EICUG 2017

Electron-Ion Collider User Group Meeting 2017   **July 18-22, 2017**

Report from parallel session 3: Phenomenology and new observables

Conveners: Zhongbo Kang   &   Cédric Lorcé

July 22, University of Trieste, Trieste, Italy

Some figures

10-1 presentations

11:20	Selected physics topics from HERA to future facilities	NEWMAN, Paul
11:50	Azimuthal Asymmetry in Dijet Production in eA Collisions	ULLRICH, Thomas
12:10	eSTARlight: towards a Monte Carlo generator for EIC	LOMNITZ, Michael
12:30	Neutral-Current Weak Interactions at an EIC	ZHAO, Yuxiang
12:50	Beyond Standard Model Interactions and Hadron Phenomenology	LIUTI, simonetta

15:00	Jet TMDs and jet axes	SCIMEMI, Ignazio
15:20	Jets at an EIC: A Window on the Partons	PAGE, Brian
15:40	Accessing the proton's tensor structure in inclusive DIS	ACCARDI, Alberto
16:00	~~Fast implementation of NNLO jets in hadronic collisions~~	~~BRITZGER, Daniel (REMOTE)~~
16:20	Transformative Measurements with Nuclei	ARMSTRONG, Whitney

+ 5 presentations in joint session with parallel 4: Nucleon and Nuclear structure and hadronisation

17:20	Transverse momentum dependent gluon distributions at a future EIC	PISANO, Cristian
17:40	Probing the gluon Sivers functions in pp-> J/psi, D +X	MURGIA, Francesco
18:00	Accessing Gluon Sivers at EIC	LEE, J.H.
18:20	Limits and uncertainties of TMD factorisation theorem	VLADIMIROV, Alexey
18:40	Features of spin dependent TMDs	GUTIÉRREZ REYES, Daniel

HERA, the EIC ancestor
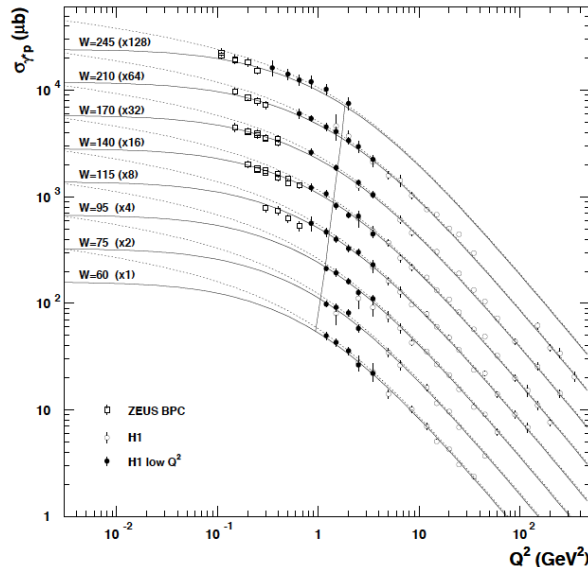
Paul Newman

Hints for gluon saturation in HERA

All data ($Q^2 > 0.05$ GeV^2) well fitted with dipole model including saturation effects

EIC will provide better acces

- **Increase of $\sqrt{s}$** ⟹ **probing lower x at fixed Q^2**
- **Increase density using nuclear targets**
- **Non-inclusive observables (e.g. diffraction)**

HERA and LHC teach us that EIC studies will need to include non-perturbative regions and a **multi-observable approach** **(ep and eA inclusive, diffractive, semi-inclusive, …)**

