Update on E12-06-107: Hadron Propagation and Color Transparency at 12 GeV
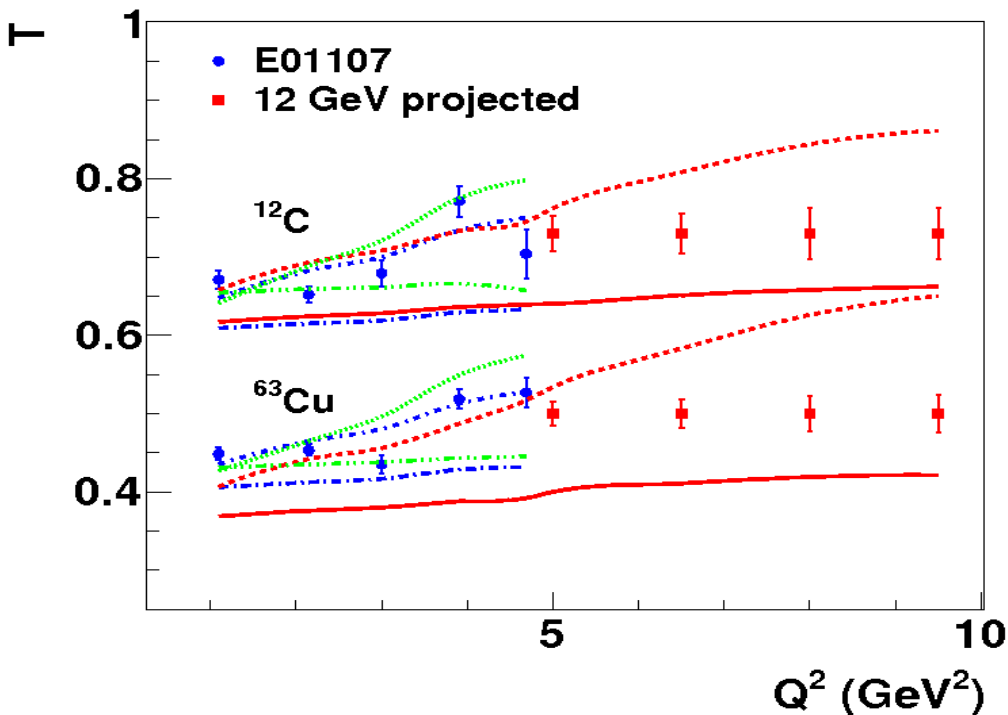
Dipangkar Dutta

Mississippi State University

26 PAC days approved for A(e,e'p) and A(e,e'π) measurement of the onset of CT.

A(e,e'p) part of experiment completed in **Spring 2018** using **8.5 PAC days**

Goal for remaining 17.5 PAC days

Map the **Q^2** and **A**-dependence of pion transparency up to $Q^2 \sim 10$ GeV^2 using the A(e,e'π) reaction.
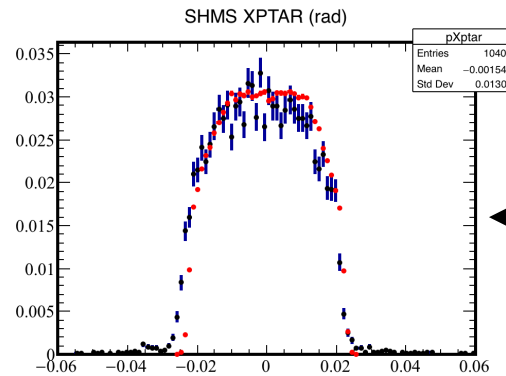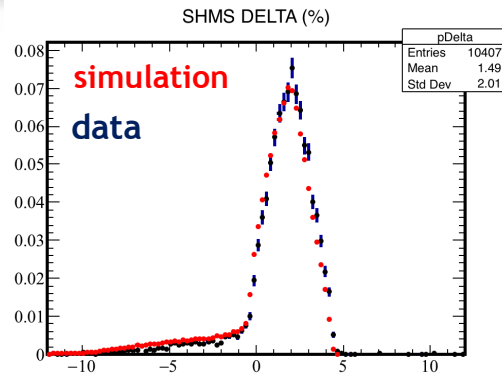
Spokespersons:
D.D. & R. Ent

