

EMC Effect at 11 GeV

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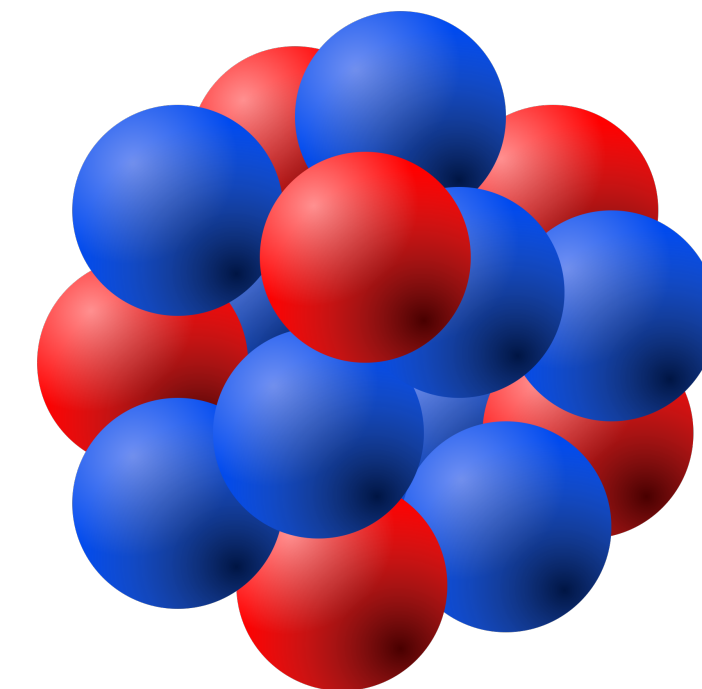
Overview

- *Physics Background*
- Experimental Setup
- Overview of E12-10-008
- Preliminary Results



What is the EMC Effect?

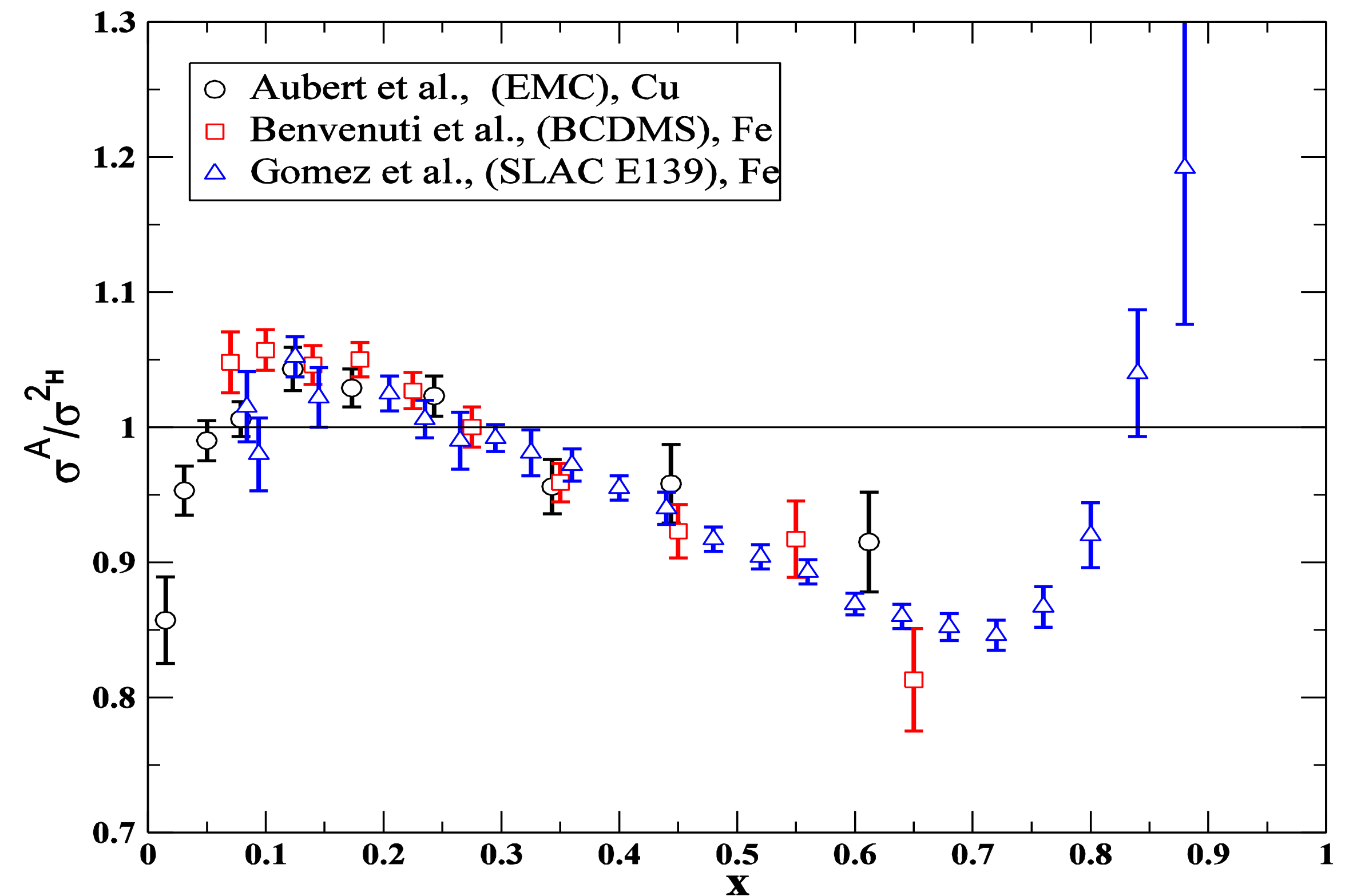
- Discovered by the European Muon Collaboration in 1983
- $F_2^A(x) = ZF_2^p(x) + NF_2^n(x)$



What is the EMC Effect?

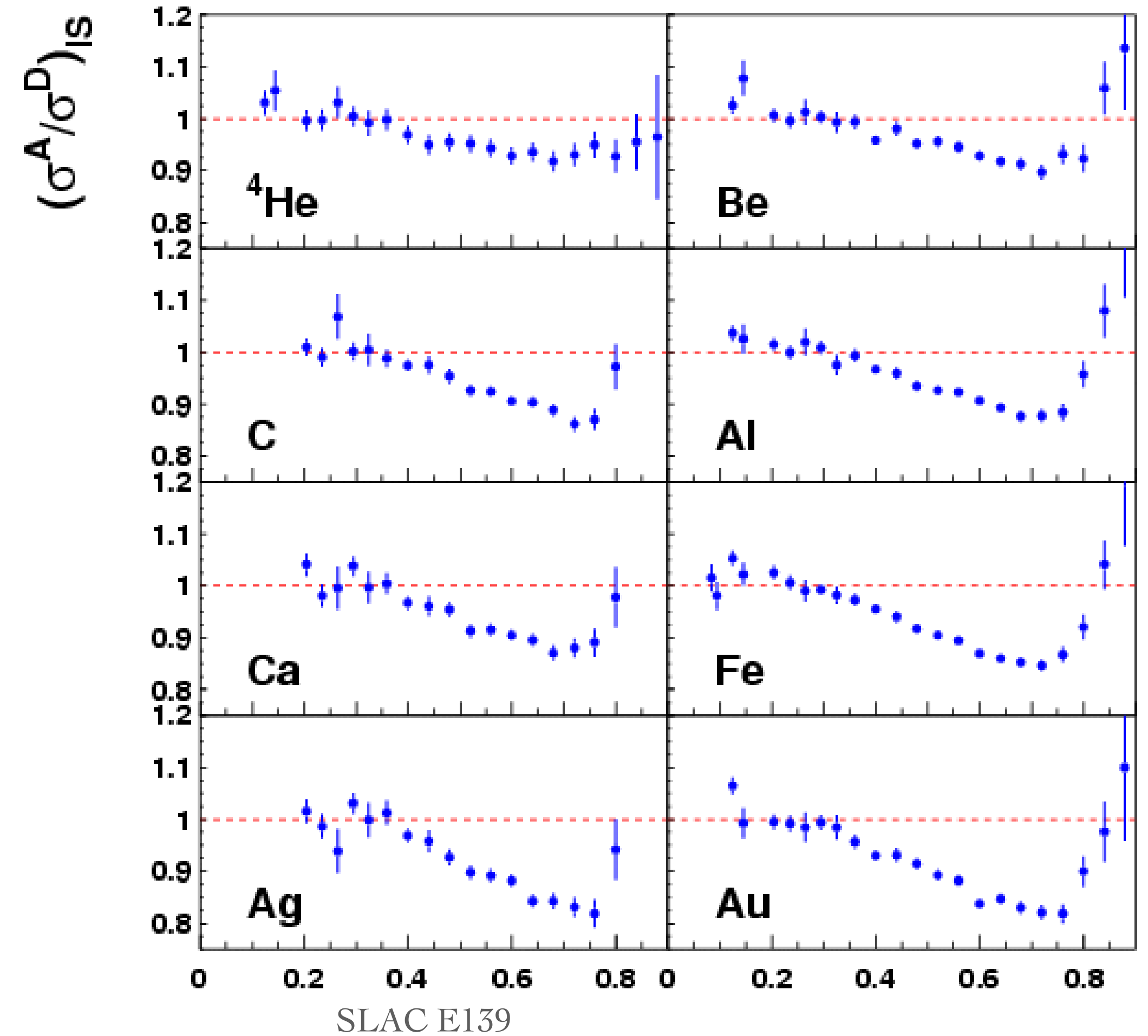
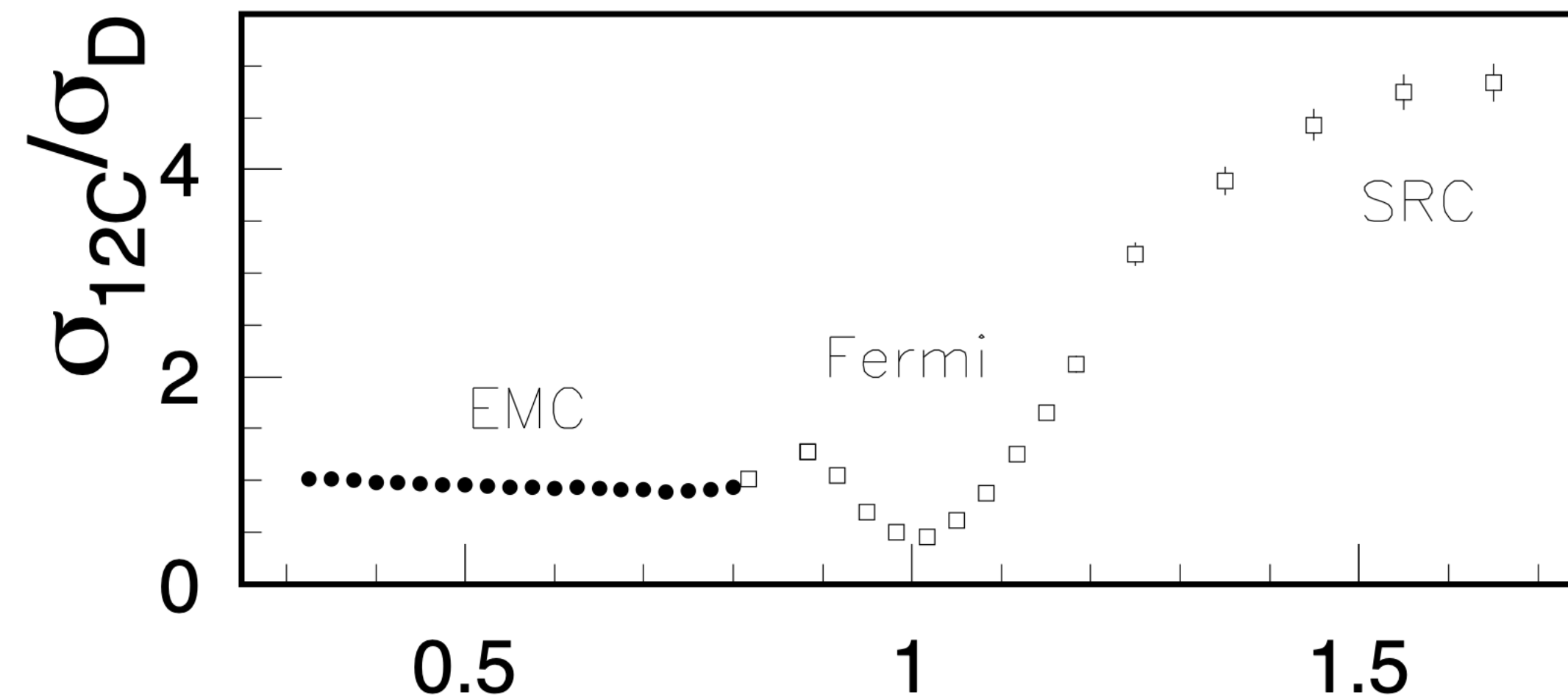
- Discovered by the European Muon Collaboration in 1983

- $F_2^A(x) \neq ZF_2^p(x) + NF_2^n(x)$



What is the EMC Effect?

