Precise Measurement of EMC Effect in Few Body Nuclei And at Large X

Jlab expt E03-103; Spokespersons: John Arrington and Dave Gaskell

For the E03-103 collaboration

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Hall C User's Meeting
01.25.07

Outline

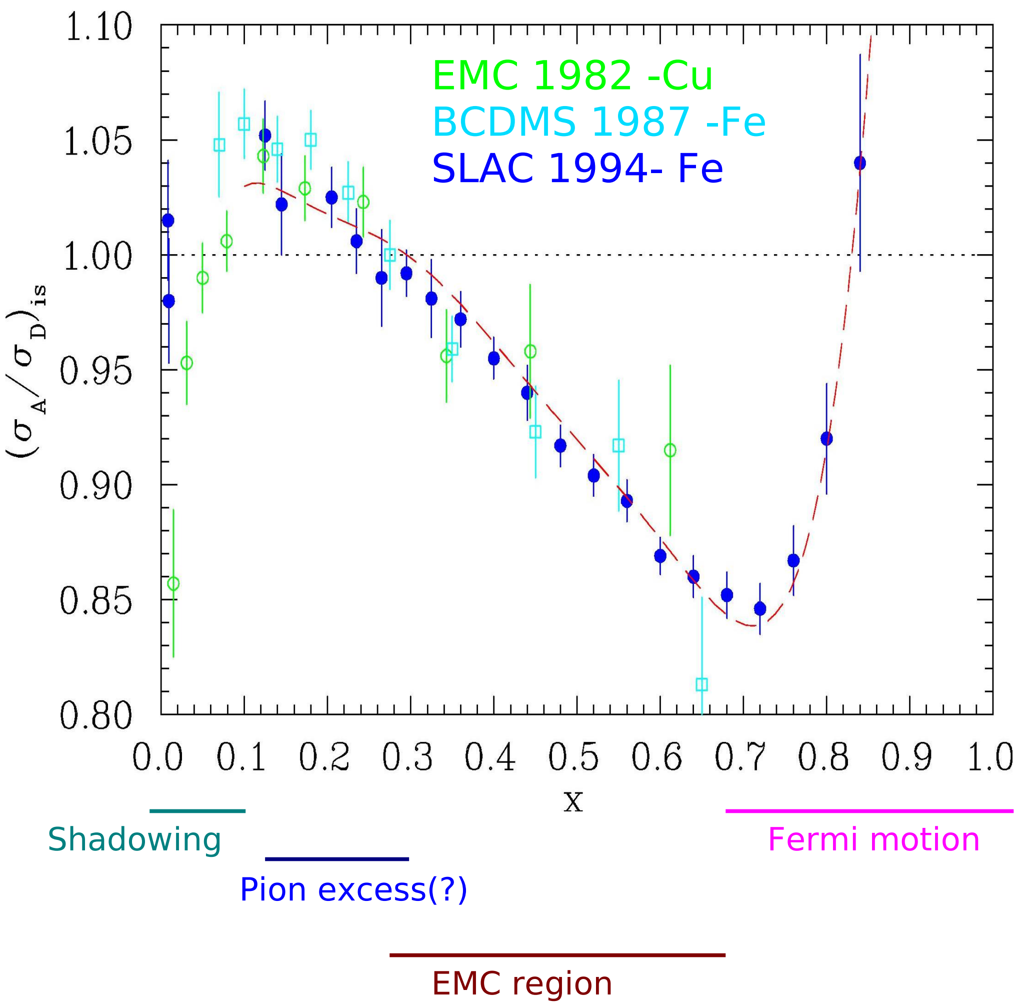
- Motivation and existing data
- Jlab experiment E03-103
- Analysis status
- Preliminary results

Introduction
EMC effect

Measurements of F_{2A}/F_{2D} have demonstrated modifications of quark distributions in nuclei.

Magnitude depends on A but shape more or less same.

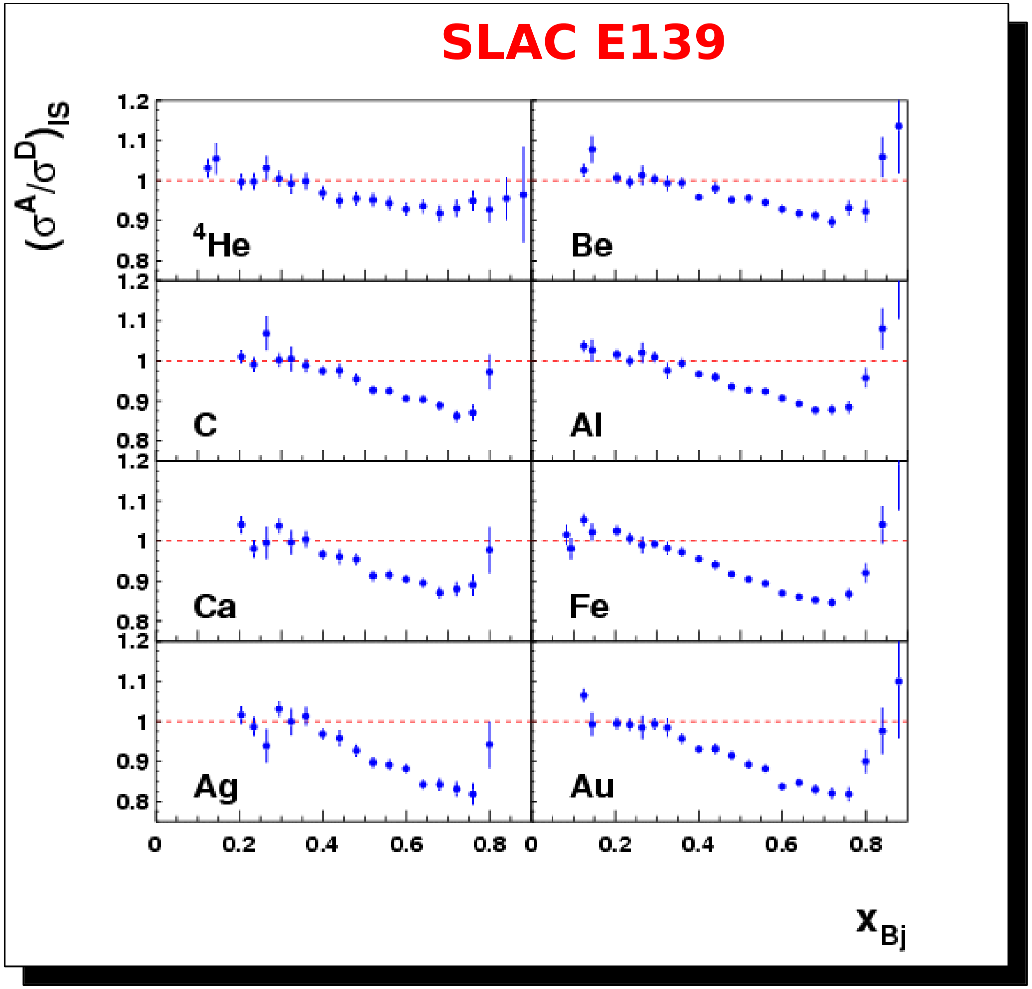
Several models, but valid only in certain kinematical regions.



