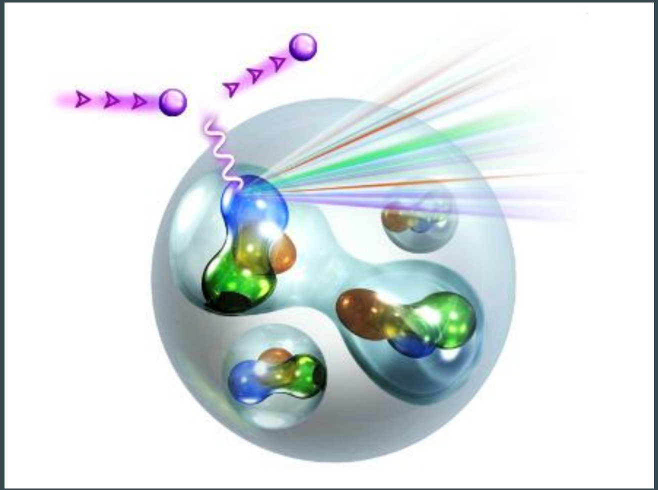
On the significance of Radiative Corrections on measurements of the EMC effect



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Sebastián Morán Vásquez

Winter CLAS Collaboration Meeting
2024

Outline

- Introduction
- Problem: Inconsistencies in world data
- Possible sources of the discrepancy
- Updated Radiative Corrections
- Impact on the EMC ratios
- Conclusions

On the significance of radiative corrections on measurements of the EMC effect

S. Moran,[1] M. Arratia,[1] J. Arrington,[2] D. Gaskell,[3] and B. Schmookler[1]

[1] *Department of Physics and Astronomy, University of CA, Riverside, California 92521, USA*
[2] *Lawrence Berkeley National Laboratory, Berkeley, CA 94720, USA*
[3] *Thomas Jefferson National Accelerator Facility, Newport News, VA 23606, USA*

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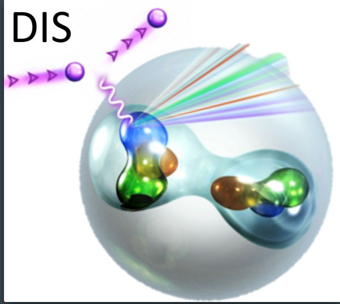
Analyzing global data on the EMC effect, which denotes differences in parton distribution functions in nuclei compared to unbound nucleons, reveals tensions. Precise measurements at Jefferson Lab, studying both x and A dependence, show systematic discrepancies among experiments, making the extraction of the A dependence of the EMC effect sensitive to the selection of datasets. By comparing various methods and assumptions used to calculate radiative corrections, we have identified differences that, while not large, significantly impact the EMC ratios and show that using a consistent radiative correction procedure resolves this discrepancy, leading to a more coherent global picture, and allowing for a more robust extraction of the EMC effect for infinite nuclear matter.