$$\left| \frac{dR_{EMC}}{dx} \right| \sim \text{from } 0.35 < x < 0.7$$

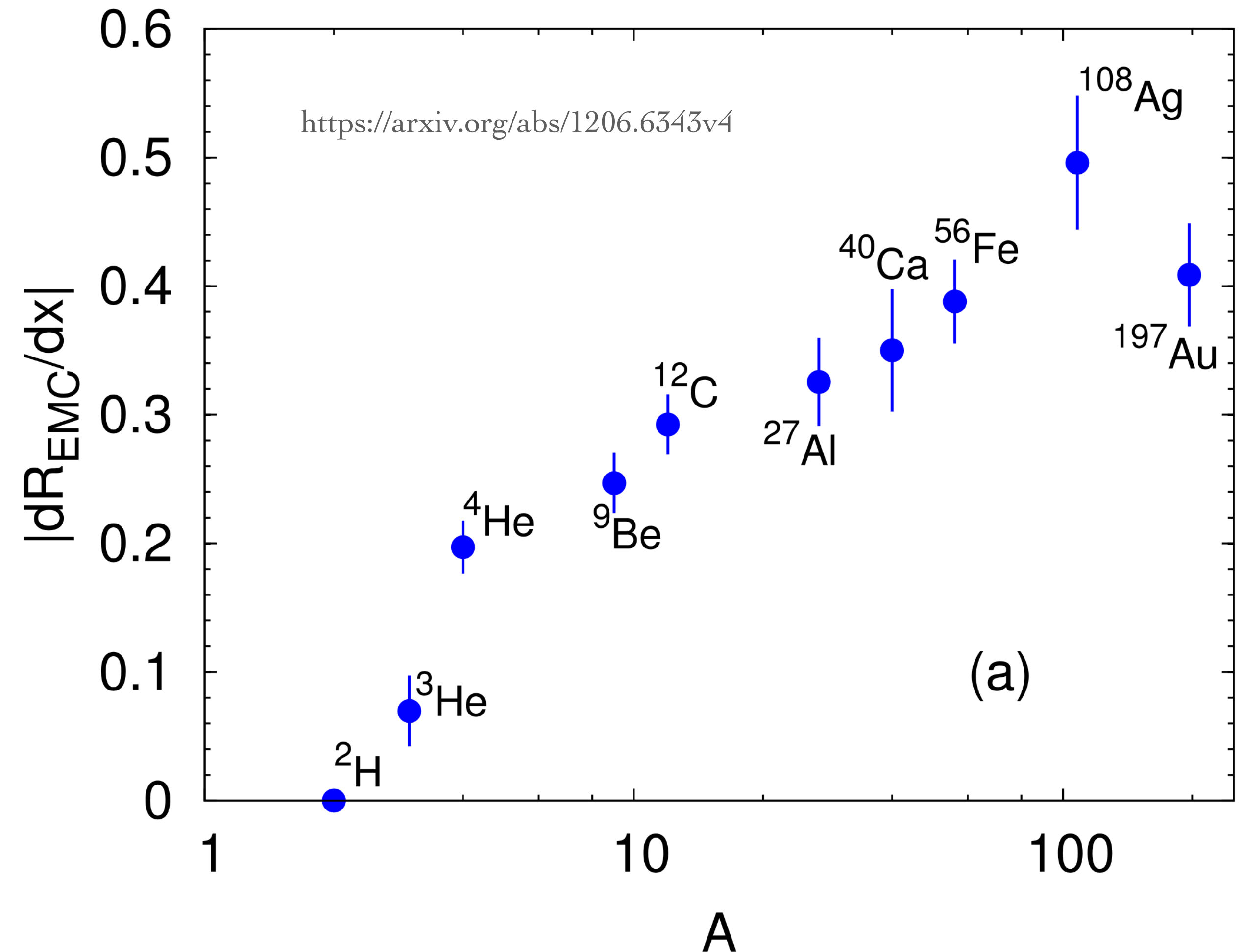


What is the EMC Effect?

- >1000s of theory papers written
- No consensus after >40 years
- Not explainable by conventional nuclear physics
- This is surprising because typical nuclear binding energies are insignificant compared to energies present in DIS experiments (MeV vs. GeV)
- Guided by experiments, we have hints:
 - SRCs
 - Local Density

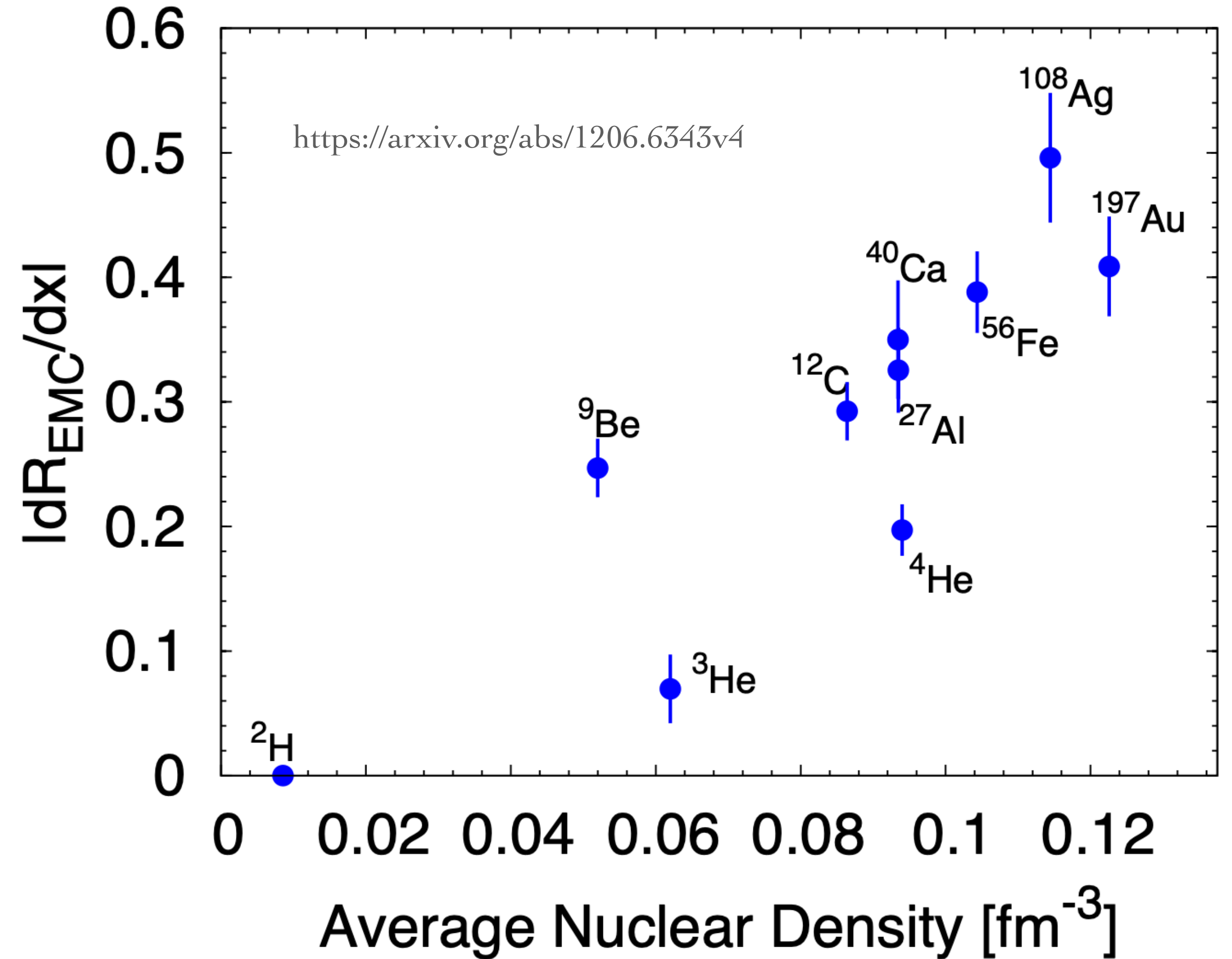
Finding Correlating Properties

- No direct relation with A

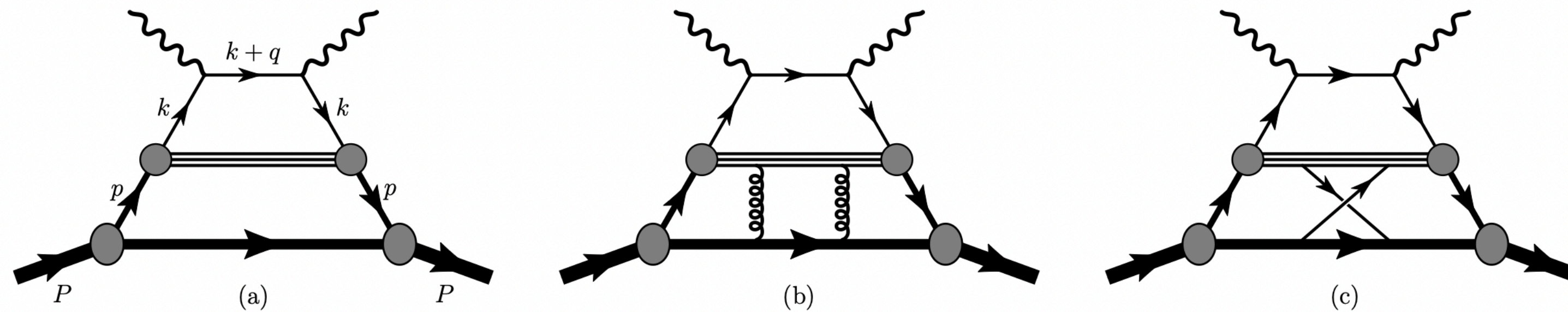


Finding Correlating Properties

- Scaling with average nuclear density is not completely satisfactory for light nuclei



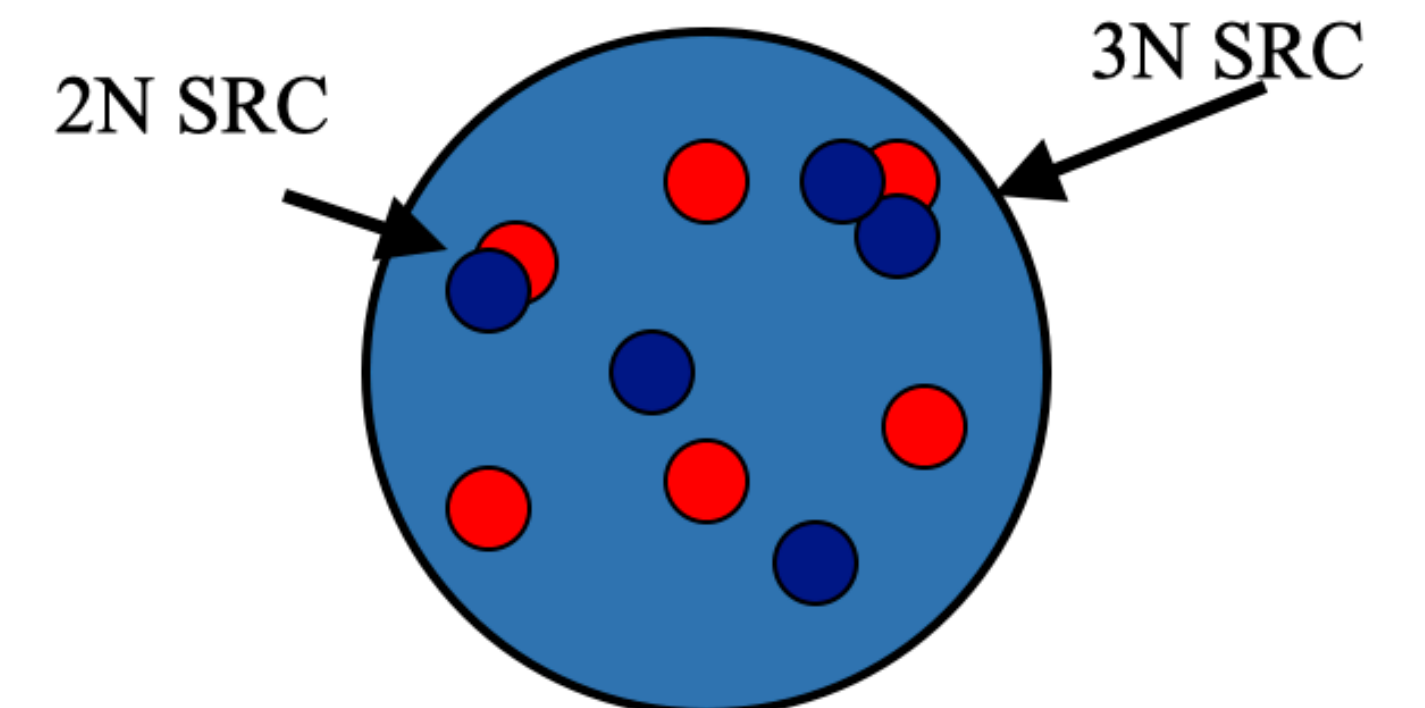
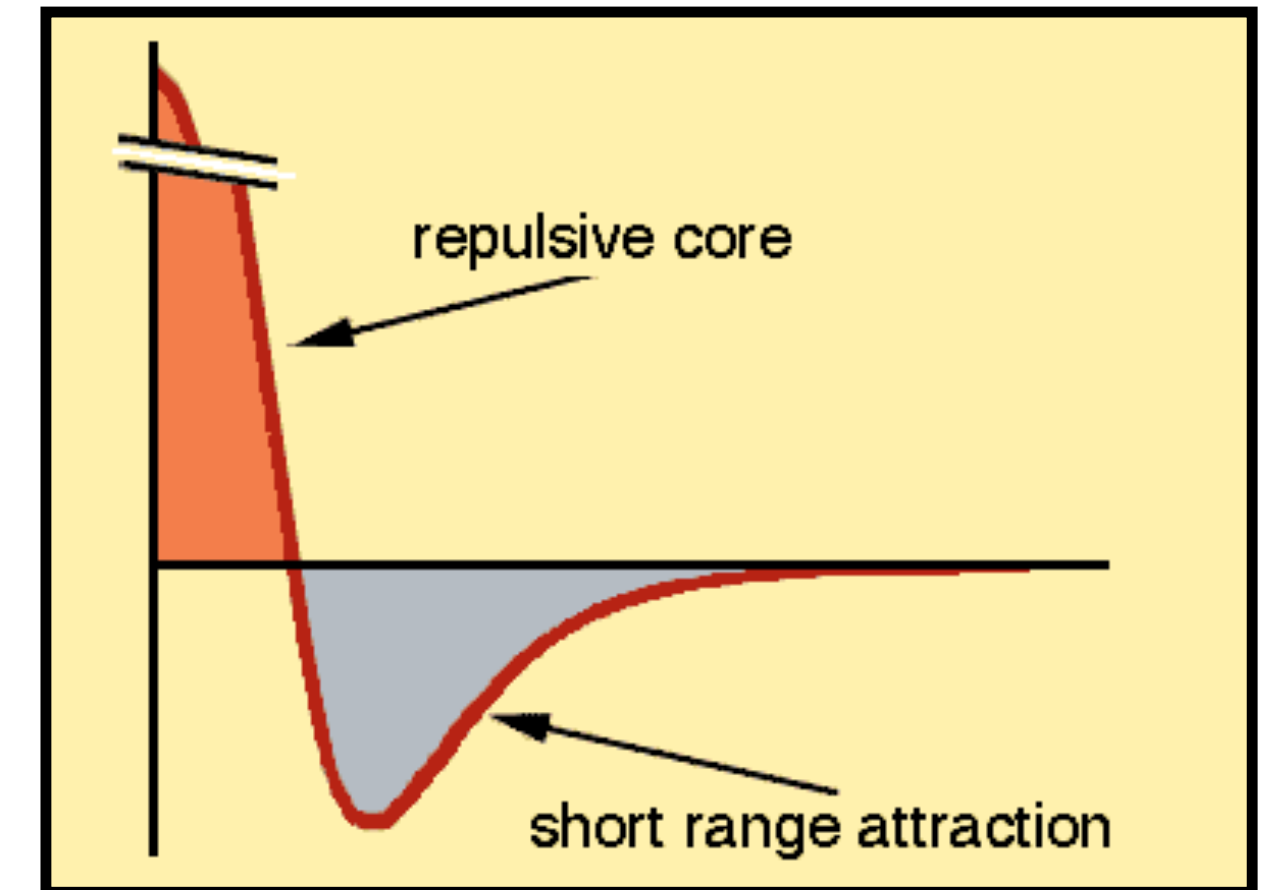
Theoretical Approaches



