Preliminary EMC results from XEM2 experiment

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January 18th 2024

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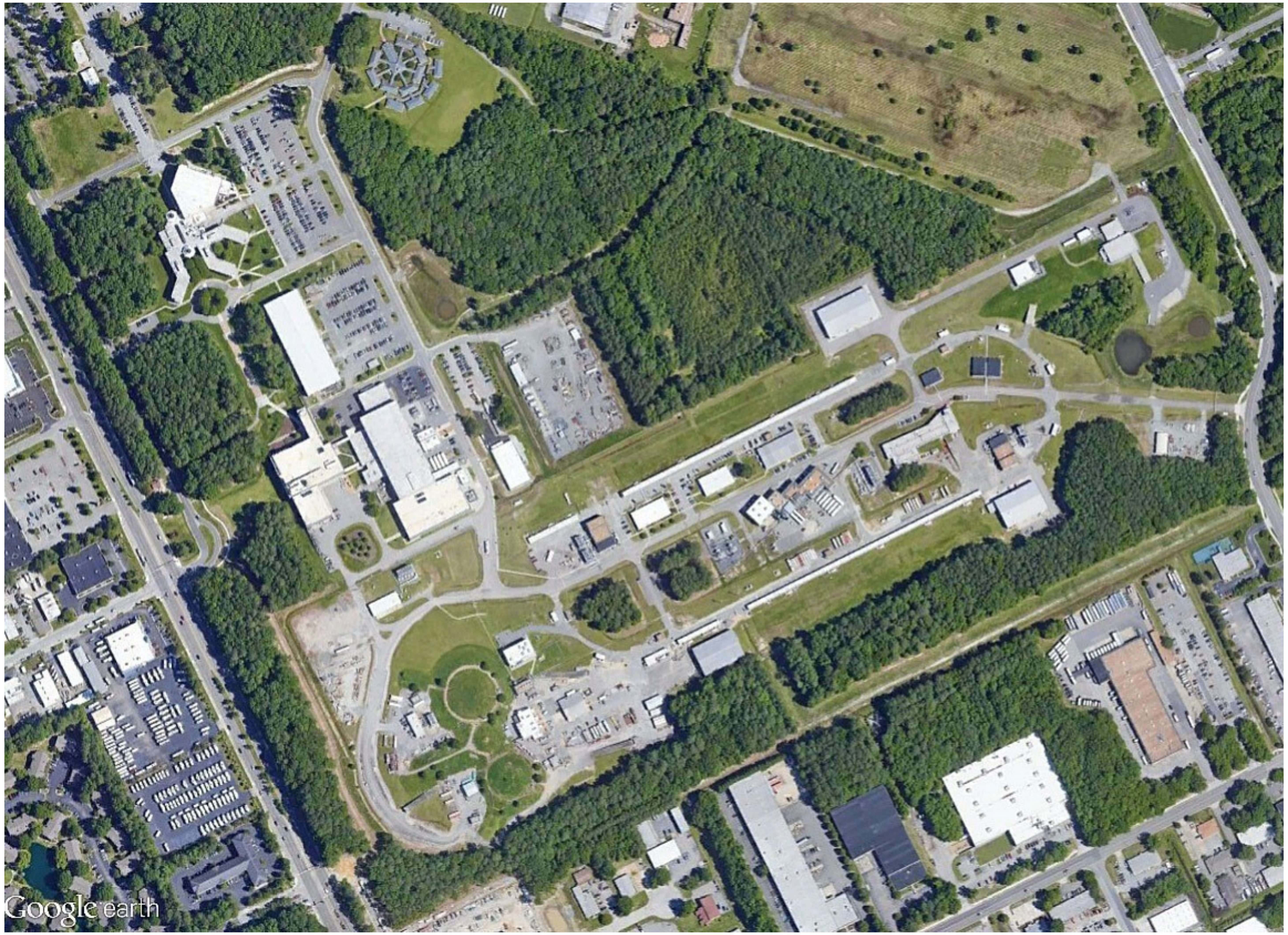
This work was supported by U.S. Department of Energy under award number: DE-SC0013615 and JSA Graduate Fellowship program

