3D NUCLEON STUDIES
TOWARDS EIC
(AN ITALIAN VIEW)

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Workshop on Physics and Engineering Opportunities at EIC 2016
October 14, 2016 - Ross Priory on Loch Lomond,

The General Equations and Dynamics

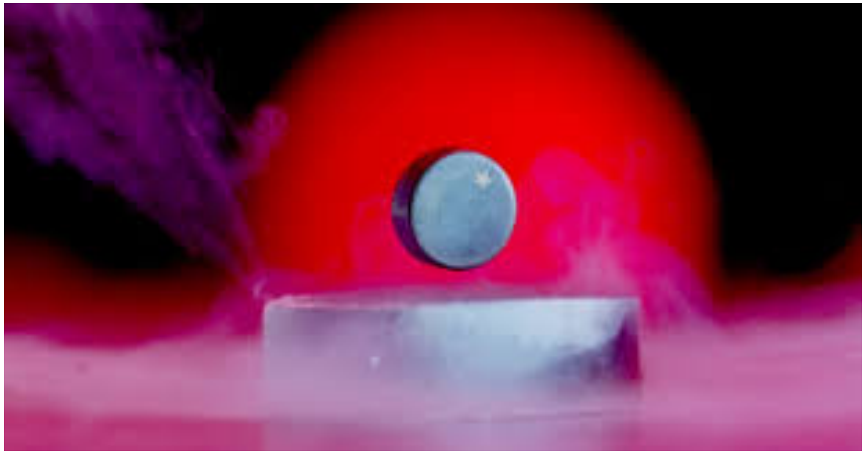
$$\nabla \cdot \mathbf{E} = \frac{\rho}{\varepsilon_0}$$

$$\nabla \cdot \mathbf{B} = 0$$

$$\nabla \times \mathbf{E} = -\frac{\partial \mathbf{B}}{\partial t}$$

$$\nabla \times \mathbf{B} = \mu_0 \mathbf{J} + \mu_0 \varepsilon_0 \frac{\partial \mathbf{E}}{\partial t}$$

$$R_{\mu\nu} - \frac{1}{2} R\, g_{\mu\nu} + \Lambda\, g_{\mu\nu} = \frac{8\pi G}{c^4} T_{\mu\nu}$$



But superconductivity ?

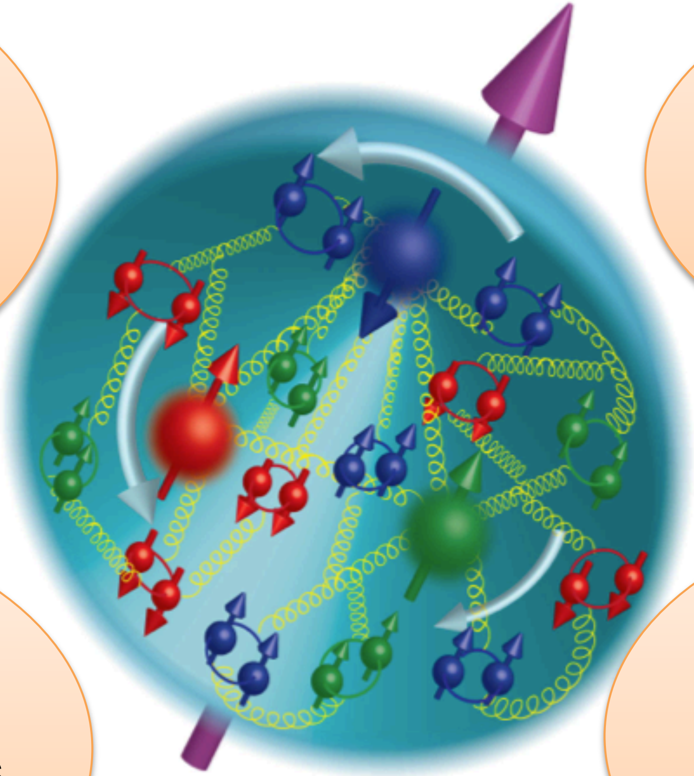
But star dynamics ?

The Strong-Force Confined-Universe

$$\mathcal{L} = -\frac{1}{4}F^{\mu\nu}F_{\mu\nu} + \sum_{q=u,d,s,c,b,t} \bar{q}\left[i\gamma^{\mu}(\partial_{\mu} - igA_{\mu}) - m_q\right]q$$

Dynamic Spin
- Parton polarization
- Orbital motion
- Form Factors
- Magnetic Moment

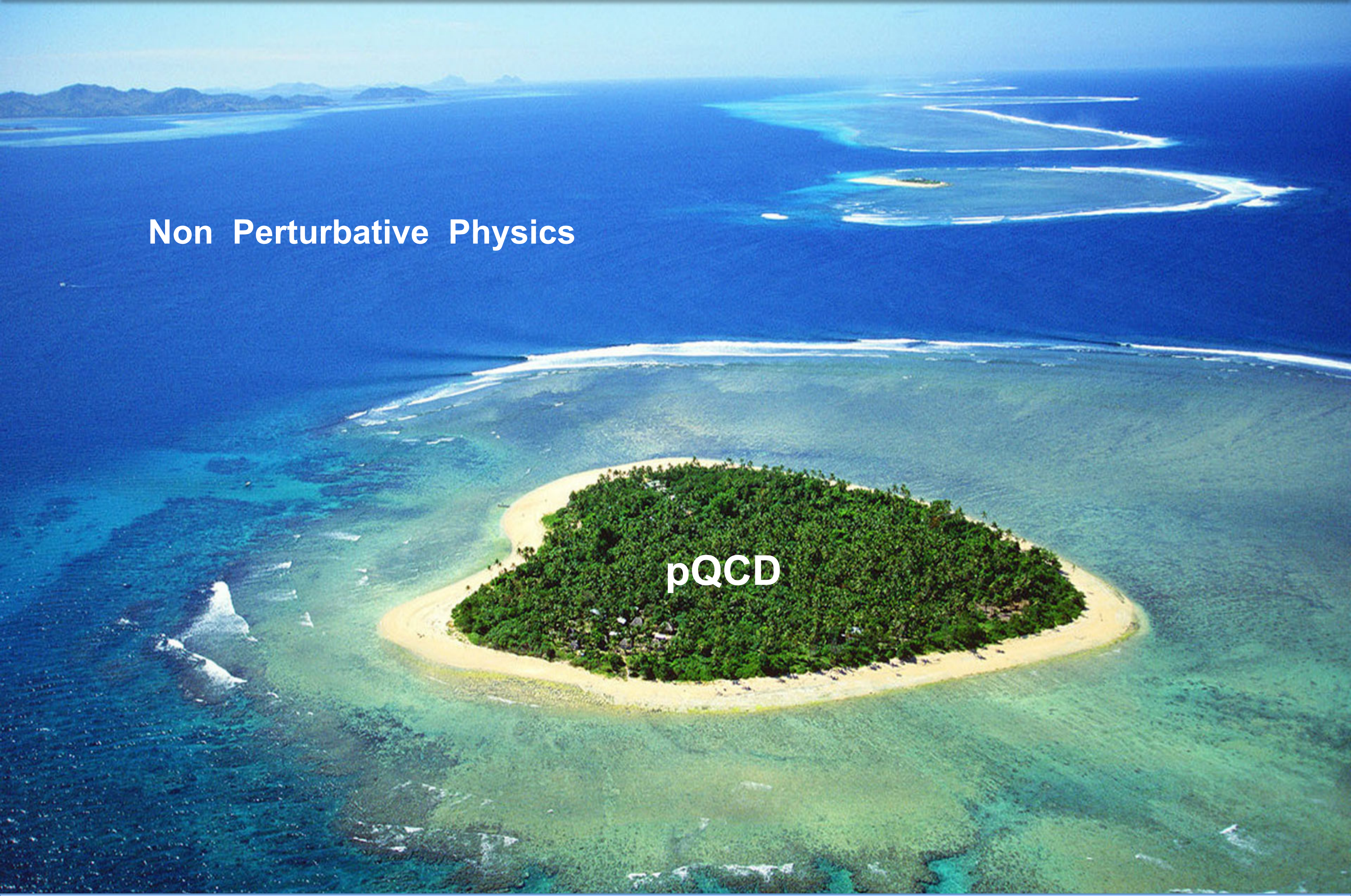
Parton Correlations
- dPDFs
- Short range
- MPI



Hadronization
- Spin-orbit effects
- Parton energy loss
- Jet quenching

Color charge density
- Nucleon tomography
- Diffractive physics
- Gluon saturation
- Color force

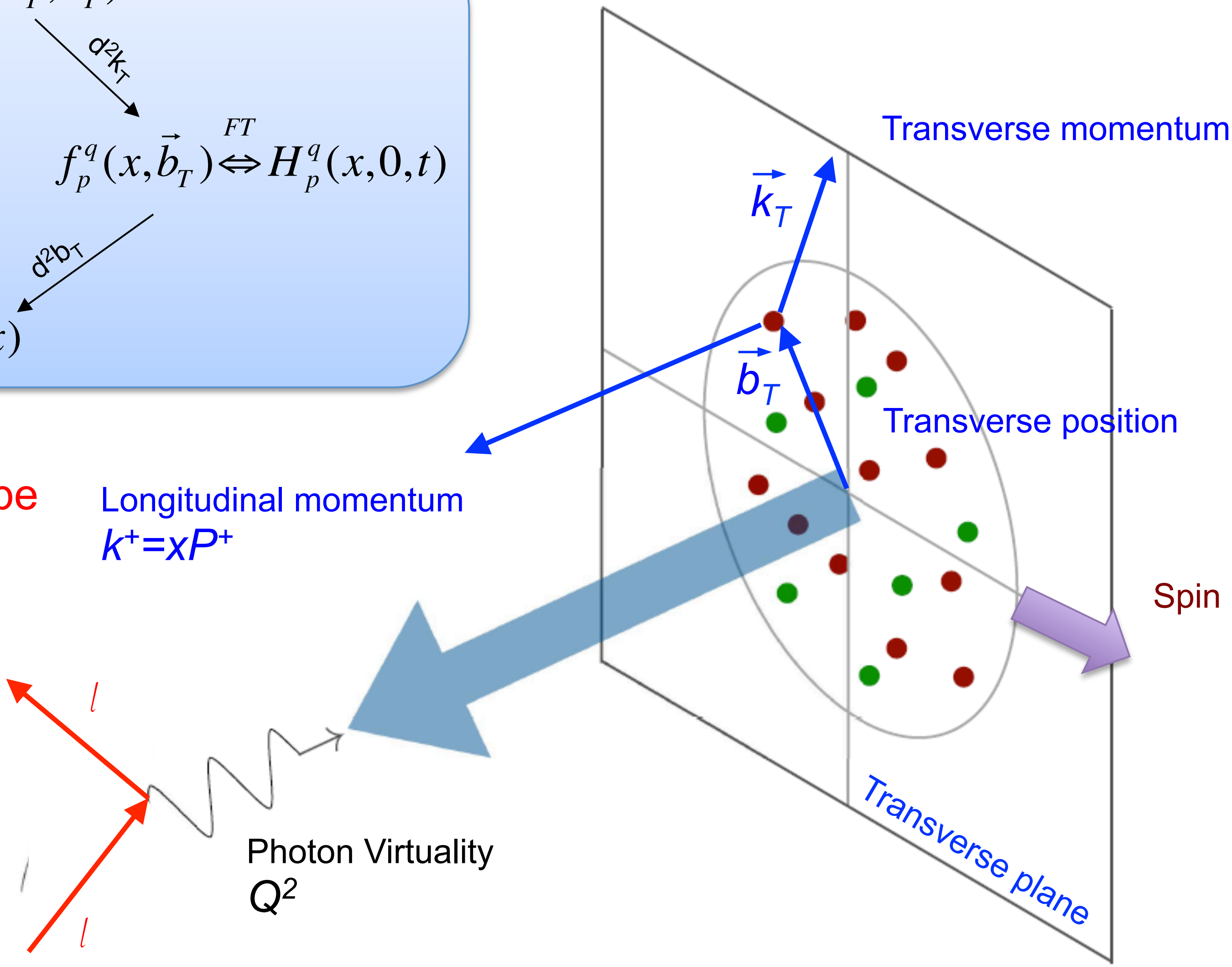
The QCD View



The 3D Nucleon Structure

$$\begin{tikzcd}
 & W_p^q(x,\vec{k}_T,\vec{b}_T) \arrow[dl, "d^2b_T"'] \arrow[dr, "d^2k_T"] & \\
f_p^q(x,\vec{k}_T) \arrow[dr, "d^2k_T"] & & f_p^q(x,\vec{b}_T) \overset{FT}{\Leftrightarrow} H_p^q(x,0,t) \arrow[dl, "d^2b_T"'] \\
 & f_p^q(x) &
\end{tikzcd}$$

Confinement Scale



Transverse momentum

$\vec{k}_T$

$\vec{b}_T$

Transverse position

Spin

Transverse plane

High Energy Probe
Hard Scale

Longitudinal momentum
$k^+=xP^+$

l

l

Photon Virtuality
Q^2

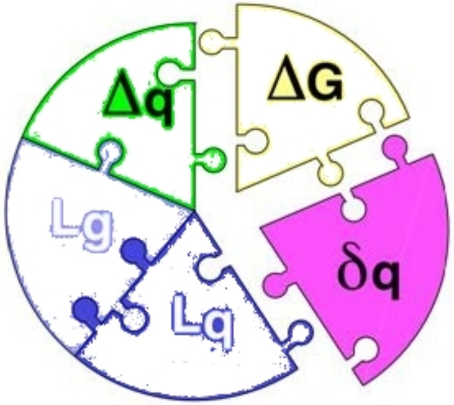
The Spin Degree of Freedom

In our exploration of the QCD micro-world

Fundamental: do not neglect spin !!

Two questions in Hadronic Physics
await explanation since too long

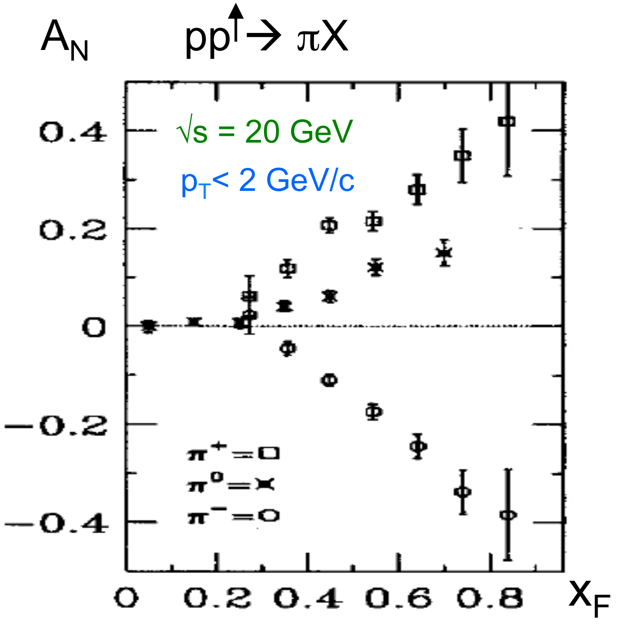
Proton Spin Budget



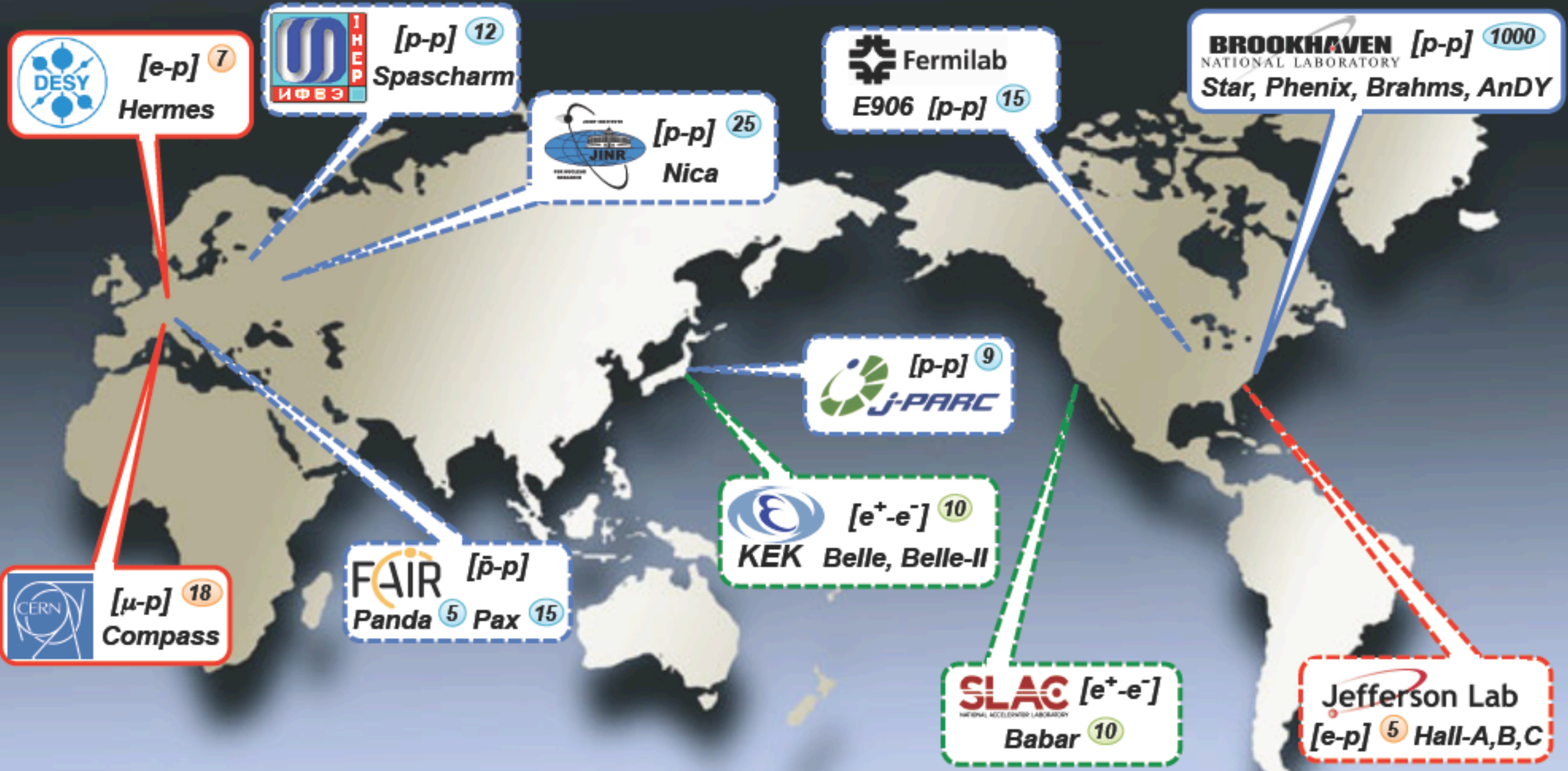
$$\frac{1}{2} = \frac{1}{2}\sum_f (q_f^+ - q_f^-) + L_q + \Delta G + L_g$$

?

Single Spin Asymmetries

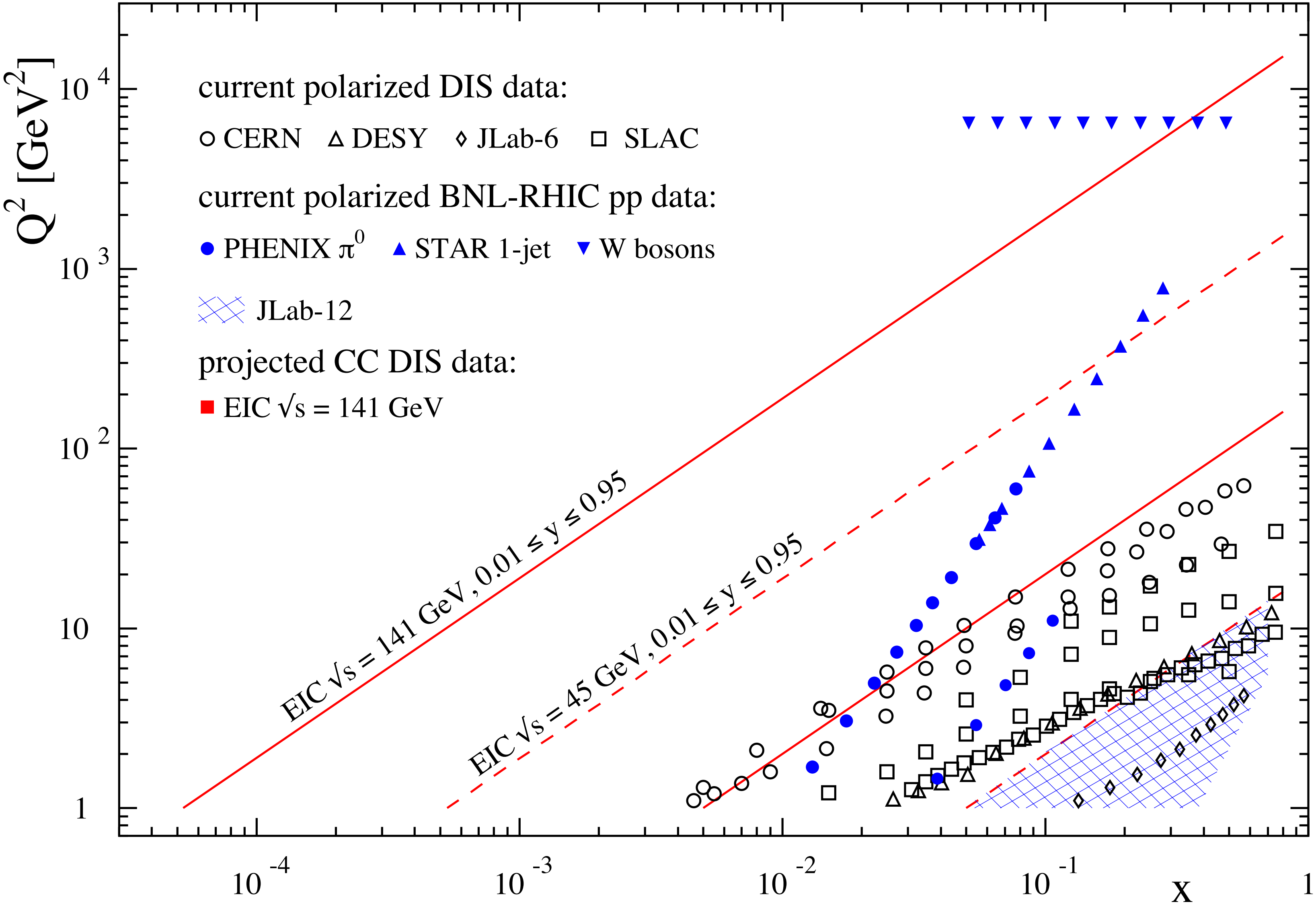


A World-wide Challenge



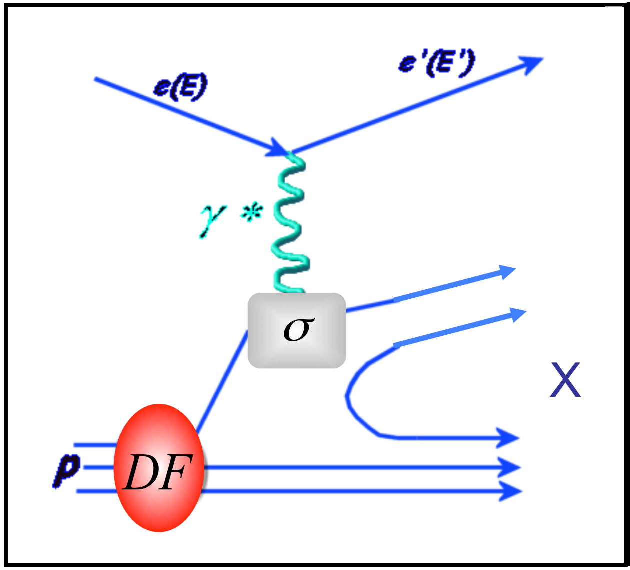
Babar (e+e-):	< 2007	SeaQuest (pp):	2012 - 2016	JPARC(pp):	2018++		
BELLE (e+e-):	< 2010	RHIC (pp):	2011, 2017++	FAIR ($\bar{p}$p):	2018++		
BELLEII (e+e-):	2017++	COMPASS (πp):	2016 – 2017	NICA (pp):	2018++	AFTER (pp):	2020++

