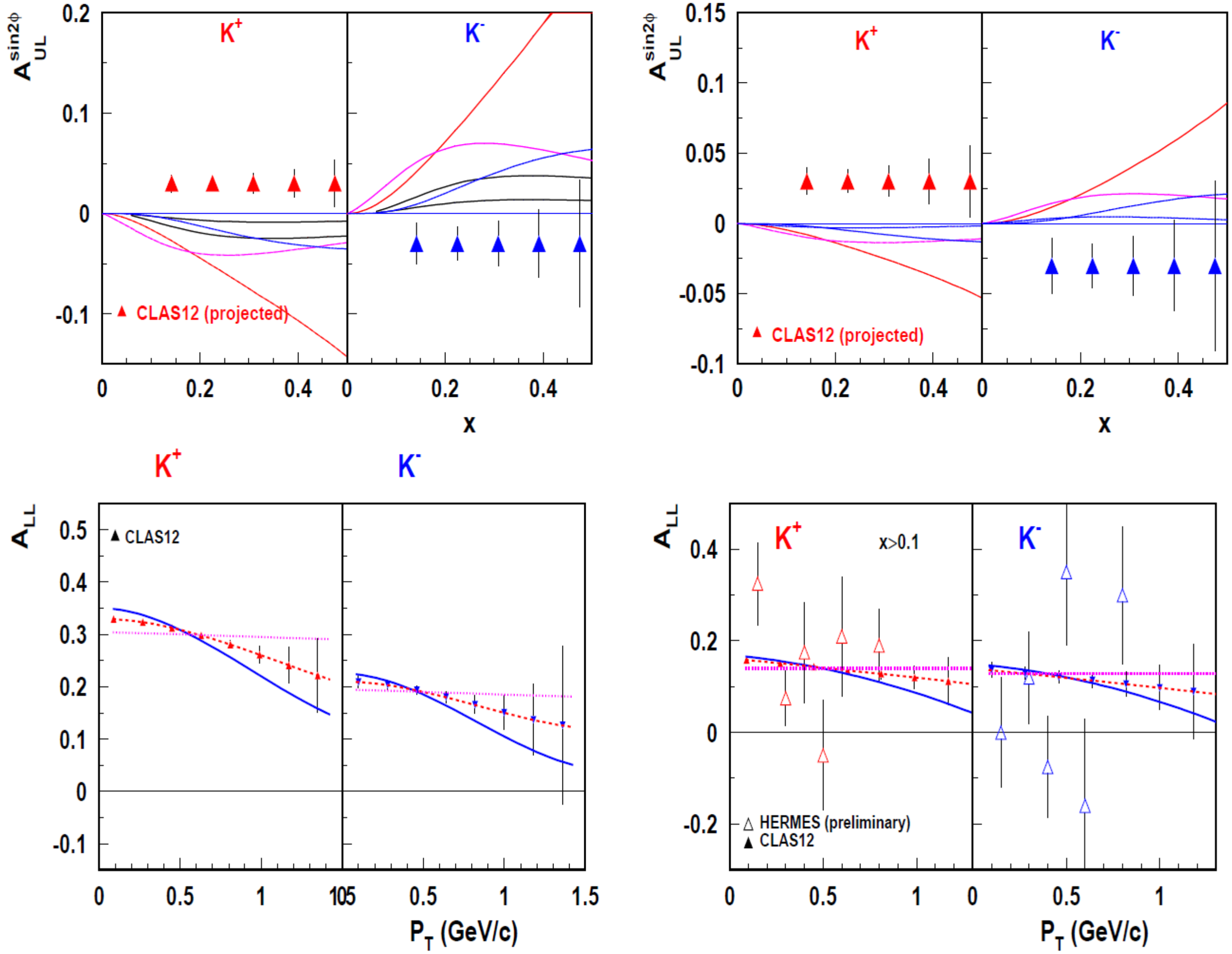




A_{UL} for kaons@Hall-B - E12-09-009

Collins fragmentations of kaons

- test of the fragmentation mechanism in the presence of a s-quark
- distribution of the sea quarks on the nucleon



85 days of beam time

$P_{target} = 85\%\ (NH_3)$, $40\% (ND_3)$

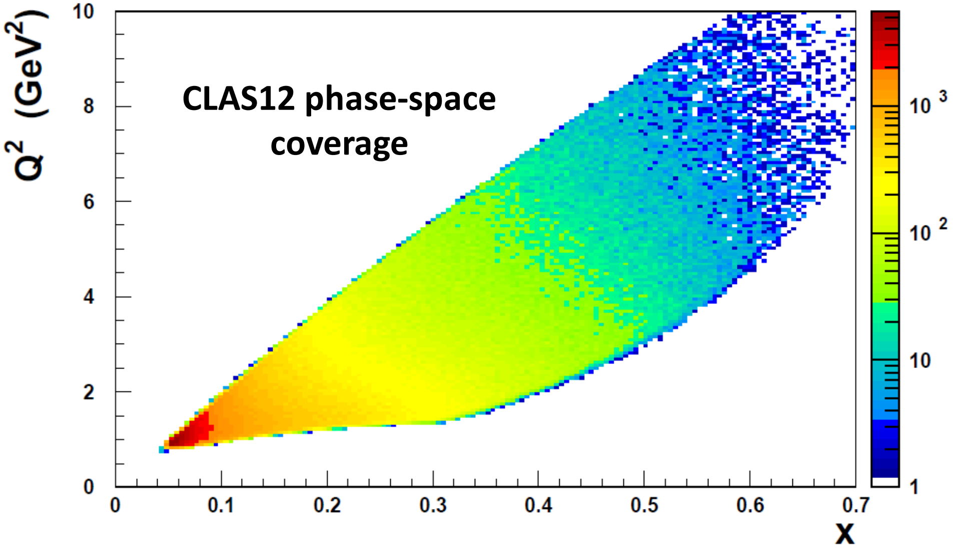
$\mathcal{L} = 10^{35} cm^{-2} s^{-1}$

Semi-Inclusive DIS and Tranverse Momentum PDFs

During the 6-GeV era JLab provided a large amount of data on the **unpolarized** and **longitudinally-polarized** modulations.

*→ at 12 GeV the use of a polarized target will open the access to the **transversely-polarized** sector.*

N/q	U	L	T
U	$\boldsymbol{f_1}$		$h_1^{\perp}$
L		$\mathbf{g_1}$	$h_{1L}^{\perp}$
T	$f_{1T}^{\perp}$	g_{1T}	$\mathbf{h_1}, h_{1T}^{\perp}$



- Tranversity $\rightarrow A_{UT}^{\sin(\varphi+\varphi_S)} \propto h_1 \otimes H_1^{\perp}$
- Sivers function $\rightarrow A_{UT}^{\sin(\varphi-\varphi_S)} \propto \mathrm{f}_{1\mathrm{T}} \otimes \mathrm{D}_1$
- Pretzelosity $\rightarrow A_{UT}^{\sin(3\varphi-\varphi_S)} \propto h_{1\mathrm{T}} \otimes H_1^{\perp}$
- Worm-gear $\rightarrow A_{LT}^{\cos(\varphi-\varphi_S)} \propto g_{1\mathrm{T}} \otimes \mathrm{D}_1$

Observables accessible through 2h Single-Spin Asymmetries

A **longitudinally polarized beam** scattering off an **unpolarized/longitudinally-polarized target** will allow to access the *higher-twist* PDF $e(\mathrm{x})$ and $h_L(x)$ that appears coupled to the Interference Fragmentation Function $H_1^{\sphericalangle q}$. A_{LU} & A_{UL} are indeed proportional to the Structure Functions

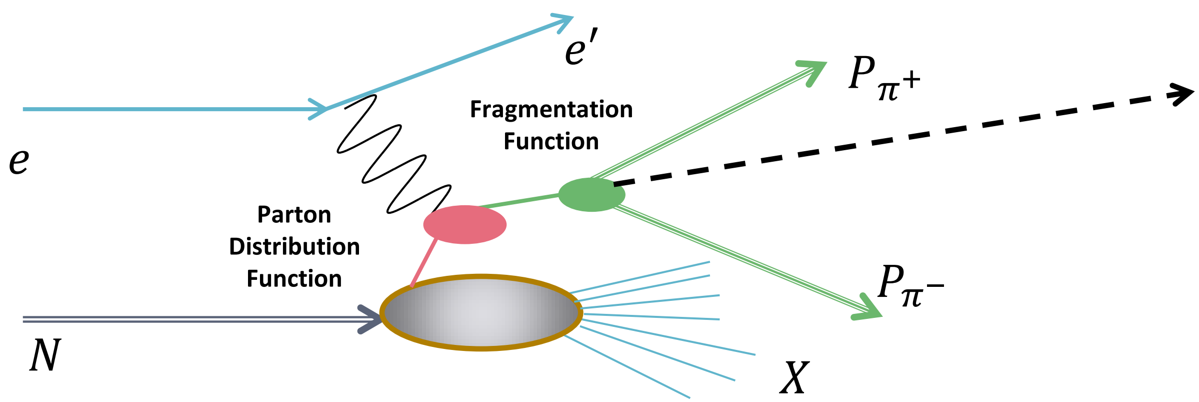
$$F_{LU}^{\sin\phi_R} = -x\frac{|\boldsymbol{R}|\sin\theta}{Q}\left[\frac{M}{M_h}\,x\,e^q(x)\,H_1^{\sphericalangle q}(z,\cos\theta,M_h) + \frac{1}{z}\,f_1^q(x)\,\widetilde{G}^{\sphericalangle q}(z,\cos\theta,M_h)\right]$$

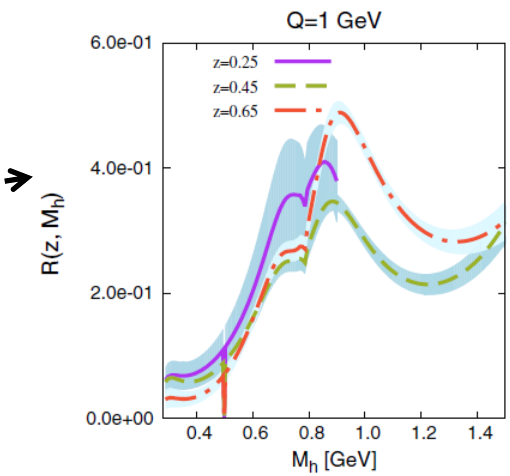
$$F_{UL}^{\sin\phi_R} = -x\frac{|\boldsymbol{R}|\sin\theta}{Q}\left[\frac{M}{M_h}\,x\,h_L^q(x)\,H_1^{\sphericalangle q}(z,\cos\theta,M_h) + \frac{1}{z}\,g_1^q(x)\,\widetilde{G}^{\sphericalangle q}(z,\cos\theta,M_h)\right]$$

$e(\mathrm{x})$ and $h_L(x)$ will provide:

1. insights into the physics of the **quark–gluon correlations**
2. $\boldsymbol{e(x)}, \boldsymbol{h_L(x)}$ **x–integral** → related to the marginally known ***scalar(/tensor)–charge*** of the nucleon

$H_1^{\sphericalangle q}$ extraction ((**PRD 85, 114023 (2012)**) from Belle e^+e^- data (**A.Vossen et al., PRL107, 072004 (2011)**))





Beam-Spin Asymmetries on H_2

The two analyses performed on CLAS on H_2 and NH_3 show consistent results.