eSTARlight

Michael Lomnitz

Monte Carlo generator for EIC based on HERA data for $\gamma p \to Vp$

Estimates $eX \to eX+V$ cross sections, rates, …

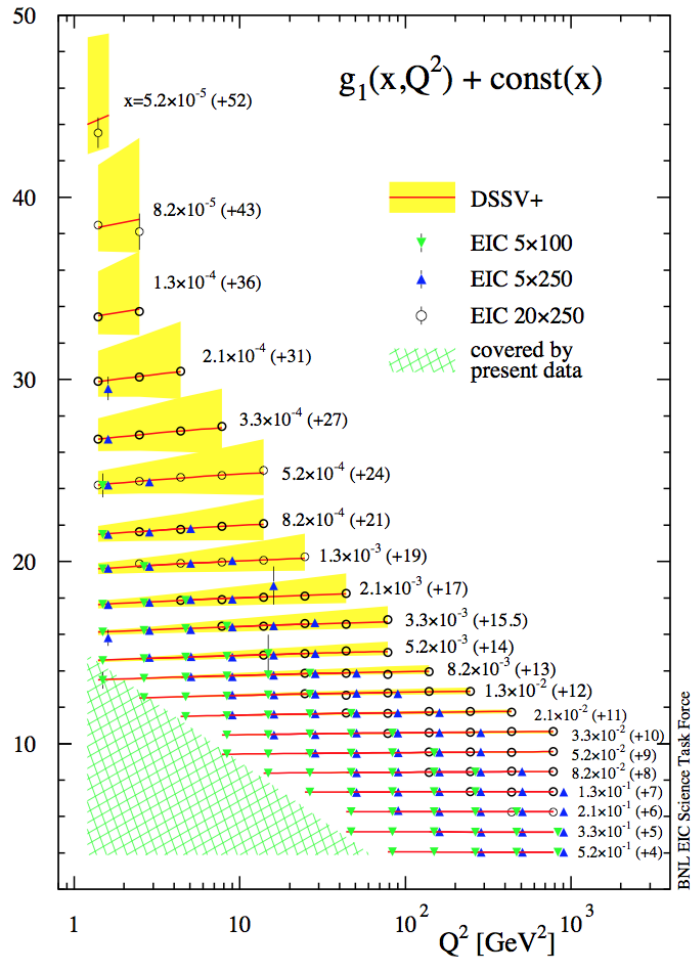**Still under development**
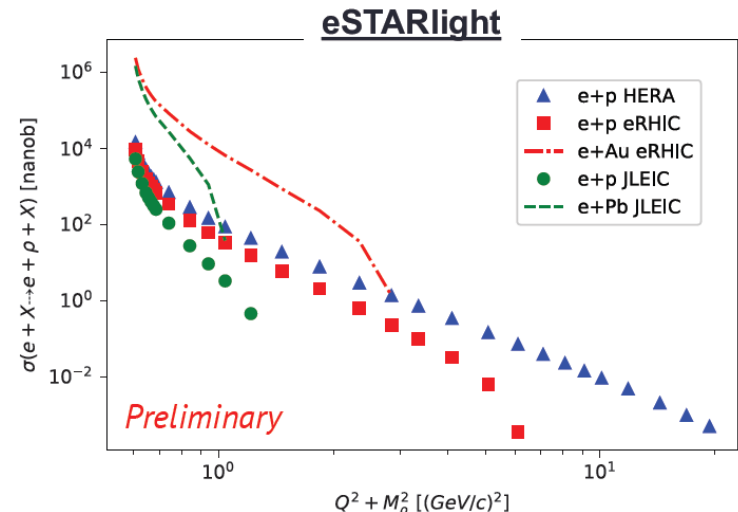
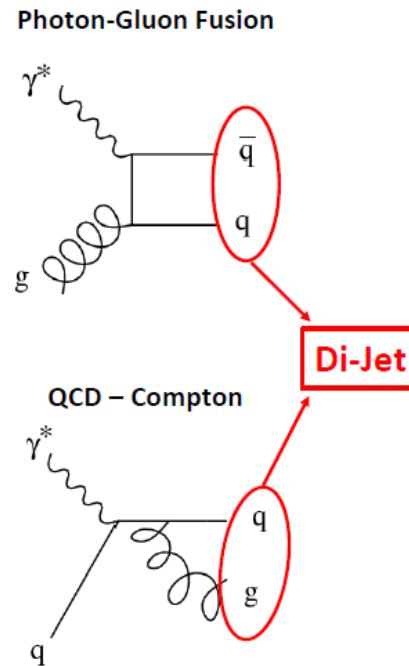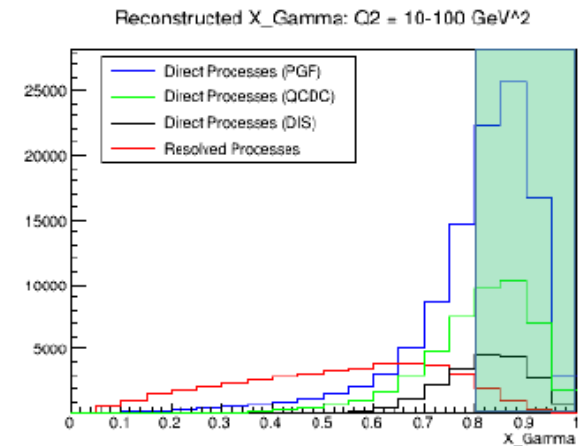**Golden measurement of ΔG is via scaling violation**   *Brian Page*