The SIDIS Landscape



Moving Out of Collinearity

Inclusive



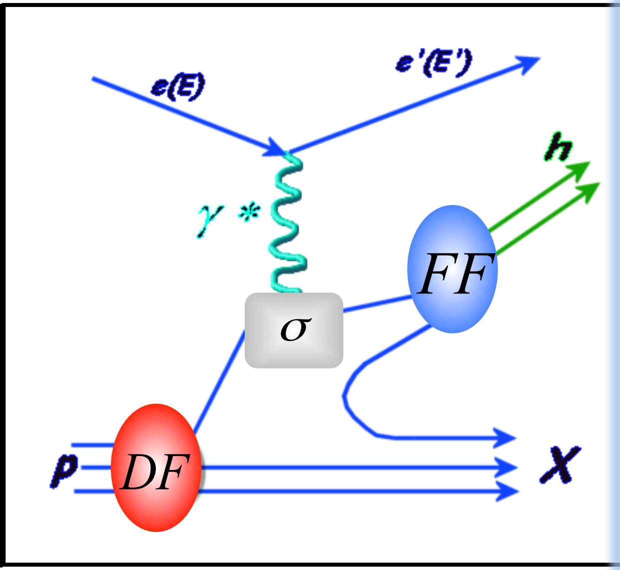
SFs (x,Q^2)

Structure functions
(unpolarized, helicity)

Sum over quark charges

$$d^2\sigma \propto F_2\left(=\sum_q e_q^2 q(x)\right)$$

Semi-inclusive



PDFs (x,z,Q^2)

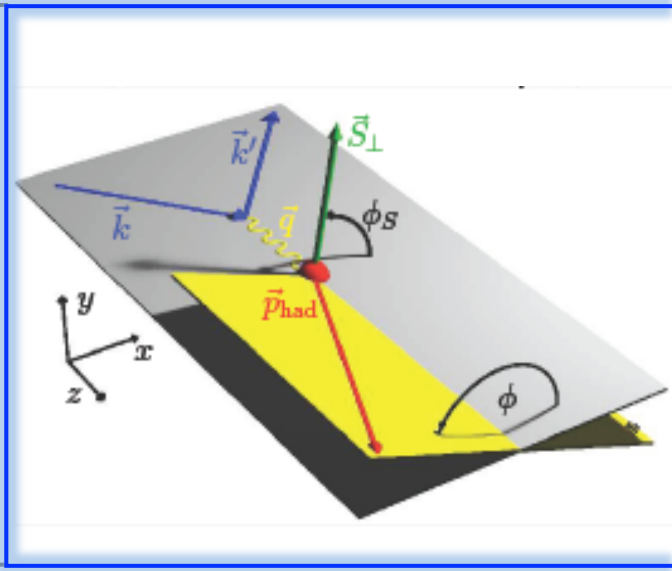
Parton distributions

$$D_u^{\pi+}(z) > D_u^{\pi-}(z)$$

Flavor sensitivity

$$d^3\sigma^h \propto \sum_q e_q^2 q(x) D_q^h(z)$$

Semi-inclusive



TMDs (x,z,$P_{h\perp}$,Q^2)

Transverse momentum
dependent parton distri.

Spin-Orbit effects

$$d^6\sigma^h \propto \sum_q e_q^2 q(x,k_T)\otimes D_q^h(z,p_T)$$

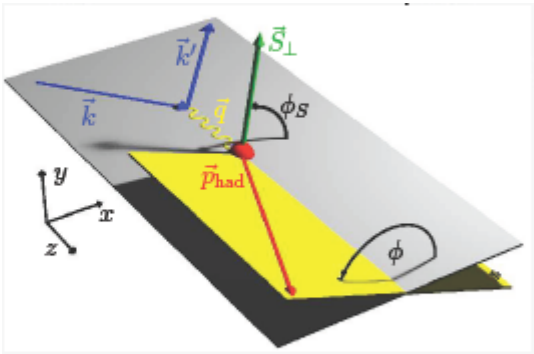
Rich and Involved phenomenology !!

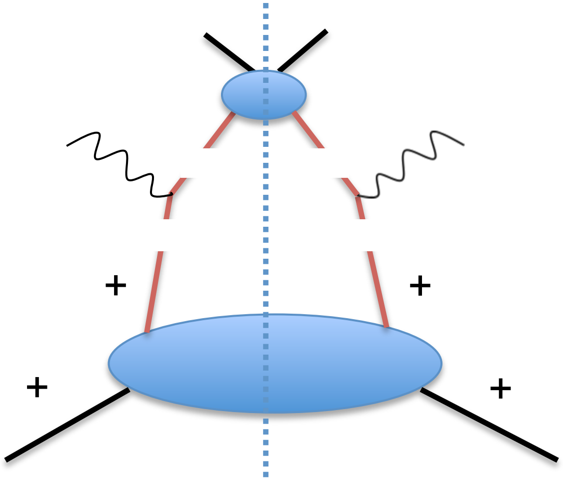
SIDIS Cross-Section & TMDs

$$\frac{d^6\sigma}{dx\,dQ^2\,dz\,dP_h\,d\phi\,d\phi_S} \overset{LT}{\propto} \left[F_{UU} + \varepsilon\cos(2\phi)F_{UU}^{\cos(2\phi)}\right] + S_L\left[\varepsilon\sin(2\phi)F_{UL}^{\sin(2\phi)}\right]$$

$$+ S_T\left[\sin(\phi-\phi_S)F_{UT}^{\sin(\phi-\phi_S)} + \varepsilon\sin(\phi+\phi_S)F_{UT}^{\sin(\phi+\phi_S)} + \varepsilon\sin(3\phi-\phi_S)F_{UT}^{\sin(3\phi-\phi_S)}\right]$$

$$+ S_L\lambda_e\left[\sqrt{1-\varepsilon^2}\,F_{LL}\right] + S_T\lambda_e\left[\sqrt{1-\varepsilon^2}\,\cos(\phi-\phi_S)F_{LT}^{\cos(\phi-\phi_S)}\right] + O\left(\frac{1}{Q}\right)$$





Quark fragmentation

TMD Factorization holds for p_T<<Q

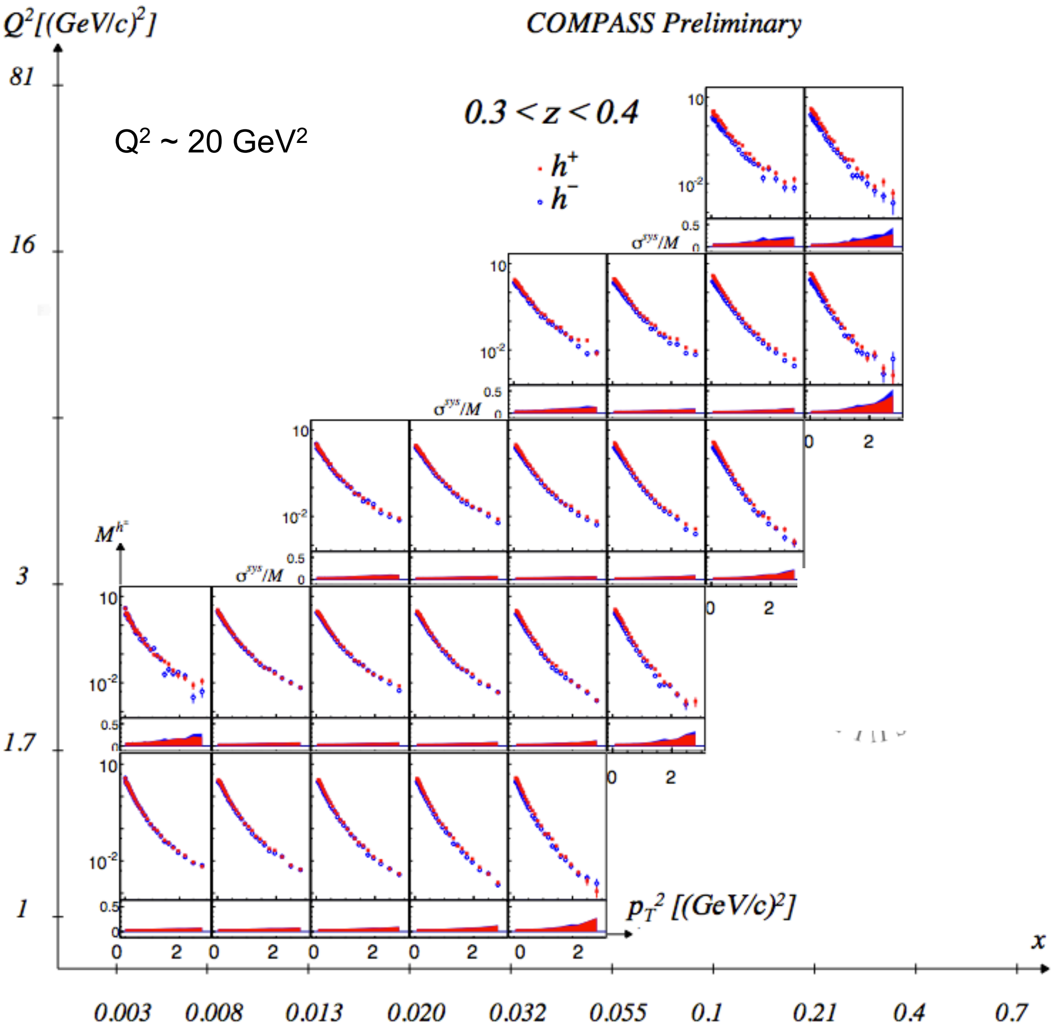
Quark parton distribution

Wide kinematic coverage is needed to resolve the convolution

$$F_{UU} = f \otimes D = x\sum_q e_q^2 \int d^2p_T\,d^2k_T\;\; \delta^{(2)}(\mathbf{P}_{h\perp} - z\mathbf{k}_T - \mathbf{p}_T)\;\; w(\mathbf{k}_T,\mathbf{p}_T)\;\; f^q(x,k_T^2)\;\; D^q(z,p_T^2)$$

The Multi-D Approach

Umpolarized Multiplicities



Q^2 ~ 20 GeV^2

Disentangle all the kinematic dependences

Asymmetries so far used to suppress systematics effects

$$A_{LL} = \frac{\sigma^+ - \sigma^-}{\sigma^+ + \sigma^-}$$

$$A_{LL} = \frac{1}{fP_T P_B} \frac{N^+ - N^-}{N^+ + N^-}$$

They suppress also physics (i.e. evolution)

Multi-D:

- naturally reduces some source of systematics
- blows up the statistical error also due to smearing and acceptance

Requires high-luminosity

First evidences

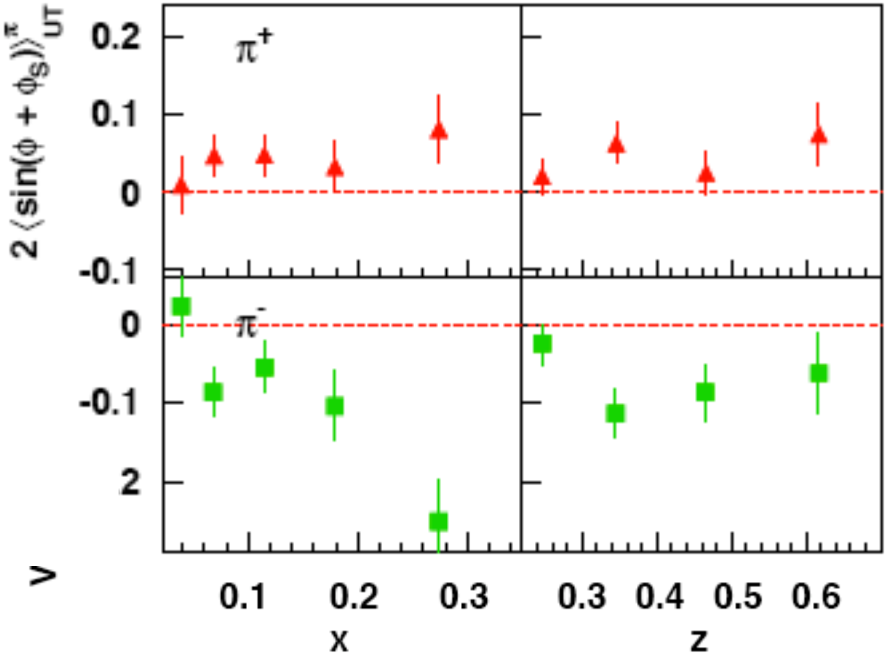
$$\sigma_{UT}^{\sin(\phi+\phi_S)} \propto h_1 \otimes H_1^{\perp}$$

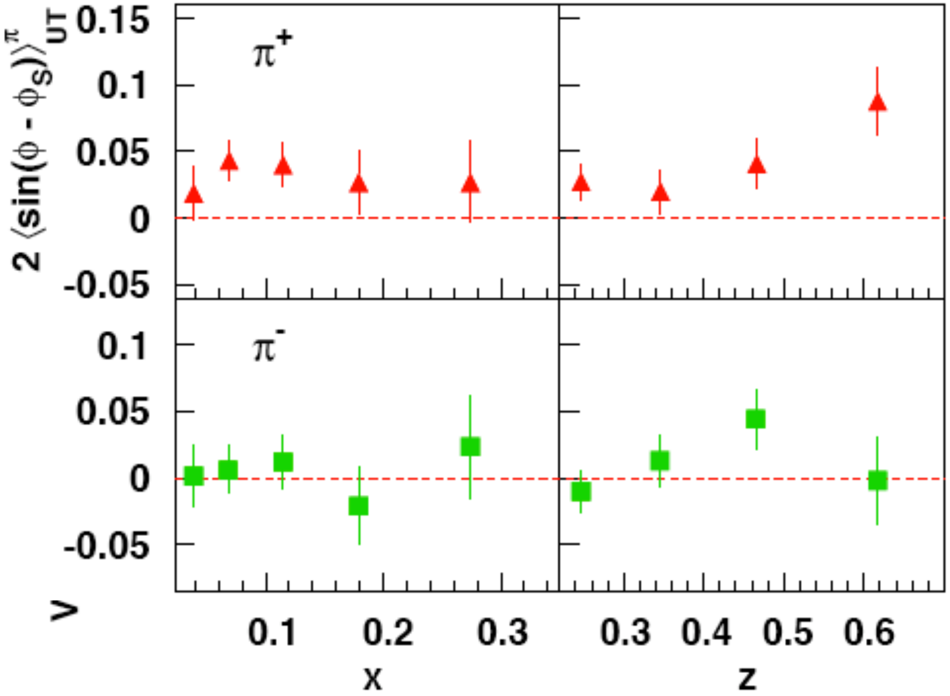
SIDIS:
ep → e'hX

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

2005: First evidence from HERMES measuring SIDIS on proton

A. Airapetian et al, Phys. Rev. Lett. 94 (2005) 012002





Non-zero transversity !!
Non-zero Collins function !!

Non-zero Sivers function !!

Parton Number Density

Transverse Momentum Dependent Distr.

quark polarisation

nucleon polarisation

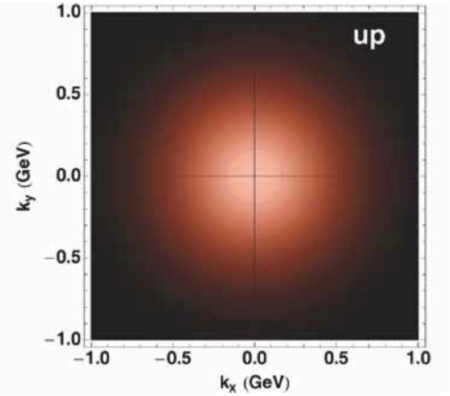
N/q	U	L	T
U	f_1		$h_1^\perp$
L		g_1	$h_{1L}^\perp$
T	$f_{1T}^\perp$	$g_{1T}^\perp$	$h, h_{1T}^\perp$

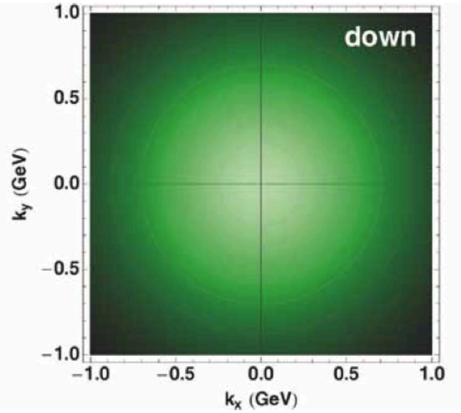
$\otimes$

hadron polarisation

quark polarisation

N/q	U	L	T
U	D_1		$H_1^\perp$





Related to:

✓ Low-pT regime:
precise xsec measurements

✓ Parton correlations:
short range, MPI

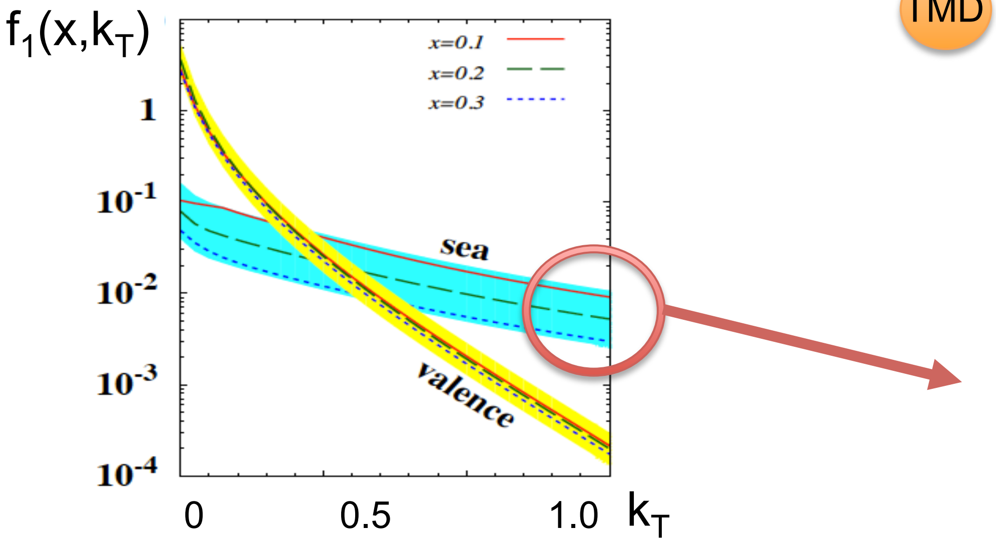
✓ Low-x physics:
color glass condensate

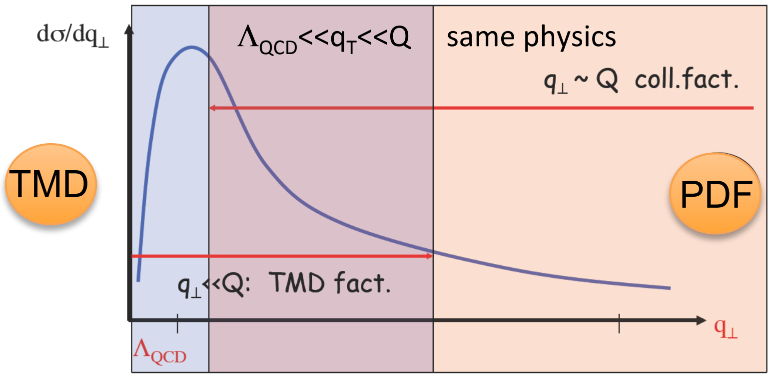
✓ Hadronization:
parton dynamic in medium

Unpolarized TMDs

$$\sigma_{UU} \propto f_1(k_T\ldots)\otimes D_1(p_T\ldots)$$

P. Schweitzer++ [arXiv:1210.1267]

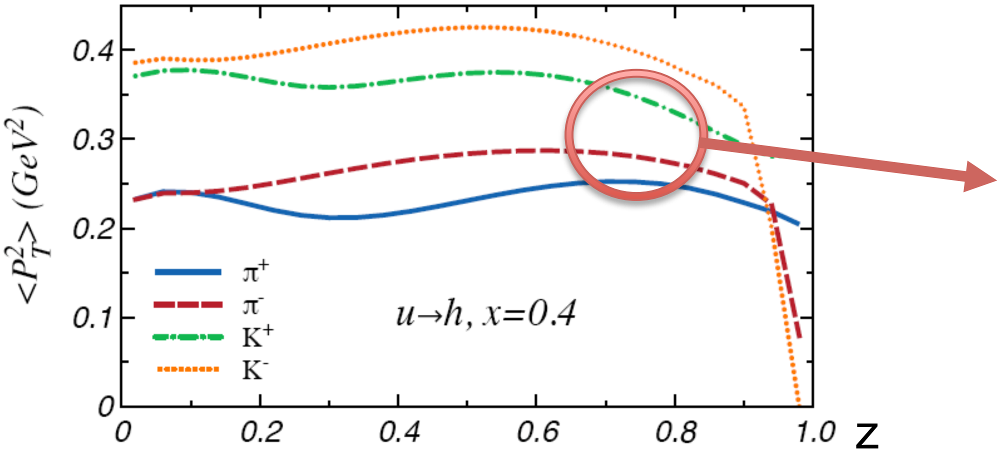




Large tiles extending up to the inverse of the gauge field fluctuation scale ρ<<M

May short range parton correlations manifest also in pp MPI ?