- The EMC effect challenges the traditional convolution formalism
- Medium modification
- Multiquark clusters- 6 quark bag?

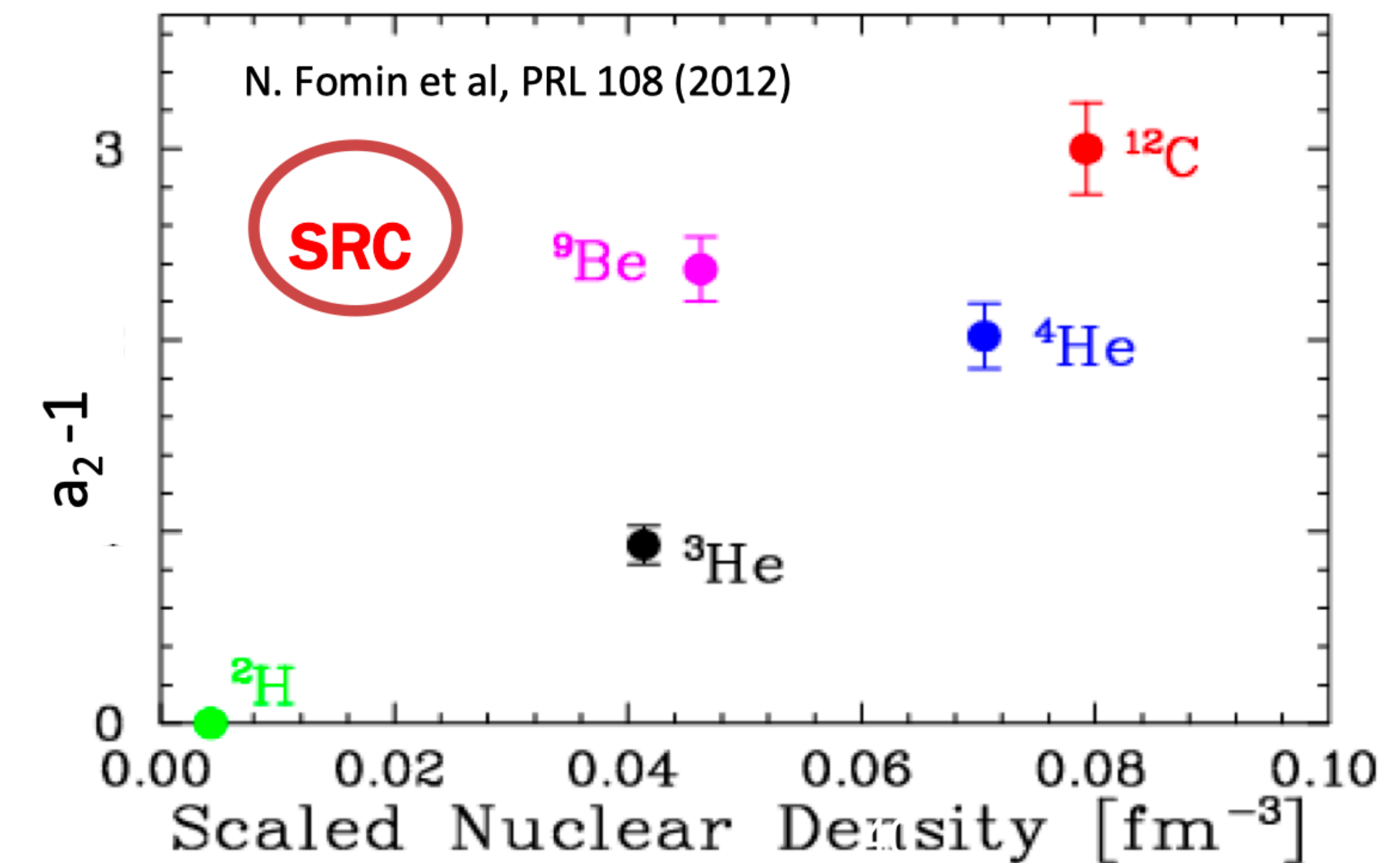
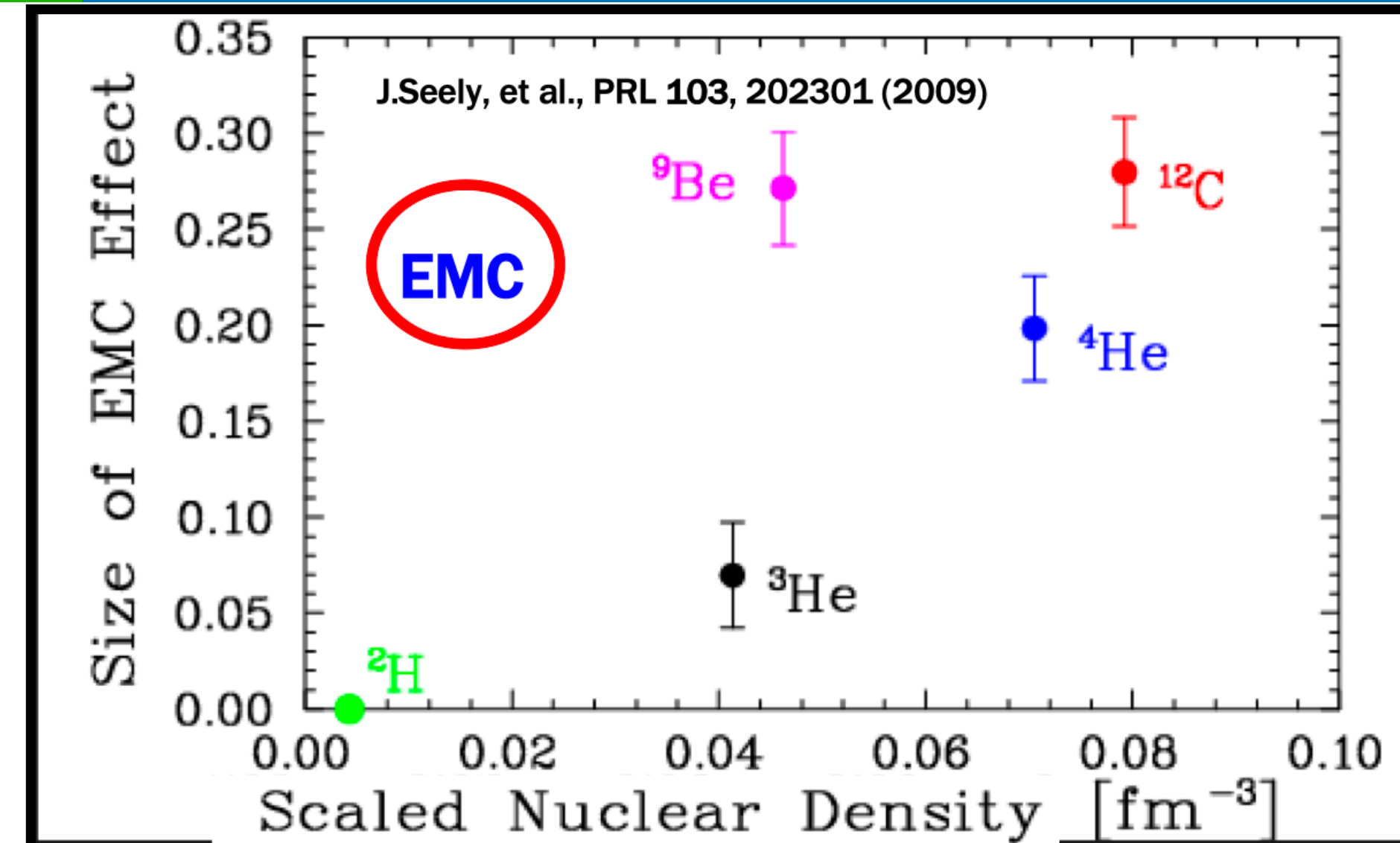
The SRC Connection

- Short-Range Correlations: Pairs of nucleons with high back-to-back momenta
- These measurements were thought of as independent to the EMC Effect