Other possibility: dijet production from PGF

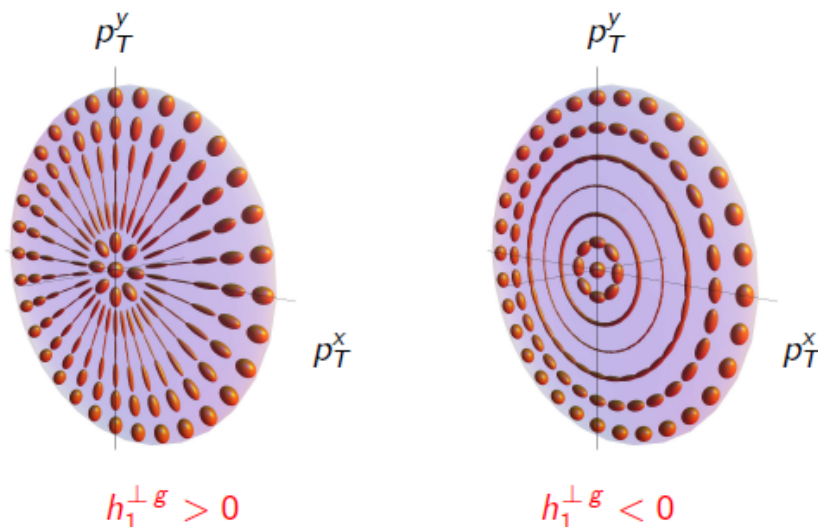**Reconstructed x_γ allows one to suppress resolved process**

Azimuthal asymmetries in heavy quark pair and dijet production provide access to new gluon distribution

Thomas Ullrich
Cristian Pisano

$h_1^{\perp g} > 0$

$h_1^{\perp g} < 0$

WW-type distribution of linearly polarized gluons in unpolarized nucleon

Plays a central role in small-x saturation phenomena

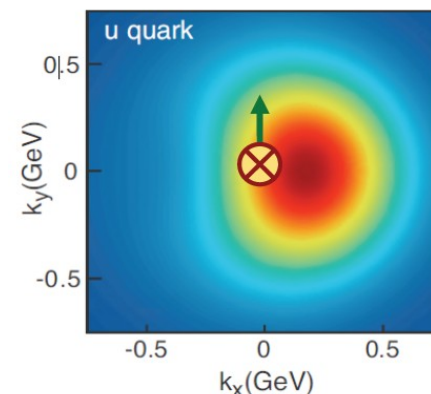**Affects also e.g. Higgs spectrum at low q_T**

Complementarity with LHC and process dependence

$$h_1^{\perp g} [e\,p \to e'\,Q\overline{Q}\,X] = h_1^{\perp g} [p\,p \to H\,X]$$

$$f_{1T}^{\perp g\,[e\,p^\uparrow \to e'\,Q\overline{Q}\,X]}(x, p_T^2) = -f_{1T}^{\perp g\,[p^\uparrow p \to \gamma\gamma X]}(x, p_T^2)$$