- Coincidence trigger: SHMS measures protons, HMS measures electrons
- Targets: 10 cm LH_2 (H(e,e'p) normalization),
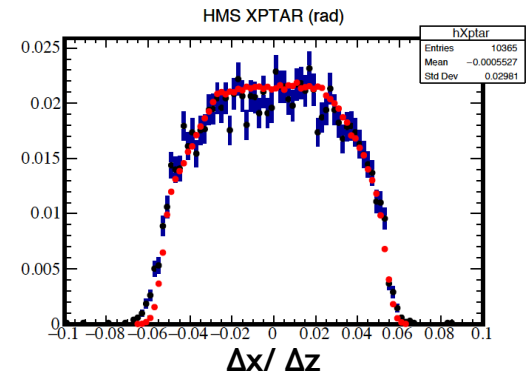- 6% ^{12}C (production),
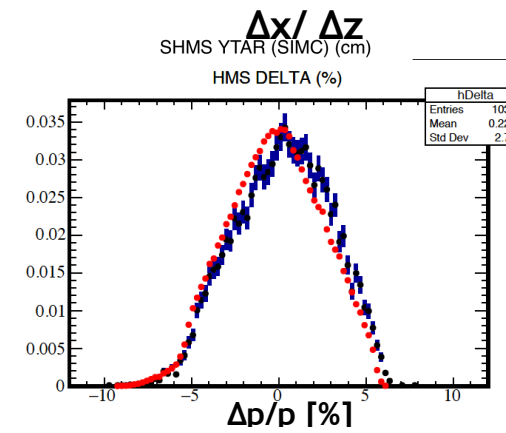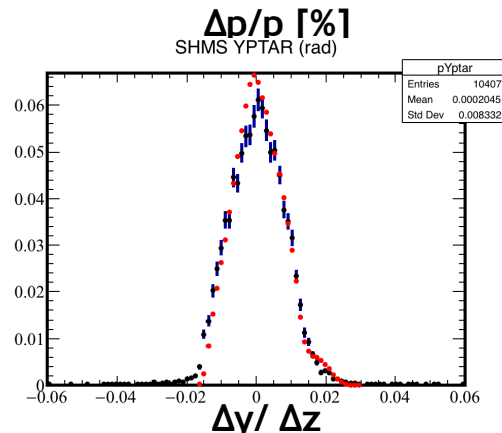- Al dummy (background)

2 thesis students:
D. Bhetuwal (MSU)
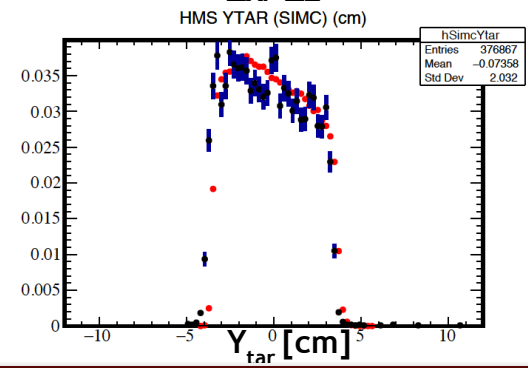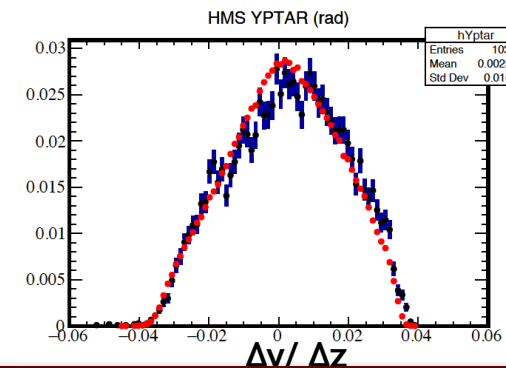**J. Matter (UVa)**