Introduction

EMC effect

- Extensive measurements on heavy targets (SLAC, NMC, BCDMS ...)
- But poor precision at large x
- Limited world data for light nuclei



E03-103 main goals

First measurement of EMC effect on ^{3}He for x > 0.4

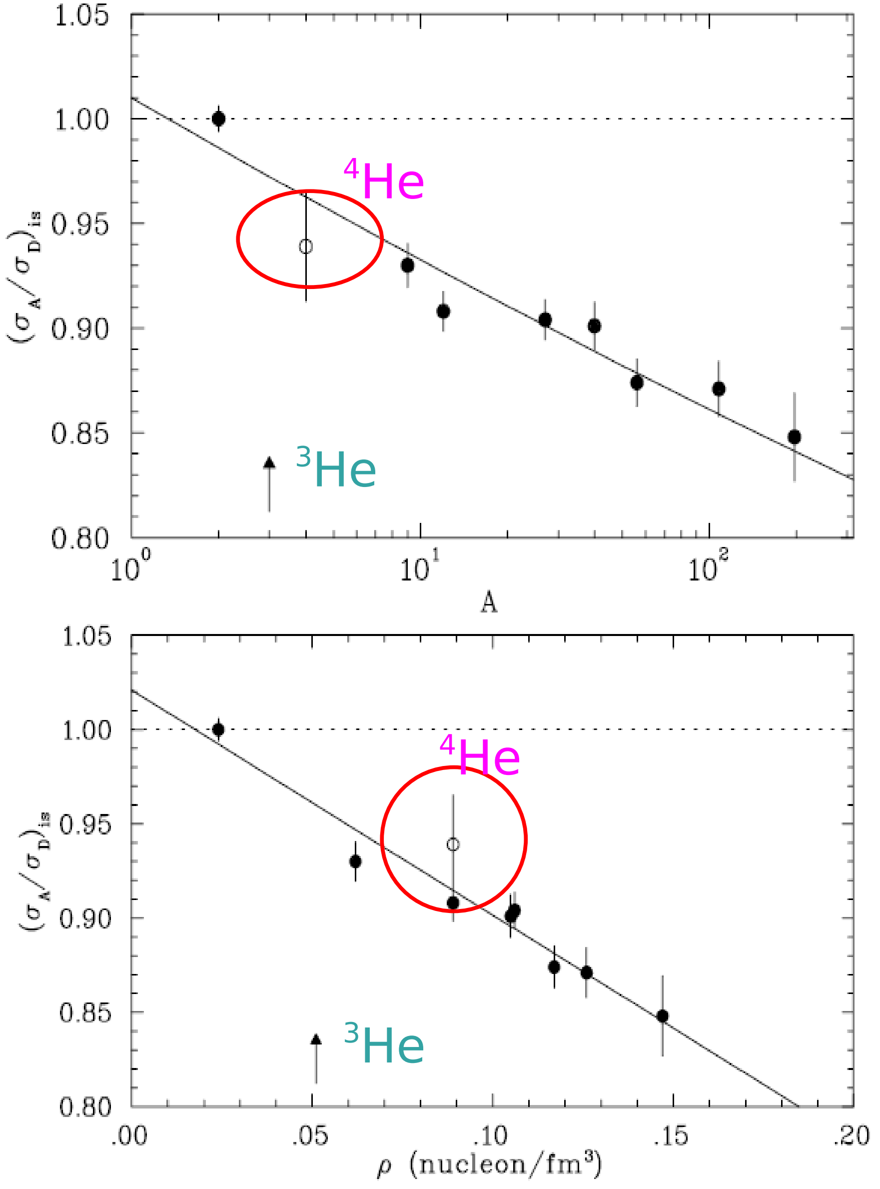
Precision data at large x for heavy nuclei

Introduction

Ratios can be parameterized as log(A) or linear density dependence

^{4}He/D is more sensitive , but uncertainty is large for existing data and consistent with both parameterizations

Addition of ^{3}He data will help to determine if EMC effect depends on nucleon number (A) or average nuclear density (ρ)



x=0.6

E03-103@JLAB
Kinematics and targets

Ran summer and fall of 2004 in HALL C of JLAB with 5.77 GeV.

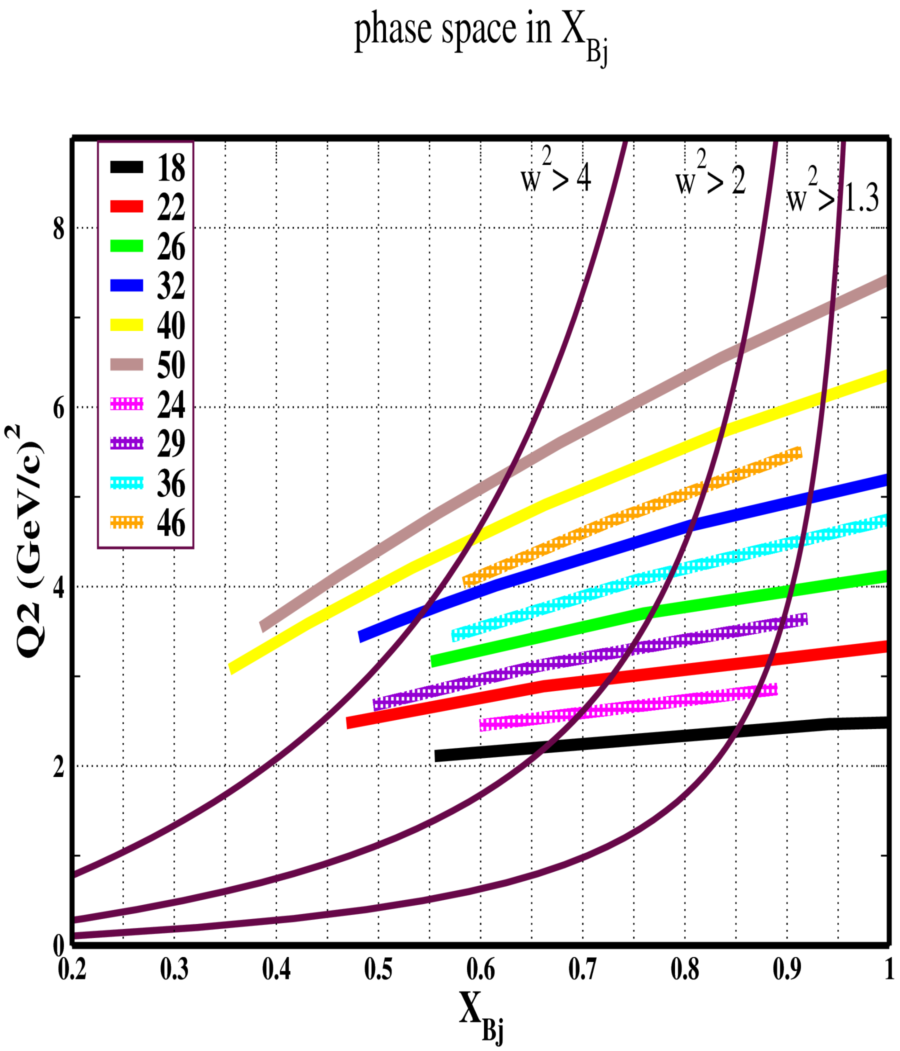
Cryo targets

H, ^{2}H, ^{3}He, ^{4}He

Solid targets

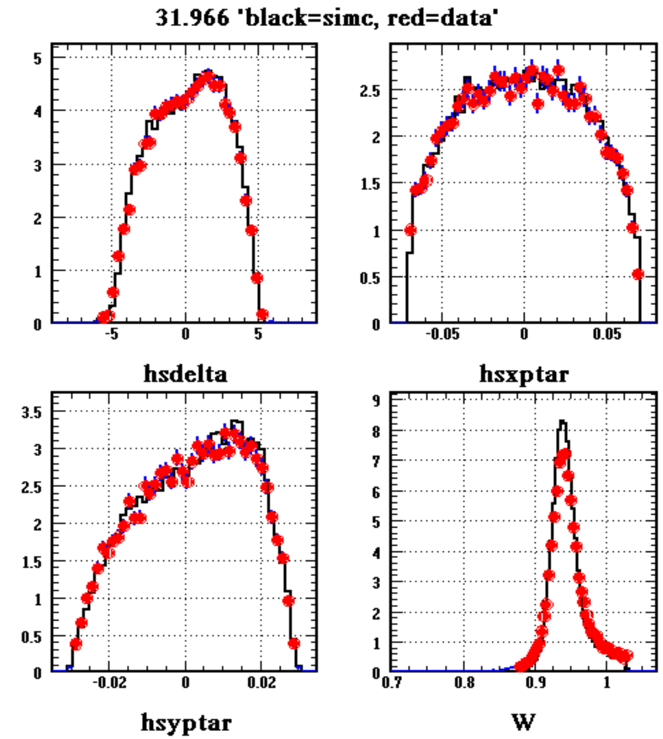
^{9}Be, ^{12}C, ^{27}Al, ^{63}Cu, ^{197}Au