On arxiv : https://arxiv.org/abs/2402.17147

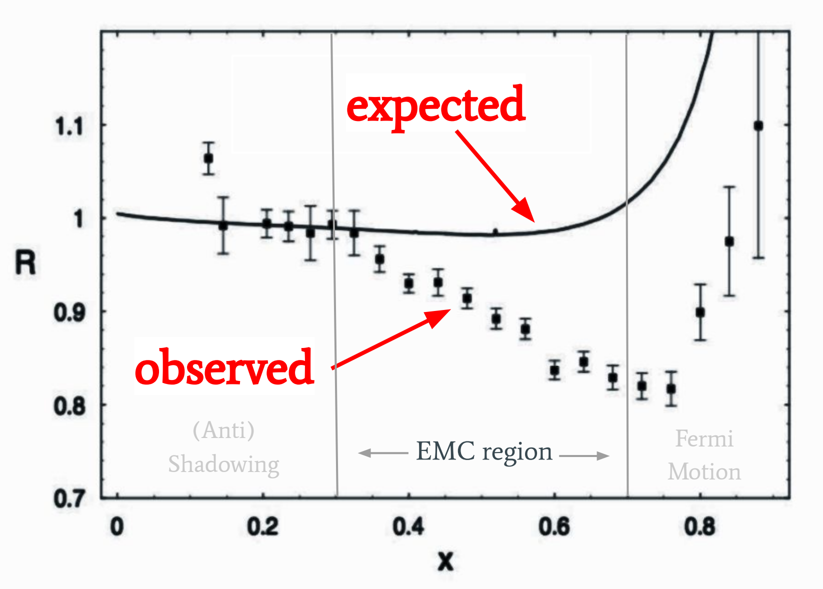
Introduction

EMC Effect

$$EMC \sim \frac{F_2^A/A}{F_2^D/2} \sim \frac{\sigma_A/A}{\sigma_D/2}$$



DIS off nucleons in nuclei $\neq$ DIS off free nucleons

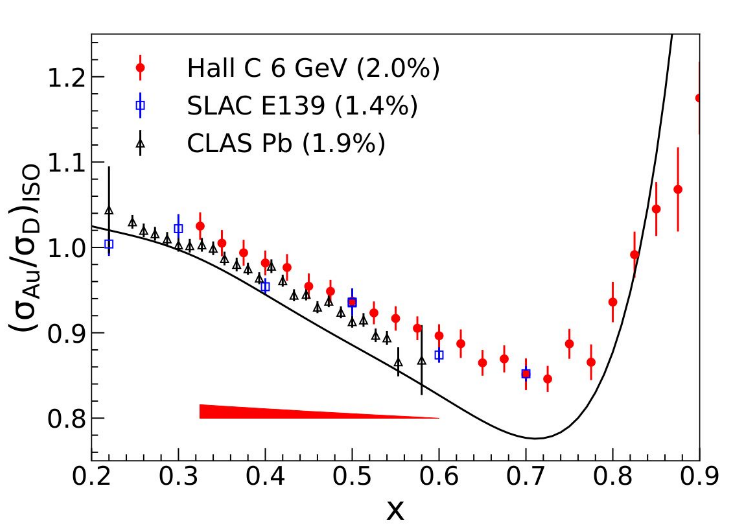


from SLAC

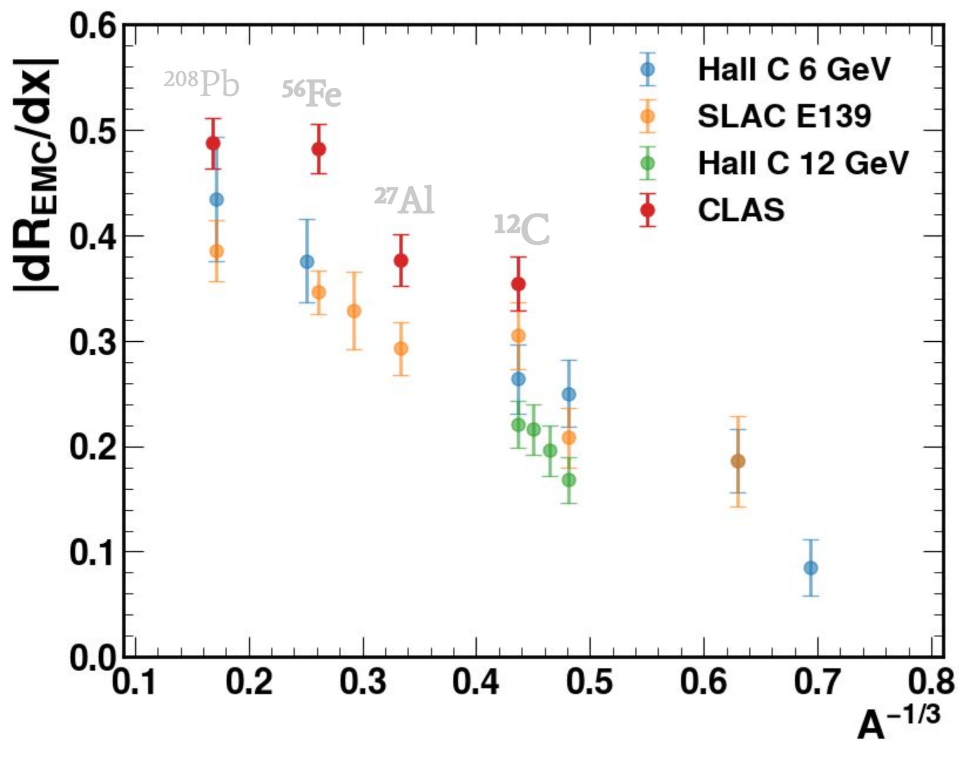
Size of the effect parametrized by slope for 0.3 ≤ x ≤ 0.7