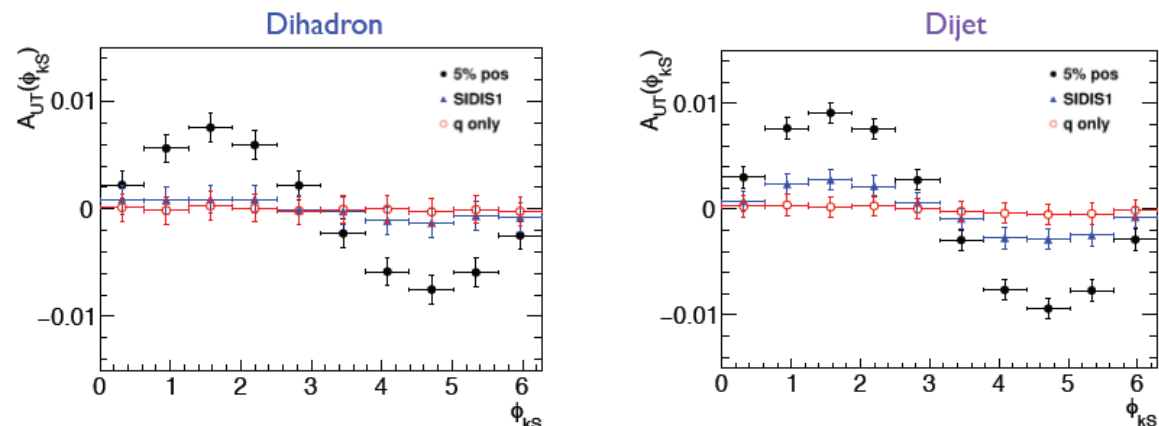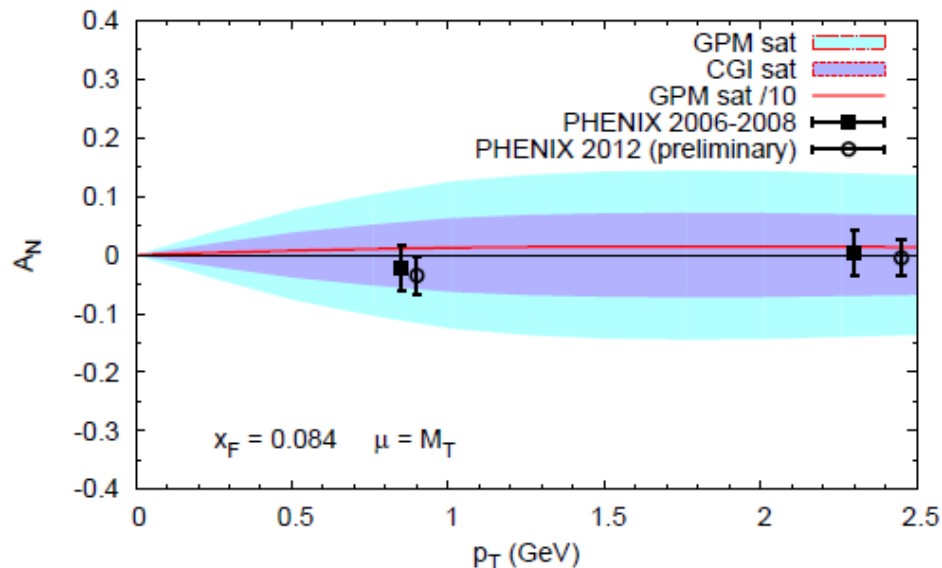**Gluon Sivers function**

