MARATHON
A = 3 EMC effect
Preliminary Results

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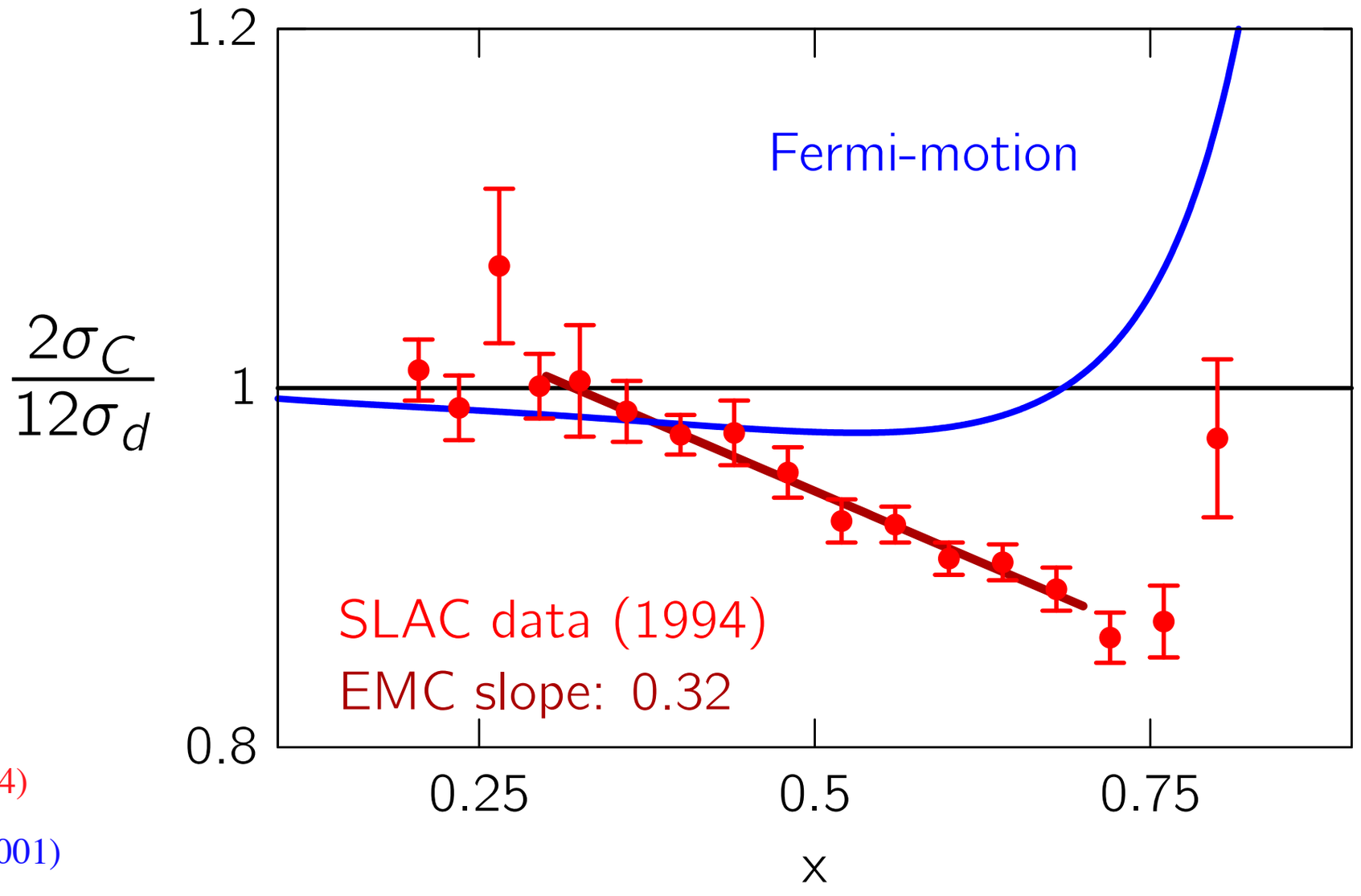
09/19/19

The EMC Effect in DIS Scattering



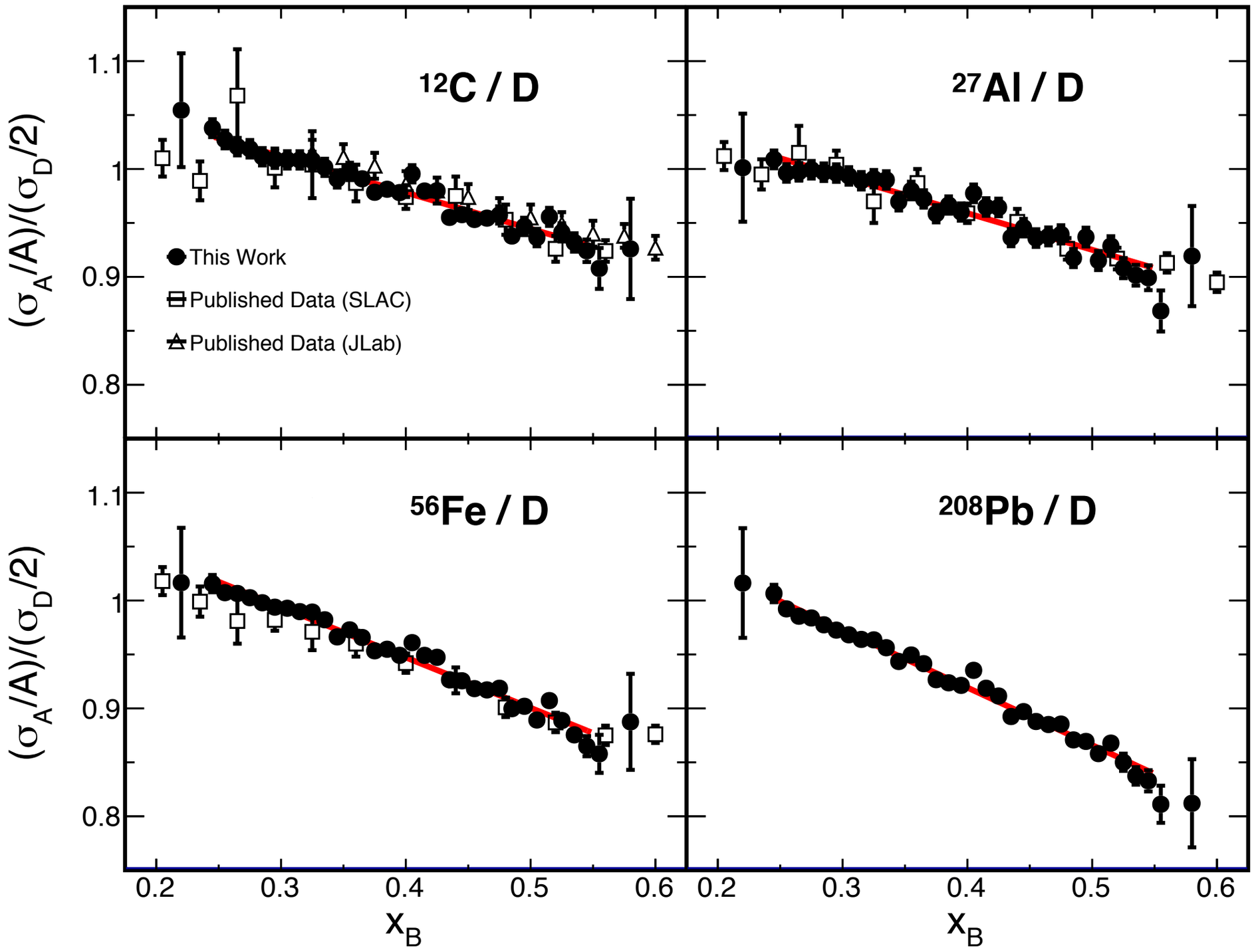
PRD 49, 4338 (1994)

PRC 65, 015211 (2001)

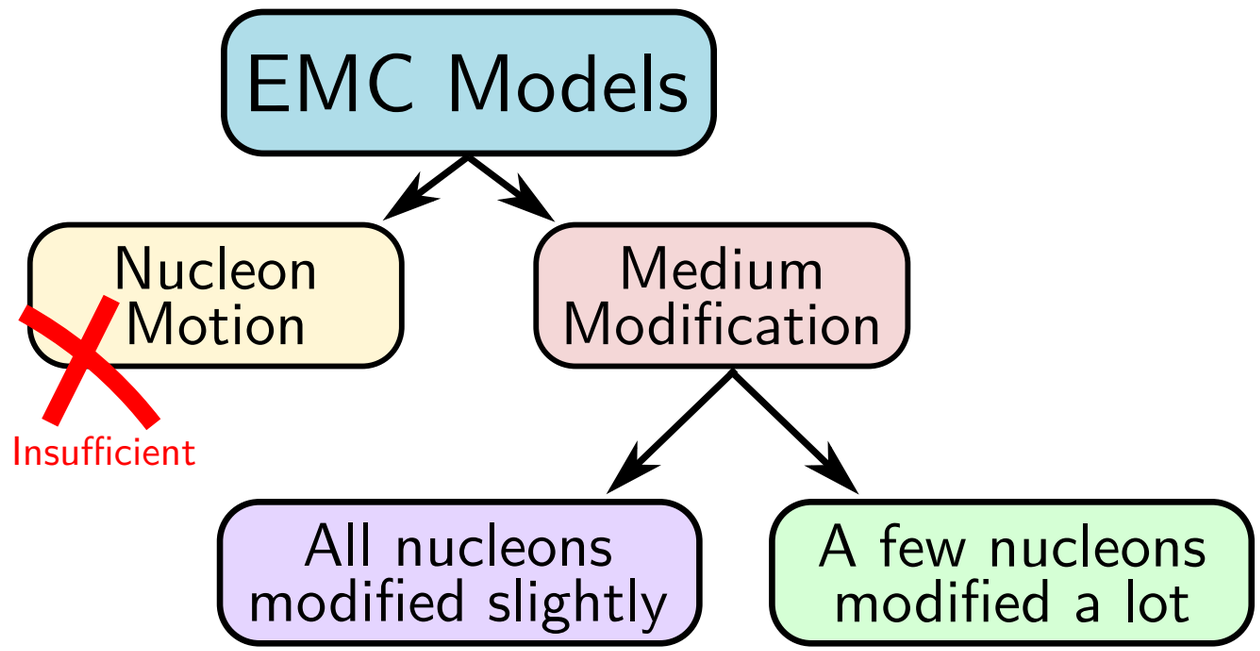
Quark distributions (F_2) in nucleons bound in nuclei different to distributions in free nucleons, here: $F_2^C \neq 6 * F_2^d$

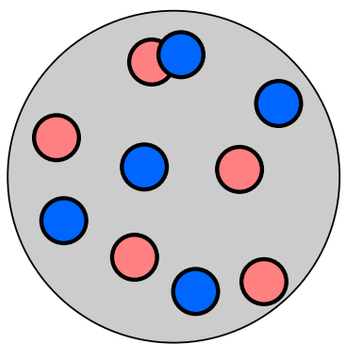
EMC Effect in Different Nuclei

B. Schmookler et al. (CLAS collaboration), Nature 566, 354 (2019)

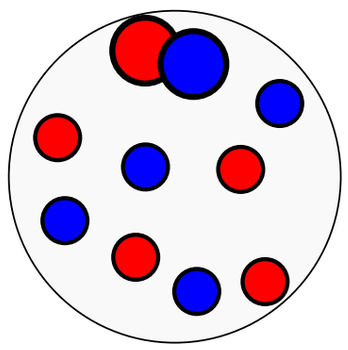


EMC Models





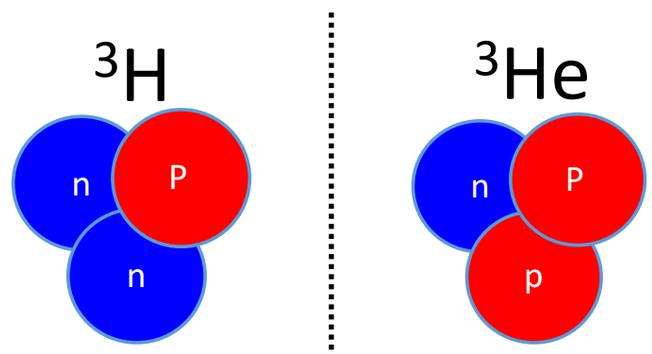
Mean Field Modifications



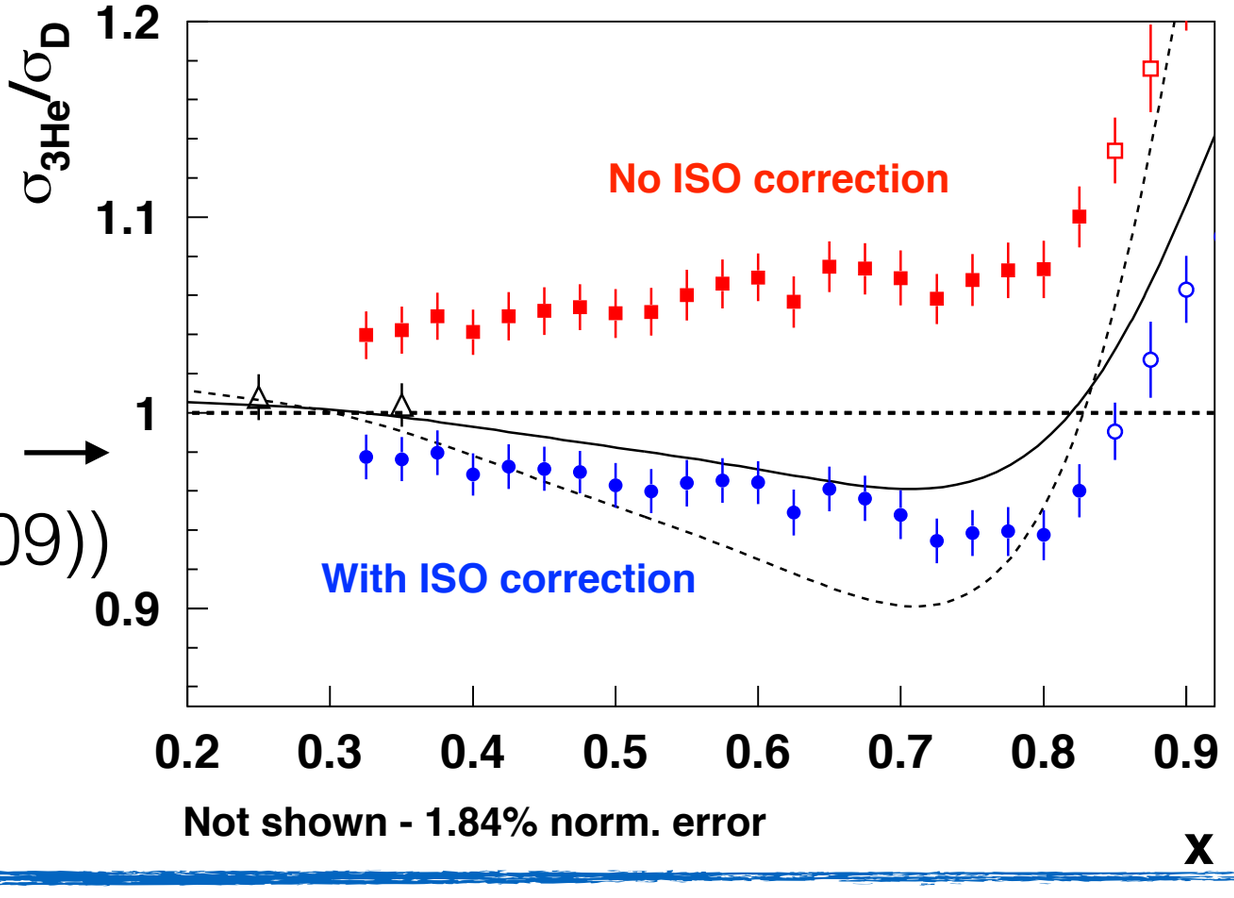
Short Range Correlations (SRC)