Matevosyan++ [arXiv:1111.1740]



Reflect different fragmentation

May be enhanced in medium.

Parton propagation in cold matter as complementary study to QGP

The $P_{h\perp}$-unintegrated multiplicities

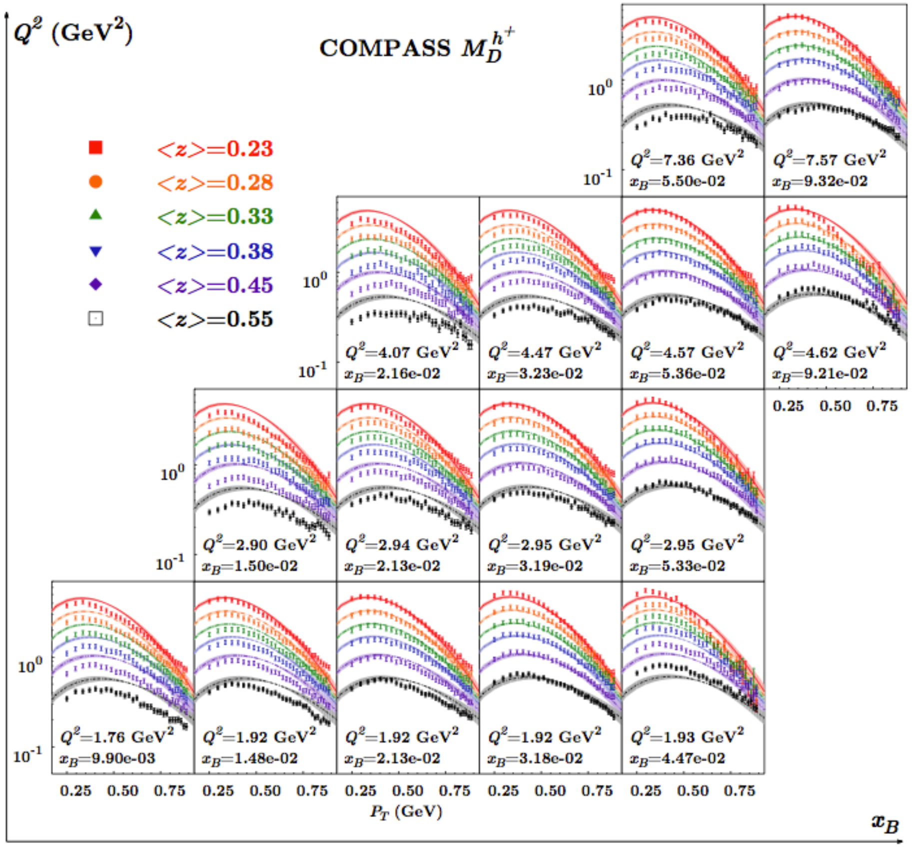
$$\sigma_{UU} \propto f_1\,(k_T\ldots) \otimes D_1\,(p_T\ldots)$$

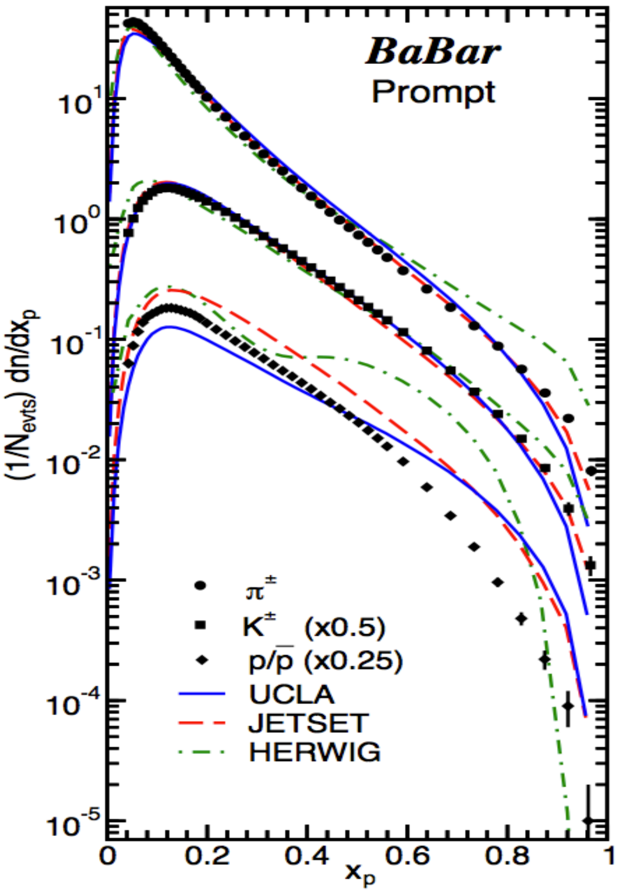
Disentanglement of z and $P_{h\perp}$: access to the transverse intrinsic quark k_T and fragmentation $p_{T,}$

i.e. from gaussian anstaz:

$$\langle P_{h\perp}^2 \rangle = z^2 \langle k_T^2 \rangle + \langle p_T^2 \rangle$$

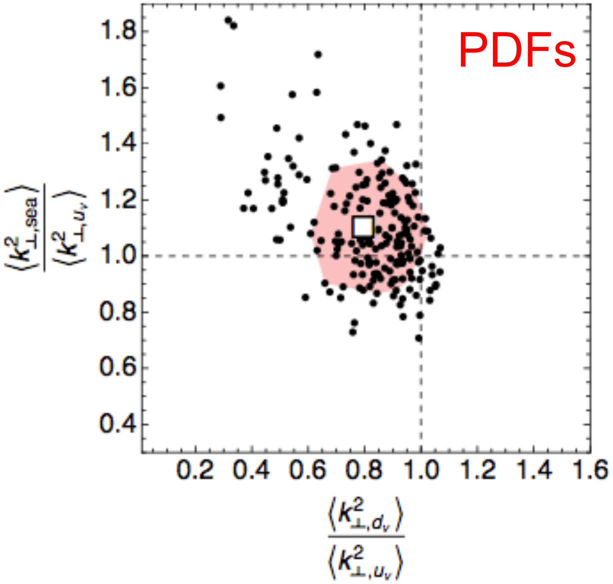
M. Anselmino++ [arXiv:1312.6261]





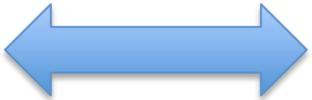
TMD Evolution

M. Anselmino++ [arXiv:1312.6261]



TMD Q^2 evolution ≠ DGLAP

Very interesting non perturbative part of evolution taken from data



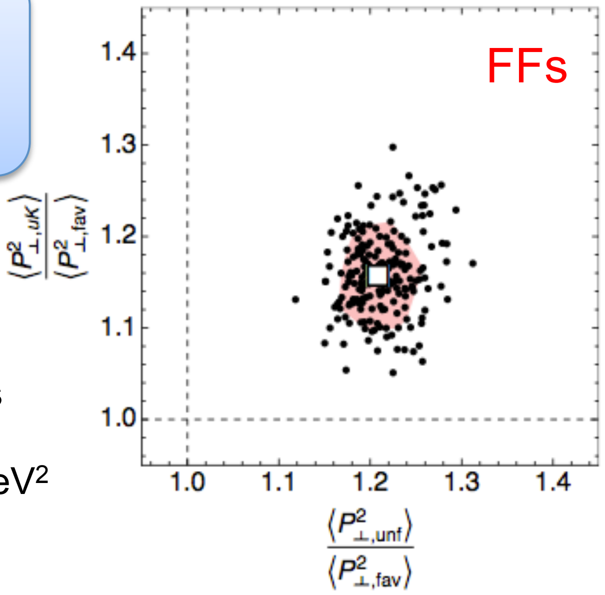
Fixed target SIDIS

Q^2 ~ few GeV^2

B-factories

Q^2 ~ 100 GeV^2

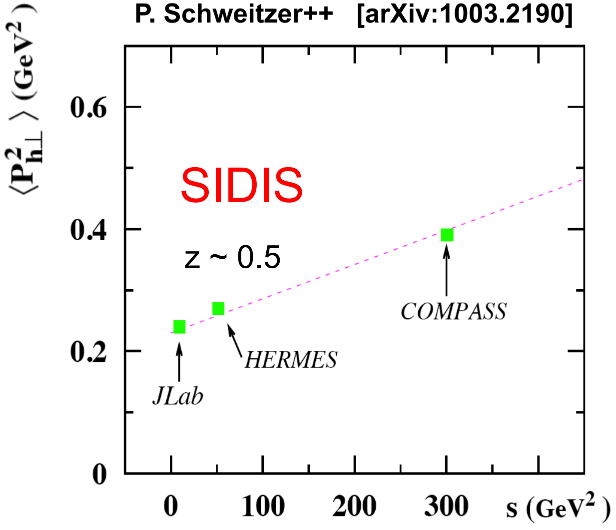
A. Signori++ [arXiv:1309.3507]



Indication of a k_T and p_T broadening with c.m. energy: TMD evolution

Energy scan at EIC in conjunction with B-factory data is crucial for effective progresses

P. Schweitzer++ [arXiv:1003.2190]

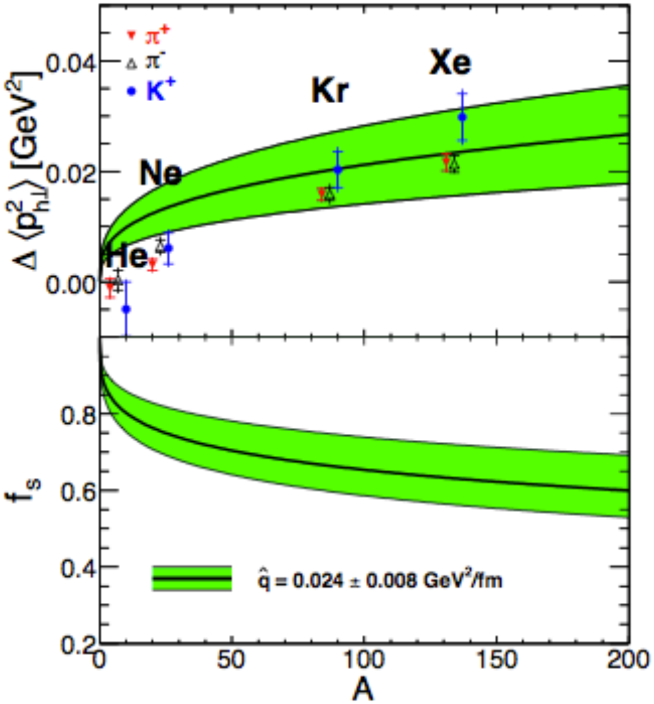


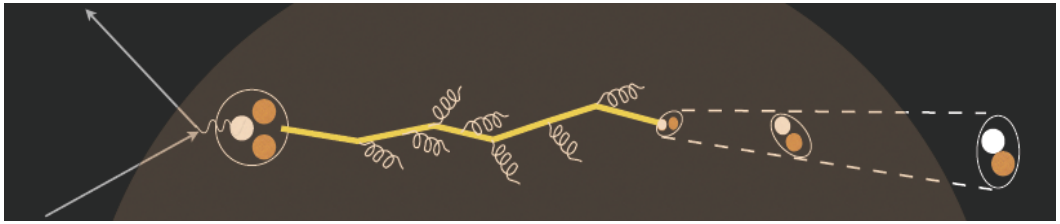
Medium modification

In terms of the QCD, there are several contributions to P_T distribution of hadrons produced in SIDIS:

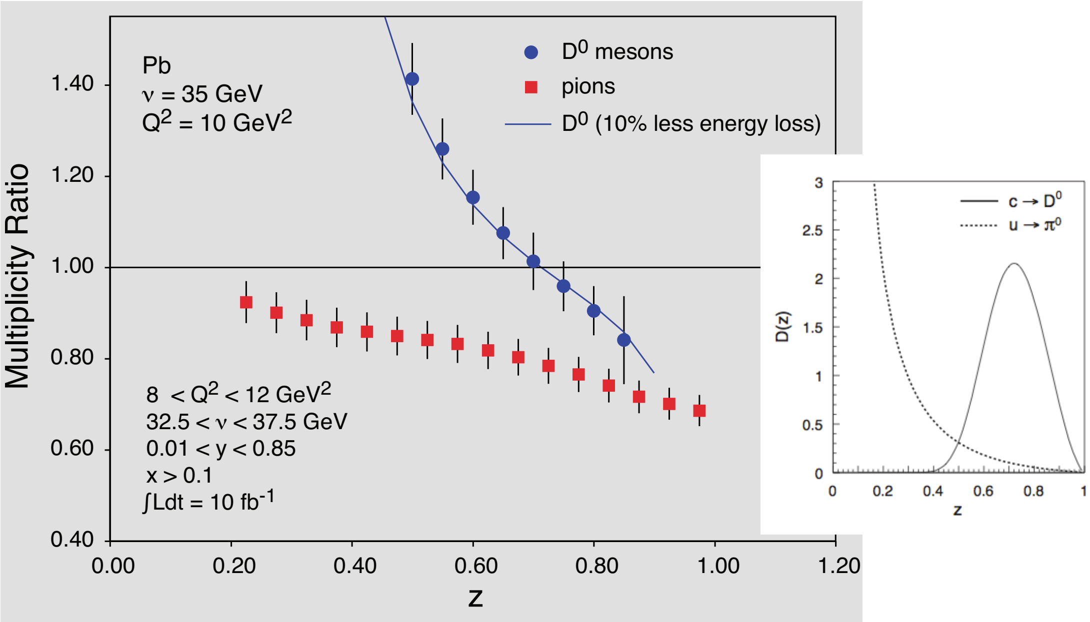
- primordial transverse momentum + gluon radiation of the struck quark
- the formation and soft multiple interactions of the “pre-hadron”
- the interaction of the formed hadrons with the surrounding hadronic medium

HERMES [arXiv: 0906.2478]





A. Accardi et al. [arXiv 1212.1701]



N-B Chang ++ [arXiv:1402.3042]

$$\Delta_{2F} = 3\sqrt{2}\hat{q}_0 r_0 A^{1/3}/4$$

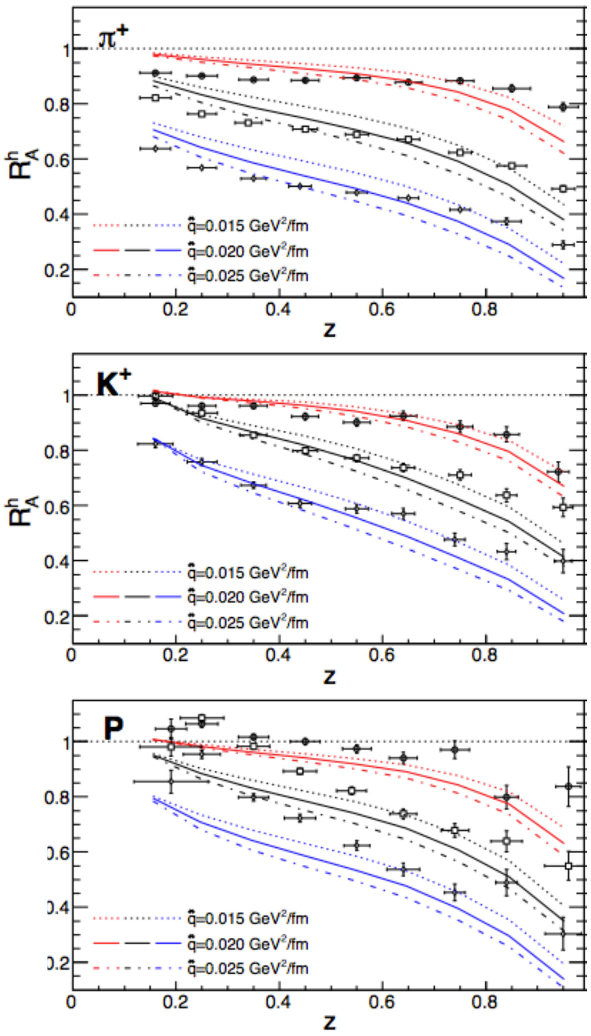
$$\frac{\langle\cos\phi\rangle^{eA}_{UU}}{\langle\cos\phi\rangle^{eN}_{UU}} \approx \frac{\langle\sin\phi\rangle^{eA}_{LU}}{\langle\sin\phi\rangle^{eN}_{LU}} \approx \frac{\alpha}{\alpha+\Delta_{2F}} = f_s$$

Medium modification

DIS

$$\hat{q}_0 \approx 0.020 \pm 0.005\ \mathrm{GeV}^2/\mathrm{fm}$$

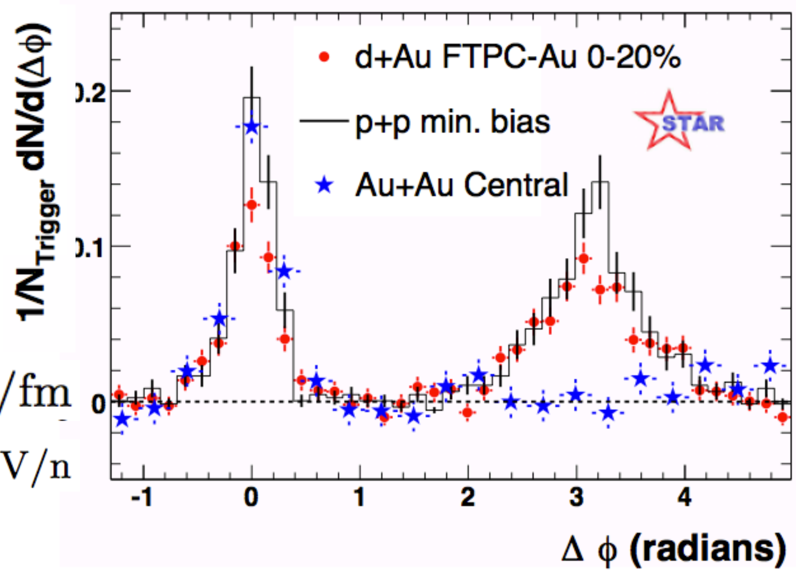
N-B Chang ++ [arXiv:1401.5109]



RHIC

$$\hat{q} \approx 1.2 \pm 0.3\ \mathrm{GeV}^2/\mathrm{fm}$$

Au+Au $\sqrt{s} = 200\ \mathrm{GeV/n}$

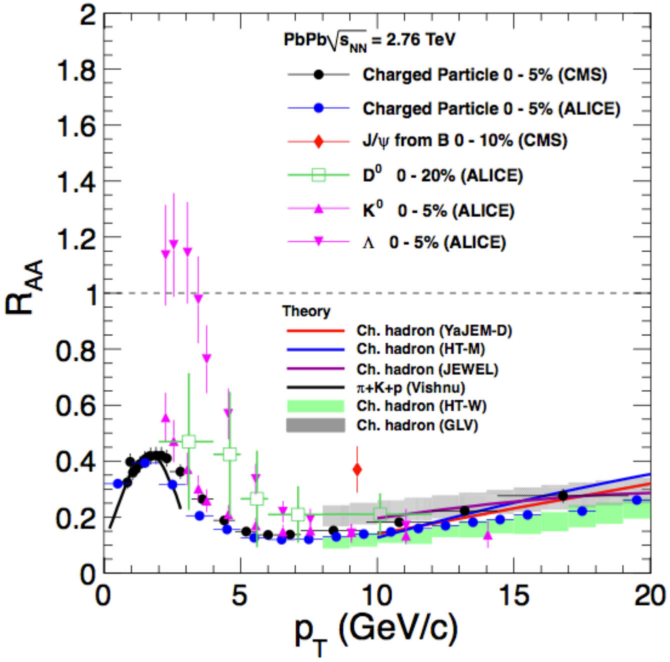


JET Coll. [arXiv:1312.5003]