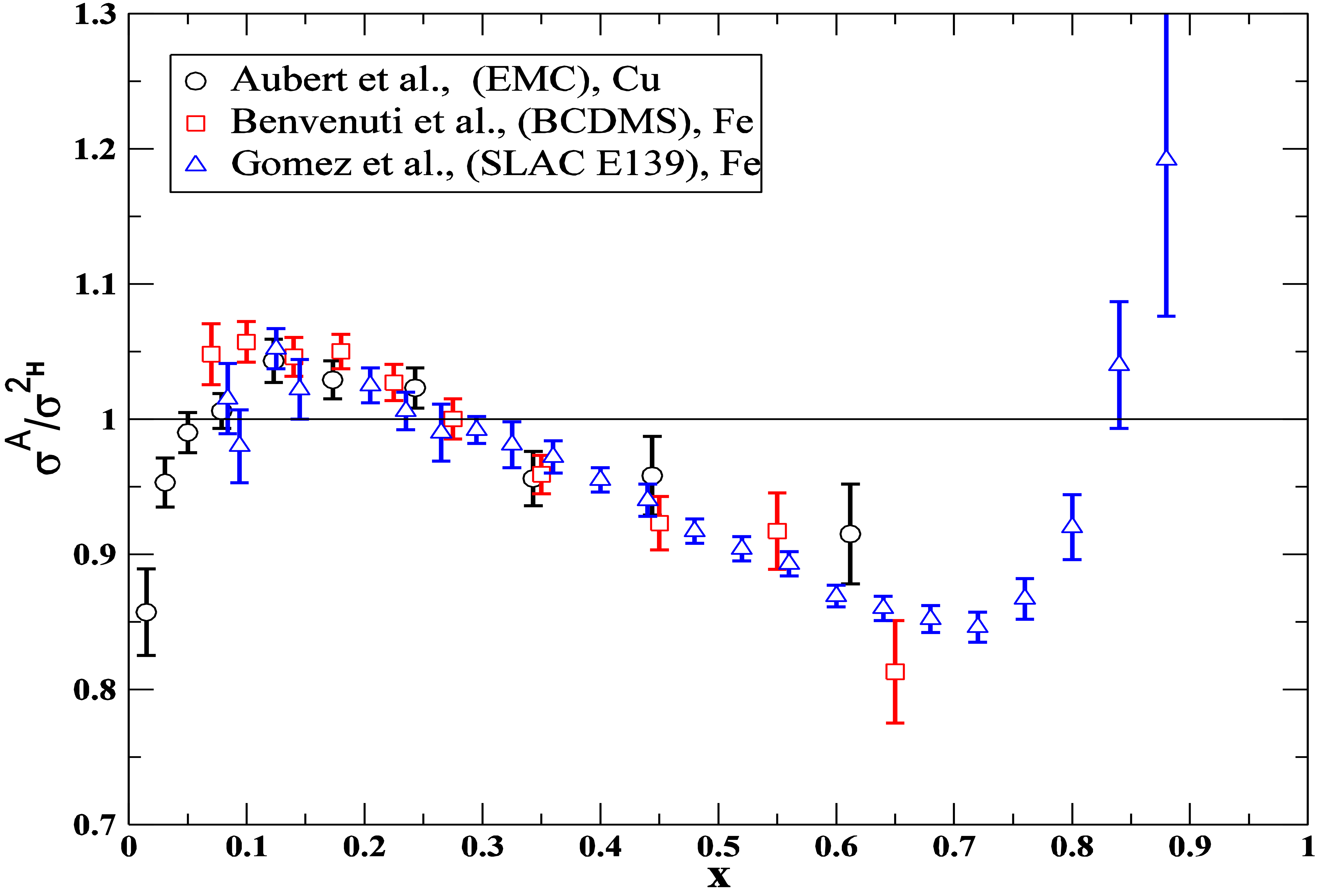
Overview

- ***Overview of E12-10-008***
- Detector Calibrations
- Preliminary results



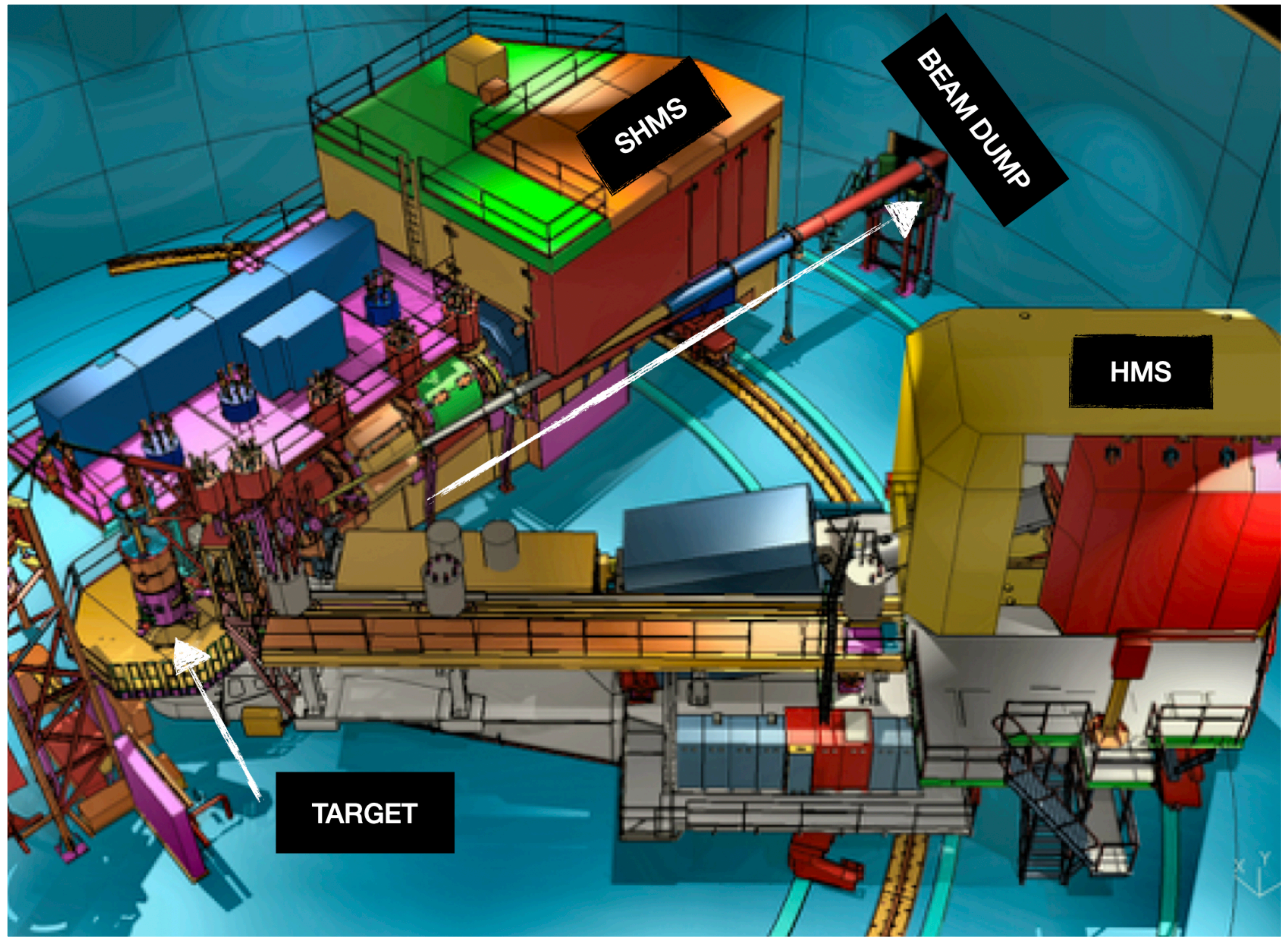
What is the EMC effect?

- >1000s of theory papers written
- No consensus after >40 years
- Typical nuclear binding energies are insignificant compared to energies in DIS experiments (MeV vs. GeV)
- Guided by experiments, we have hints



Experimental Overview

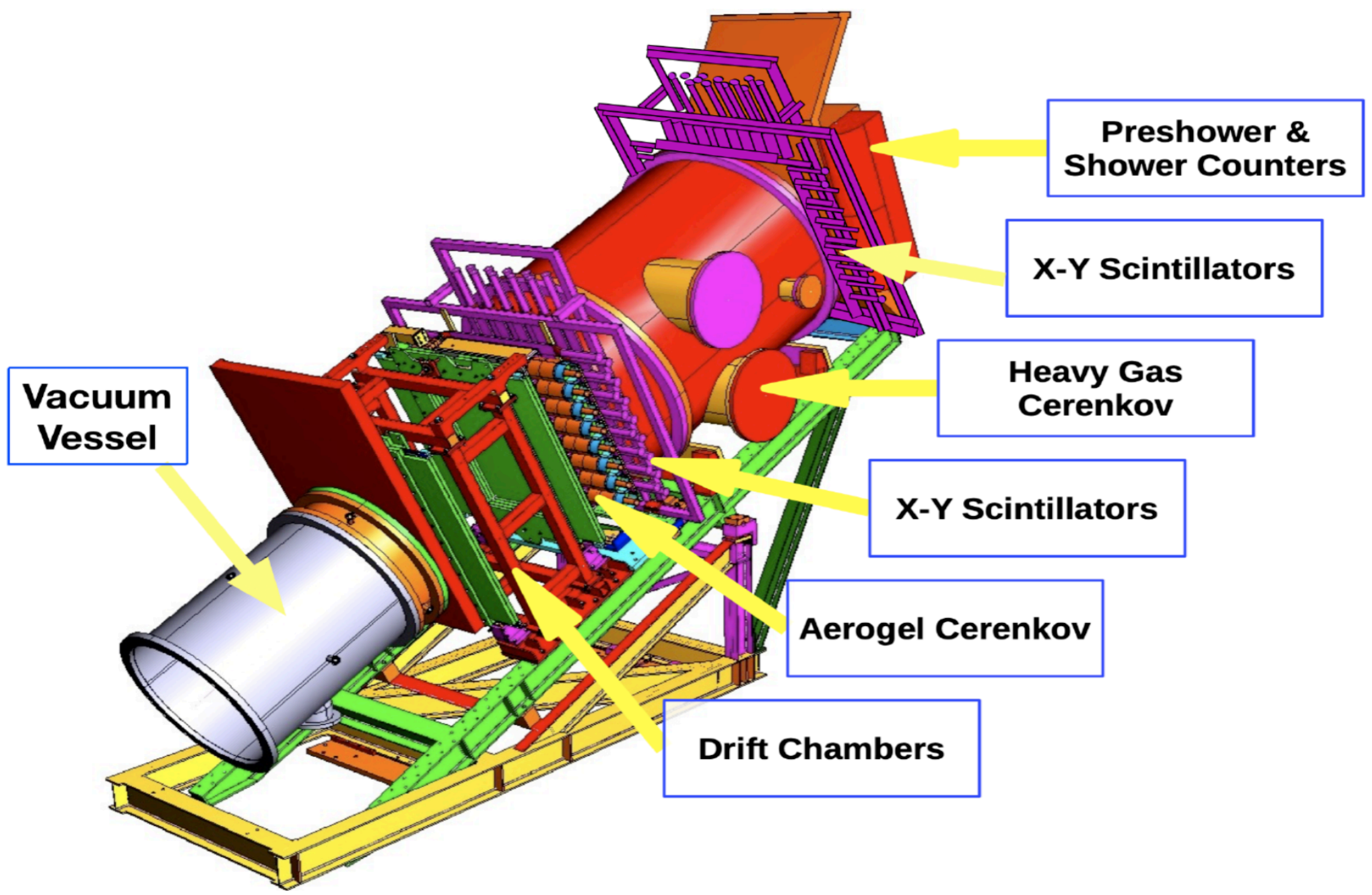
- Experiment E12-10-008 performed in Hall C at JLab
- Ran simultaneously with E12-06-105 (primarily Bjorken-x>1)
- Single arm data taken in HMS
- E12-06-105 took data in SHMS



A CAD drawing of Hall C

High Momentum Spectrometer

1. **Drift Chambers**
   - Provides tracking information
2. **Heavy Gas Cerenkov**
   - Particle identification
3. **Hodoscopes**
   - Trigger
   - Tracking Efficiency
4. **Calorimeter**
   - Particle identification

