QCD in Nuclei @ 12 GeV

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Introduction

There is consensus that QCD works, but not on how it works

pQCD mechanisms dominate at high energies and small distances ⟷ what energy is high enough for pQCD to be un-ambiguously applicable

Issues to be addressed, & also part of JLab's Scientific mission

+ What is the mechanism of confinement?
+ Where does the q-q interaction make a transition from the confinement to the perturbative QCD regime (understand N-N force in terms of QCD)?
+ How does the nucleon mass, spin, shape come about from the quarks/anti-quarks and gluons (How hadrons are constructed)?
+ Do quarks and gluons play any direct role in Nuclear Matter?

Introduction

There is consensus that QCD works, but not on how it works

pQCD mechanisms dominate at high energies and small distances ⟷ what energy is high enough for pQCD to be un-ambiguously applicable

How do we address some of these questions @ 11 GeV

+ Study fundamental exclusive processes and their universal scaling behavior.
+ Look for signatures of QCD such as Color Transparency & Nuclear Filtering.
+ Explore role of heavy quarks (such as intrinsic charm, J/Ψ-N interaction).
+ Study properties of quarks in-medium (e.g. unpacking the "EMC effect").
+ Study quark distributions at x>1 (super-fast quarks).
+ Measure quark propagation through nuclei.
+ Look for rare processes such as "hidden color", Φ-N & J/Ψ-N bound state
+ New ideas ……

Connect with an alternative framework which advocates the dominance of the handbag mechanism (measure GPDs).

Outline

- Universal Scaling
- Color transparency & Nuclear filtering
- Quark distributions in nuclei
- Heavy quarks
- Summary

Universal Scaling Behavior

The constituent quark counting rules:

Exclusive two body reactions (A+B →C+D) at large momentum transfers should scale as:

$$\frac{d\sigma}{dt} = f(\theta_{CM}) \frac{1}{s^{n-2}}$$

s = c.m. energy sq.
n = # of constituent fields

- First derived based on dimensional analysis (Matveev et al., Brodsky, Farrar,….)
- Confirmed within short distance pQCD framework (Brodsky, LePage)
- Recently, derived from anti-de Sitter/Conformal Field Theory correspondence or string/gauge duality (Polchinski, Strassler …..)

Many exclusive processes exhibit global scaling behavior

elastic pp scattering @ 90 deg CM angle ($\frac{d\sigma}{dt} \propto s^{-10}$)

deuteron photo-disintegration at large angles ($\frac{d\sigma}{dt} \propto s^{-11}$)

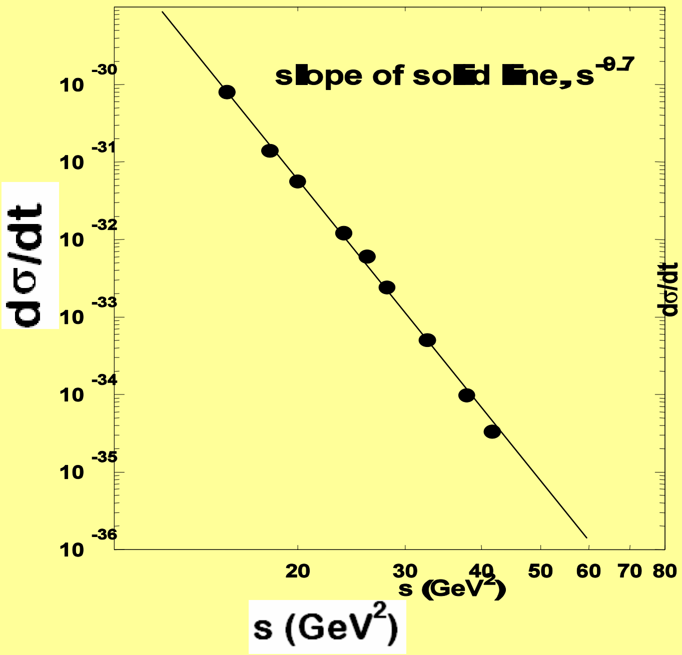
(C. Bochna et al., PRL 81, 4576 (1998), E.C. Schulte, et al., PRL 87, 102302 (2001), M. Mirazita et al., PRC 70, 014005 (2004), P. Rossi, PRL 94, 012301 (2005)).

Photopion production from nucleon at large angles ($\frac{d\sigma}{dt} \propto s^{-7}$)

(L.Y. Zhu et al., PRL 91, 022003(2003))

Some Examples

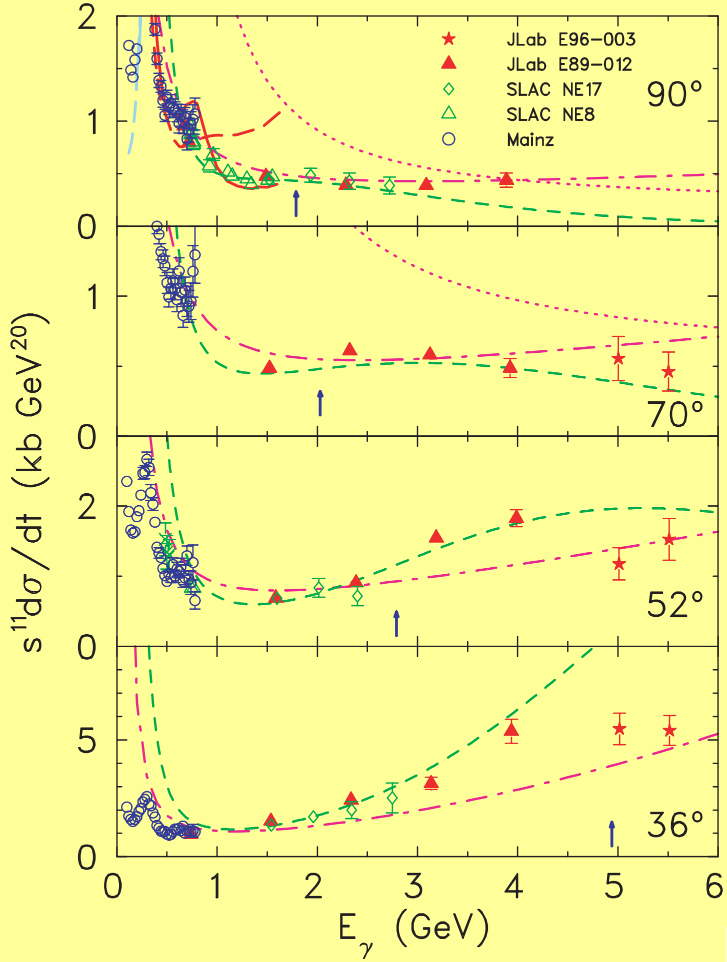
$p + p \rightarrow p + p$



quark counting rule predicts $\frac{d\sigma}{dt} \propto s^{-10}$

From data compilation of Landshoff and Polkinghorn

$\gamma + d \rightarrow p + n$



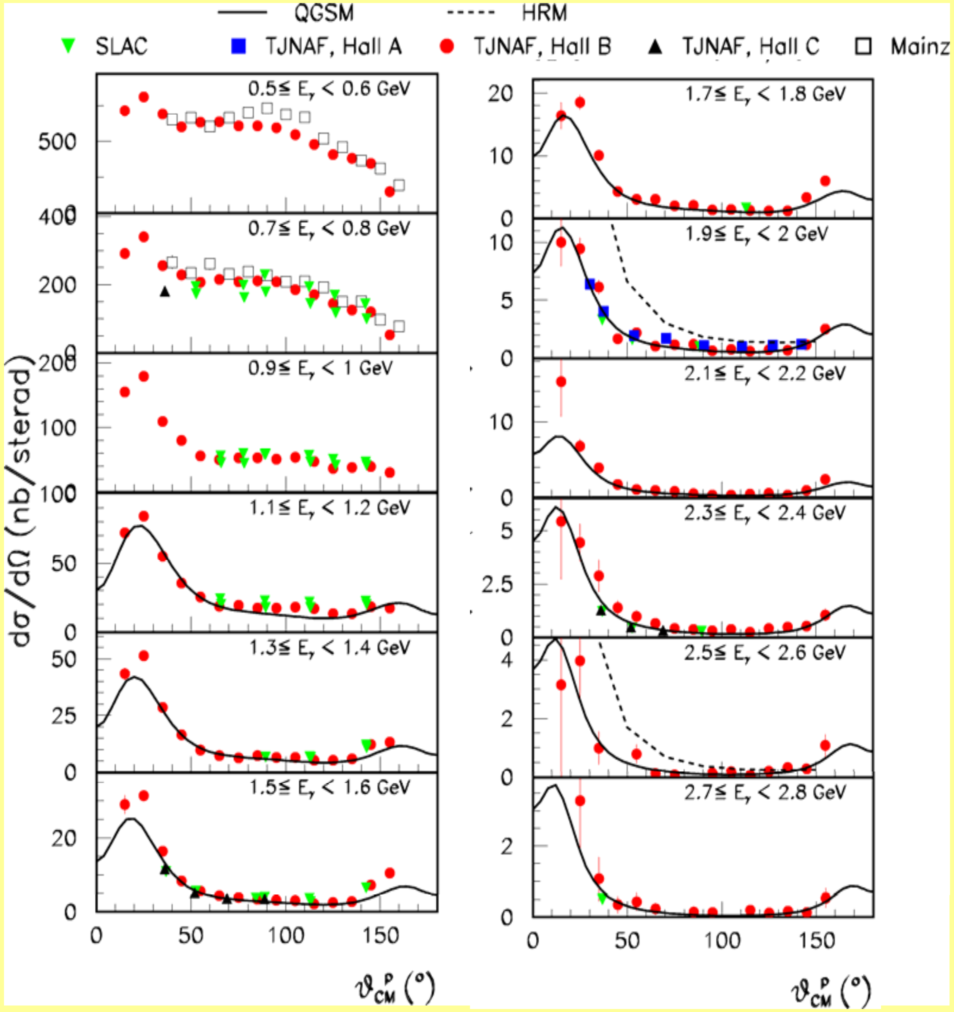
quark counting rule predicts $\frac{d\sigma}{dt} \propto s^{-11}$

C.Bochna *et al.*, PRL 81,4576 (1998)
E. Schulte et al. PRL 87, 102302 (2001)

Deuteron Photodisintegration

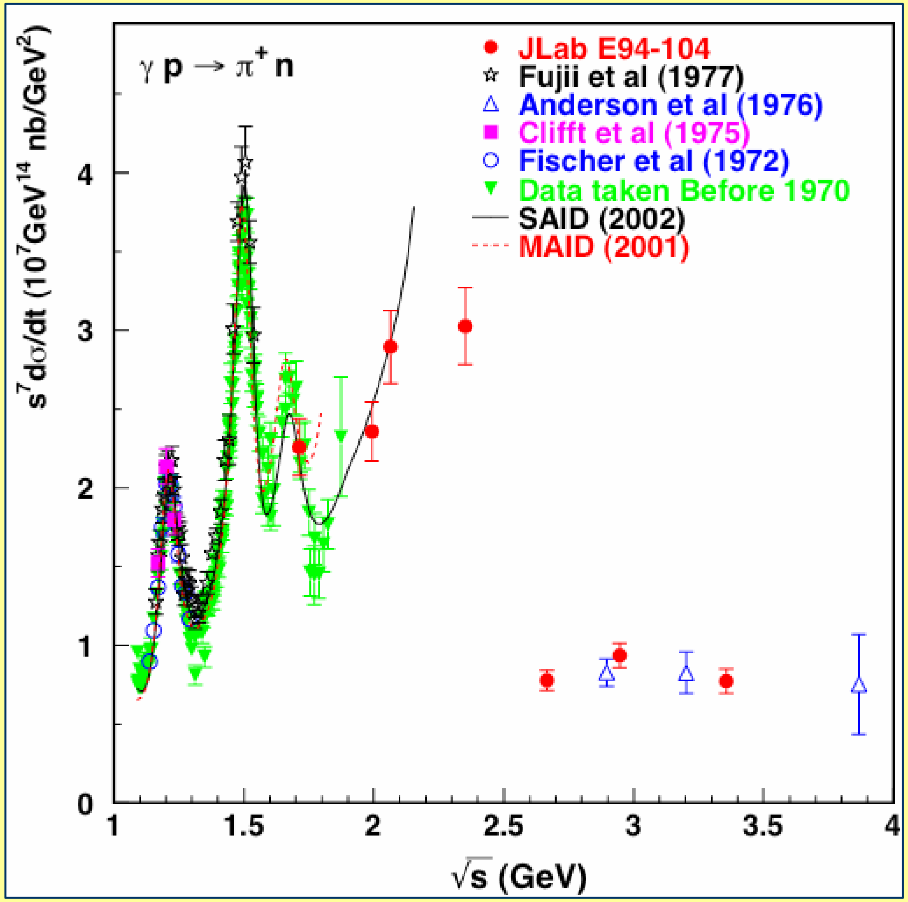
Now nearly complete angular distributions of $D(\gamma,p)n$ up to E_γ = 3 GeV with CLAS

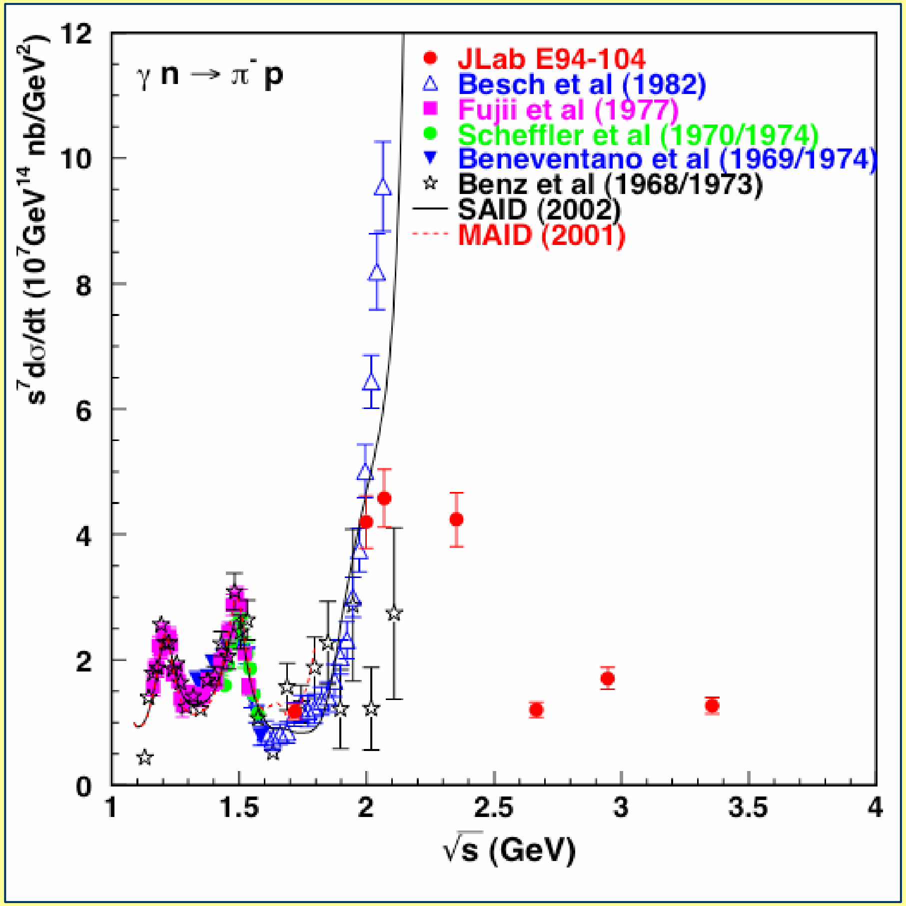
Excellent fit of data with $d\sigma/dt \propto s^{-11}$ for p_T ~ 1.0-1.3 GeV/c.