Gluon distributions

J.H. Lee

Accessing gluon Sivers function from dihadron and dijets SSA in EIC

Dihadron

Dijet

Estimates of SSA with RHIC results

Francesco Murgia

Testing universality of gluon Sivers function with

$$p^{\uparrow}p \to J/\psi\, X \qquad p^{\uparrow}p \to D\, X$$

based on color gauge invariant extension of Generalized Parton Model

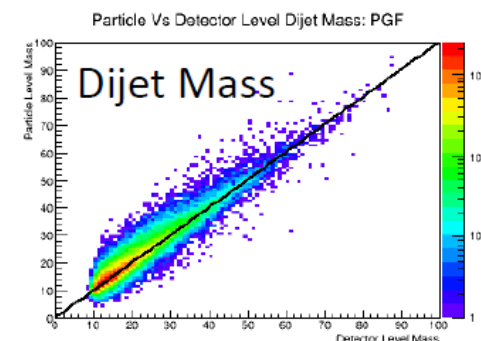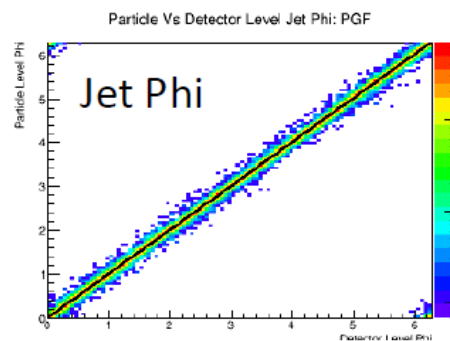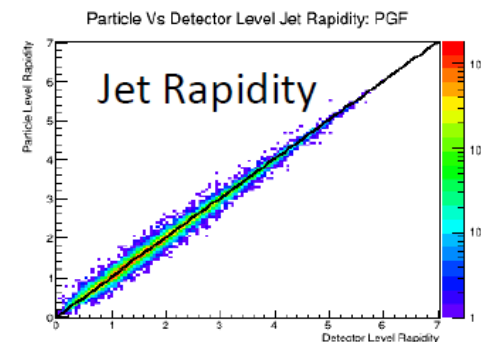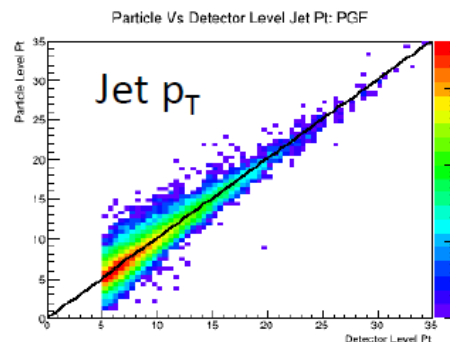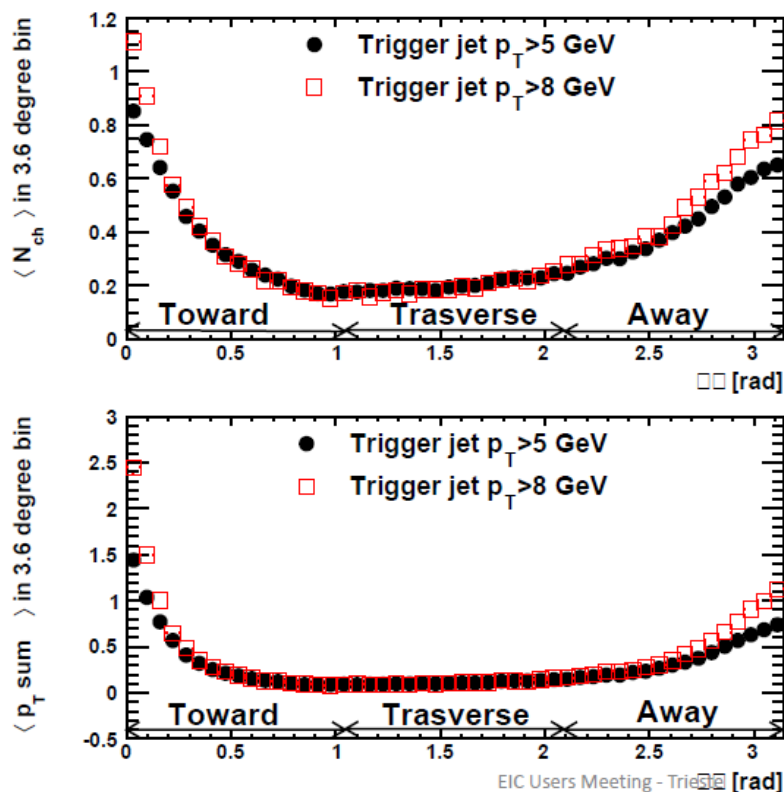# Theory vs experiment