SHMS

HMS

e- beam
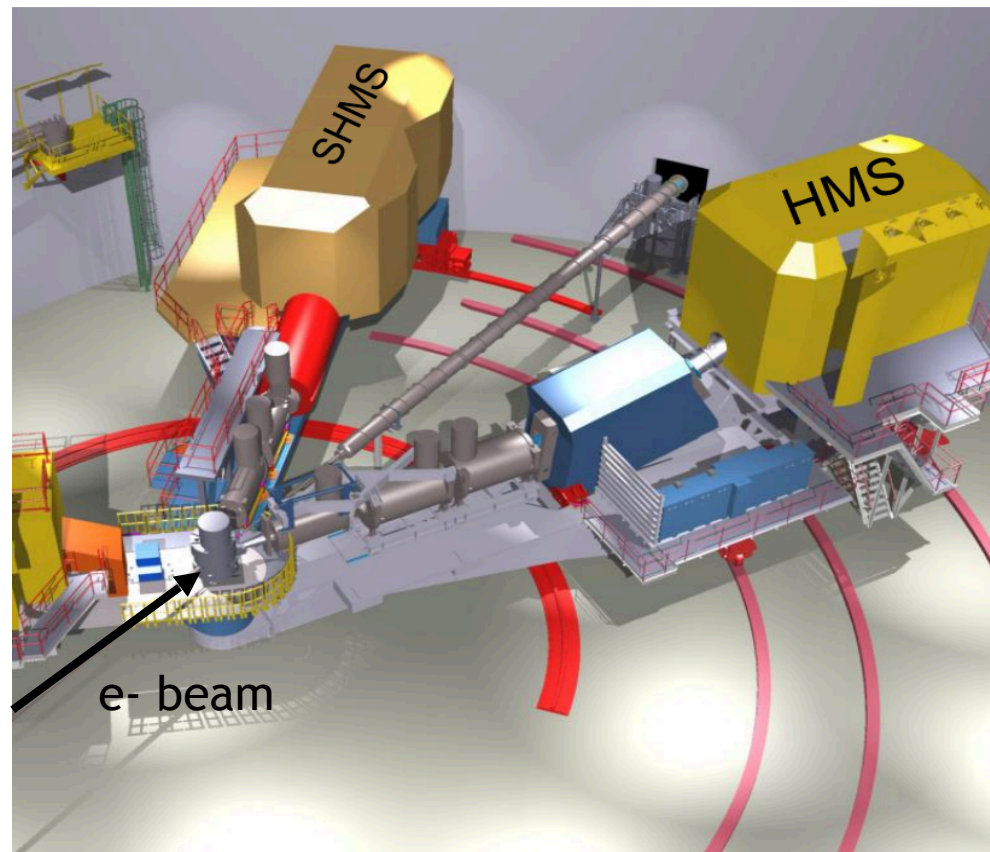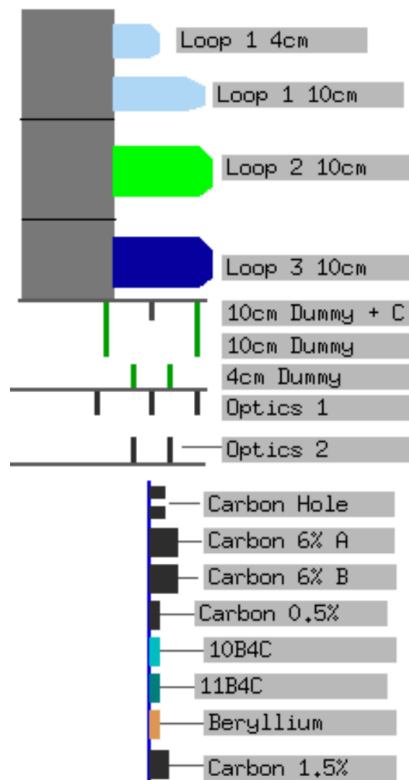
We demonstrate that the Hall C spectrometers are well understood and are backed up by mature simulations.
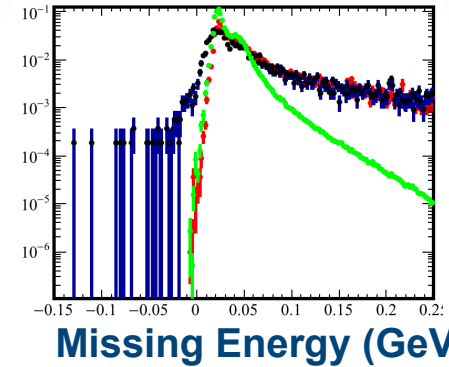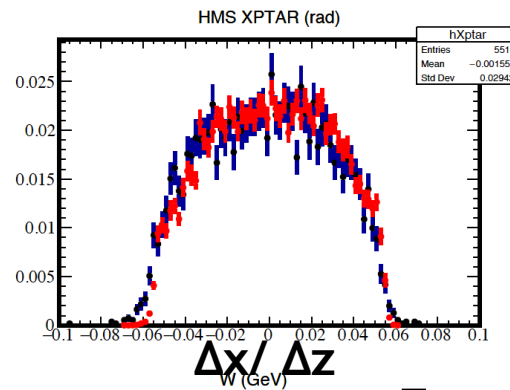

Hydrogen spectra for SHMS:
Q² = 8 GeV²

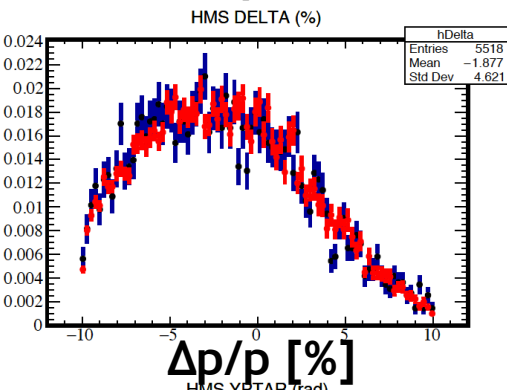**Hydrogen spectra for HMS:**
Q² = 8 GeV²

The Hall C spectrometers are well understood and are backed up by mature simulations.