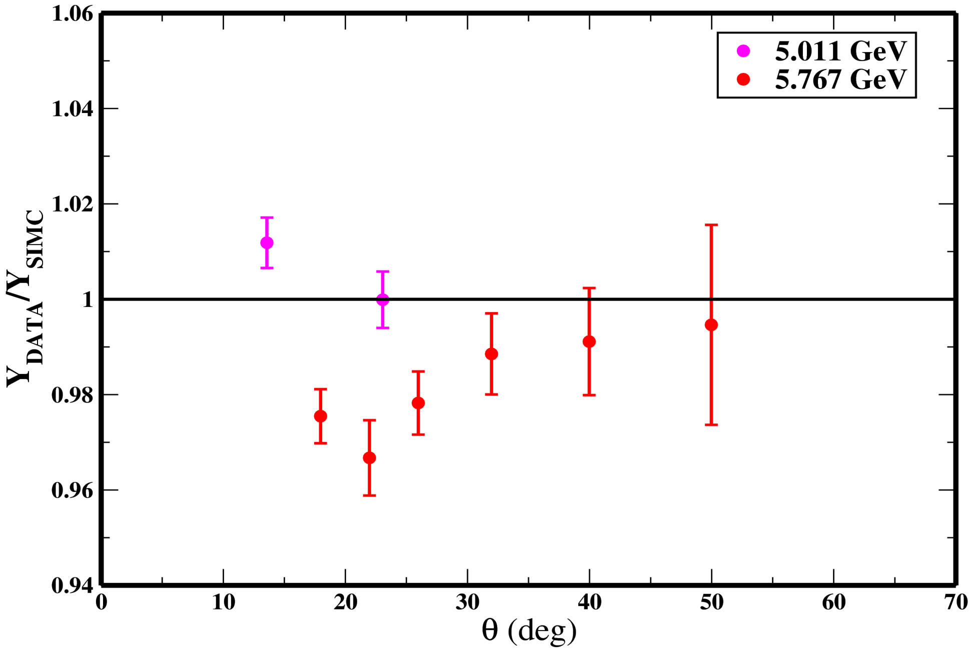
Additional data at 5 GeV on carbon and deuterium to investigate Q^2 dependence in the EMC ratios



Analysis
Elastic yield : SIMC analysis

Representative detector distributions





Cross checking the elastic yields with Hall C Monte Carlo

Yield Ratios

Analysis
Model iteration

Same cross section model for radiative corrections, bin centering and Coulomb corrections $2< Q^2 <10$ GeV^2

For all X

LD2 model ⇒ E. Christy F_{2p} fit + P. Bosted F_{2n} fit (free n) + smearing (QE parameters from XEM data)
See N. Fomin's Talk

Nuclear model

sig_born_total= sig_born_inel + sig_born_qe

X < 0.8 ⇒ F_{2D} x emc_fit

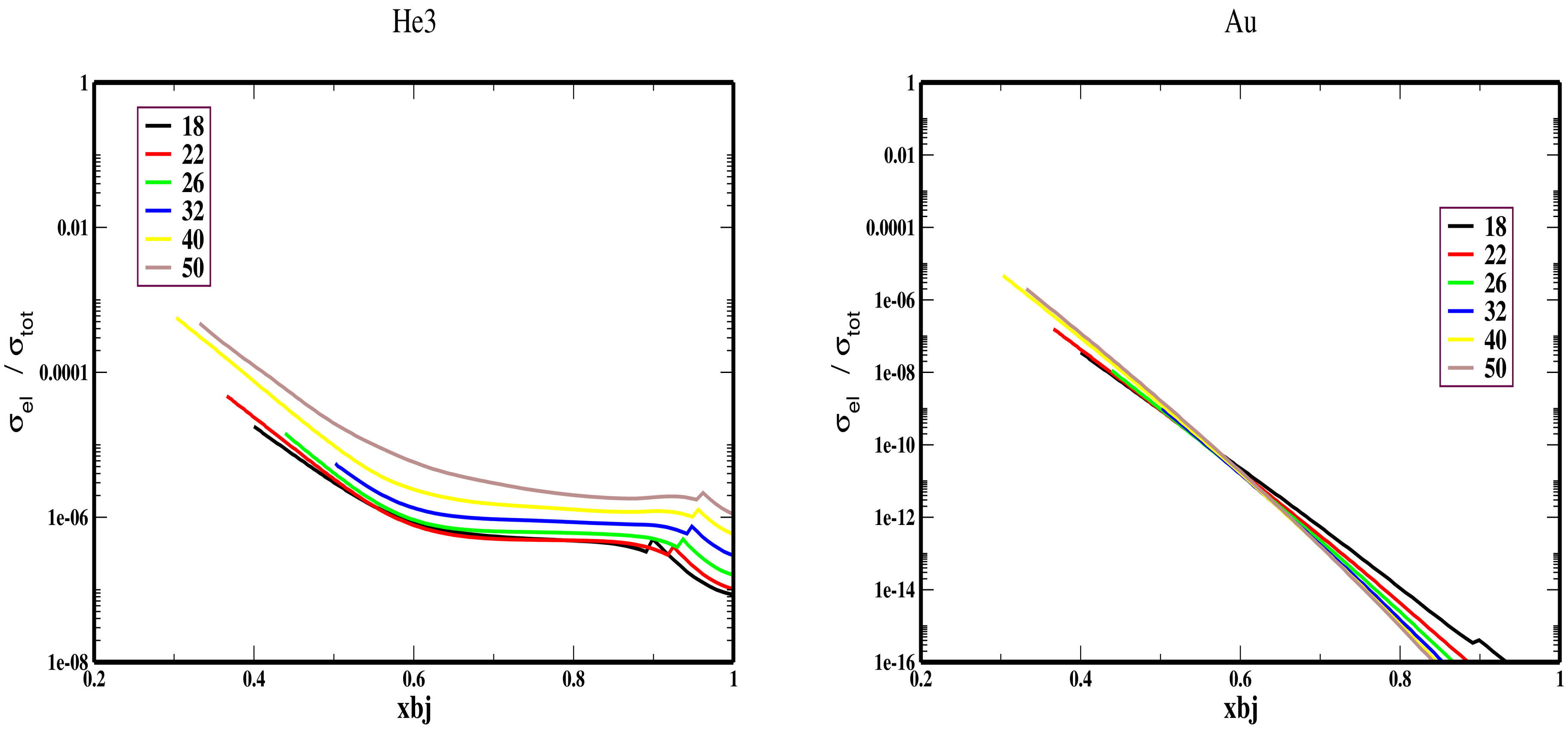
X > 0.9 ⇒ smearing

Y scaling model

(QE parameters from xem data)