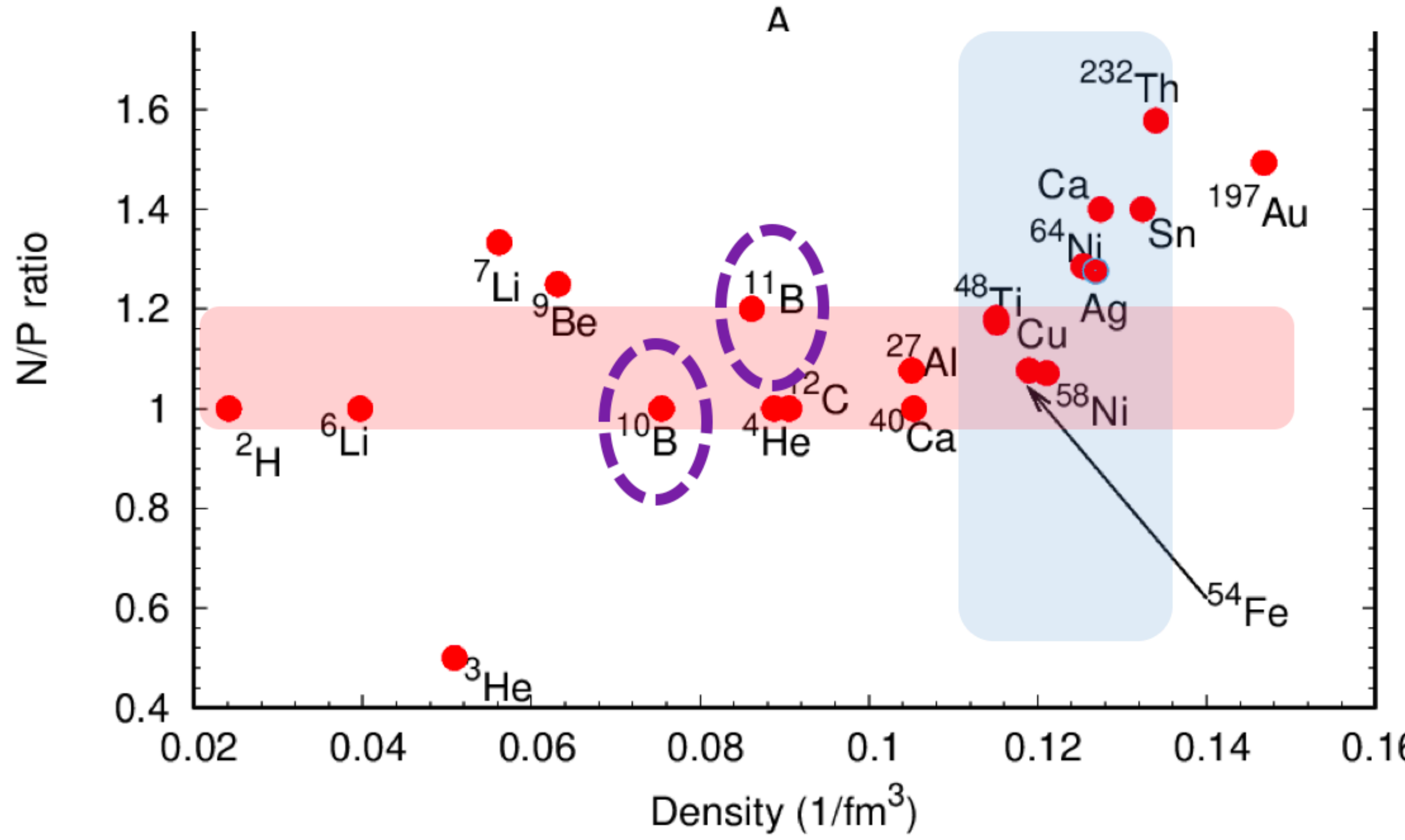


CAD Drawing of the HMS detector stack

JLab Hall C standard equipment manual

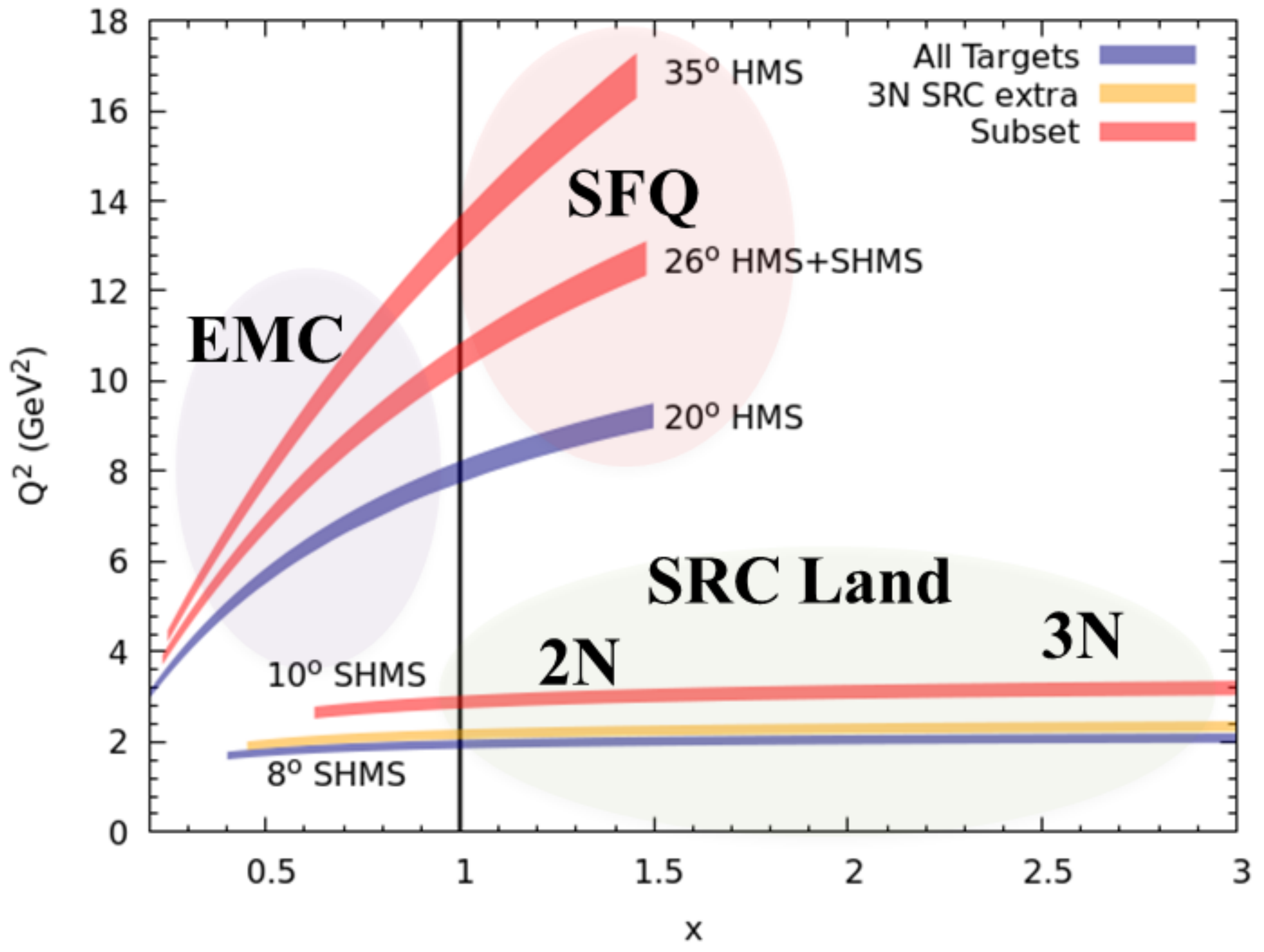
E12-10-008: Targets

- Investigates EMC effect in various light to medium nuclei
- Uses ^{40}Ca and ^{48}Ca which will provide insight into models predict a significant flavor dependence in the EMC effect.
- Will study the nuclei at low x and increased Q^2 than before, which will help in studying the EMC effect with greater precision
- Comparisons of nuclei which differ by just one nucleon (^{11}B-^{10}B, ^{7}Li-^{6}Li, ^{12}C-^{11}B) will allow to study isospin dependence