A = 3 System and EMC Effect

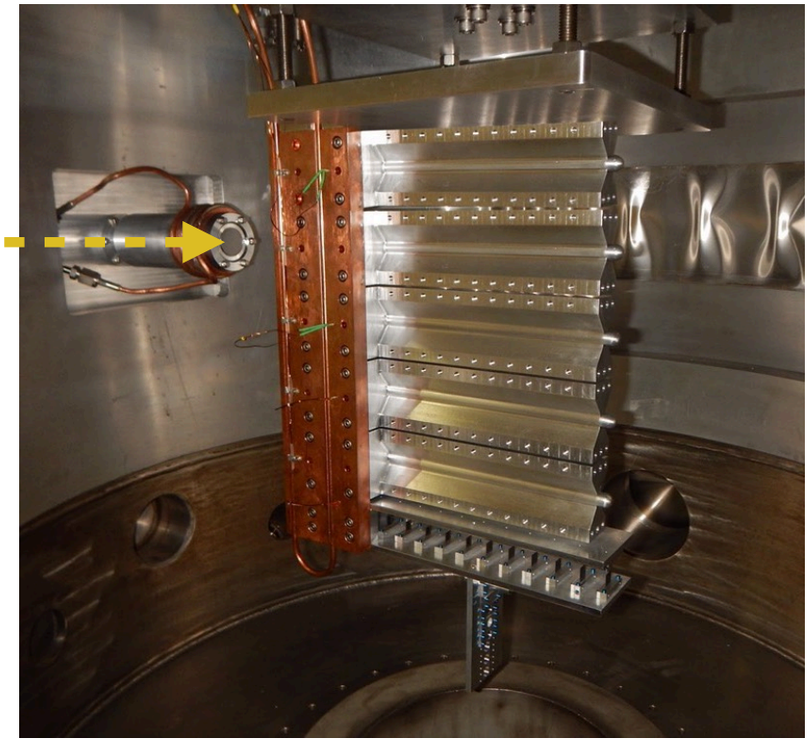
- Mirror Nuclei
- High Asymmetry A/2Z = 1.5
- Isospin Doublet

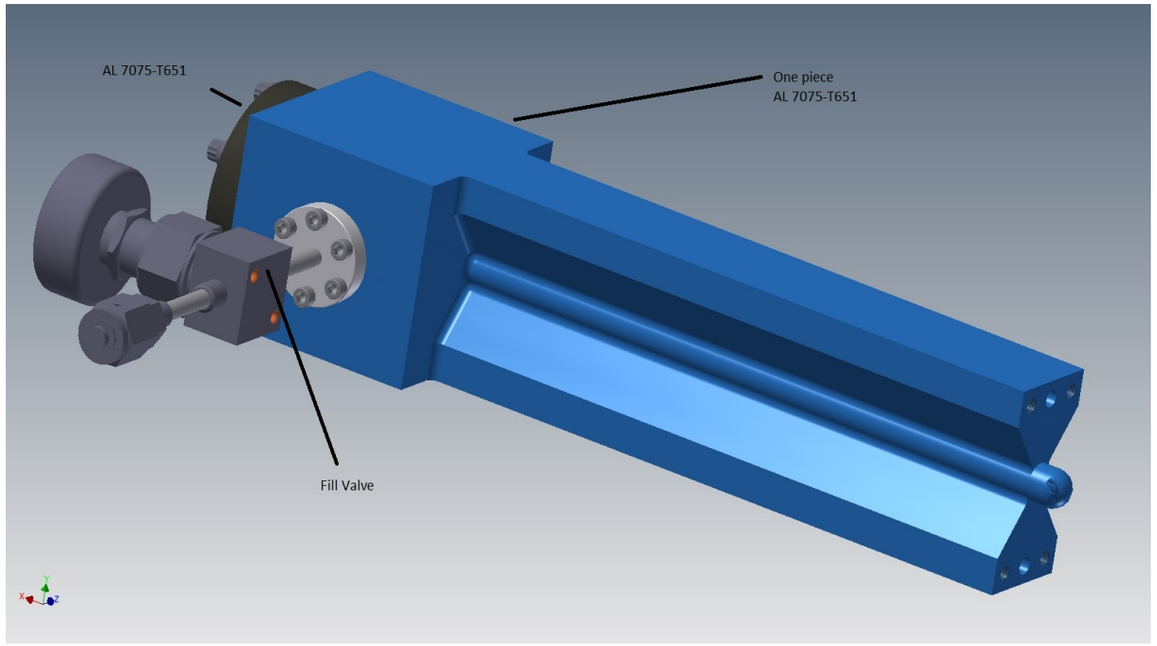


- **First time ^{3}H EMC data**
- ^{3}He EMC @ HallC (E03103) → (Seely et al.,PRL 103, 202301 (2009))



MARATHON Target

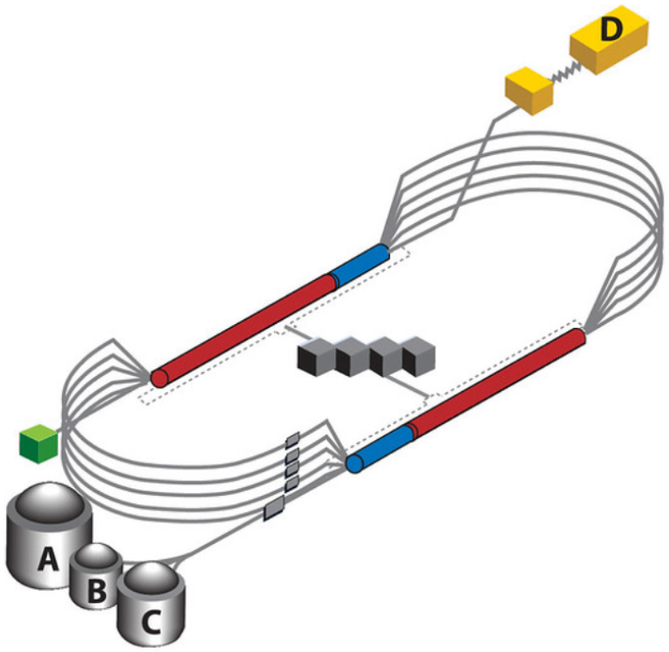




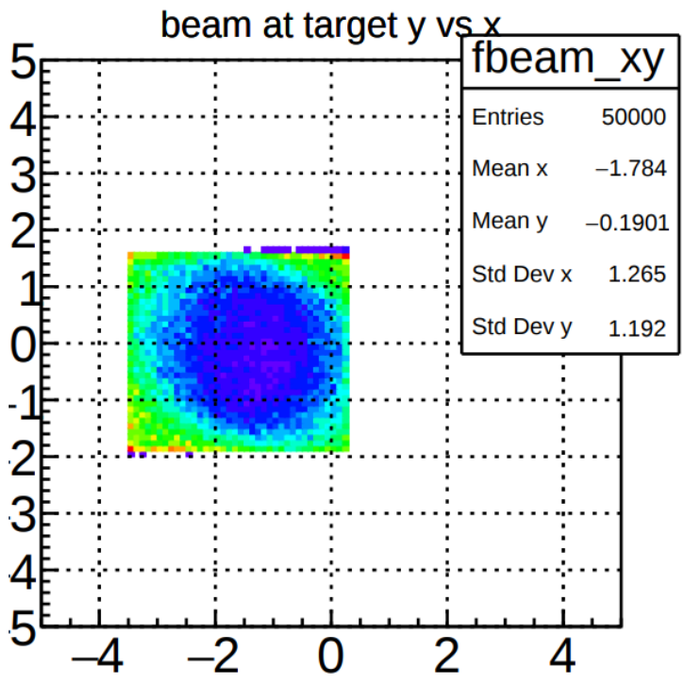
- Tritium
- Helium-3
- Deuterium
- Hydrogen
- Empty Cell