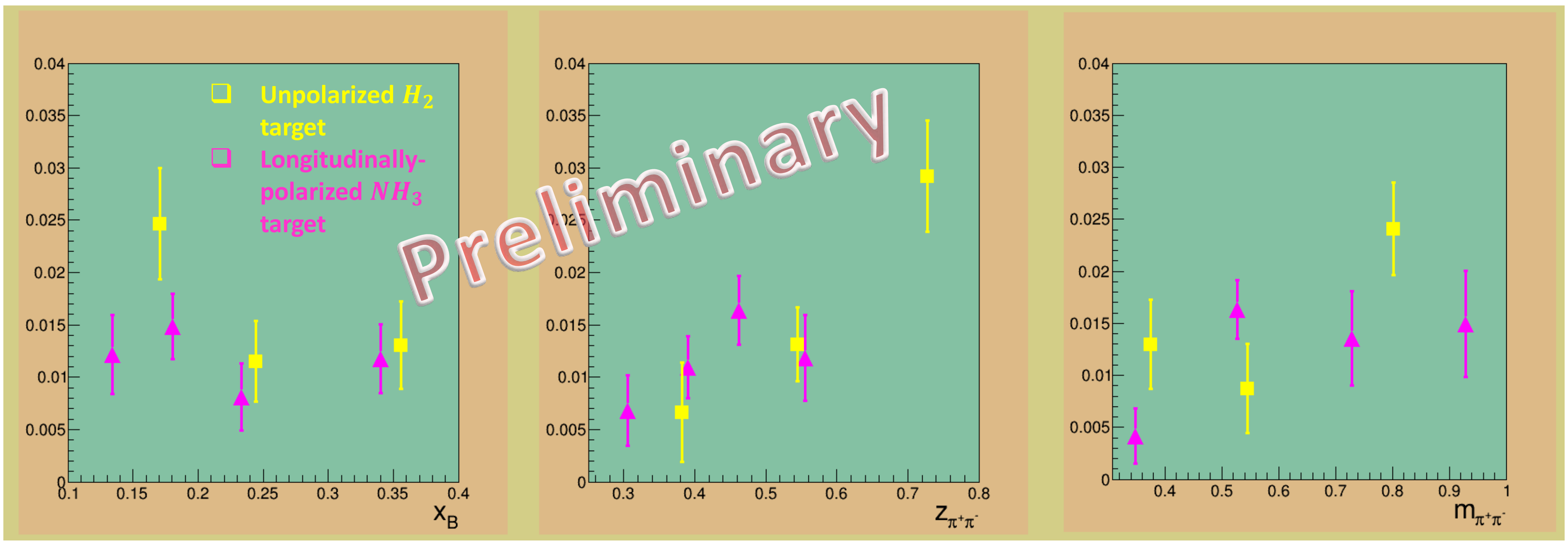
The Beam-Spin Asymmetries extracted through these data sets have been binned in $x_B, z, m_{\pi^+\pi^-}$.

$$\Delta\sigma_{LU} \propto [e(x)\ H_1^{\sphericalangle q} + f(x)\ \tilde{G}_1^{\sphericalangle q}]\, sin\, \varphi_R$$

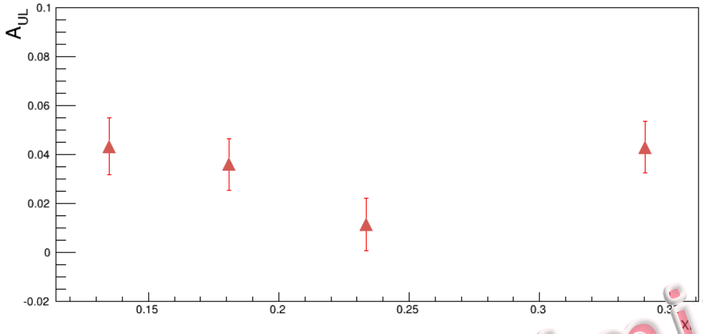
→ **Significantly non-zero asymmetries**

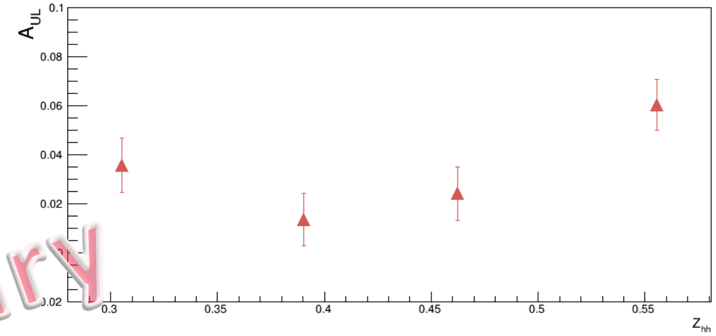
→ **Good agreement among the two datasets**

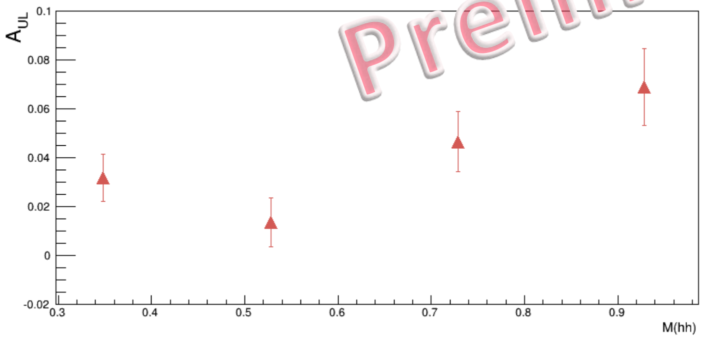
→ **no alteration from nuclear background on $A_{LU}{}^{\sin \varphi_R}$**



Target-Spin Asymmetry on NH_3







$$\Delta\sigma_{UL} \propto [h_L(x)\ H_1^{\sphericalangle q} + g_1(x)\ \tilde{G}_1^{\sphericalangle q}]\ \sin\varphi_R$$

→ **Significantly non-zero asymmetries**

→ **further modulations under investigation**

Other di-hadron observables

$$F_{UU,T} = x f_1^q(x)\, D_1^q\big(z, \cos\theta, M_h\big),$$

$$F_{UU,L} = 0,$$

$$F_{UU}^{\cos\phi_R} = -x \frac{|\boldsymbol{R}|\sin\theta}{Q}\, \frac{1}{z}\, f_1^q(x)\, \widetilde{D}^{\sphericalangle q}\big(z, \cos\theta, M_h\big),$$

$$F_{UU}^{\cos 2\phi_R} = 0,$$

$$F_{LU}^{\sin\phi_R} = -x \frac{|\boldsymbol{R}|\sin\theta}{Q} \left[\frac{M}{M_h}\, x\, e^q(x)\, H_1^{\sphericalangle q}\big(z, \cos\theta, M_h\big) + \frac{1}{z}\, f_1^q(x)\, \widetilde{G}^{\sphericalangle q}\big(z, \cos\theta, M_h\big)\right],$$

$$F_{UL}^{\sin\phi_R} = -x \frac{|\boldsymbol{R}|\sin\theta}{Q} \left[\frac{M}{M_h}\, x\, h_L^q(x)\, H_1^{\sphericalangle q}\big(z, \cos\theta, M_h\big) + \frac{1}{z}\, g_1^q(x)\, \widetilde{G}^{\sphericalangle q}\big(z, \cos\theta, M_h\big)\right],$$

$$F_{UL}^{\sin 2\phi_R} = 0,$$

$$F_{LL} = x g_1^q(x)\, D_1^q\big(z, \cos\theta, M_h\big),$$

$$F_{LL}^{\cos\phi_R} = -x \frac{|\boldsymbol{R}|\sin\theta}{Q}\, \frac{1}{z}\, g_1^q(x)\, \widetilde{D}^{\sphericalangle q}\big(z, \cos\theta, M_h\big),$$