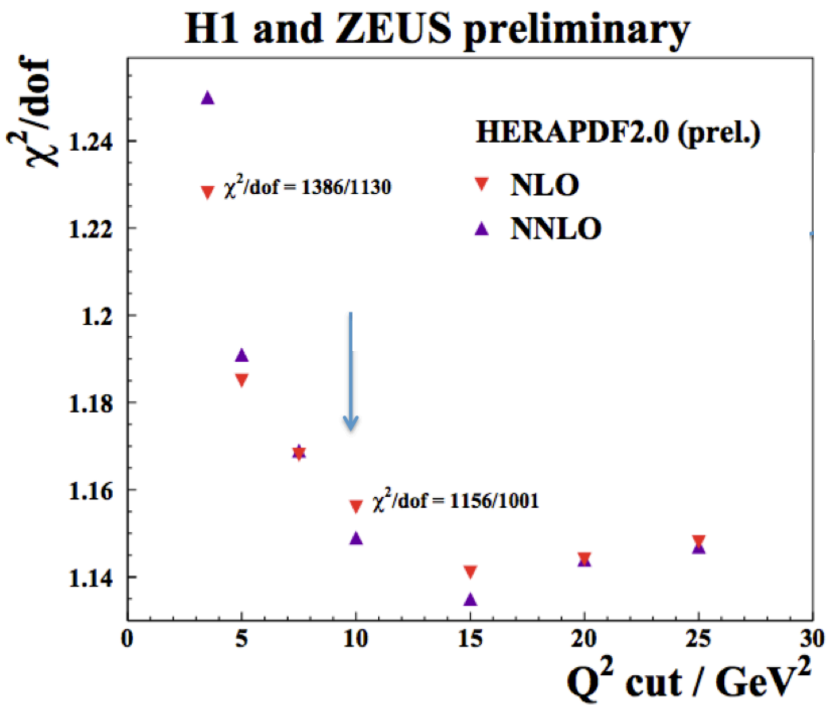
LHC

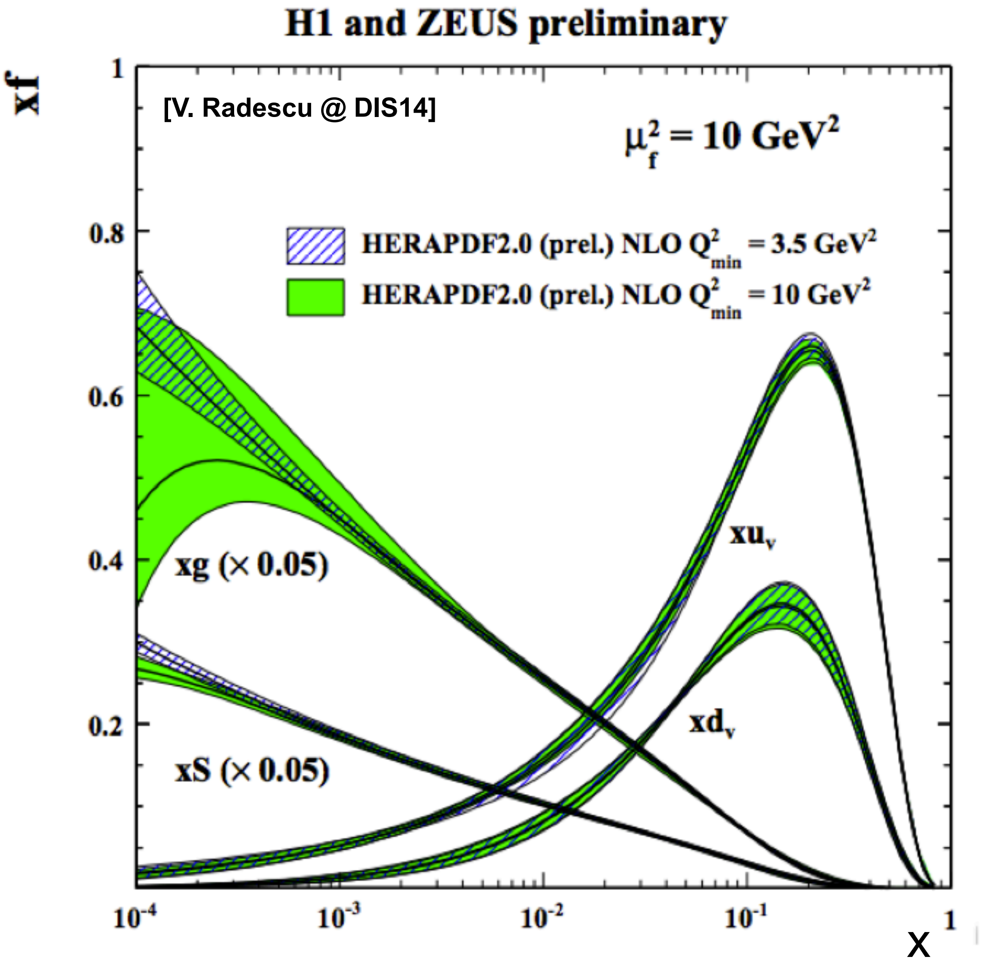
$$\hat{q} \approx 1.9 \pm 0.7\ \mathrm{GeV}^2/\mathrm{fm}$$

Pb+Pb $\sqrt{s} = 2.76\ \mathrm{TeV/n}$



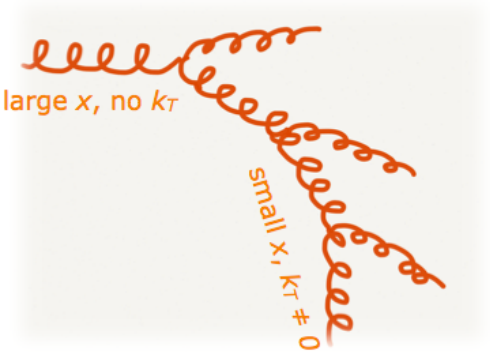
Low-x Physics

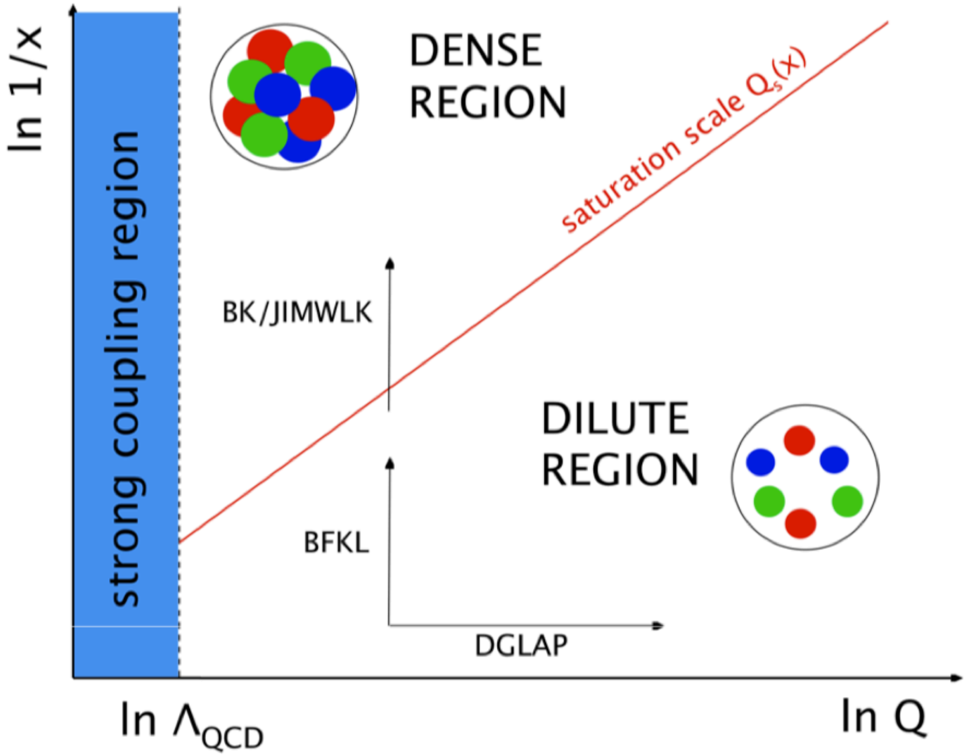




Interplay of the data cut at low Q^2 and impact on gluon at low x

QCD Phase Diagram





x low, Q^2 not too high:

- **partonic k_T** may become important!
  - are (perturbative) parton showers enough to describe this?
  - or does one need something more? k_T-dependent parton densities?

BFKL must be the correct theory of low-x QCD

It naturally incorporates k_T-unintegrated PDFs

Mechelen at DIS2014: no clear evidence of BFKL in experimental data

Gluon TMDs

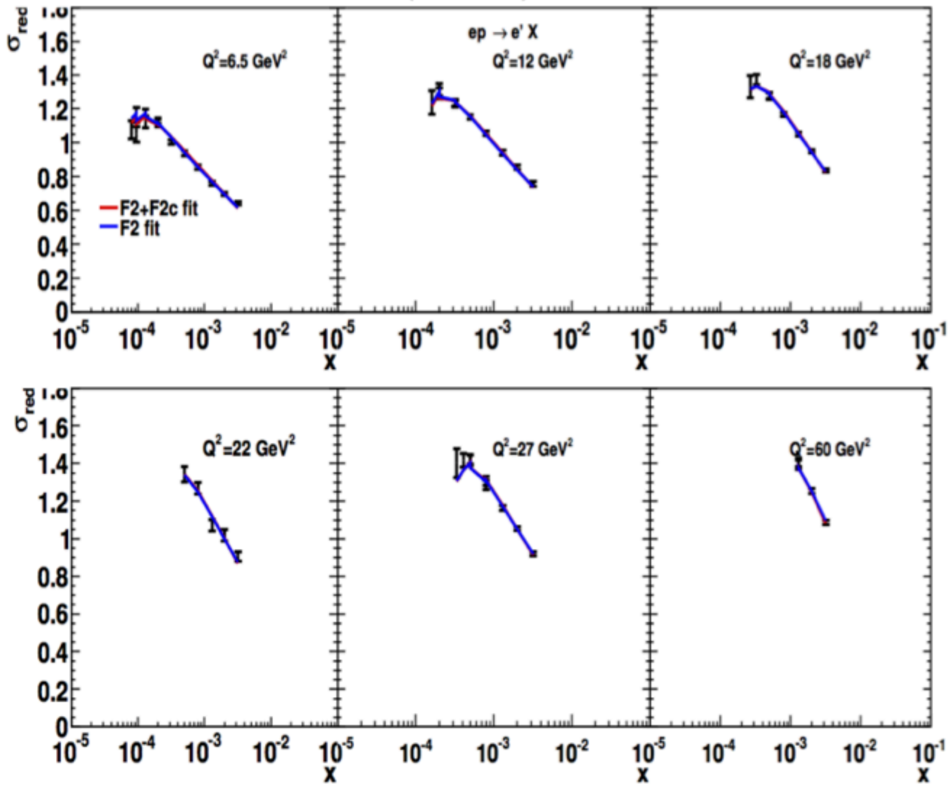
Starting distribution for gluons at q_0

$$x\mathcal{A}_0(x,k_\perp) \;=\; N x^{-B}\cdot(1-x)^C\left(1-Dx+E\sqrt{x}\right)\exp[-k_t^2/\sigma^2]$$

$\sigma^2 = q_0^2/2$

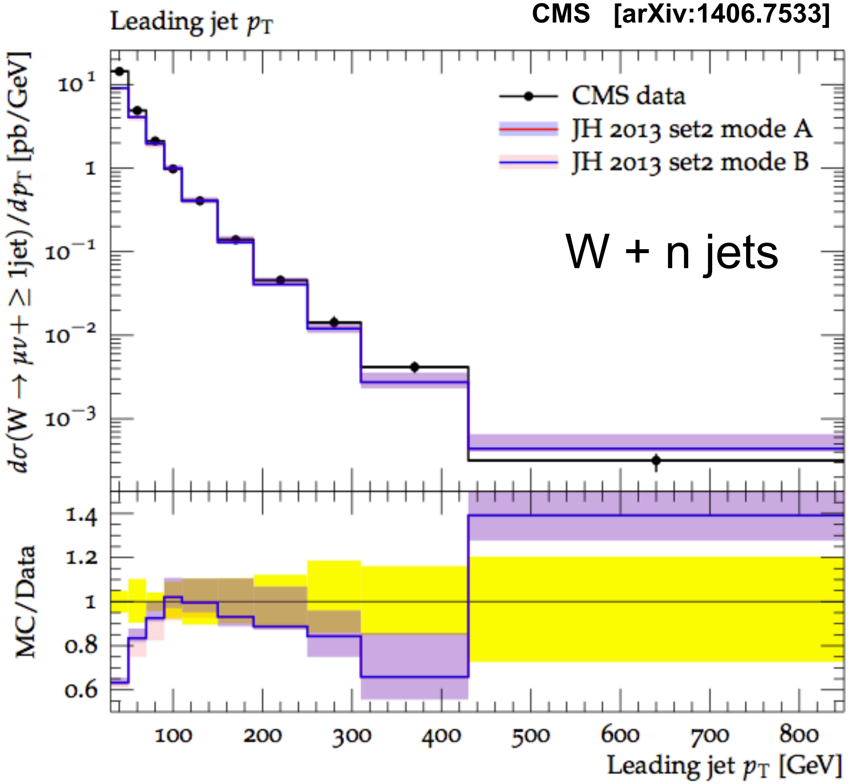
CCFM (BFKL like) evolution + Herafitter package

$F_2(x,Q^2)$

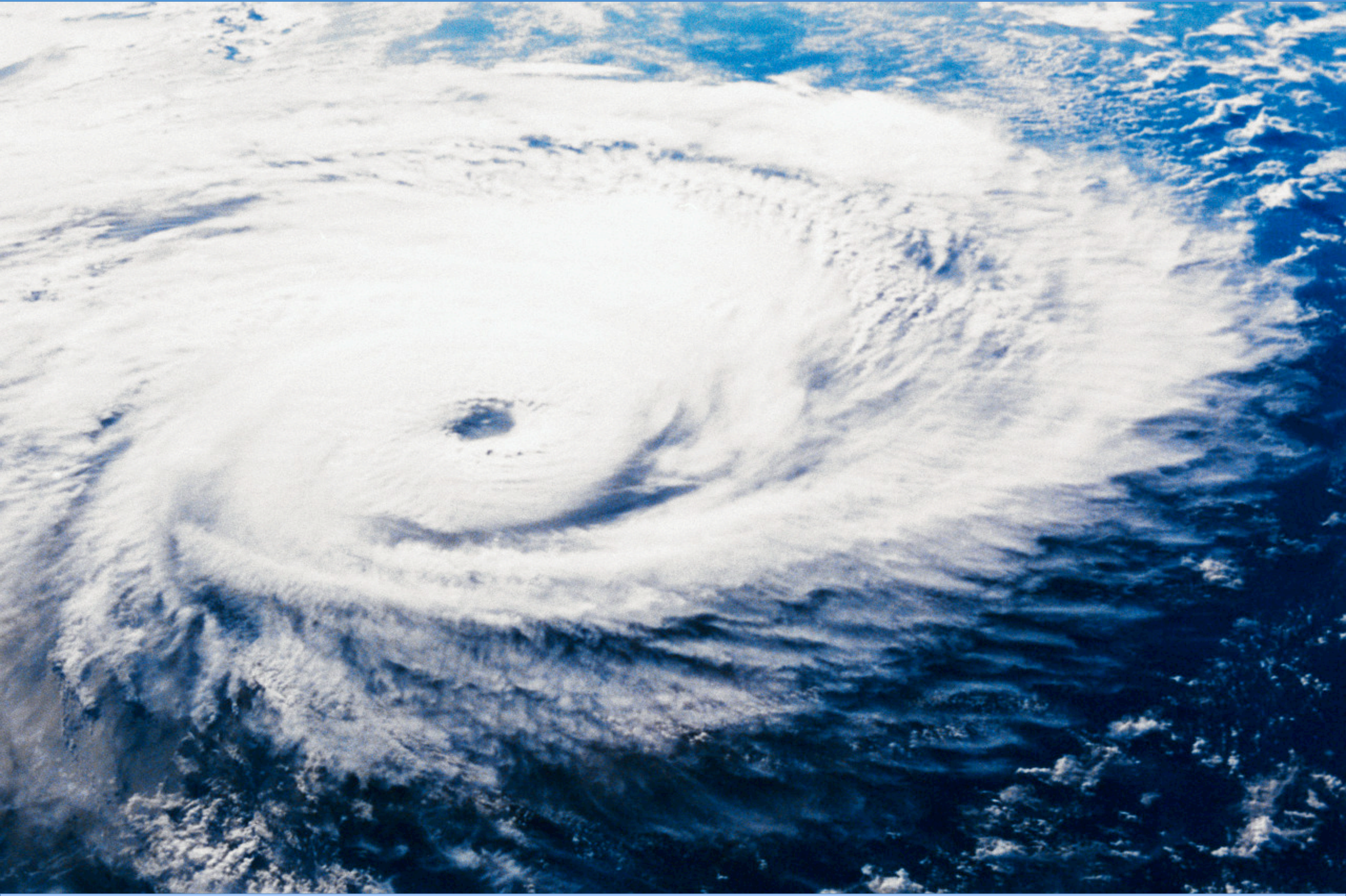


S. Dooling ++ [arXiv 1406.2994]

CMS [arXiv:1406.7533]



Spin-Orbit Effects



Transverse Momentum Dependent Distr.

quark polarisation

nucleon polarisation

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

$\otimes$

quark polarisation

hadron polarisation

N/q	U	L	T
U	D_1		$H_1^\perp$

Transversity:

different from helicity distribution as rotation and boost do not commute

- sensitive to the relativistic effects
- related to the tensor charge
- non-singlet type evolution
- chirally-odd

  it requires a chirally-odd fragmentation

Related to:

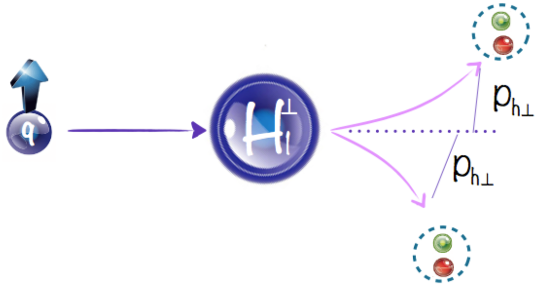
✓ Tensor Charge & Coupling

✓ SSA in hadron interactins

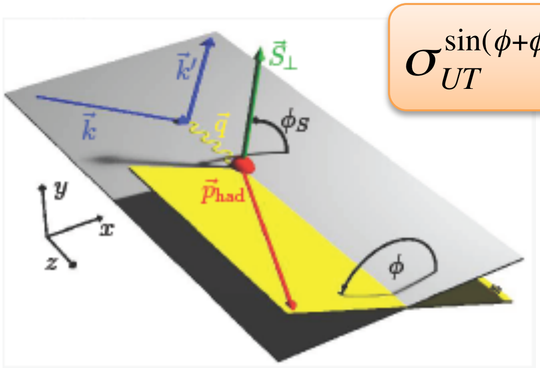
Collins function:

a spin-p_T correlator in fragmentation

$$D_{q/h}(z,\vec{p}_\perp,\vec{s}_q) = D_{q/h}(z,p_\perp^2) + \frac{1}{zM_h} H_1^{\perp q}(z,p_\perp^2)\vec{s}_q \cdot (\hat{k} \times \vec{p}_\perp)$$

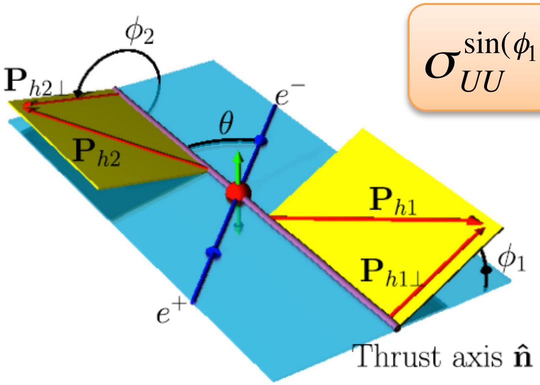


Transversity & Collins Evidences



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

$Q^2 \sim 5\text{-}7\ \mathrm{GeV}^2$

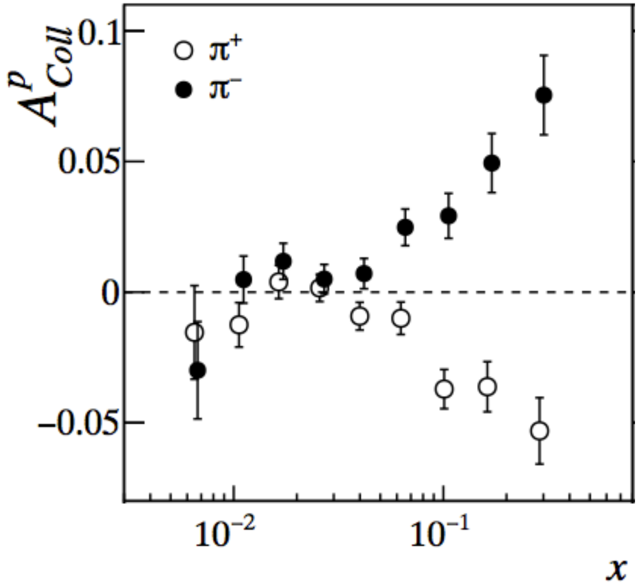


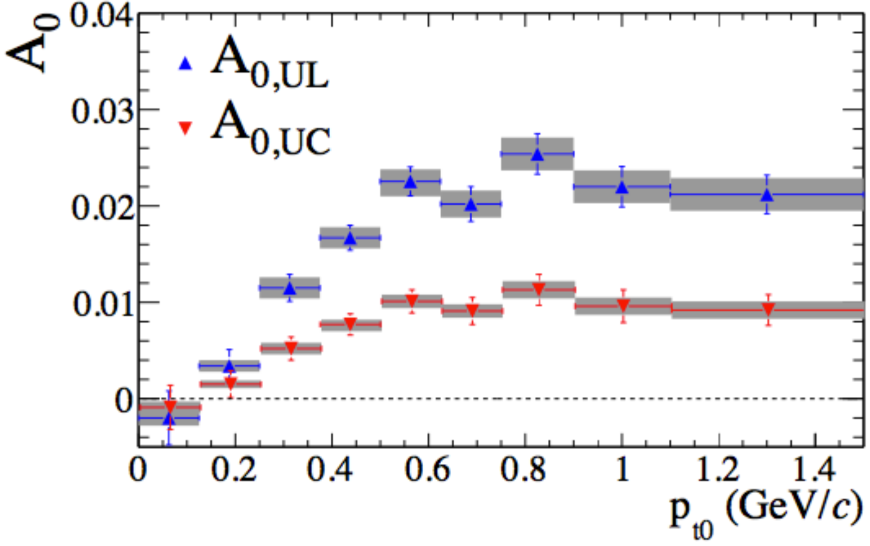
$$\sigma_{UU}^{\sin(\phi_1+\phi_2)} \propto H_1^\perp \otimes H_1^\perp$$

$Q^2 \sim 110\ \mathrm{GeV}^2$

HERMES	**[arXiv 0408013]**
HERMES	**[arXiv 0906.3918]**
COMPASS	**[arXiv 1005.5609]**
COMPASS	**[arXiv 1408.4405]**

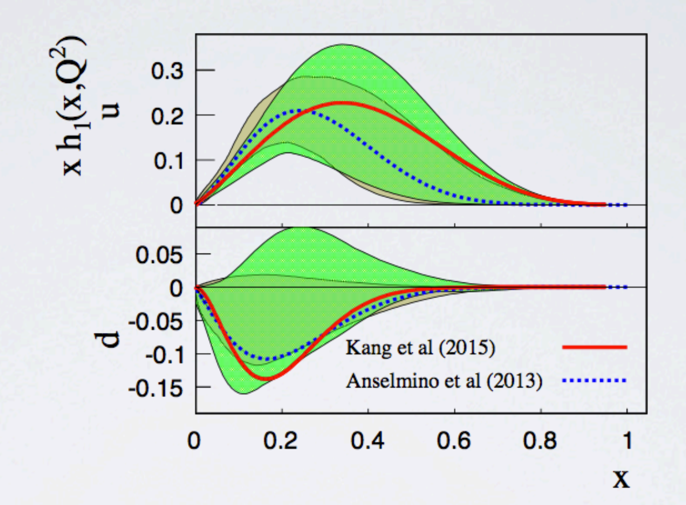
Belle	**[talk at DIS2014]**
BESIII	**[arXiv 1507.06824]**
Babar	**[arXiv 1309.5278]**