Problem: Inconsistencies in world data

World's data on x- and A- dependence



Identical iso-scalar corrections applied



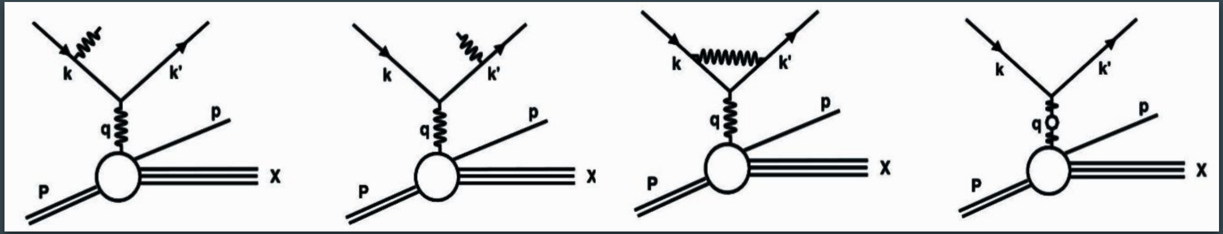
CLAS slopes systematically higher, by ~ 0.1
Excluded from global A dependence fits

Possible sources of the discrepancy

- **Lower beam energy, lower Q^2.**
- **Large-acceptance, modest resolution detector.**
- **Different Iso-scalar, Radiative, and Coulomb corrections.**

Only correction that might have a significant contribution:

Radiative Corrections → x and A dependent



$$N_{RC} = \frac{N_{meas}}{\delta_{RC}} \quad ; \quad \sigma_{Rad} = \delta_{RC} \times \sigma_{Born}$$

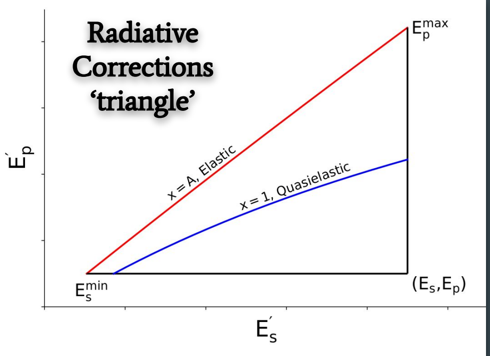
Updated Radiative Corrections (RC)

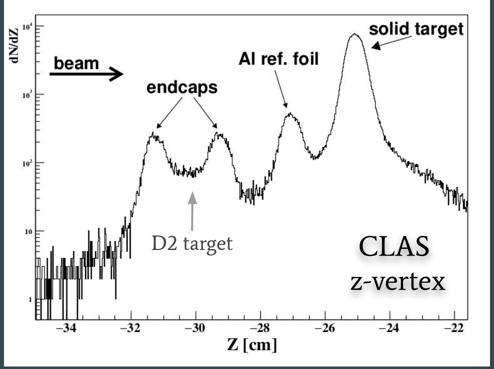
EXTERNALS v/s INCLUSIVE

- Both based on Mo and Tsai formalism.
- Differences:
  - Evaluation of the correction over the full phase space that can contribute to a given event.

    EXTERNALS → Full 2D integration

    INCLUSIVE → 'Energy-peaking approximation' (pair of 1D integrals)
  - INCLUSIVE does <u>not</u> include effects of external radiation in the upstream D2 target.