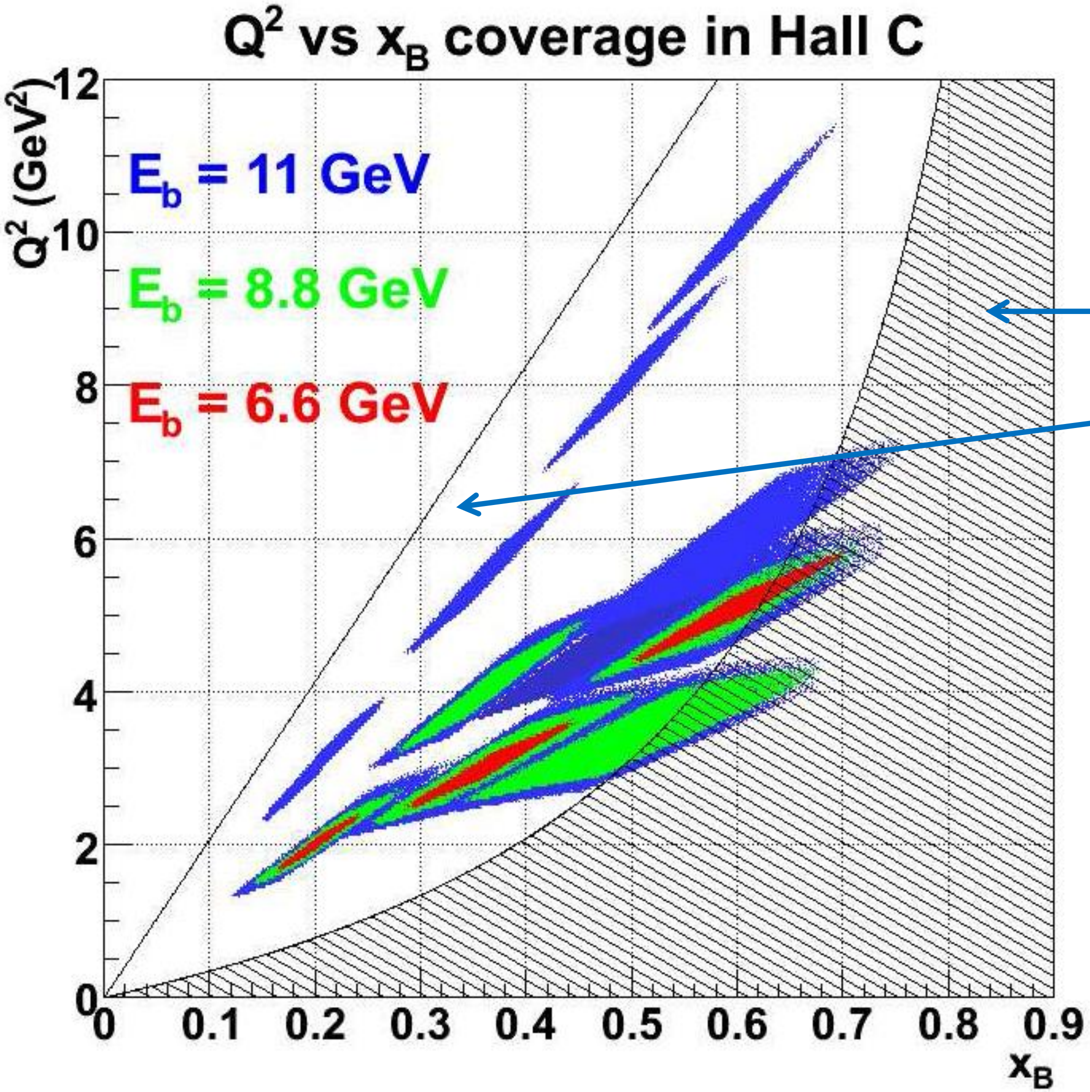
Unpolarized terms $\rightarrow f_1(x) D_1(z, cos\,\varphi_R, M_h)$ (*leading-twist*) and $\widetilde{D}_1(z, cos\,\varphi_R, M_h)$ (*higher-twist*)

1. $f_1(x)$ is well-known
2. good description of detector acceptance and efficiences is needed

A_{LL} numerator (cross-section differences) $\rightarrow$ $g_1(x) D_1(z, \cos\varphi_R, M_h)$

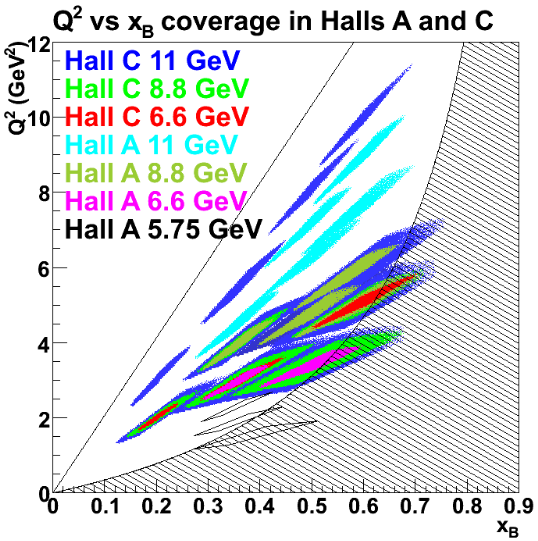
1. $g_1(x)$ is well-known
2. good description of detector acceptance and efficiences is needed

Hall-C@12 GeV: E12-13-010

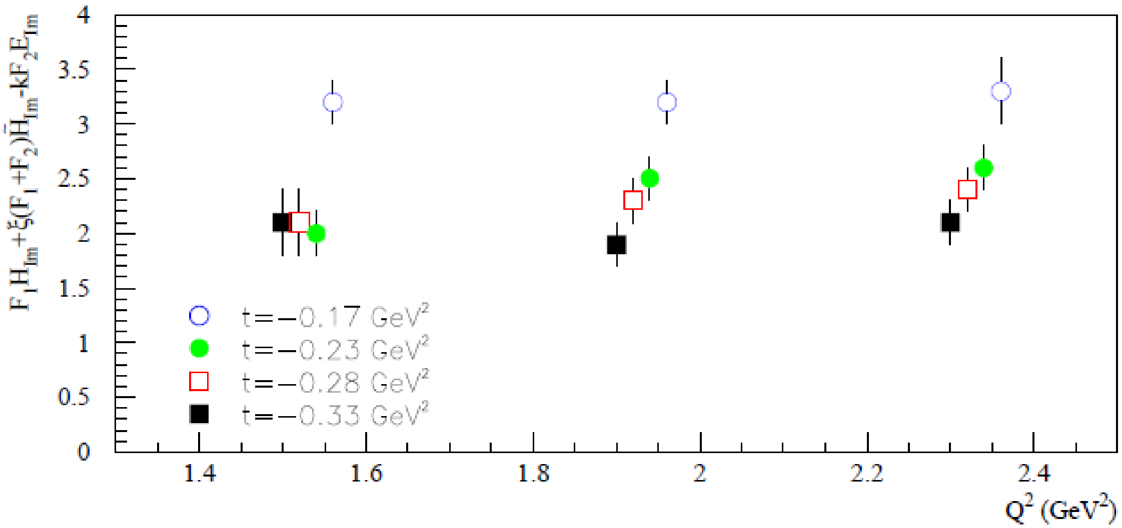


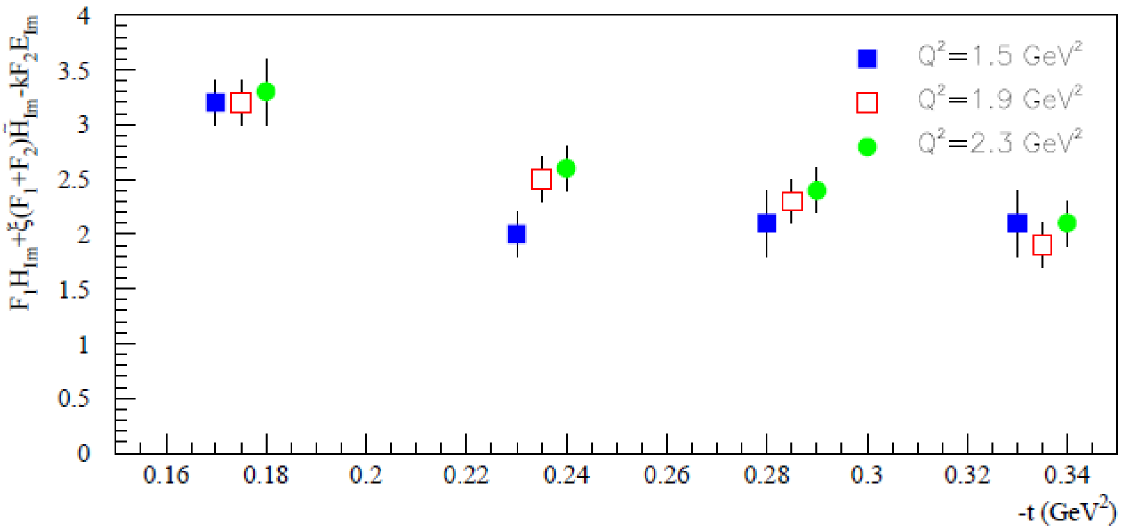
1. Energy separation of the DVCS cross section
2. Low-x_B extension thanks to sweeping magnet

- Shaded area → resonance region $W > 2\ GeV$
- Physical region accessible with a max beam energy $E_{beam} = 11\ GeV$