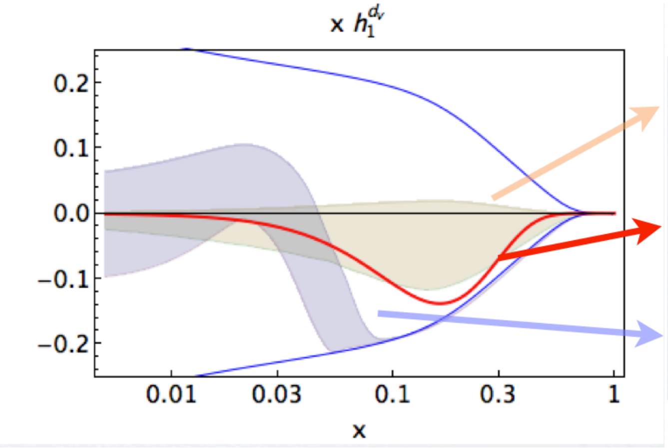


Transversity & Tensor Charge

Distributions:



x



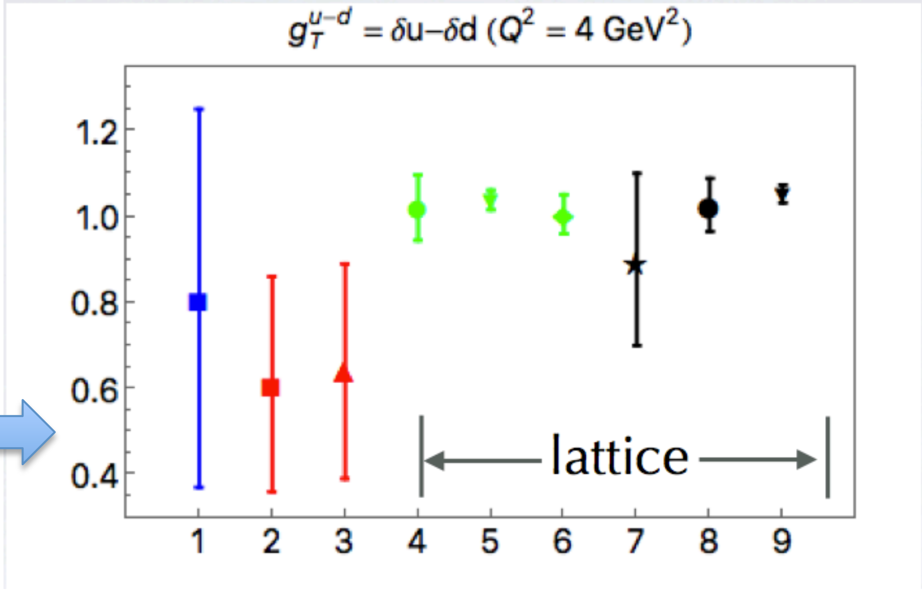
Torino 2013

Kang *et al.*

Pavia
(DiFF)

Charges:

$$\delta q \equiv \int_0^1 dx\,[\Delta_T q(x) - \Delta_T \bar{q}(x)]$$



current most stringent constraints on BSM tensor coupling from $\pi^+ \to e^+\nu_e\gamma$ and neutron β-decay is

$$|\,\varepsilon_T\, g_T\,| \lesssim 5 \times 10^{-4}$$

A. **Bychkov++ [arXiv:0804.1815]**
B. **Pattie++ [arXiv:1309.2499]**

Transverse Momentum Dependent Distr.

quark polarisation

nucleon polarisation

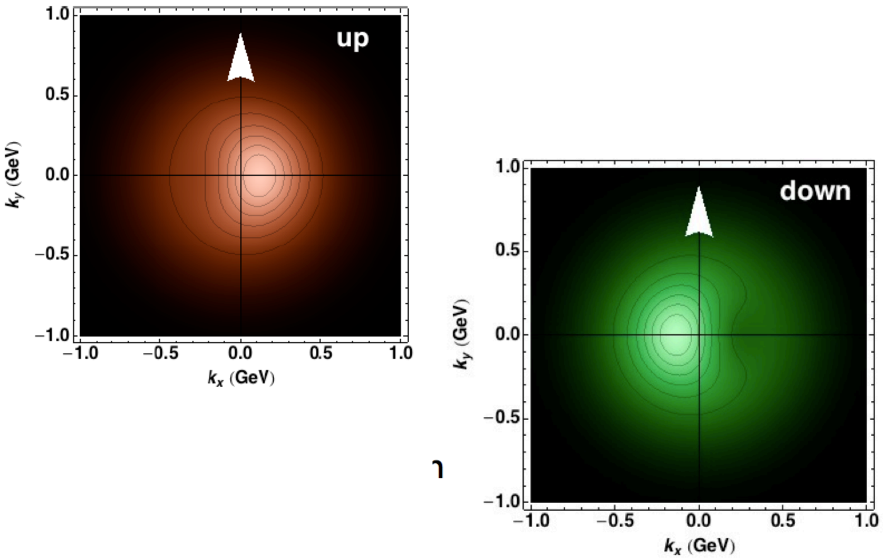
N/q	U	L	T
U	f_1		$h_1^\perp$
L		g_1	$h_{1L}^\perp$
T	$f_{1T}^\perp$	$g_{1T}^\perp$	$h, h_{1T}^\perp$

$\otimes$

quark polarisation

hadron polarisation

N/q	U	L	T
U	D_1		$H_1^\perp$



Off-diagonal elements:

Interference between wave functions with different angular momenta: testing QCD at the amplitude level

T-odd elements:

→ Sign change between DY and SIDIS
Generalized universality of TMDs

Related to:

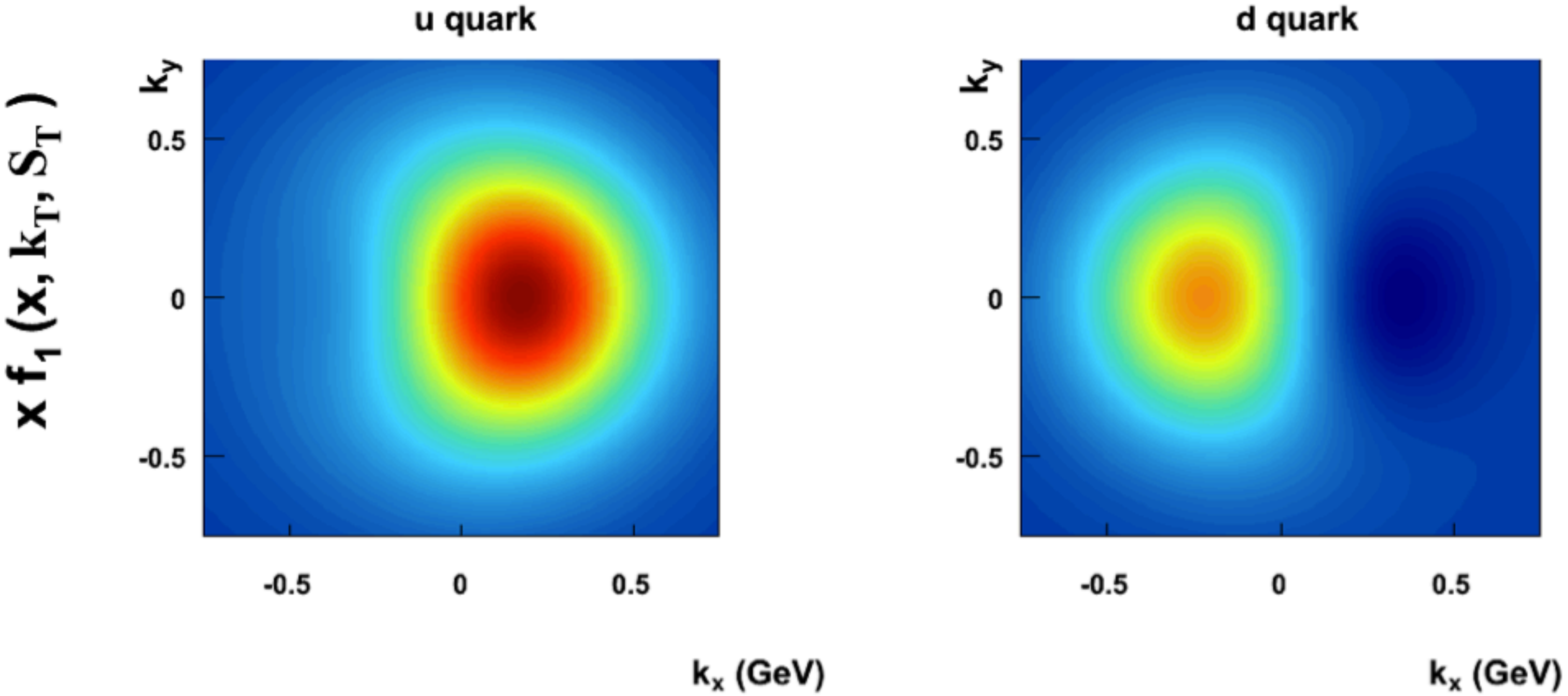
- ✓ SSA in adronic interactions
- ✓ Parton Orbital motion
- ✓ Anomalous Magnetic Moment

Sivers Correlations

$$f_{q/h^\uparrow}(x,\vec{k}_\perp,\vec{S}) = f_{q/h}(x,k_\perp^2) - \frac{1}{M} f_{1T}^{\perp q}(x,k_\perp^2)\vec{S}\cdot(\hat{P}\times\vec{k}_\perp)$$

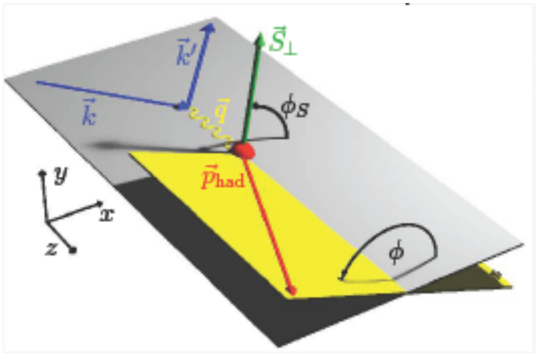
Spin independent

Spin dependent

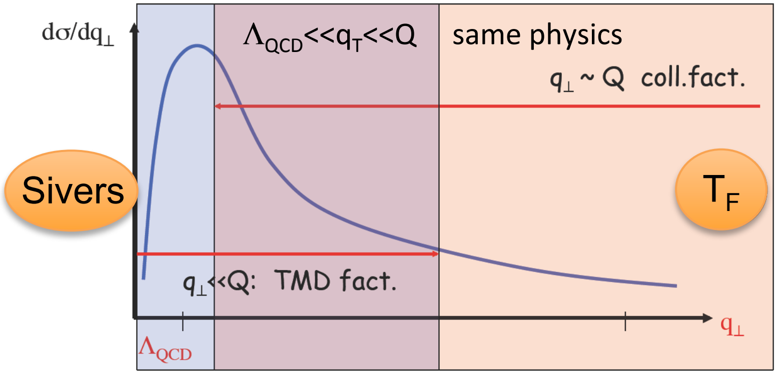


Sivers Signals

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



Sivers from polarized SIDIS

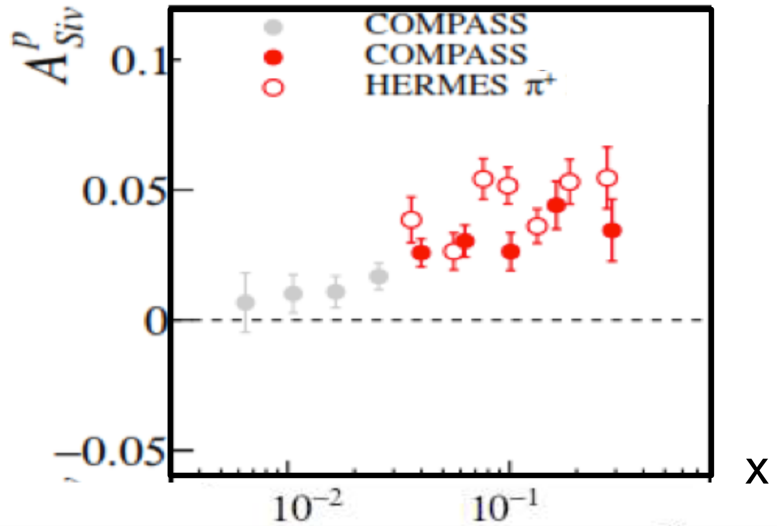


$$gT_{q,F}(x,x) = -\int d^2k_\perp \frac{|k_\perp|^2}{M} f_{1T}^{\perp q}(x,k_\perp^2)|_{\rm SIDIS}$$

May generate the misterious hadronic SSA

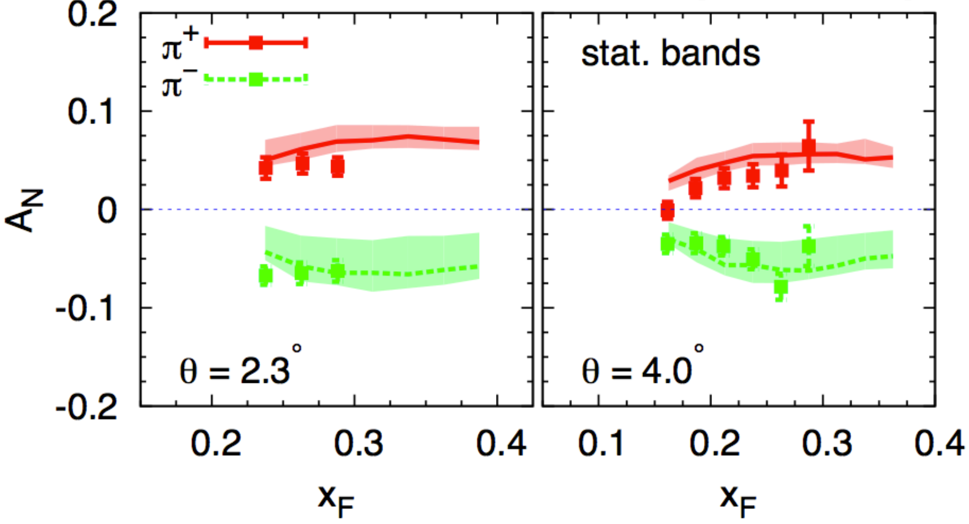
HERMES **[arXiv:0906.3918]**

COMPASS **[arXiv:1205.5122]**



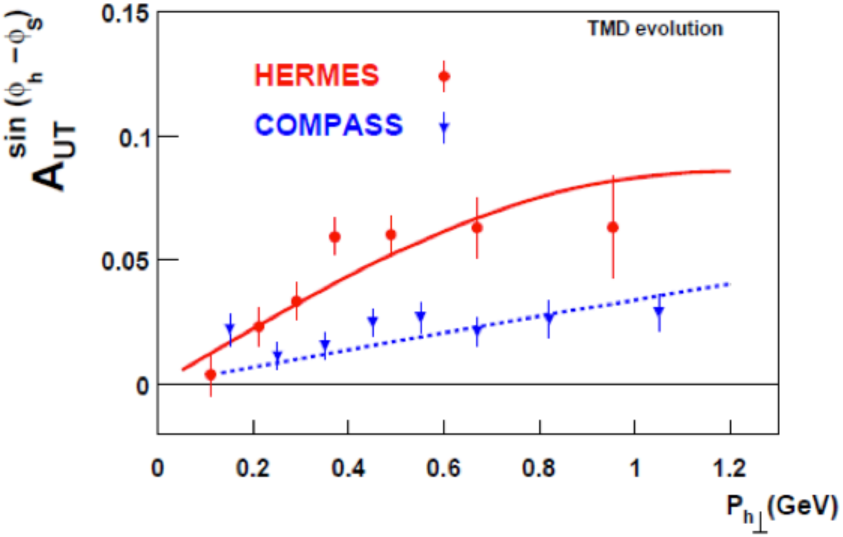
$p^\uparrow p \rightarrow \pi X$

M. Anselmino et al. [arXiv 1304.7691]

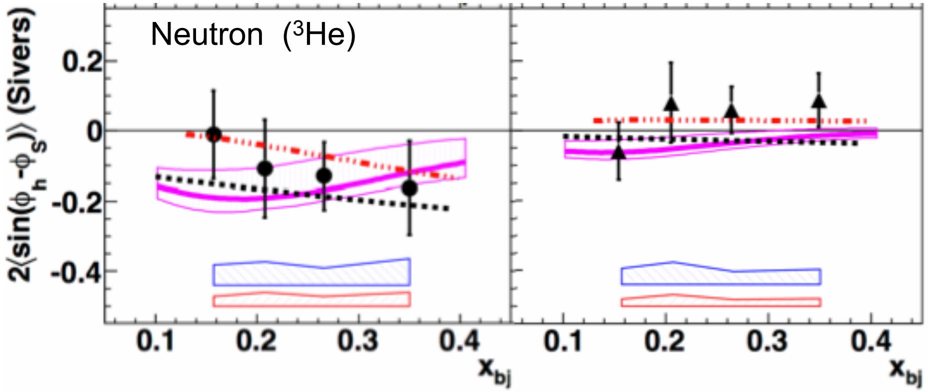


The Sivers Function

Evolution may play a role



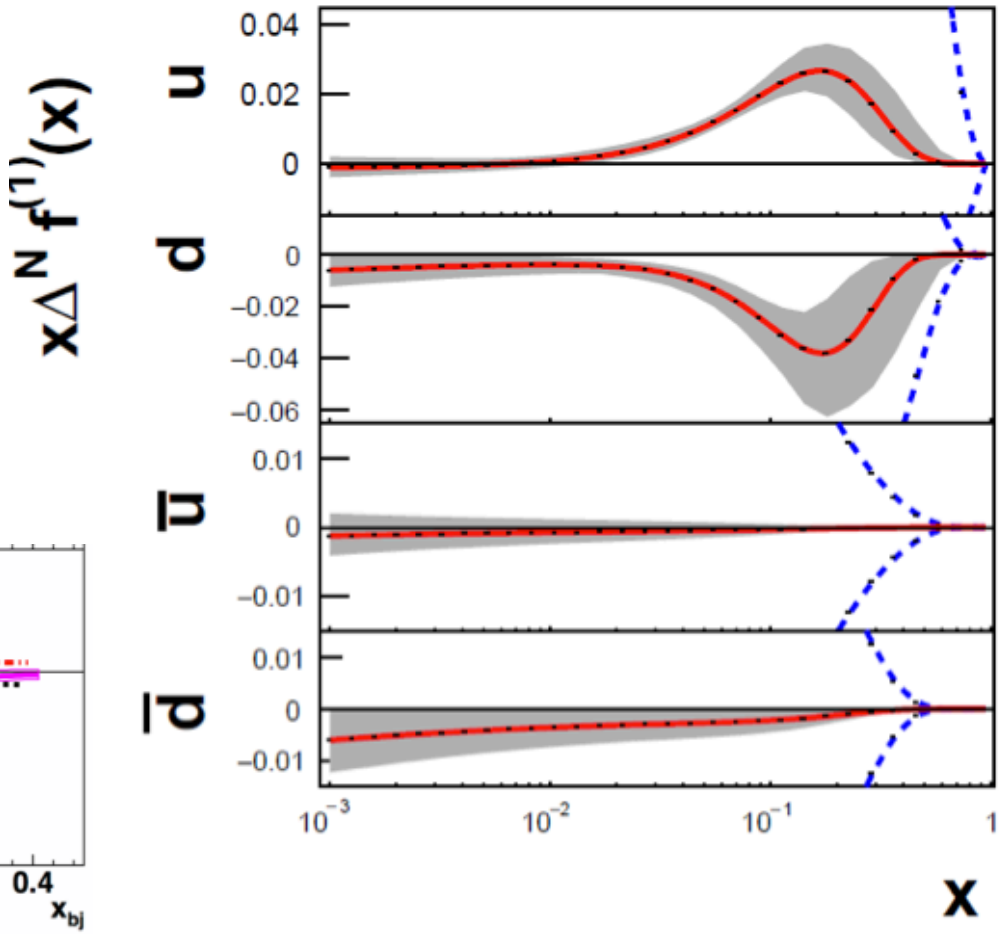
Flavor decomposition



X. Qian *et al.*, PRL 107, 072003 (2011).

Role of the sea ?

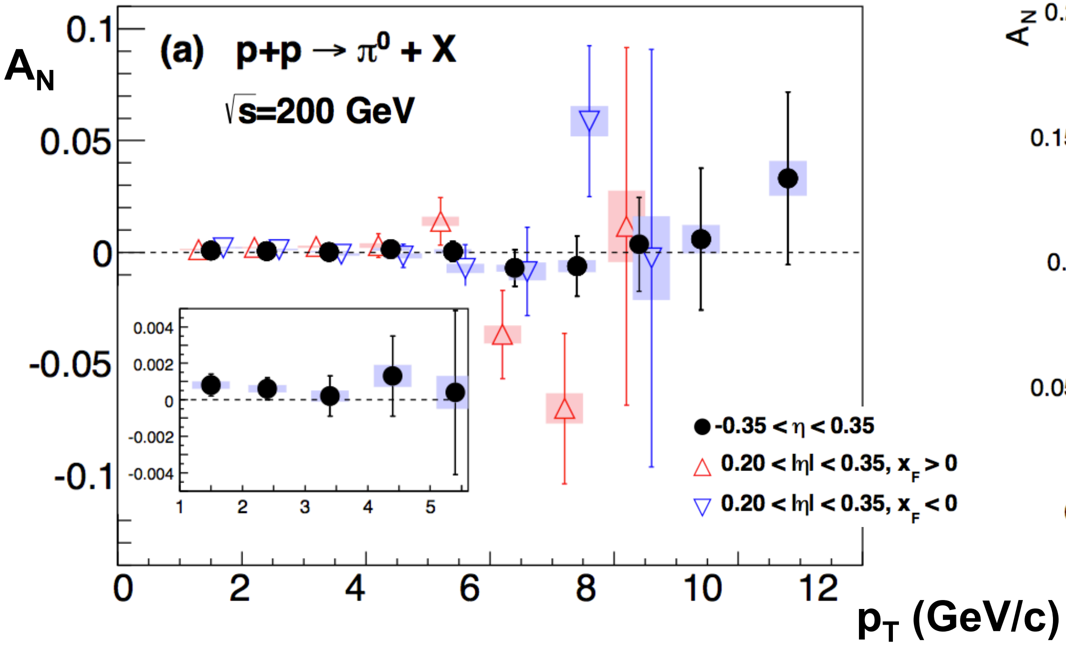
E. Boglione **[talk at QCD-N16]**

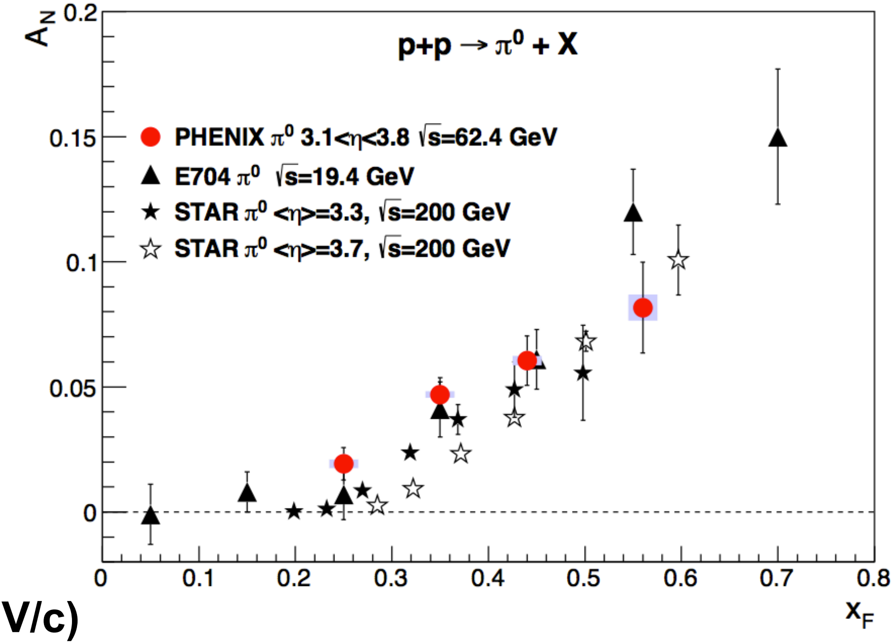


Sivers in the Sea ?