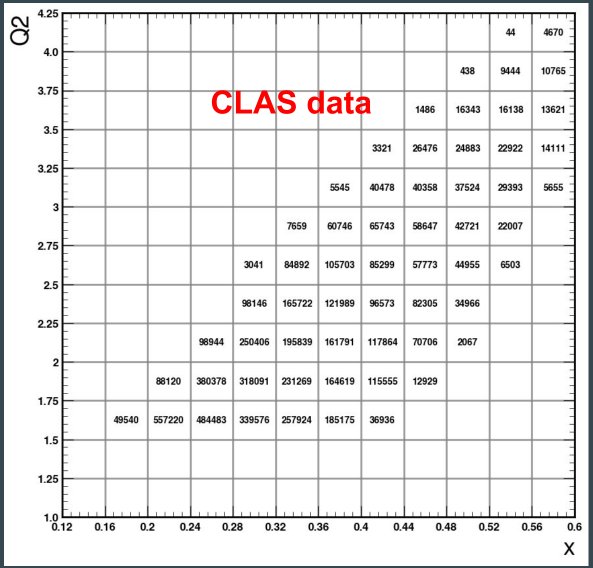




Dual target system

Averaging Process

Yield



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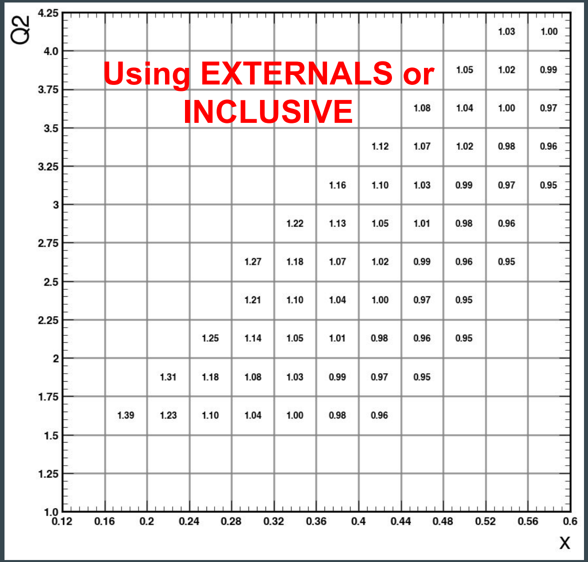
RC factors (δ)



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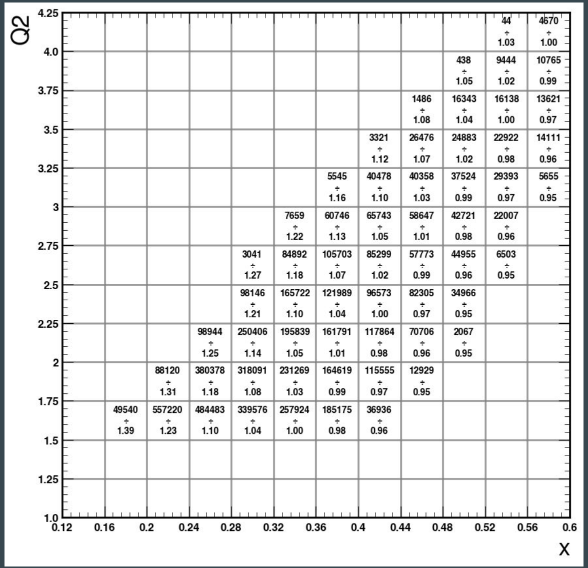
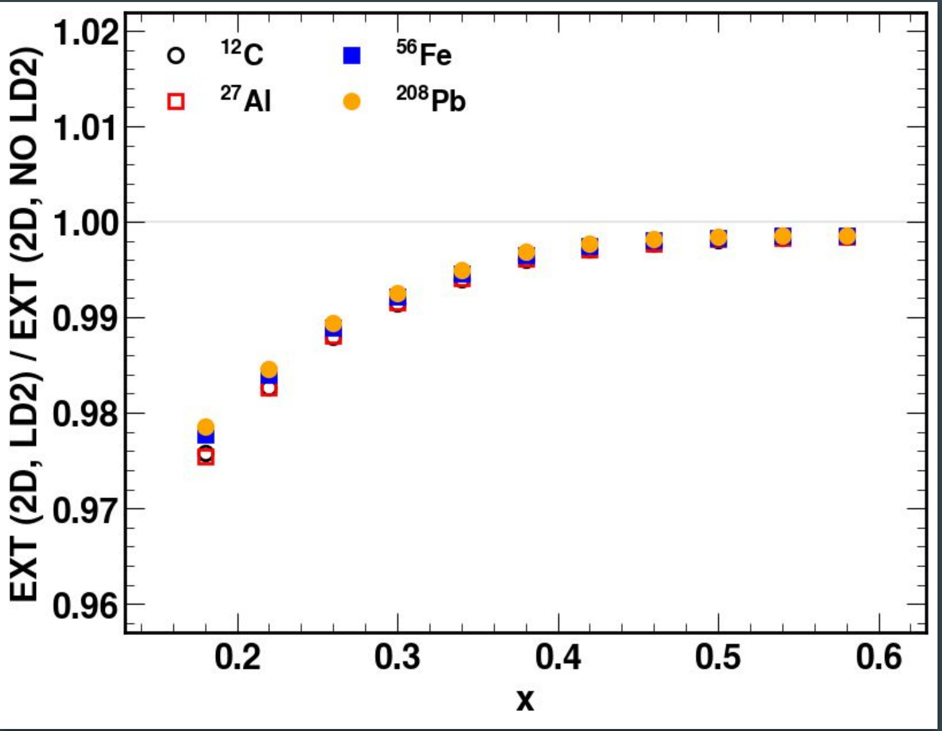
Corrected Yield



Performed same calculation using a cross-section model instead of real data and differences were negligible. Published results are using the model