M. Mirazita et al., PRC 70, 014005 (2004), P. Rossi, PRL 94, 012301 (2005

Pion Photoproduction





$\gamma N \to \pi N$

$n-2=7$

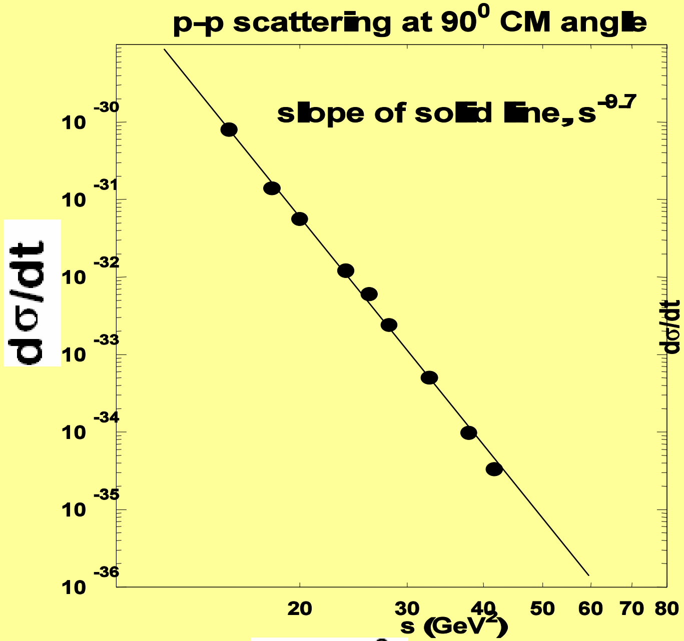
$$\frac{d\sigma}{dt} \propto s^{-7}$$

JLab, E94-104

L.Y. Zhu, PRL 91, 022003 (2003)

Scaling Violations

$$p + p \rightarrow p + p$$

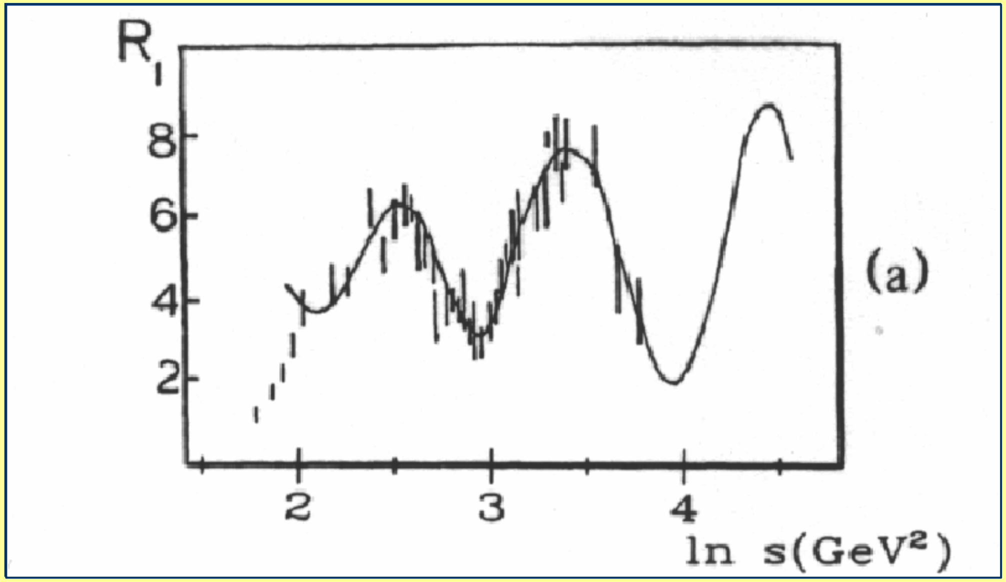


s (GeV^2)

quark counting rule predicts $\frac{d\sigma}{dt} \propto s^{-10}$

From data compilation of Landshoff and Polkinghorn

$$R_1 \propto s^{10} \frac{d\sigma}{dt}$$



J. P. Ralston and B. Pire, PRL 61, 1823 (1988)

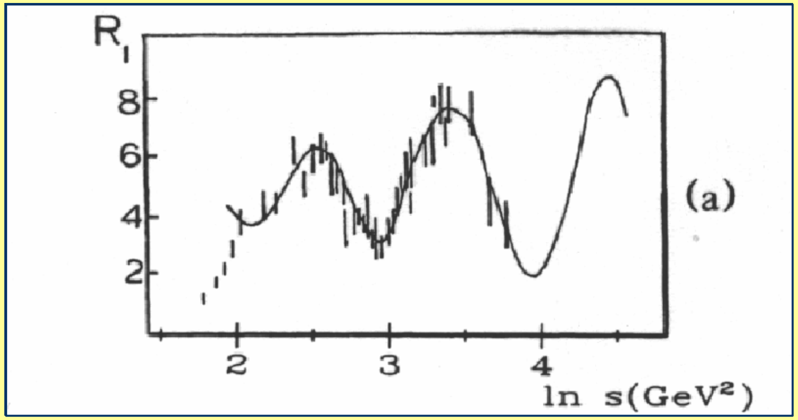
Scaling Violations

The oscillations in the scaled cross-section explained as:

- ❑ Resonance state production near the charm threshold (Brodsky, Schmidt , …….).

- ❑ Interference between short distance (Born) and long distance (Landshoff) amplitudes, (Ralston & Pire and Carlson, Myhrer,…)

$$R_l \propto s^{10} \frac{d\sigma}{dt}$$

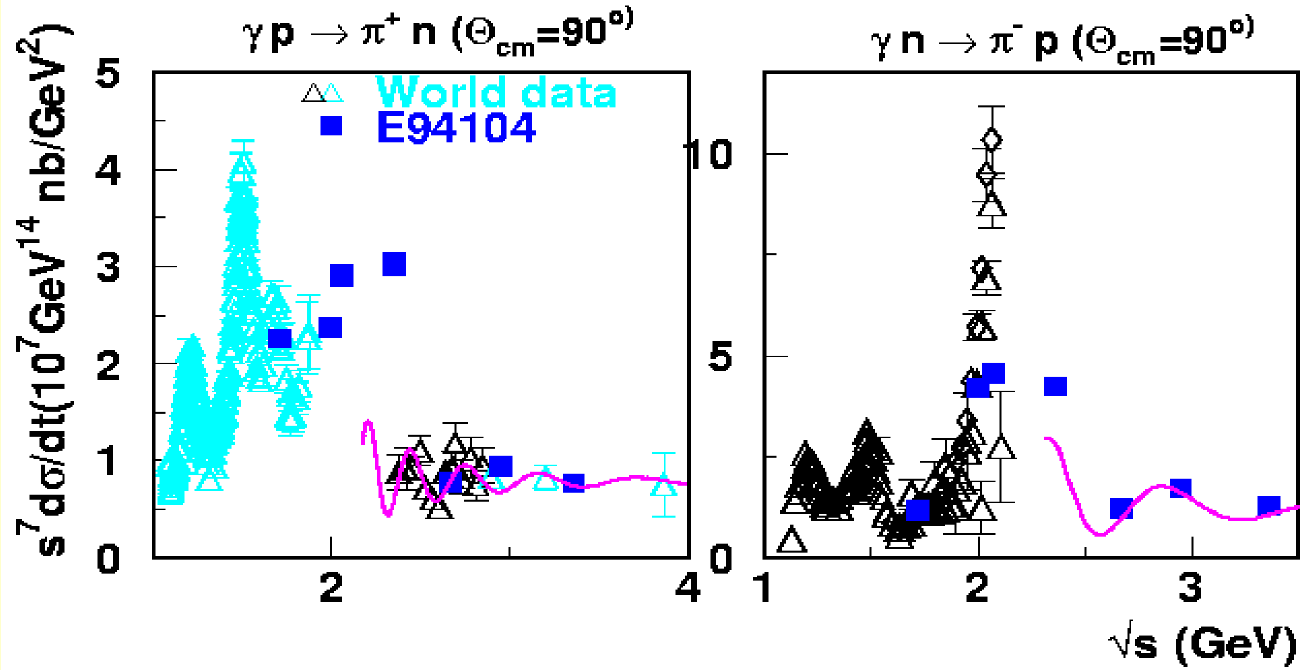


J. P. Ralston and B. Pire, PRL 61, 1823 (1988)

Pion Photoproduction

- Lacks two hadrons in the initial state, but Landshoff terms can contribute at sub-leading order.
  - can also contribute due to fluctuations to a vector-meson.

Hints of oscillation also seen in pion-photoproduction.



quark counting rule predicts $\frac{d\sigma}{dt} \propto s^{-7}$

L. Y. Zhu *et al.*, PRL 91, 022003 (2003)

More data needed to answer the question: are oscillations a general feature of QCD ?

New Developments

❑ Scaling violations can arise from "restricted locality" of the quark-hadron duality (Zhao and Close).

❑ a generalized counting rule based on pQCD analysis, by systematically enumerating the Fock components of a hadronic light-cone wave function. (Ji, Ma & Yuan and also Brodsky et al.)

- The generalized counting rule includes parton orbital angular momentum.
- They provide the scaling behavior of the helicity flipping amplitudes

$$\Delta\sigma \propto s^{-1-\sum_H (n_H + |l_{zH}| - 1)}$$

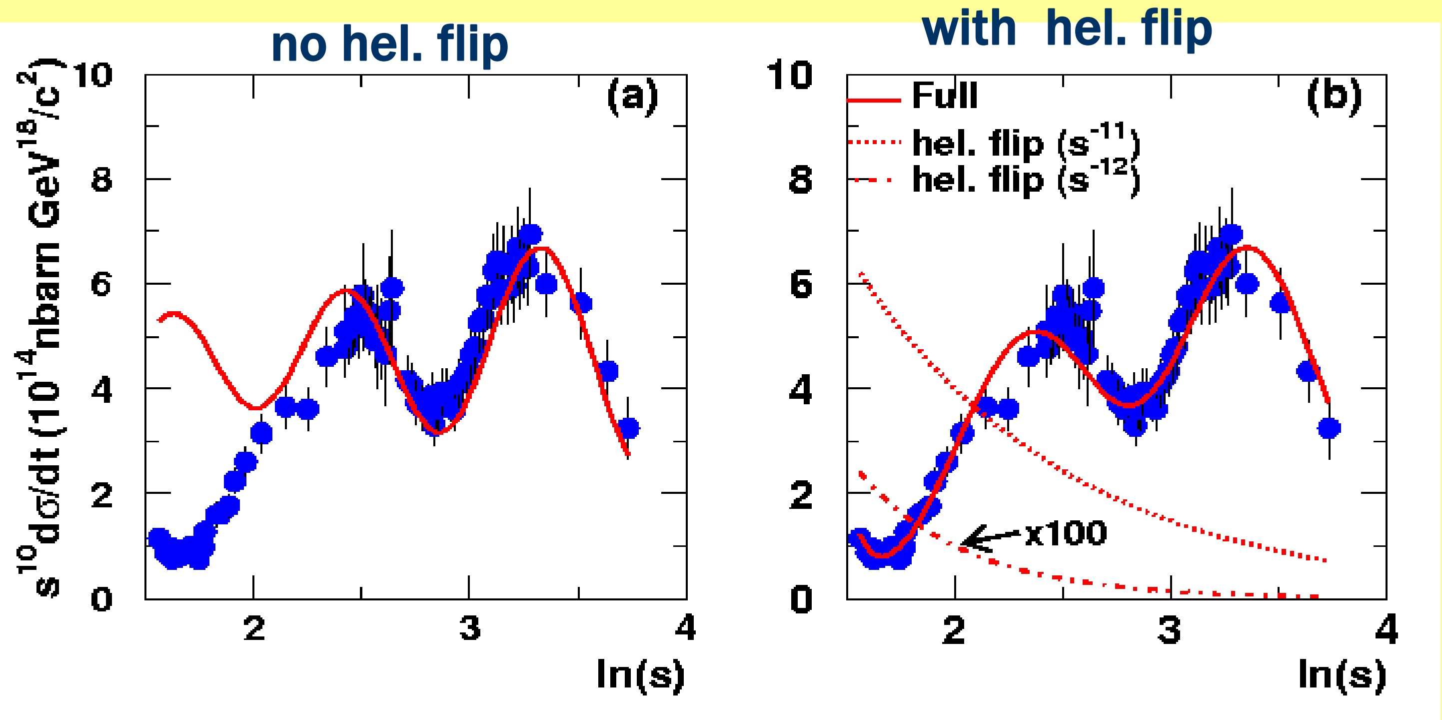
If l_{zH} = 0;
reduces to constituent quark counting rule of Brodsky-Farrar.

number of partons (n_H)

orbital angular momentum projection (l_{zH})

New Developments

Using their Generalized Counting Rule Ji *et al.* predict the s dependence of the helicity flipping amplitudes in pp elastic scattering as $\sim s^{-4.5}$ and $\sim s^{-5}$



D.Dutta and H. Gao, PRC 71, 032201R (2005)

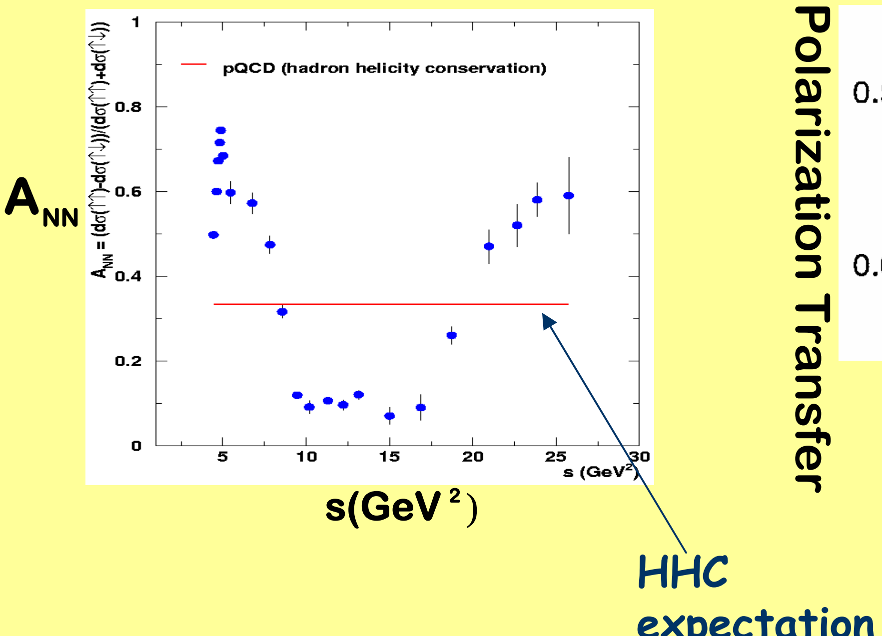
Hadron Helicity Conservation

Short distance pQCD predicts helicity conservation in exclusive two-body processes (A+B→C+D)

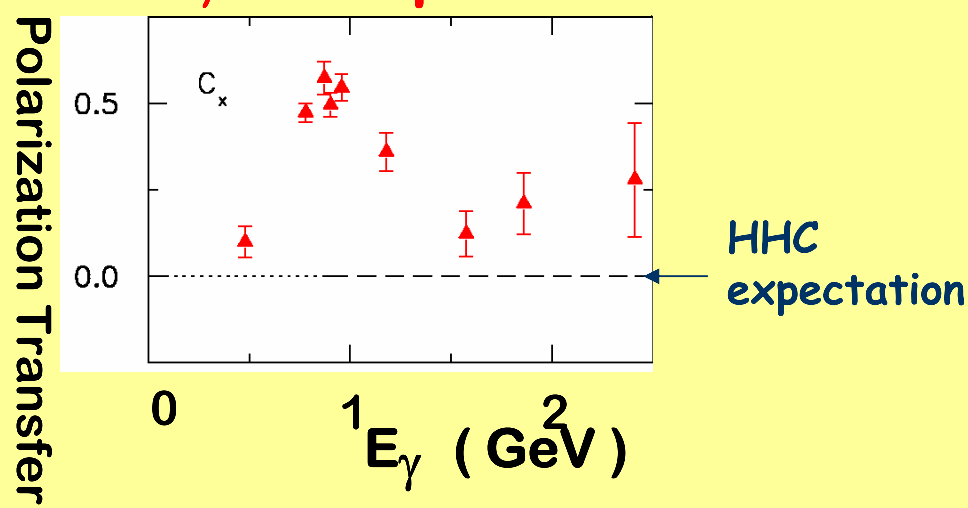
$$\lambda_A + \lambda_B = \lambda_C + \lambda_D$$

- **Based on quark helicity conservation, neglecting quark orbital angular momentum.**
- Experimental data tends not to agree with HHC.

elastic pp scattering; $A_{NN} = \frac{d\sigma(\uparrow\uparrow) - d\sigma(\uparrow\downarrow)}{d\sigma(\uparrow\uparrow) + d\sigma(\uparrow\downarrow)}$