- Sealed cell
- 25cm long
- 40K cold gas
- 1kCu Tritium

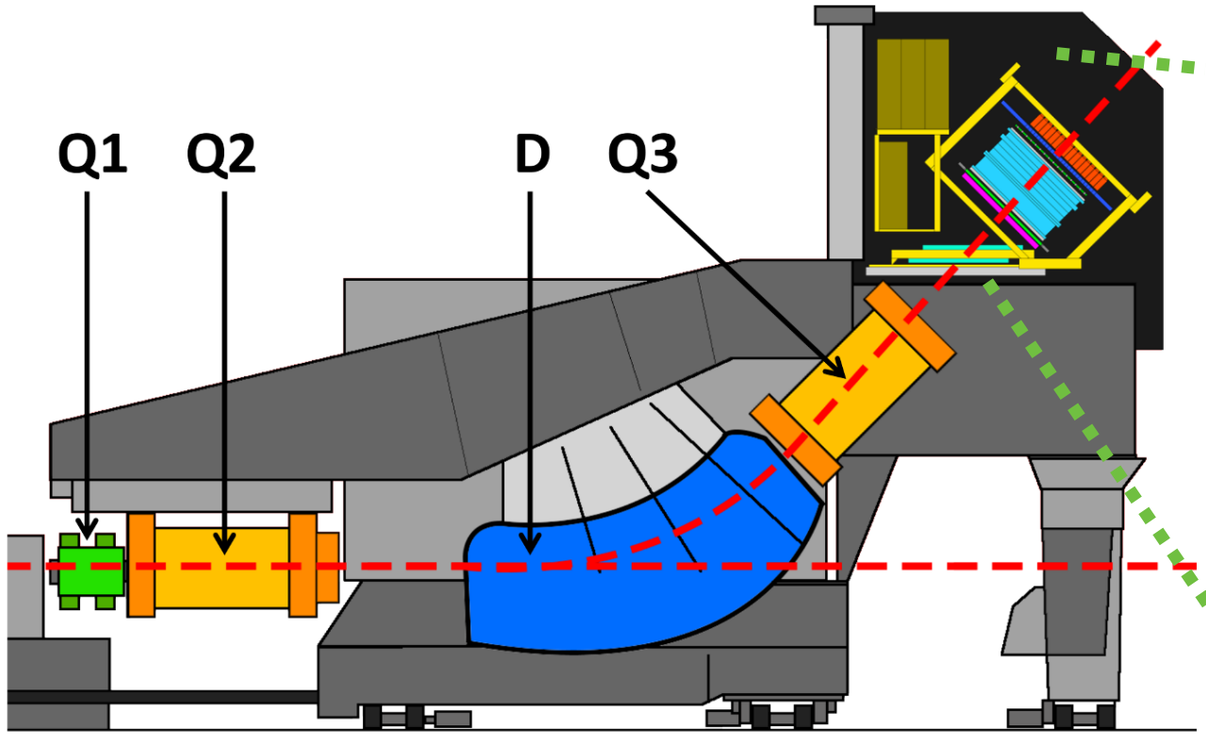
Electrons from CEBAF

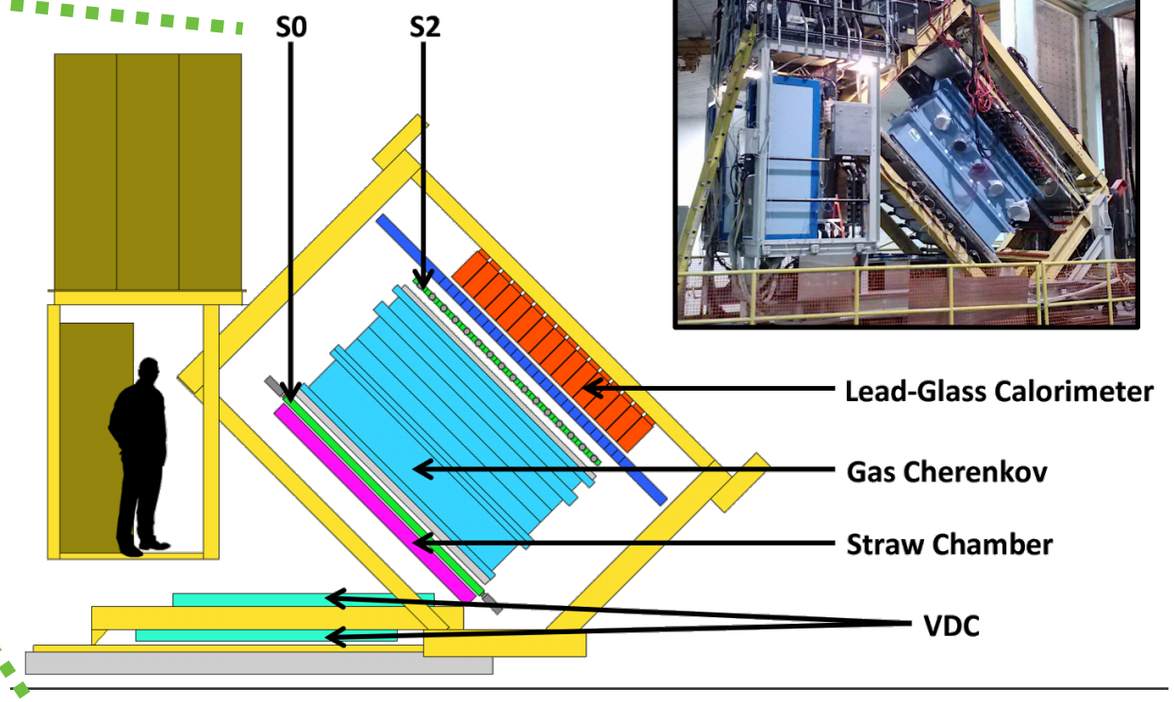


- 10.6 GeV energy
- 22.5uA current
- 2x2mm^2 rastered beam



HallA Spectrometer

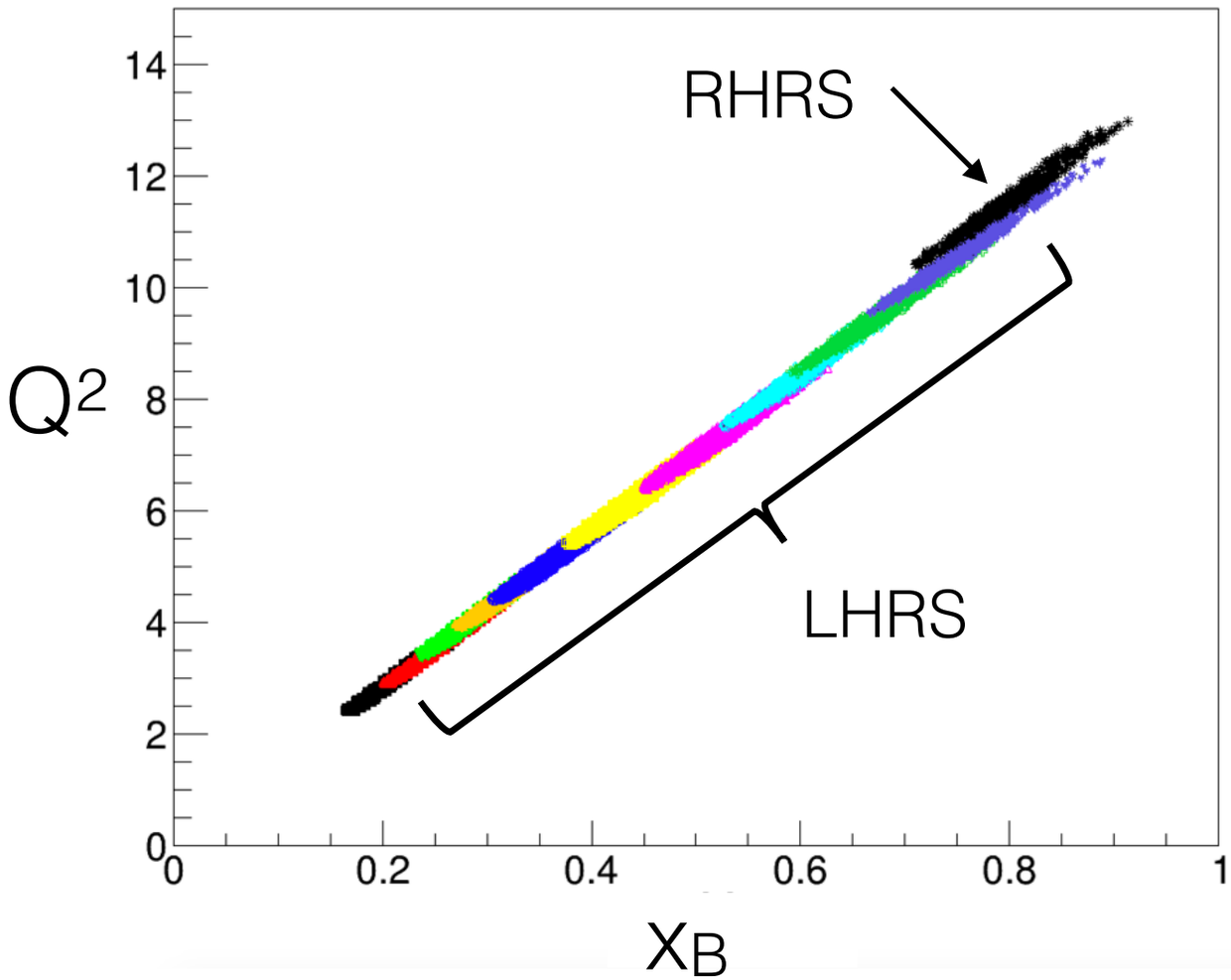


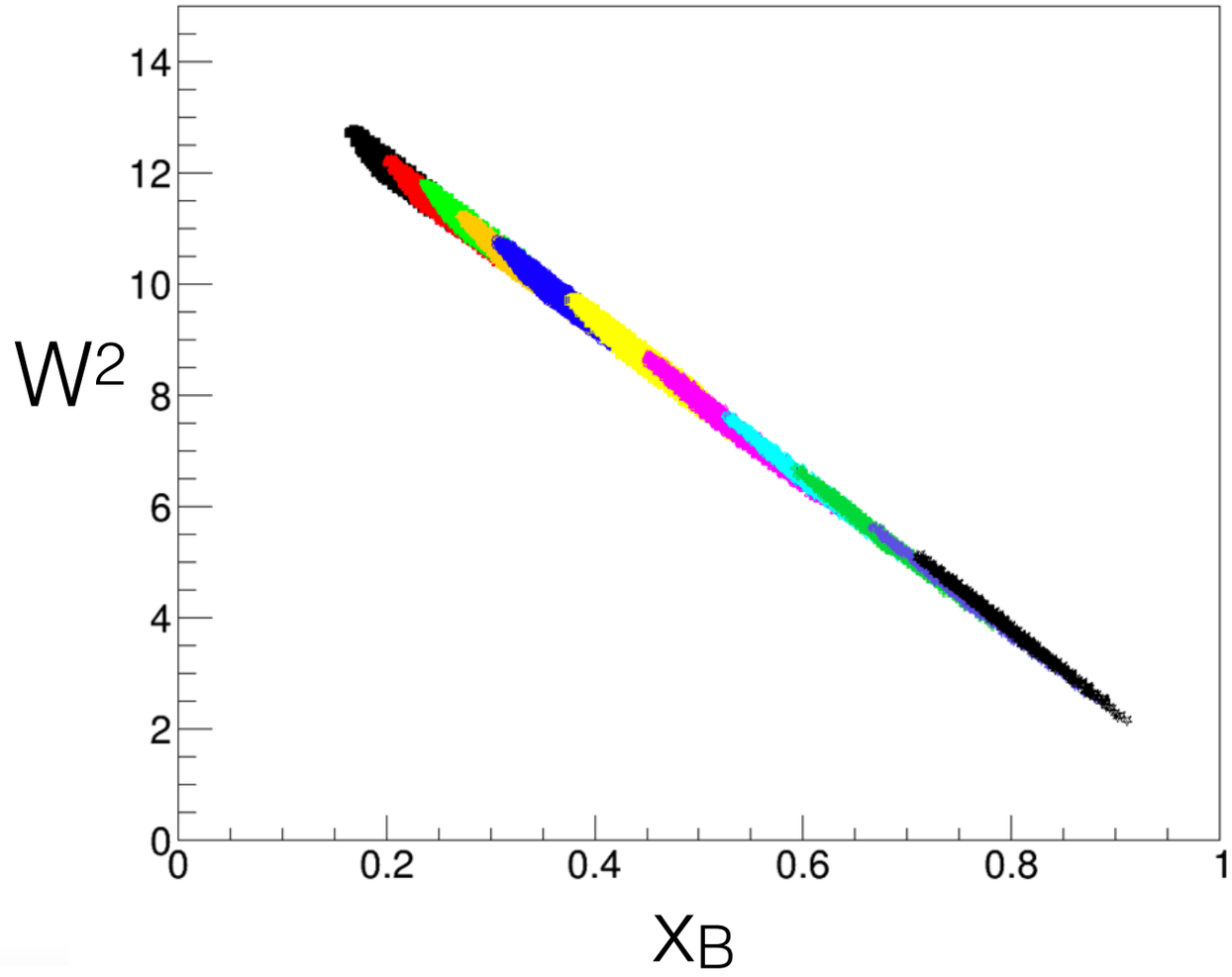


- Δp/p: ±5%
- In-plane angle: ±30 mrad
- Out-plane angle: ±60 mrad
- Electron Trigger: Scintillators (S0&S2) && Gas Cherenkov

MARATHON Data

- 10.6 GeV beam energy
- LHRS momentum 3.1 GeV
- RHRS momentum 2.9 GeV (due to magnet problems)
- HRS angles between 17° to 36°
- $0.19 < x < 0.83$



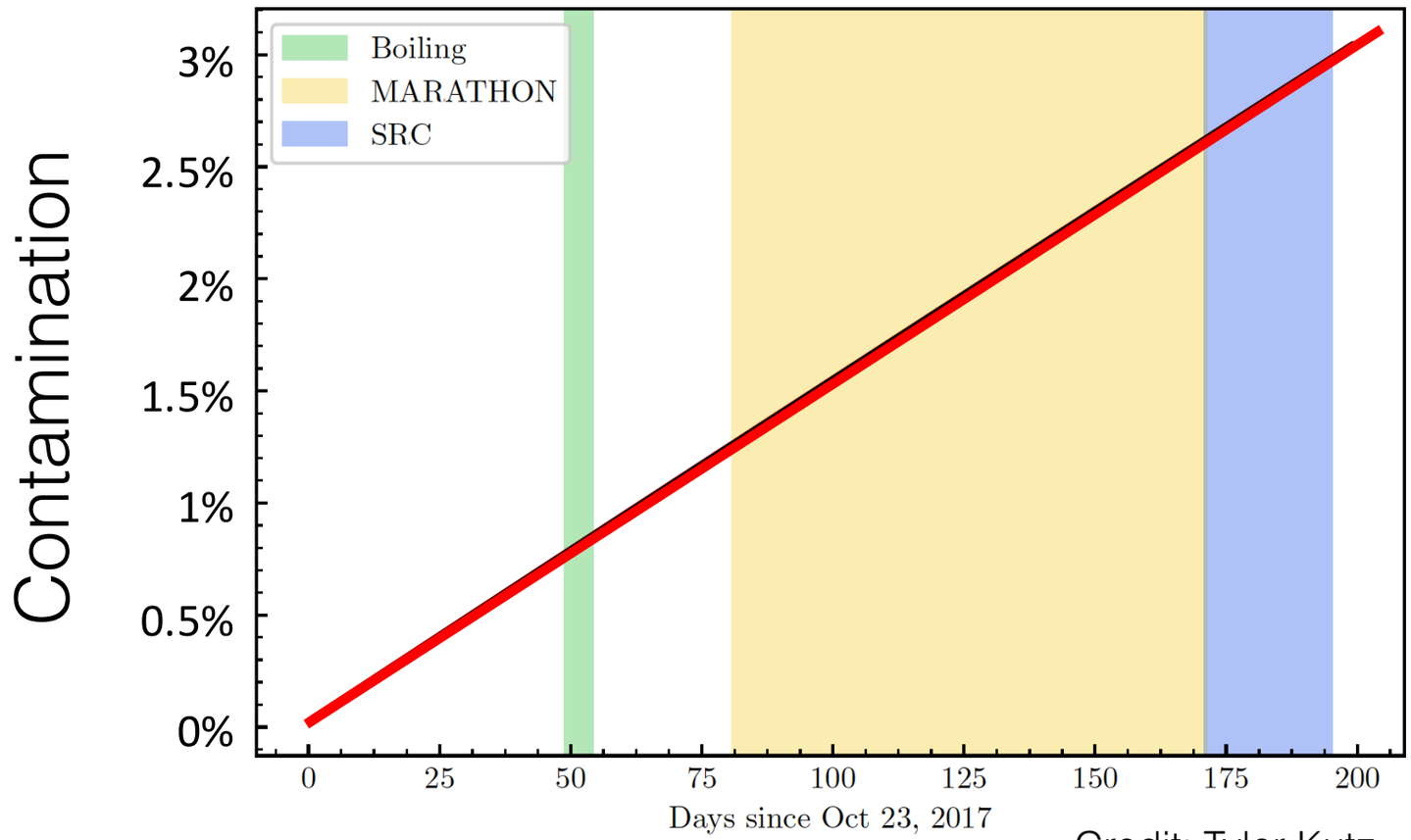


Tritium Decay

$$\tau(^3H) = 4600 \pm 8 \text{ days}$$

- Contamination

$$c = \frac{\eta_{^3\mathrm{He}}(t)}{\eta_{\mathrm{tot}}}$$

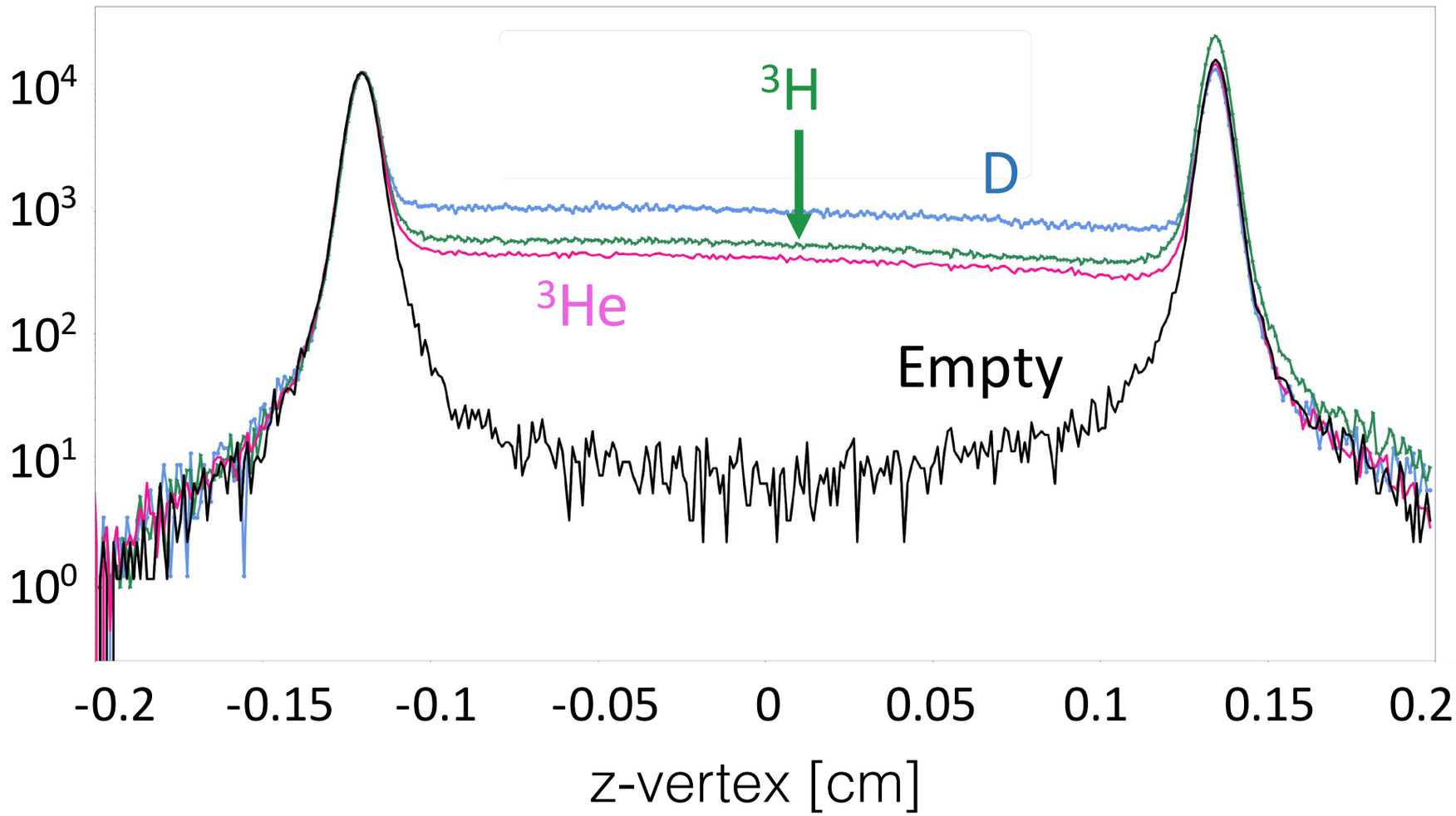


Credit: Tyler Kutz

- Correction:

$$\sigma_{^3\mathrm{H}} = \left(\frac{\sigma_{\mathrm{tot}}}{\sigma_{^3\mathrm{He}}}\right)\left(\frac{1}{1-c}\right) - \frac{c}{1-c}$$