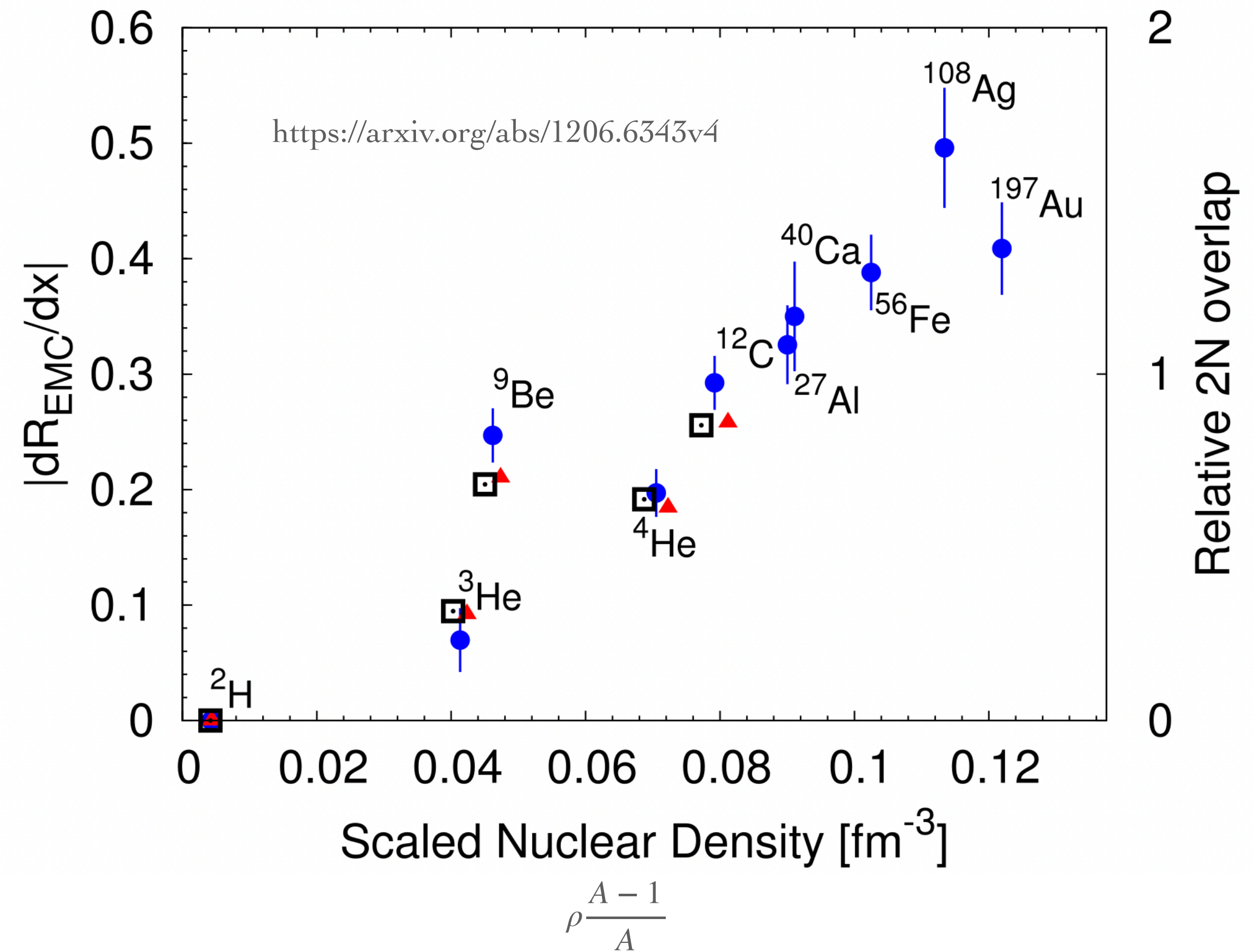
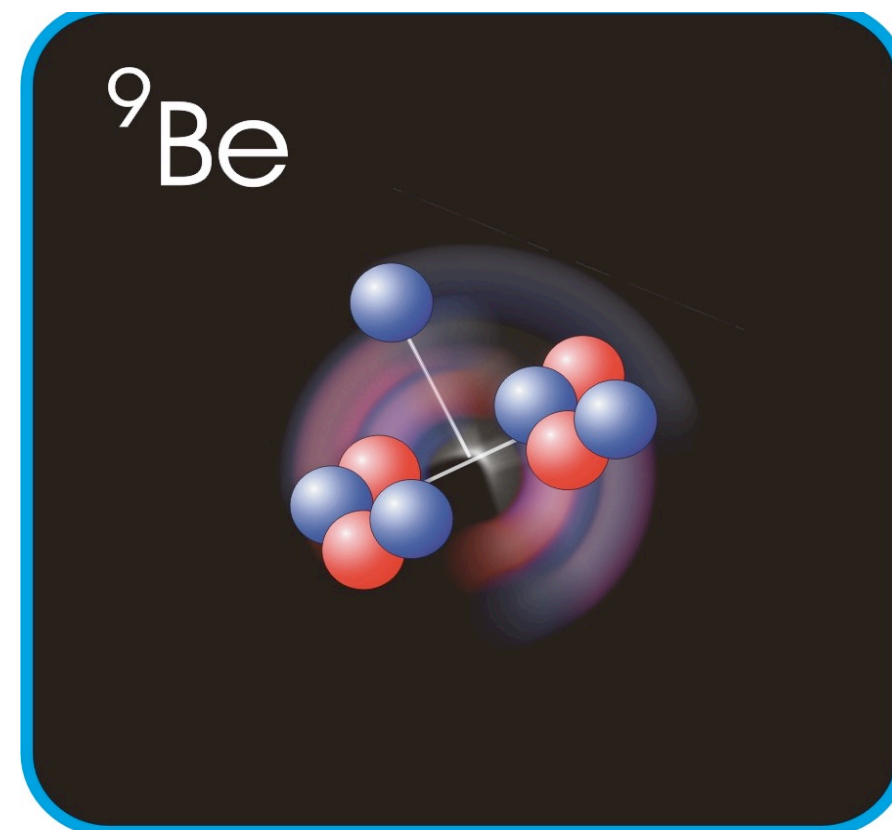
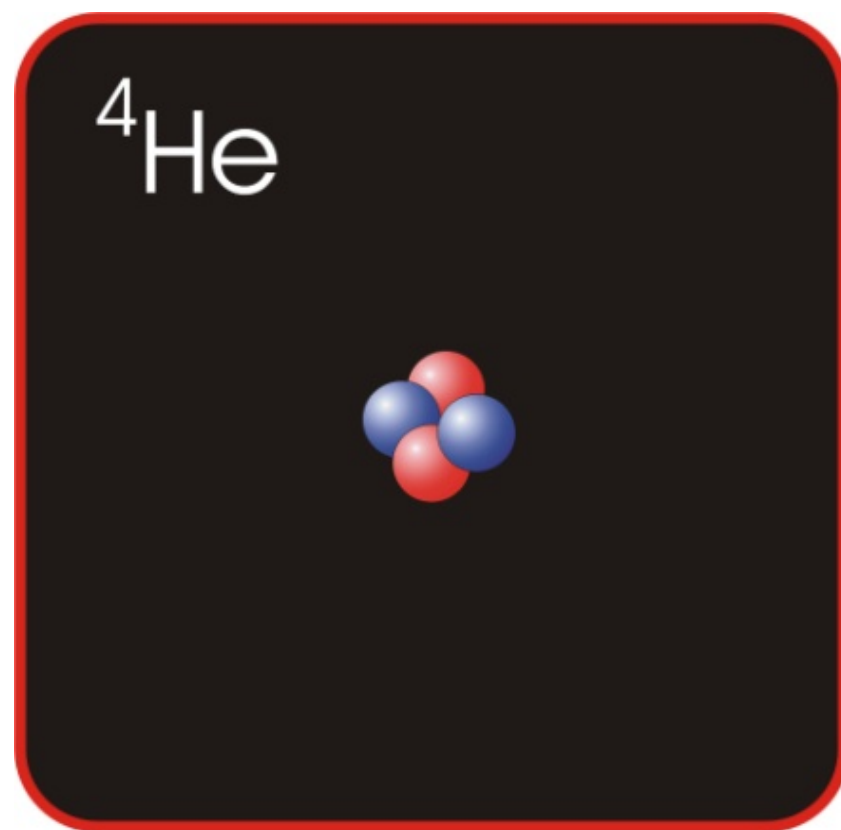
Results from the 6 GeV era

- Ran in Hall C@JLab in 2004
- EMC Effect and SRCs closely correlated
- Could they modify the nucleon structure?
- This experiment will address that



Local Density

- Seems to be a better indicator of the size of the EMC Effect
- Example: ${}^9\text{Be}$ vs ${}^4\text{He}$



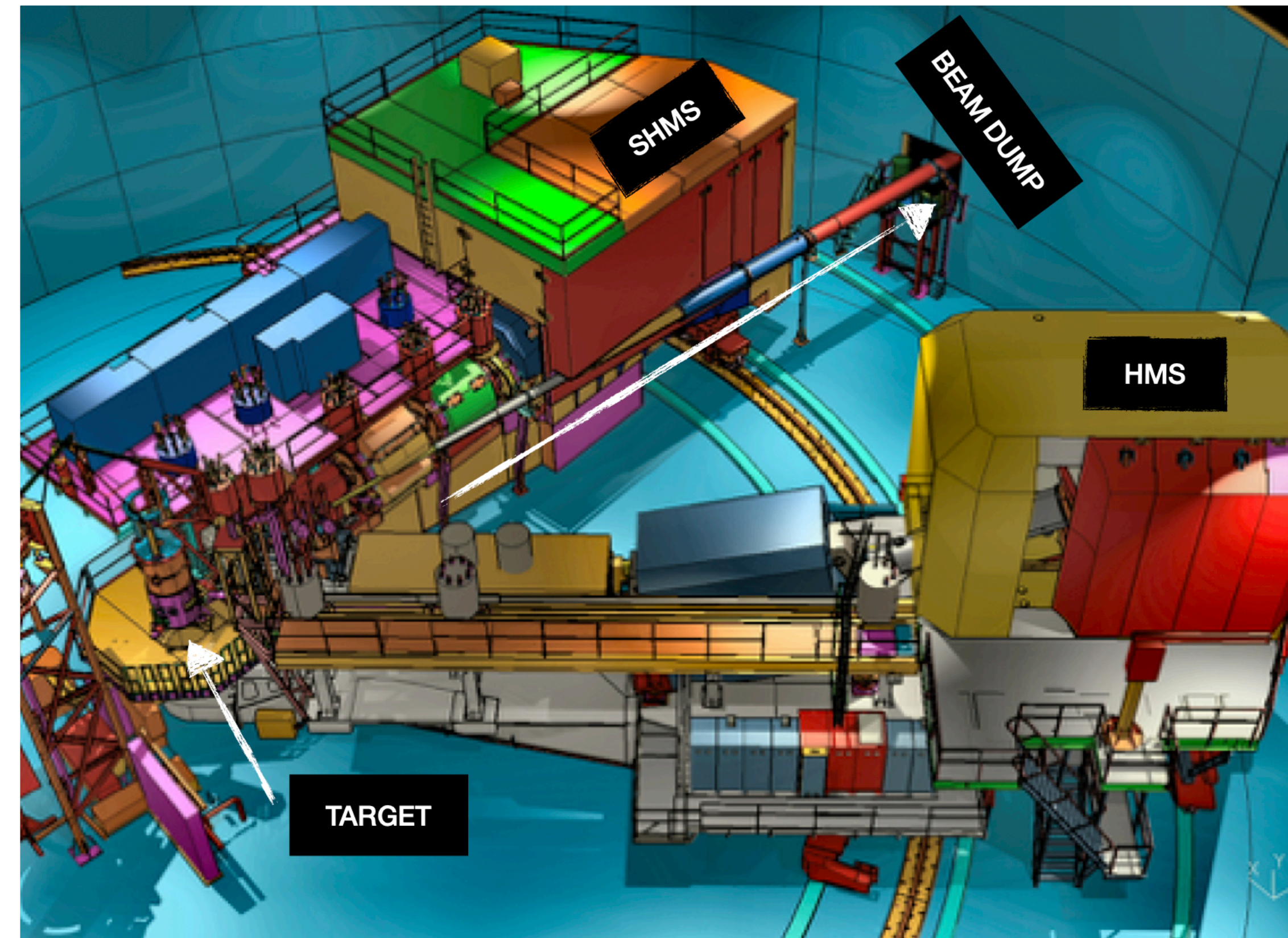
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Let's Find Out

- Experiment E12-10-008 performed in Hall C
- Ran simultaneously with E12-06-105(SRCs)
- Inclusive scattering using 10.5GeV electron beam from CEBAF
- Single arm data taken in HMS
- E12-06-105(SRCs) took data in SHMS