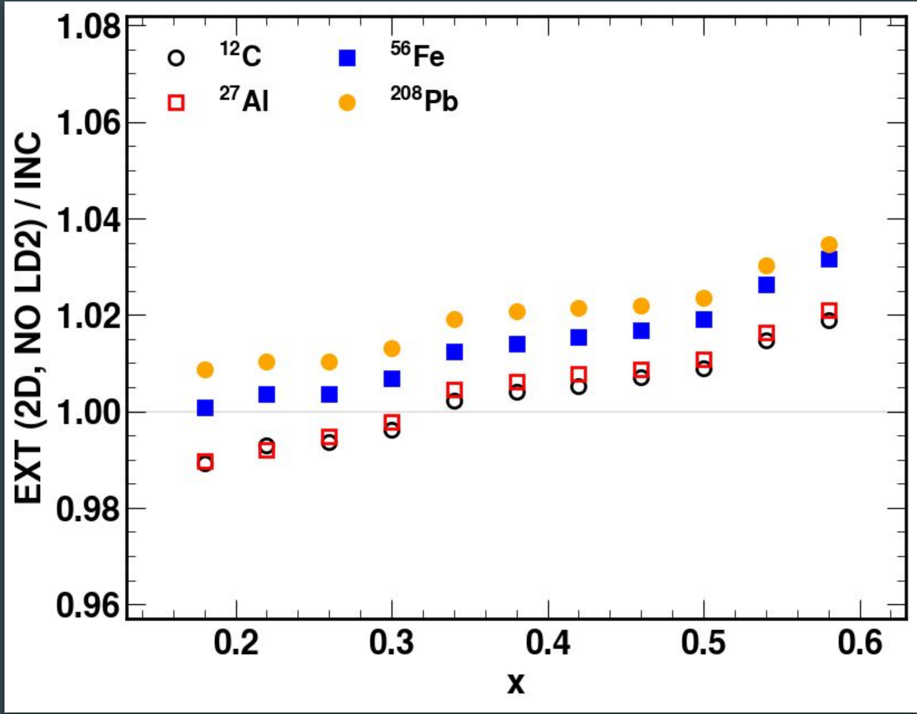
Impact of adding the LD2 target upstream of the solid target position



Reduction of the EMC ratio at low x values.

Nearly A independent

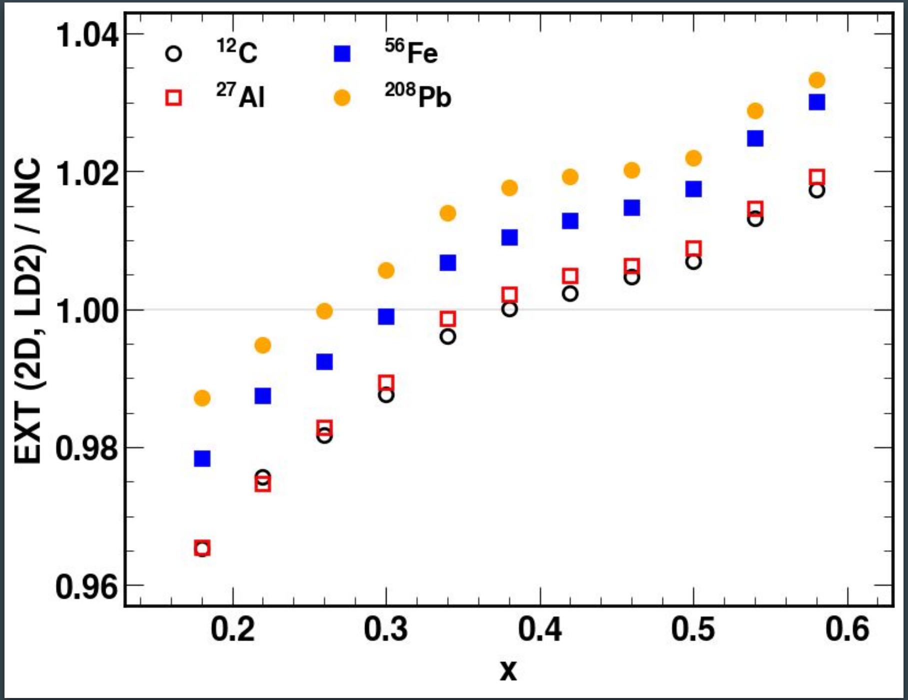
Impact of switching from the INCLUSIVE to EXTERNALS RC code, without the inclusion of the upstream LD2 target



Roughly linear in x correction that decreases the faloff of the EMC ratio.