**Very nice asymmetries in theory...
but in practice jets, background, detector smearing, ...**

*Brian Page
Thomas Ullrich*

**Systematic quantification of underlying event
confirms ep event is very clean**

Detector smearing under investigation

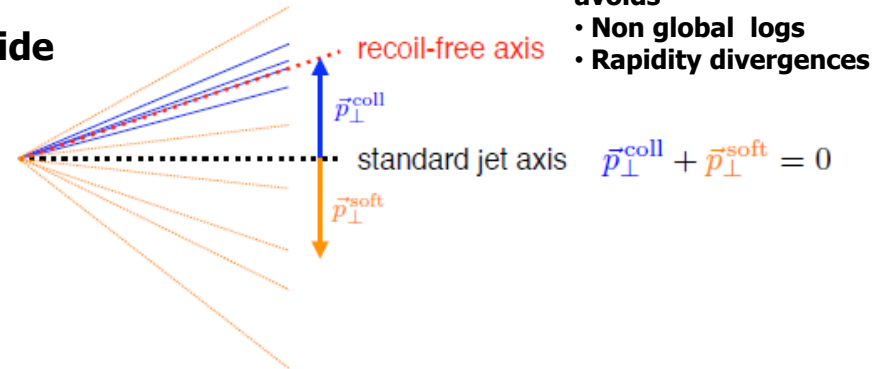➡ **First simulations are very encouraging for the extraction of asymmetries @EIC !**

Ignazio Scimemi

Transverse momentum spectrum of hadron inside a jet w.r.t. judicious axis

@ small transverse momenta
⟹ **New TMD fragmentation functions (Jet TMDs)** **Universal !**

avoids
· Non global logs
· Rapidity divergences

recoil-free axis

$\vec{p}_\perp^{\,\mathrm{coll}}$

standard jet axis $\vec{p}_\perp^{\,\mathrm{coll}} + \vec{p}_\perp^{\,\mathrm{soft}} = 0$

$\vec{p}_\perp^{\,\mathrm{soft}}$

Potential applications: · **study of nuclear modification effects in heavy ion collision**
· **identification of boosted heavy resonances**

Standard DIS analysis revisited with « jet » correlator to avoid on-shell quark in the final state

Alberto Accardi
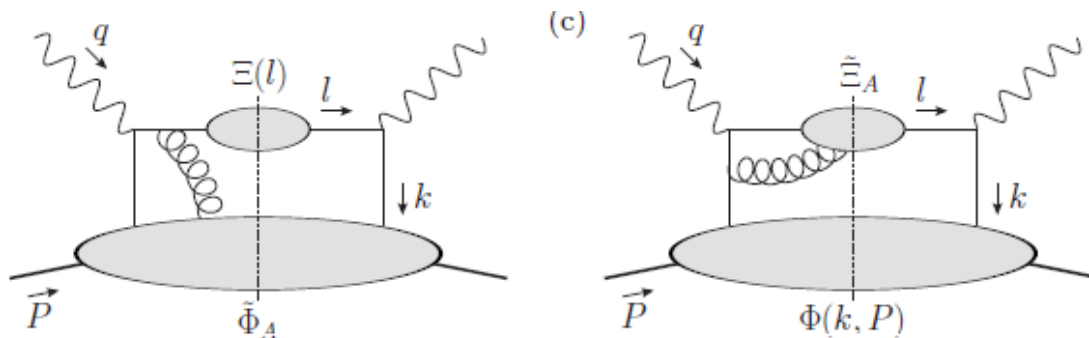
Large twist-3 contribution to g_2 structure function