Target Background from Endcaps

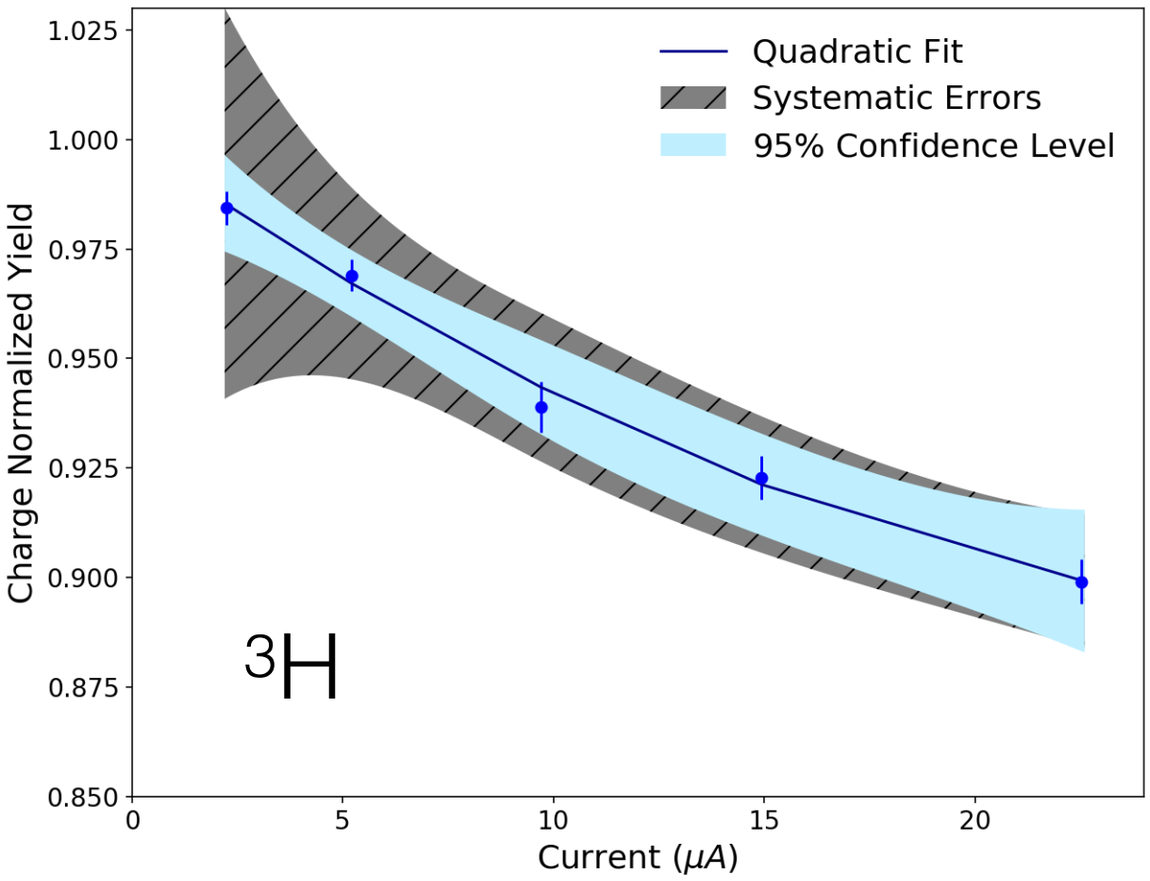


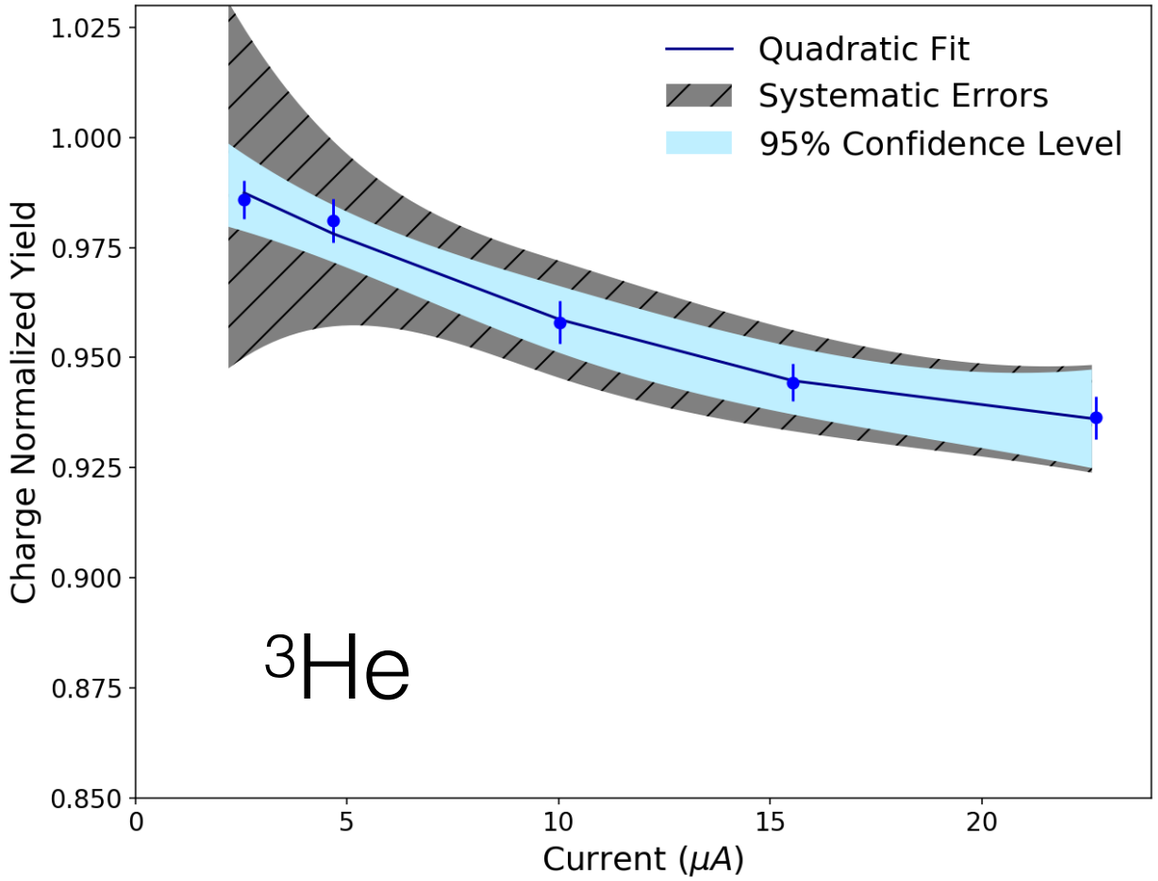
Credit: Tong Su

- Background around 2-3%
- Similar for all targets

Target Boiling

S.N. Santiesteban, S. Alsalmi et al., NIM A950, 351 (2019)



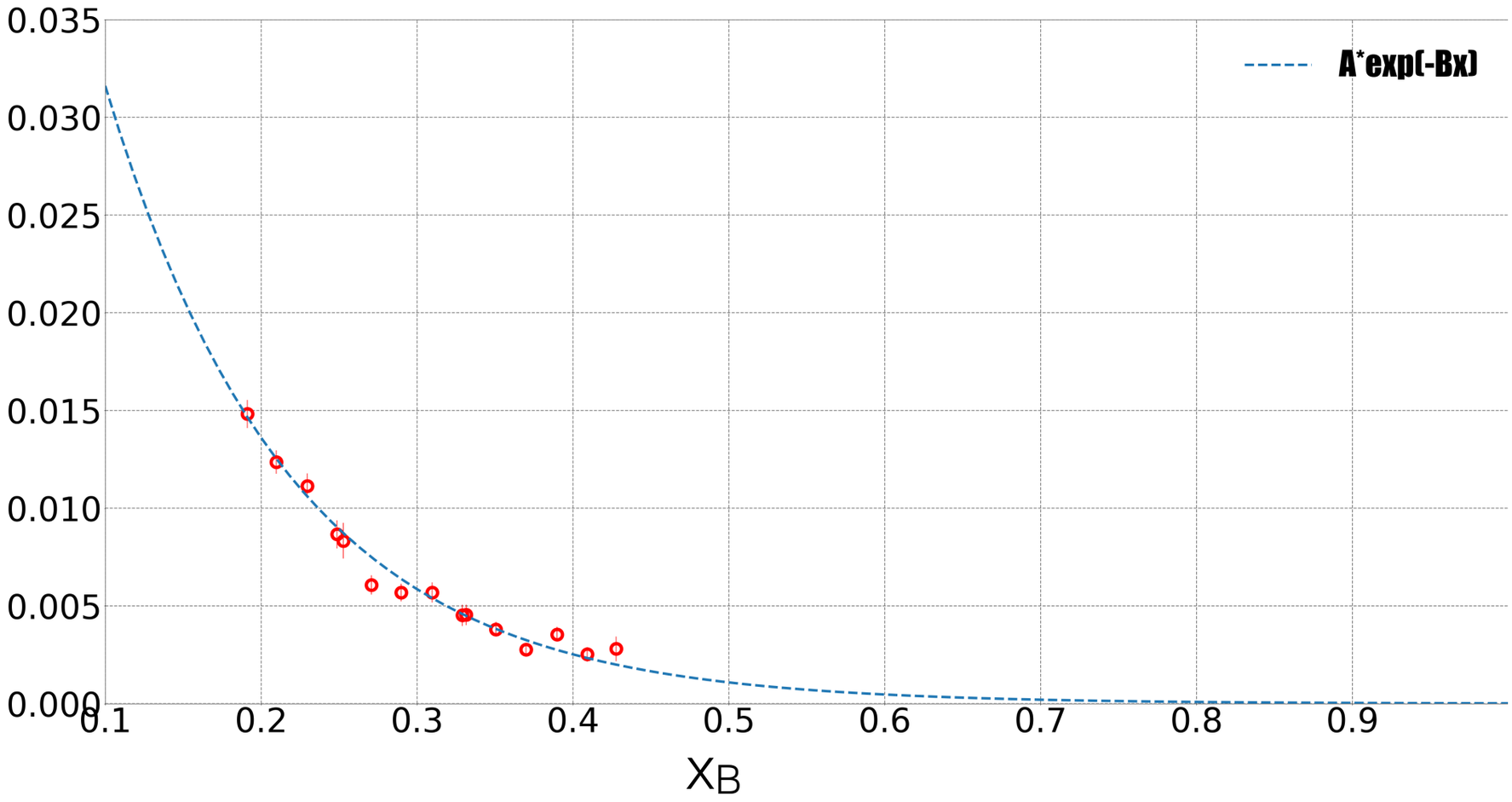


- Beam heats target —> Density changes due to boiling
- Larger boiling for Tritium than Helium
- Correction factor for each run file

Positron Contamination

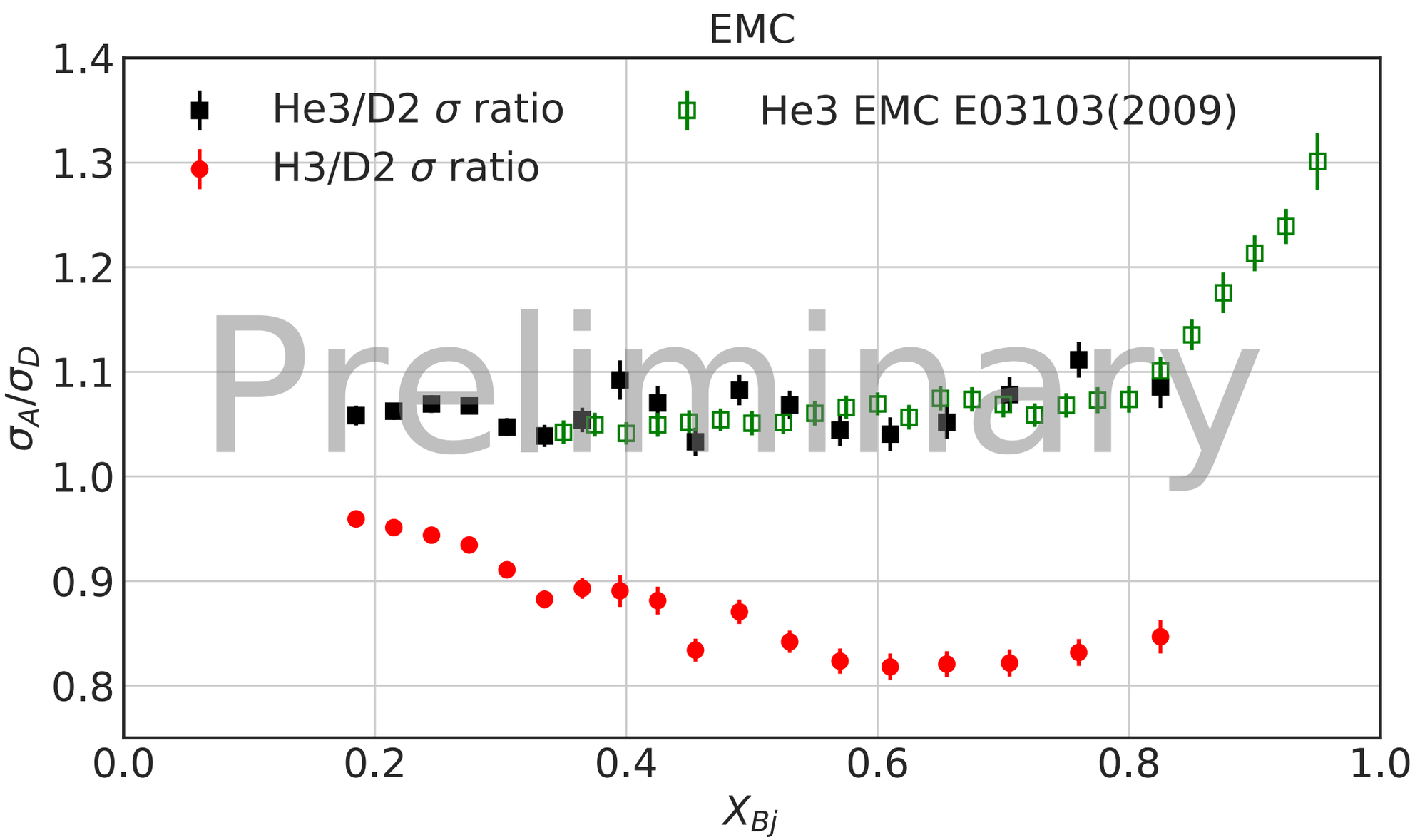
- γ decay to e^+e^- pairs
- Measure positrons to account for pairs
- HRS measurement in low-x kinematics
- Exponential fit to extrapolate to high-x

e^+/e^- (^{3}H)