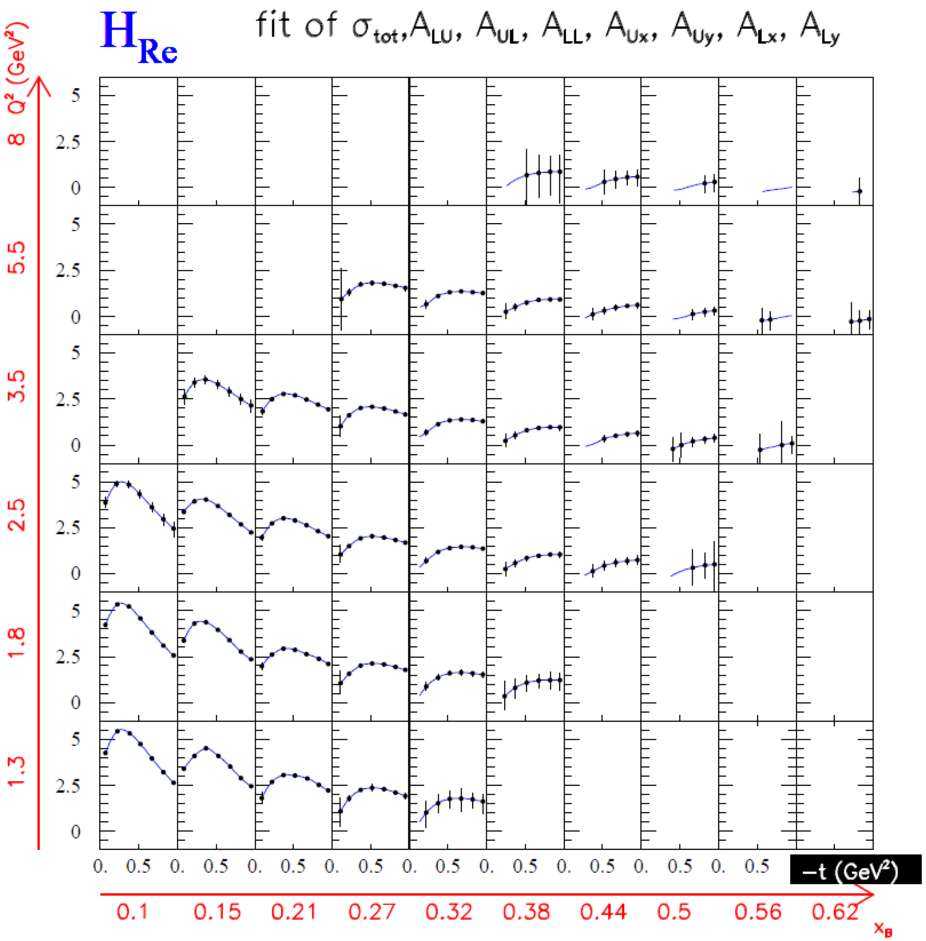


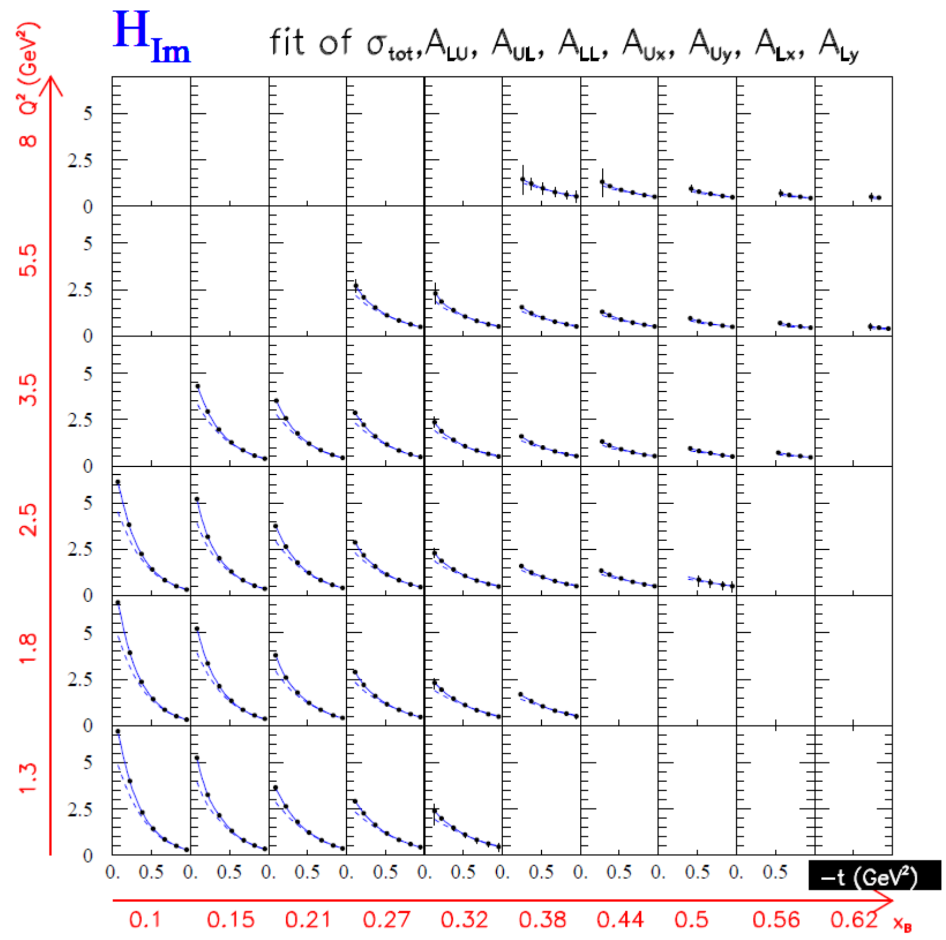
Scaling@Hall-A at 6 GeV





JLab12 impact on $Im(\mathcal{H})$&$Re(\mathcal{H})$



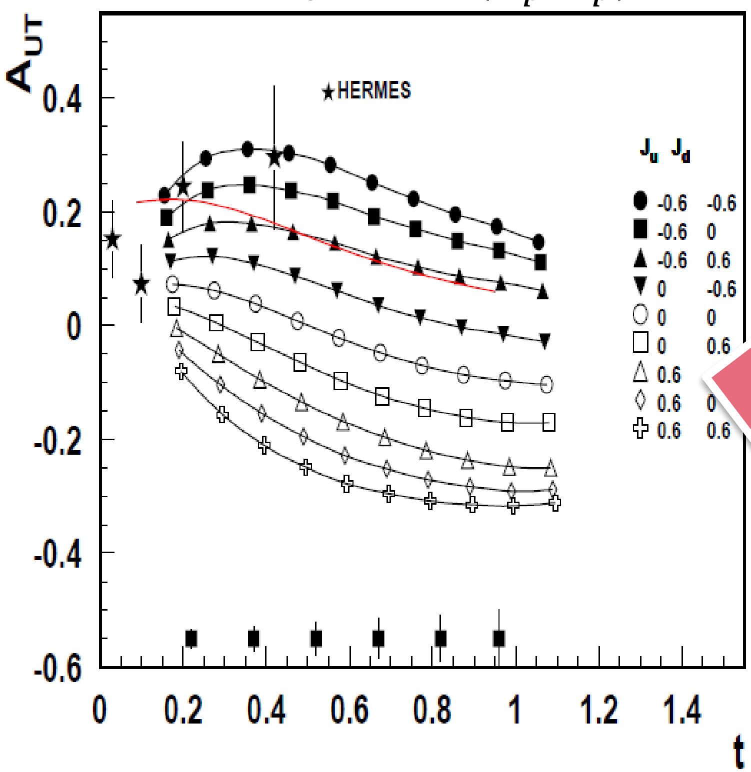


M. Guidal, H. Moutarde, M. Vanderhaeghen: hep-ph > arXiv:1303.6600

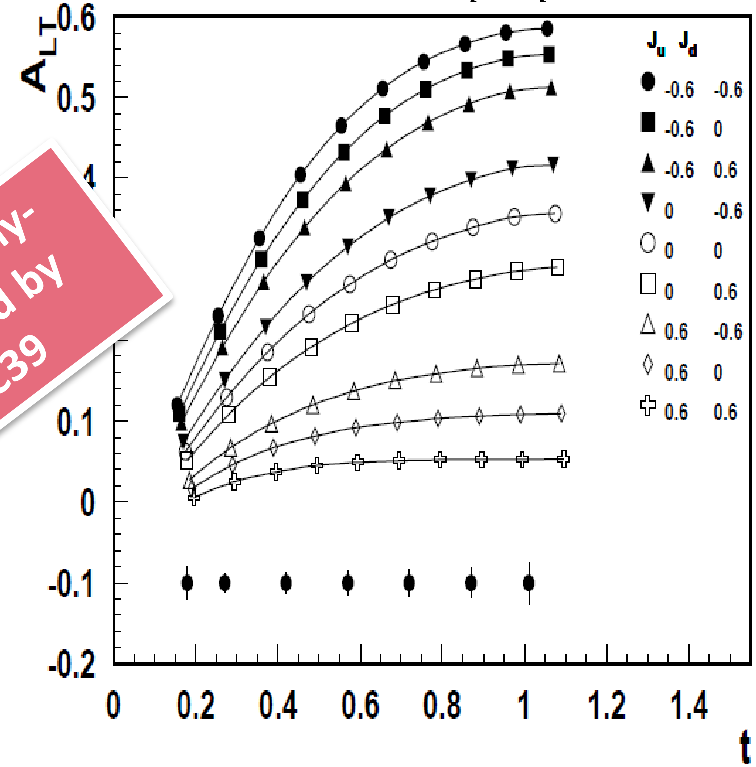
Hall-B@12 GeV: A_{UT} on a polarized proton – PR12-12-010

A_{UT} provides access to the GPD $\mathcal{E}$ → sensible to the **u-quark contribution to the proton spin**

$\Delta\sigma_{UT} \propto Im(H_p, E_p)$



$\Delta\sigma_{LT} \propto Im(H_p, E_p)$



conditionally-approved by PAC39

100 days of beam time

$P_{target}(HD) = 60\%, \mathcal{L} = 10^{33}\, cm^{-2} s^{-1}$

$1 < Q^2 < 10\ GeV^2,\ 0.06 < x_B < 0.66,\ -t_{min} < t < 1.5\ GeV^2$

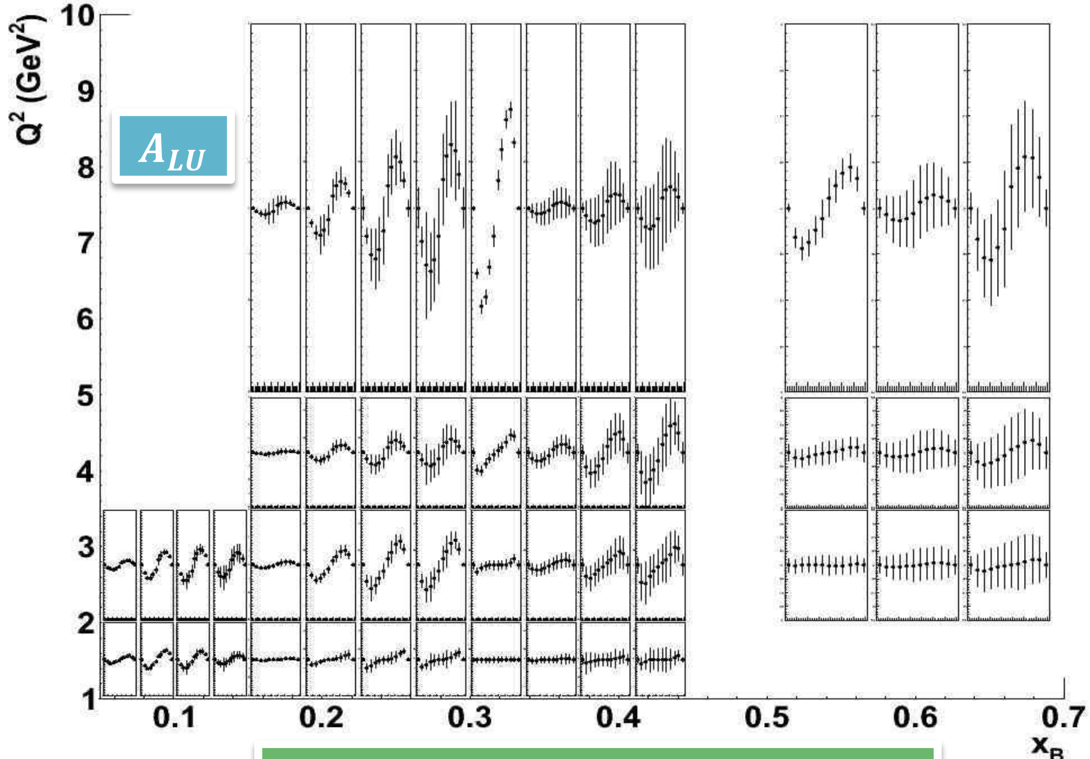
Hall-B@12 GeV: DVCS on the neutron – PR12-11-003