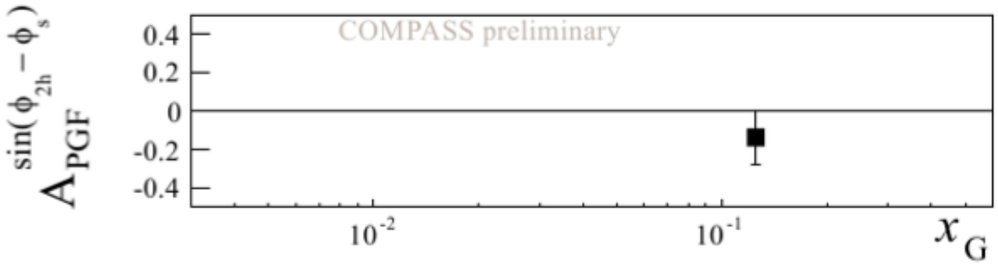
A_N @ RICH: mid rapidity (gluon+sea) and Forward (valence) rapidity

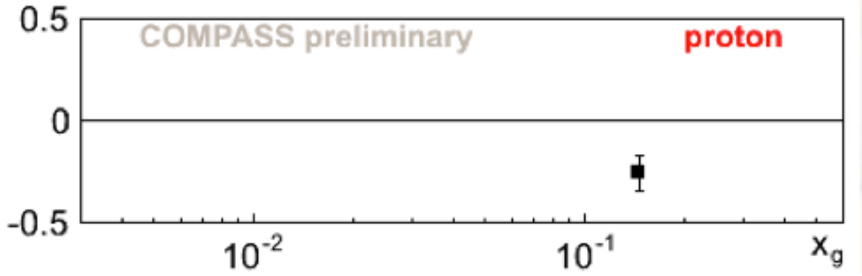
PHENIX [arXiv: 1312.1995]



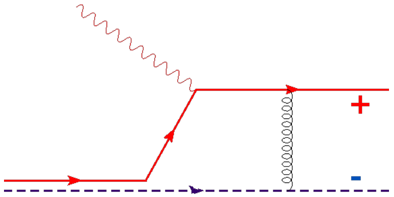


PGF @ COMPASS: gluon Sivers from deuterium and proton targets

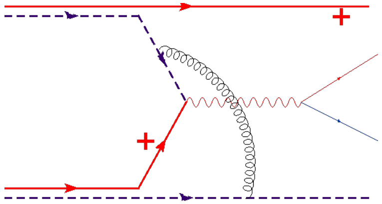




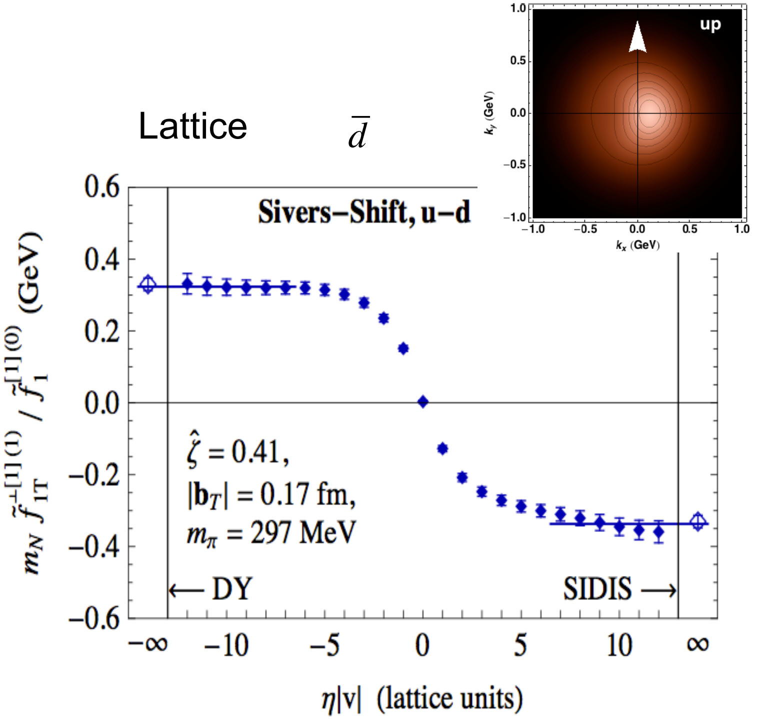
Sivers Sign Change



$$f_{1T}^{\perp SIDIS} = -f_{1T}^{\perp DY}$$

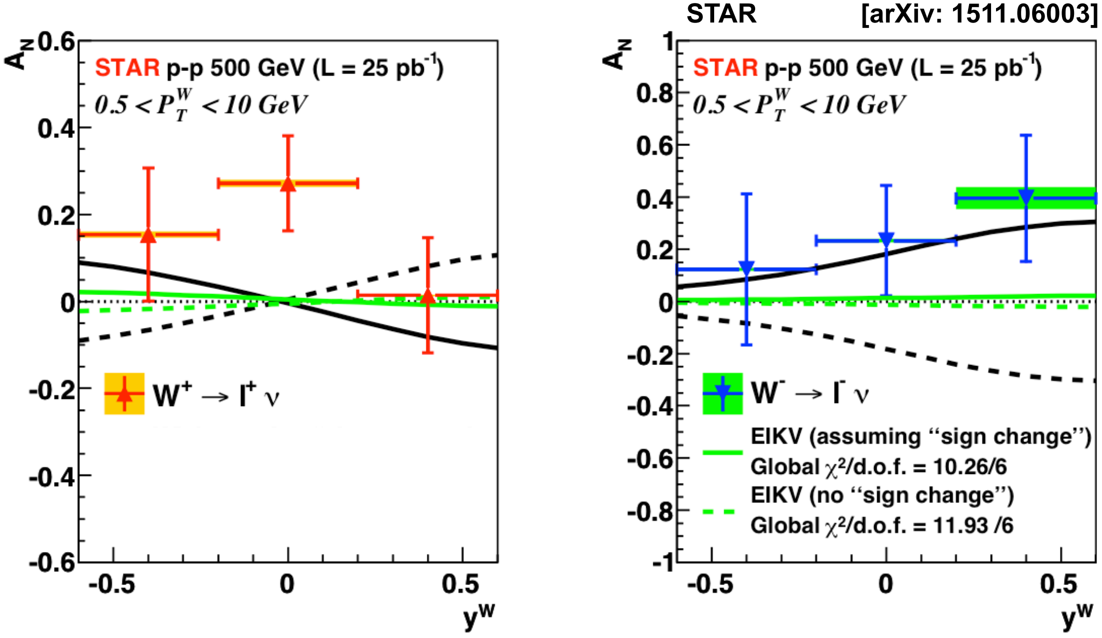


Lattice $\bar{d}$



Weak boson production p p → WX @ STAR

STAR [arXiv: 1511.06003]



Solid line: assumption of sign change for Sivers
Dashed line: assumption of no sign change for Sivers
KQ prediction (unevolved)
EIKV prediction (largest predicted evolution effect)

Kang and Qiu, [PRL 103 (2009) 172001]
Echevarria++, [PRD 89 (2014) 074013]

Parton 3D Dynamic

GPD E:

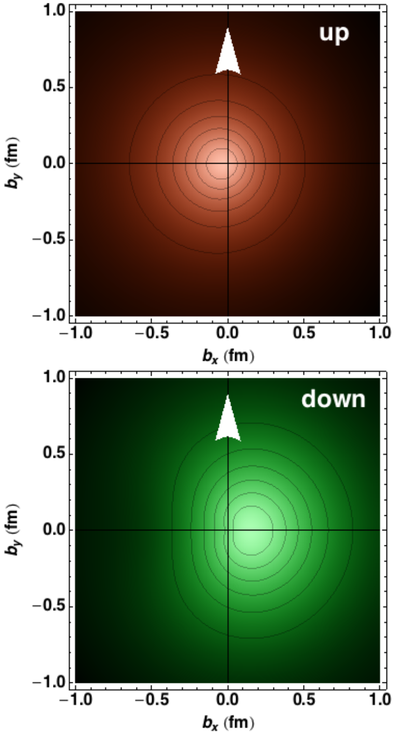
Imbalance in the probed parton spatial distribution

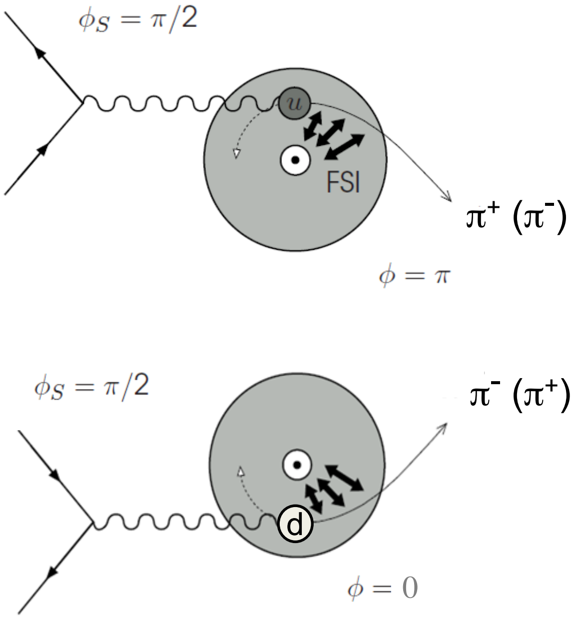
$$q_X(x,\mathbf{b}_\perp) = q(x,\mathbf{b}_\perp) - \frac{1}{2M}\frac{\partial}{\partial b_y}\mathcal{E}_q(x,\mathbf{b}_\perp)$$

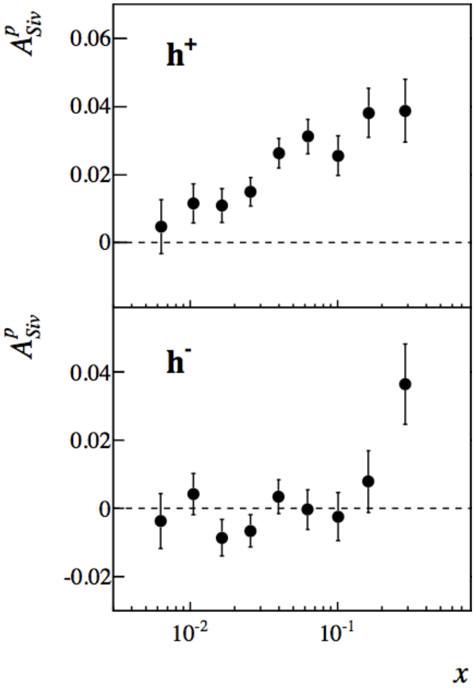
Sivers TMDs:

Imbalance in the observed
hadron momentum distribution

$$f_{1T}^{\perp q} \sim -\kappa^q$$







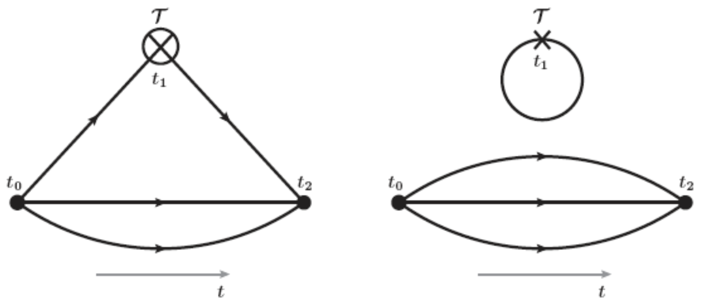
Parton Orbital Motion

$$J_q = \frac{1}{2}\Delta\Sigma + L_q = \lim_{t\to 0}\int_{-1}^{1} dx\ x\ \left[H(x,\zeta,t)+E(x,\zeta,t)\right]$$

Anomalous Magnetic Moment

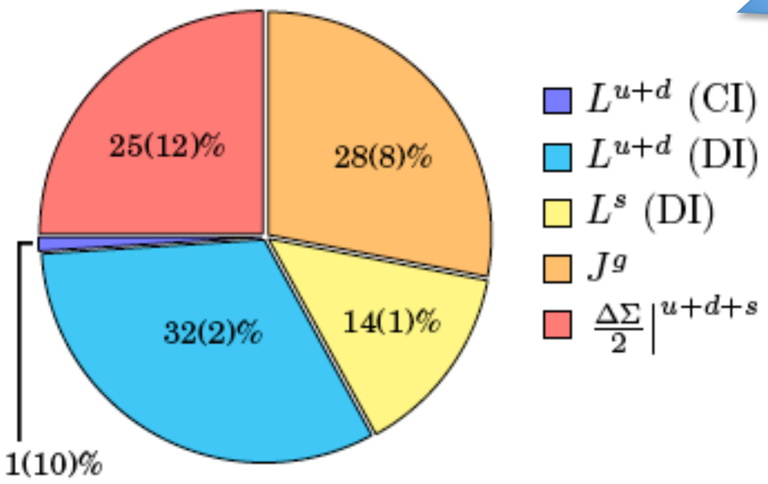
$$\int_{-1}^{1} dx \int d^2\mathbf{b}_\perp \mathcal{E}_q(x,\mathbf{b}_\perp) = F_{2,q}(0) = \kappa_q$$

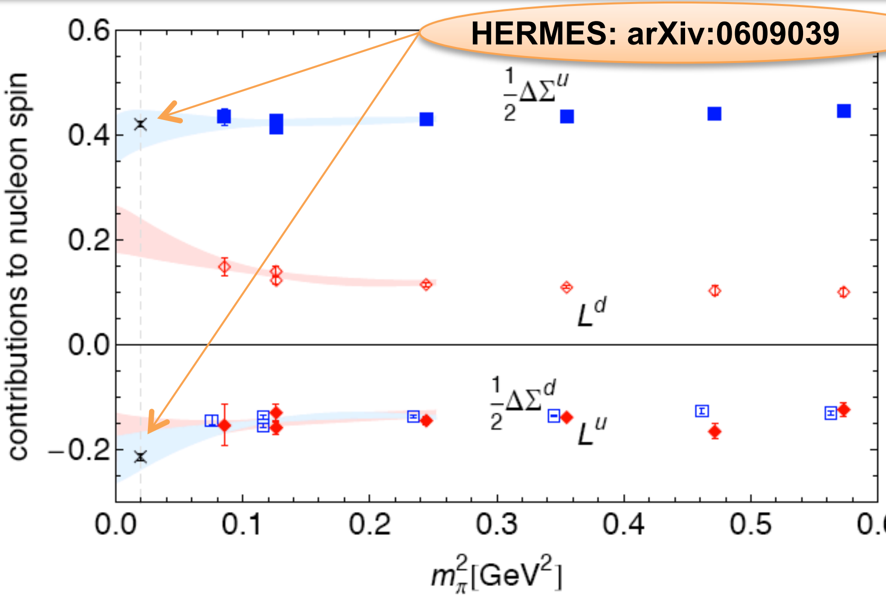
Spin Budget from Lattice



With (dis)connected diagrams

Liu ++, arXiv:1203.6388



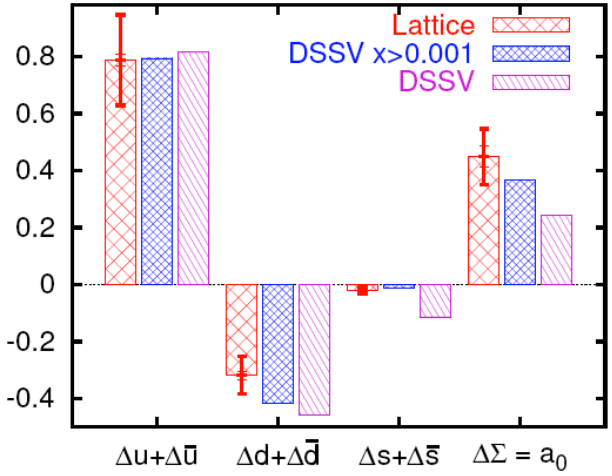


HERMES: arXiv:0609039

Bali ++,: arXiv:1112.3354

$$\Delta\Sigma = \Delta u + \Delta d + \Delta s = 0.45(4)(9)$$

$$\Delta s = -0.020(10)(4)$$



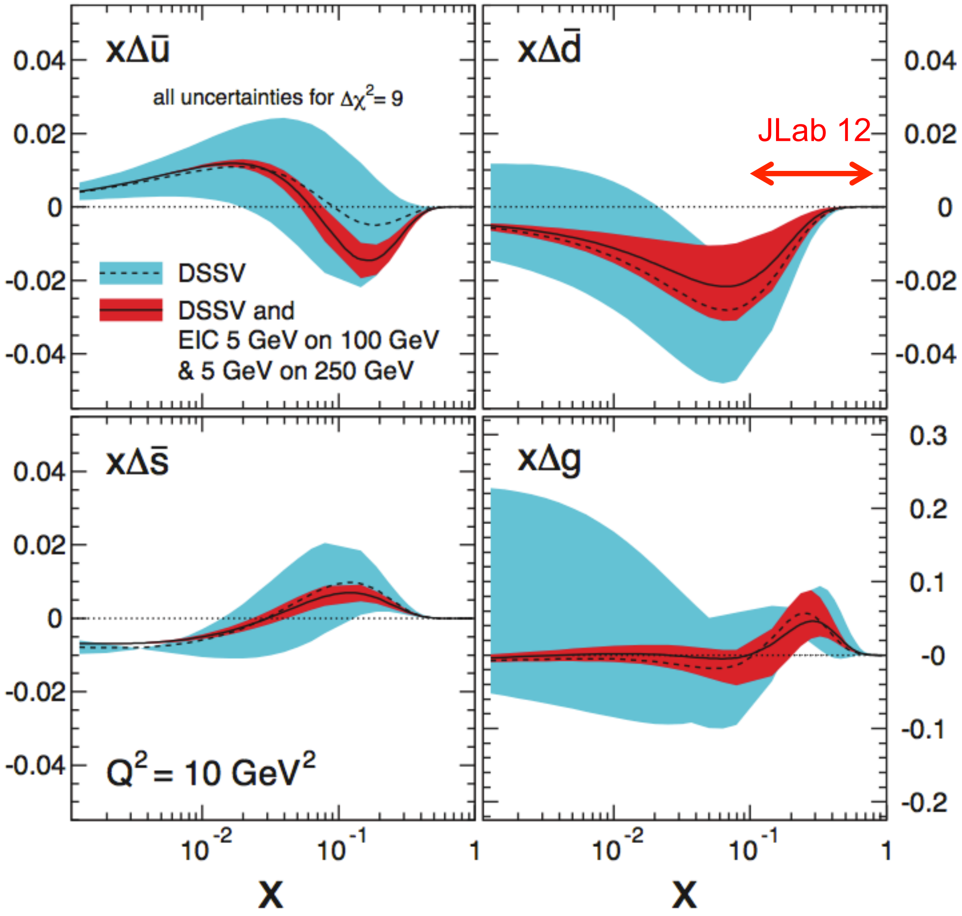
Δs (DI) = -0.12(1)
L_q mainly from sea and up to 50 % of the proton spin