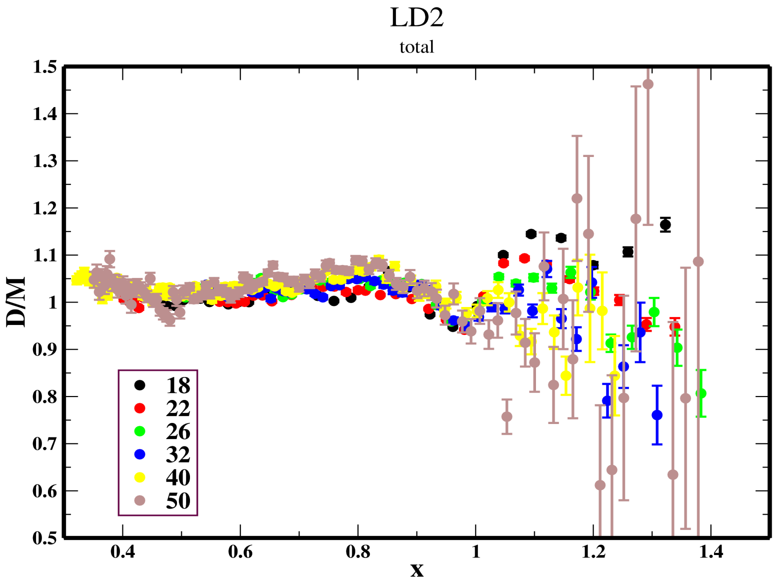
0.8>X>0.9 ⇒ X weighted average

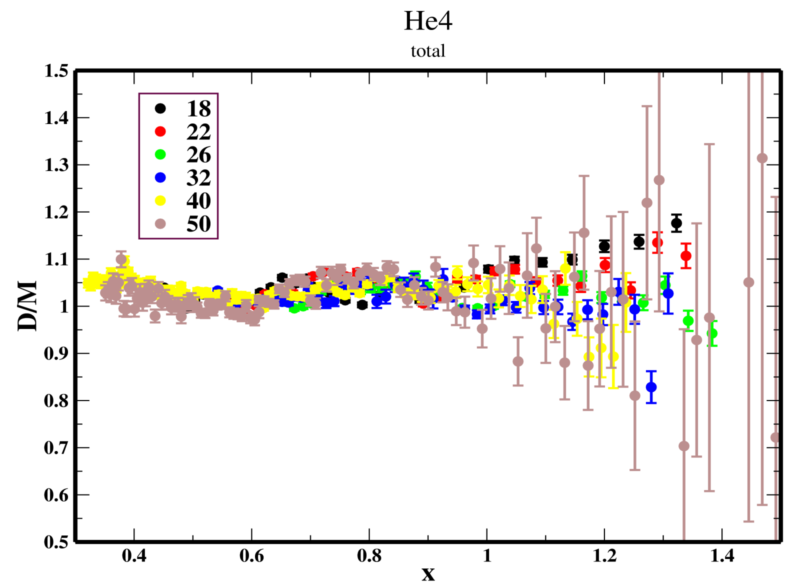
Analysis
Radiative corrections

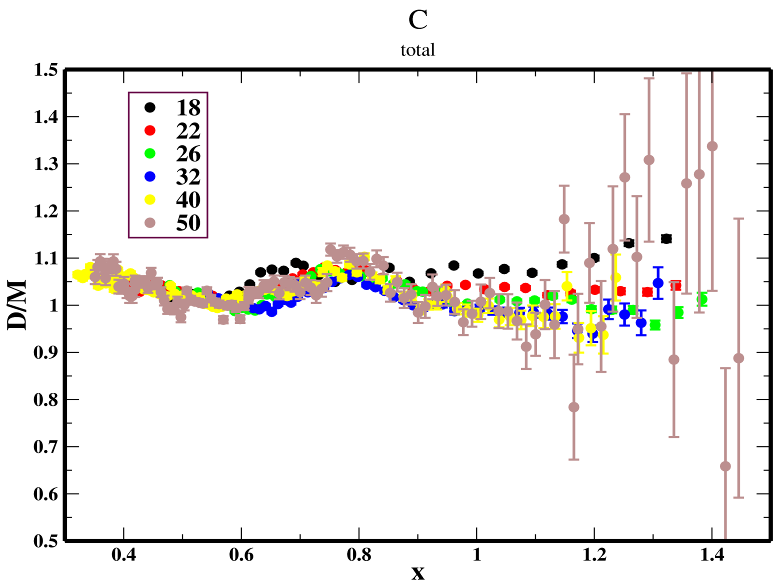


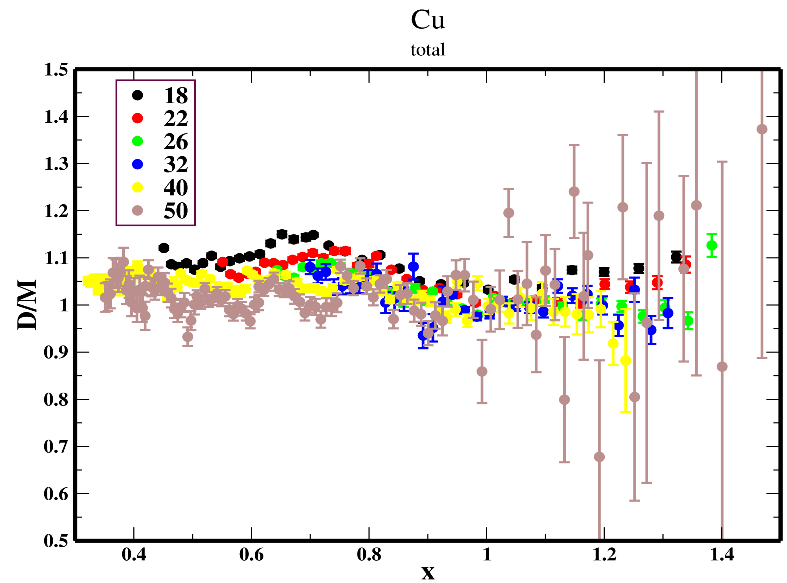
Negligible nuclear elastic contribution, so we ignore it. (P. Bosted Code)

Model iteration
Subset of XEM data: data to model ratio



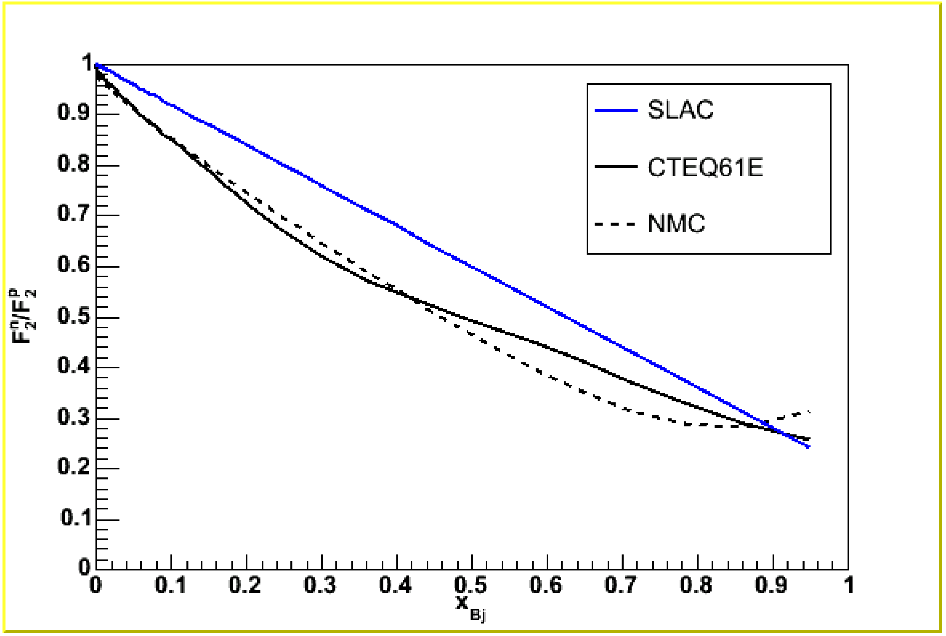






Corrections to data

Isoscalar corrections



SLAC parametrization: 1 - 0.8x

NMC : $F_{2n} = F_{2D} - F_{2p}$

CTEQ fit :global fit @ $10GeV^2$

F_{2n}/F_{2p} correction large for ^{3}He and heavy nuclei @ large X.

(at large X, size of the correction~15%)

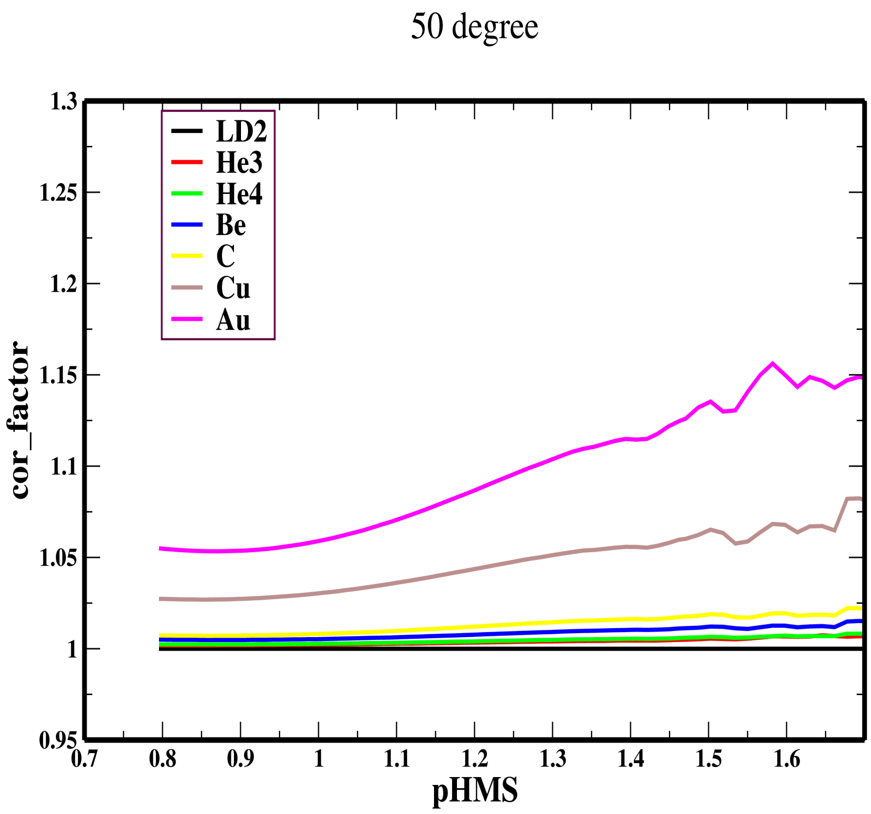
SLAC fit is used for this analysis

Corrections to data

Coulomb corrections

Incoming and scattered electron kinematics are shifted and a correction factor is determined using the born model to account for the coulomb distortion effects.