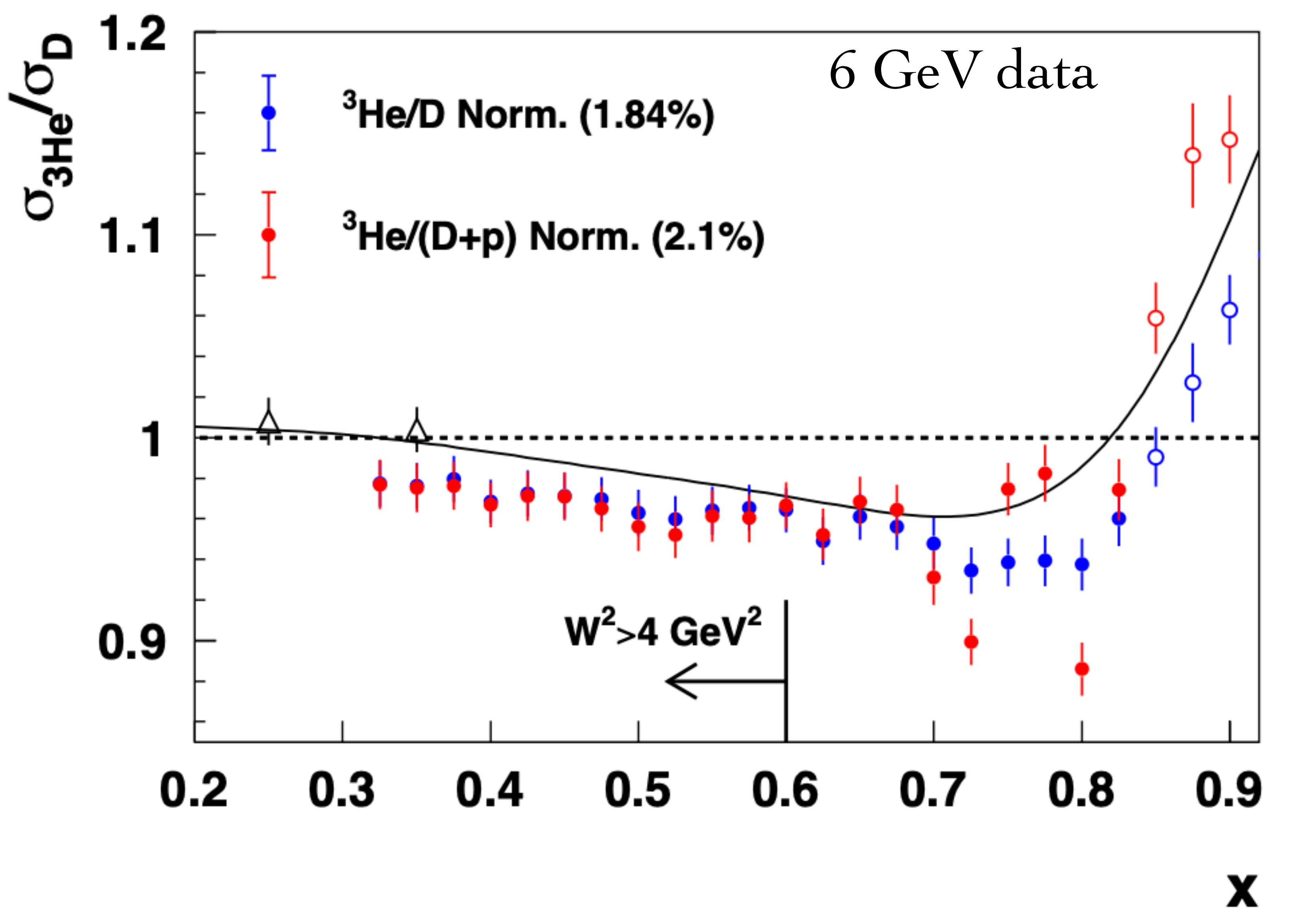
E12-10-008: Kinematic Coverage

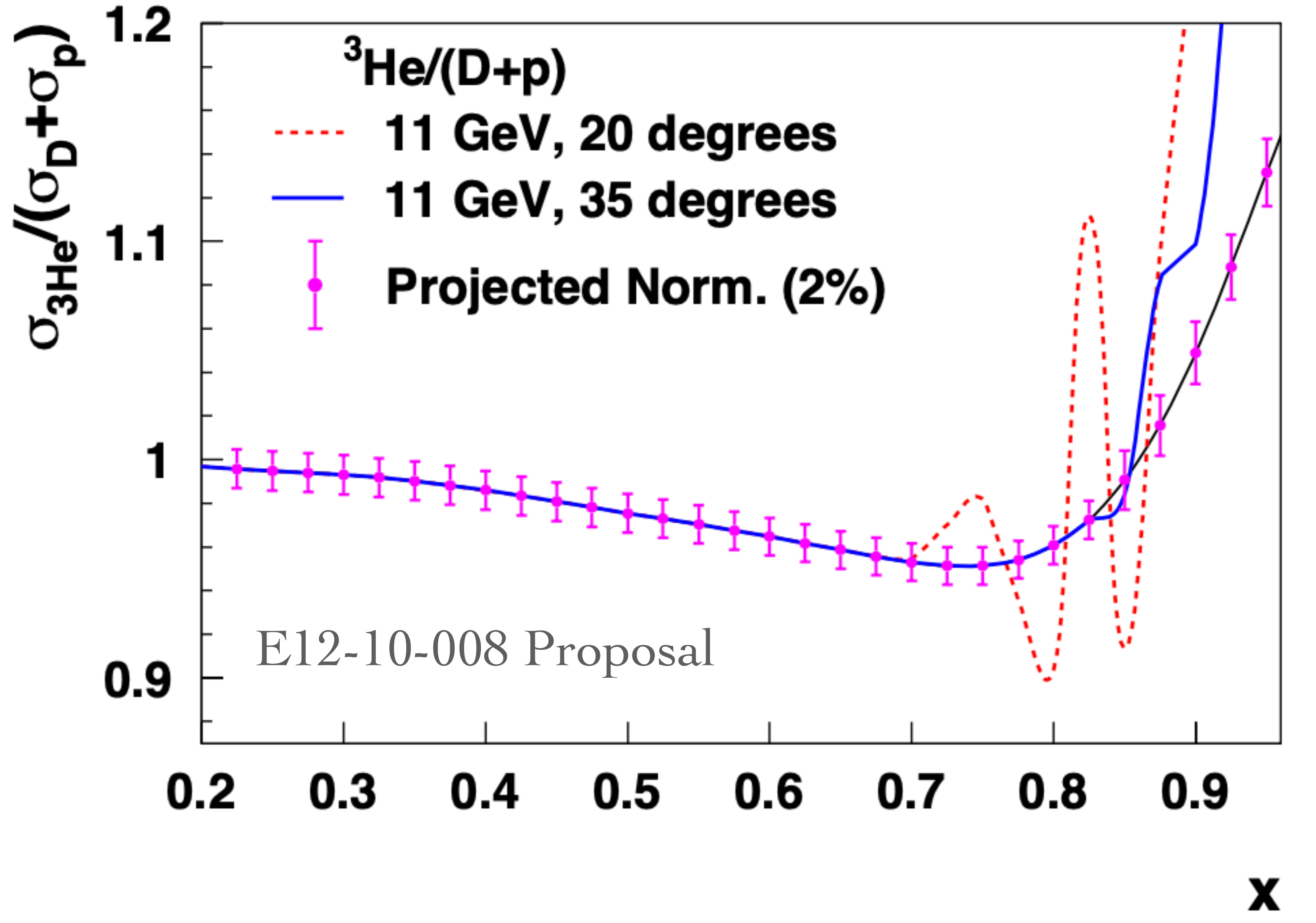
- ~20 momentum settings for various targets
- HMS ran at high Q^2
- We measured EMC effect in several light nuclei
- Light nuclei are conducive to exact theoretical calculations



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

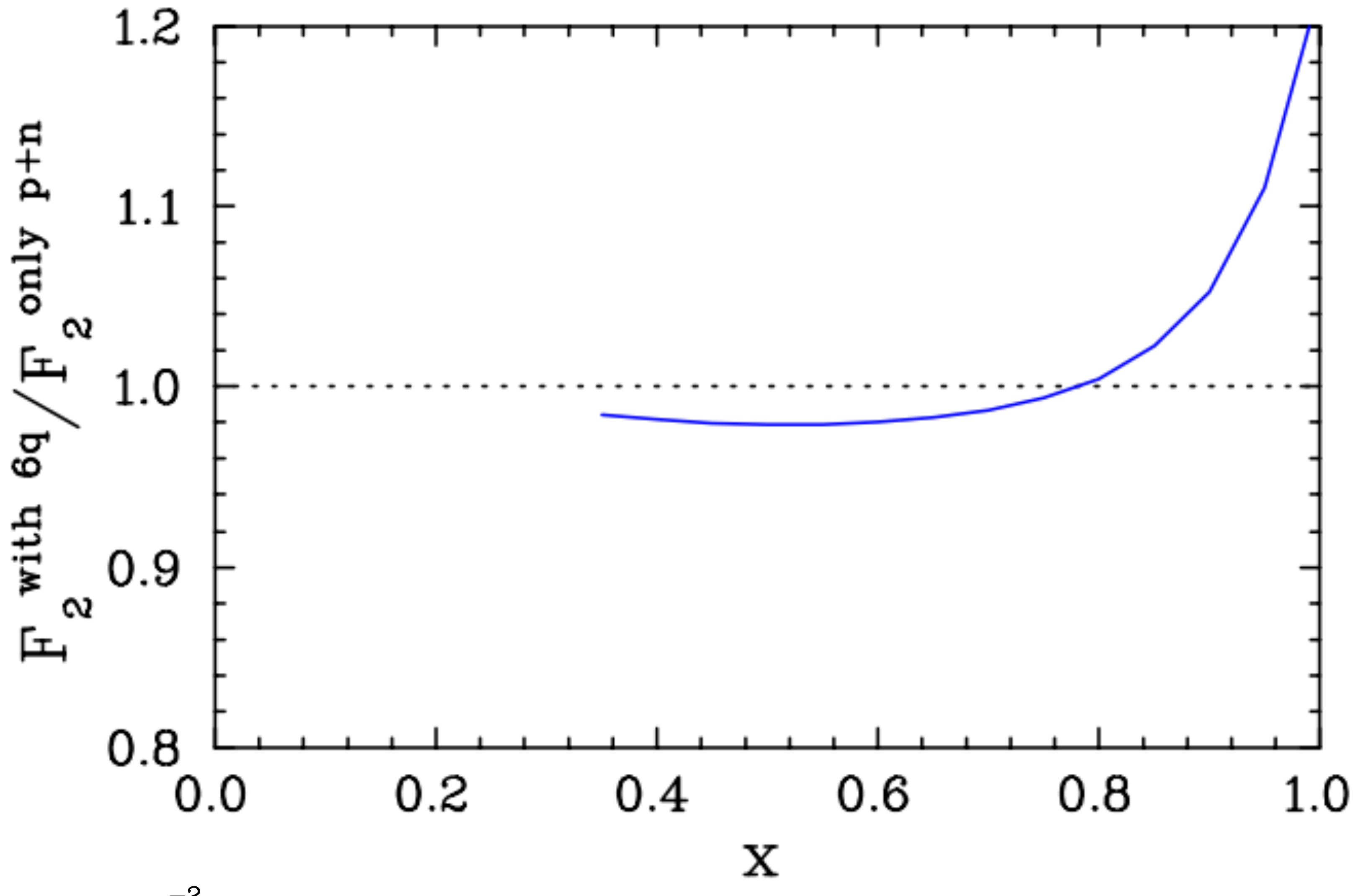
- Higher beam energy+ higher Q^2 allows us to skip the resonance region
- Can access higher x
- Can get $^3He/(^2H+^1H)$ without relying heavily on large isoscalar corrections
- Avoids the uncertainty associated with knowledge of the neutron structure function