HMS spectra for Carbon: : Q² = 8 GeV²

6% ¹²C target

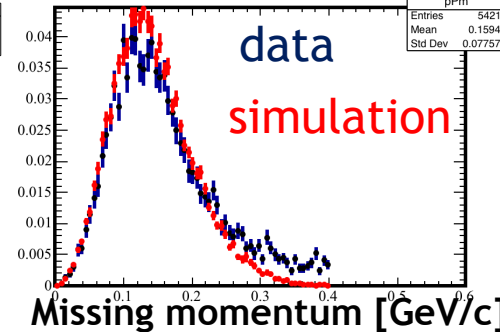**data**
with radiation
without radiation

Missing Energy (GeV)

SHMS spectra for Carbon: Q² = 8 GeV²

data
simulation
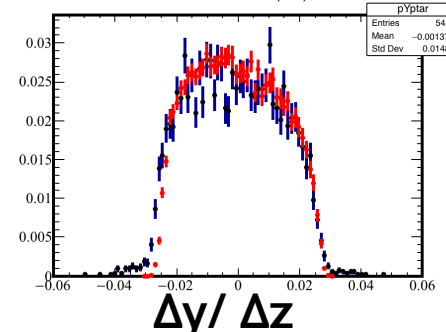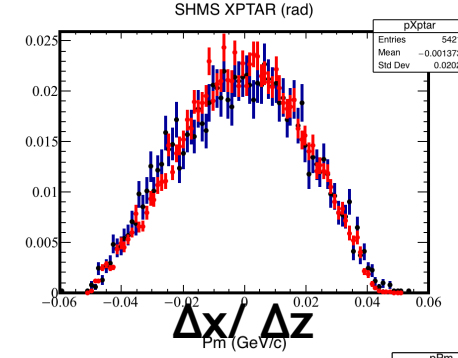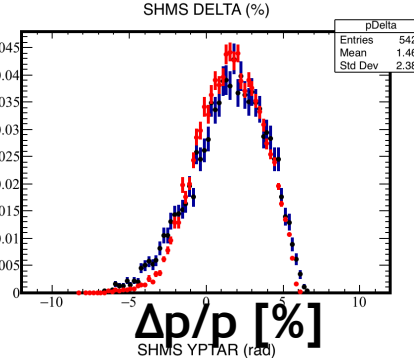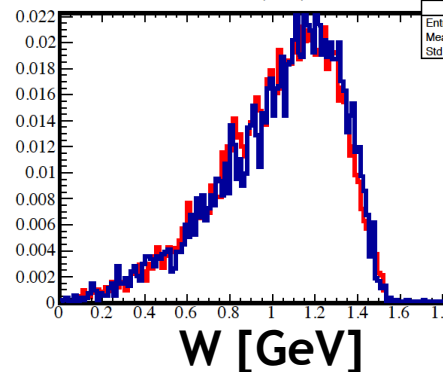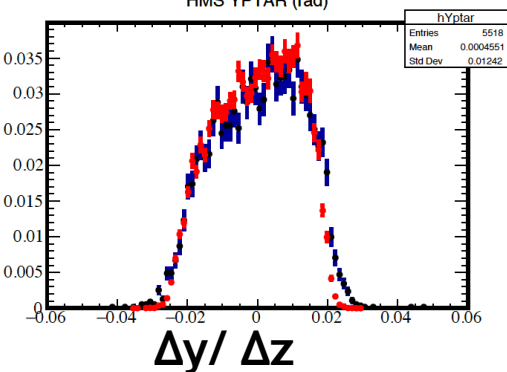
Plots courtesy of Holly Szumila-Vance

Preliminary carbon transparency results do not show the onset of CT in protons.
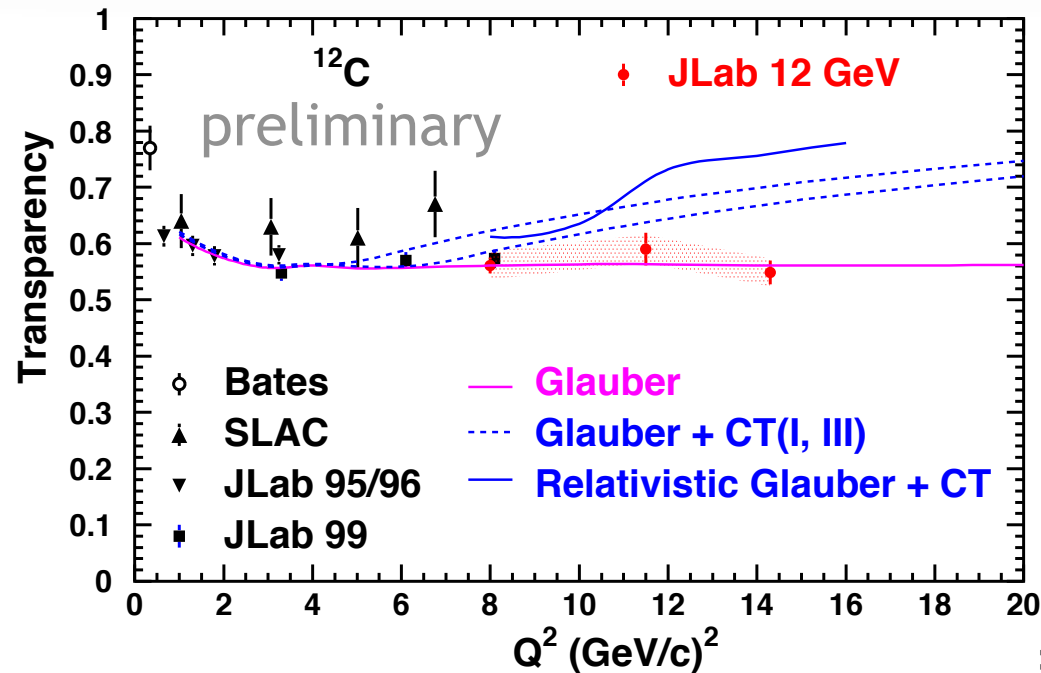
Preliminary results presented
at the recent APS meeting in Denver