A CAD drawing of Hall C

High Momentum Spectrometer

1. Drift Chambers

- Provides tracking information

2. Cerenkov

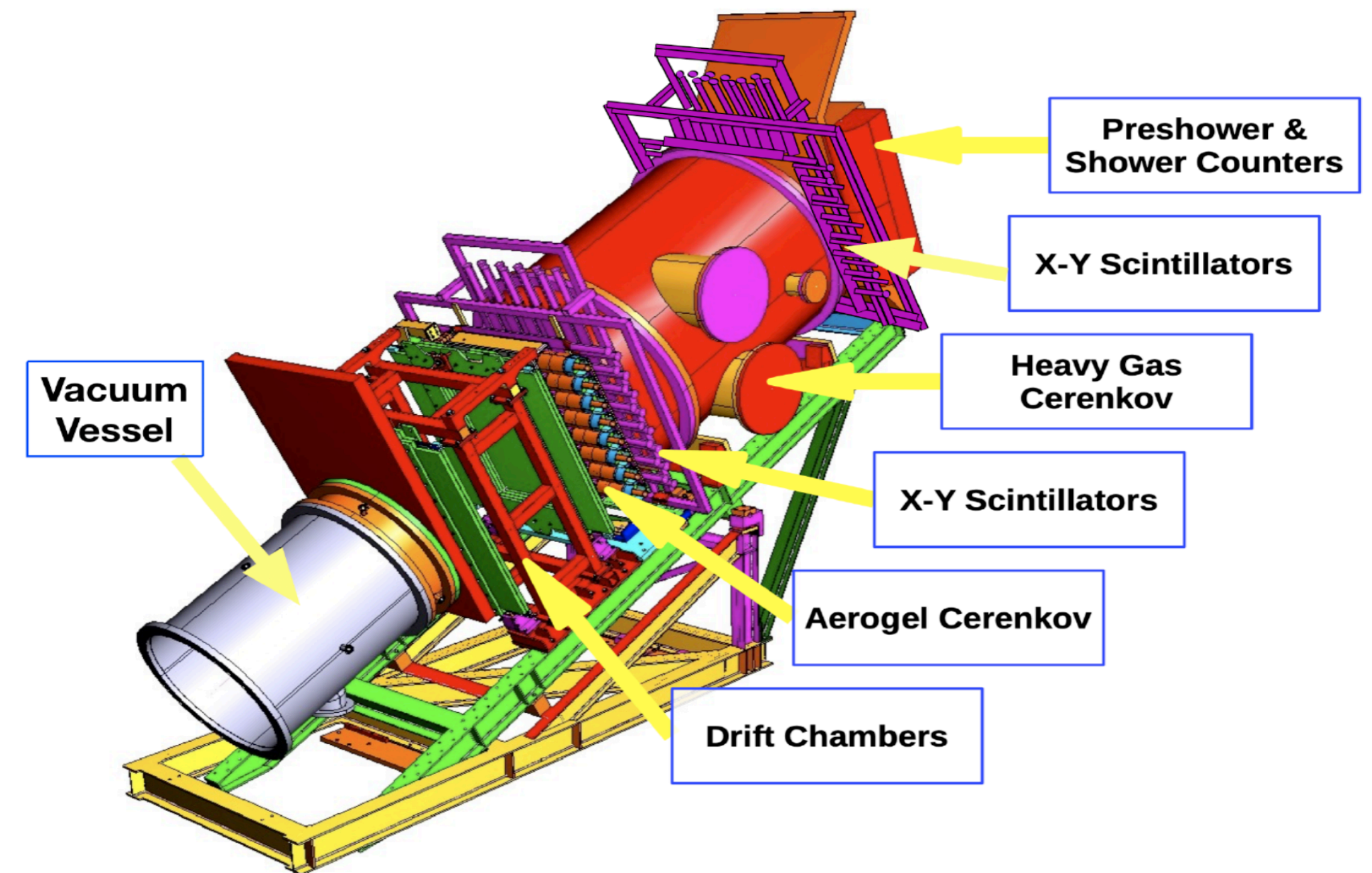
- Particle identification

3. Hodoscopes

- Trigger
- Tracking Efficiency

4. Calorimeter

- Particle identification



CAD Drawing of the HMS detector stack

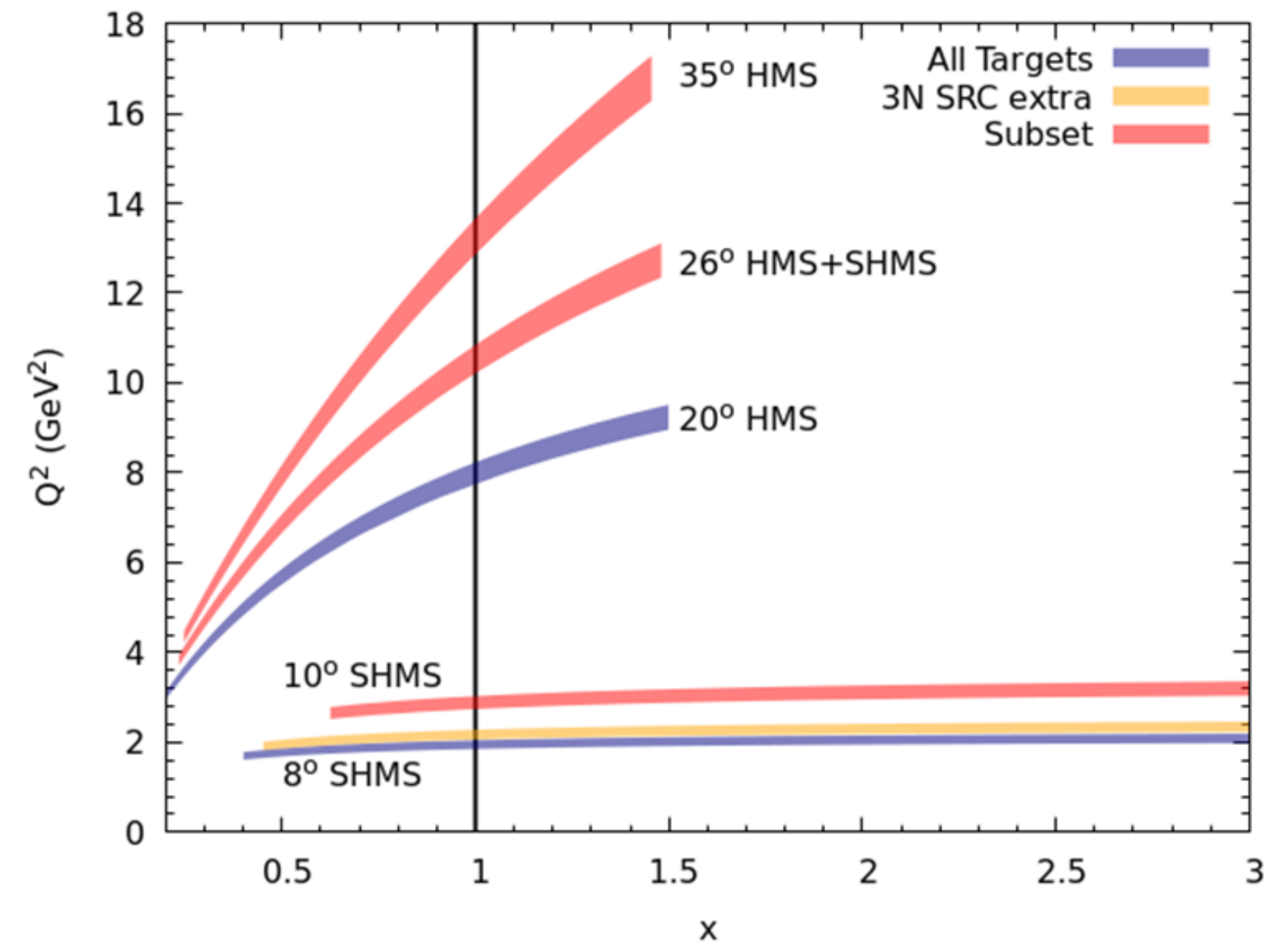
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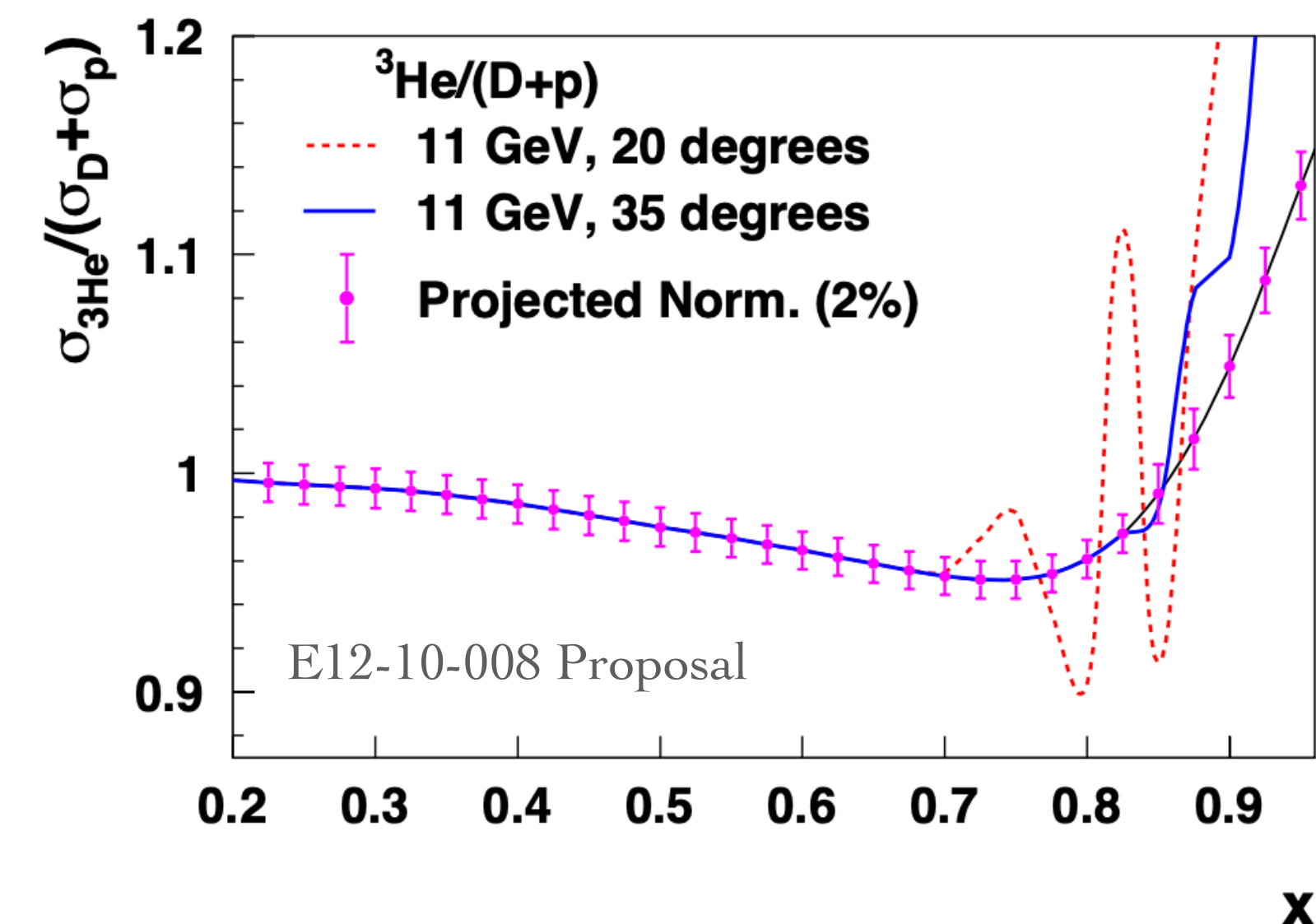
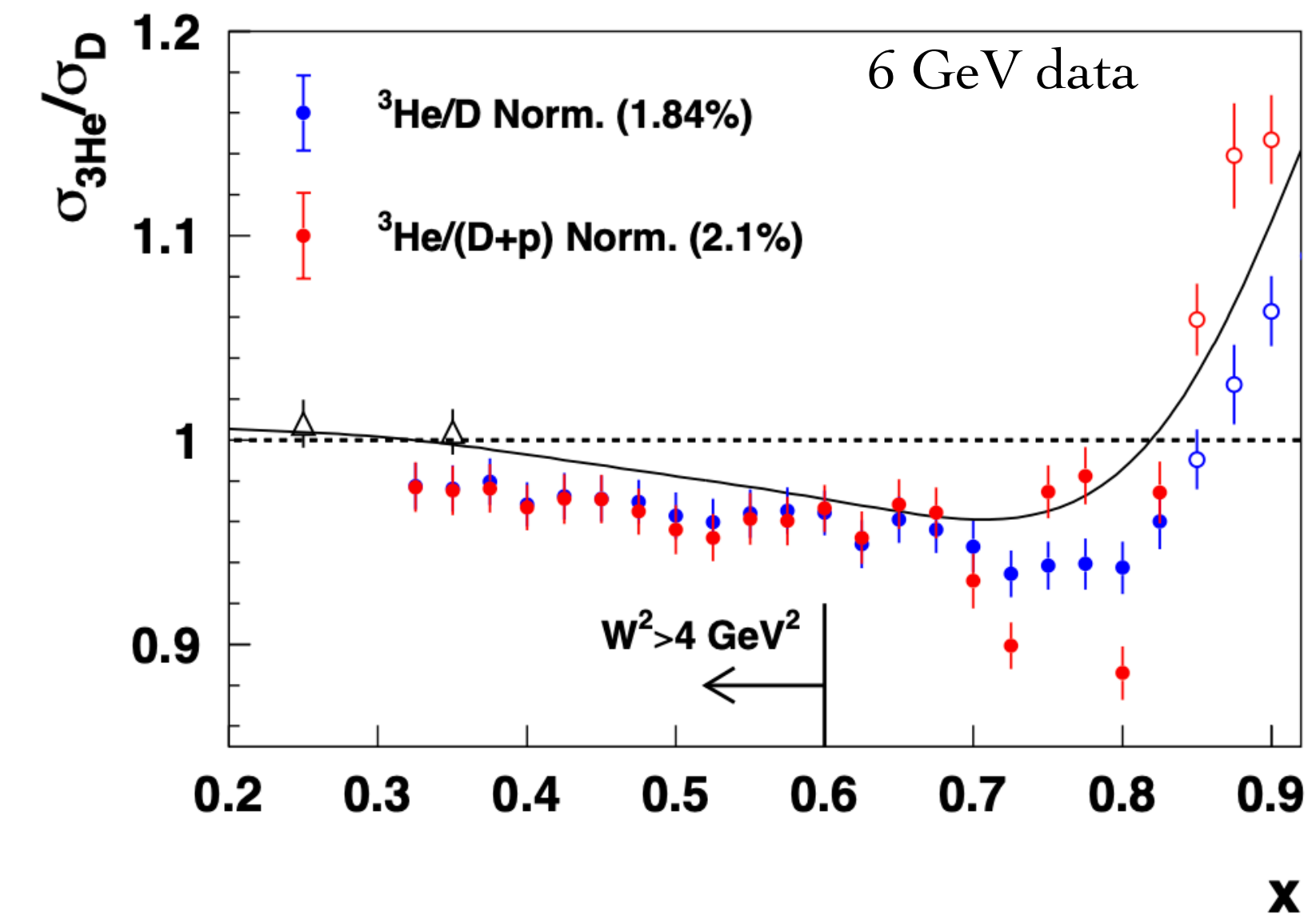
E12-10-008: Kinematic Coverage

- Ran from Sep '22-Feb '23
- ~20 momentum settings for various targets
- HMS ran at high Q^2
- Will measure EMC effect in several light nuclei (${}^6\text{Li}$ & ${}^7\text{Li}$)
- Light nuclei are conducive to exact theoretical calculations