$A^n{}_{LU}$ is the most sensitive observables to the GPD E

$$(H,E)_u(\xi,\xi,t) = {}^{9}/_{15}\left[4(H,E)_p(\xi,\xi,t) - (H,E)_n(\xi,\xi,t)\right]$$

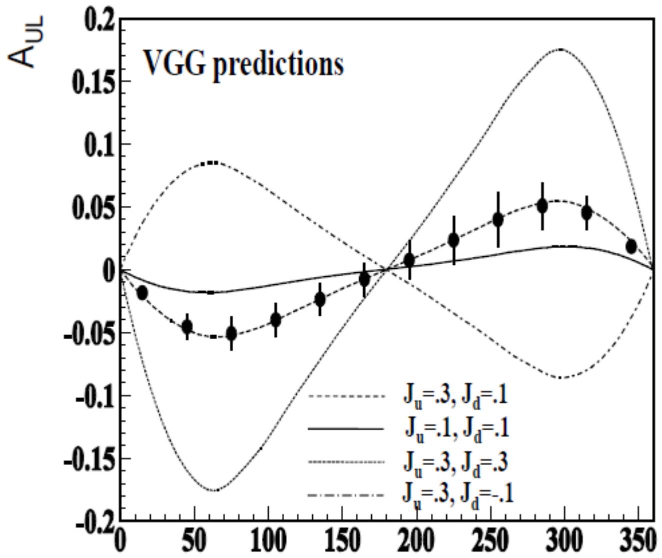
$$(H,E)_d(\xi,\xi,t) = {}^{9}/_{15}\left[4(H,E)_n(\xi,\xi,t) - (H,E)_p(\xi,\xi,t)\right]$$

→ Flavor separation of GPDs

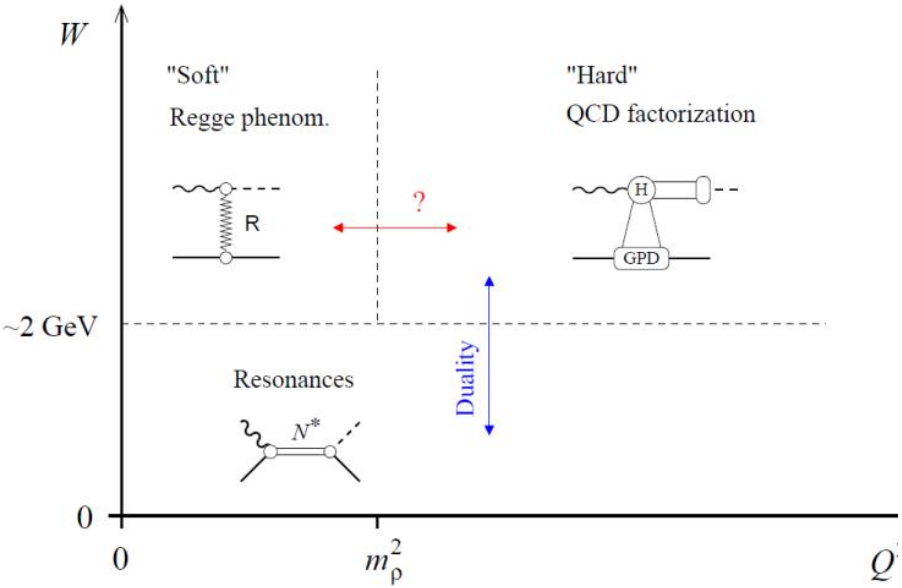


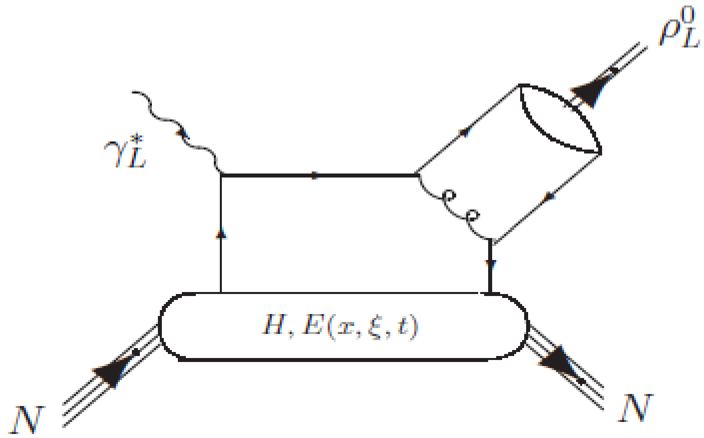
80 days of beam time
$P_{beam} = 85\%, \mathcal{L} = 10^{35} cm^{-2} s^{-1}$

Impact on quark total OAM



Deeply-Virtual π^0, η Production – PR12-06-108

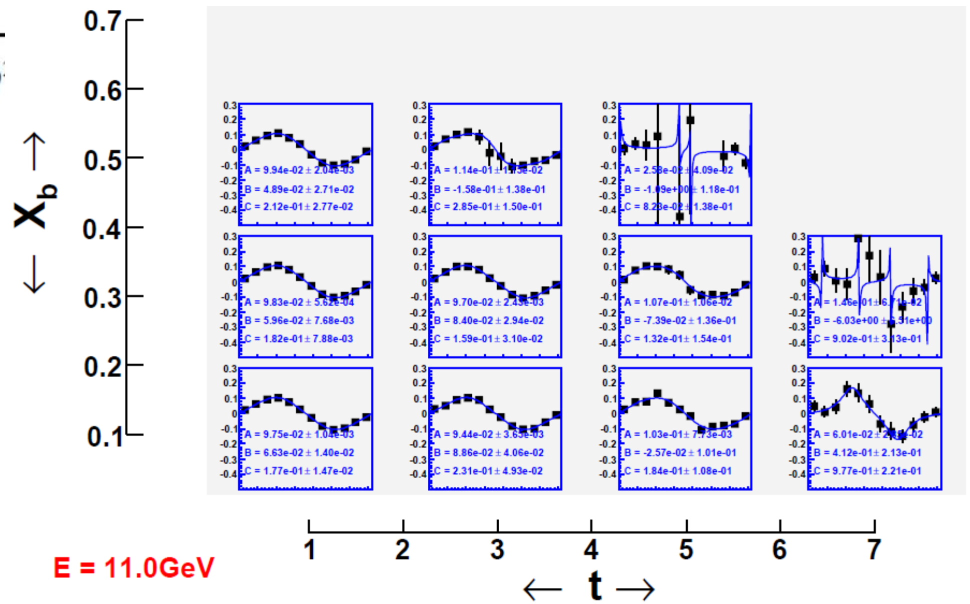




1. explore the transition from hadronic to partonic regime
2. ***chiral-odd GPDs*** in the proton