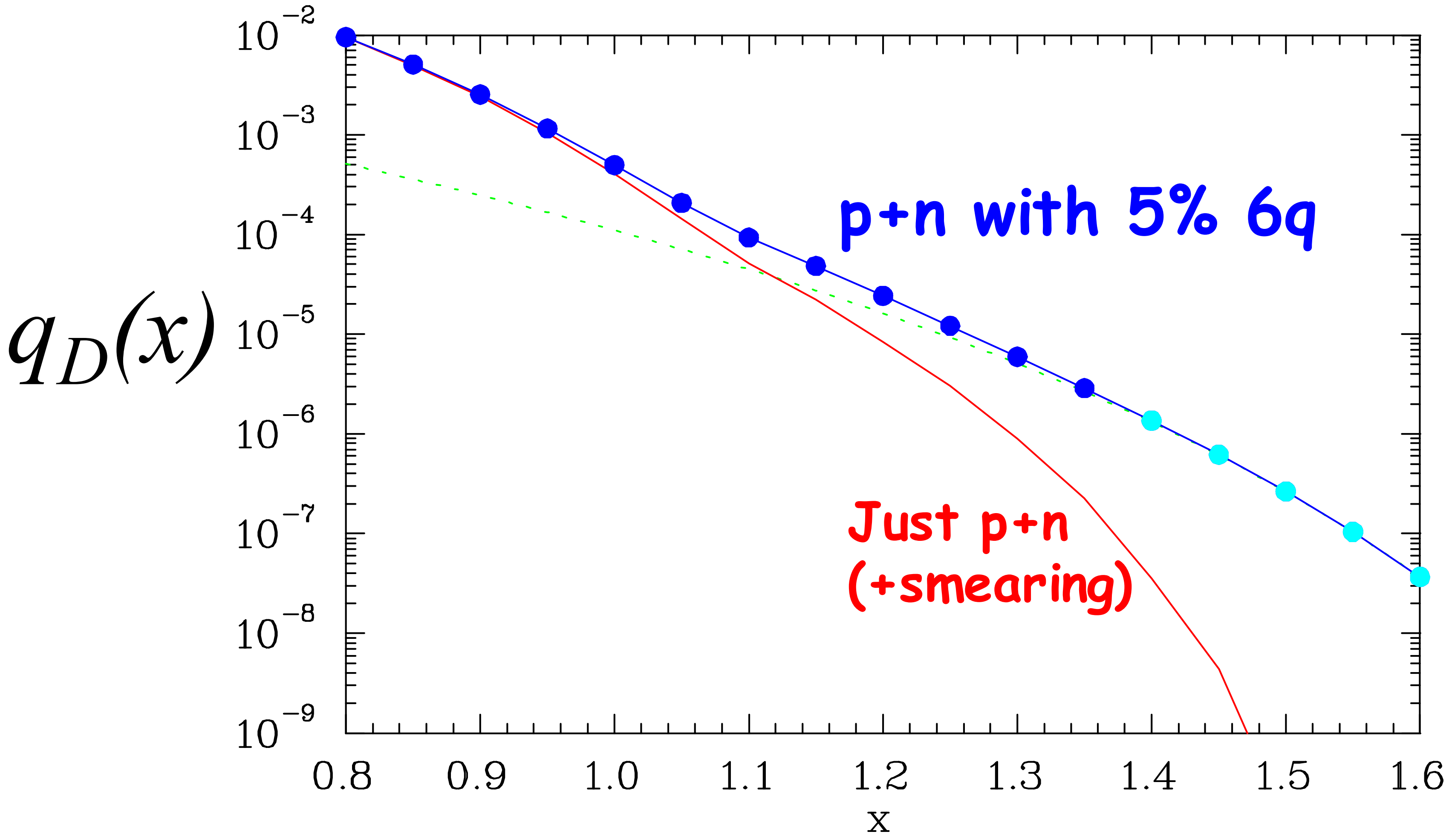




Superfast Quarks

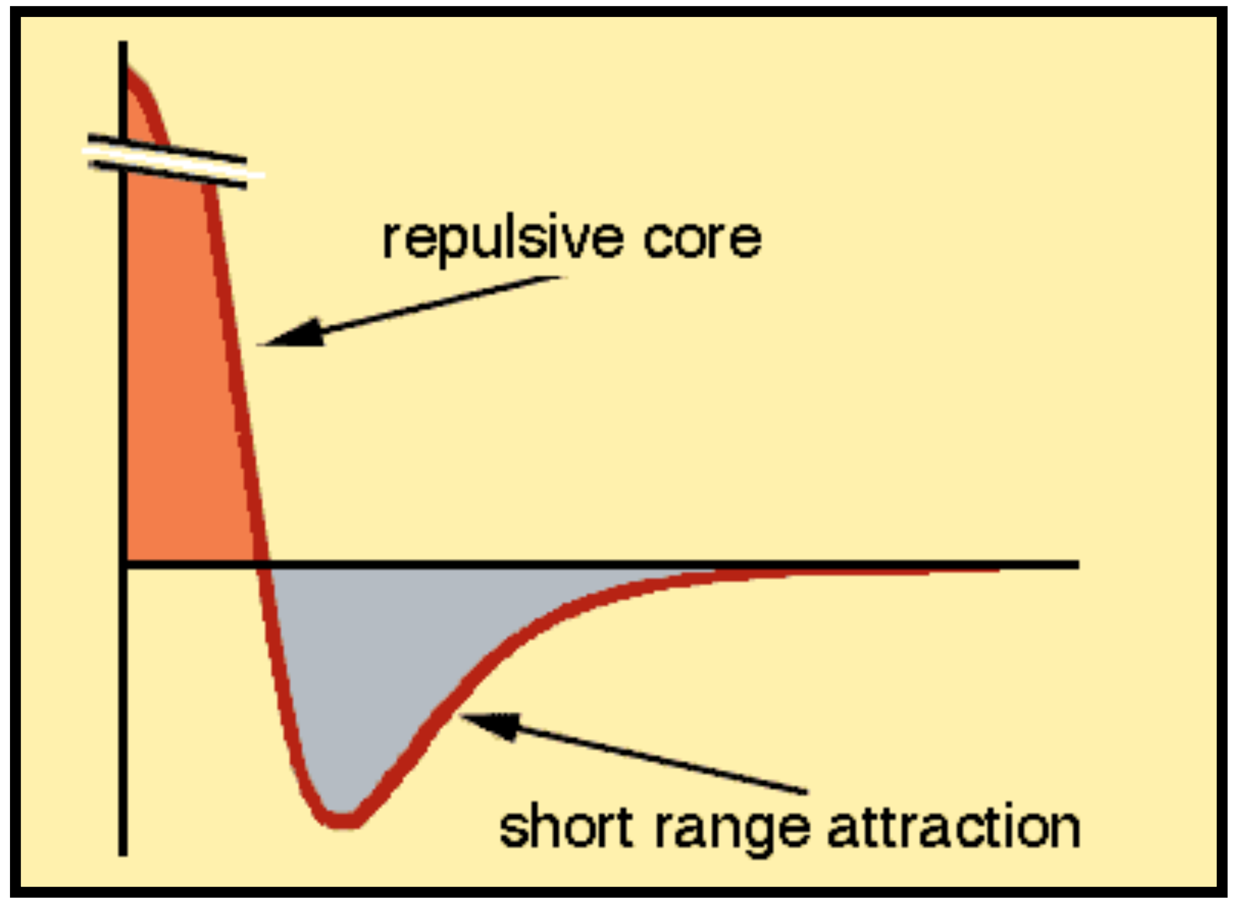
- HMS@35°
- Q^2 ~17 GeV^2/c
- Multiquark Structures- 6 quark bag?
- Great data for testing exotic models
- SFQ data for: ^2H, ^9Be, ^{10}B, ^{11}B, ^{12}C, ^{40}Ca & ^{48}Ca!
- Stay for Zoe's talk next