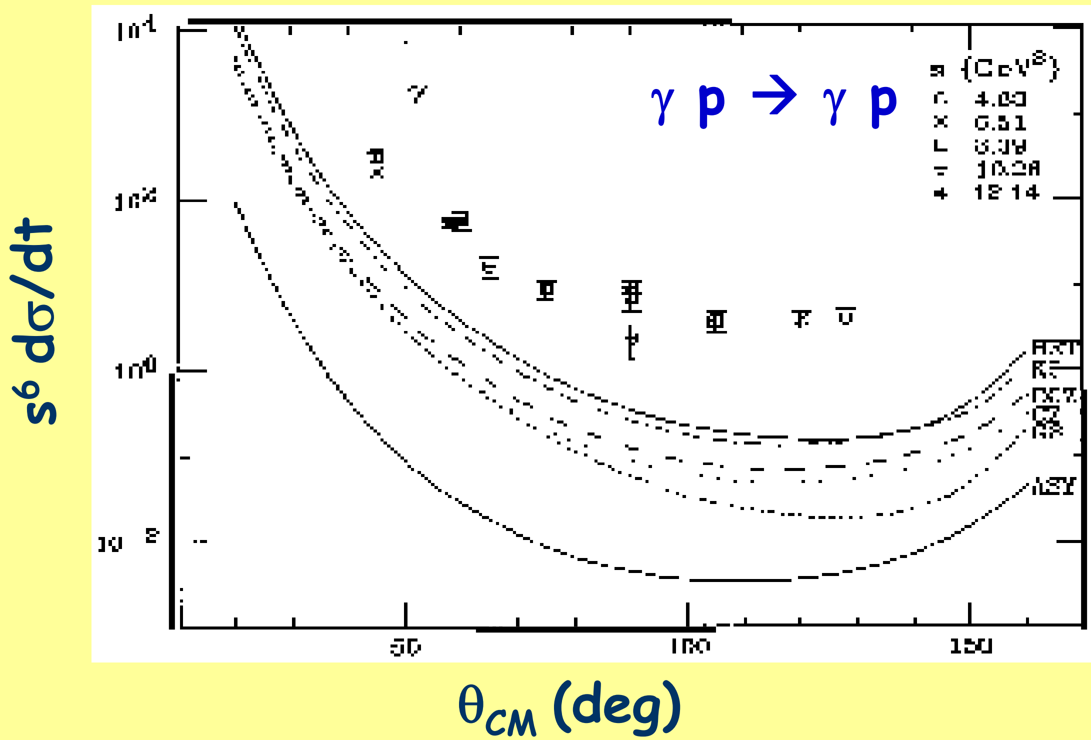
$\vec{\gamma} + d \rightarrow \vec{p} + n$



K. Wijesooriya *et al.*, PRL 86, 2975 (2001)

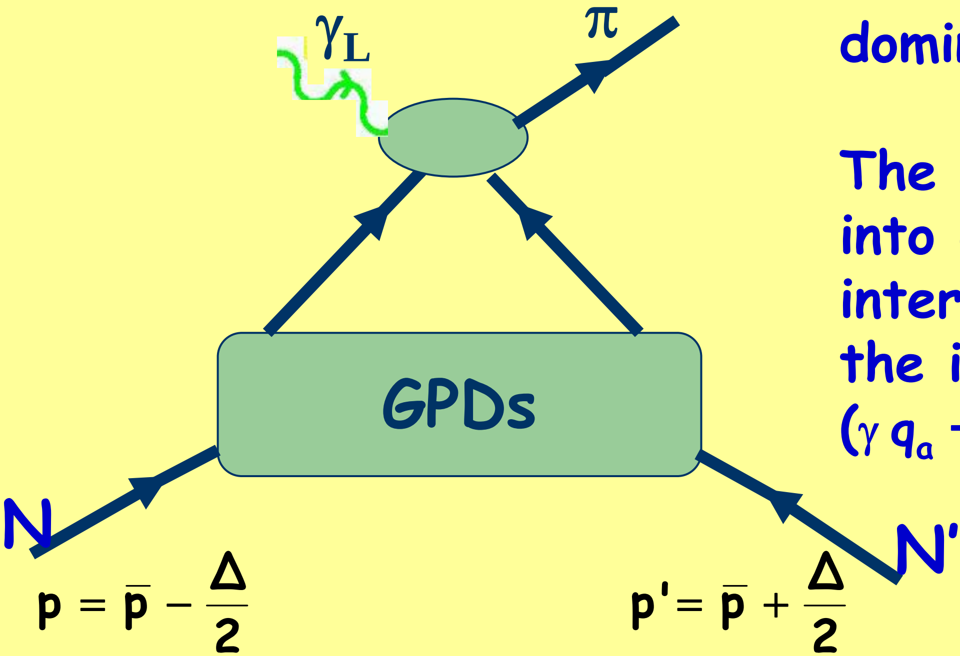
Cross-sections

pQCD based cross-section calculations for exclusive processes such as wide angle Compton scattering are invariably lower than measured values sometime by an order of magnitude.



Brooks and Dixon, PRD 62, 114021 (2000)

The Handbag Mechanism



An alternate framework assumes the dominance of the handbag mechanism.

The reaction amplitude factorizes into a sub-process involving a hard interaction with a single quark from the incoming and outgoing nucleon ($\gamma q_a \rightarrow \pi q_b$) and GPDs.

Recent DVCS and wide angle Compton scattering results disagree with pQCD predictions but are consistent with the dominance of handbag mechanism.

Pion photoproduction is next in complexity to wide angle Compton scattering and should be explored in these models.

Charged Pion Ratio

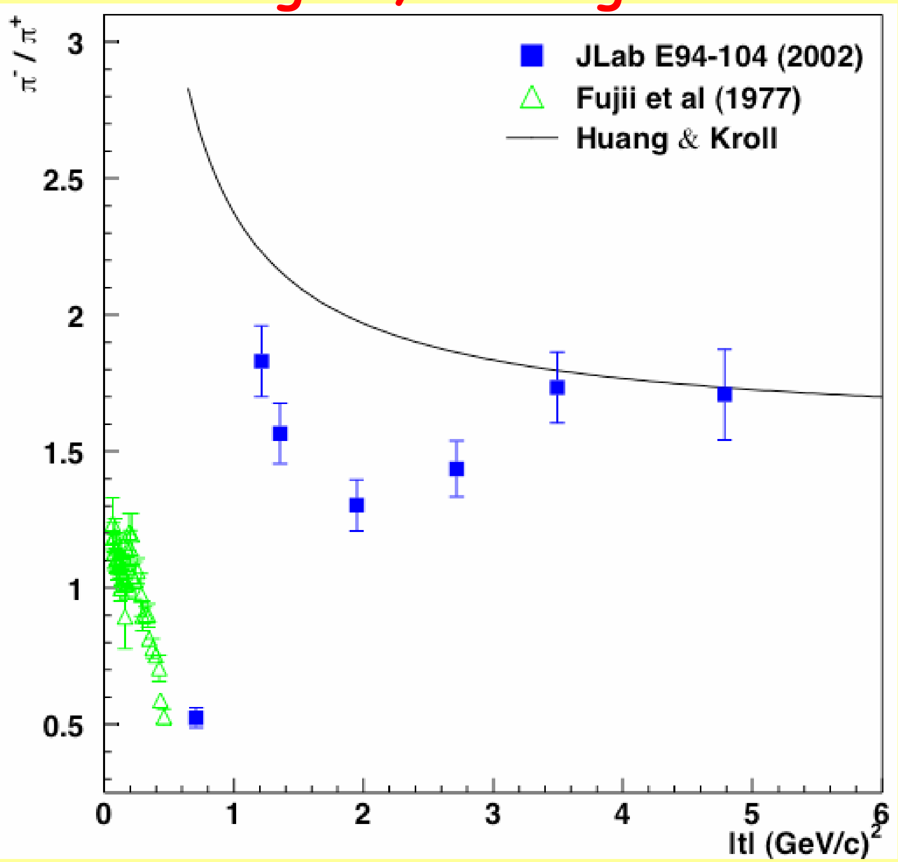
Some recent work already looks promising

Calculations in the framework of handbag mechanisms, with factorization into $\gamma\, q_a \rightarrow \pi\, q_b$ sub-process and GPDs, show that the GPD part of the contribution cancel in the ratio.

Huang & Kroll, EPJC, 17, 423 (2000), Huang, Jakob,Kroll & Passek-Kumericki, hep-ph/0309071, Afanasev, Carlson & Wahlquist, PLB 398, 393 (1997).

Onset of scaling expected to be earlier in ratio.

90 degree, CM angle



L.Y. Zhu, PRL 91, 022003 (2003)

Must extend these measurements to higher |t|

11 GeV Proposal

Measure the cross-section for the $\gamma p \rightarrow \pi^+ n$ process on a ^1H target and the $\gamma n \rightarrow \pi^- p$ (quasifree) process on a ^2H target, over a pion C.M. angular range of $30^0 < \theta_{CM} < 150^0$ in 15^0 steps..

.

A 6% radiation length copper radiator will be used to generate the bremsstrahlung photon beam. Standard Hall C cryotargets with HMS+SHMS in standard configuration will be used. Additional aerogel Cerenkov detector is needed.

PR12-06-103: D. Dutta, H. Gao and R. Holt

11 GeV Proposal

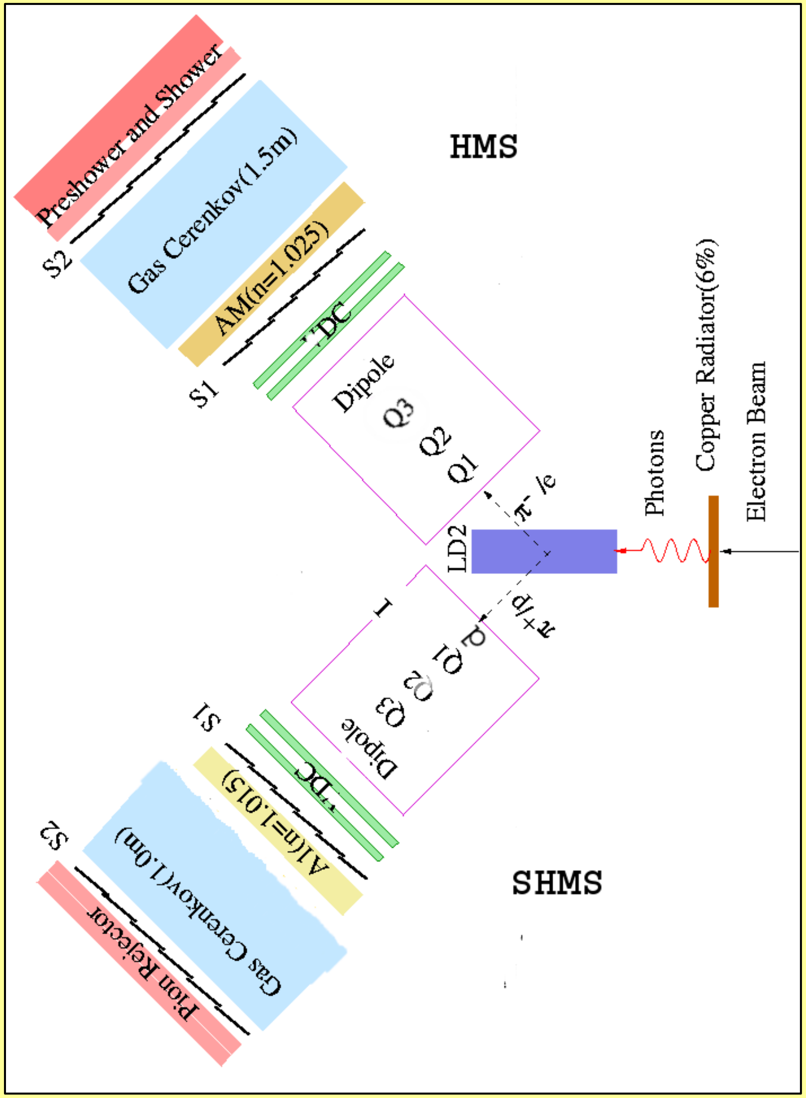
- Detailed investigation of the angular dependence of the onset of scaling as observed in deuteron photodisintegration. This will help understand the origins of the scaling behavior.

- Push these measurements to significantly higher CM energies beyond the charm threshold.

- Study the ratio of differential cross-sections for charged pion photoproduction from nucleons as a function of momentum transferred square. This ratio can be extended to significantly higher $|t| \sim 11\ (GeV/c)^2$ compared to the pion form factor experiment, which will go to $Q^2 \sim 6\ (GeV/c)^2$

- A successful completion can lead to later experiments that will use a finer scan in center of mass energy to investigate exciting new developments, such as the generalized counting rules.

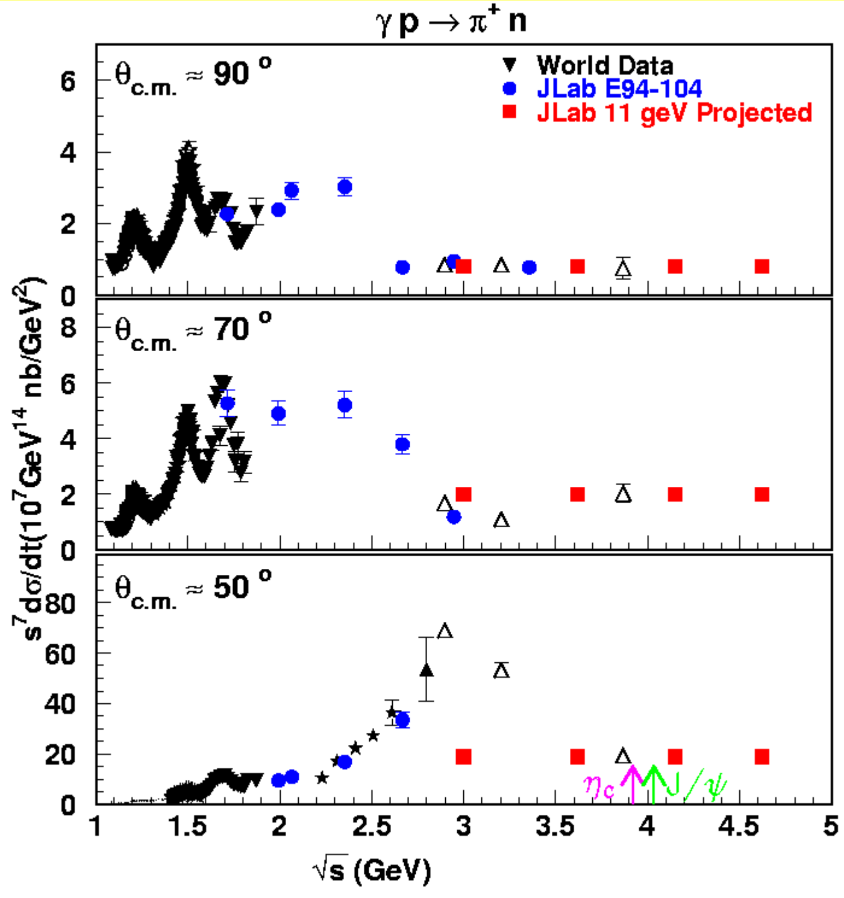
11 GeV Proposal

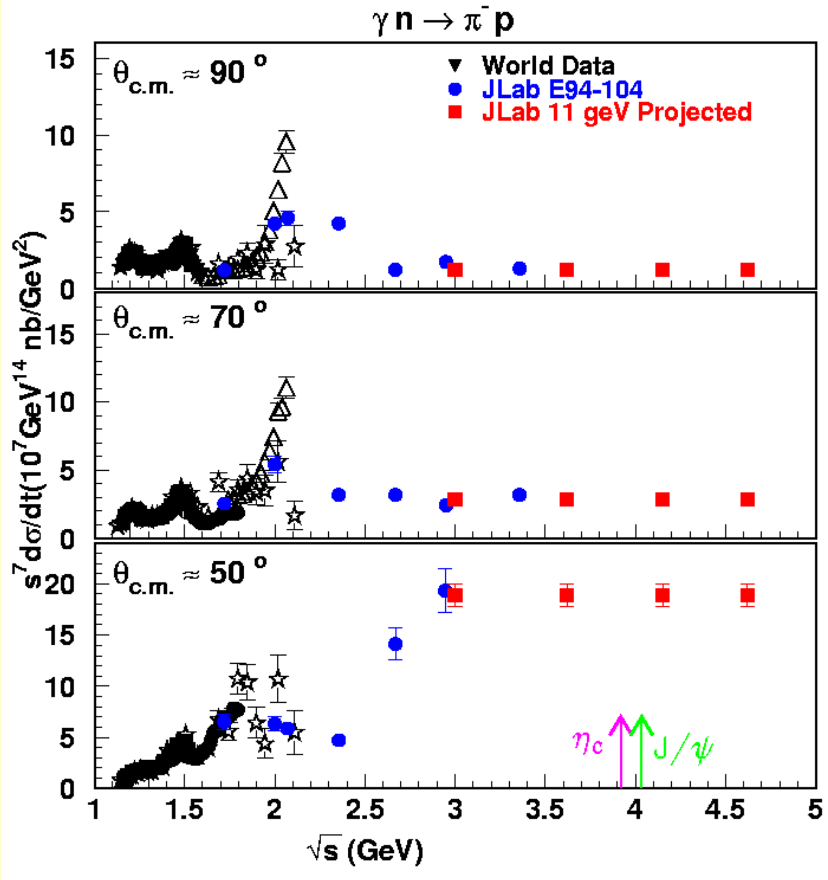


- 50 muA CW beam on 6% copper radiator
- LH2, LD2 targets
- HMS/SHMS for pi+ detection (for LH2 target)
- HRS for pi- and SHMS for P detection (for LD2 target, except at $\theta_{CM} > 135^0$)
- Gas Cerenkov detector for e/pi separation combination of aerogel and heavy gas Cherenkov for P/K/pi separation.