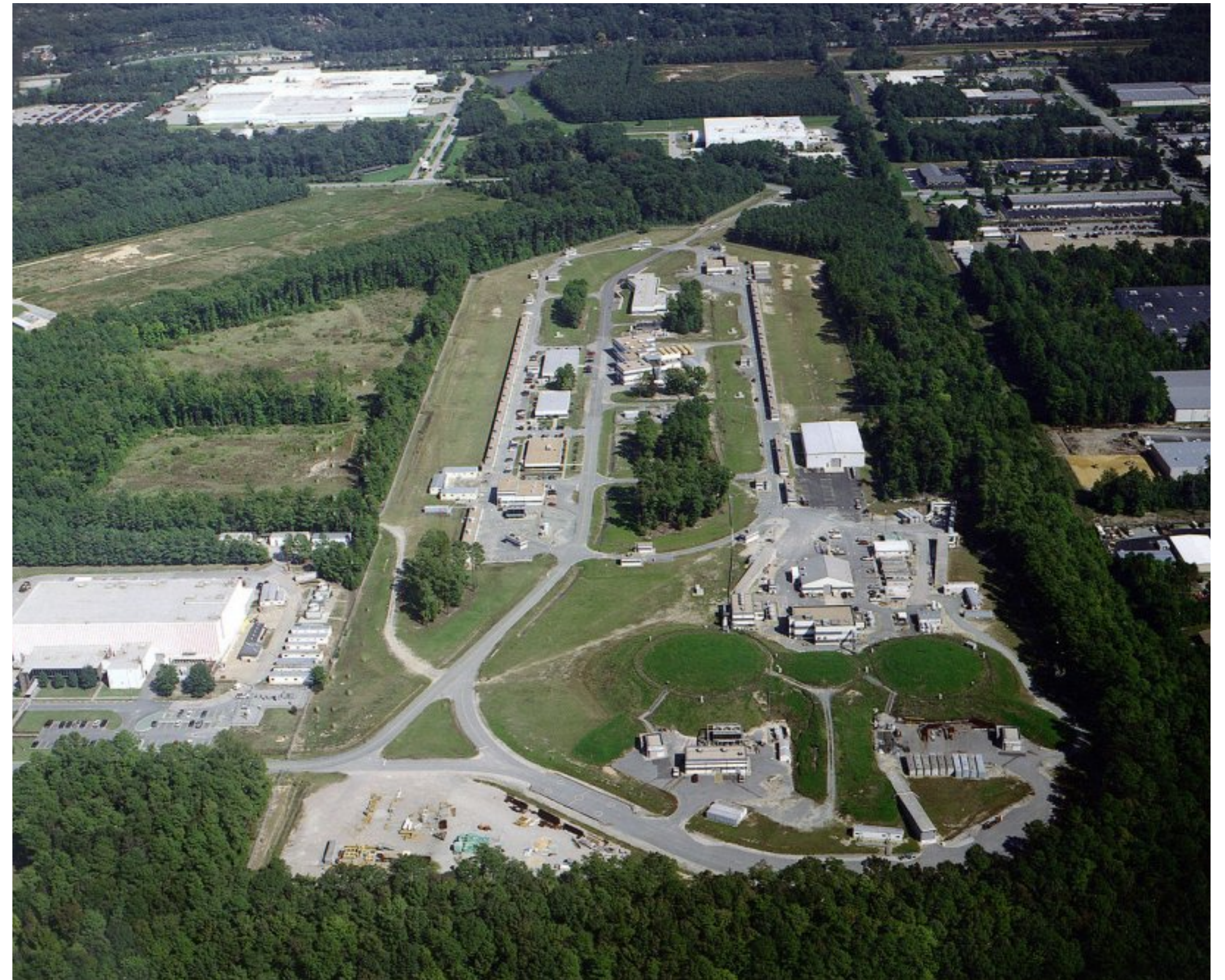
E12-10-008: With Great Energy Comes Great Data

- Higher beam energy+ higher Q^2 allows us to skip the resonance region
- Can access higher x
- Can get ${}^3\text{He}/({}^2\text{H}+{}^1\text{H})$ without relying heavily on large isoscalar corrections
- Avoids the uncertainty associated with knowledge of the neutron structure function



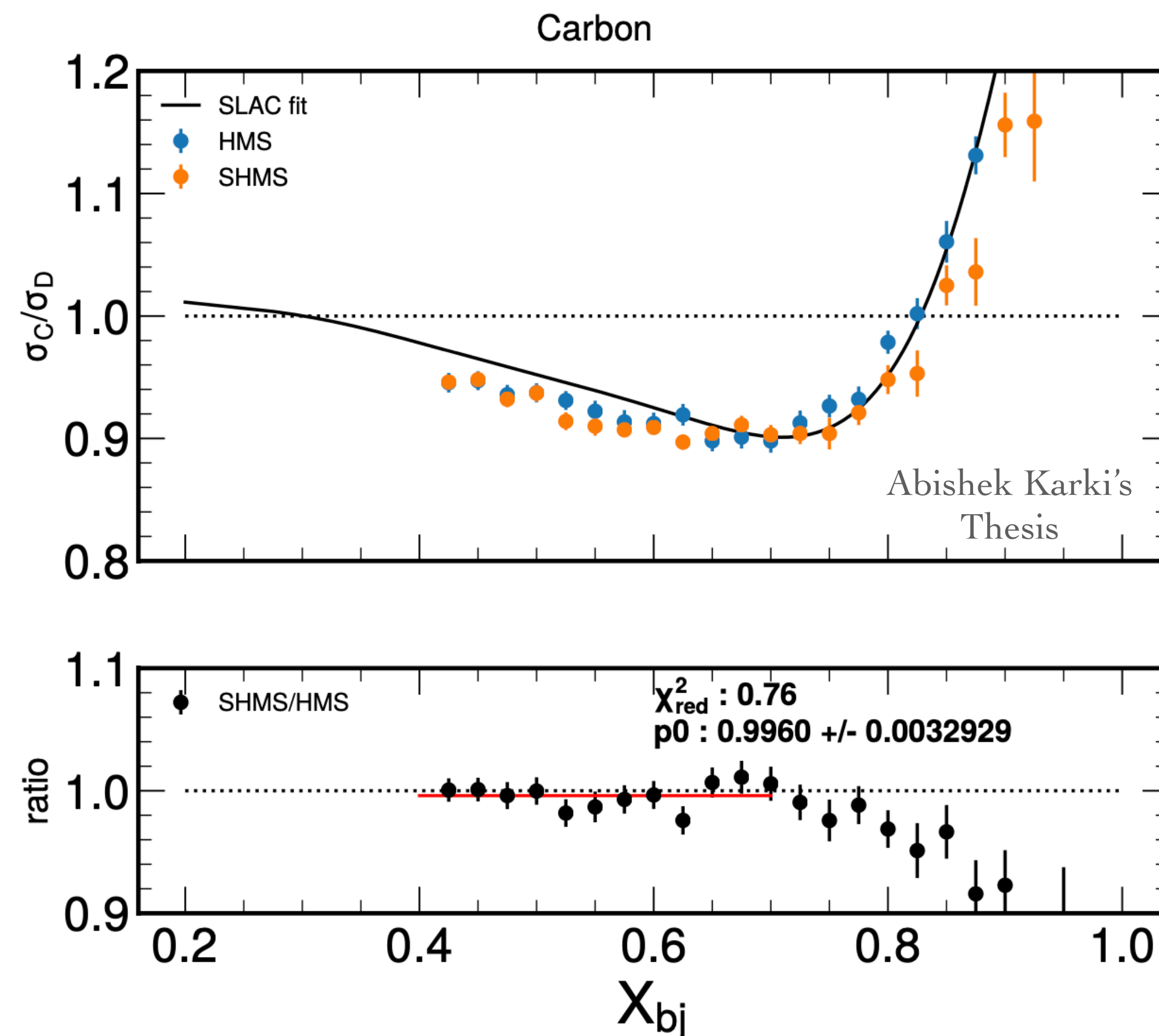
Overview

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- *Preliminary Results*



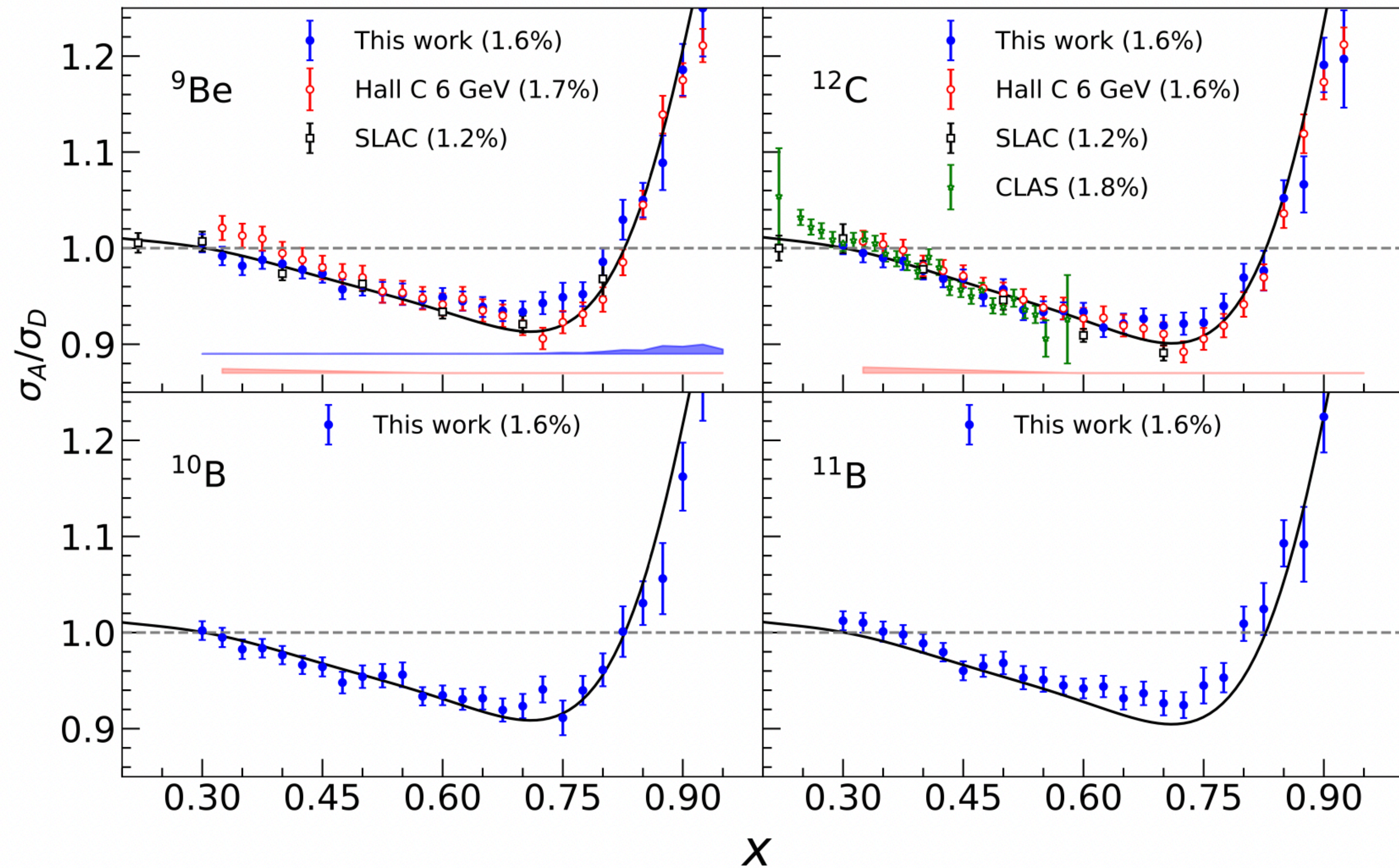
E12-10-008: We have results

- Commissioning data
- Ran for ~2 days in February 2018
- Cross-section ratios were compared for ^{12}C from HMS and SHMS
- SHMS values were compared with well-understood HMS to help refine the runplan for the full experiment