Results

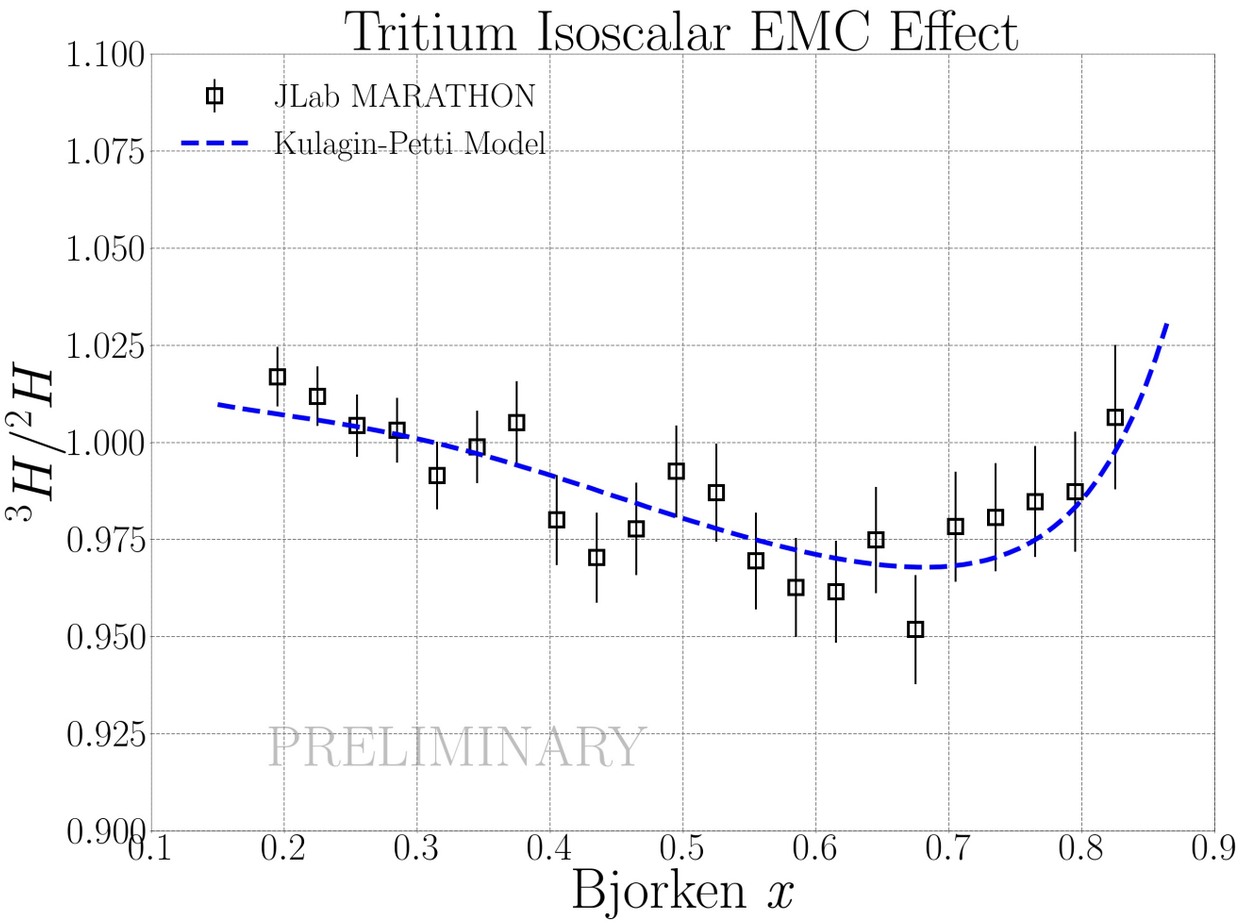
Raw EMC Ratios

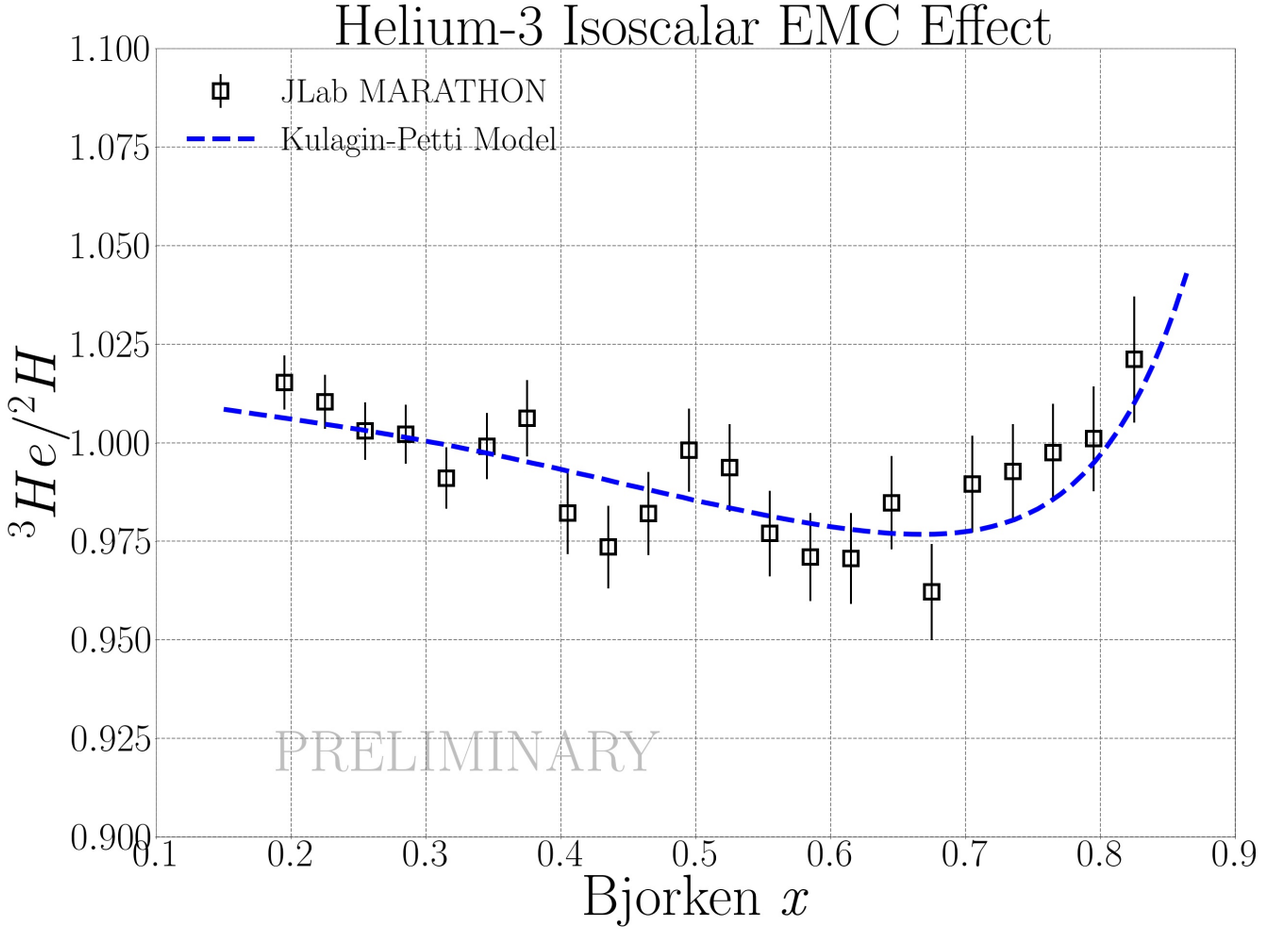


- No normalizations
- No Isoscaler corrections

—> ^{3}He EMC from MARATHON and HallC agrees

Isoscalar EMC Results with Normalization

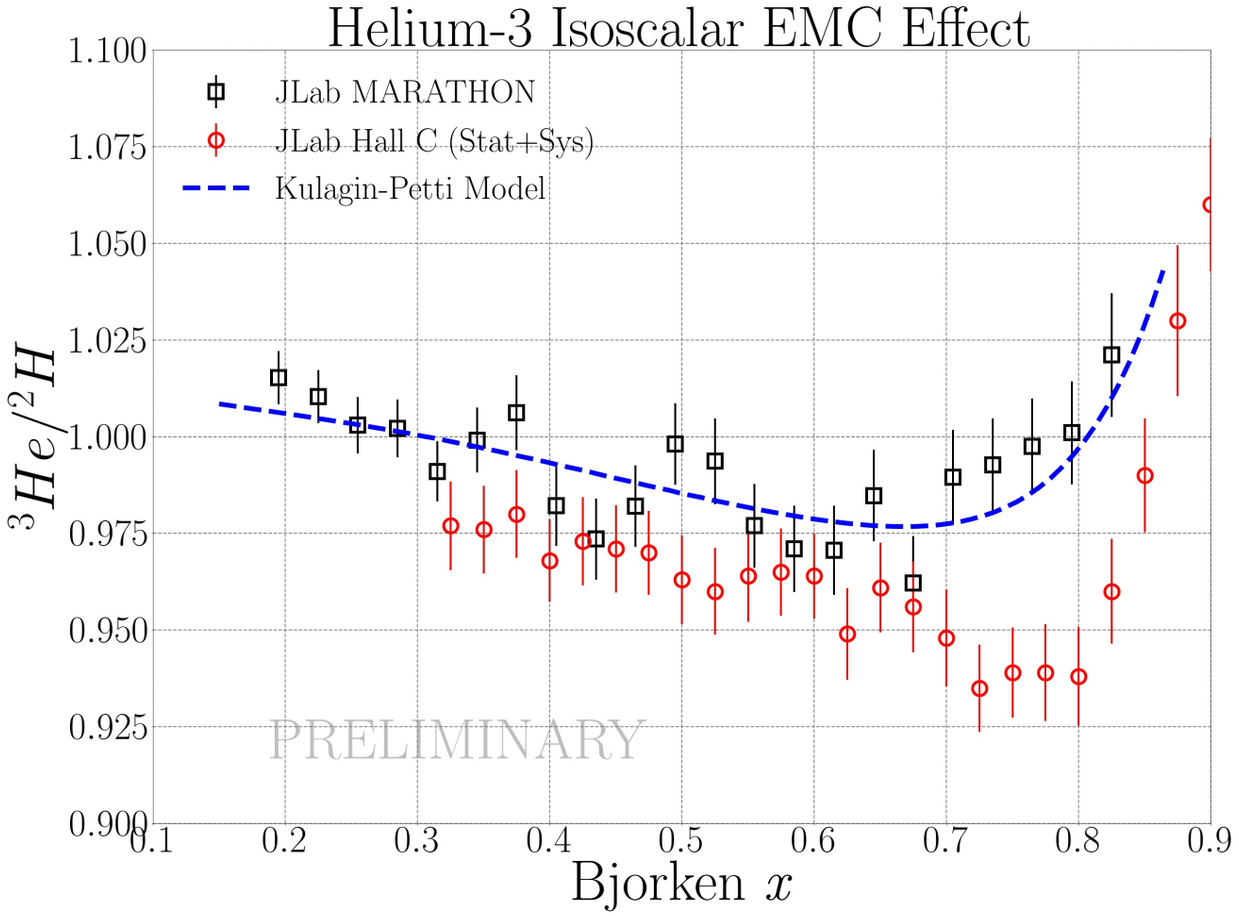




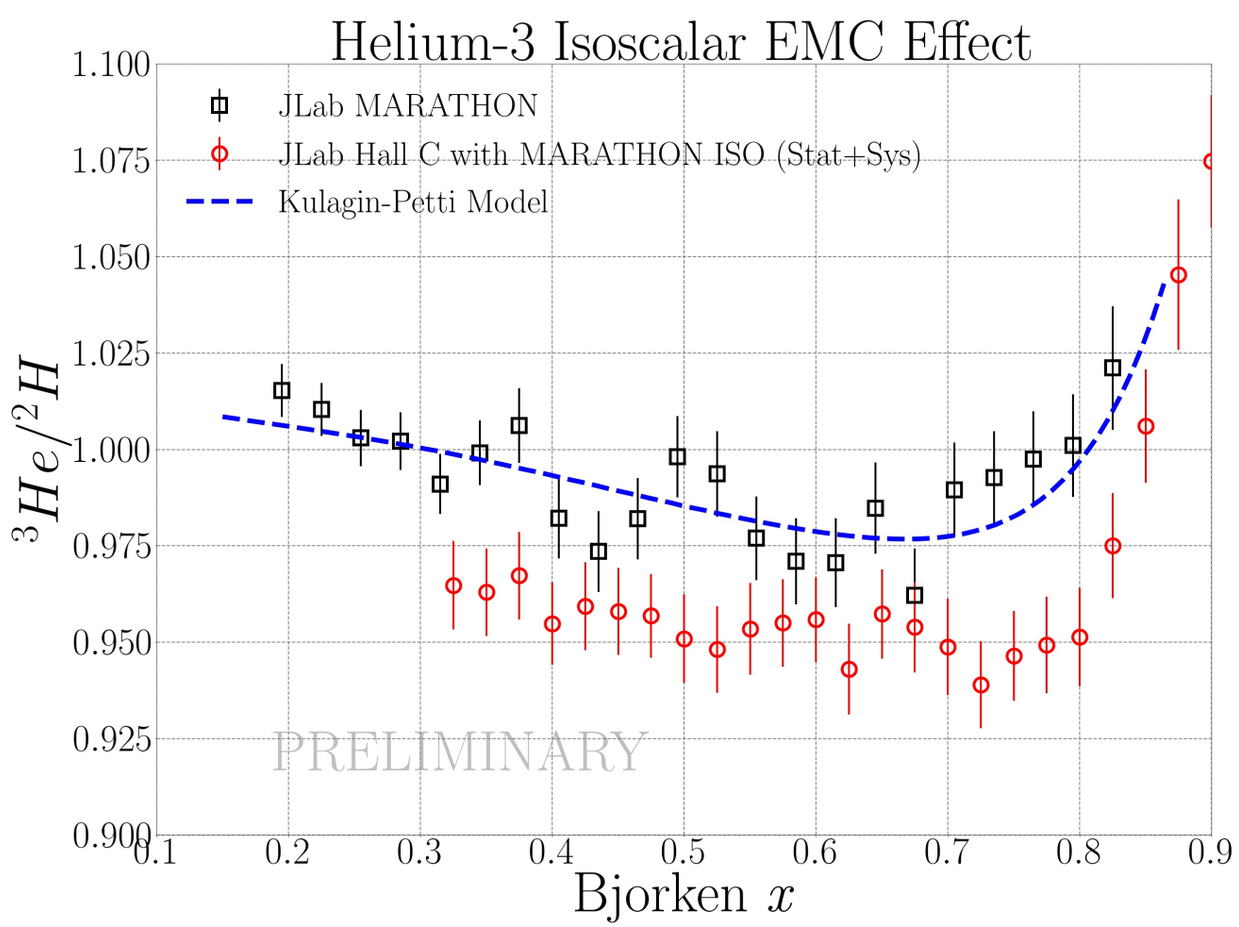
- ^{3}H normalized by -0.4%
- ^{3}He normalized by 2.4%
- Isoscalar correction from MARATHON F_2(n/p)

All following plots from MARATHON have these normalizations!