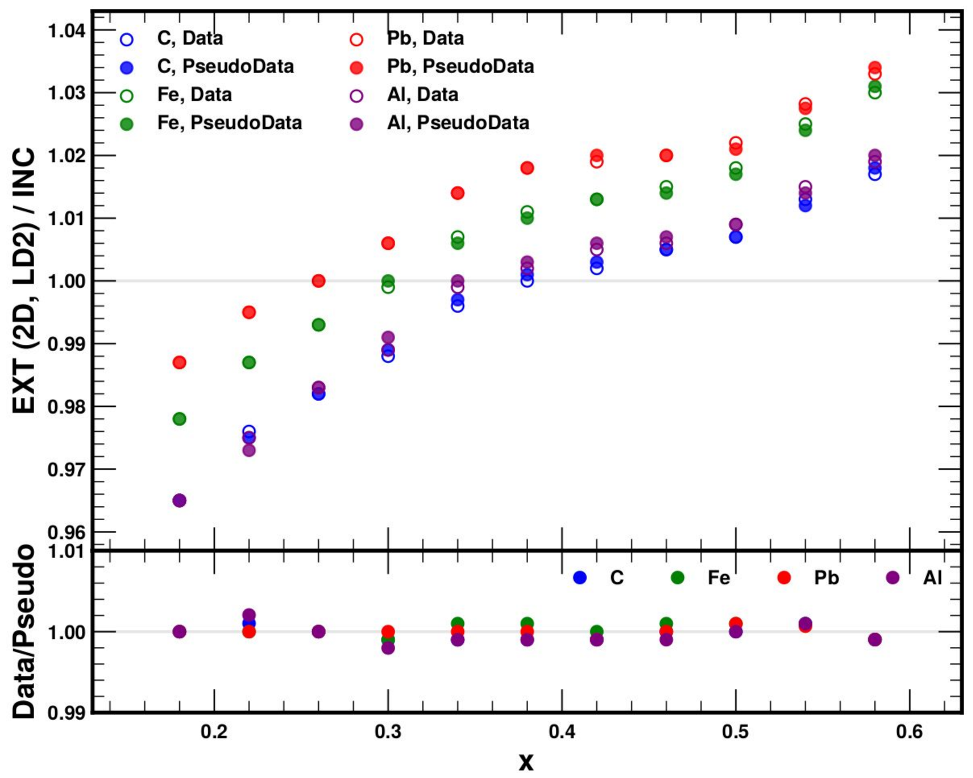
Slope reduction!

Impact of RC procedure (EXTERNALS, including upstream LD2 target) vs original (INCLUSIVE, no LD2 target) on EMC ratios



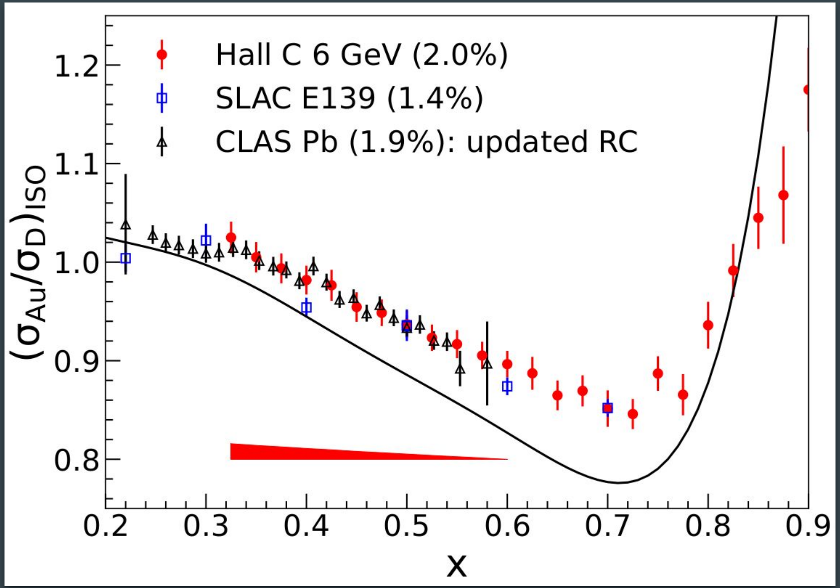
Typically <~2%
Systematic x dependence similar for all targets, decreasing the extracted EMC slopes