$$\text{correction\_factor} = \frac{\sigma_{Born}}{\left(F^2 \cdot \sigma_{BornShifted}\right)}$$

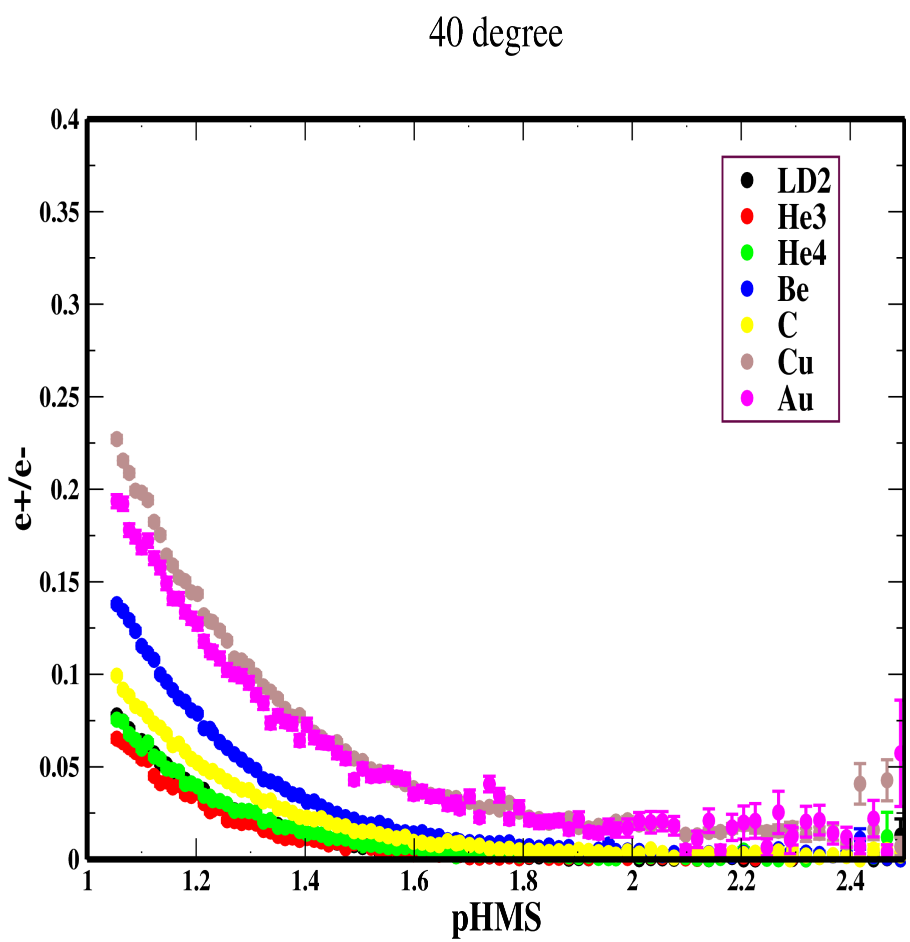


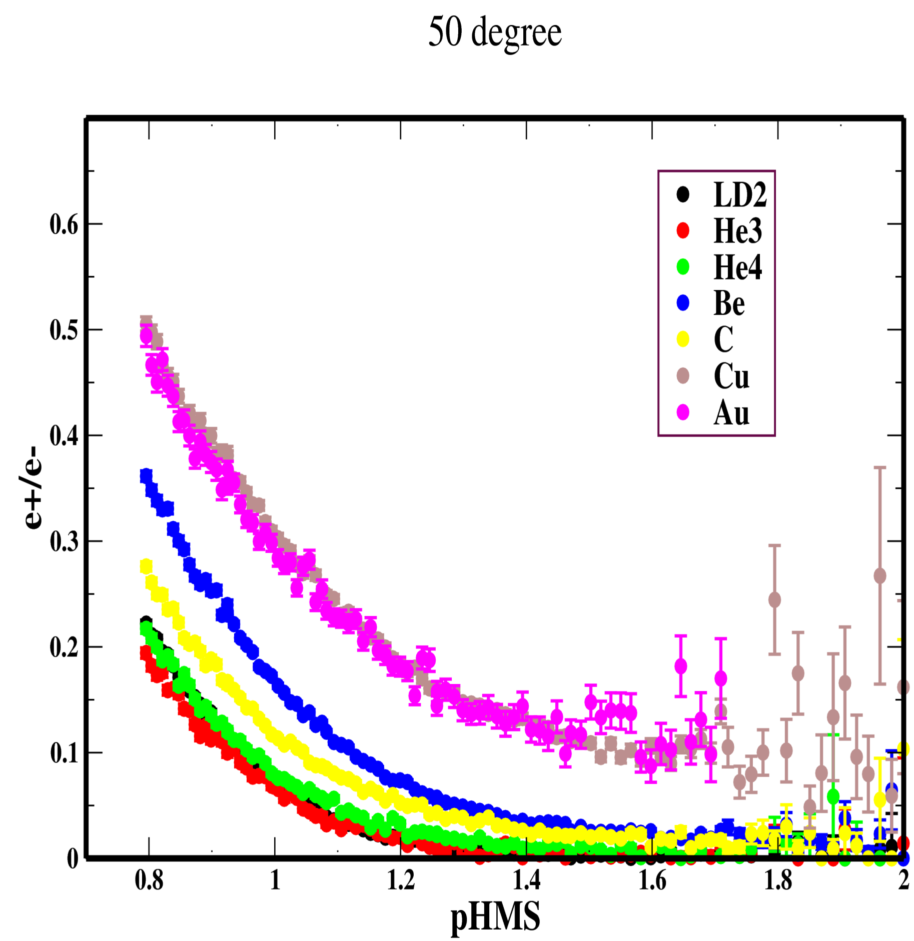
F is the focusing factor which accounts for the focusing of incoming electron wave in the nuclear center

Aste et al., Eur. Phys. J. A 26, 167 (2005)