Projected Results

Extend measurements to high energies beyond the charm threshold

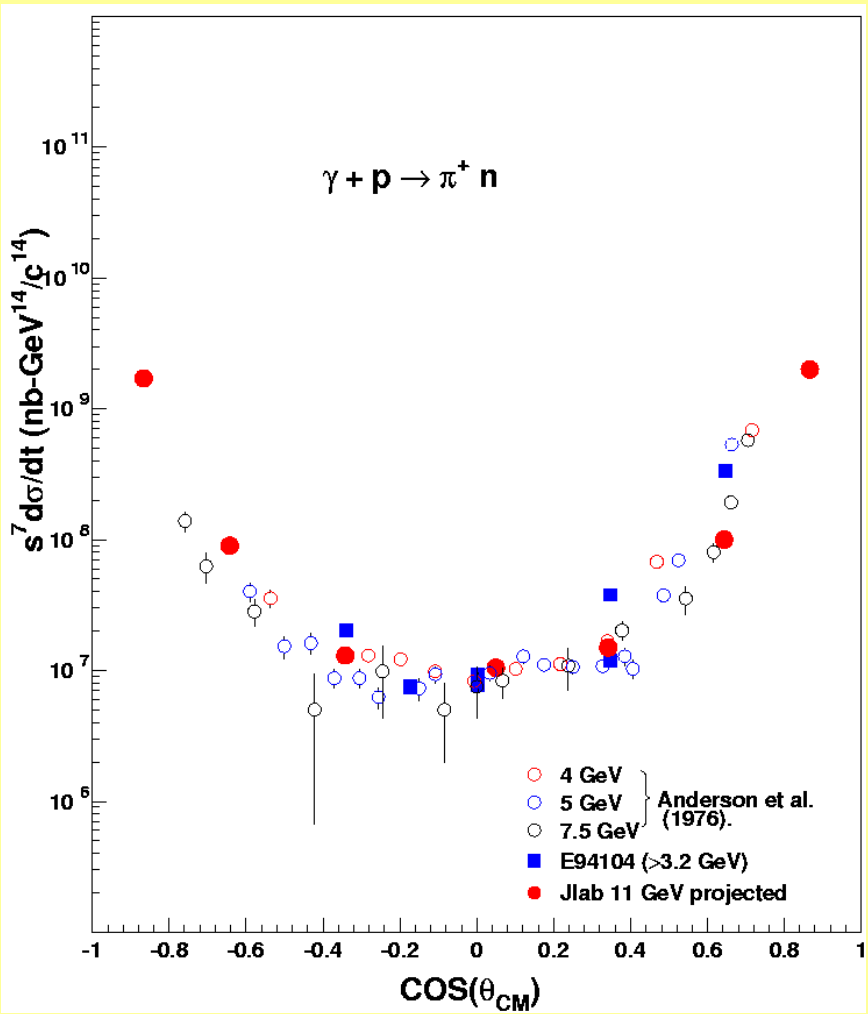


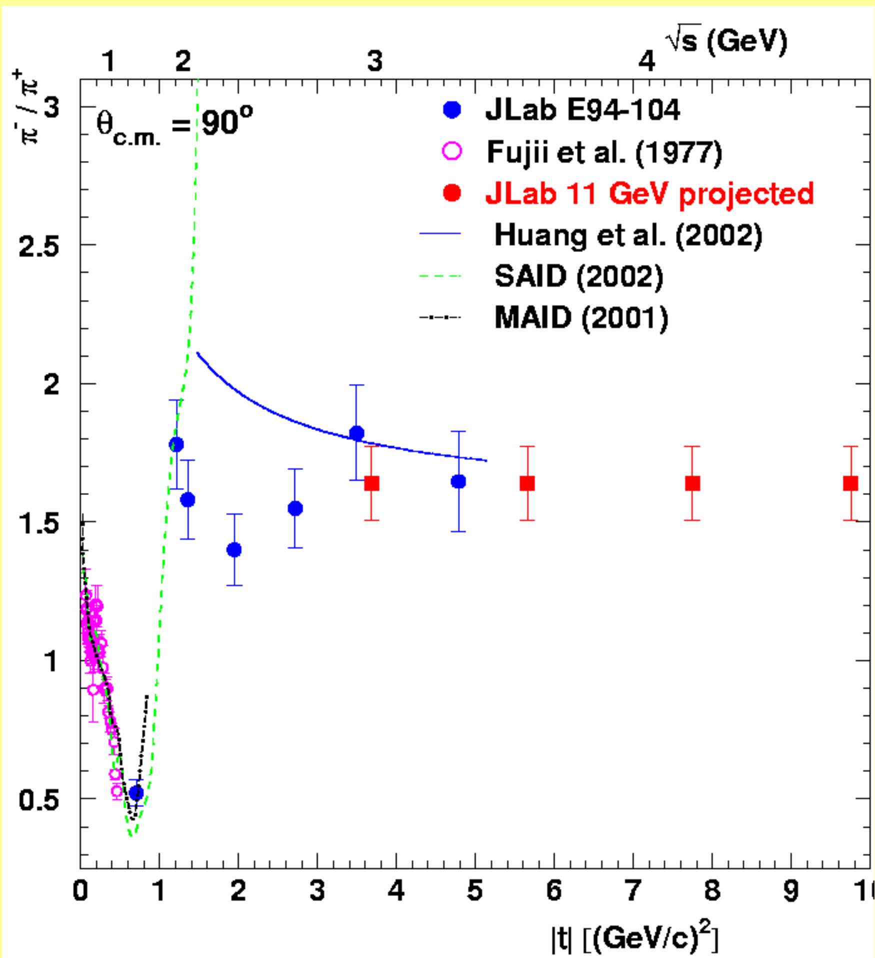


The systematic uncertainties (~8% total, 5% pt-to-pt) were estimated based on E94104 where it was dominated by calculation of the photon yield, pion absorption and decay, nuclear transparency correction for ^2H target, acceptance and PID.

Projected Results

Provide a wide angular coverage





Ratio measuremnt extended to very high |t|

Color Transparency
&
Nuclear Filtering

Color Transparency

CT refers to the vanishing of the h-N interaction for h produced in exclusive processes at high Q

A.H.Mueller in Proc. of 17th recontre de Moriond, Moriond, p13 (1982)
S.J.Brodsky in Proc. of 13th intl. Symposium on Multiparticle Dynamics, p963 (1982)

- At high Q , the hadron involved fluctuates to a small transverse size – called the PLC (quantum mechanics)
- The PLC remains small as it propagates out of the nucleus (relativity).
- The PLC experiences reduced attenuation in the nucleus – it is color screened (nature of the strong force).

CT is totally unexpected in a strongly interacting hadronic picture. But it is quite natural in a quark-gluon framework. It is very good indicator of a transition from hadron to quark dof.

Nuclear Filtering

What happens to the oscillatory scaling behavior in the nuclear medium ?

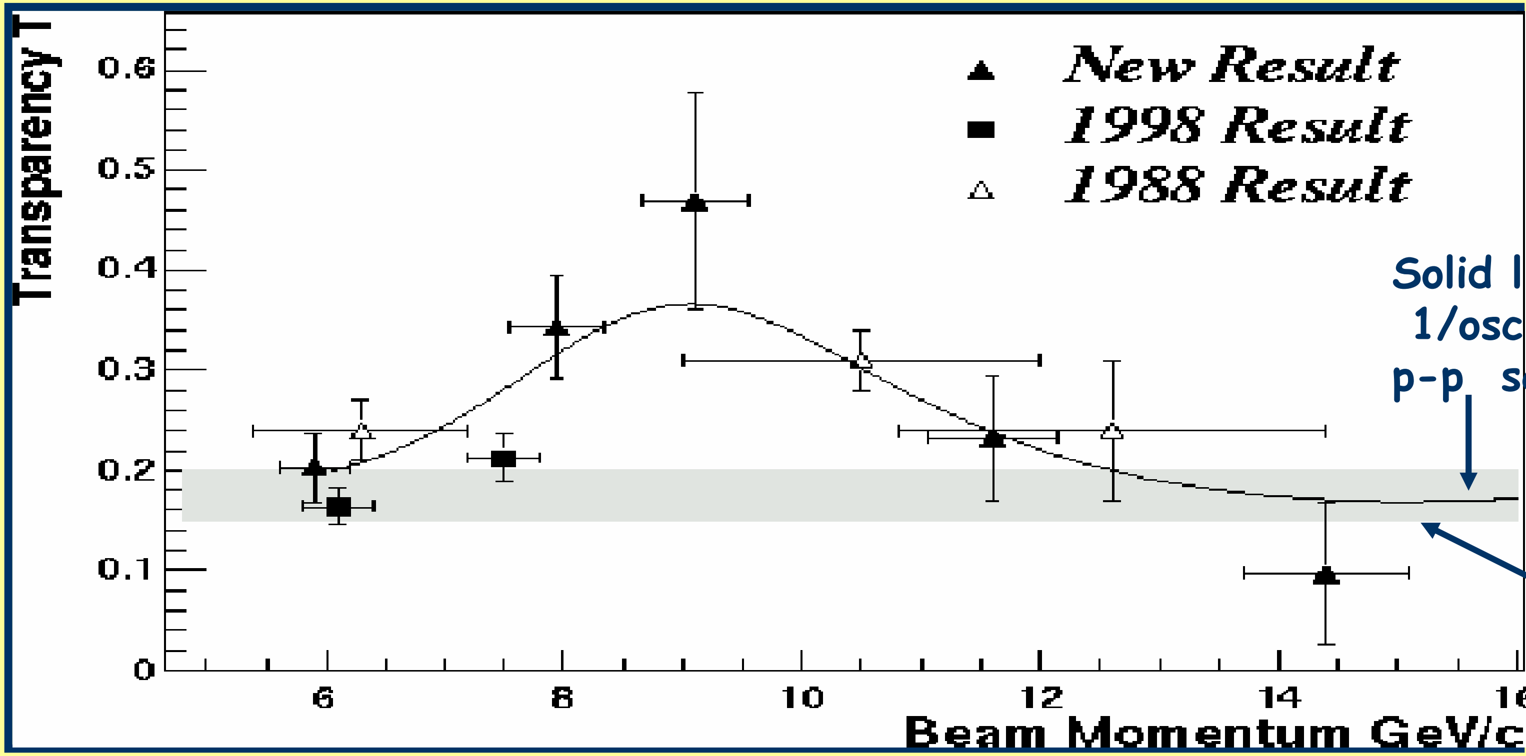
- It has been suggested that they are damped out because the long distance amplitude is suppressed in the nuclear medium.

- This is called " Nuclear Filtering."

- This implies there should be oscillations in nuclear transparency 180^0 out-of-phase with the oscillations in the free cross-section.

Transparency in A(p,2p) Reaction

First experiment to look for color transparency



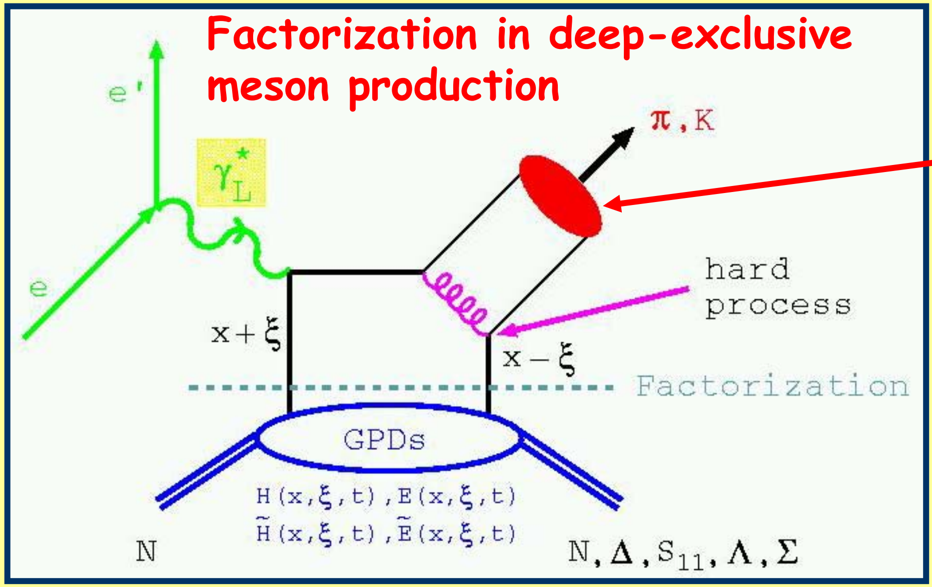
Solid line is fit to 1/oscillation in p-p scattering data

Shaded band Glauber calculation

Results inconsistent with CT only. But can be explained by including additional mechanisms such as nuclear filtering or charm resonance states.

CT & Factorization/GPDs

Factorization theorems have been derived for deep-exclusive processes and are essential for access to GPDs.



Meson distribution amplitude

calculable in pQCD

It is still uncertain at what Q^2 value reaches the factorization regime

Factorization is not rigorously possible without the onset of CT. - Strikman, Frankfurt, Miller and Sargsian

CT is a necessary but not sufficient condition for factorization

Connecting GPDs & CT

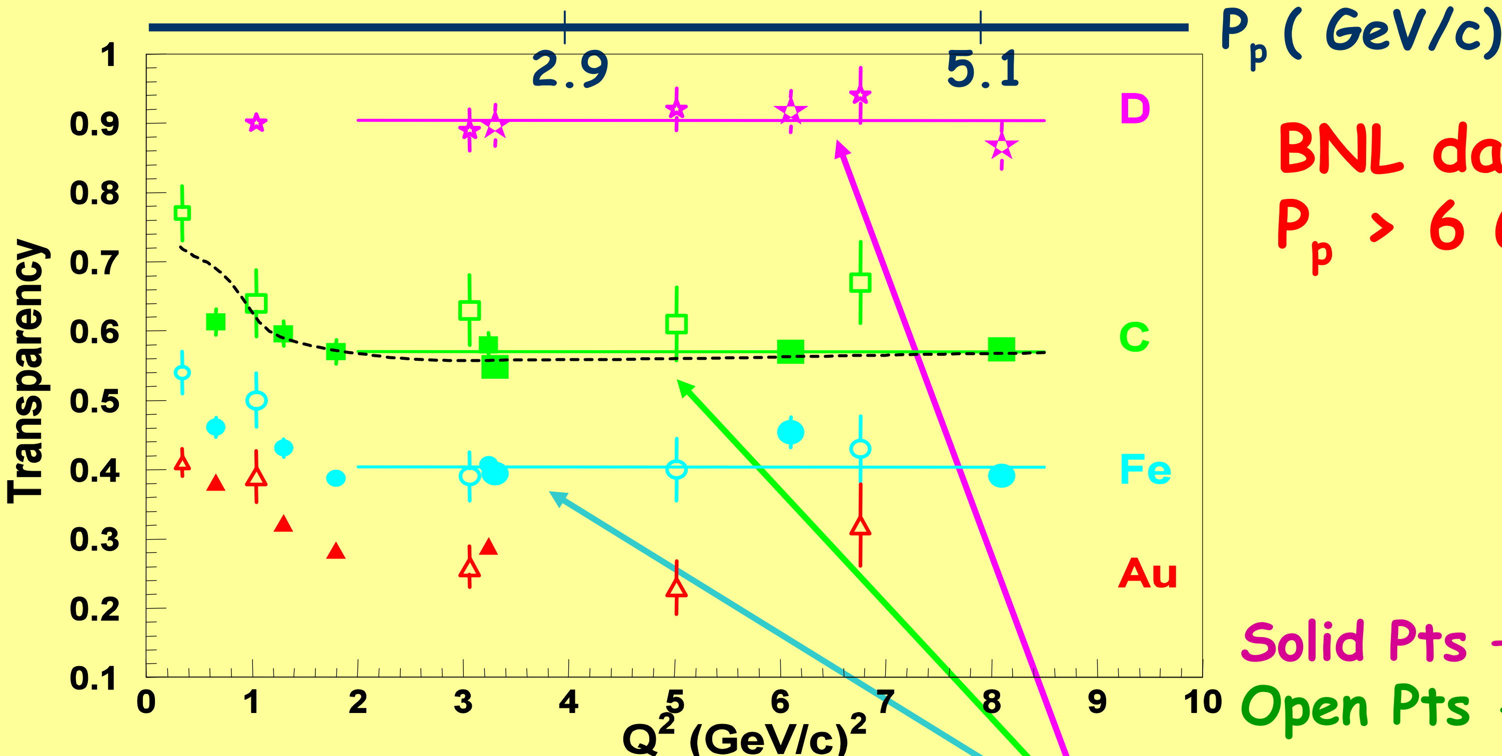
Recent theoretical work identifies connections between GPDs and CT.