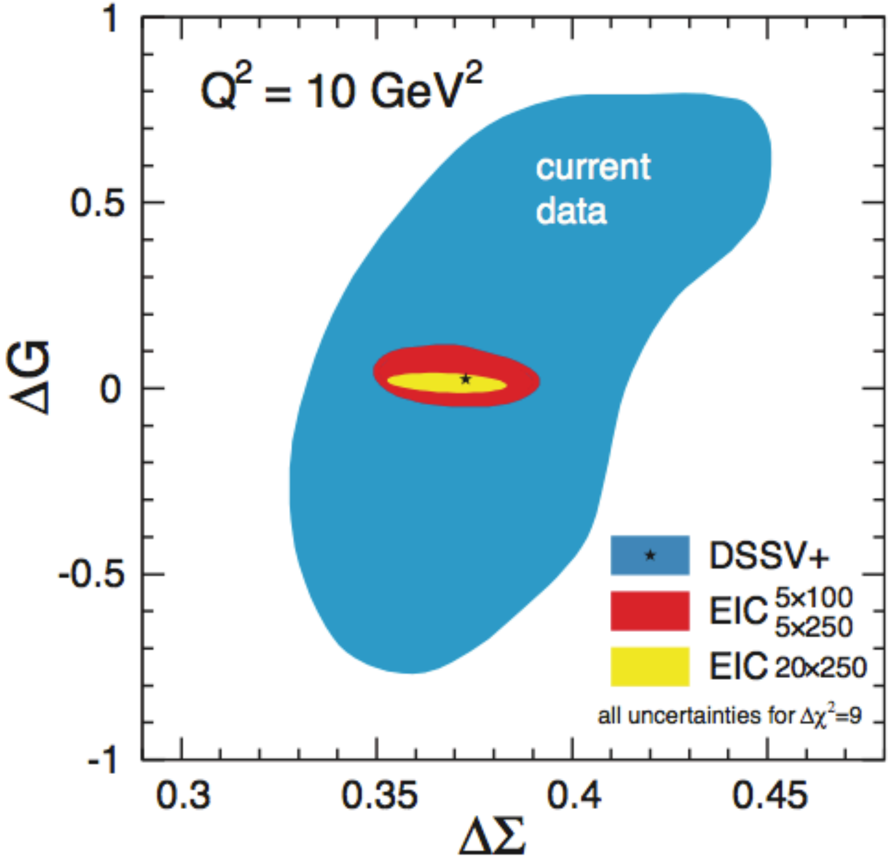
Parton Helicity @ EIC

Proton Spin Decomposition:

$$\frac{1}{2} = \frac{1}{2}\sum_f (q_f^+ - q_f^-) + L_q + \Delta G + L_g$$

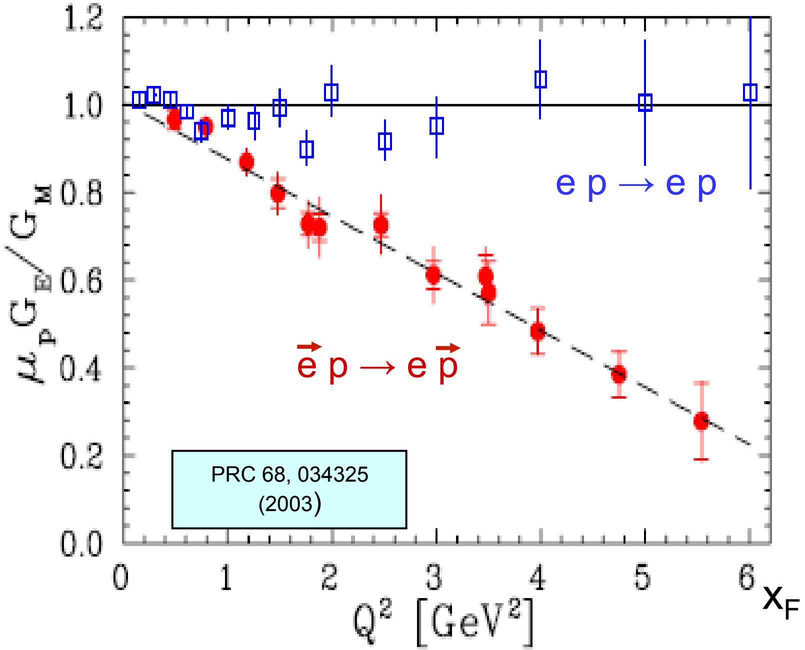
EIC measurement at high-Q^2 and low-x → Precise helicity flavor decomposition

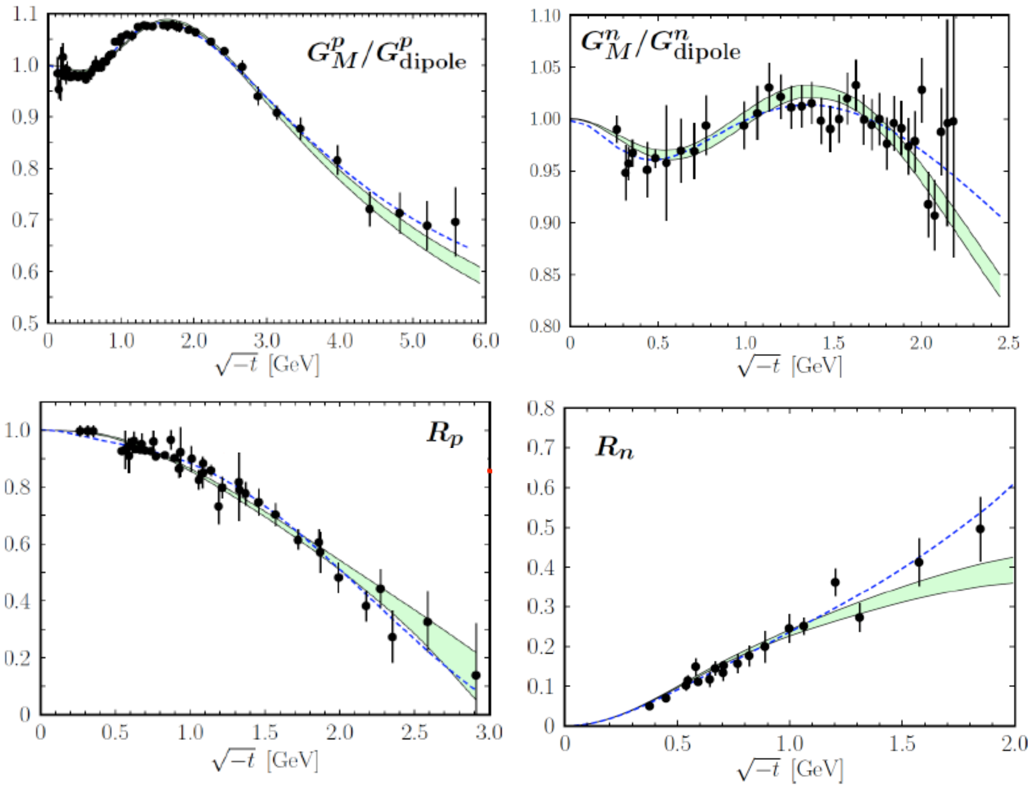




GPDs from FFs

$$R^p = G_E^p / (G_M^p / \mu_p)$$





- obtain at μ = 2 GeV

$$J_v^u = 0.230^{+0.009}_{-0.024} \qquad J_v^d = -0.004^{+0.010}_{-0.016}$$

Diehl et al. arXiv: 1302.4604

- within errors consistent with determination from Sivers distrib. and model for chromodynamic lensing:

$$J_v^u = 0.214^{+0.009}_{-0.013} \qquad J_v^d = -0.029^{+0.021}_{-0.008}$$

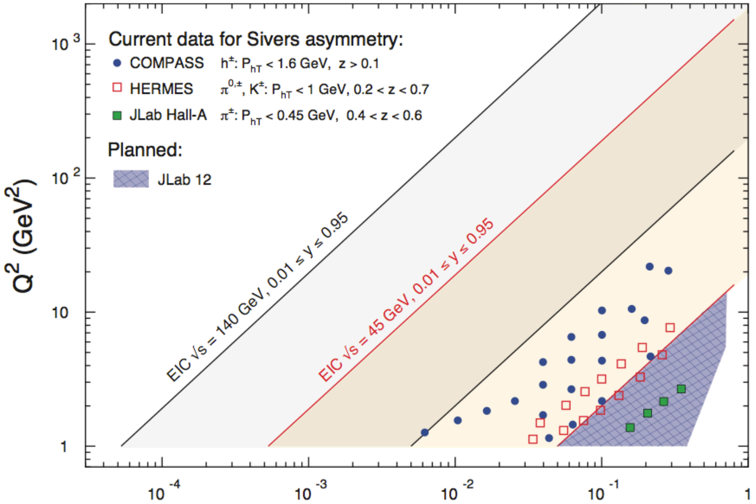
Bacchetta et al. arXiv: 1107.5755

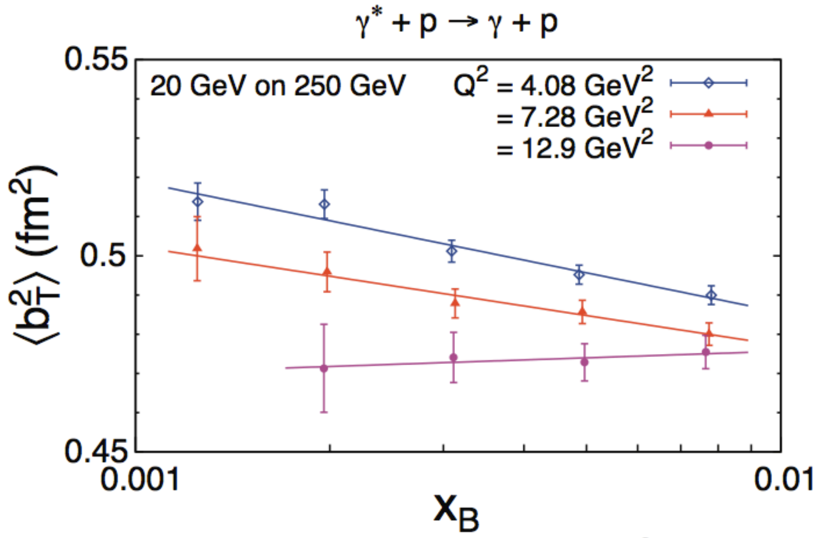
Nucleon Multi-D Mapping

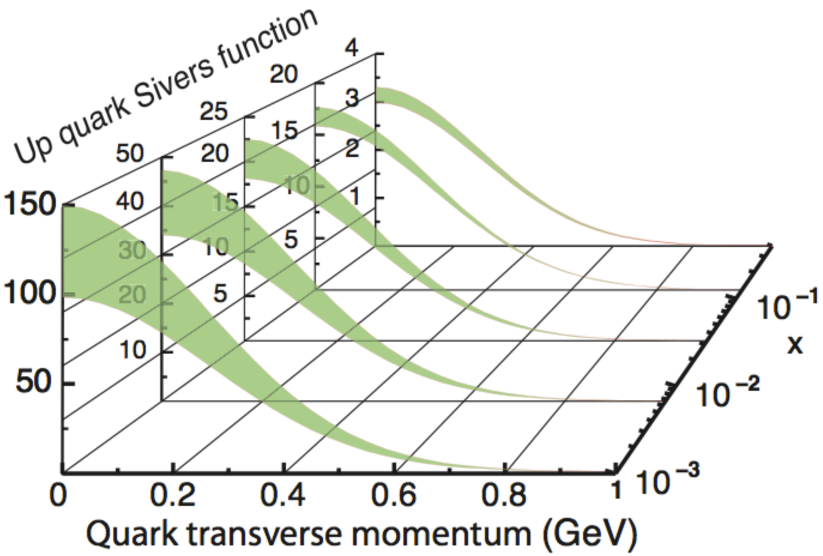
Transverse Momentum (TMDs)

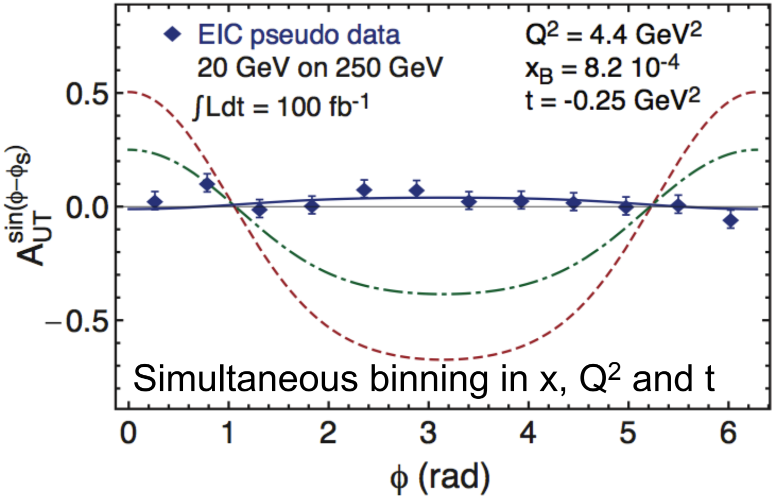
Impact parameter (GPDs)

A. Accardi et al. [arXiv 1212.1701]



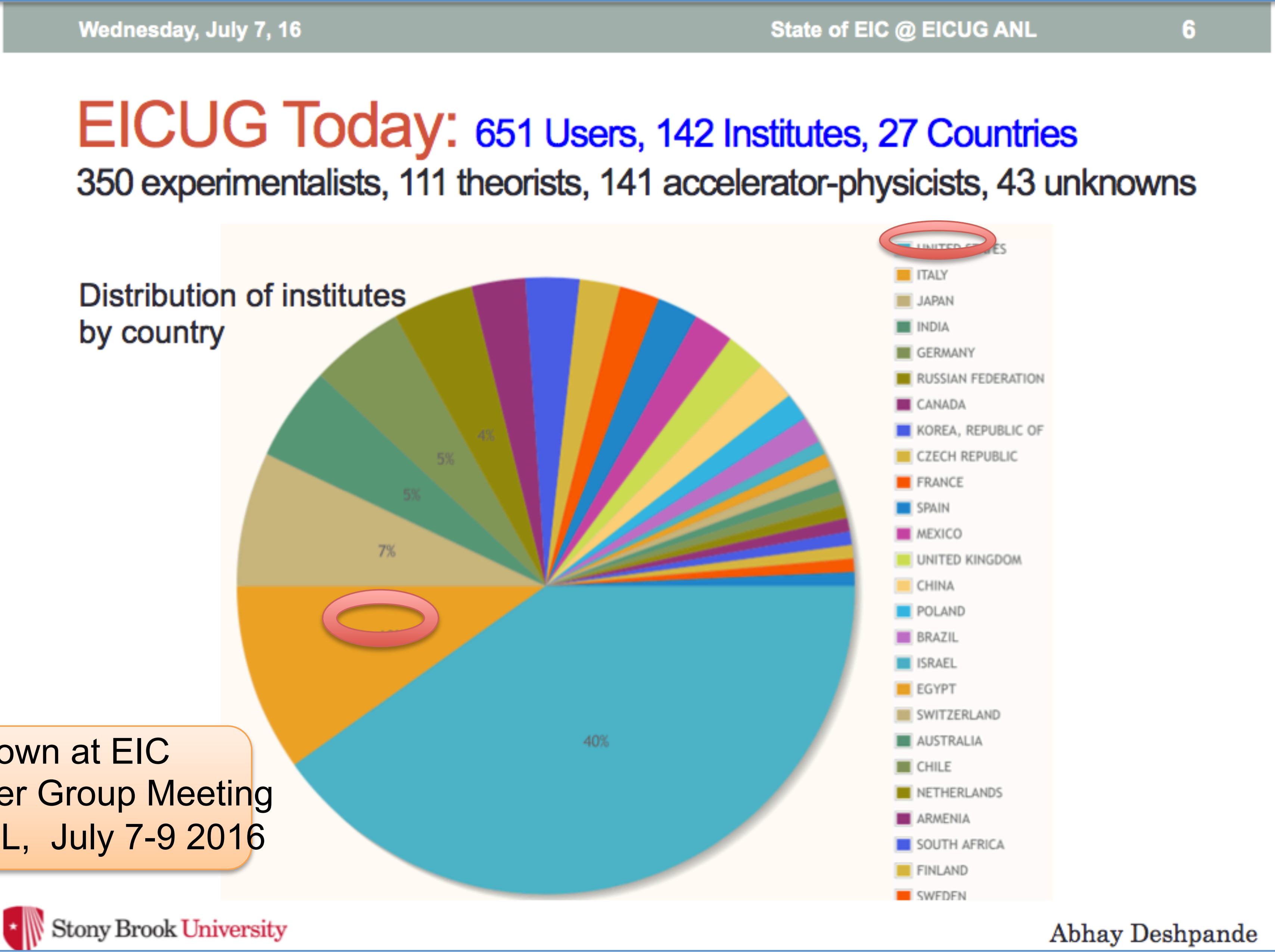






Simultaneous binning in x, Q^2 and t

EIC User Group



Wednesday, July 7, 16 State of EIC @ EICUG ANL 6

EICUG Today: 651 Users, 142 Institutes, 27 Countries

350 experimentalists, 111 theorists, 141 accelerator-physicists, 43 unknowns

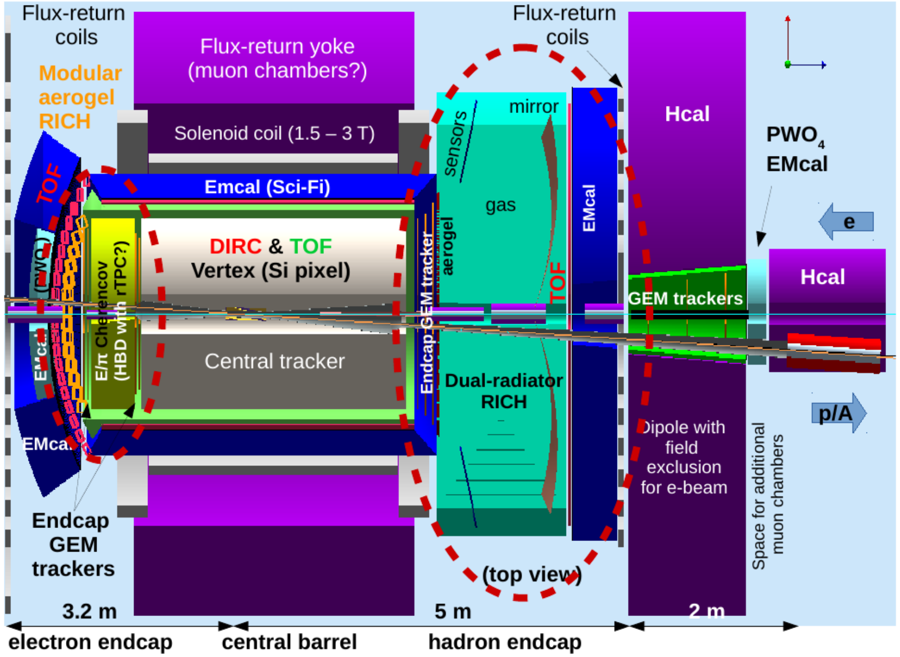
Distribution of institutes by country

Stony Brook University

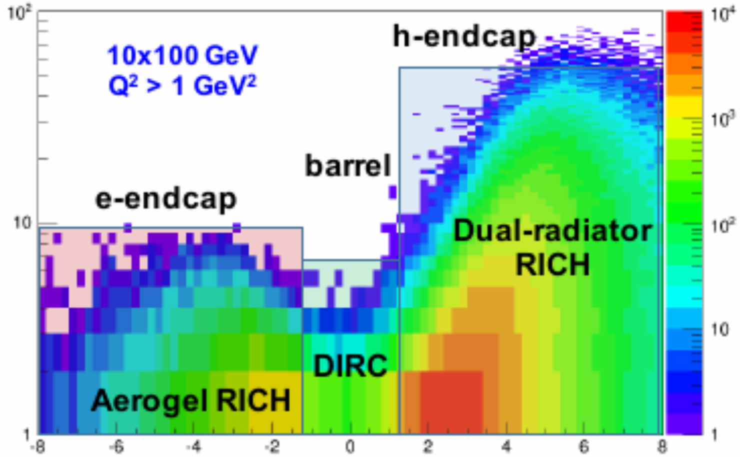
Abhay Deshpande

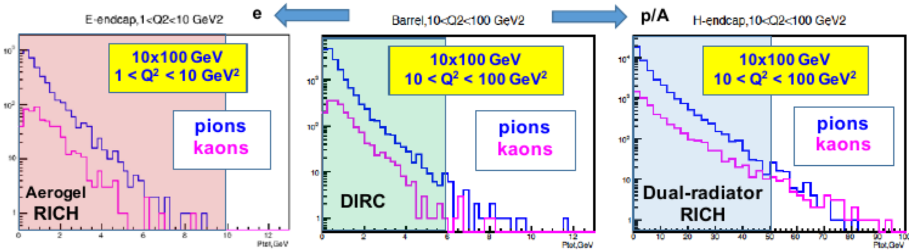
Shown at EIC User Group Meeting ANL, July 7-9 2016

EIC Detector



The JLab central detector concept includes a DIRC, a dual-radiator and a modular aerogel RICH detectors and a 4π TOF for the PID. Three models of the EIC detector are under study at JLab and BNL, with slightly different layouts of the hadron identification. The PID consortium aims to develop an integrated solution useful for both BNL and Jlab.