Modification of BC and ELT sum rules

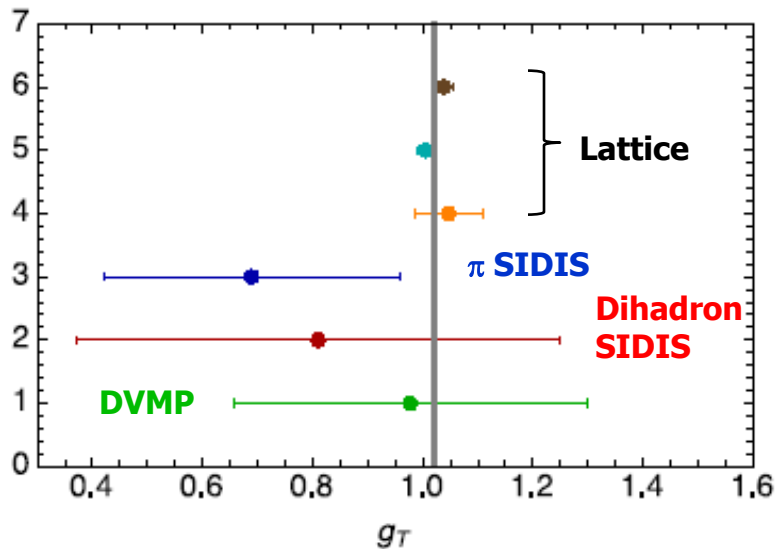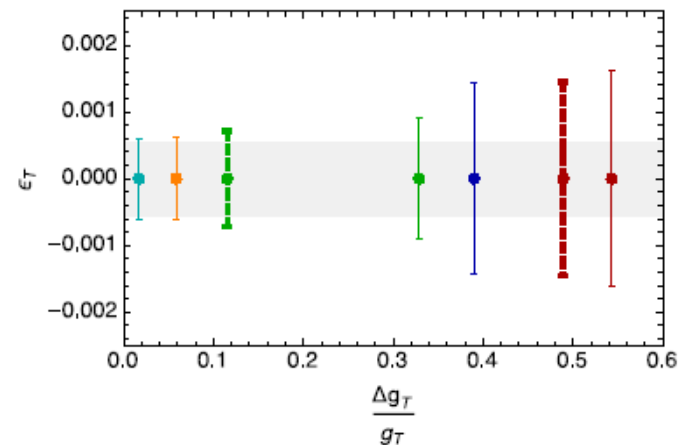**Possible new way to access tensor charge !**

Simonetta Liuti

Impact of spin-dependent observables @EIC on BSM physics deserves probably more attention

E.g. non V-A couplings (S,P,T) in neutron beta decay
→ **need for hadronic matrix elements (e.g. tensor charge)**

Uncertainty on effective BSM coupling

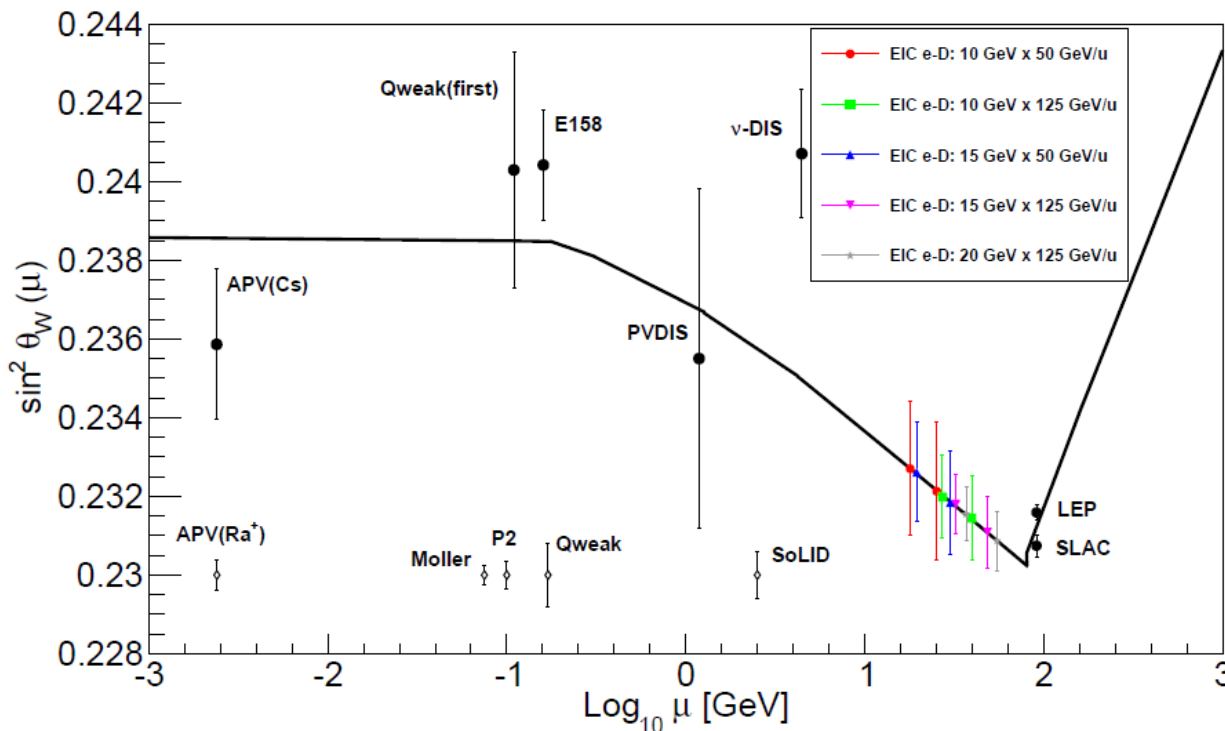**New γ-Z interference structure functions accessible in parity-violating asymmetries in DIS**