M. Burkardt and G. Miller (hep-ph/0312190) have derived the effective size of a hadron in terms of GPD's:
Color transparency would place constraints on the analytic behavior and would provide testable predictions for GPD's

S. Liuti and S. K. Taneja (PRD 70,07419 (2004)) have explored structure of GPD in impact parameter space to determine characteristics of small transverse-separation components
Nuclei can be used as filters to map the transverse components of hadron wave function: i.e.a new source of information on GPD's

A(e,e'p) Results

Q^2 dependence consistent with standard nuclear physics calculations



BNL data
P_p > 6 GeV/c

Solid Pts – JLab
Open Pts -- other

Constant value fit for Q^2 > 2 (GeV/c)^2 has $\chi^2/\mathbf{df} \cong 1$

N. C. R. Makins et al. PRL 72, 1986 (1994)
G. Garino et al. PRC 45, 780 (1992)
D. Abbott et al. PRL 80, 5072 (1998)
K. Garrow et al. PRC 66, 044613 (2002)

Extending the A(e,e'p) Measurements

It is possible to extend the A(e,e'p) measurements to $Q^2 \sim 16\ (GeV/c)^2$, $P_p \sim 10$ GeV/c with SHMS+HMS

The peak in the BNL A(p,2p) transparency is at $P_p \sim 9$ GeV/c

The A(e,e'p) process will provide valuable information on the interpretation of the rise in transparency found in the BNL A(p,2p) experiments. This is true even if these experiments do not find a rise in transparency in the Q^2 range covered.

qqq vs $q\bar{q}$ systems

- There is no unambiguous, model independent, evidence for CT in qqq systems.

- Small size is more probable in 2 quark system such as pions than in protons.

  \- B. Blattel et al., PRL 70, 896 (1993)

- Onset of CT expected at lower Q^2 in $q\bar{q}$ system.

- Formation length is ~ 10 fm at moderate Q^2 in $q\bar{q}$ system.

- Onset of CT is directly related to the onset of factorization required for access to GPDs in deep exclusive meson production.

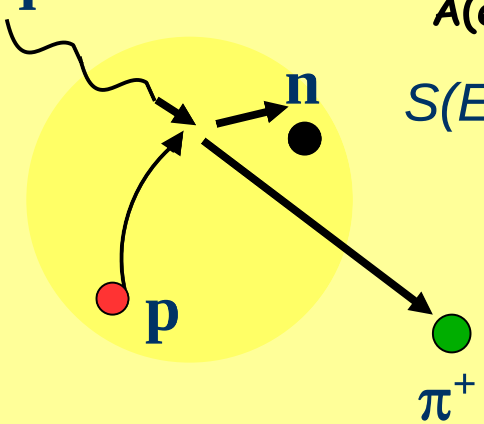
  \- Strikman, Frankfurt, Miller and Sargsian

$A(e,e'\pi^+)$ for CT Search

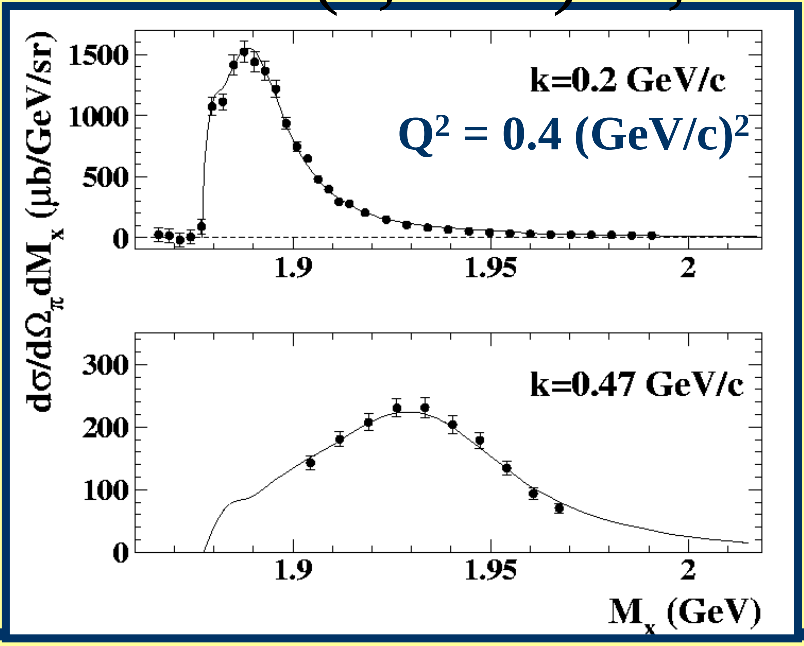
If π^+ electroproduction from a nucleus is similar to that from a proton we can determine nuclear transparency of pions.

$$\sigma_{A(e,e'\pi^+)X} = \sigma_{p(e,e'\pi^+)n} \otimes S(E,p)$$

$S(E,\mathbf{p})$ = Spectral function for proton



$^2H(e,e'\pi^+)nn,$



E91003 has demonstrated the ability to describe data via a quasifree reaction including fermi smearing, FSI and off-shell effects.

D.Gaskell, Ph.D Thesis

The Quasi-free Model

virtual photon flux

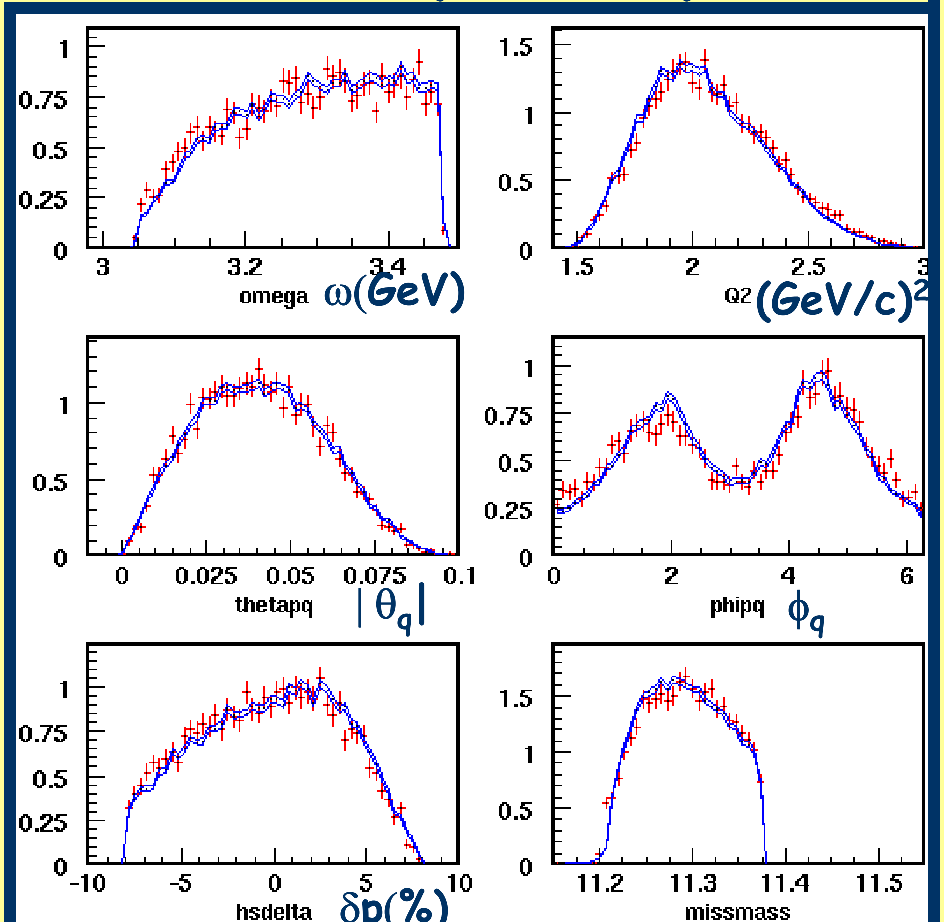
nucleon cross section from hydrogen data

$$\frac{d^6\sigma_A}{d\Omega_e dE d\Omega_\pi dP} = \frac{d}{dP}\int dE_m dp_m S(E_m, p_m) f_\Gamma \Gamma_v J \frac{d^2\sigma}{dt d\varphi}$$

spectral function

correction to flux for a moving proton

$^{12}C(e,e'\ \pi^+)$



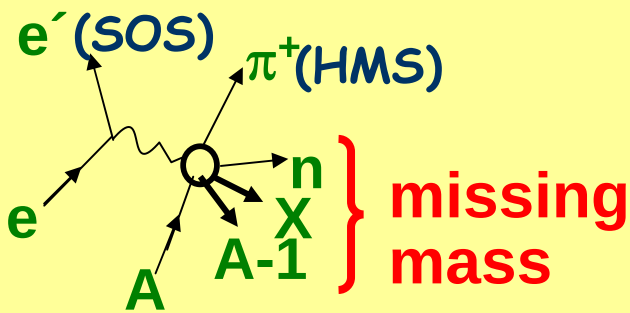
Data in Red

Blue is quasi-free model with

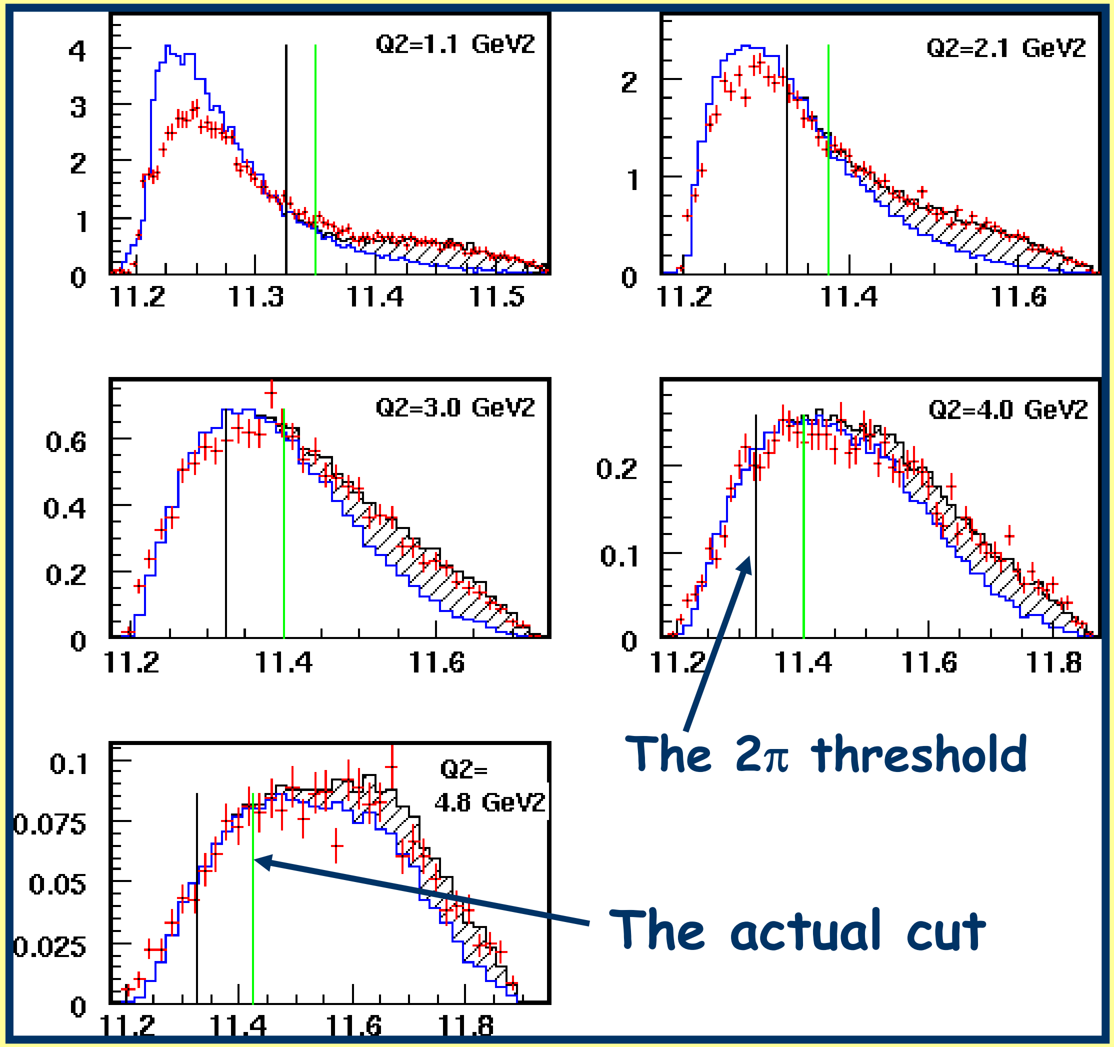
- ^{12}C spectral function
- Pauli Blocking[1]
- off-shell effects (both proton and spectator)