10 GeV e and 100 GeV p is a common JLab/BNL setting
Maximum momentum coverage is Important for physics (i.e. SIDIS)

e-endcap: aerogel RICH with TOF (or dE/dx) for lower momenta

h-endcap: combined gas and aerogel RICH to cover the full range with TOF

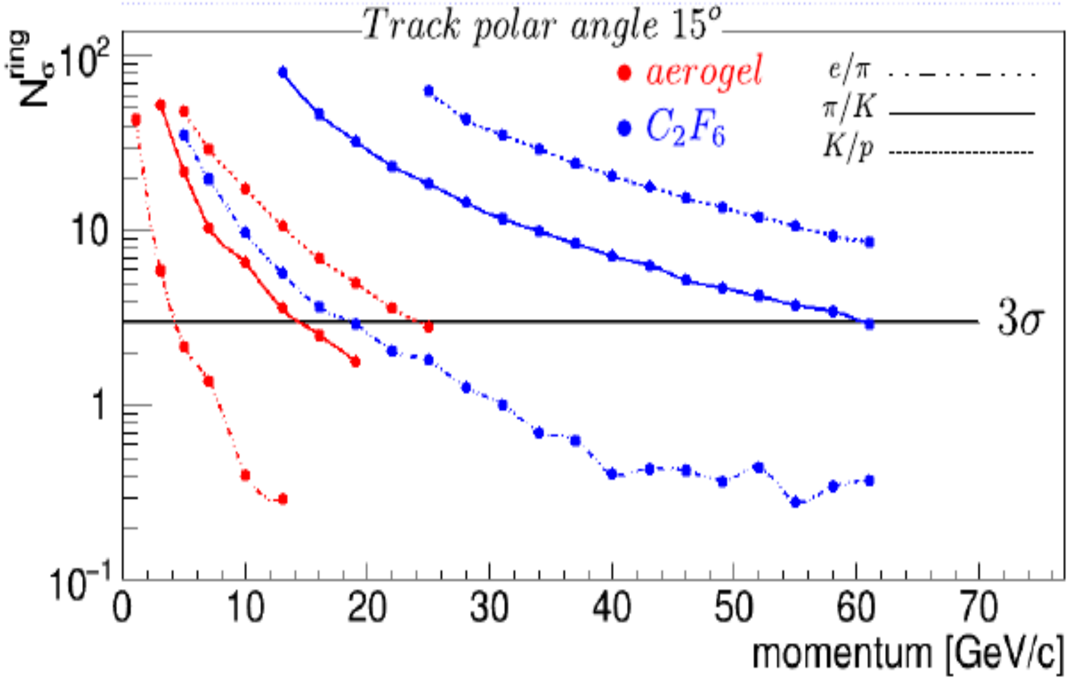
Dual-Radiator RICH

4 cm aerogel (n=1.02) & 160 cm C_2F_6 (or CF_4) gas

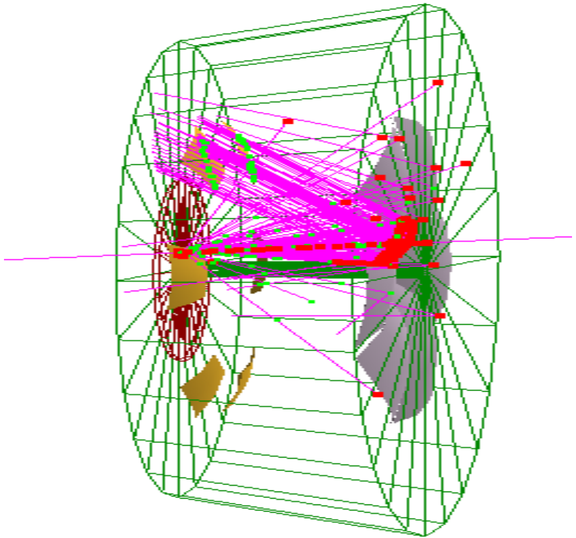
- Focusing mirror configuration (focal -plane away from the beam, reduced area and background)

- *RICH is in magnetic field (3T in the simulation)*

Discrimination power for particle types



Geant4 (GEMC) simulation



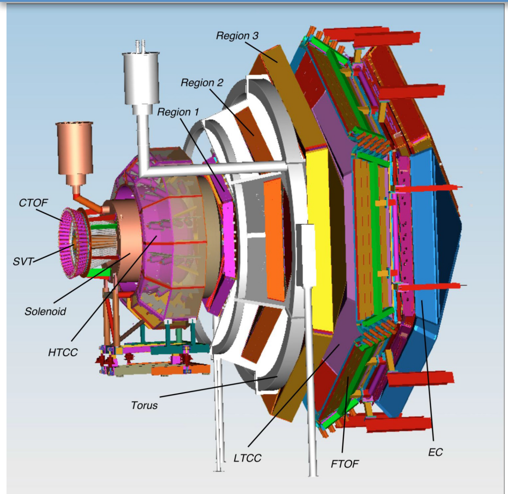
mirror R = 2.8 m

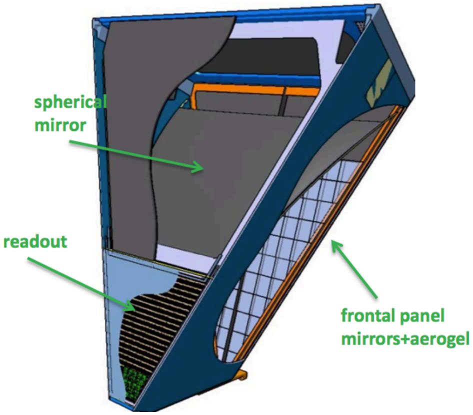
Photo-detector: spherical shape, *8500 cm^2* (per sector), pixel size 3 mm

6 sectors of 60° in azimuthal angle

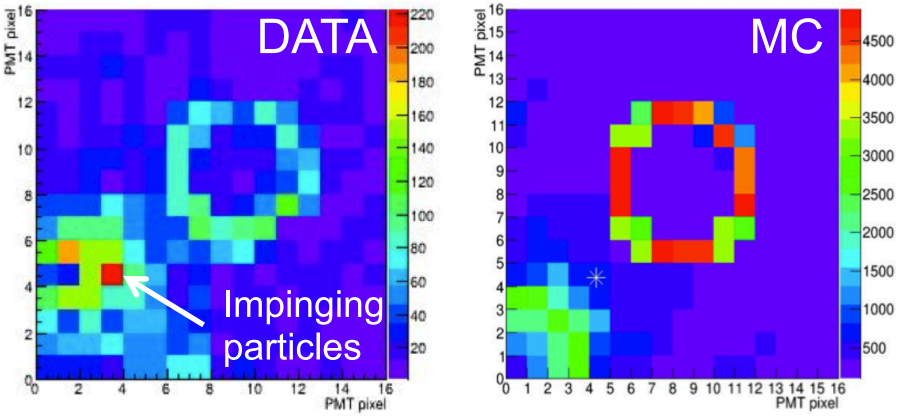
Reconstruction by Inverse Ray Tracing algorithm. Improved clarity of aerogel and n = 1.02 allow pi/K separation up to 13 GeV/c at 3 sigma

Modular RICH

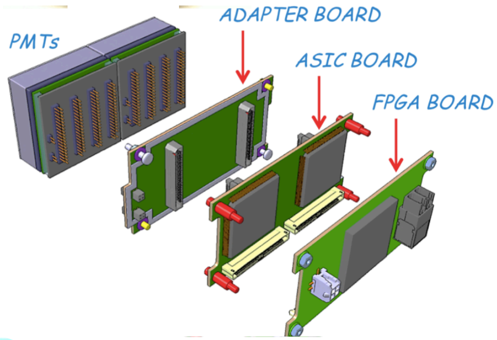


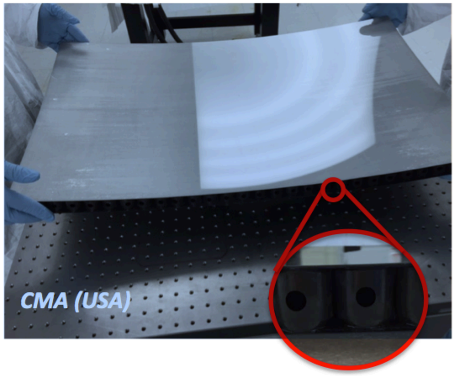


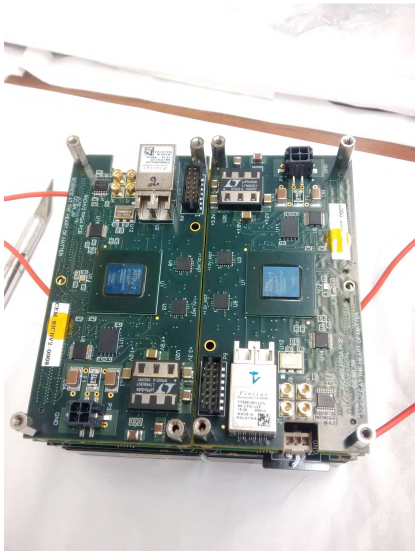
Test beam of small EIC mRICH prototype
to validate fresnel lens focalization

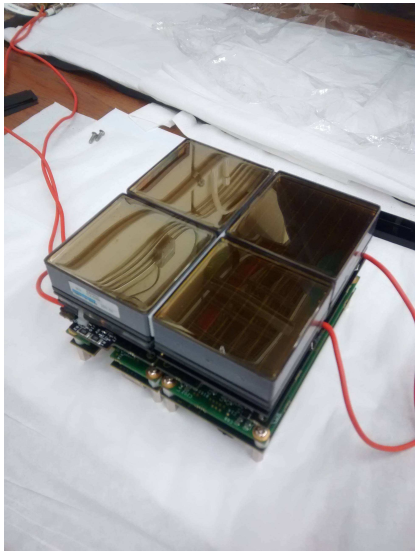


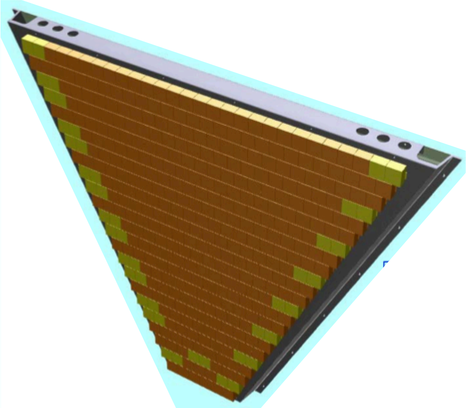
Cherenkov detector expertise from CLAS12
for aerogel radiator and readout electronics

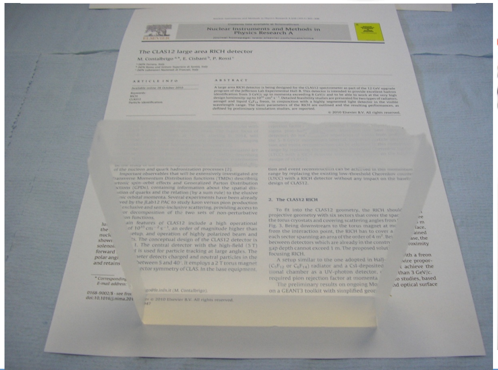




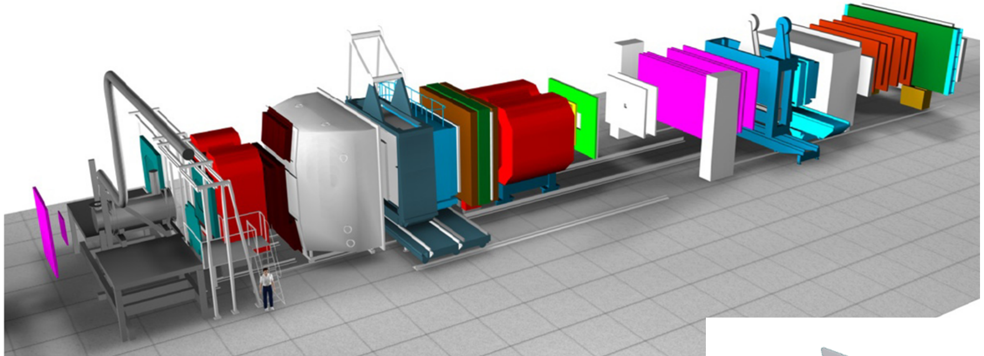




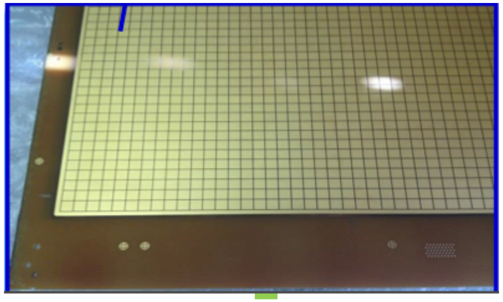


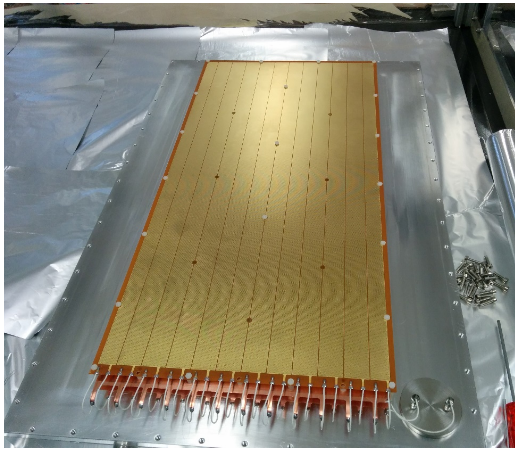


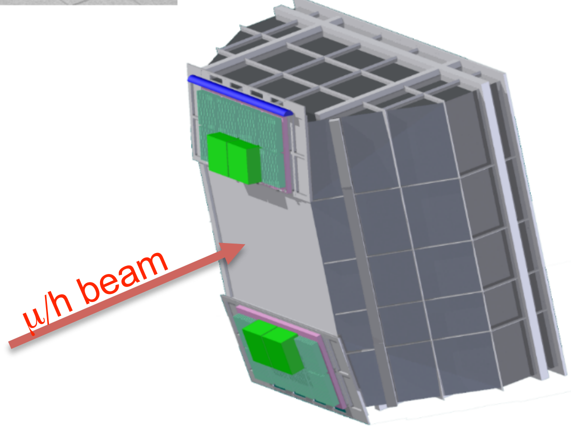
Thick GEM

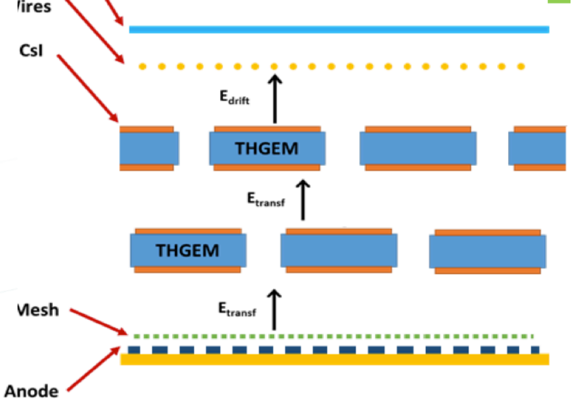


GEM expertise from COMPASS RICH
for Cherenkov detector and tracking (eRD6)

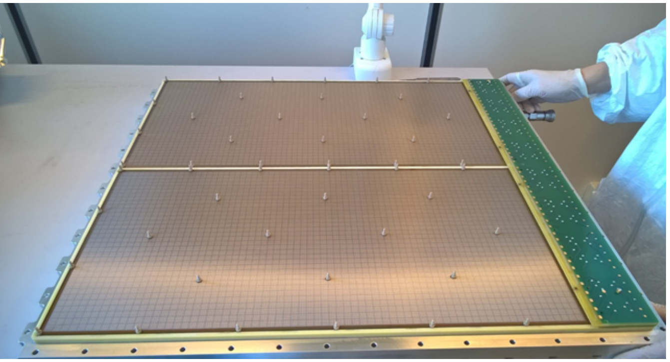


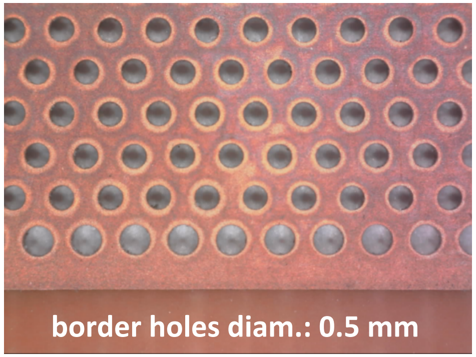






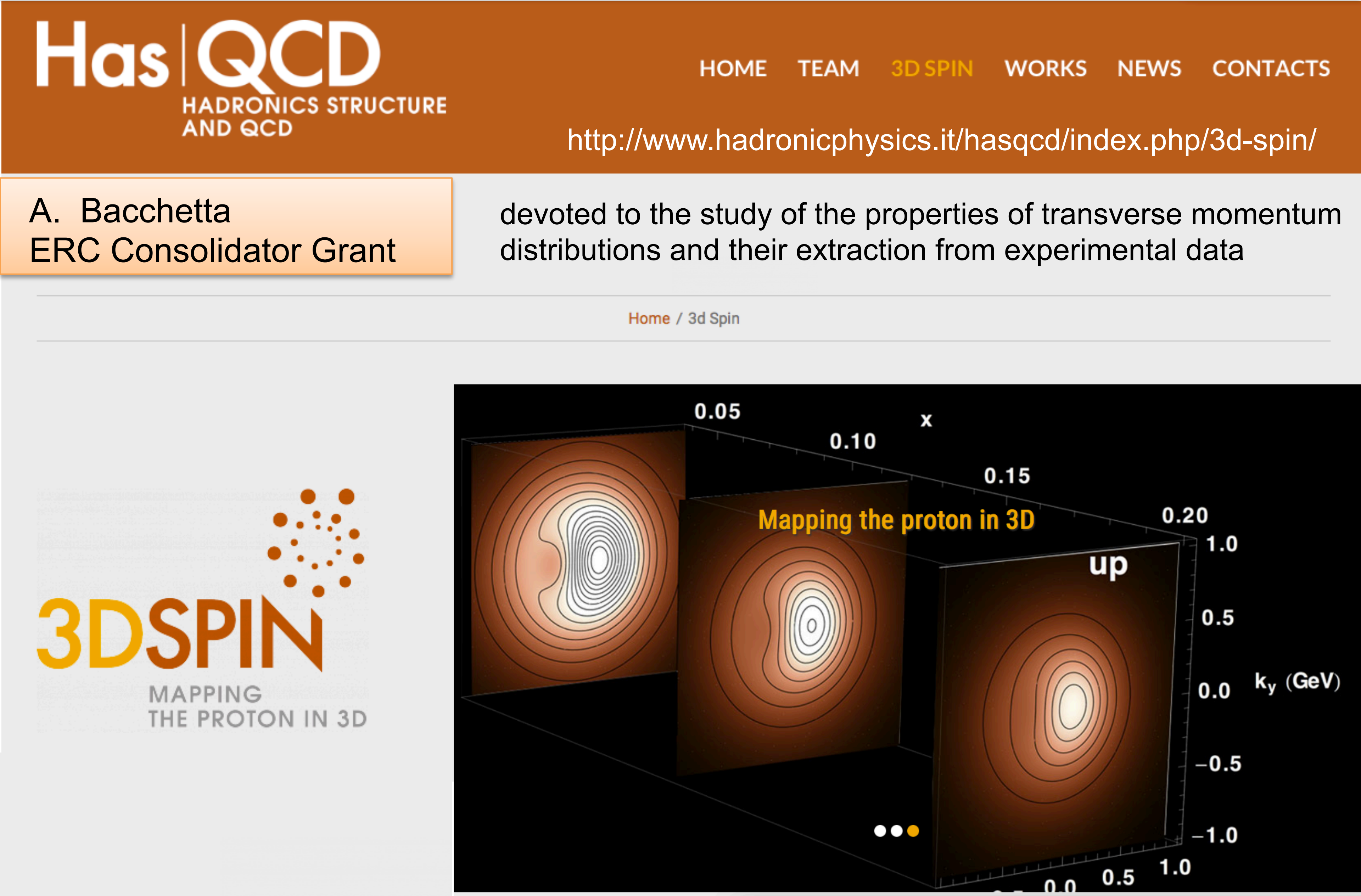
THGEM
Coated
with CsI





Program
- Novel THGEM material
- Miniature Pads
- THGEM vs GEM
- IBF optimization
- Operation w/ Fluorocarbon

3D Phenomenology



http://www.hadronicphysics.it/hasqcd/index.php/3d-spin/

A. Bacchetta
ERC Consolidator Grant

devoted to the study of the properties of transverse momentum distributions and their extraction from experimental data

EIC Case Discussions in Italy

Terzo incontro Nazionale di Fisica Nucleare INFN2106 LNF, 14-16 November 2016
https://agenda.infn.it/conferenceDisplay.py?ovw=True&confId=10586

INFN
Istituto Nazionale di Fisica Nucleare

Terzo Incontro Nazionale di Fisica Nucleare
INFN2016

CSN3 | fisica nucleare CSN4 | fisica teorica CSN5 | fisica delle tecnologie

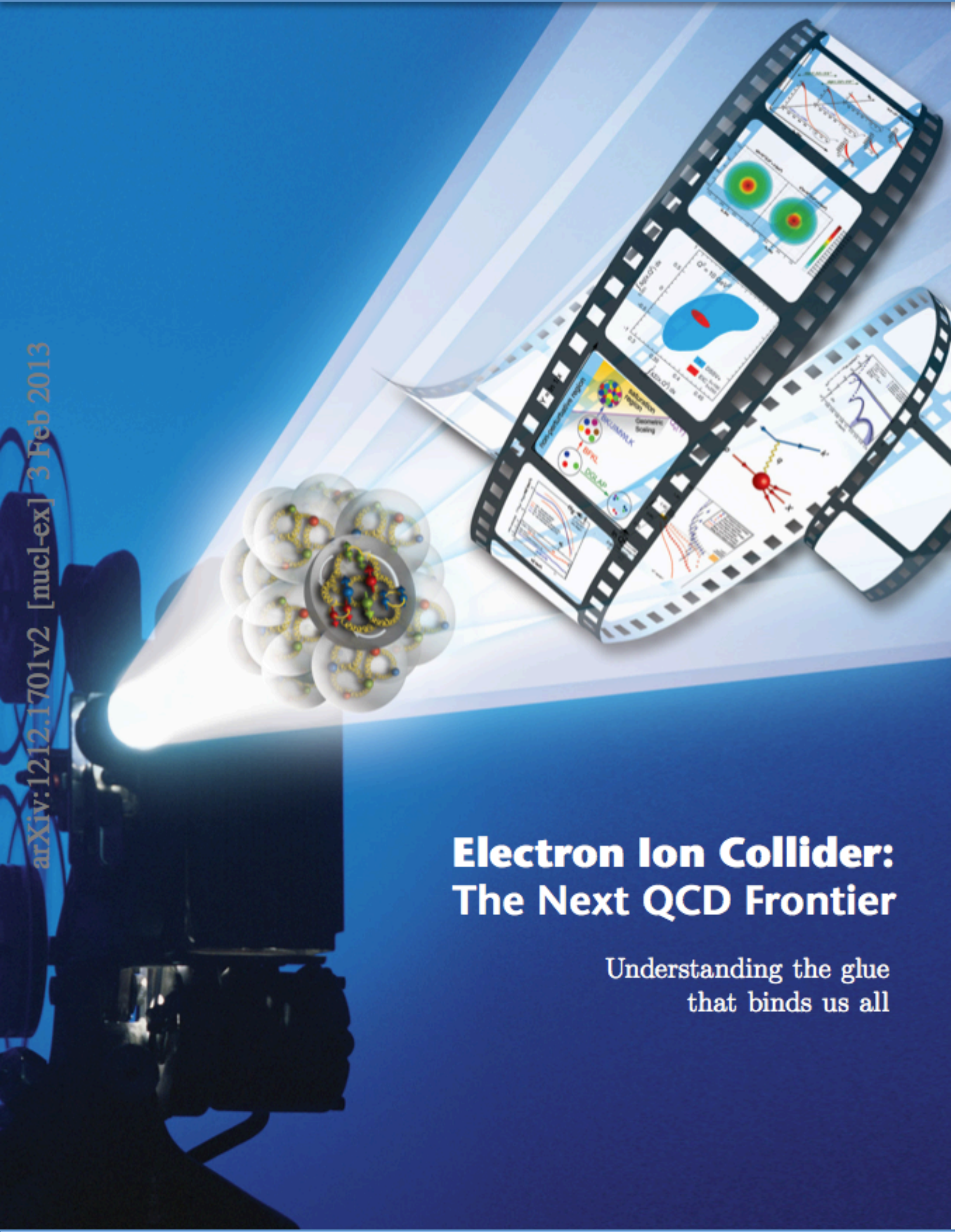
3D Parton Distributions: Path to the LHC LNF, 29/11 – 2/12 2016
http://www.lnf.infn.it/conference/2016/3DPDF/

3D PARTON DISTRIBUTIONS: PATH TO THE LHC
INFN-Laboratori Nazionali di Frascati
29/11 - 2/12/2016

Opportunities at EIC Workshop (winter time)

EIC User Group Meeting
18/07 – 22/07 2017, Trieste

The Next QCD Frontier



arXiv:1212.1701v2 [nucl-ex] 3 Feb 2013

Electron Ion Collider:
The Next QCD Frontier

Understanding the glue
that binds us all

3D nucleon:
an endeavor on NPQCD dynamics
with many
connections with other QCD topics

EIC is a unique opportunity
for a comprehensive study
and possible breakthroughs

A strong effort is ongoing to make it
a reality by a motivated
and experienced community
all over the world

This projects deserve the strongest
support as we may all benefit !!

EIC case discussion @ NPQCD
Cortona, 20-22 April 2015

Another round likely to happen soon