Corrections to data

Charge symmetric back ground





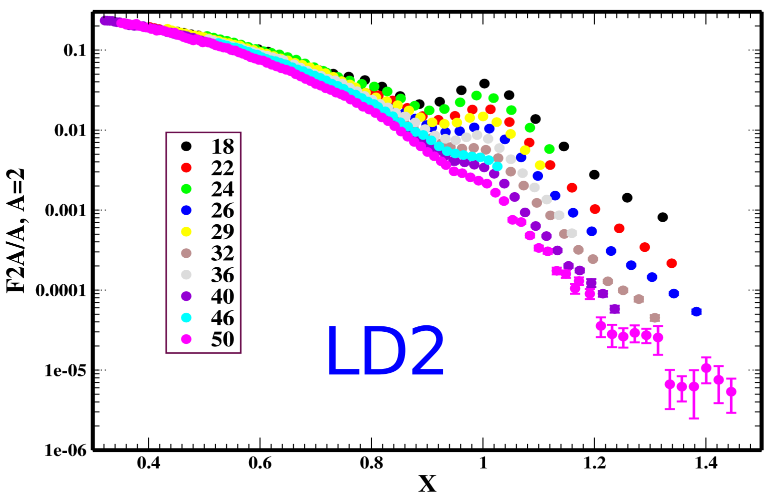
For heavy nuclei and at low X

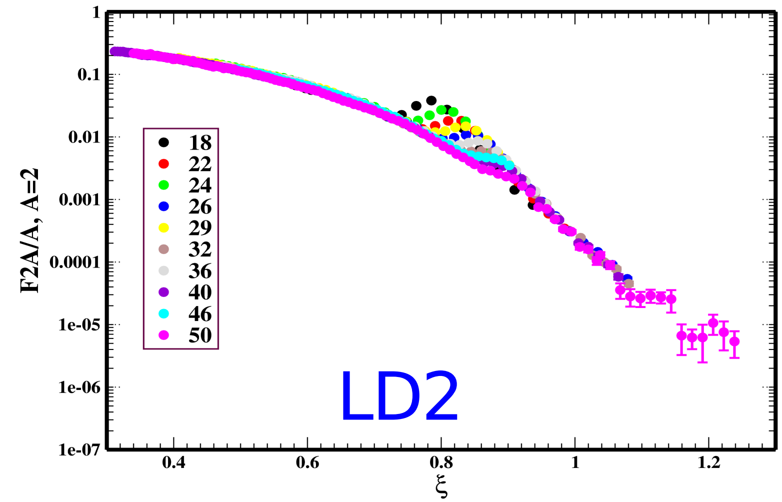
Signal~ background

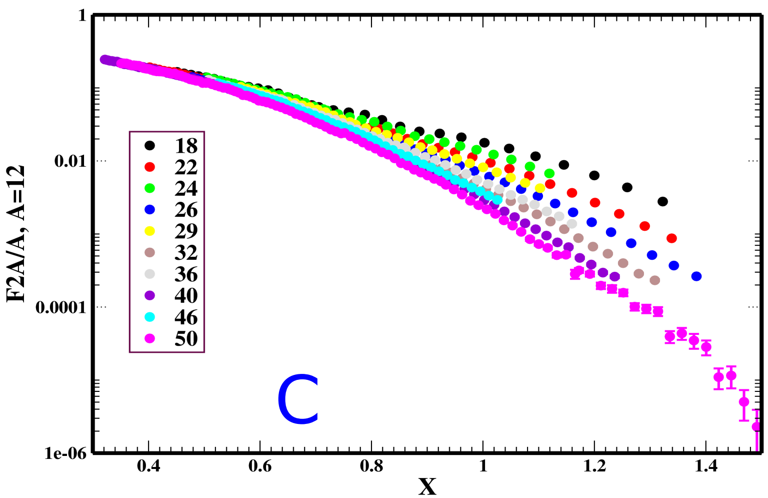
e^+ and e^- data acquisition on HMS

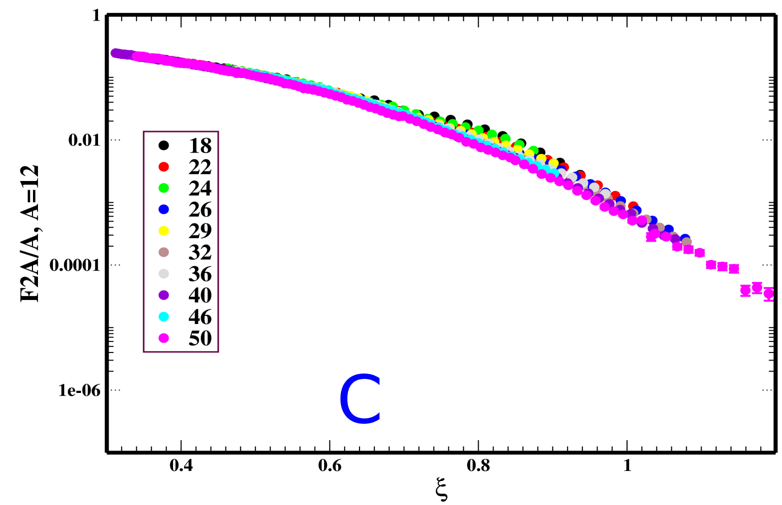
Preliminary results

Scaling of F_2







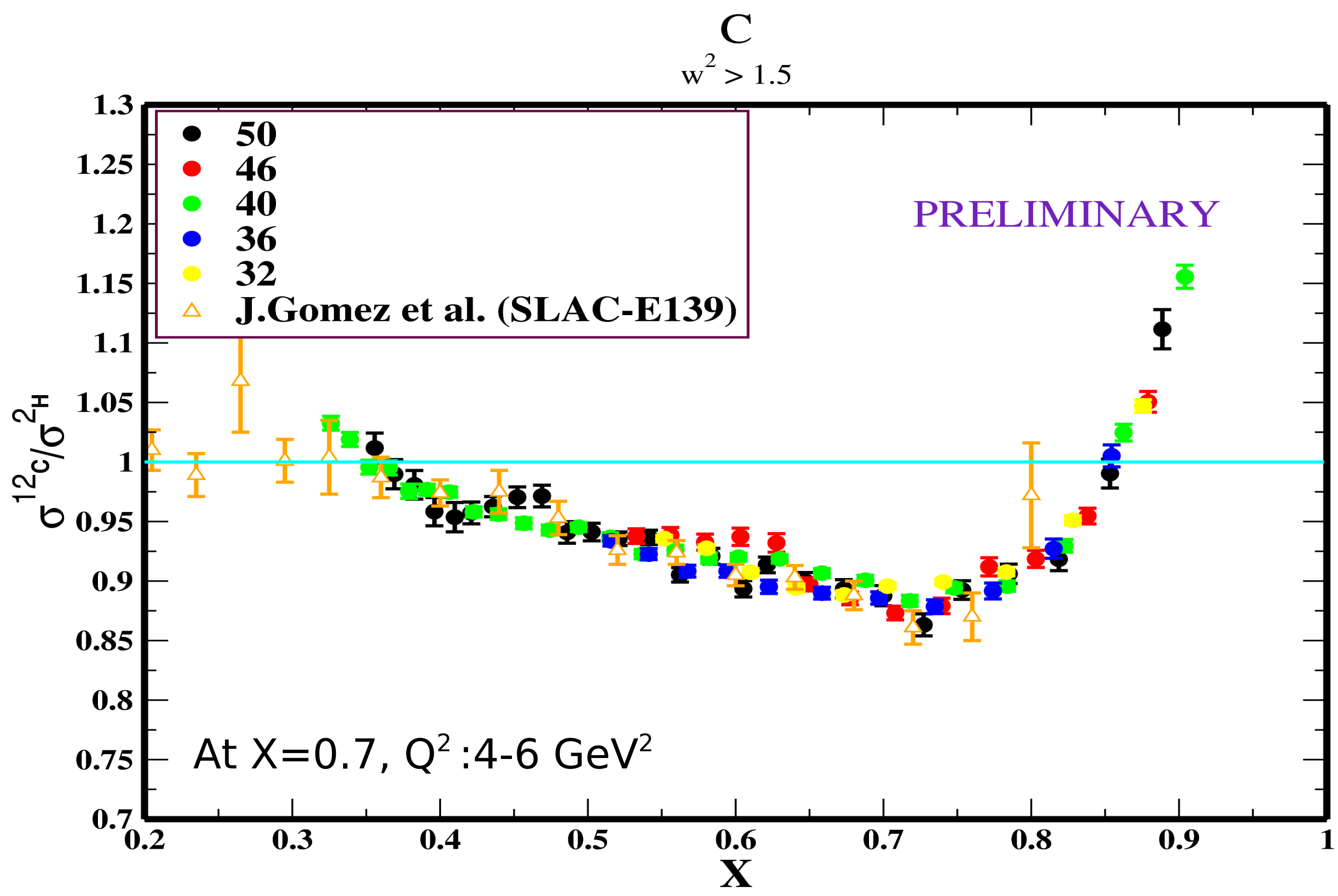


ξ is the Nachtmann variable and at large Q^2, $\xi \sim X$