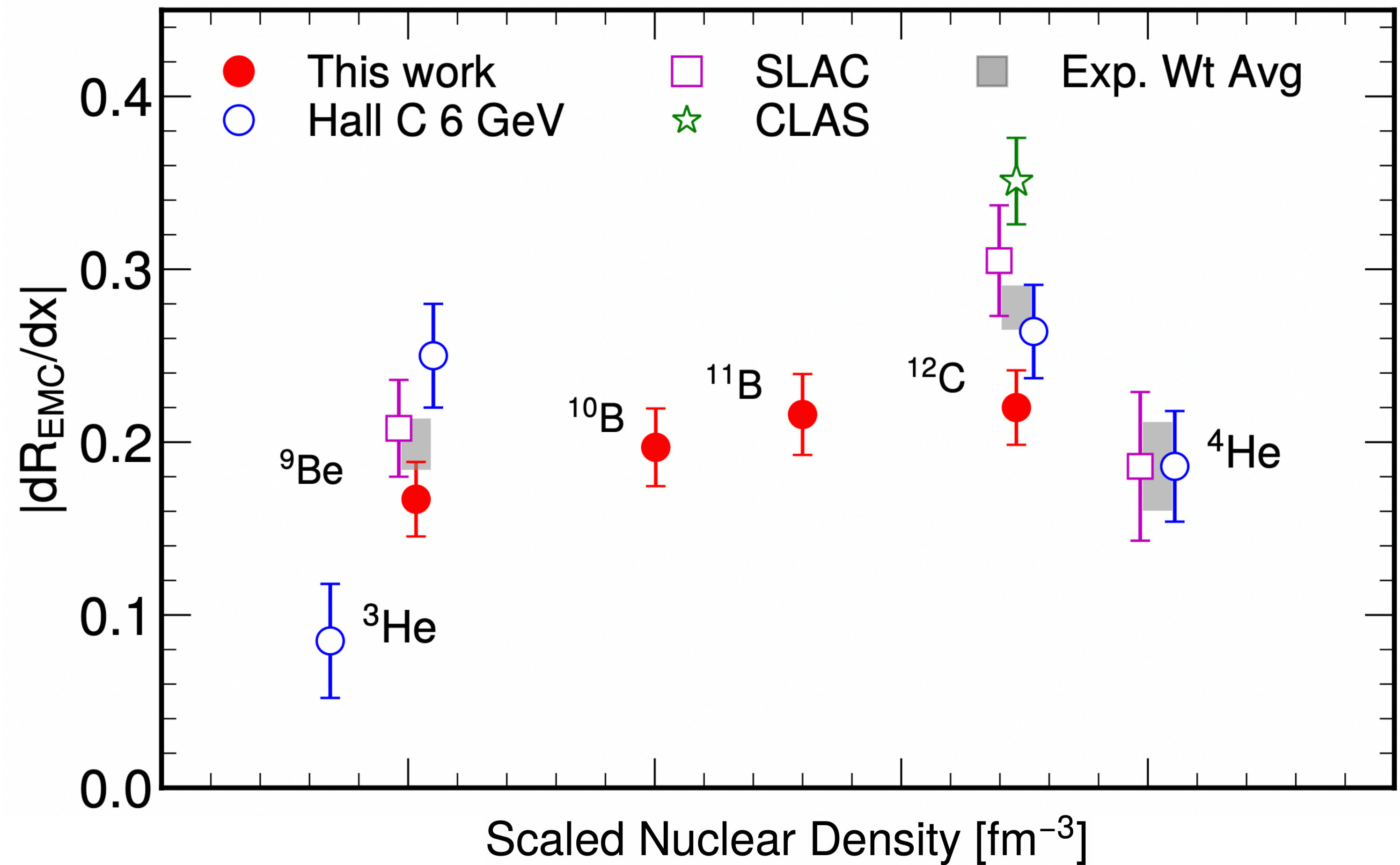
E12-10-008: We have results

- Characteristic EMC shape!
- First ever measurements for ^{10}B and ^{11}B
- Submitted to PRL, under peer review



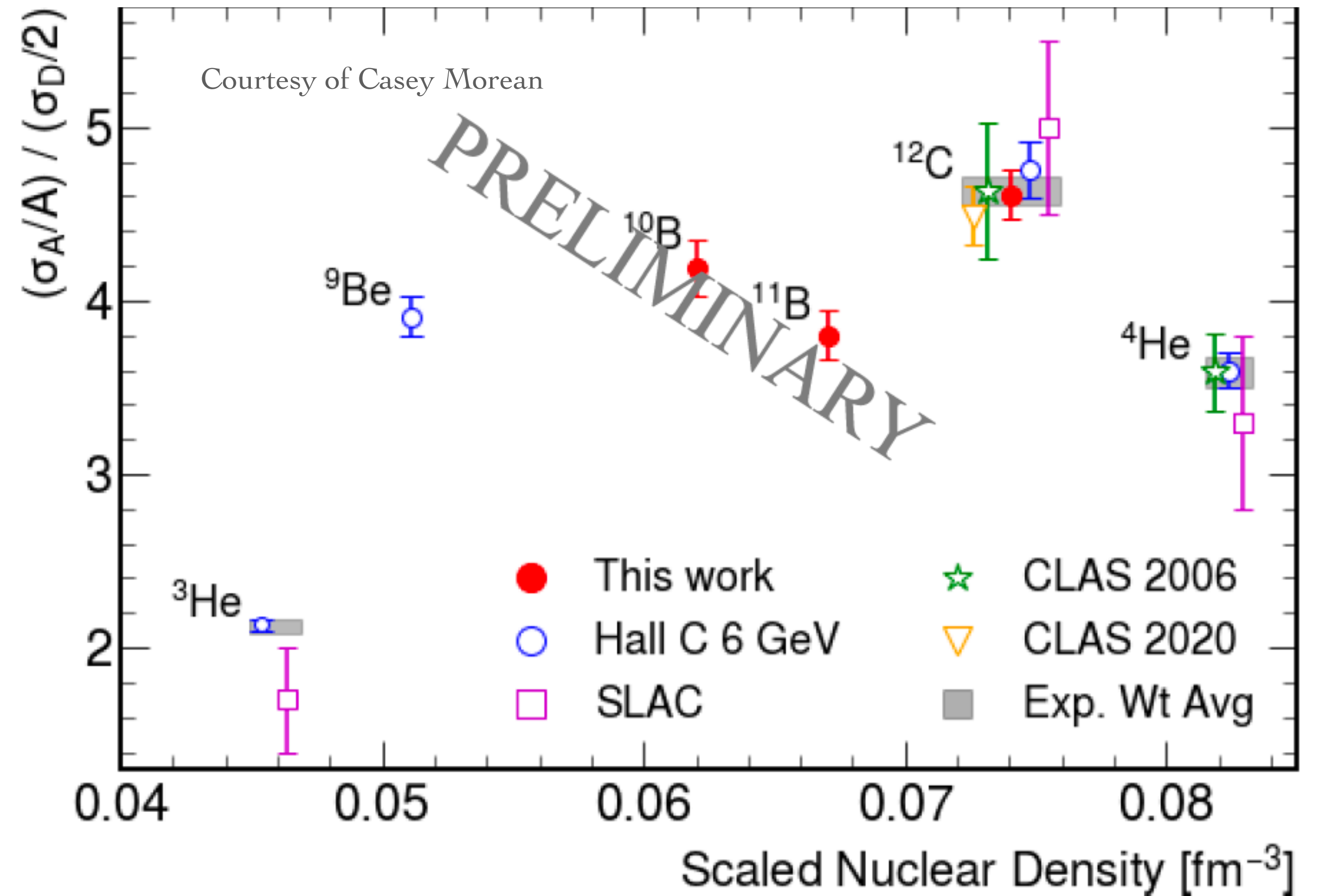
E12-10-008: We have results

- ^4He and ^9Be have similar strength EMC effect
- ^{10}B & ^{11}B also thought to have alpha clustering
- Little nuclear dependence



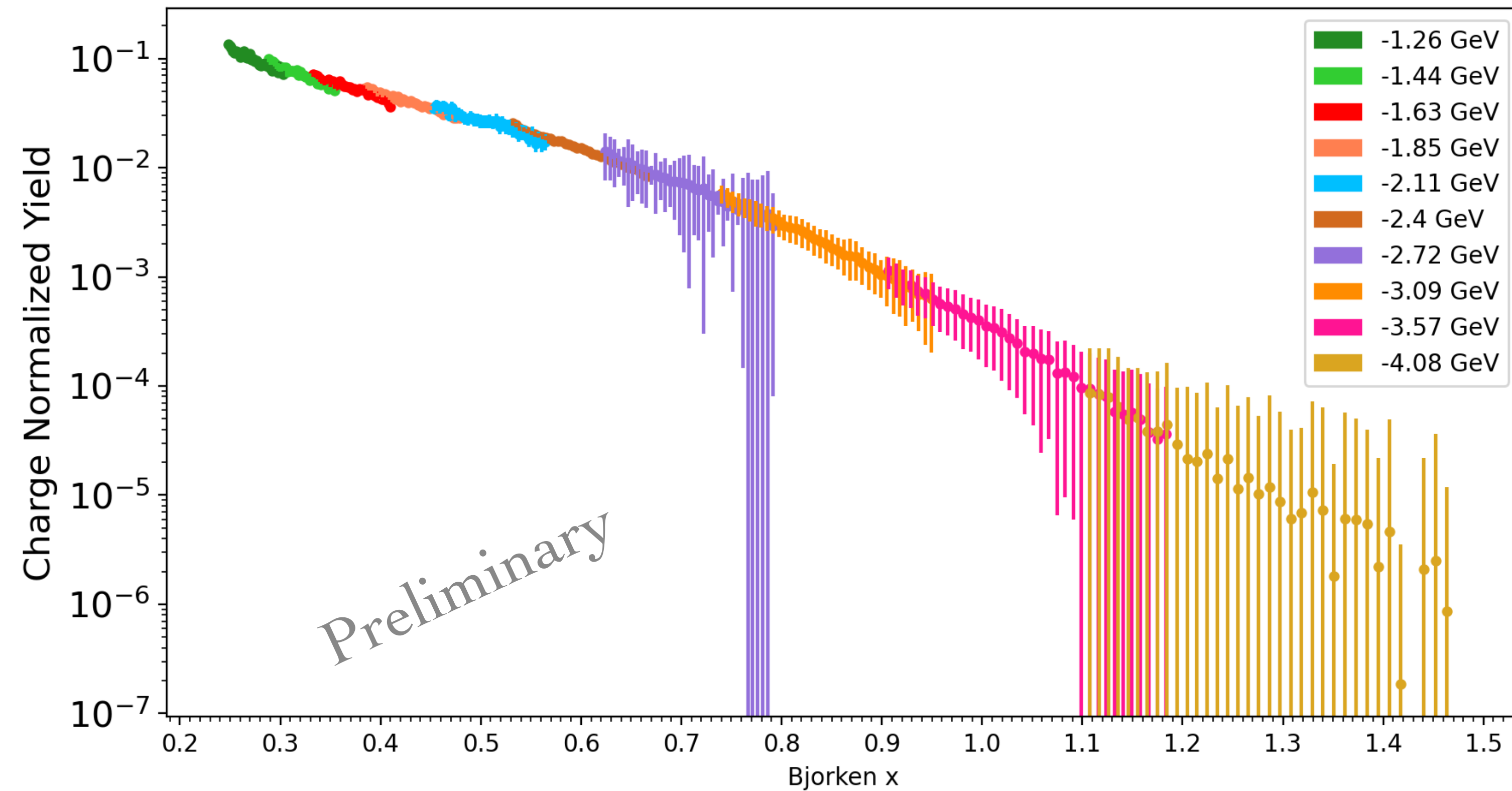
SRC results

- See Burcu Duran's talk
- Correlates with the EMC effect data



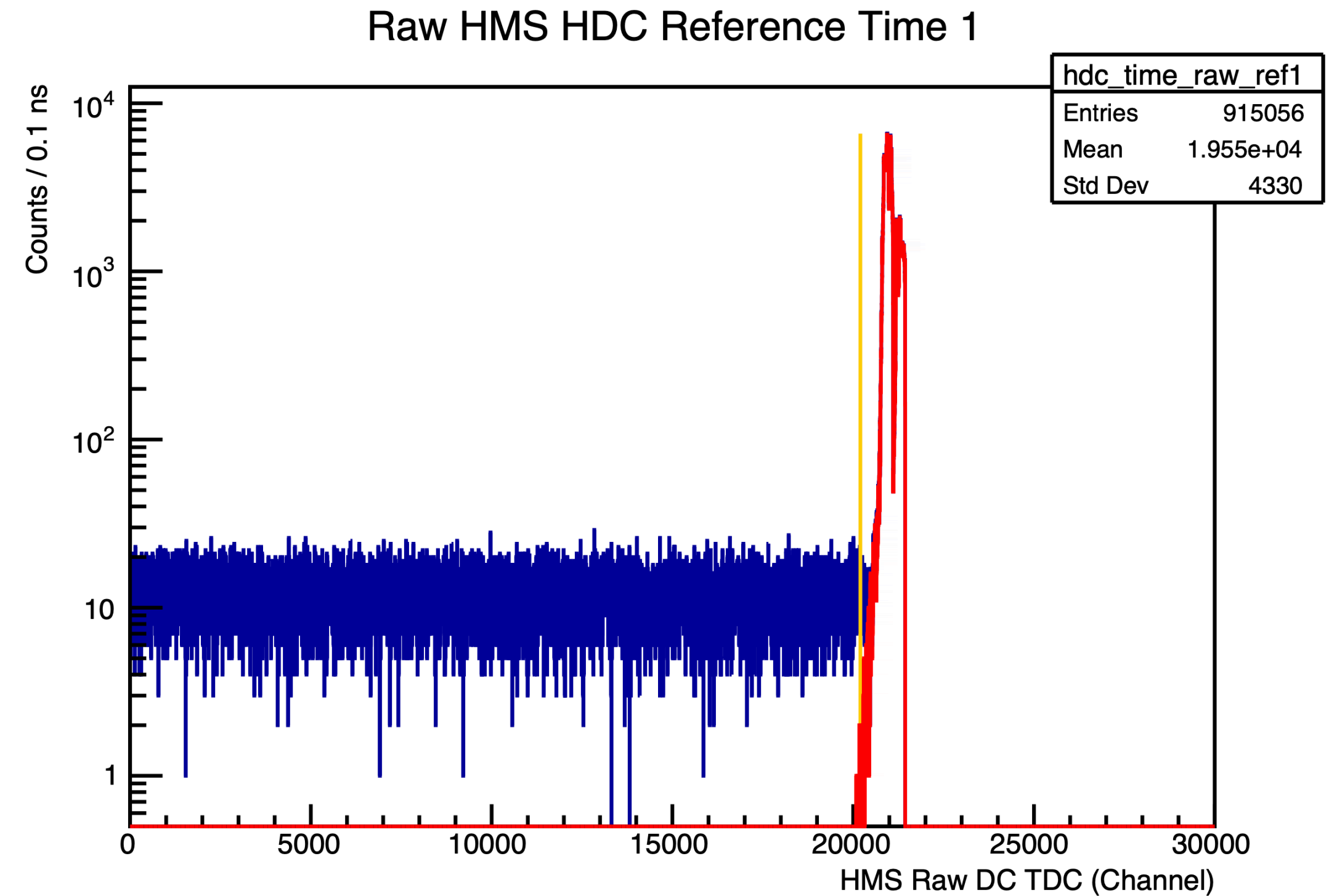
Latest Data

- Charge Normalized Yield vs x
- C12 Target@35°
- Does not have any radiative corrections, acceptance corrections