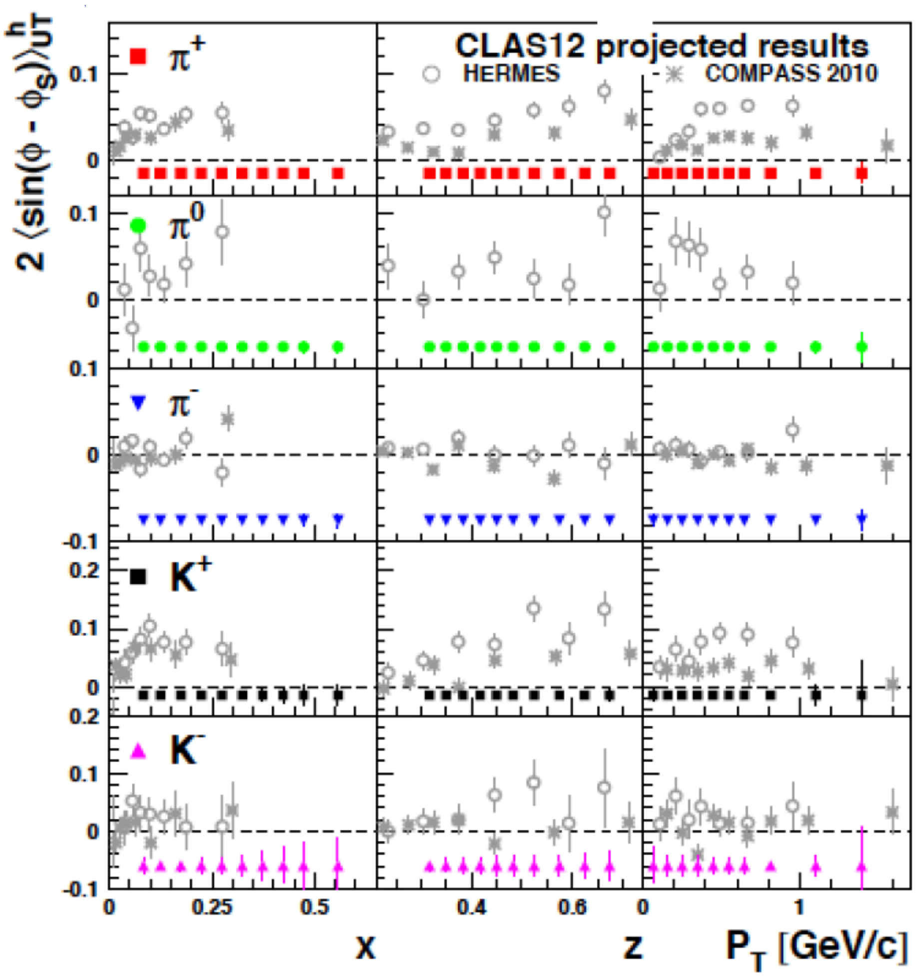
$$\pi^0 : \quad 2\Delta u - \Delta d$$

$$\eta : \quad 2\Delta u + \Delta d$$

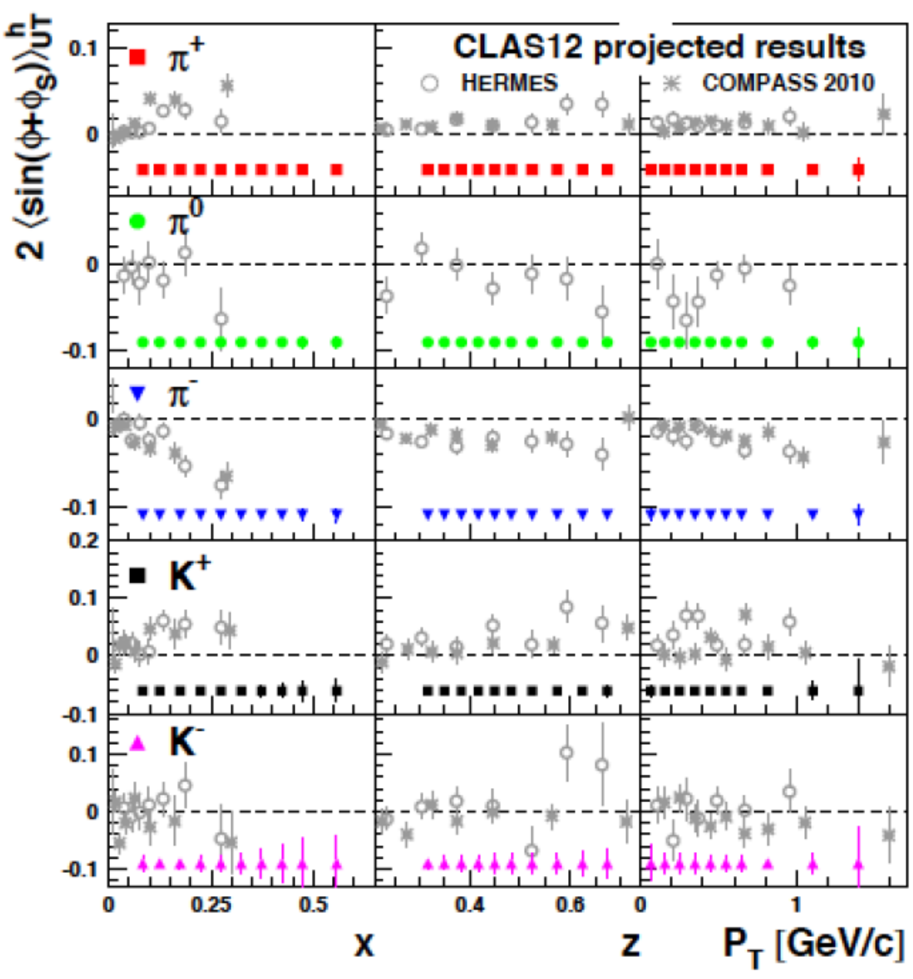


Collins&Sivers on p@Hall-B – 80 days@$\mathcal{L} = 10^{34} cm^{-2} s^{-1}$

Sivers@CLAS12



Collins@CLAS12



Collins&Sivers on n@Hall-A – C12-09-018

Both pions and kaons considered

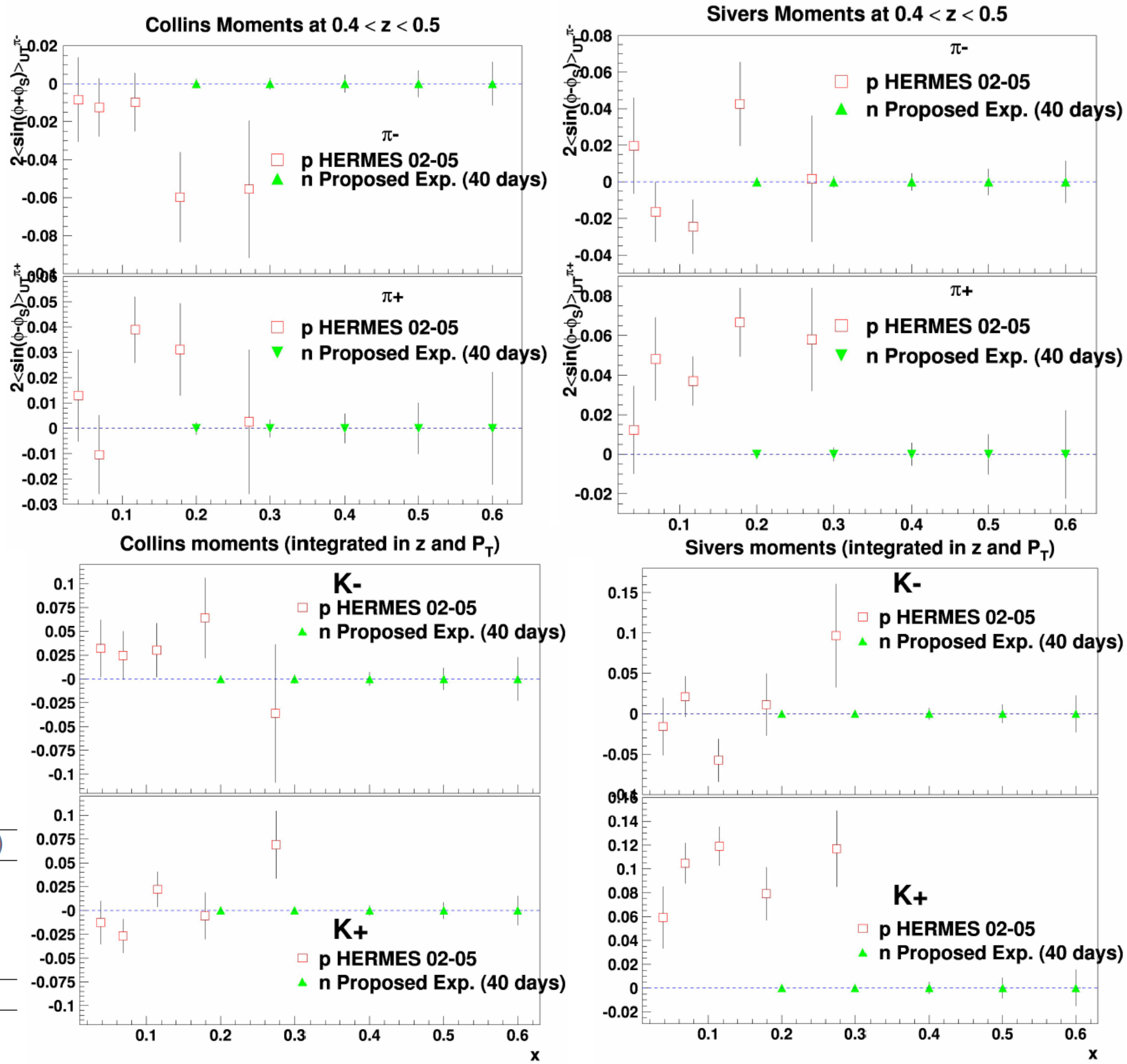
High-luminosity polarized ^3He target

SuperBiBite Spectrometer→ hadron arm
BiBite → electron arm

Two beam-energies used →
evaluation of Q^2 dependence

80 days@$\mathcal{L} = 10^{34} cm^{-2} s^{-1}$

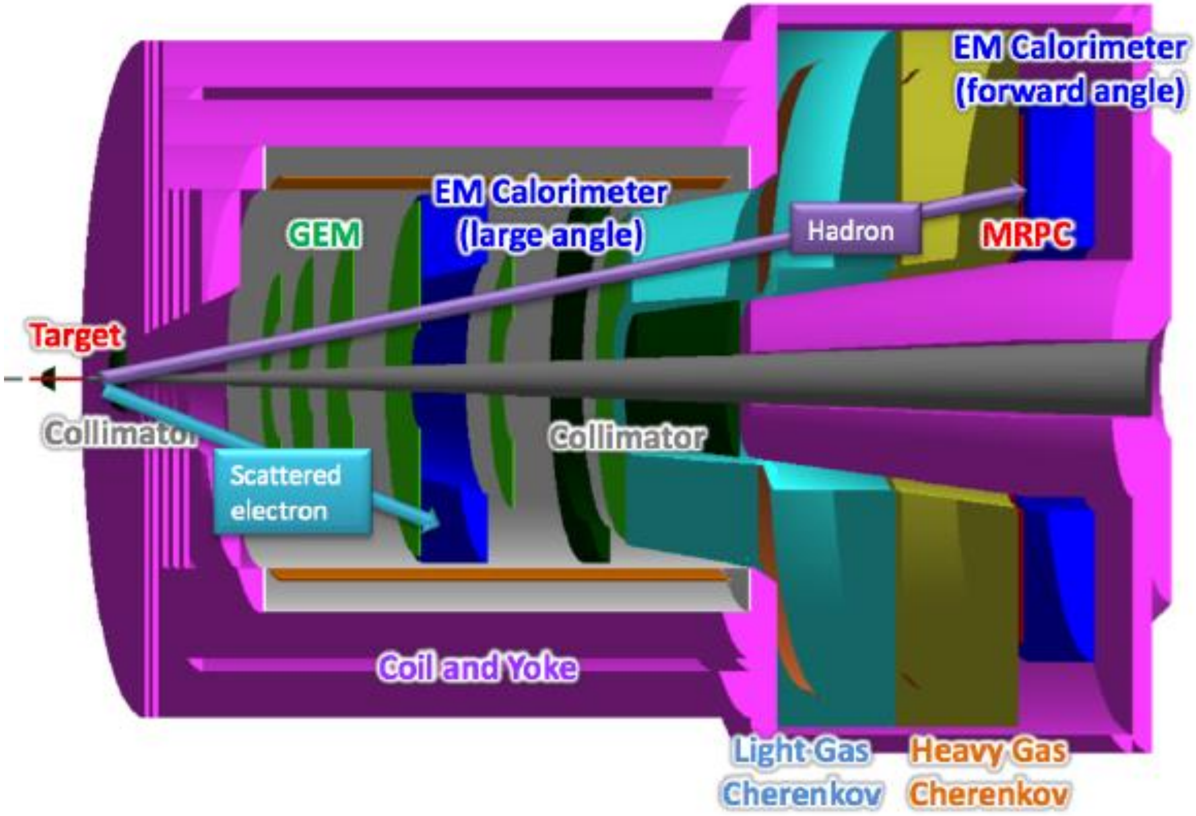
	Time (day)
Production run at $E = 11$ GeV	40
Production run at $E = 8.8$ GeV	20
Calibration Runs	2
Target maintenance and configuration changes	2
Total	64