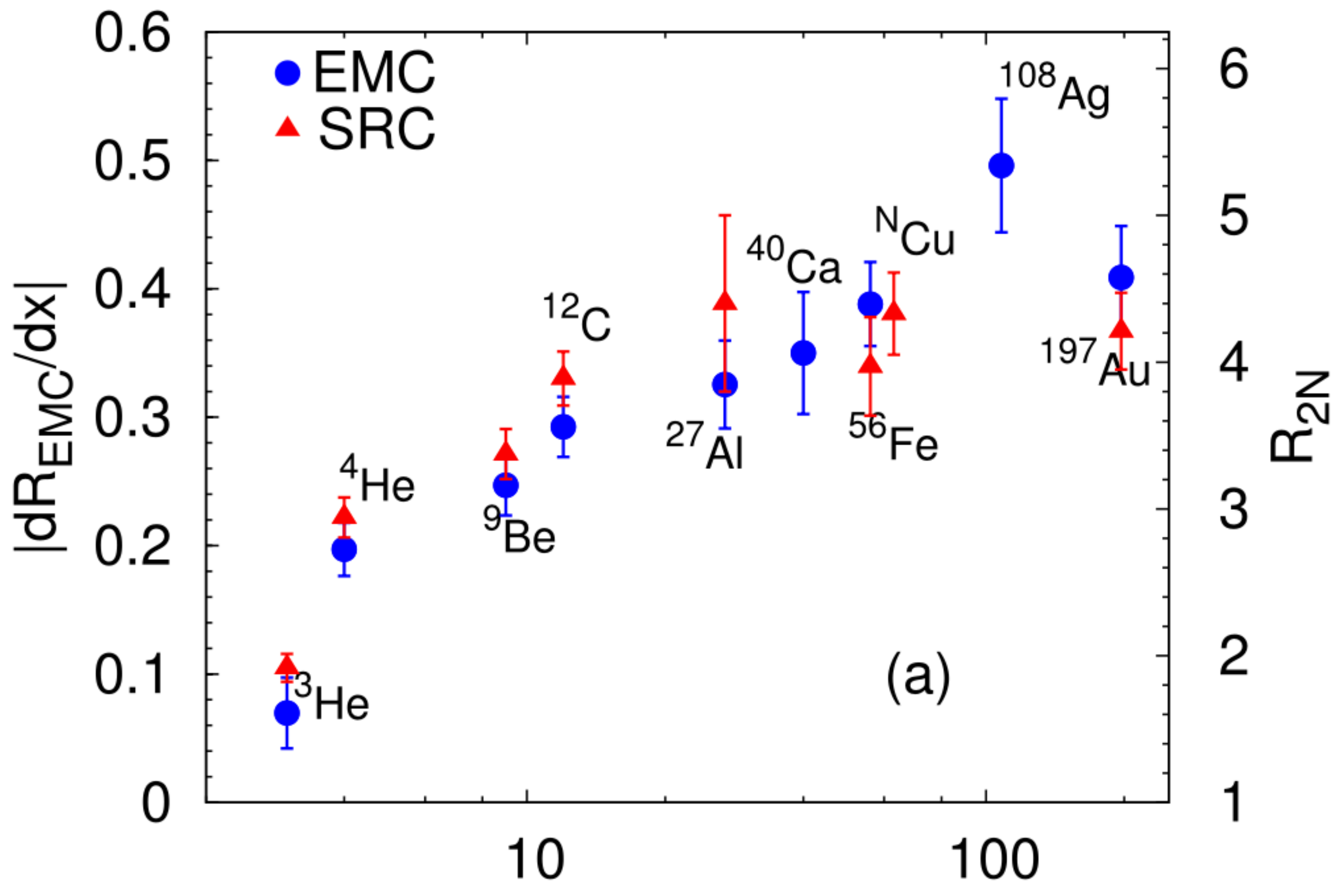


Credit- John Arrington

The SRC Connection

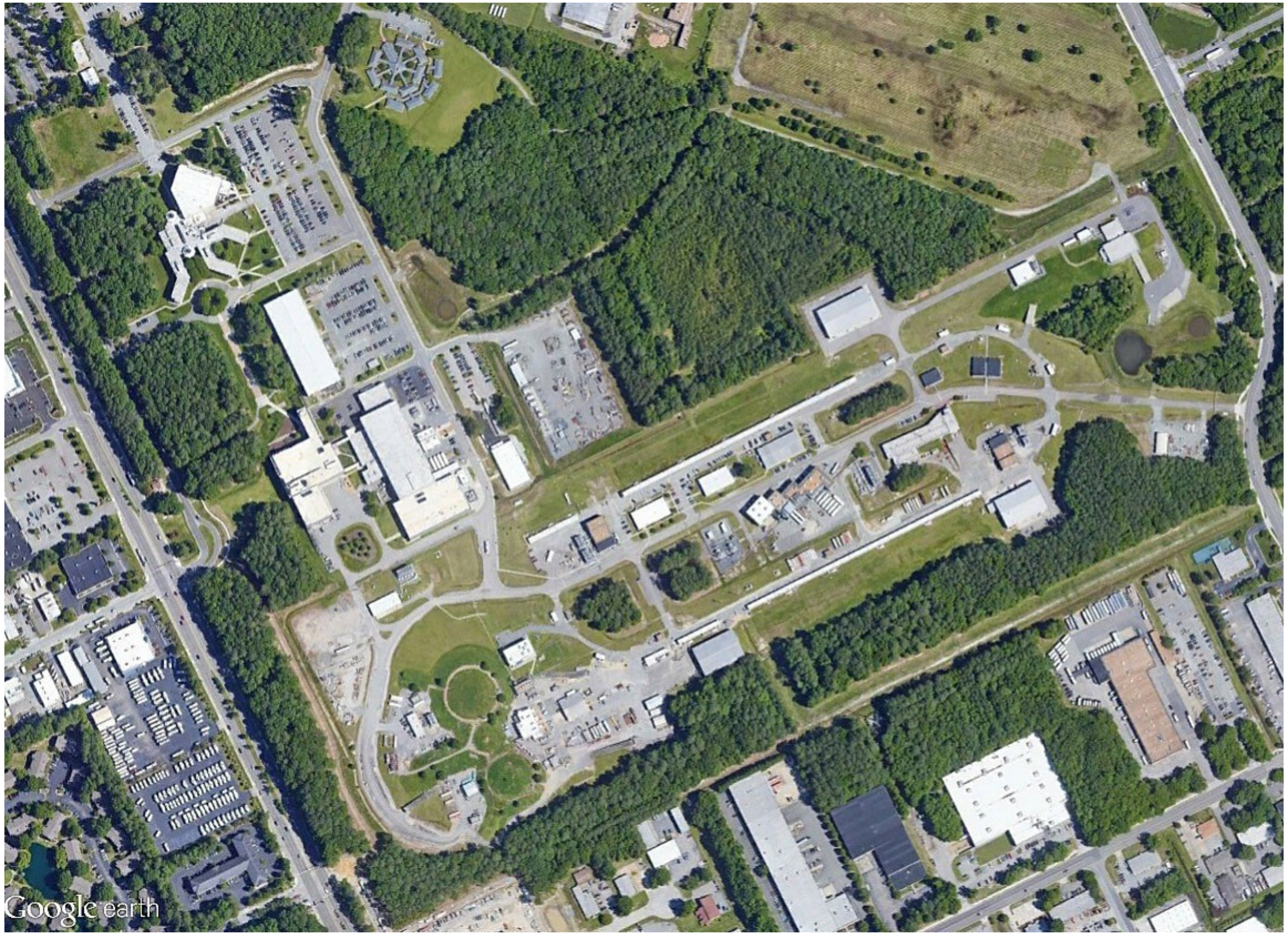


- Short-Range Correlations: Pairs of nucleons with high back-to-back momenta



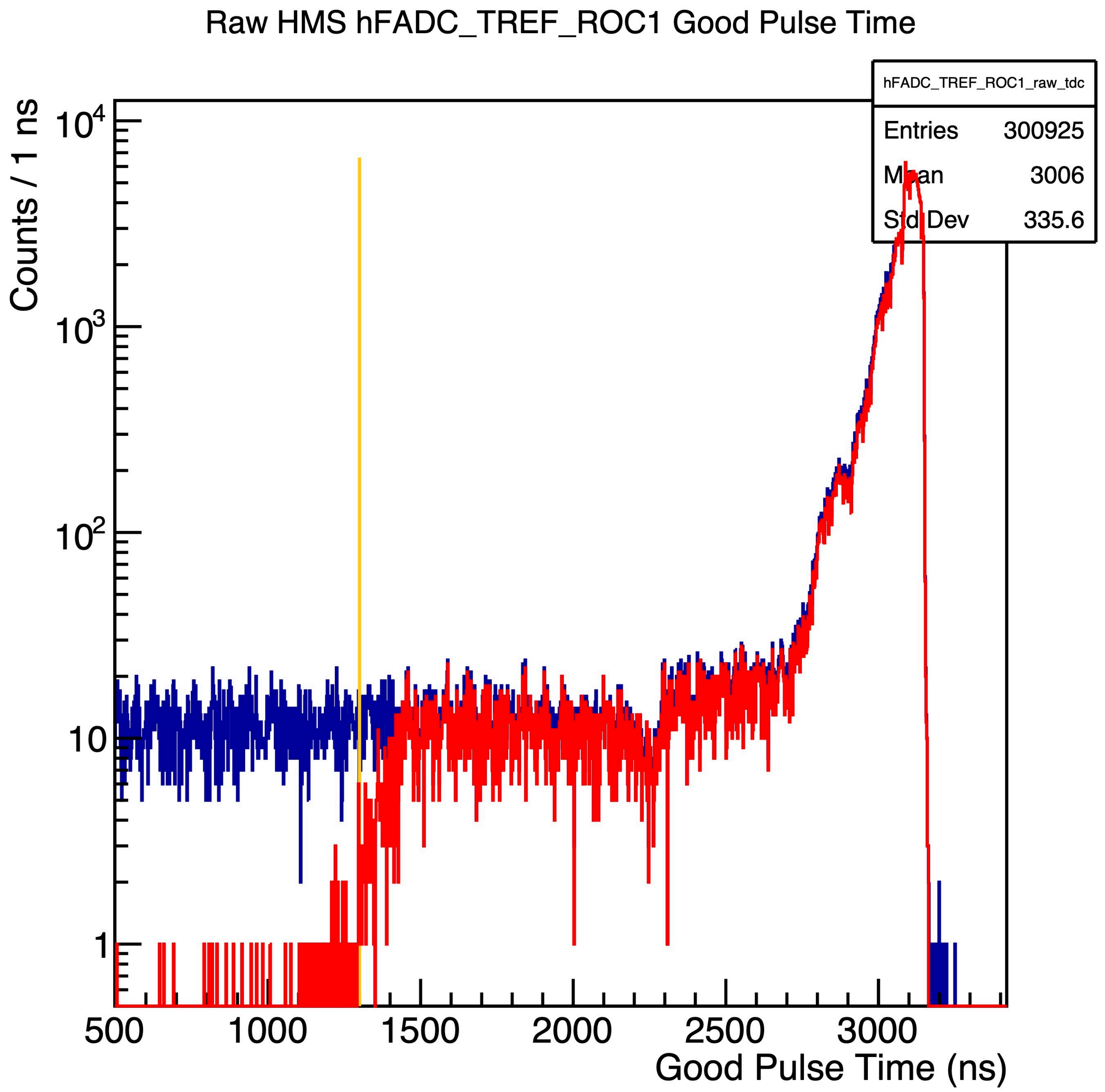
Overview

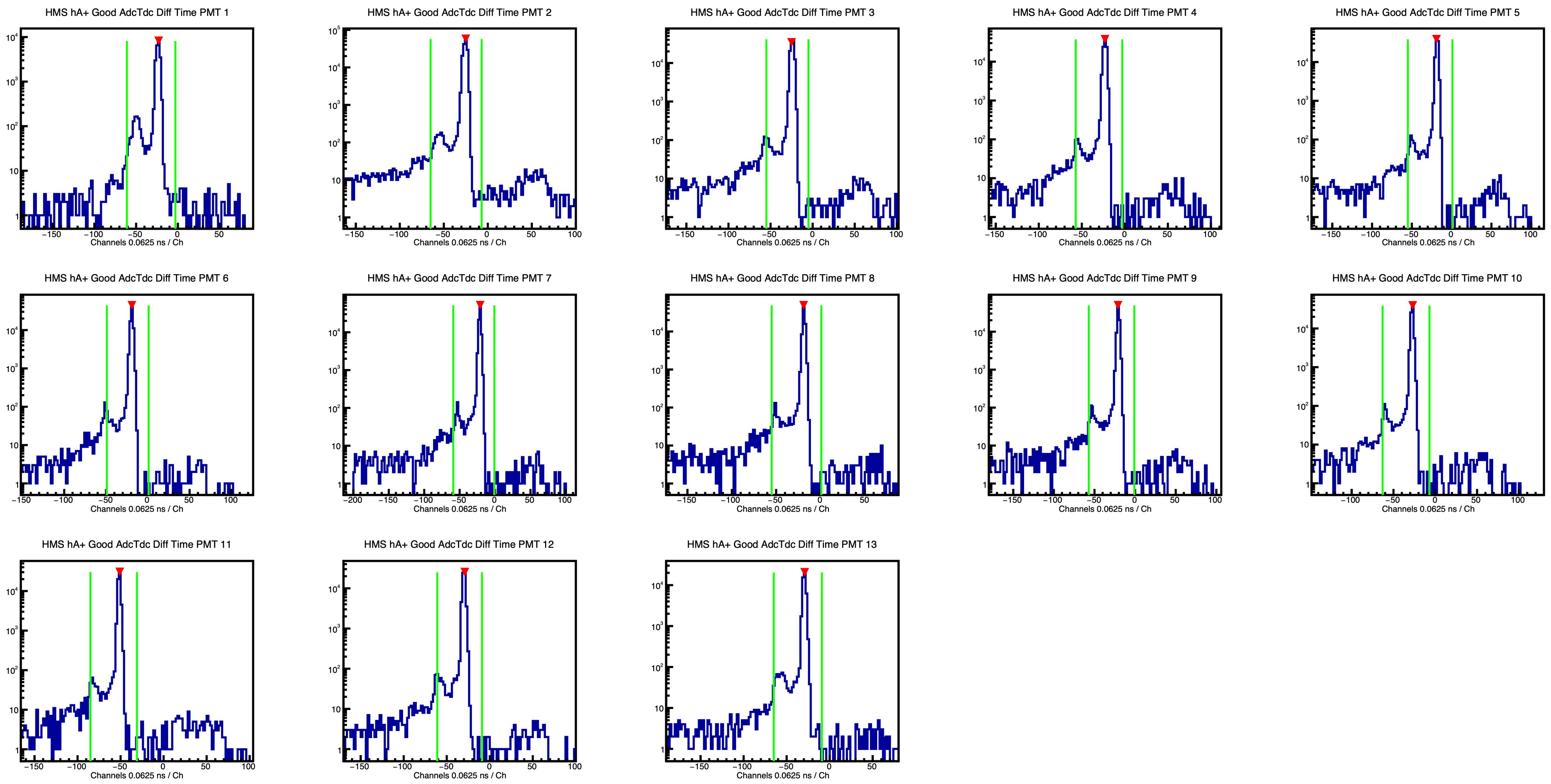
- Overview of E12-10-008
- ***Detector Calibration***
- Preliminary results