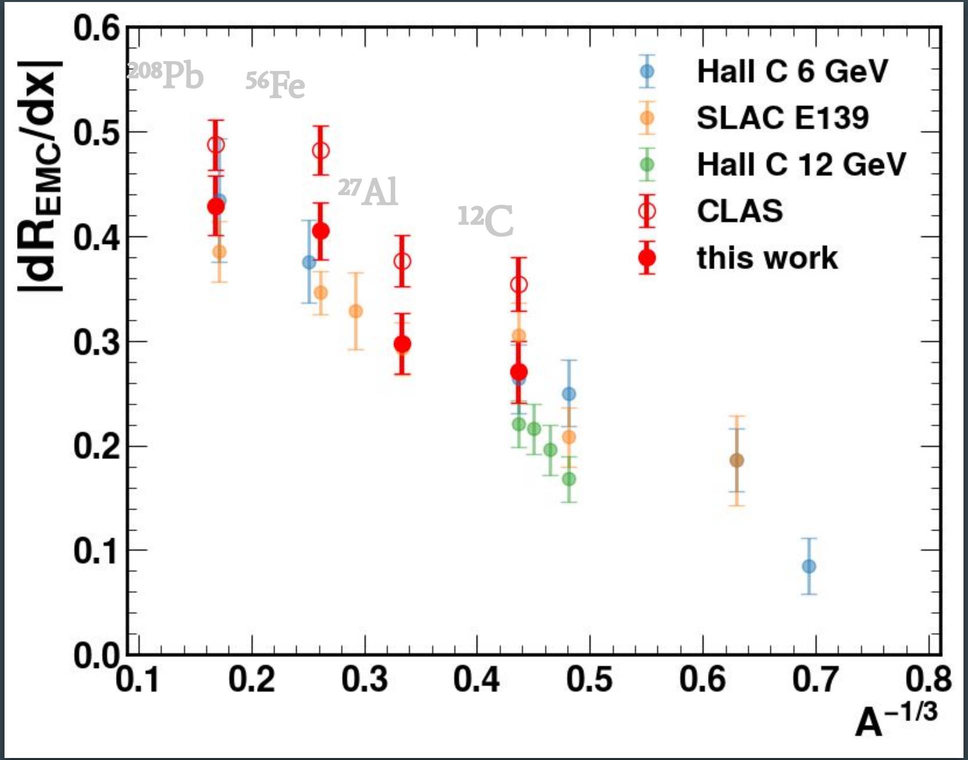
Real Data v/s Pseudo-Data (model for cross-sections)