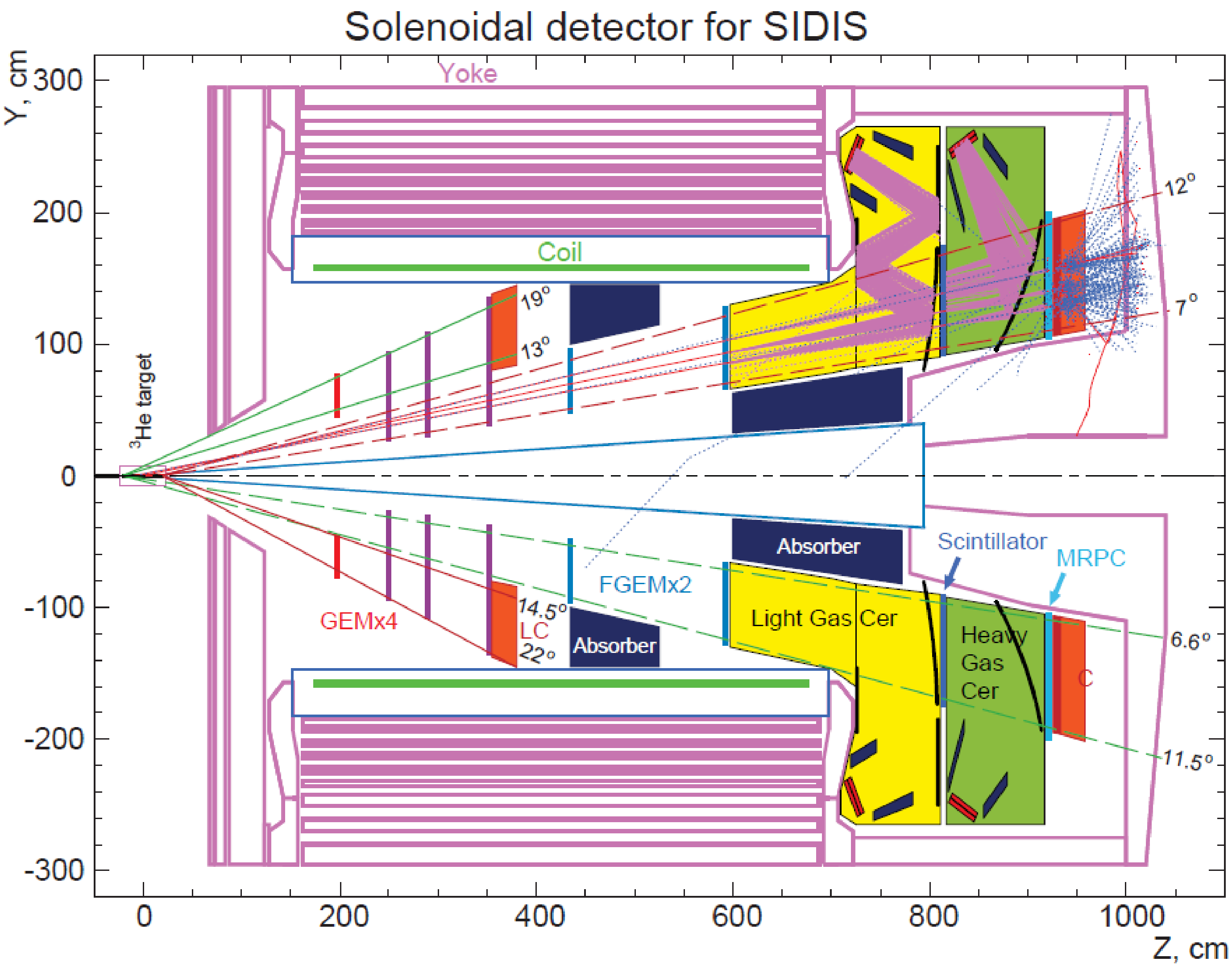
SoLID

1. Scattering electron identified both in the forward and in the large angle part
   - **Large**-& **Forward**-angle electromagnetic calorimeter

2. SIDIS hadrons will be detected in the forward part → 8÷15° through
   - **Cherenkov counters**
   - **MRPC** for Time-Of-Flight
   - Forward-Angle **EC**
   - **GEM** for tracking



SoLID



Solenoidal detector for SIDIS
Y, cm
Z, cm
300
200
100
0
-100
-200
-300
0
200
400
600
800
1000
Yoke
Coil
^{3}He target
19°
13°
12°
7°
14.5°
LC
22°
6.6°
11.5°
GEMx4
FGEMx2
Absorber
Absorber
Light Gas Cer
Heavy Gas Cer
Scintillator
MRPC
EC

SBS&BB acceptance

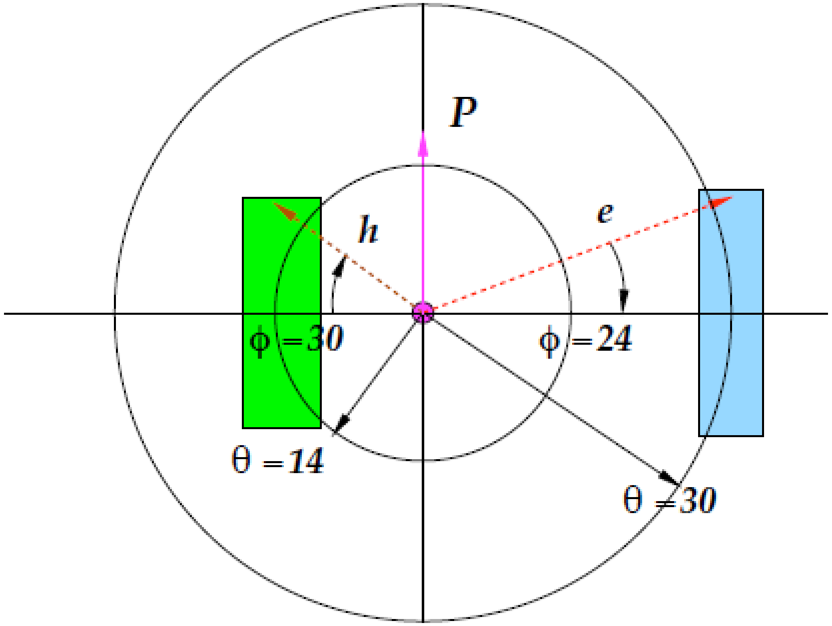
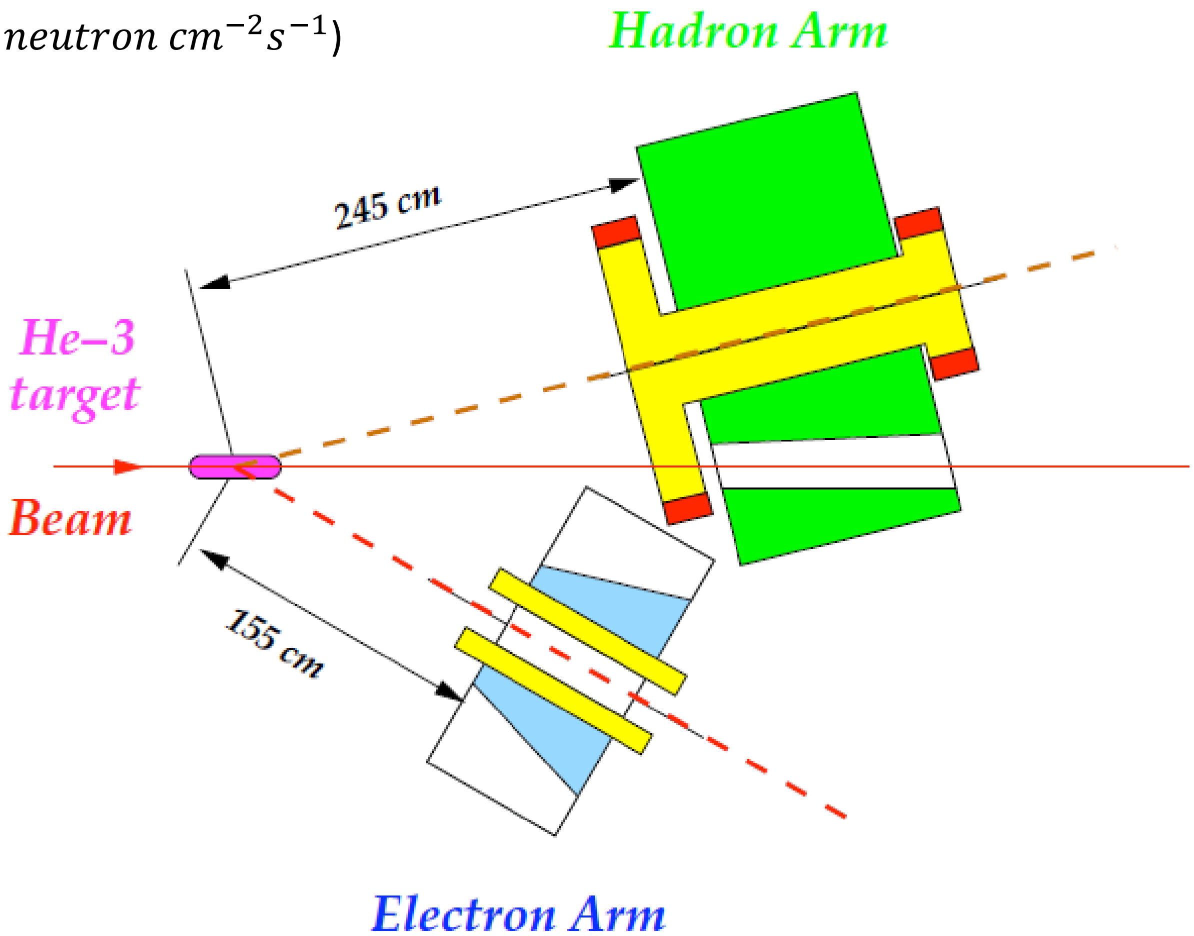