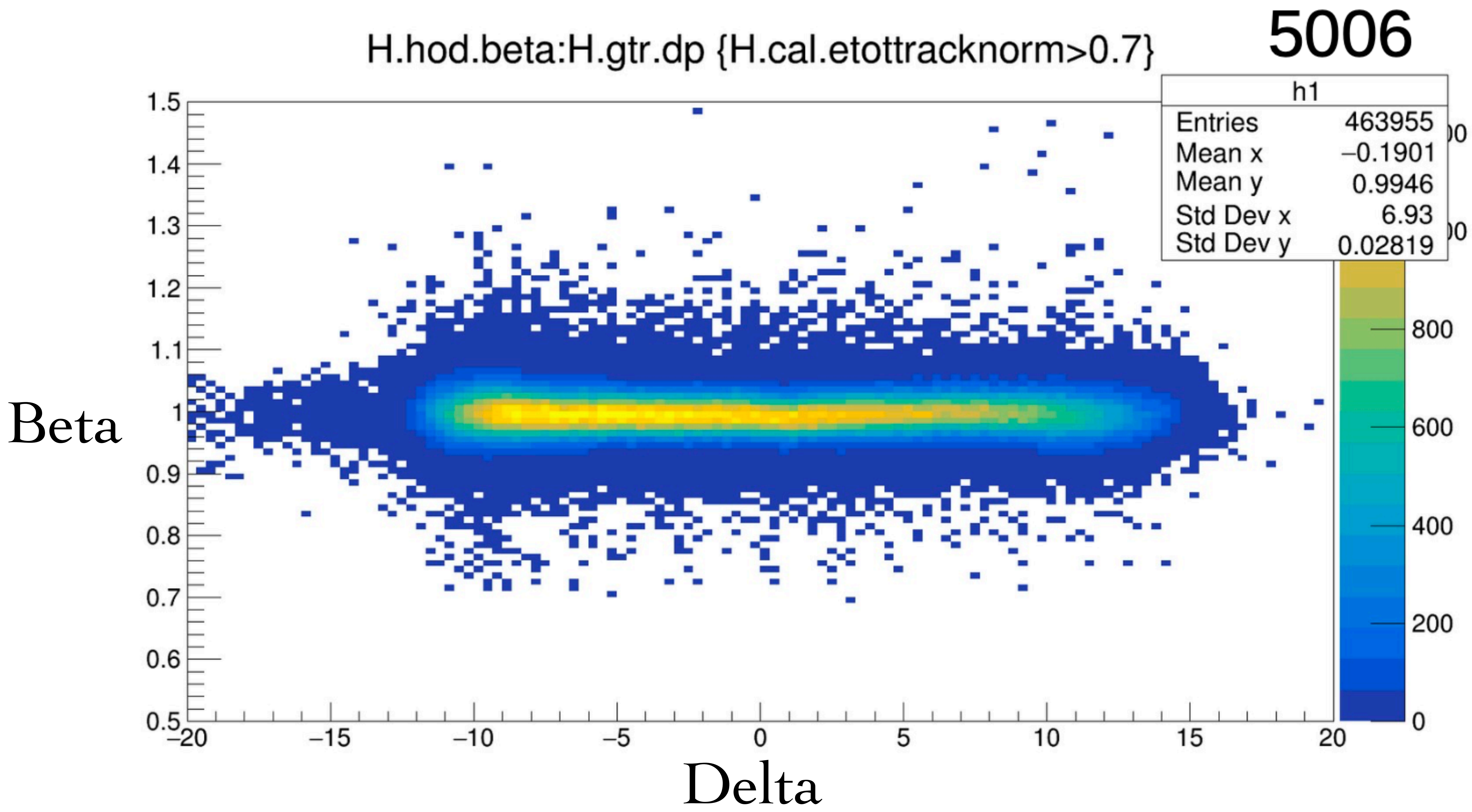
Timing Windows and Reference Time Cuts

- Cuts made to exclude background events



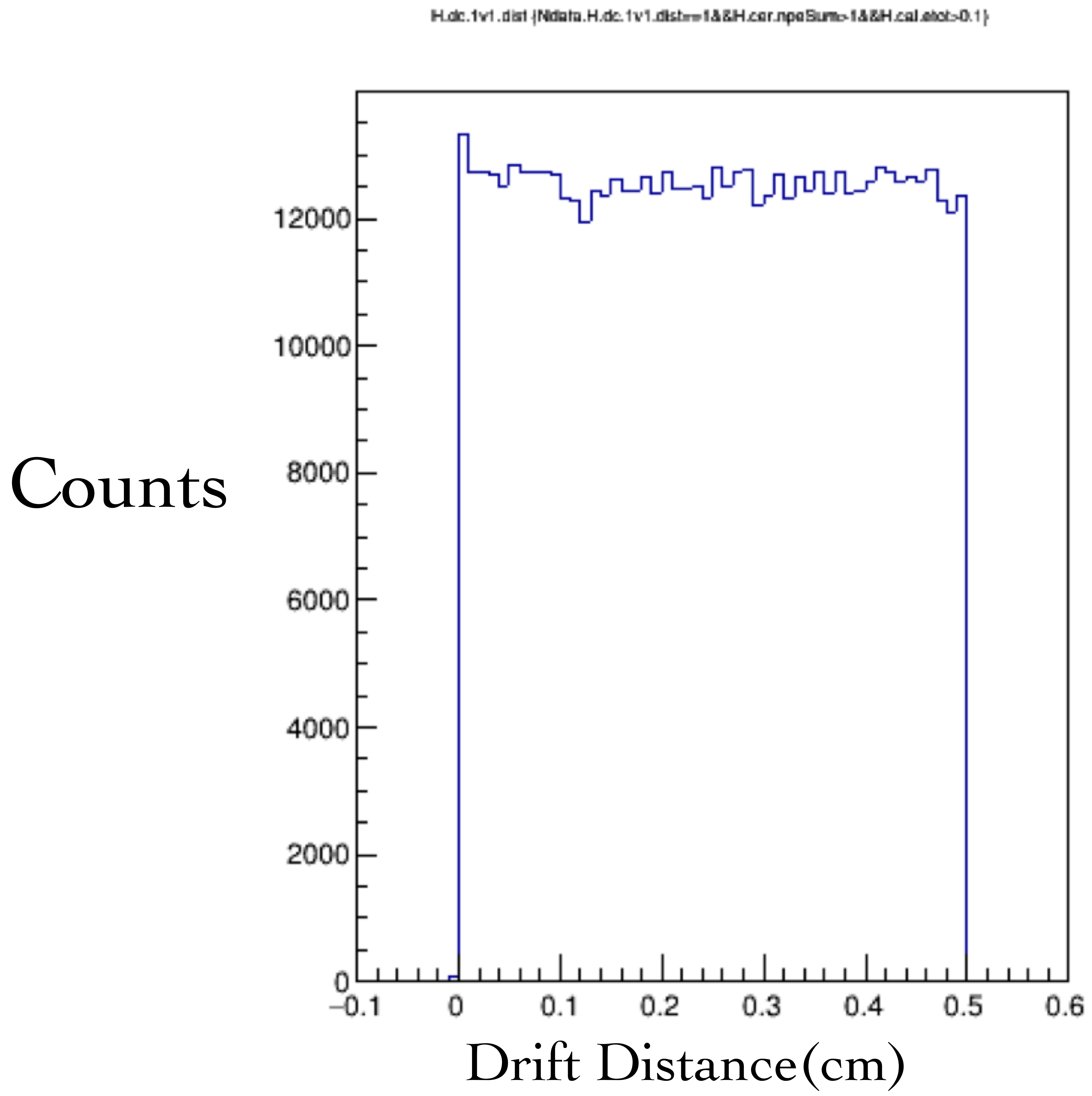


Hodoscope Calibration



Courtesy of Cameron Cotton

Drift Chamber Calibration

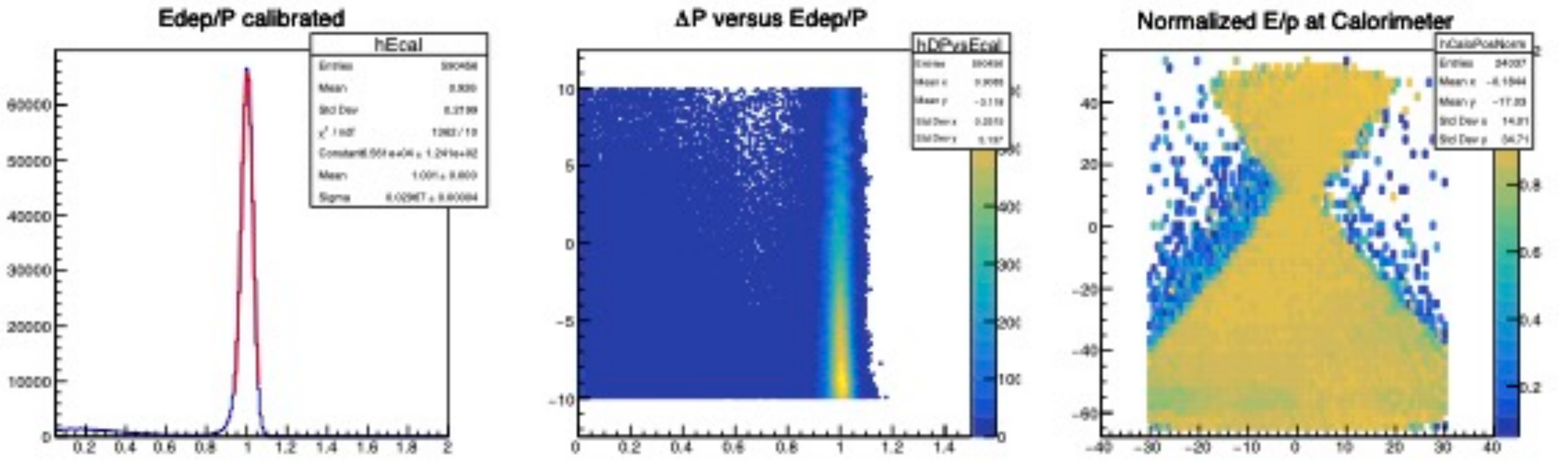


Courtesy of Cameron Cotton

HMS Calorimeter Calibration

- Calorimeter calibrated by varying gain correction for blocks to keep output signals of the same size

- The calibration produces a set of gain constants. Each corresponding to a PMT.

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; Calibration constants for file hms_replay_cal_4402_-1.root, 763785 events processed

;fDeltaMin  fDeltaMax   fBetaMin fBetaMax       fLoThr   fHiThr
;-10    10       0.5      1.5      0.865631       1.03143
hcal_pos_gain_cor= 15.18,  6.41,  8.83, 10.45, 12.98, 12.76, 12.21, 12.22,  9.66, 16.29, 15.81, 13.43,  9.85,
                   10.53, 12.43,  7.86, 15.26,  8.65,  5.54,  7.19,  7.79,  8.80, 12.15, 11.31, 12.28, 12.31,