BNL observations unlikely to be because of CT
Places very stringent constraints on all existing CT models
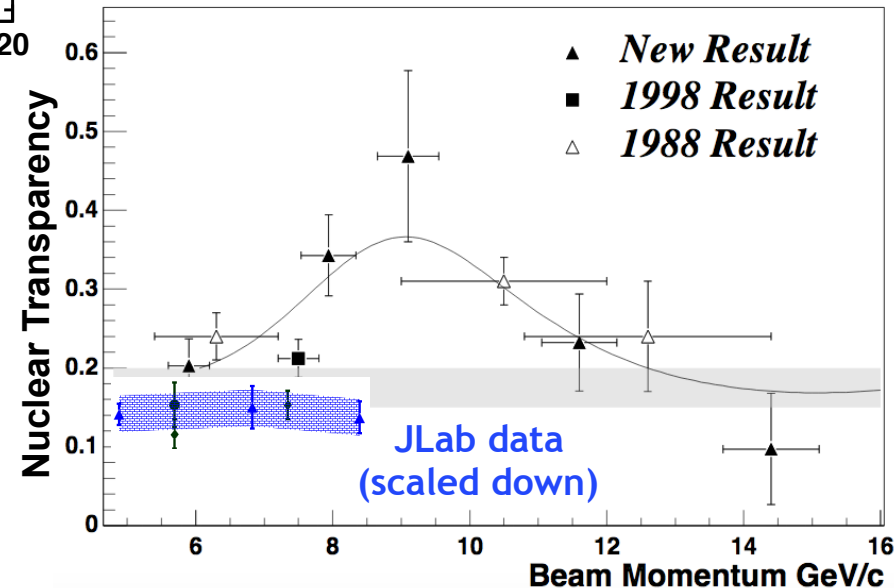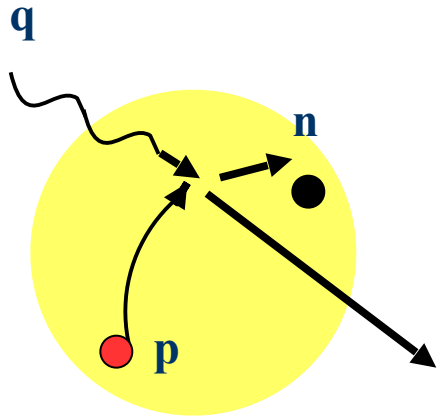
$$\sigma_{A(e,e'\pi^+)X} = \sigma_{p(e,e'\pi^+)n} \otimes S(E,p)$$

S(E,p) **= Spectral function for proton**

q

n

p

Goals

- **Map the Q^2 and A-dependence of pion transparency up to $Q^2 \sim 10$ GeV^2 using the A(e,e'π) reaction.**

- **Access the Q^2 where the CT effect is expected to be the largest ($Q^2 \sim 10$ GeV^2).**

- **Confirm it is CT by using 3 nuclear targets to measure the A-dependence.**

Since the proposal was approved, JLab experiments have observed tantalizing hints of the onset of CT in mesons.