[1]Fermi distribution of Fantoni et al. (1984) including correlations

The multi-pion Background



$^{12}C(e,e'\ \pi^{+})$

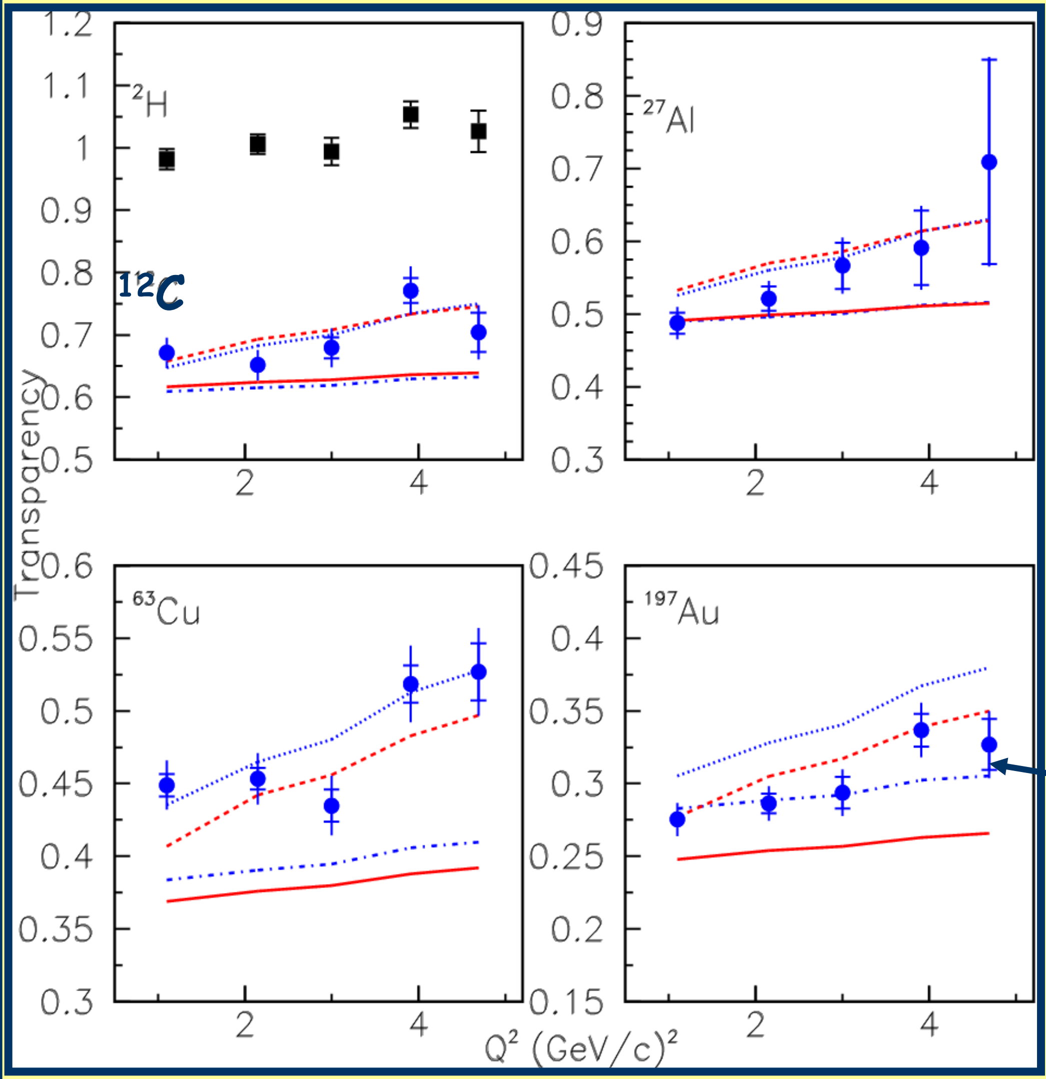


Data in Red

Blue is quasi-free model with

- ^{12}C spectral function
- Pauli Blocking
- off-shell effects

'Q²' Dependence of Transparency



$$T = \frac{(\text{Data/Simulation})_A}{(\text{Data/Simulation})_p}$$

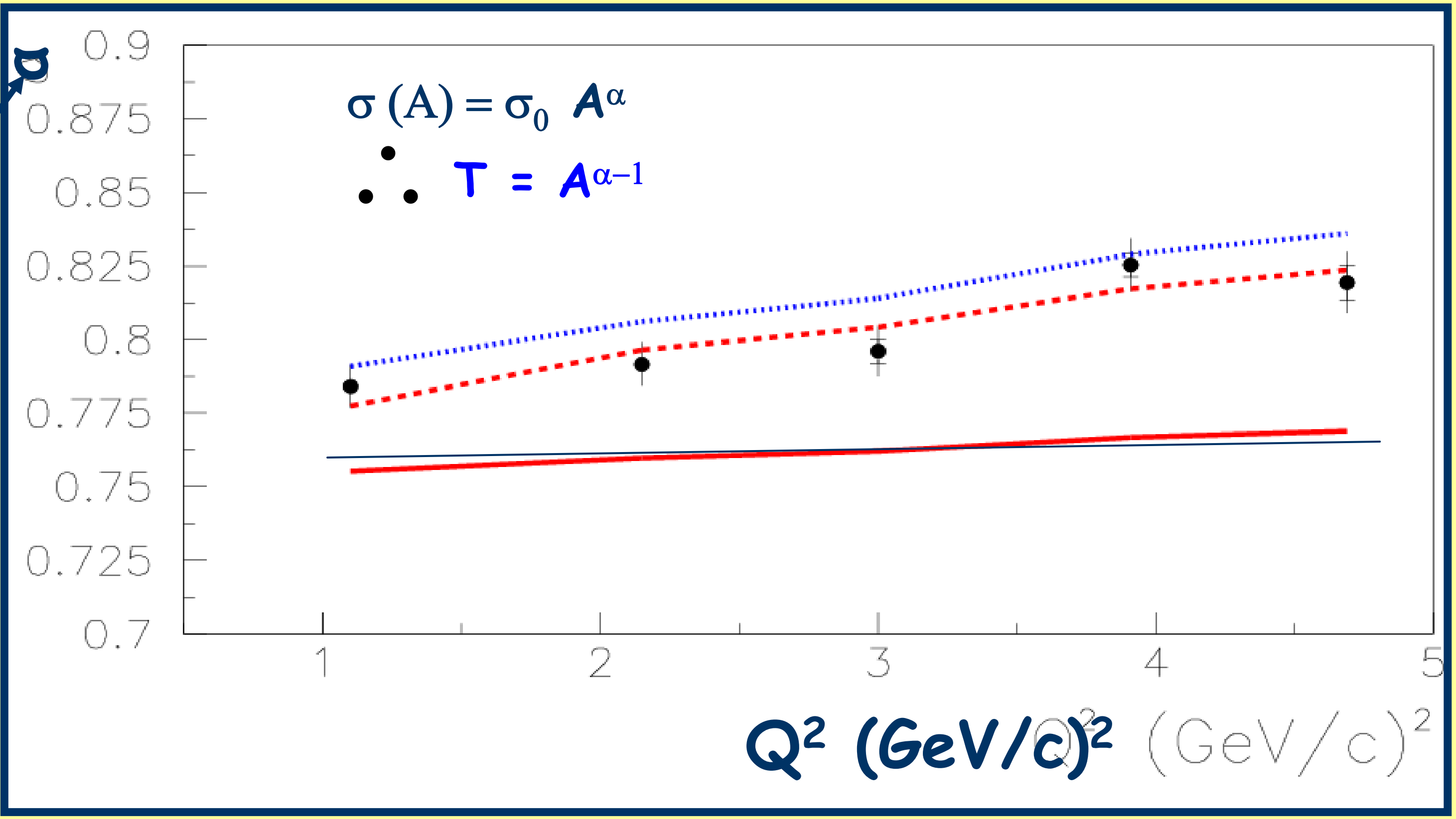
Red solid : Glauber (semi-classical)
Red dashed : Glauber +CT (quantum diff.)
Larson, Miller & Strikman, PRC 74, 018201 ('06)

Blue dot-dash : Glauber (Relativistic)
Blue dotted : Glauber +CT (quantum diff.) +SRC
Cosyn, Martinez, Rychebusch & Van Overmeire, PRC 74, 062201R ('06)

Inner error bar are statistical uncertainties outer error bar are the quadrature sum of statistical and pt. to pt. systematic uncertainties.

B. Clasie et al. PRL 90, 10001, (2007)

'A' Dependence of Transparency



from fit of
$T(A) = A^{\alpha-1}$
at fixed Q^2

line: α = 0.76 from Pion nucleus scattering
Carroll et al., PLB 80, 319 ('79)

B. Clasie et al. PRL 90, 10001, (2007)

Red solid : Glauber (semi-classical)
Red dashed : Glauber +CT (quantum diff.)
Larson, Miller & Strikman, PRC 74, 018201 ('06)

Blue dashed : Glauber +CT (quantum diff.) +SRC
Cosyn, Martinez, Rychebusch & Van Overmeire, PRC 74, 062201R ('06)

11 GeV Experiment

A(e,e'π)

- A sensitive search for the onset of CT phenomena in a region of Q^2 that seems optimally suited for this search
- The A(e,e'π^+) process can validate the strict applicability of factorization theorems for meson electroproduction experiments.

A(e,e'p)

- The A(e,e'p) process will provide valuable information on the interpretation of the rise in transparency found in the BNL A(p,2p) experiments. This is true even if these experiments do not find a rise in transparency in the Q^2 range covered.

E12-06-107: D. Dutta and R. Ent

11 GeV Experiment

Measure A(e,e'p) cross-section on ^{1}H and ^{12}C with 80μA, 8.8 and 11.0 GeV beam.

Cover Q^2 range of 8.0 – 16.0 $(GeV/c)^2$ (P_p ~ 5.0 – 9.6 GeV/c)

Targets: 15 cm (2%) liq. ^{1}H and 6% solid ^{12}C

HMS: electron arm, SHMS: hadron arm

Measure A(e,e'π) cross-section on ^{1}H, ^{2}H, ^{12}C and ^{63}Cu with 80μA, 11 GeV beam.

Cover Q^2 range covered 5.0 – 9.5 $(GeV/c)^2$

Targets: 15 cm (2%) liq. ^{1}H and ^{2}H, and 6% solid ^{12}C and ^{63}Cu

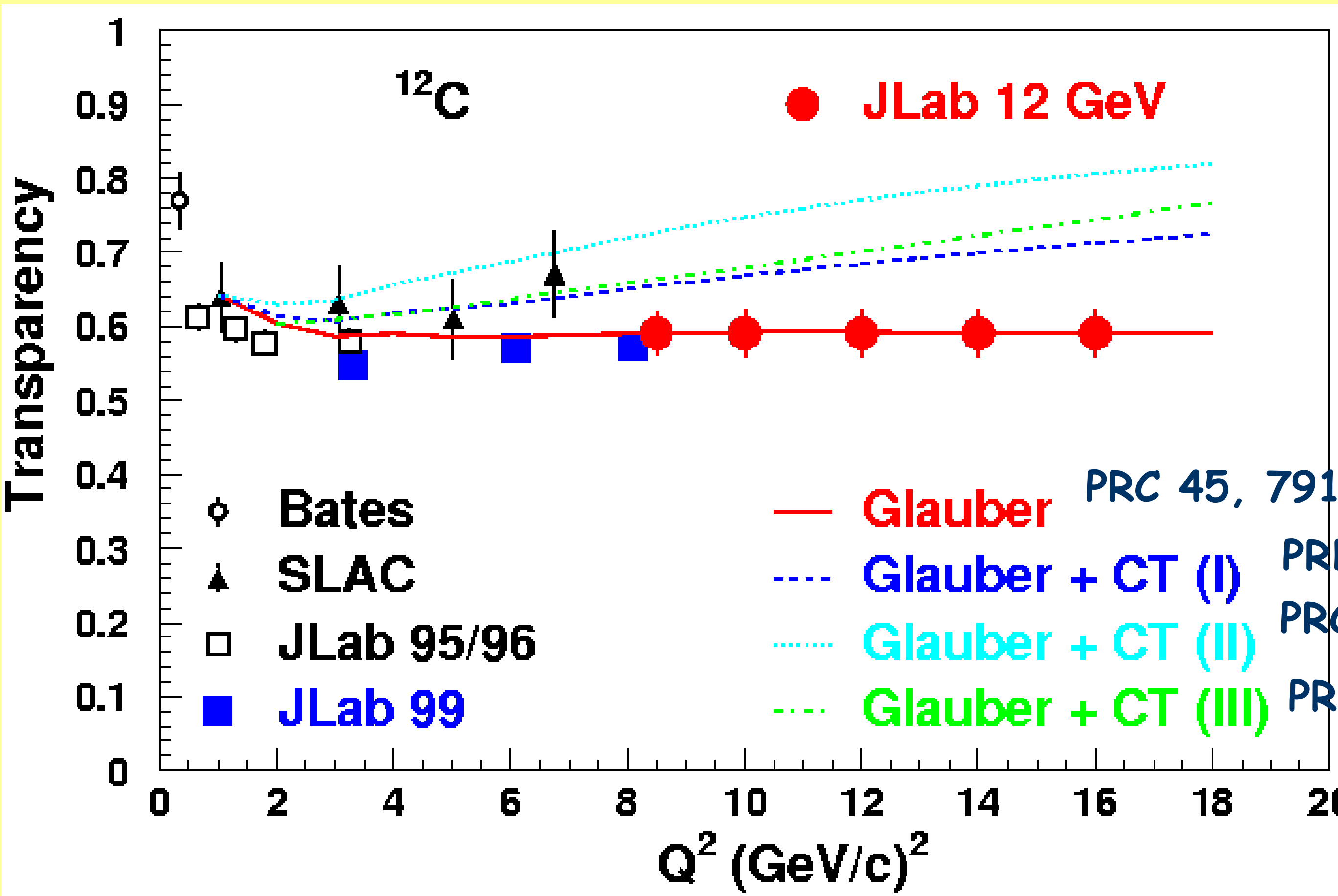
HMS: electron arm, SHMS: hadron arm

PID: Standard detector package + Aerogel in SHMS

Projected Results

A(e,e'p)

stat + syst. uncertainties



Can help interpret the rise seen in the BNL A(p,2p) data.

PRC 45, 791 (1992)

PRD 62, 113009 (2000)

PRC 50, 2189 (1994)

PRC 50, R1296 (1994)

Peak of BNL A(p,2p) results at P_p = 9 GeV/c

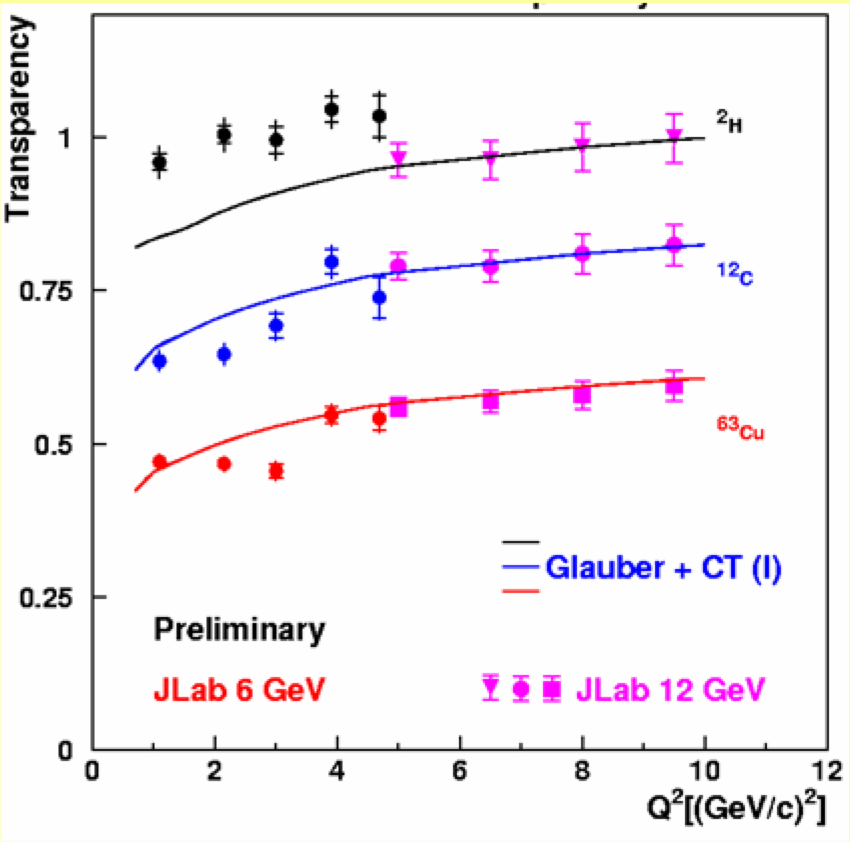
2.9 5.1 7.3 9.6 P_p (GeV/c)

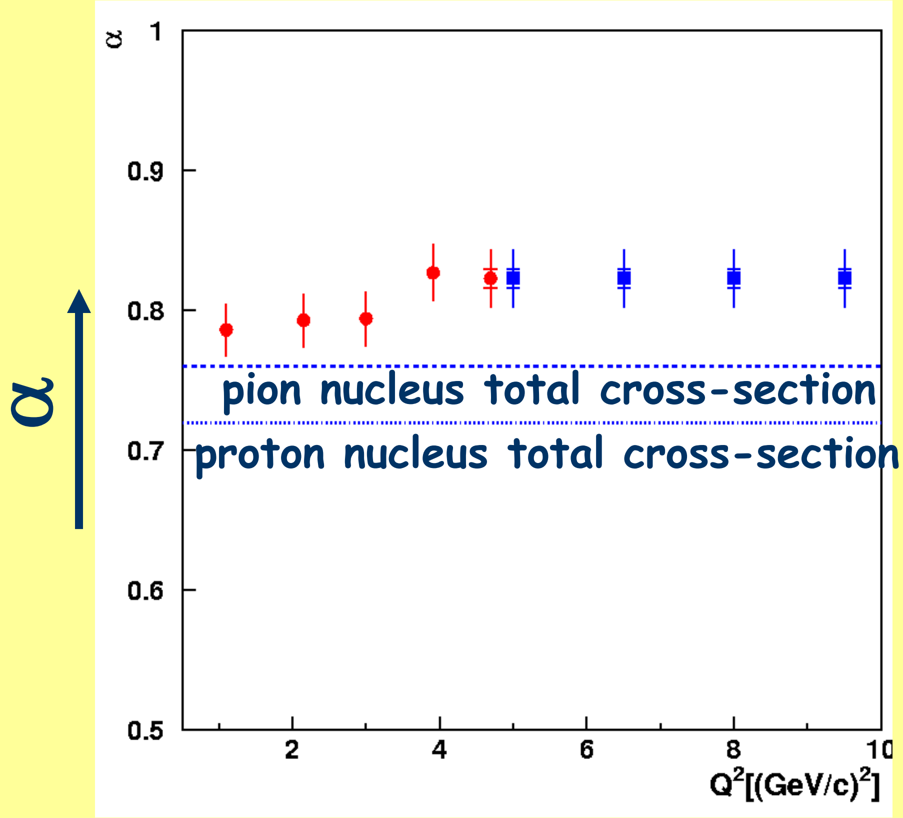
Projected Results

Cu theory curve scaled by 10% to match data.