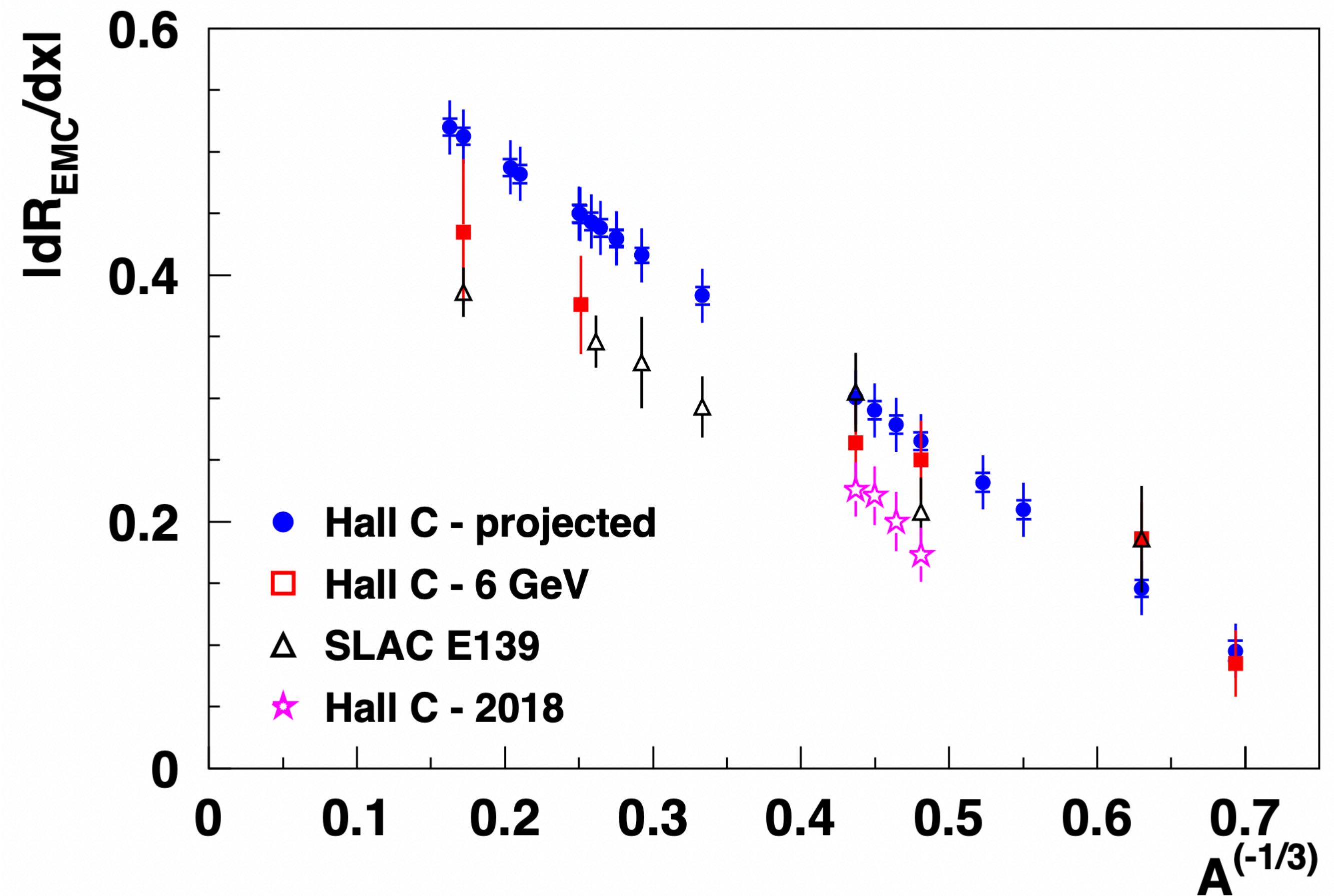
Current Status

- Data taking completed just 7 weeks ago
- Detector Calibrations underway
- Data checks
- Hope to have preliminary results by later this year



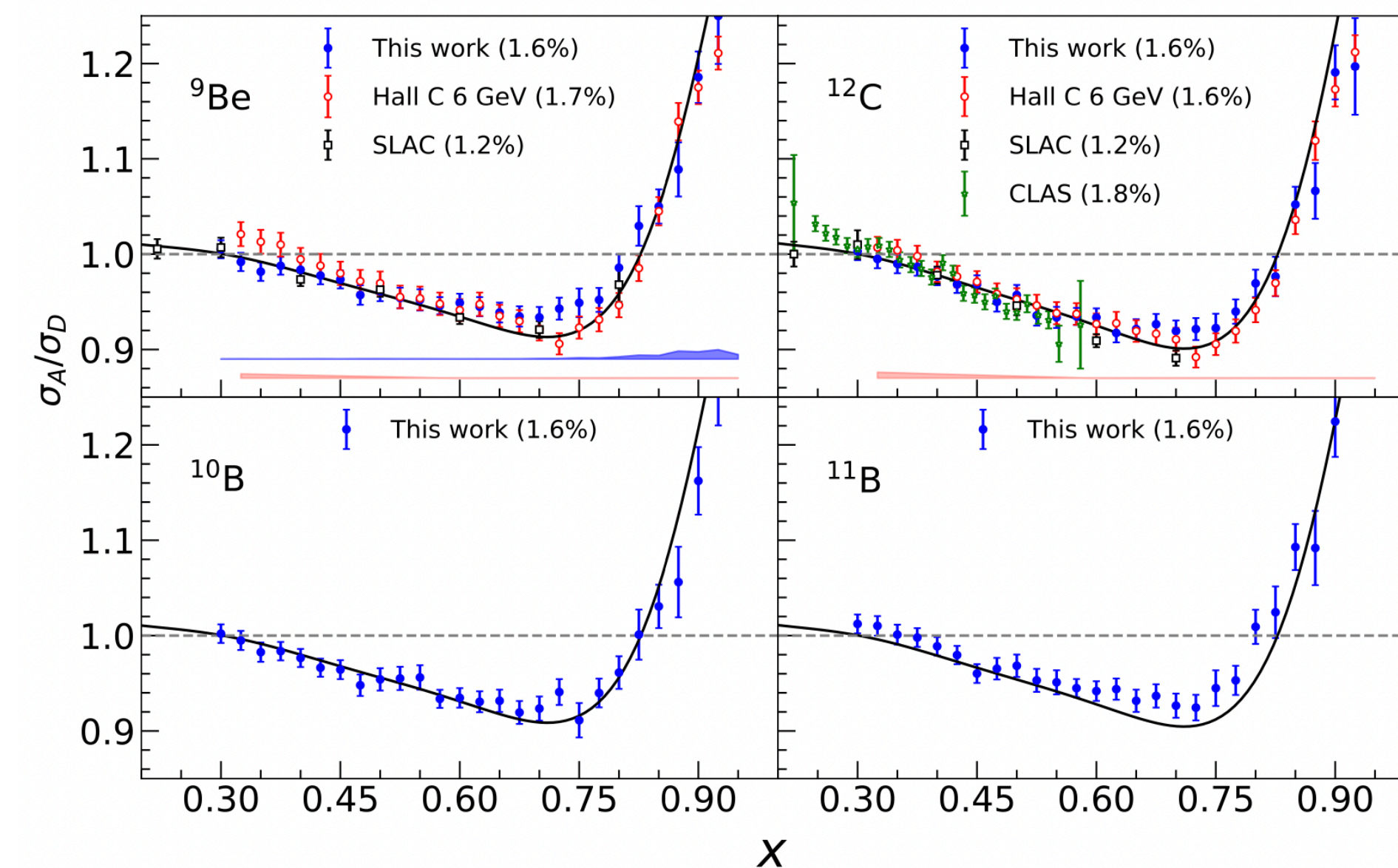
Stay Tuned

- Lot of EMC effect and SRC data on the horizon
- Will help to shed light upon the origin of the EMC effect
- Superfast Quarks
- SRC correlation



Summary

- The origin of the EMC effect is still a mystery
- E12-10-008 will provide several key results:
 - Isospin dependence
 - Measurement in several light nuclei
 - More data for comparison with SRCs
 - Can get ${}^3\text{He}/({}^2\text{H}+{}^1\text{H})$ without relying heavily on large isoscalar corrections
- We have some results and much more to come



Acknowledgement

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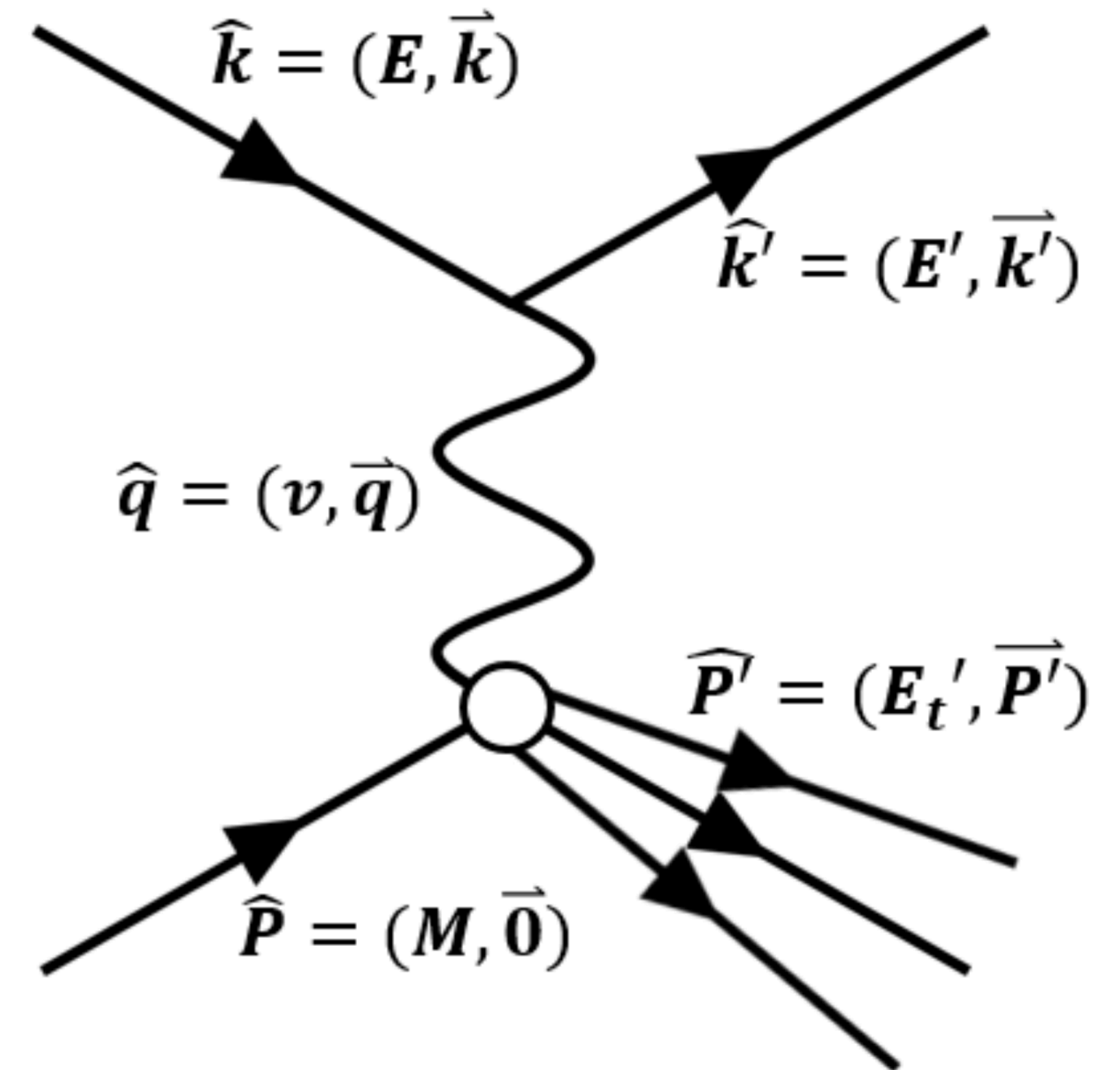


Thank you!

Backup

Physics Background

- In inclusive DIS, only the scattered electron's final state is measured in the spectrometer
- θ
- $\nu = E - E'$
- M



Physics Background

- $Q^2 \equiv -q^2 \simeq 4EE' \sin^2(\theta/2)$
- $W^2 = 2M\nu + M^2 - Q^2$
- $x = x_{Bj} \equiv \frac{Q^2}{2M\nu}$