Gives access to new linear combinations of quark flavors

→ **Potential 6-flavor separation in interesting kinematic region**

Monte Carlo study using ePHENIX design

Yuxiang Zhao

Uncertainty projections for $\sin^2\theta_W$ using e-d collisions

Constraint on BSM (e.g. new Z boson, …)

Before EIC, the ALERT experiment   *Whitney Armstrong*
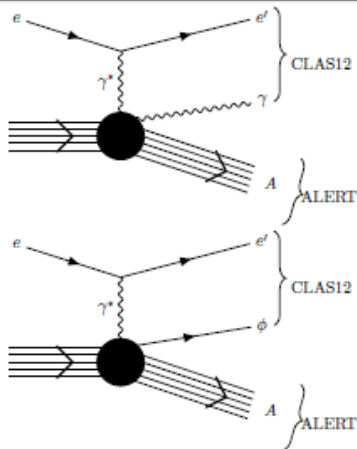
Comprehensive program to study the origin of EMC effect

Coherent Processes on ^{4}He

- ^{4}He$(e, e'\,^4$He $\gamma)$
- ^{4}He$(e, e'\,^4$He $\phi)$

Explores the partonic structure of ^{4}He

Incoherent processes on ^{4}He and ^{2}H

- ^{4}He$(e, e'\gamma\, p + ^3$H$)$
- ^{4}He$(e, e'\gamma + ^3$He$)n$
- ^{2}H$(e, e'\gamma + p)n$

Identify medium modified nucleons
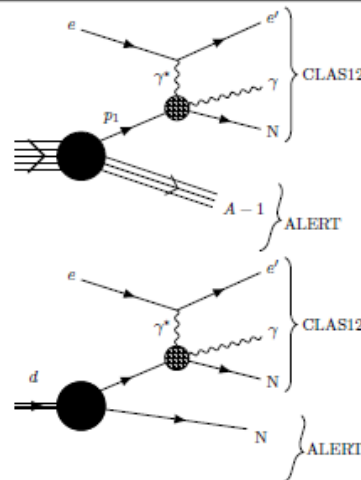
DIS on ^{4}He and ^{2}H : Tagged EMC Effect

- ^{4}He$(e, e' + ^3$H$)$X (proton DIS)
- ^{4}He$(e, e' + ^3$He$)$X (neutron DIS)
- ^{2}H$(e, e' + p)$X (neutron DIS)

Test FSI and rescaling models
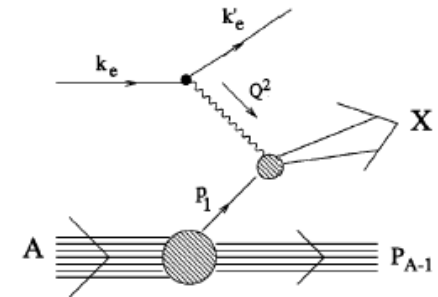
Studying QCD in nuclei presents an opportunity to transform our understanding of nuclear matter