^{3}He EMC Isoscalar Corrections

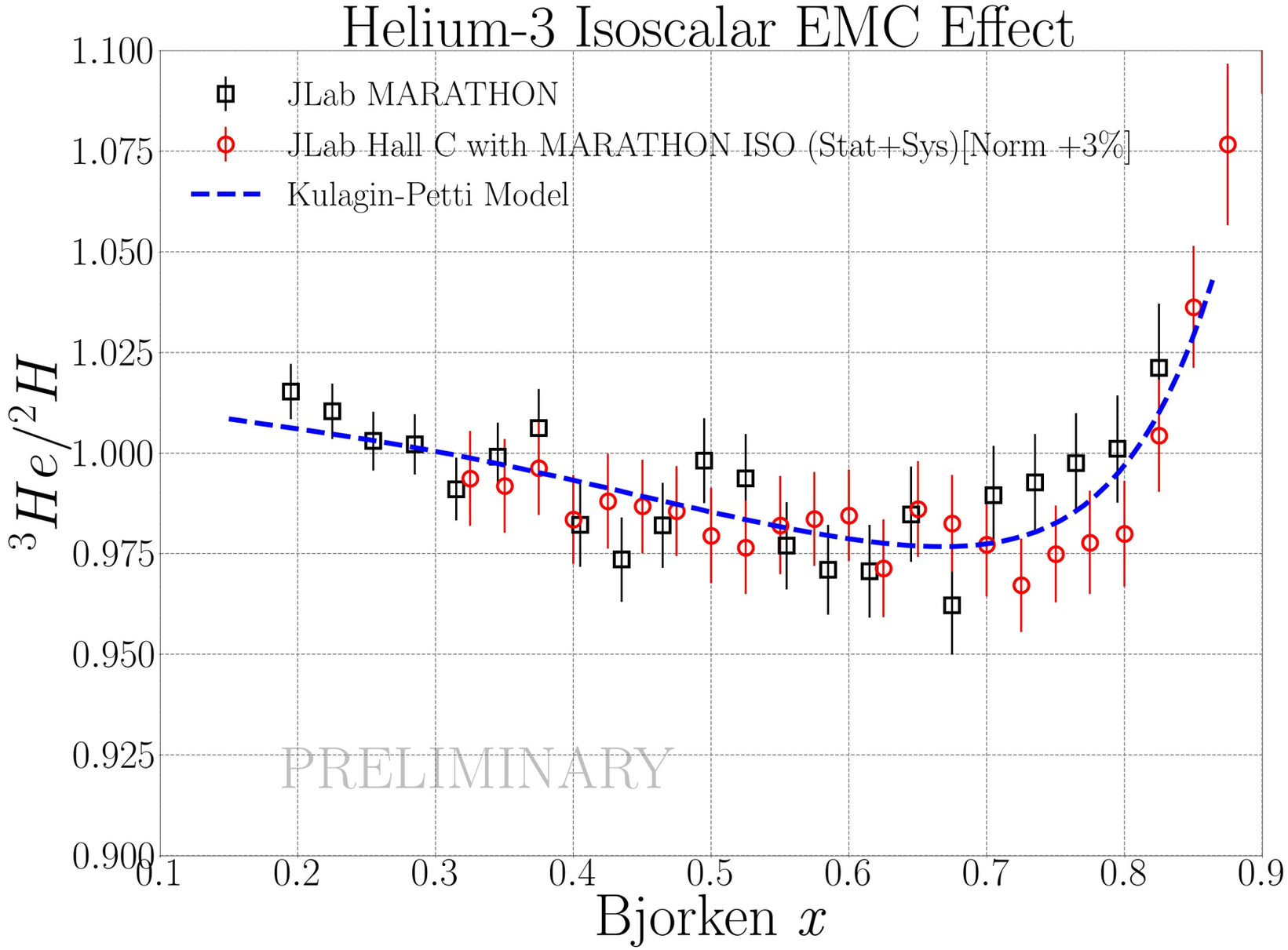


- different Isoscalar corrections from Marathon and HallC



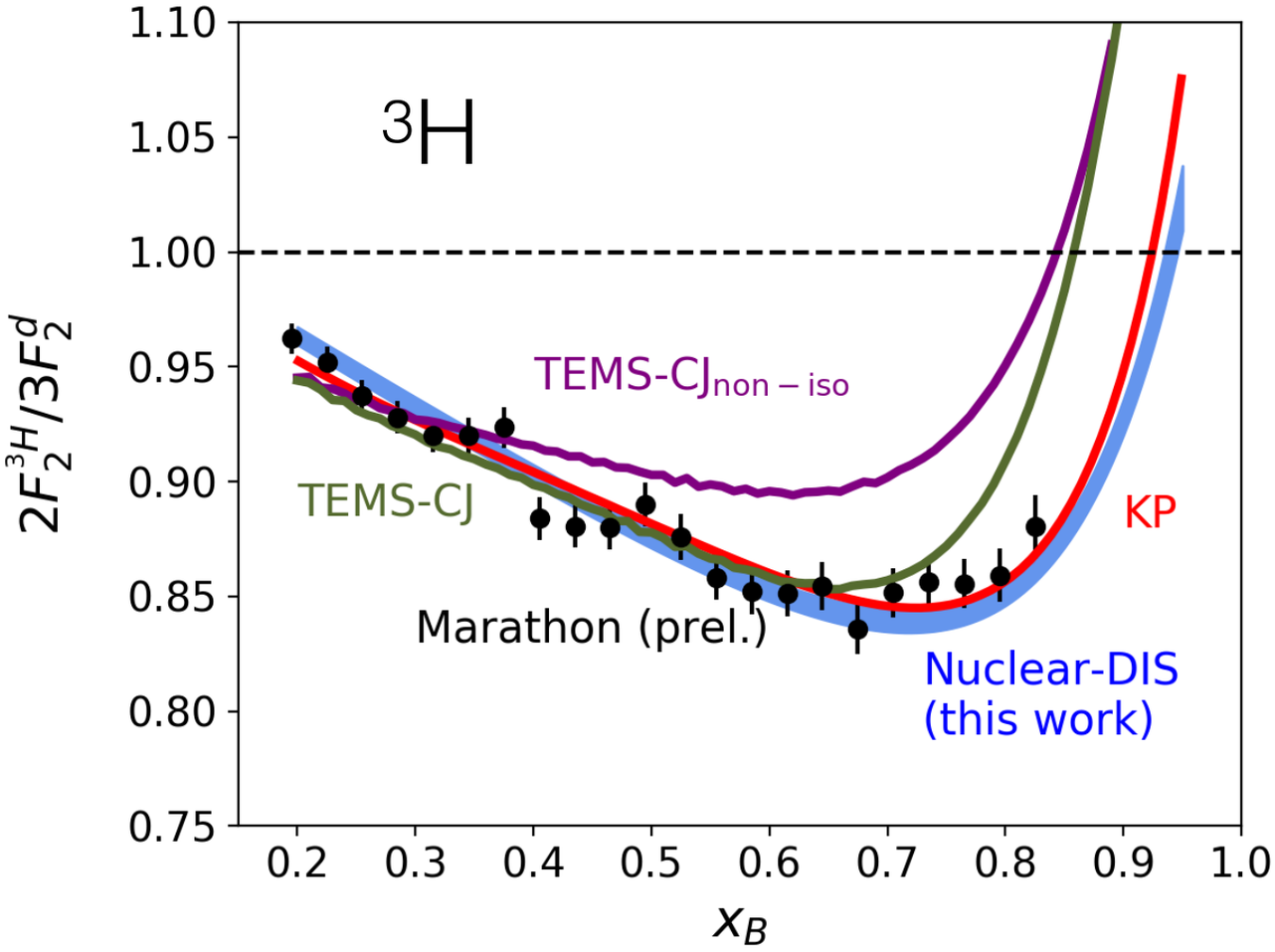
- MARATHON Isoscalar corrections applied to both data sets

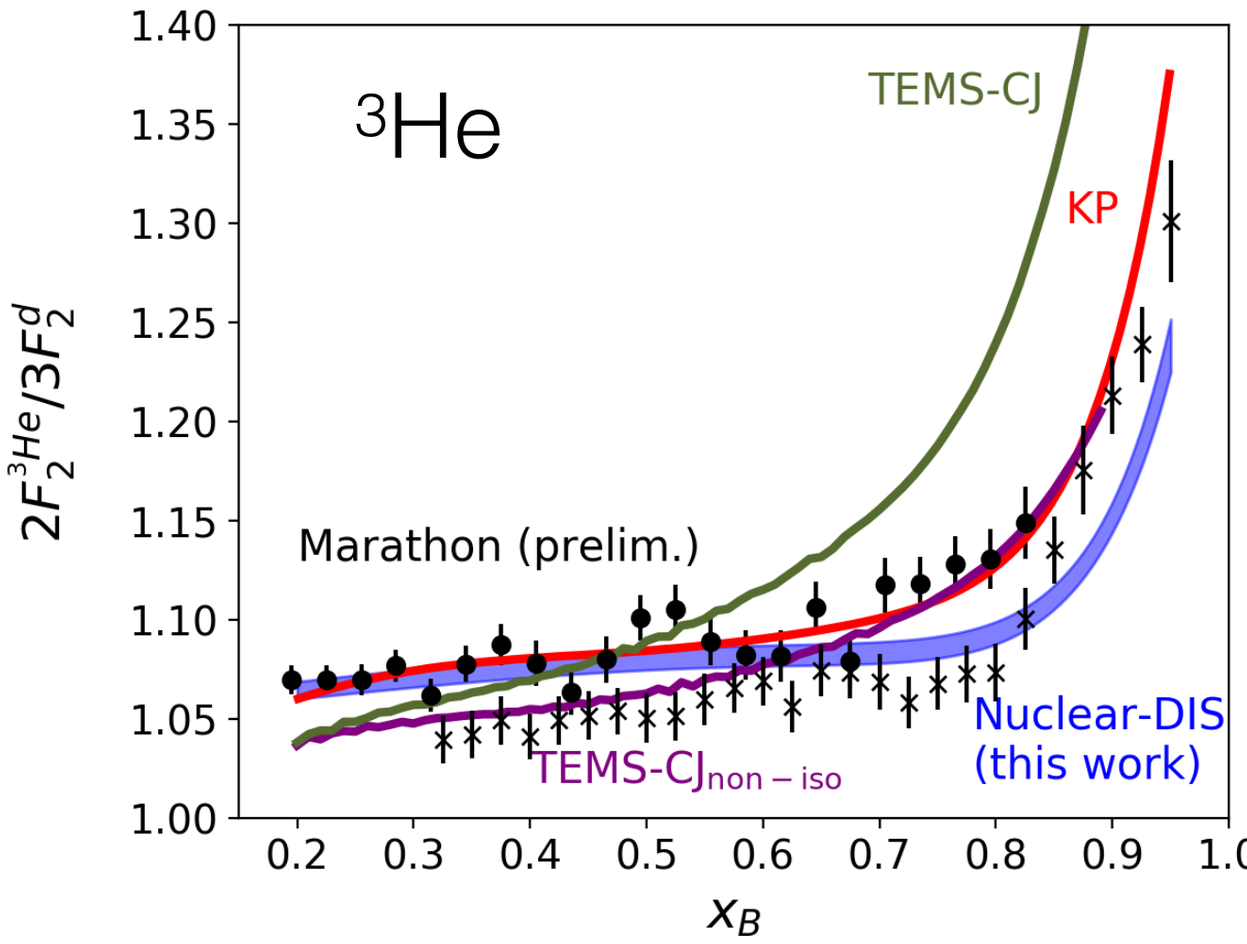
^{3}He EMC



- MARATHON Isoscaler corrections applied
- HallC data scaled as in KP paper (PRC82, 054614 (2010))

A = 3 EMC - Comparison with Theories



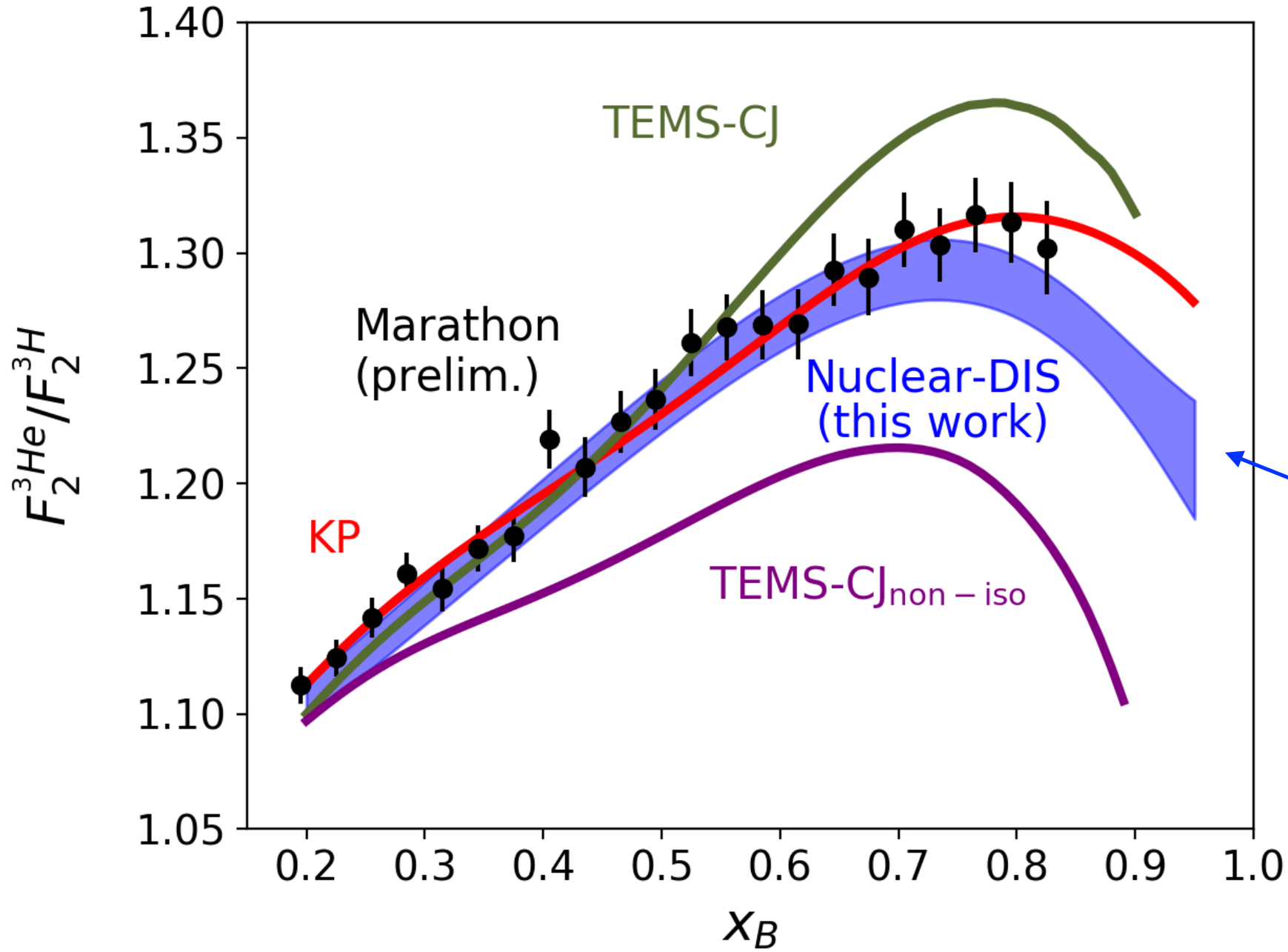


- No isoscalar correction applied
- No scaling on Seely data (crosses)