$A(e,e'\pi^+)$

Preliminary results and projections shown with stat. + pt-to-pt syst. uncertainties only





Solid lines : Kundu et al. PRD 62, 113009 (2000)

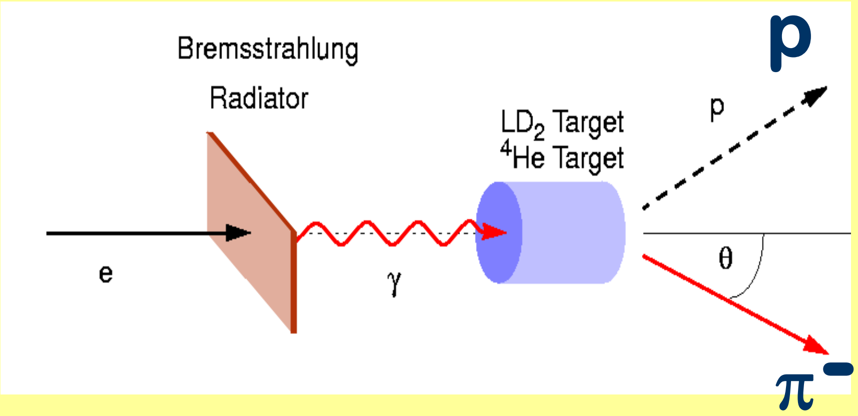
$A(e,e'\pi)$ results will verify the strict applicability of factorization theorems for meson electroproduction

Pion Photoproduction

Hall A Experiment E94-104

(H. Gao & R. Holt Spokespersons)

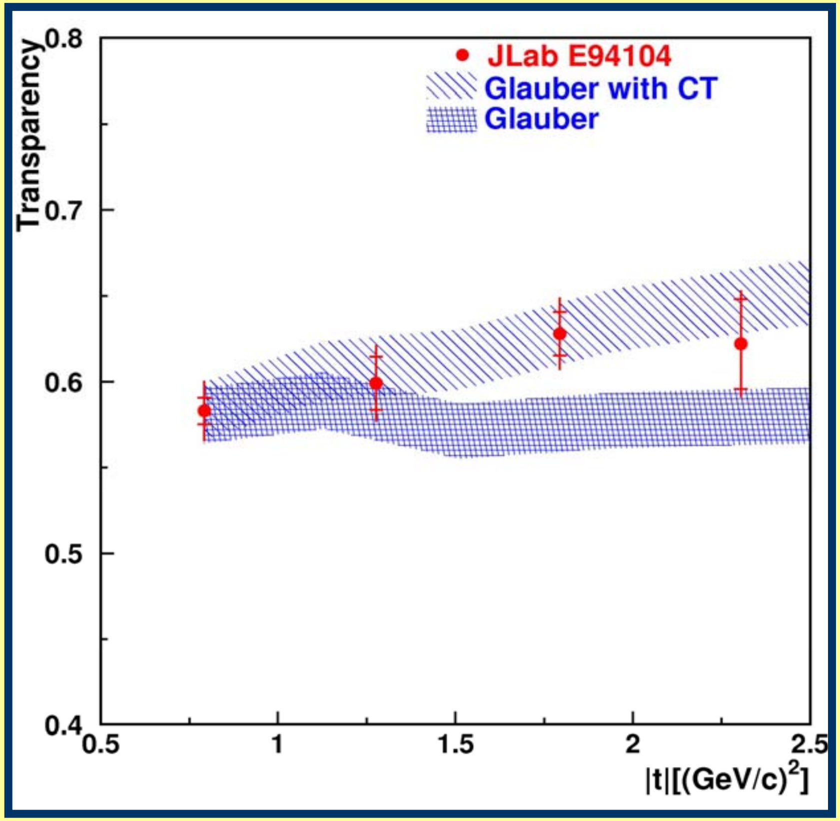
$$\gamma + {}^4\mathrm{He} \longrightarrow \pi^- + p + X \Big/ \gamma + D \rightarrow \pi^- + p + (p)$$

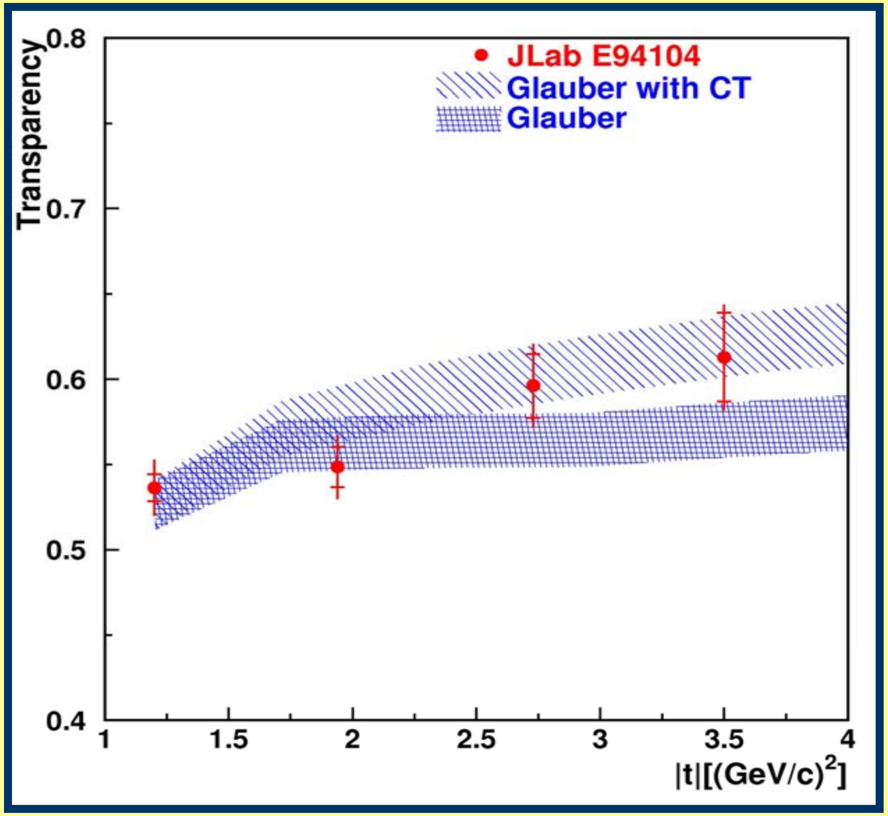


$$T = \frac{\left(\dfrac{Y_{data}}{Y_{MC}}\right)_{\gamma + {}^4He \rightarrow \pi^- + p + {}^3He}}{\left(\dfrac{Y_{data}}{Y_{MC}}\right)_{\gamma + {}^2H \rightarrow \pi^- + p + p}} T({}^2H)$$

$^4He(\gamma,\pi^- p)$ Results

70^0 pion C.M. angle | **90^0 pion C.M. angle**





Deviations from Glauber !

Dutta et al. PRC 68, 021001R (2003)
Gao et al. PRC 54, 2779 (1996)

11 GeV Proposal

- Measure A(γ,π^-p) cross-section on ^{4}He and D targets with 20-50 μA electron beam on 6% copper radiator with five different electron energies between 3.3 and 11.0 GeV, using bremstrahlung end point technique.

- t: 3.0-9.0 GeV^2 s: 7.5-20 GeV^2

- Target: ^{4}He, LD_2, LH_2 (background study).
- HMS: π^- 2.0-5.25 GeV/c 23.8-37.5 deg
- SHMS: proton 2.3-5.65 GeV/c 22.0-31.4 deg

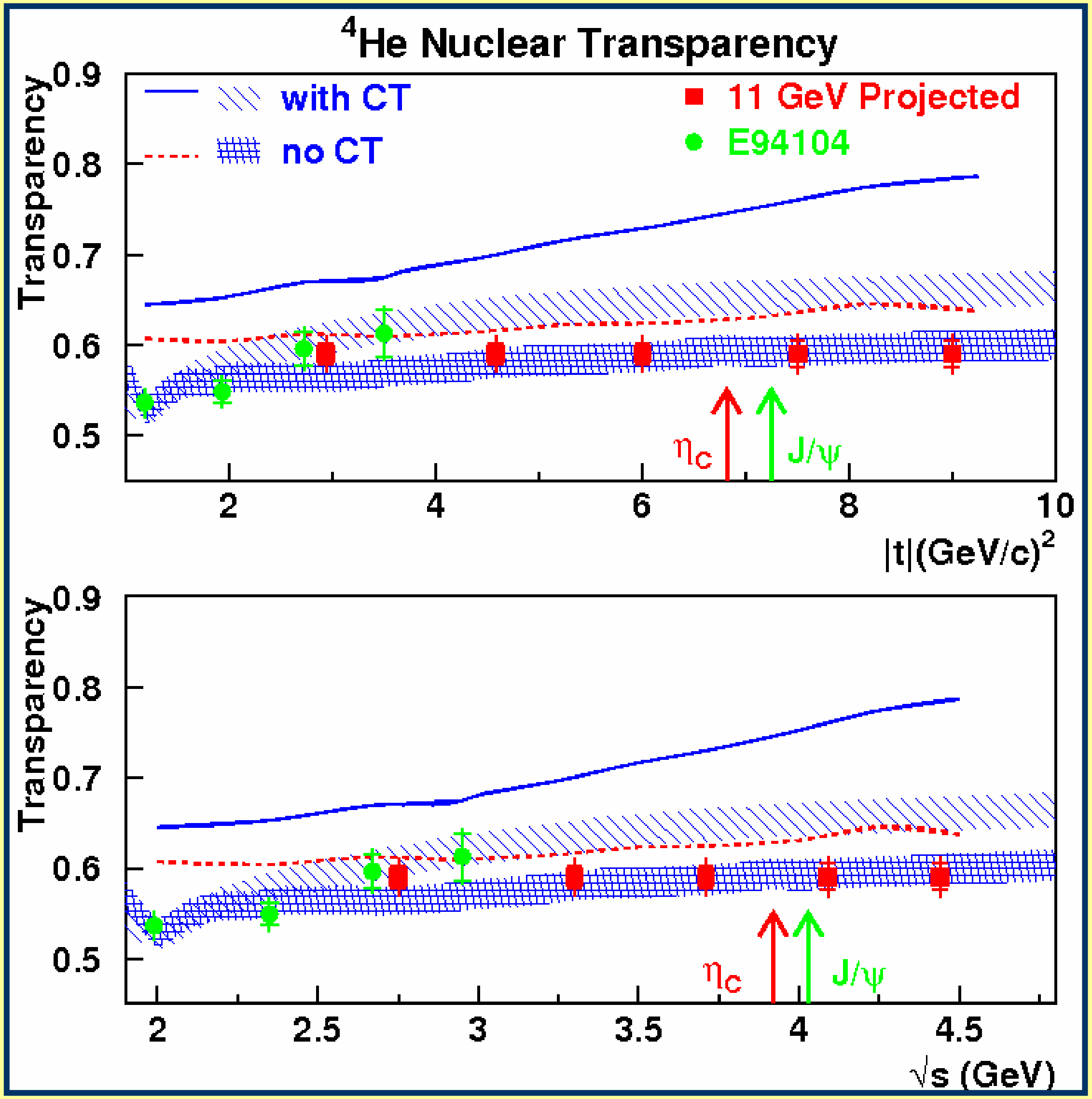
- PID: Gas-Cerenkov, Shower Counter for HMS to reject electron. Gas-Cerenkov and aerogel detector will reject positron and π^+ in SHMS.

PR12-07-103: D. Dutta and H. Gao

$^4He(\gamma, p\pi^-)$ at 11 GeV

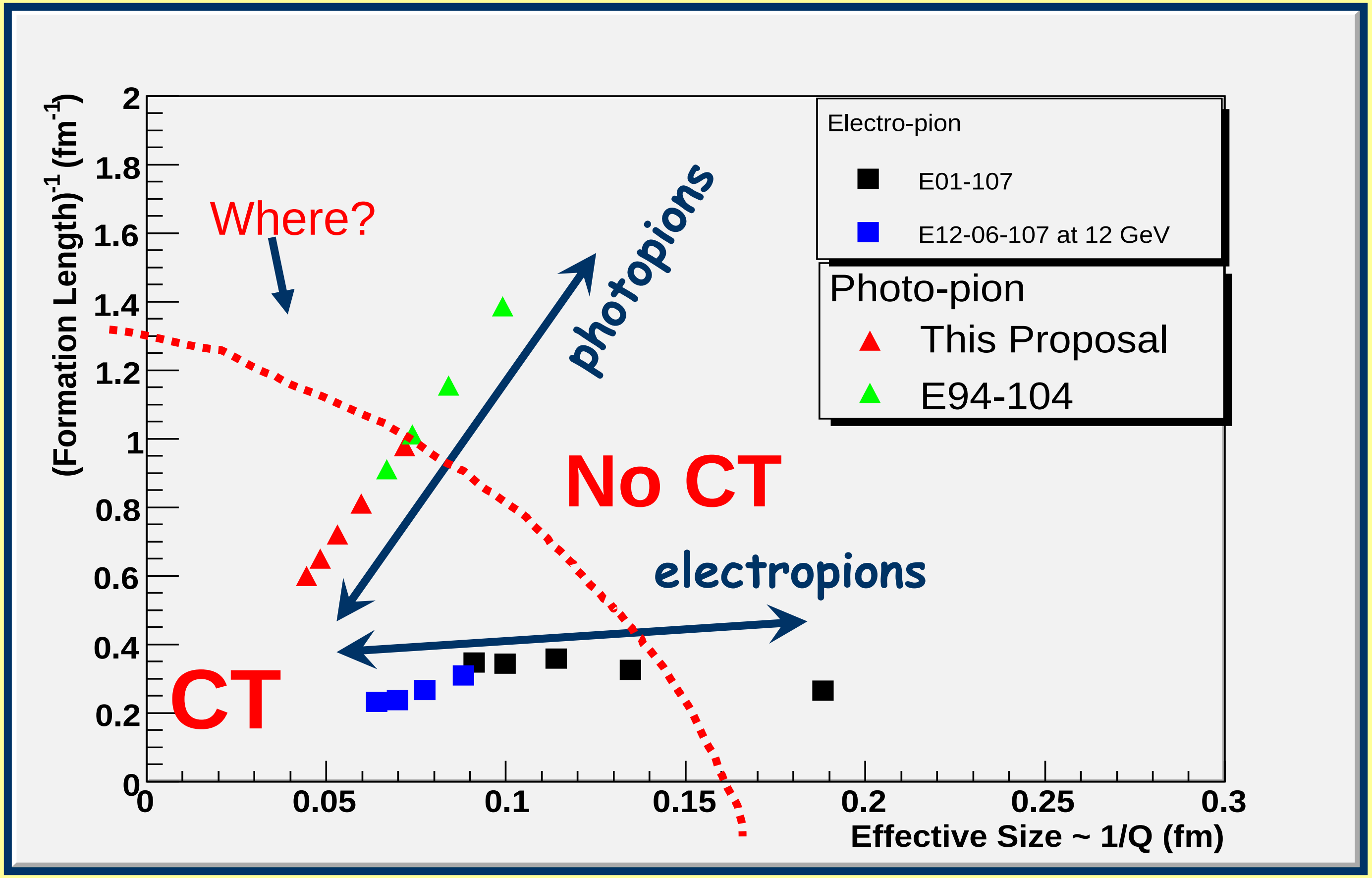
$$T = \frac{\gamma + {}^4\mathbf{He} \rightarrow \pi^- + \mathbf{p} + \mathbf{X}}{\gamma + {}^2\mathbf{H} \rightarrow \pi^- + \mathbf{p}} \mathbf{T}({}^2\mathbf{H})$$

Measures across the charm threshold, it could help understand the p2p results from BNL



Need Both Electro and Photo Pions

Formation length
~ $P_h * \Delta t / m_h$

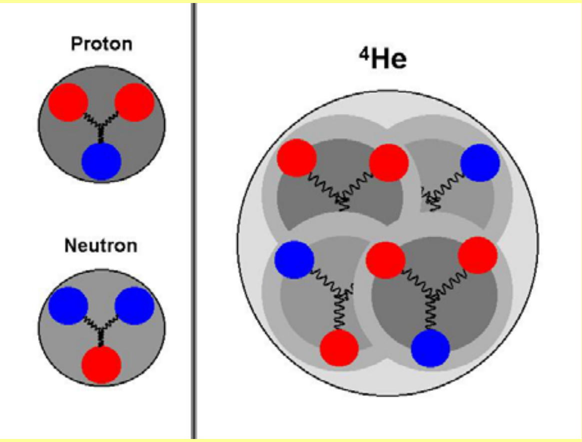


Effective Size ~ 1/Q

- Electro produced pions and photo produced pions sample different regions of the "Formation Length" vs " PLC Size" space

Hadrons in the Nuclear Medium

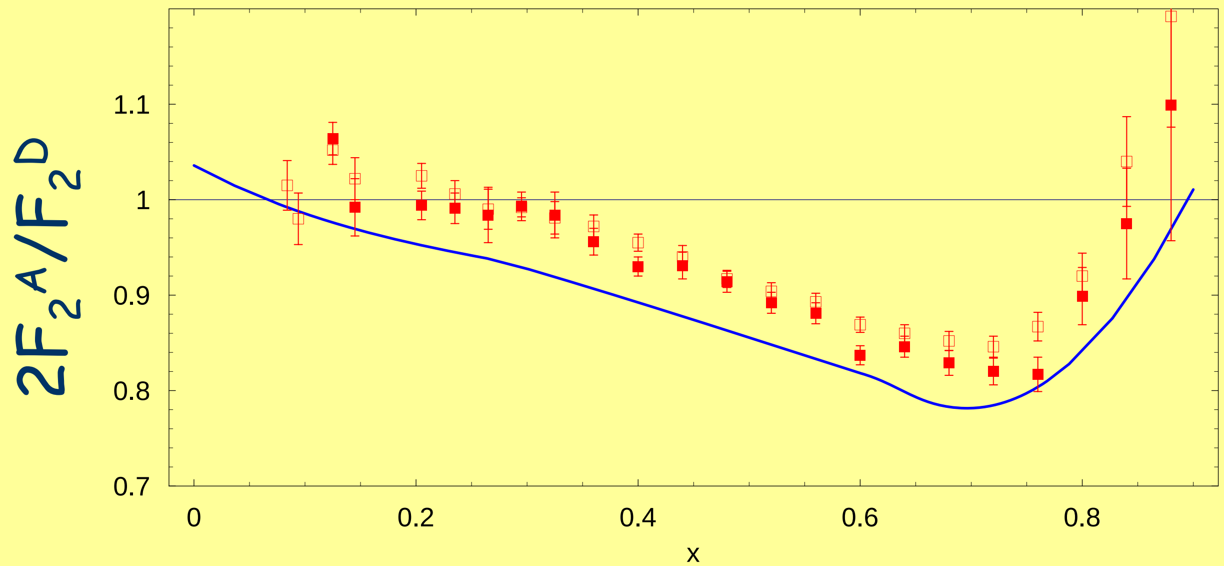
- At nuclear matter densities of 0.17 nucleons/fm^3, nucleon wave functions overlap considerably.