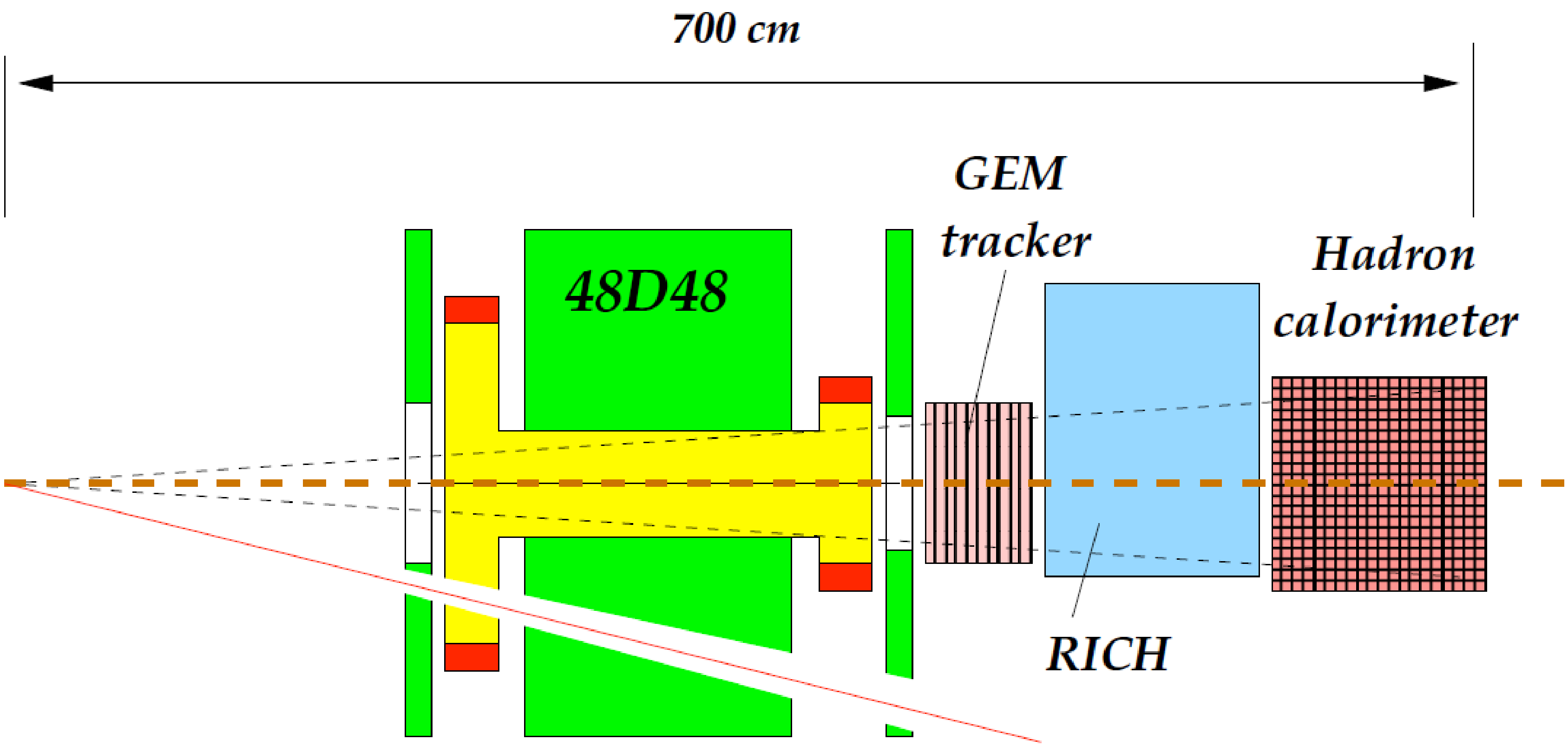
Figure 2.1: The schematic angular acceptance of the setup with SBS and BB viewed along the beam direction. The central angles are: $\theta_h = 30^\circ$ for BB and $\theta_e = 14^\circ$ for SBS. Azimuthal ranges in respect to the beam are: $\pm 24^\circ$ for BB and $\pm 30^\circ$ for SBS.

Hall-A setup: SBS (hadrons) & BB (electron)

^3He → 60-cm long target
Projected luminosity: $2x10^{37} electron - nucleon\ cm^{-2} s^{-1}$
($2x10^{36} electron - polarized\ neutron\ cm^{-2} s^{-1}$)



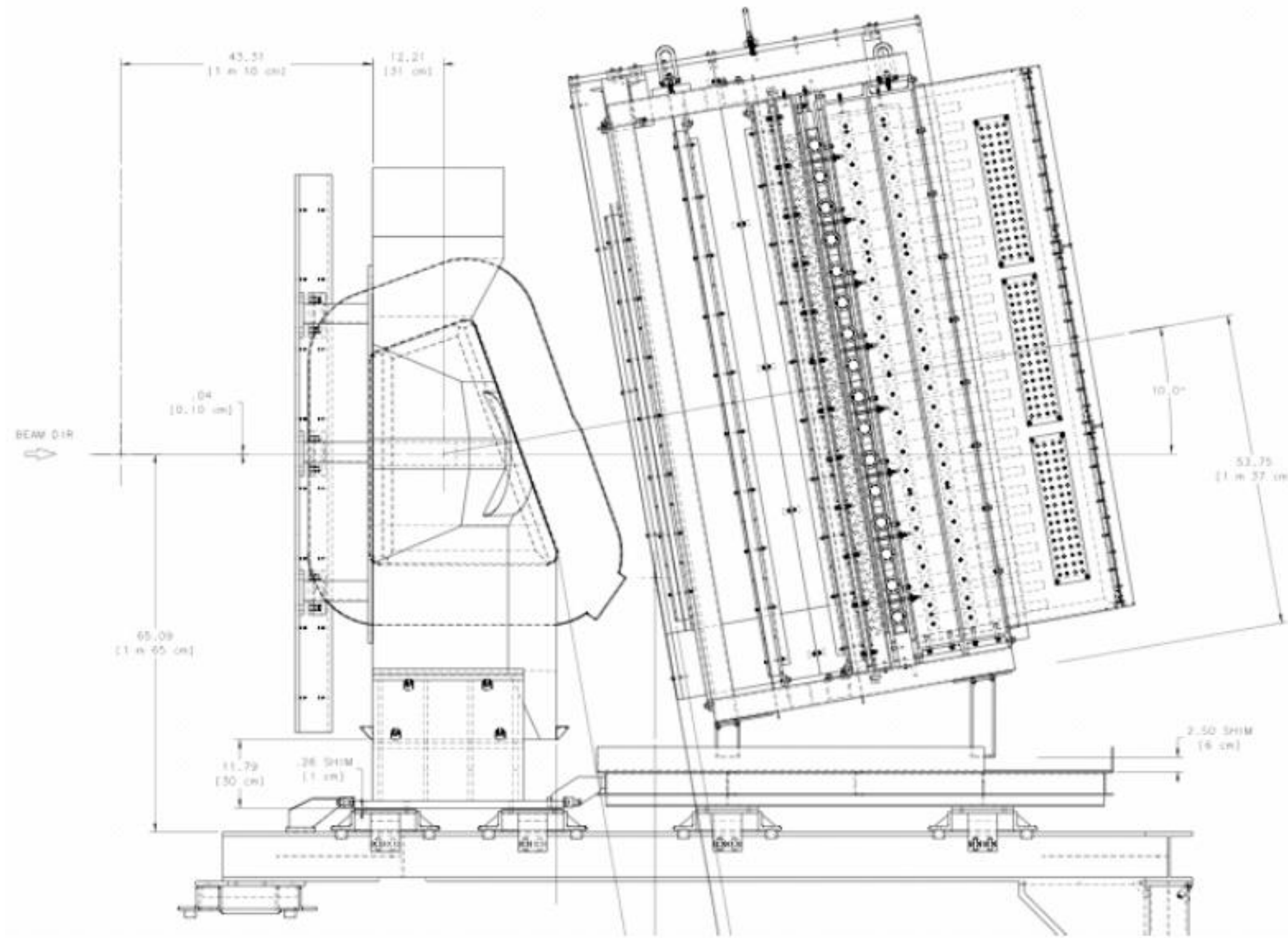
SBS for SIDIS experiments



Distance from the target to the detector, cm	417
Central angle θ_c , degree	14
horizontal range: $\Delta\theta_h$, degree	±3.6
vertical range: $\Delta\theta_v$, degree	±12
angular resolution: σ_{θ_c}, degree	0.02
vertex resolution (along beam), cm	0.2
momentum resolution σ_p/p	$0.001\times$p[GeV]

BigBite

1. tracker
2. gas Cherenkov counter
3. two-layer electromagnetic calorimeter
4. scintillator hodoscope



title

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