E. Segarra et al., arXiv:1908.02223 (2019)

A. Tropiano et al., PRC 99, 035201 (2019)

$F_2^{^3\mathrm{He}}/F_2^{^3\mathrm{H}}$ Ratio

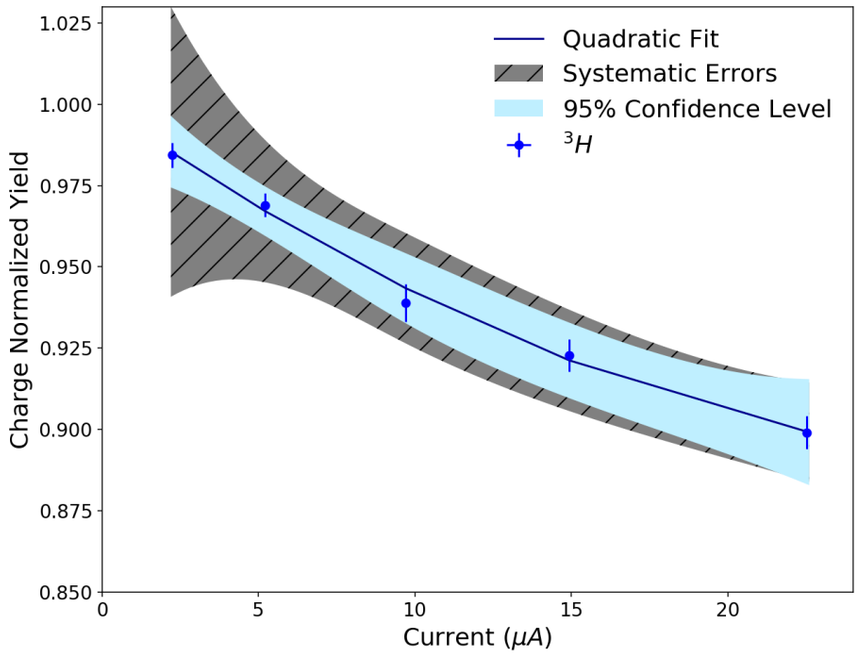


E. Segarra et al., arXiv:1908.02223 (2019)

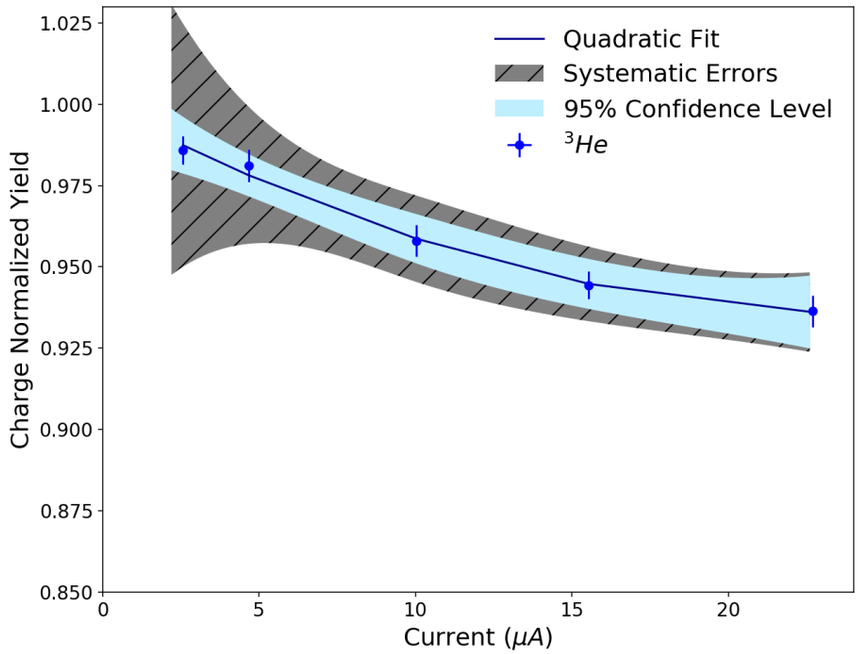
A. Tropiano et al., PRC 99, 035201 (2019)

Back up slides

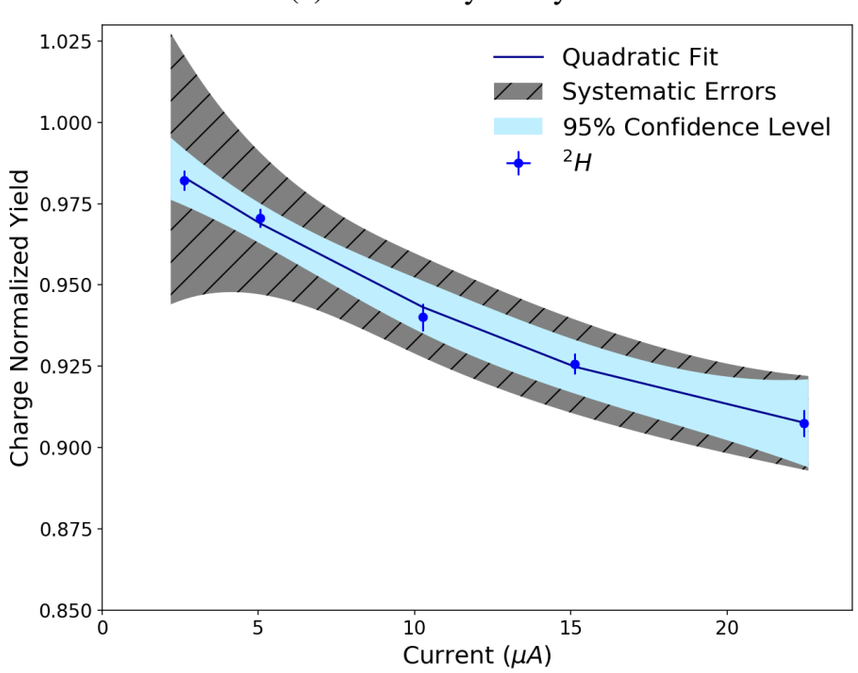
Target Boiling - All targets



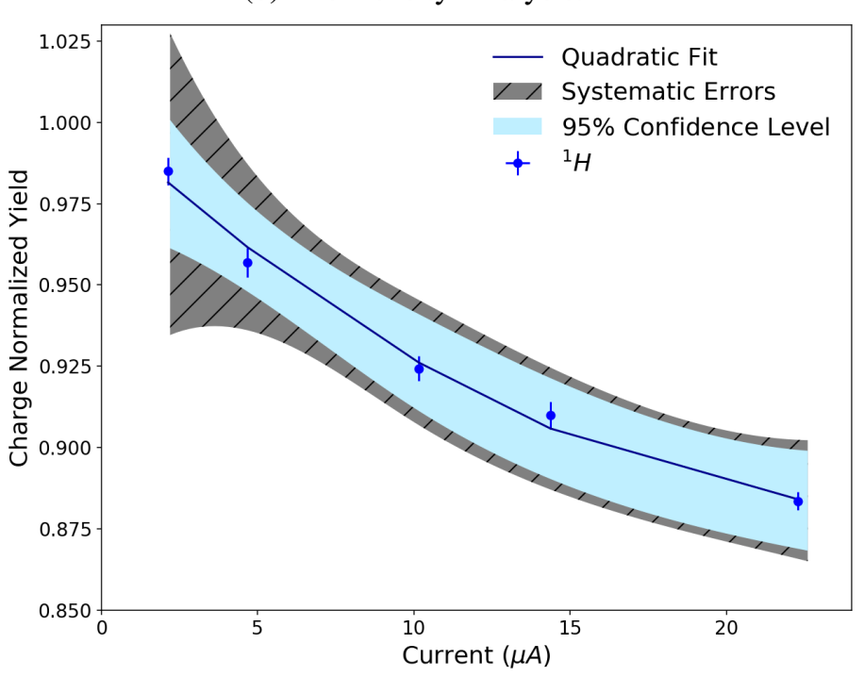
(a) ^{3}H Density Analysis.



(b) ^{3}He Density Analysis.



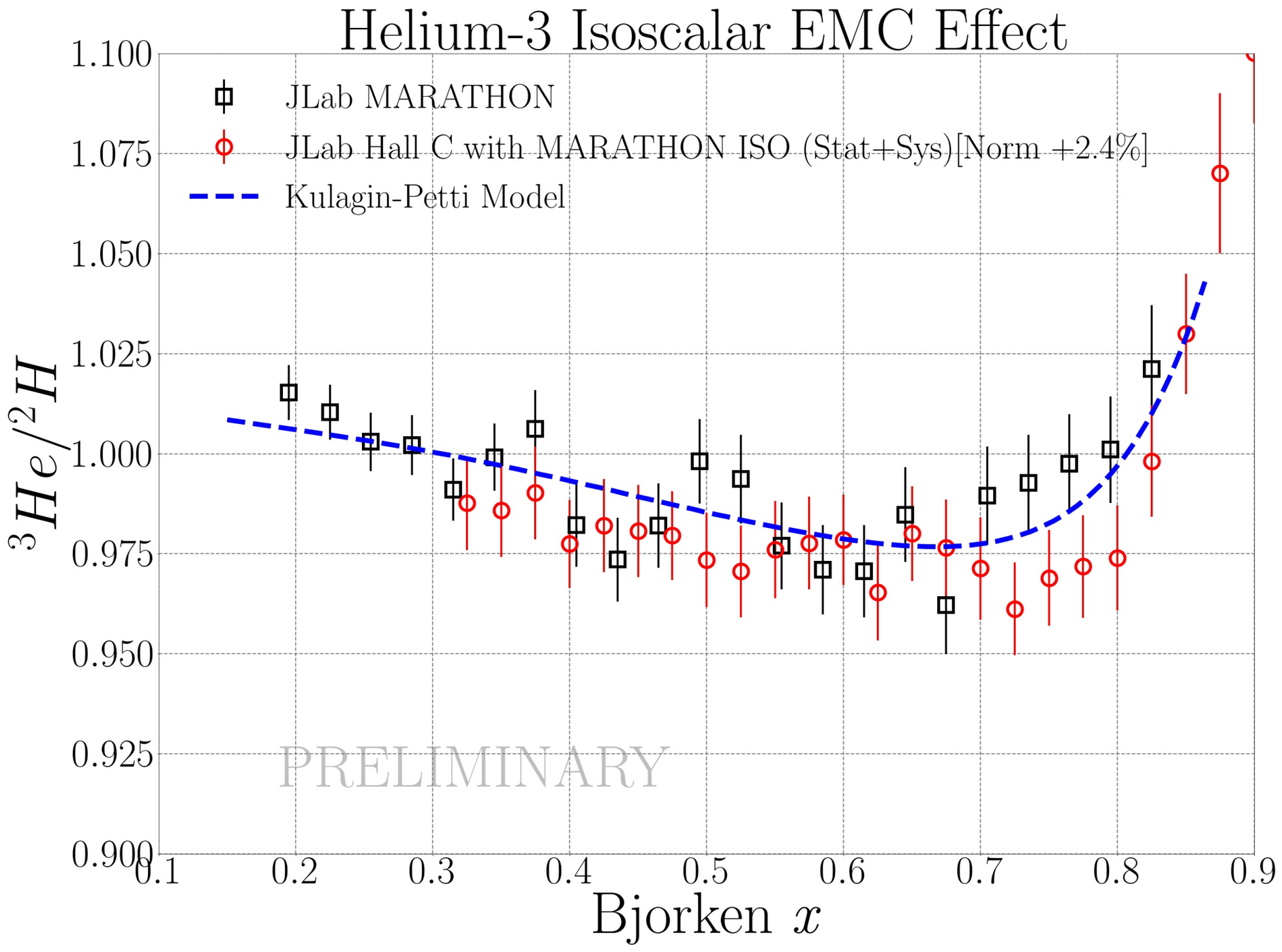
(c) ^{2}H Density Analysis.



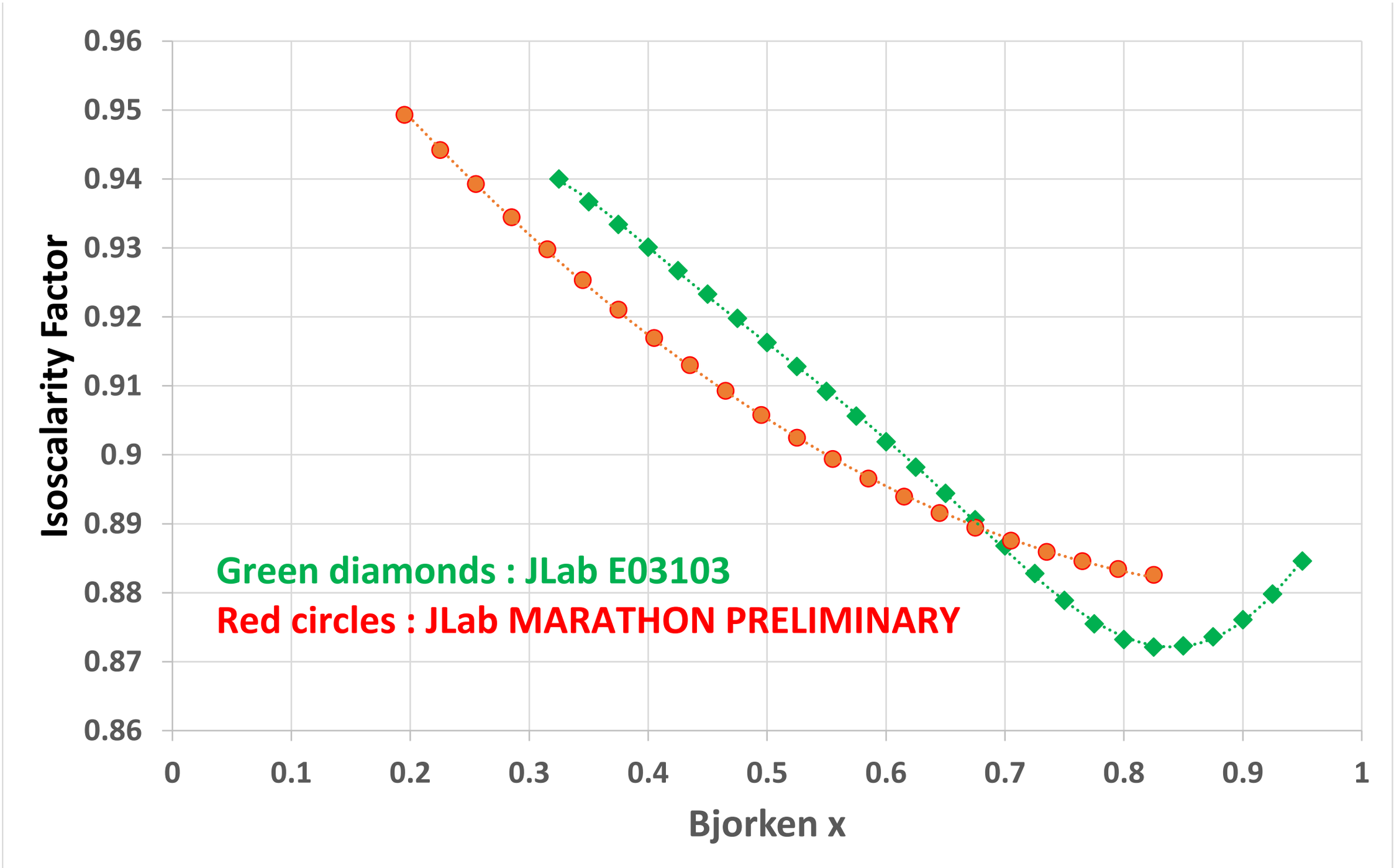
(d) ^{1}H Density Analysis.