Differences are negligible for all targets

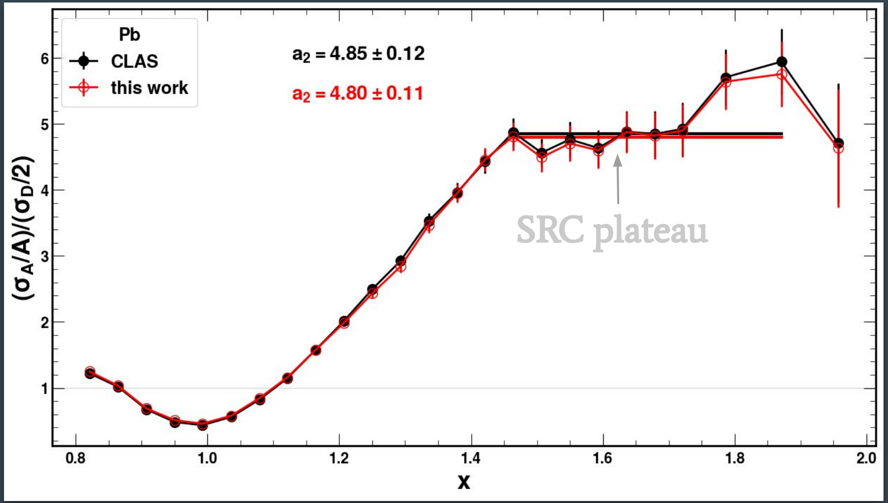
Impact on the EMC ratios

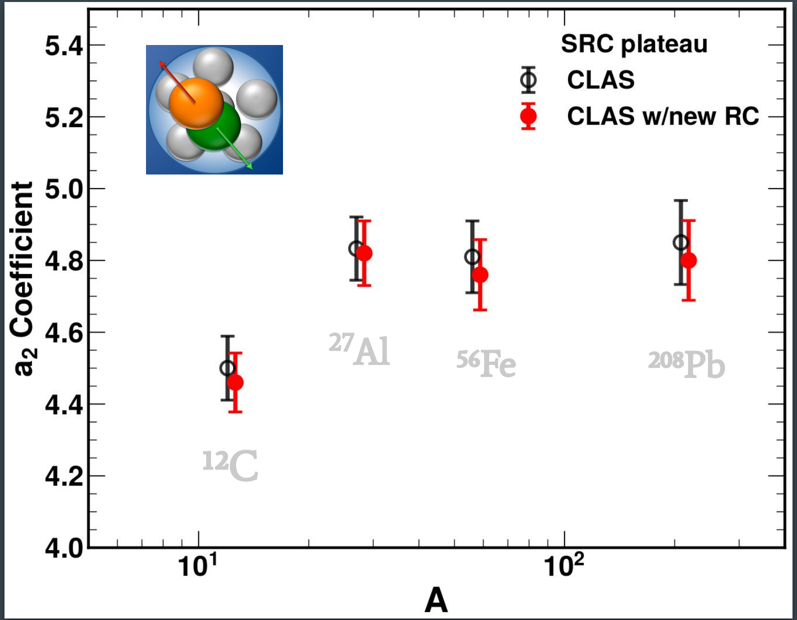




CLAS slopes are in better agreement with other measurements. Global A dependence is now more robust

Impact on the Quasi-elastic scattering at x > 1





The updated RCs does not have a systematic impact in the comparison to the previous SRC measurements

Conclusions

- We compared INCLUSIVE and EXTERNALS radiative correction methods. Using the more complete EXTERNALS formalism on CLAS data seems to resolve discrepancies with EMC ratios from SLAC and Jefferson Lab Hall C experiments.

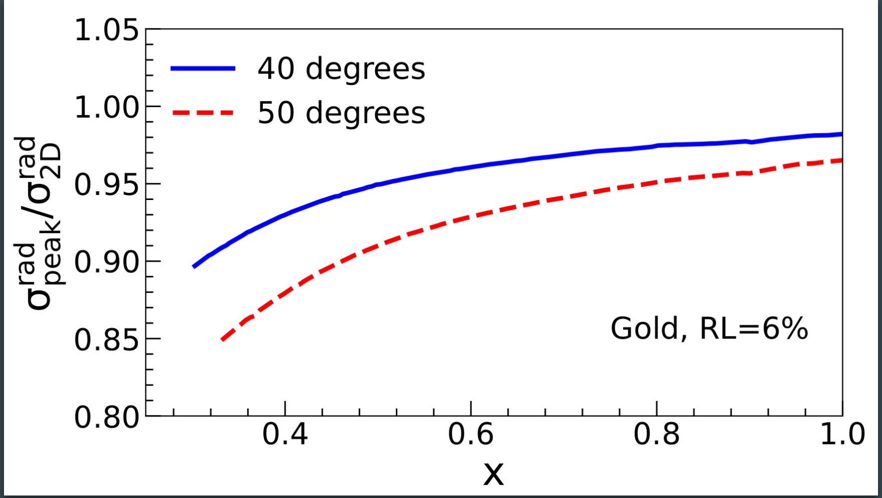
- Improved numerical-integration and inclusion of upstream LD2 target are the main significant differences.

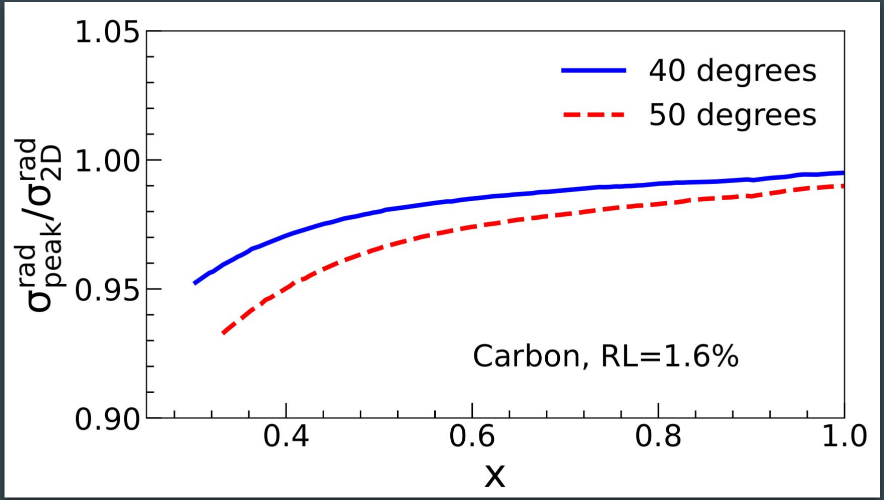
- For quasi-elastic scattering corrections are small and coefficients are in agreement with previous CLAS measurements.

Thanks!

Backup Slides

Cross-sections comparison with and without energy-peaking approximation





Hall C experiment (E03103)