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

$A(e,e'\rho^0)$
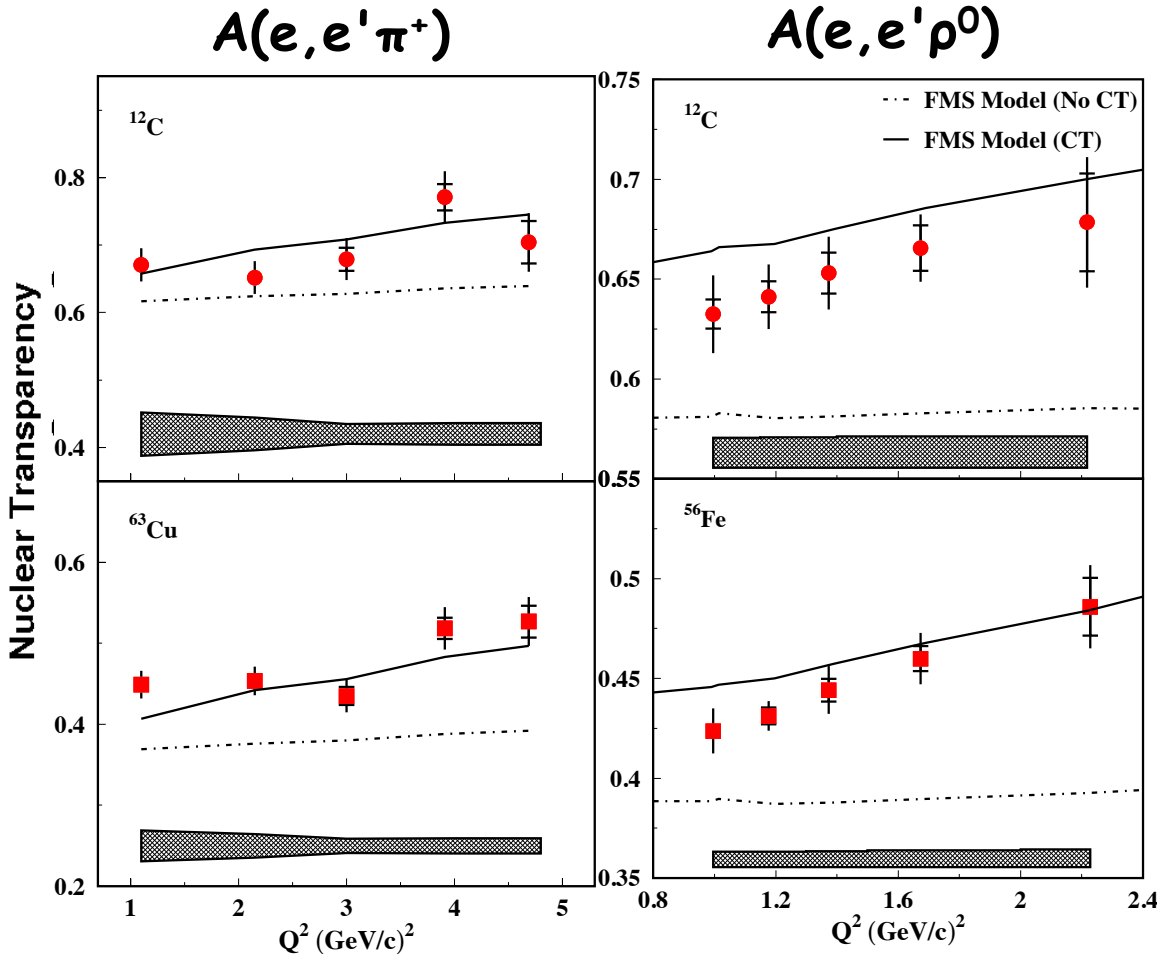
·Hall-C Experiment E01-107: pion electroproduction from nuclei found an enhancement in transparency with increasing Q^2 & A, consistent with the prediction of CT.

X. Qian et al., PRC81:055209 (2010),
B. Clasie et al, PRL99:242502 (2007)

·CLAS Experiment E02-110: rho electroproduction from nuclei found a similar enhancement, consistent with
·the same predictions

L. El-Fassi, et al., PLB 712, 326 (2012)

.

FMS: Frankfurt, Miller and Strikman, Phys. Rev., C78: 015208, 2008

Confirmation of the CT mechanism required observation of both Q² and A dependence (need minimum 3 targets).

non-perturbative calculations can produce similar Q² dependence, but not A-dependence
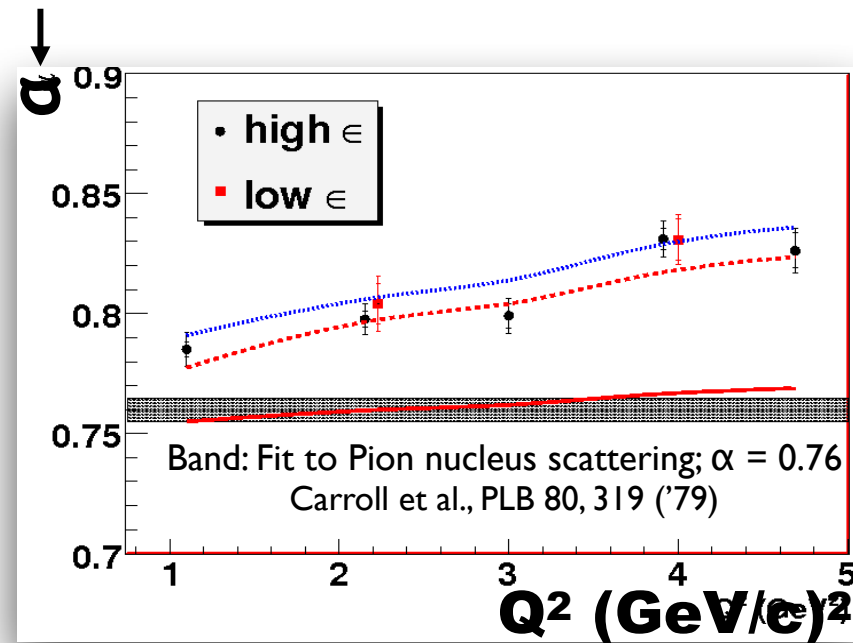