In nuclei, extended scaling in resonance region due to increased Fermi smearing

Preliminary results

Q^2 dependence in the emc ratios



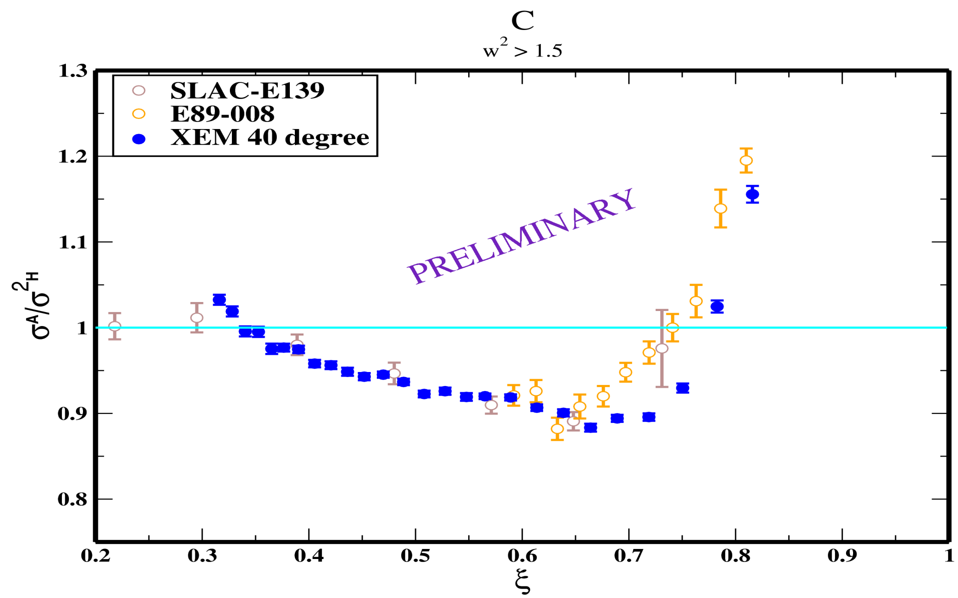
XEM error bars are only statistical

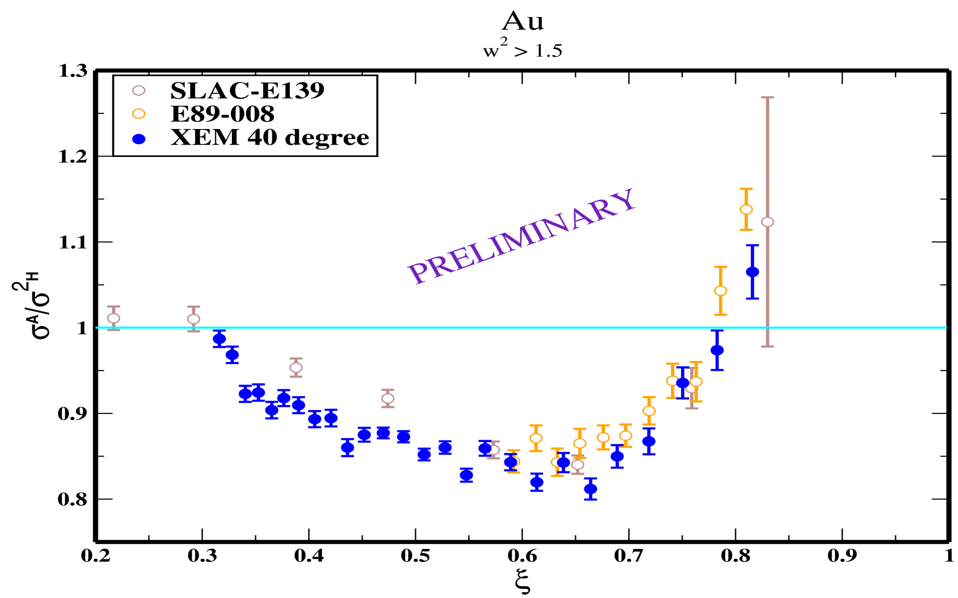
Preliminary results

EMC ratios in ξ

E139 DIS region
E89008 Resonance region

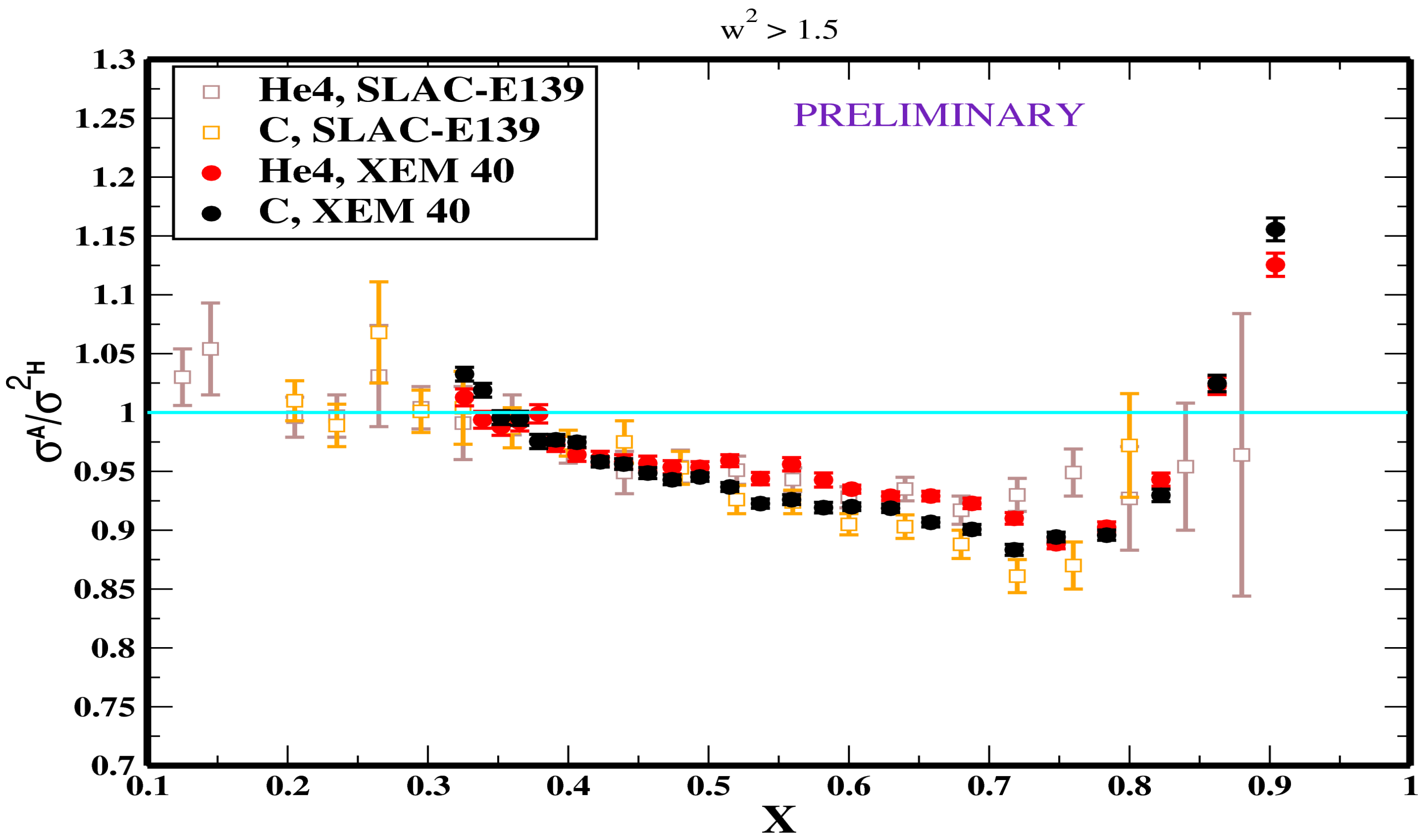
Preliminary results indicate no significant A dependence for the cross over at large ξ





