
Session

“Exclusive Reactions”: Summary and Outlook

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Workshop on Nuclear Chromo-Dynamic Studies with a Future EIC
Argonne National Lab, April 7-9, 2010

Program of session “Exclusive Reactions”

- 1) L. Zhu, Measurements of nuclear structure functions at small Bjorken- x with EIC: An extension of JLab 12 GeV proposal PR10-012
- 2) M. Lamont, An overview of MC Tools at BNL for an EIC
- 3) S. Liuti, Overview of generalized parton distributions in nuclei
- 4) L. Frankfurt, Black disk regime for hard processes in QCD
- 5) I. Cloet, Nucleons in the medium

Goals of sessions

- Bring together people interested in EIC physics from JLab, JLab Users and BNL who would be interested to do simulations
- Discuss and identify open questions than can be addressed at EIC
- Identify key measurements and define strategy

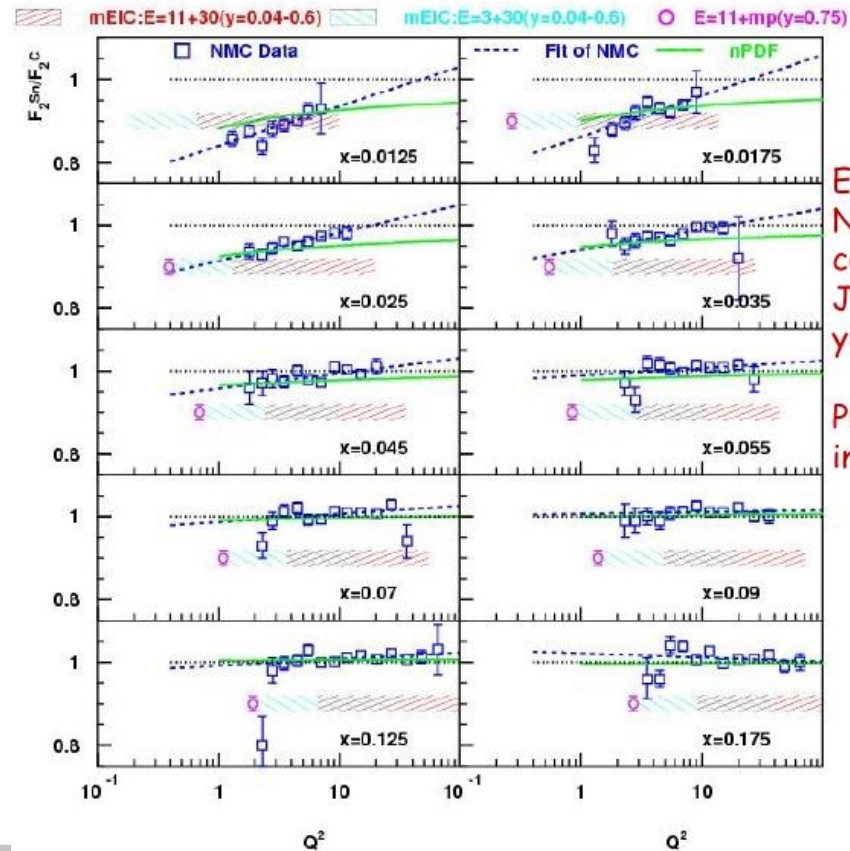
YES
Partially
No, let's
try now

L. Zhu, Measurements of nuclear structure functions at small Bjorken-x with EIC: An extension of JLab 12 GeV proposal PR10-012

Three related physics measurements at small x:

- $[F_2]$ The nuclear dependence of F_2 scaling violation
- $[R=\sigma_L/\sigma_T]$ The Q^2 and nuclear dependence of R/F_L
- $[F_L]$ F_L moments at $Q^2 = 3.75 \text{ GeV}^2$

Projection on F_2 ratio at small x



EIC enables us to cover NMC kinematics and connect to Jlab 12 GeV kinematics at $y=0.75$.

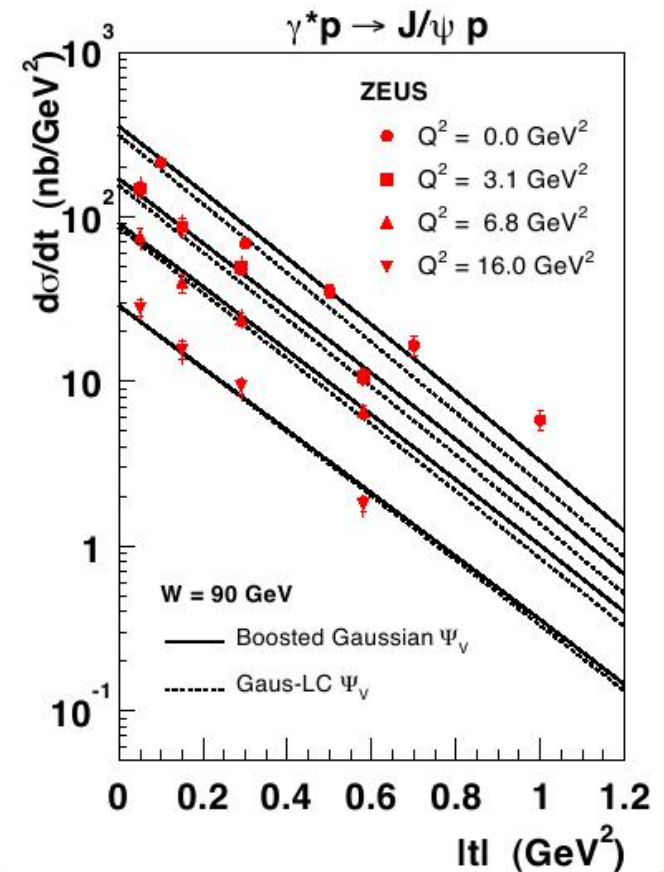
Precision of 2% is assumed in cross section ratios.