from fit of $T(A) = A^{\alpha-1}$
at fixed Q^2
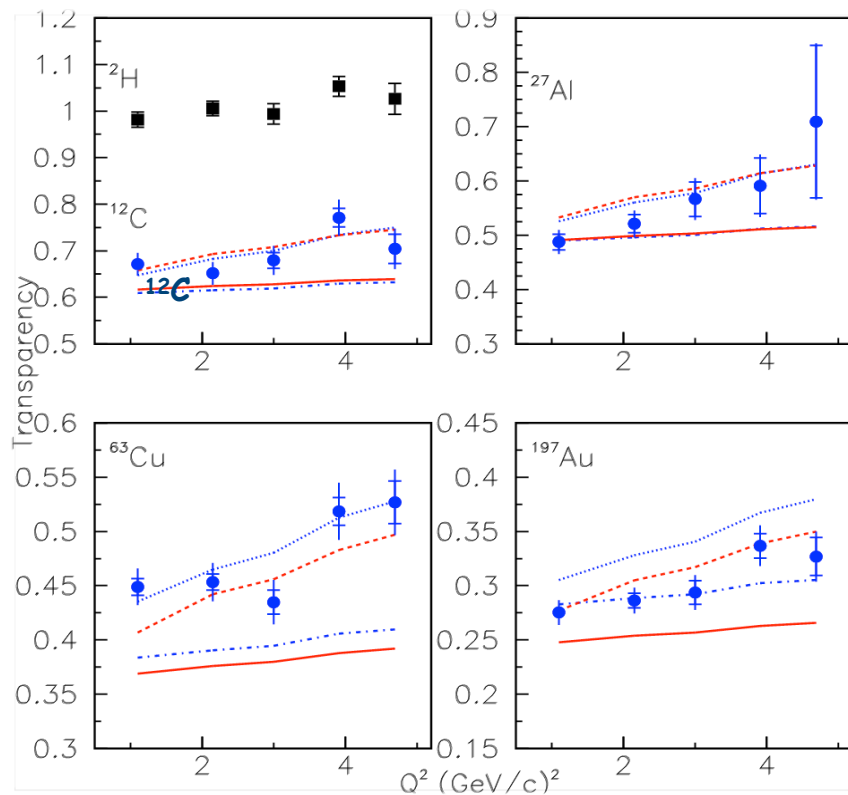
B. Clasie et al. PRL 90, 10001, (2007)
X. Qian et al., PRC81:055209 (2010)

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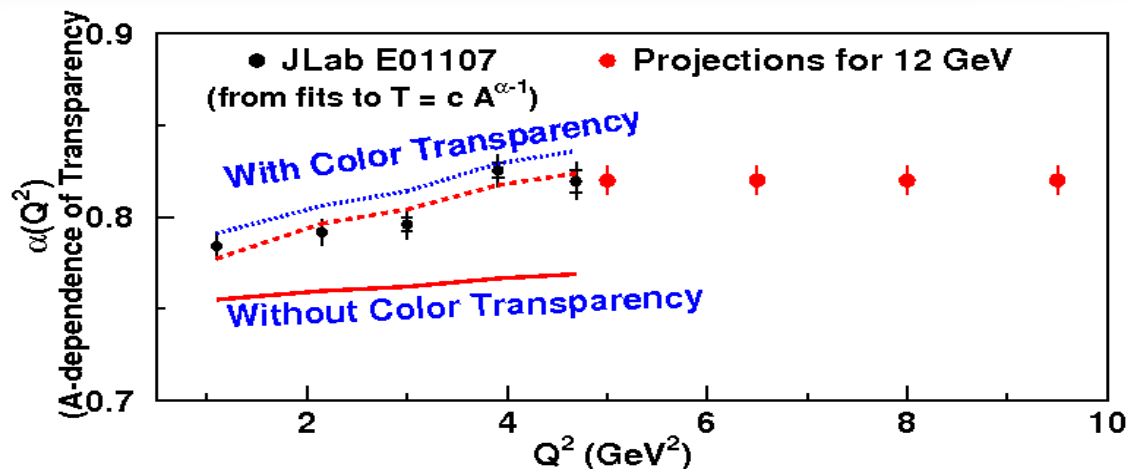Larson, Miller & Strikman, PRC 74, 018201 ('06)

6 GeV experiment produced 4 publications

dot-dash : Glauber (Relativistic); dotted : Glauber +CT +SRC
Cosyn et al., PRC 74, 062201R ('06)