S.N. Santiesteban, S. Alsalmi et al., NIM A950, 351 (2019)

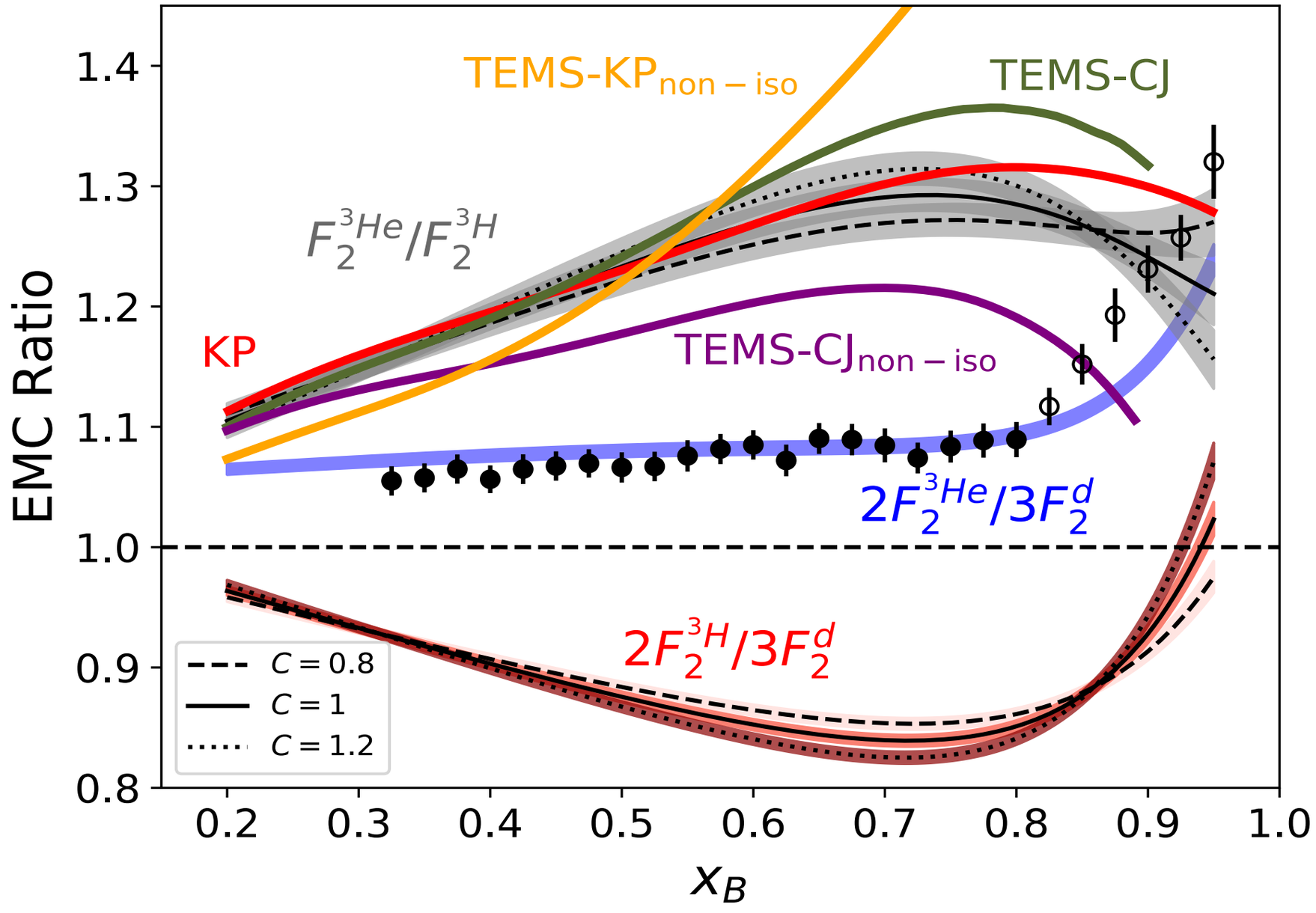
^{3}He EMC: Same Normalization Factor



^{3}He: Isoscalar Corrections Comparison



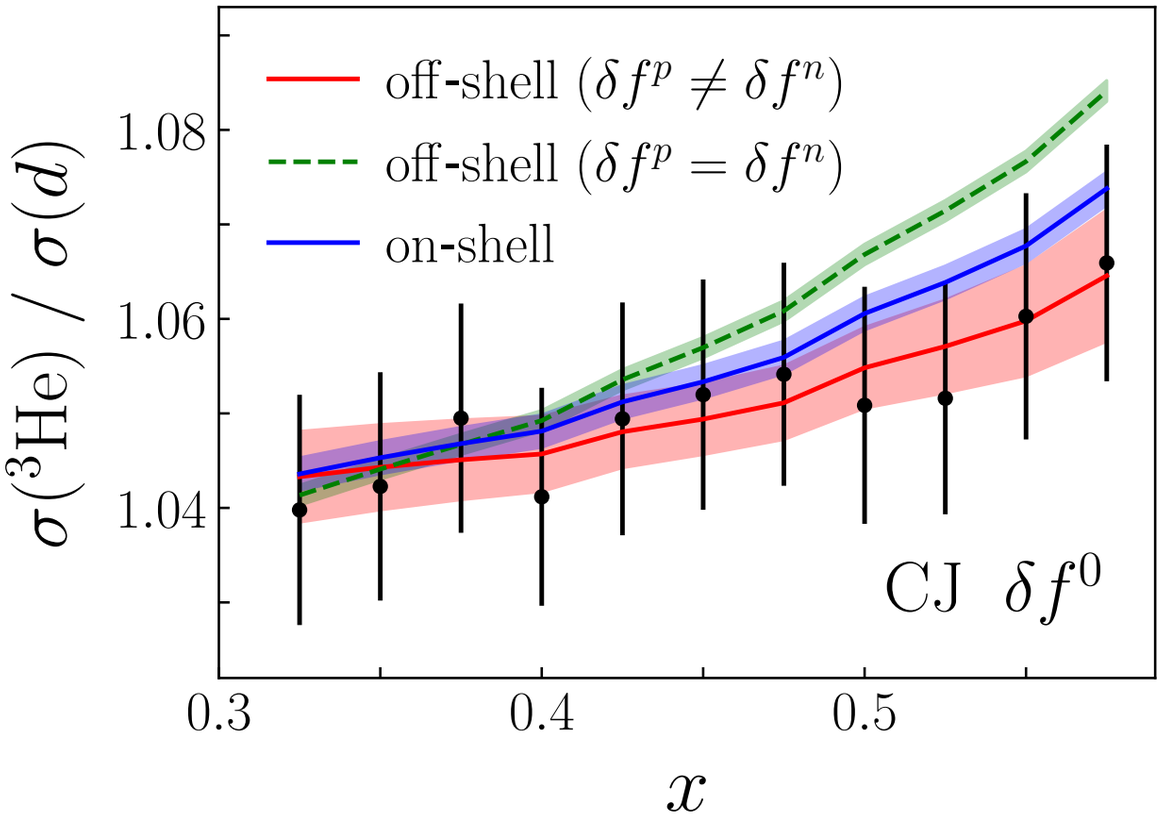
Full Predictions from Nuclear-DIS model

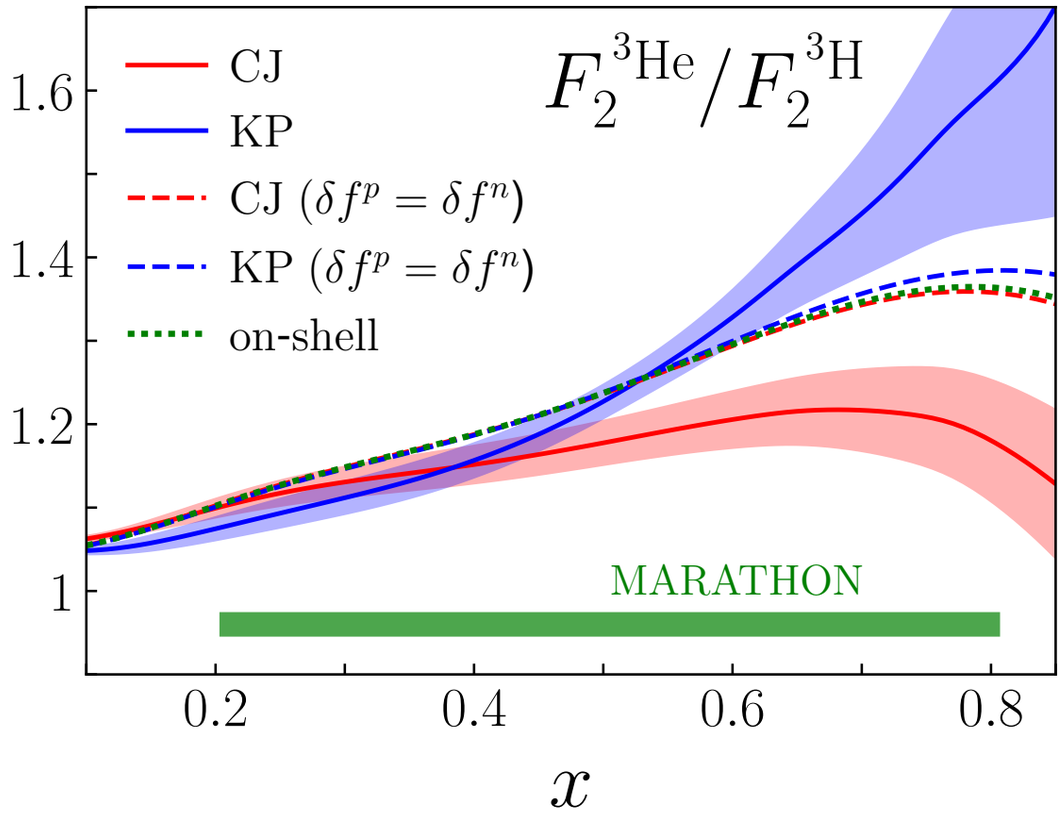


- HallC data normalized by 1.4%

E. Segarra et al., arXiv:1908.02223 (2019)

TEMS Predictions

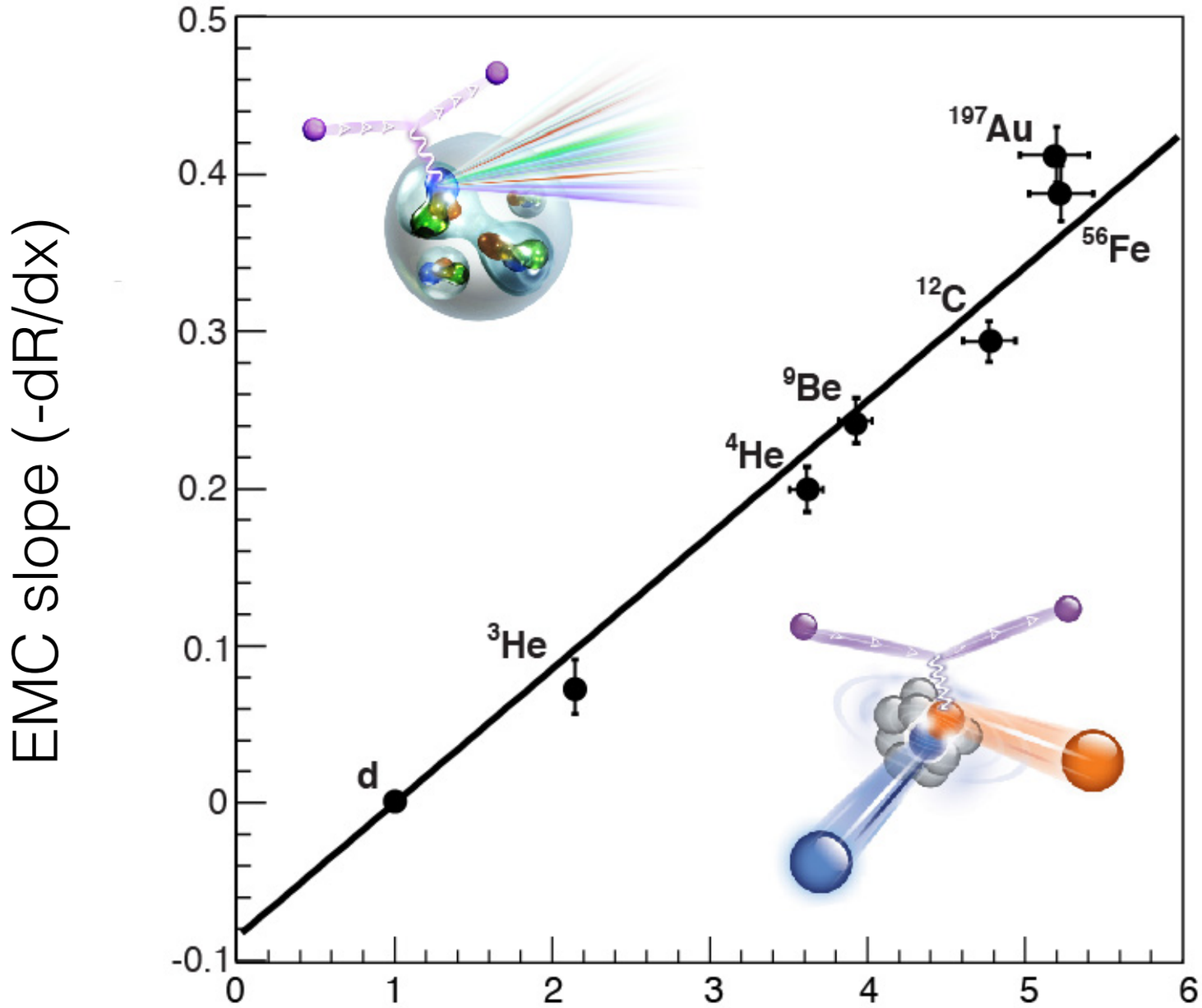




- The CJ lines were plotted before and in Segarra et al.
- $\mathrm{CJ}_{\text{non-iso}}$ curve is from $\delta f^p \neq \delta f^n$

A. Tropiano, J. Ethier, W. Melnitchouk, N. Sato, PRC 99, 035201 (2019)

EMC and SRC Correlation



Weinstein et al., PRL 106, 052301 (2011), Hen et al.,PRC 85, 047301(2012)