XEM error bars are only statistical

Preliminary results
EMC ratios for ^{4}He and C



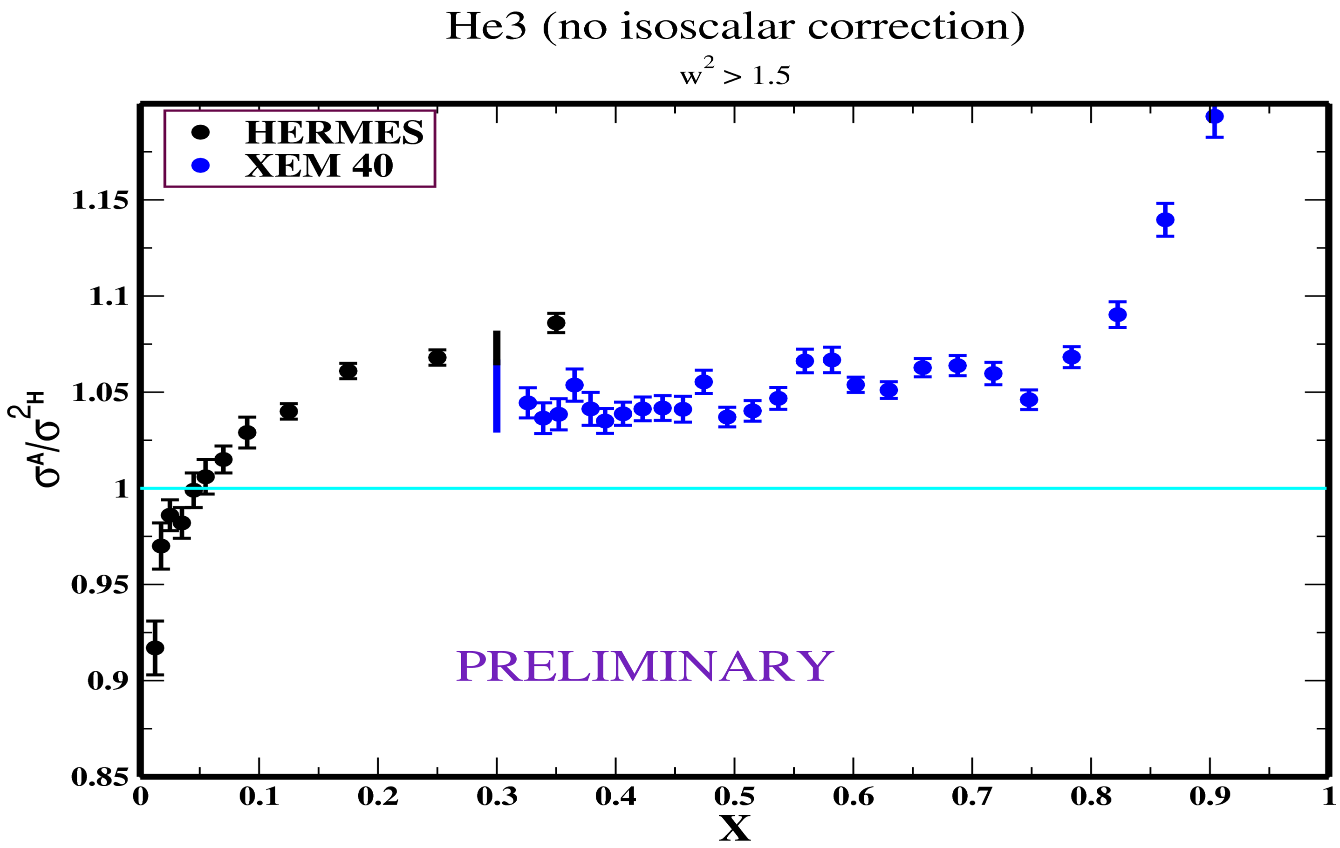
^{4}He and C: Isoscalar nuclei
Small Coulomb distortions

XEM error bars are only statistical

No significant difference in size and shape of the effect

Preliminary results

^{3}He EMC ratios : with out isoscalar correction



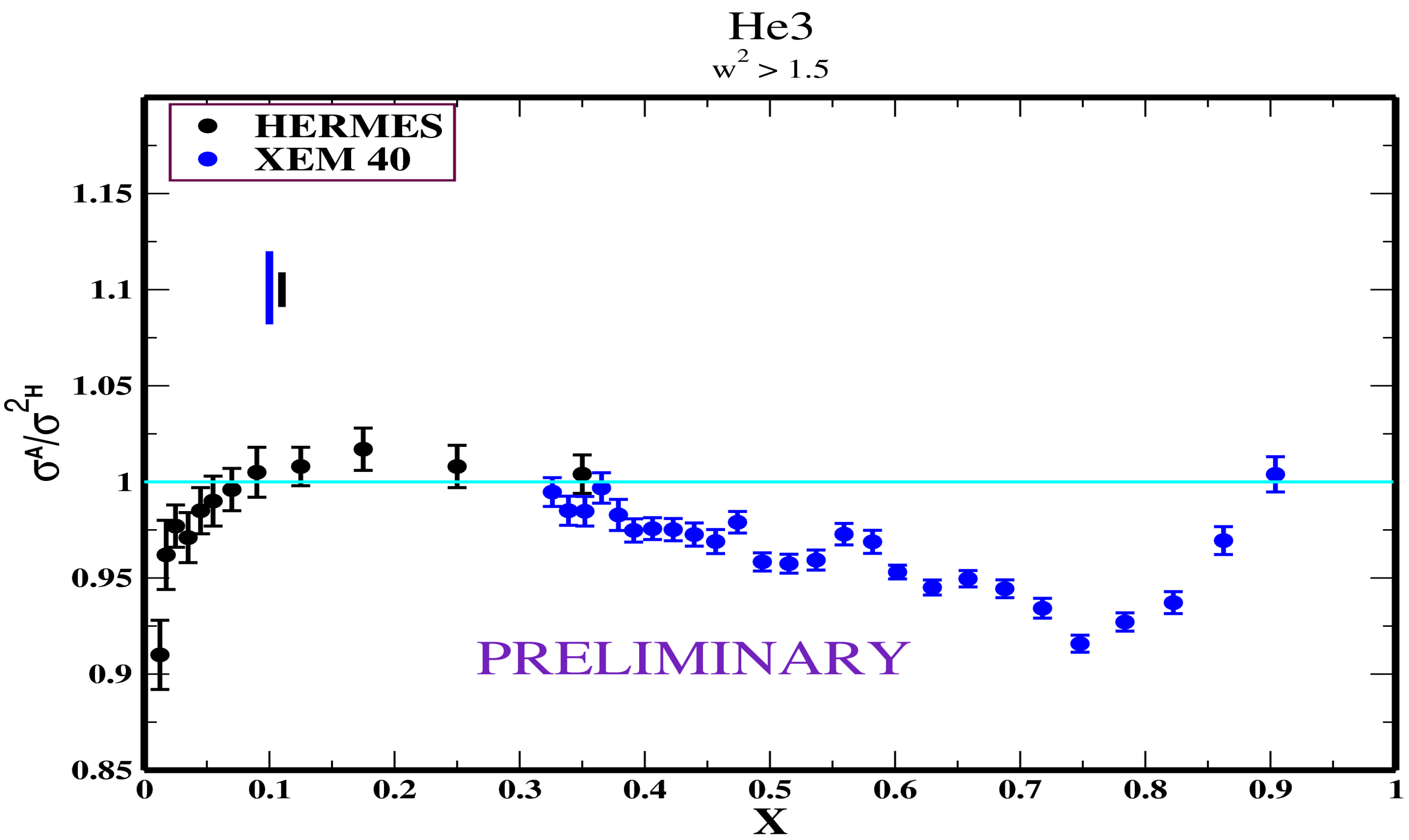
Result very sensitive to isoscalar corrections

XEM error bars are only statistical

HERMES normalization 0.9%
XEM normalization 1.9%
(large temperature and pressure derivatives)

Preliminary results

^{3}He EMC ratios : with isoscalar correction



Result very sensitive to isoscalar corrections
HERMES used NMC fit
XEM: SLAC fit (1-0.8x)

XEM error bars are only statistical

HERMES normalization 0.9%
XEM normalization 1.9%
(large temperature and pressure derivatives)

Summary

- Study of the EMC effect in light nuclei will help us to distinguish between models and impose new constraints.

- E03-103 data in resonance region allows to study the large x behavior of EMC ratios. Need to look into detailed scaling studies.

- Precise measurement of Q^2 dependence of F_2 and EMC ratios.

- Systematic uncertainties and model dependency of radiative corrections and isoscalar corrections are still under investigation.

XEM Collaboration

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