Need both C and Cu targets to extract Q^2 and A-dependence to confirm the CT effect
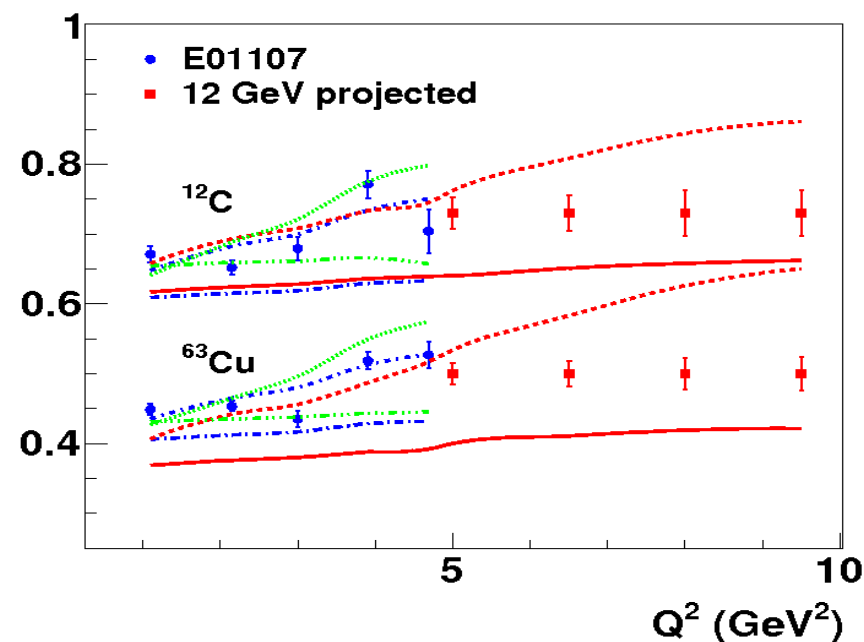

pionic color transparency is expected to be largest around $Q^2 \sim 10$ GeV^2

Larson, Miller & Strikman, PRC 74, 018201 (2006)

Formation length of the PLC in mesons is about the nuclear size at $Q^2 \sim 10$ GeV^2 (the PLC can traverse the entire nucleus without any interaction).

12 GeV JLab can reach Q^2 = 9.5 GeV^2 for A(e,e'π) or p_π = 9.4 GeV/c

Summary

Tantalizing hints of the onset of CT have been observed in 6-GeV JLab experiment on meson and rho electroproduction.

The pion transparency part of E12-06-107 is essential to confirm the onset observed at 6 GeV and also to map out the Q^2 and A dependence of pionic CT to $Q^2 \sim 10$ GeV^2.

A robust and mature Monte Carlo simulation already exists for $A(e,e'\pi)$ in Hall-C, making quick, almost online results likely.
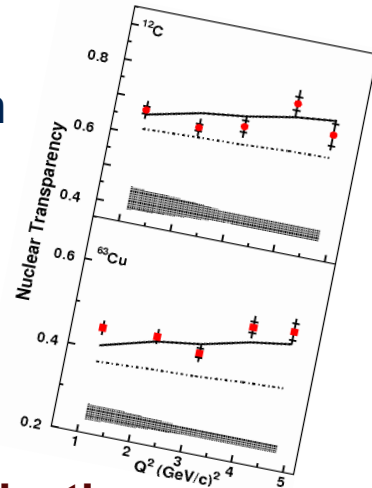
6 GeV experiment produced 4 publications
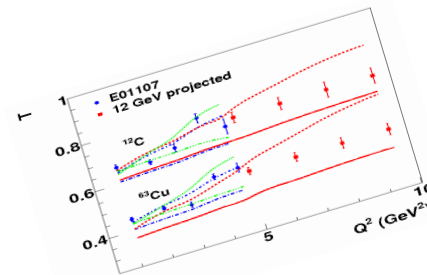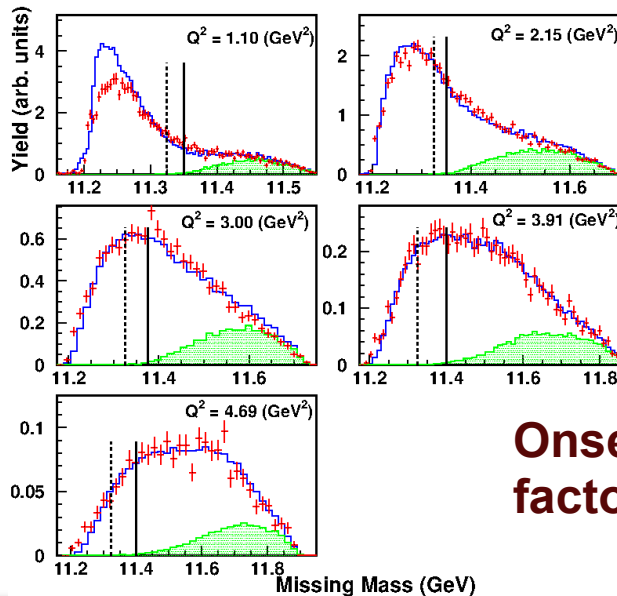
Onset of CT is directly related to the onset of factorization required for access to GPDs .

- Strikman, Frankfurt, Miller and Sargsian