- set of measurements to determine nPDFs (q, antiq, glue) in shadowing and antishadowing region
- continue simulations to address extraction of PDFs

M. Lamont, An overview of MC Tools at BNL for an EIC

- reviewed MC's: spin, diffraction, exclusive
- xDVMP for exclusive production of VM
uses dipole formalism
- no nuclei yet, easy to implement

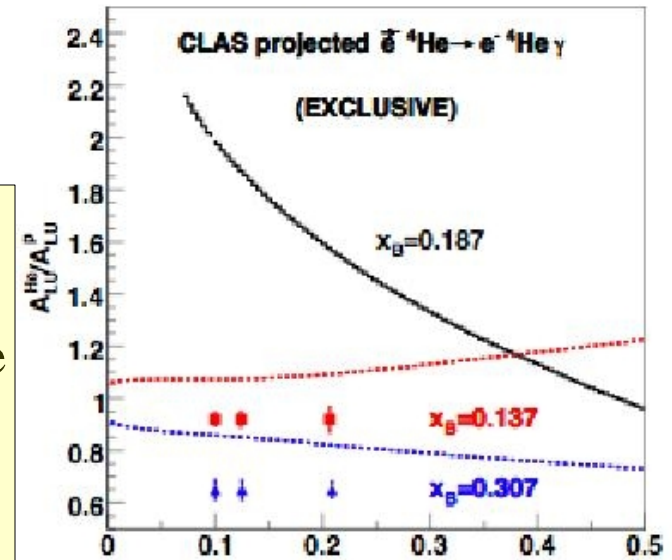
- when nuclei done, practical tool to access gluon and qbar GPDs in antishadowing and shadowing region
- quantitative and model-dependent way to study the onset of saturation
- establish collaboration and study DVCS?



S. Liuti, Overview of generalized parton distributions in nuclei

- emphasis of medium modifications of the nuclear GPDs in the EMC region
- a particular model for those modifications using convolution over long. and transverse coordinated of nucleons
- dramatic effect on usual and off-diagonal EMC effect
- modification of transverse radii in nuclei

- need to develop qualitative picture of medium modifications
- need to provide “propaganda” figure for transverse size over the entire kinematics
- need to explain why need an EIC



L. Frankfurt, Black disk regime for hard processes in QCD

At ultra-high energies, the interaction of gamma* with A is maximal (black) -> definite predictions

Signals of Proximity to black disk limit.

- * Total cross sections Frankfurt, Guzey, McDermott, MS (FGMS-01)

$$F_{2A}(x, Q^2) = \frac{Q^2}{12\pi^3} \left(\sum_f e_f^2 \right) (2\pi R_A^2) \ln \frac{x_0(Q^2)}{x},$$

where $x_0(Q^2)$ slowly decreases with increasing Q^2 (update to QCD of Gribov BD of 68)

The same prediction for DVCS amplitude at $t=0$.

- * *Vector meson exclusive and semiexclusive production* - a fine probe of onset of BDR for interaction of small quark dipoles and dynamics of dipole media interaction. In BDR

$$\frac{d\sigma^{\gamma^*+A \rightarrow V+A}}{dt} = \frac{M_V^2}{Q^2} \frac{d\sigma^{\gamma^*+A \rightarrow V+A}}{dt} = \frac{(2\pi R_A^2)^2}{16\pi} \frac{3\Gamma_V M_V^3}{\alpha(M_V^2 + Q^2)^2} \frac{4|J_1(\sqrt{-t} R_A)|^2}{-t R_A^2}$$



Gross violation of Collins and F.S. factorization theorem
- enhancement by a factor Q^4

- Model-independent regime and predictions
- Certainly, will not be reached, but can onset be seen? Need to quantify.

Open Questions

GLOBAL QUESTIONS:

- 1) Quark and gluon parton distributions in nuclei?
- 2) Transverse distribution on partons in nuclei?
- 3) Medium modifications of PDFs, GPDs, radii?
- 4) Origin of EMC effect?
- 4) Signals of saturation/break-down of leading twist?

HOW CAN EXCLUSIVE PROCESSES HELP?

- 1) Complimentary to inclusive and diffractive measurements
- 2) Direct measurement of transverse distributions
- 3) Shadowing, antishadowing (?), EMC effect enhanced
- 4) Saturation effects (if can be accessed) enhanced

Measurements, questions and strategy

(Let us discuss)

1) Nuclear DVCS

- Do we need light and heavy A?
Advantages vs. disadvantages?
- What are the Lumi requirements?
- Will beam polarization be useful?
- Role of incoherent nuclear DVCS?
- Is there any principle difficulties, or one needs to do simulations of cross sections, and the interpretation in terms of GPDs can be done later?

2) Exclusive vector meson: rho, omega ... anti q and glue J/Psi ... glue

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Short-term strategy (next 2 months):

- involve people at JLab (F.-X. Girod and H. Egiyan) and BNL (M. Lamont) and do simulations of rates, required Lumi, etc.