- EMC effect: Change in the inclusive deep-inelastic structure function of a nucleus relative to that of a free nucleon.

The EMC Effect

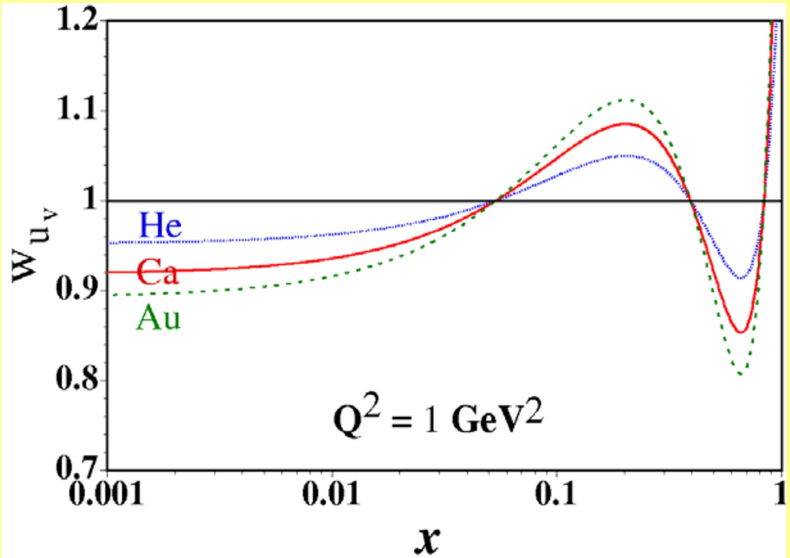
European Muon Collaboration:
muon scattering to measure nuclear structure functions

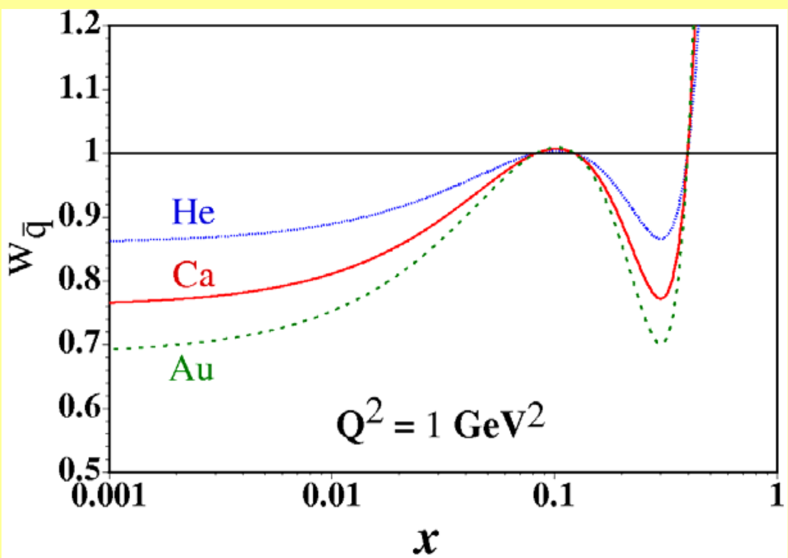


1982

- nuclear structure function $F_2^A(x)$ **depleted in $0.3<x<0.8$** (valence quark region)
- **Specific cause for depletion remains unclear: conventional nuclear effects or nucleon swelling?**
- **J. Smith & G.A. Miller (2003): chiral quark soliton model of the nucleon**
  claim: **Conventional nuclear physics does not explain full EMC effect**

Nuclear PDFs





$$u_v^A(x, Q_0^2) = w_{u_v}(x, A, Z)\,\frac{Z u_v(x, Q_0^2) + N d_v(x, Q_0^2)}{A},$$

$$d_v^A(x, Q_0^2) = w_{d_v}(x, A, Z)\,\frac{Z d_v(x, Q_0^2) + N u_v(x, Q_0^2)}{A},$$

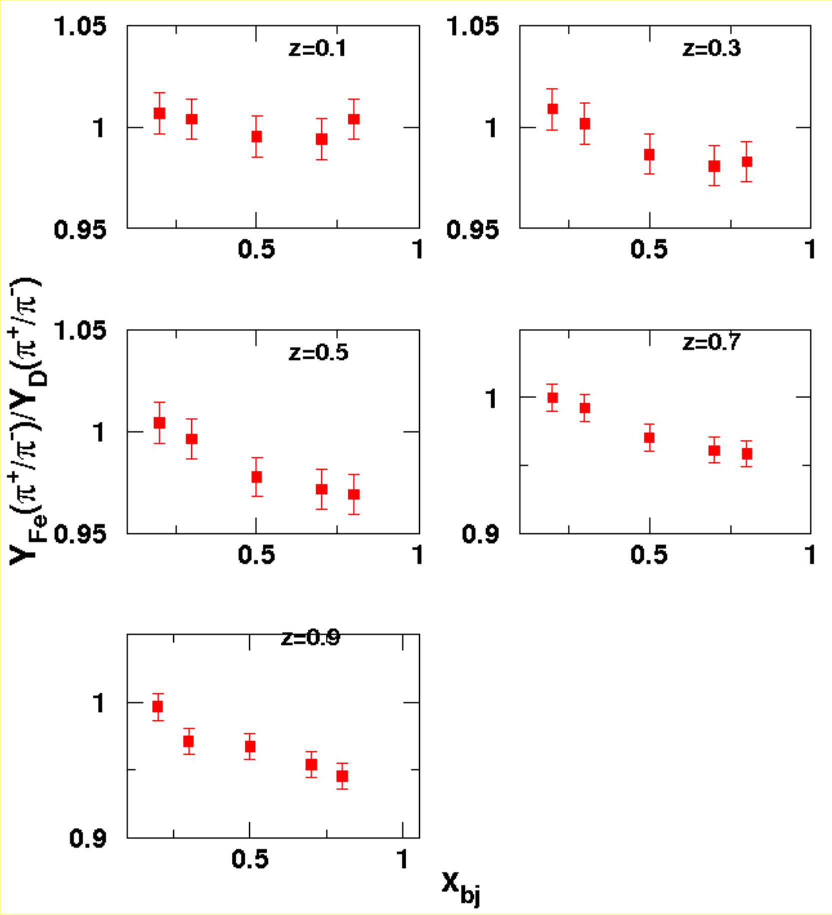
$$\bar{q}^A(x, Q_0^2) = w_{\bar{q}}(x, A, Z)\,\bar{q}(x, Q_0^2),$$

$$g^A(x, Q_0^2) = w_g(x, A, Z)\,g(x, Q_0^2).$$

Un-packing the EMC Effect

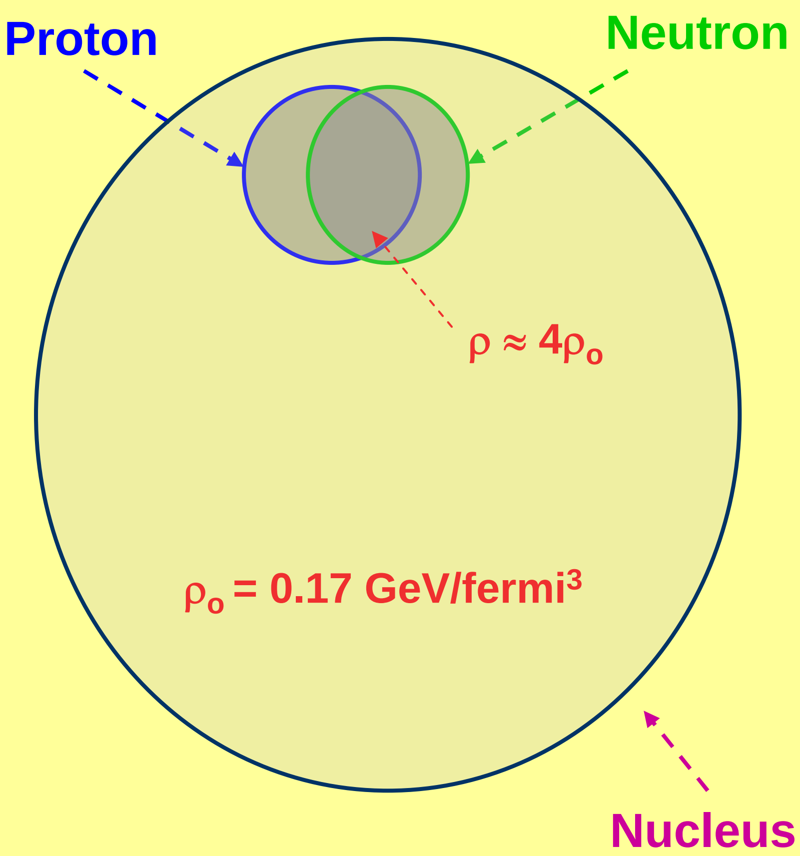
Using ratio of charged pion electroproduction from Nuclei to Deuterium in the DIS region.

$$\frac{\sigma_A(\pi^+/\pi^-)}{\sigma_D(\pi^+/\pi^-)}$$

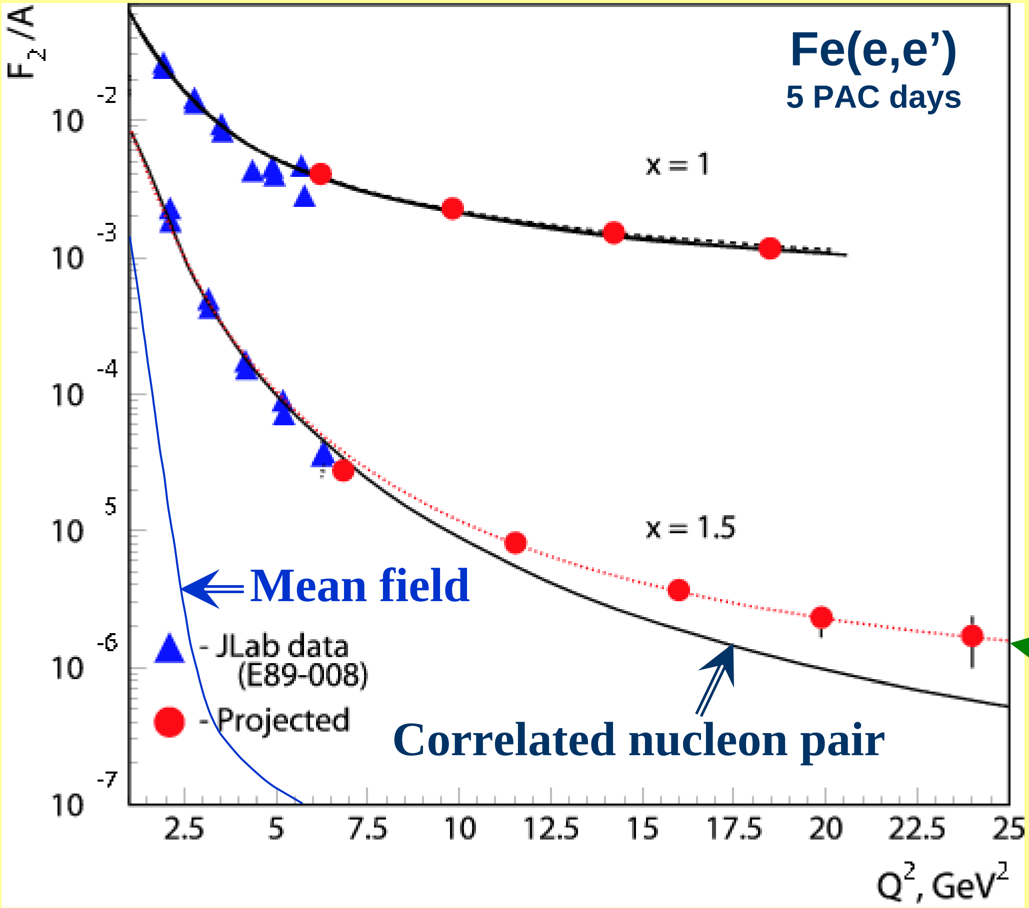


EMC Effect at x > 1

- A typical distance for 2 nucleons participating in a short-range correlation (SRC) is ~1.0 fm → the local density can increase by a factor of ~4: this is comparable to the density of neutron stars.
- Nucleons participating in a SRC are deeply bound, i.e. their structure should be modified, (their shape or quark distributions.)
- $x = Q^2/2M\nu > 1$ → can be used to select quarks inside nucleon participating in a SRC → superfast quarks!



EMC Effect at x > 1

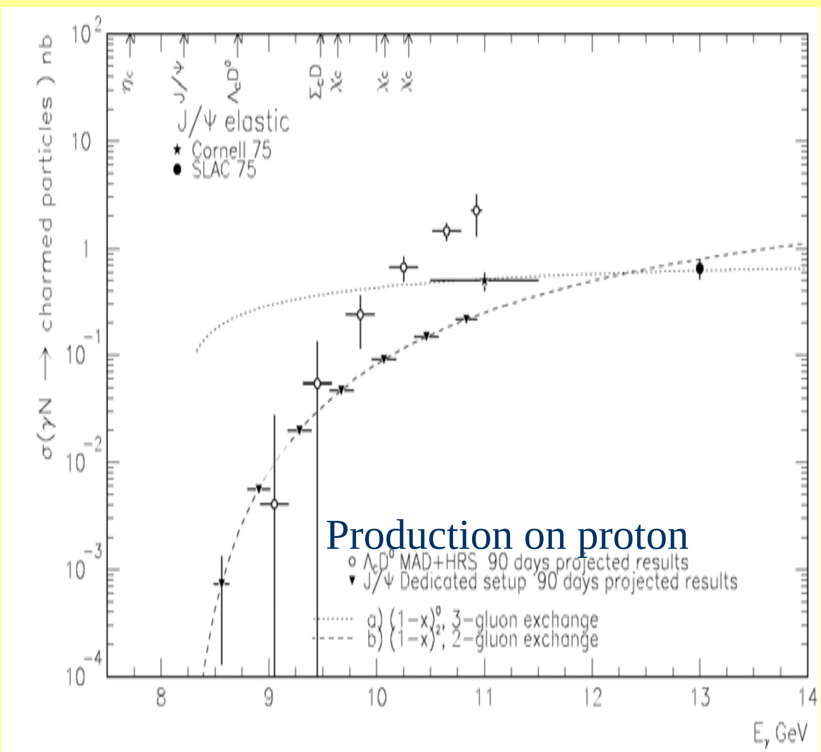


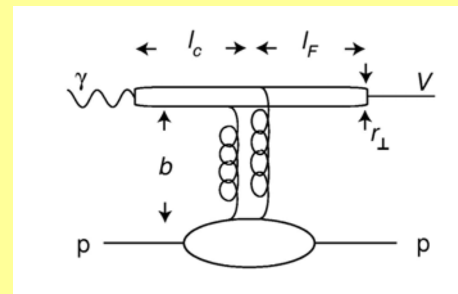
Six-quark bag
(4.5% of wave function)

E12-06-105: J. Arrington, M. Cristy and D. Day

Threshold J/Ψ Photoproduction on Nuclei

- Essentially only produced by gluons ($c\bar{c}$)
- Small color dipole probing the gluon field of the target
- Can estimate J/Ψ –nucleon cross section; relevant for QGP, can distinguish between 2/3 gluon exchange…
- May form a stable bound state





E12-07-106:
P. Bosted, E. Chudakov and J. Dunne

Summary

- Exploring QCD in Nuclei is one of the key motivations for JLab @ 12 GeV.
- An exciting program is planned to address questions such as the role of quarks and gluons in nuclear matter, how hadrons are constructed, the energy scale for transition from confinement to pQCD regime and exploring the role of handbag mechanism.
- The program includes experiments measuring universal scaling, CT and nuclear filtering, un-packing the EMC effect, EMC effect at x>1 and much more…
- Guided by the results at 6 GeV the program at 12 GeV should be able to tell us if "QCD matters in the real world"?