                   25.29, 14.68, 19.57, 24.81, 18.33, 21.14, 26.86, 22.31, 24.10, 26.40, 19.38, 23.02, 21.33,
                   33.98, 18.51, 22.78, 19.90, 20.27, 21.05, 23.09, 19.51, 22.85, 23.78, 20.92, 22.53, 26.62,
hcal_neg_gain_cor= 15.83, 16.03, 15.51, 12.17, 10.39, 16.17, 16.46, 21.05, 13.74, 12.15, 11.21, 12.08, 16.20,
                   14.65, 14.03, 15.65, 14.38, 16.26, 18.98, 21.23, 18.27, 18.34, 11.49, 17.01, 13.40, 10.85,
                    0.00,  0.00,  0.00,  0.00,  0.00,  0.00,  0.00,  0.00,  0.00,  0.00,  0.00,  0.00,  0.00,
                    0.00,  0.00,  0.00,  0.00,  0.00,  0.00,  0.00,  0.00,  0.00,  0.00,  0.00,  0.00,  0.00,
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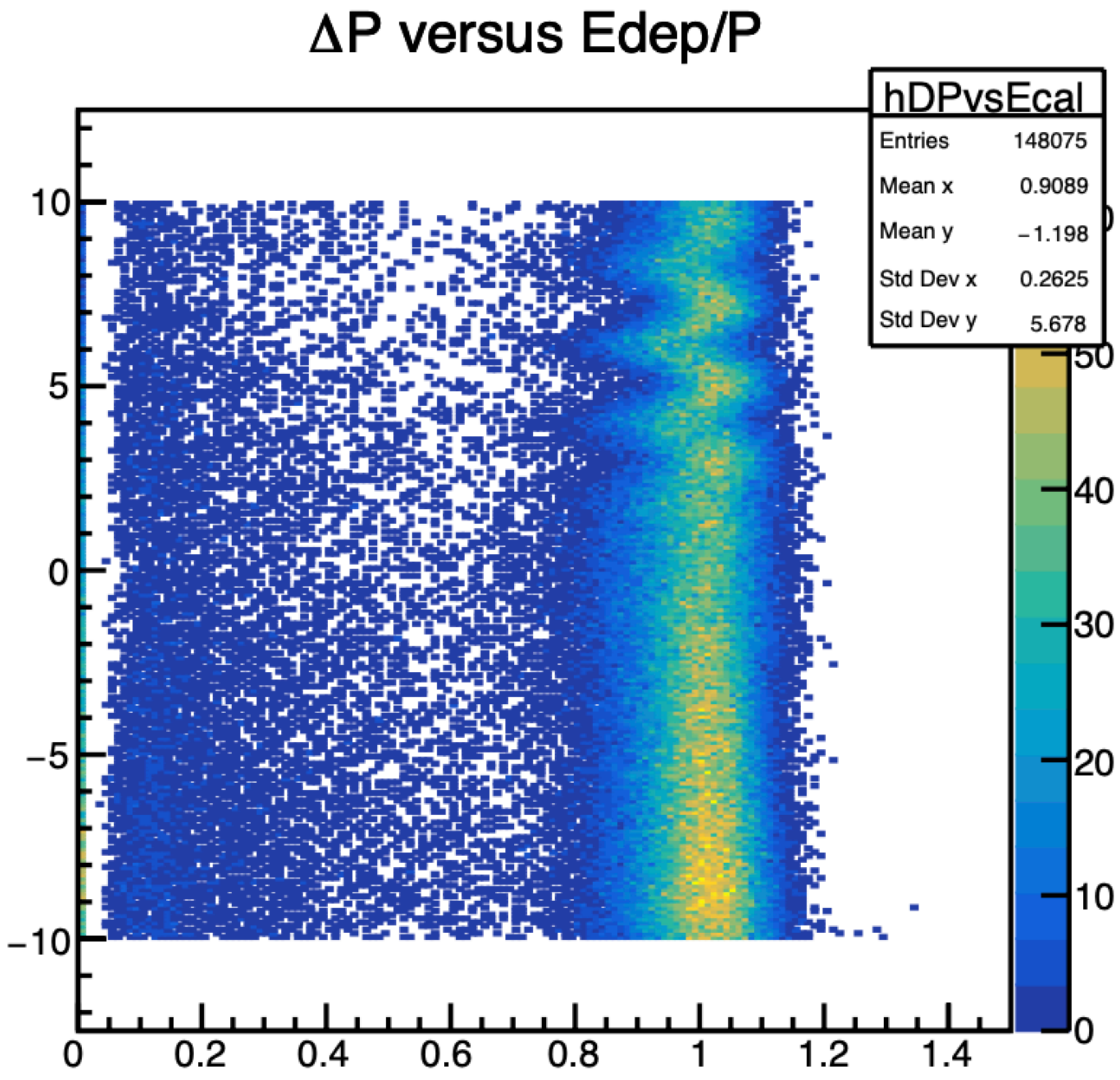
HMS Calorimeter Calibration

- Saw some wiggles
- Electron not firing the particular PMT due to the threshold voltage being too high
- Is a known issue for the HMS
- Not a big problem for our data

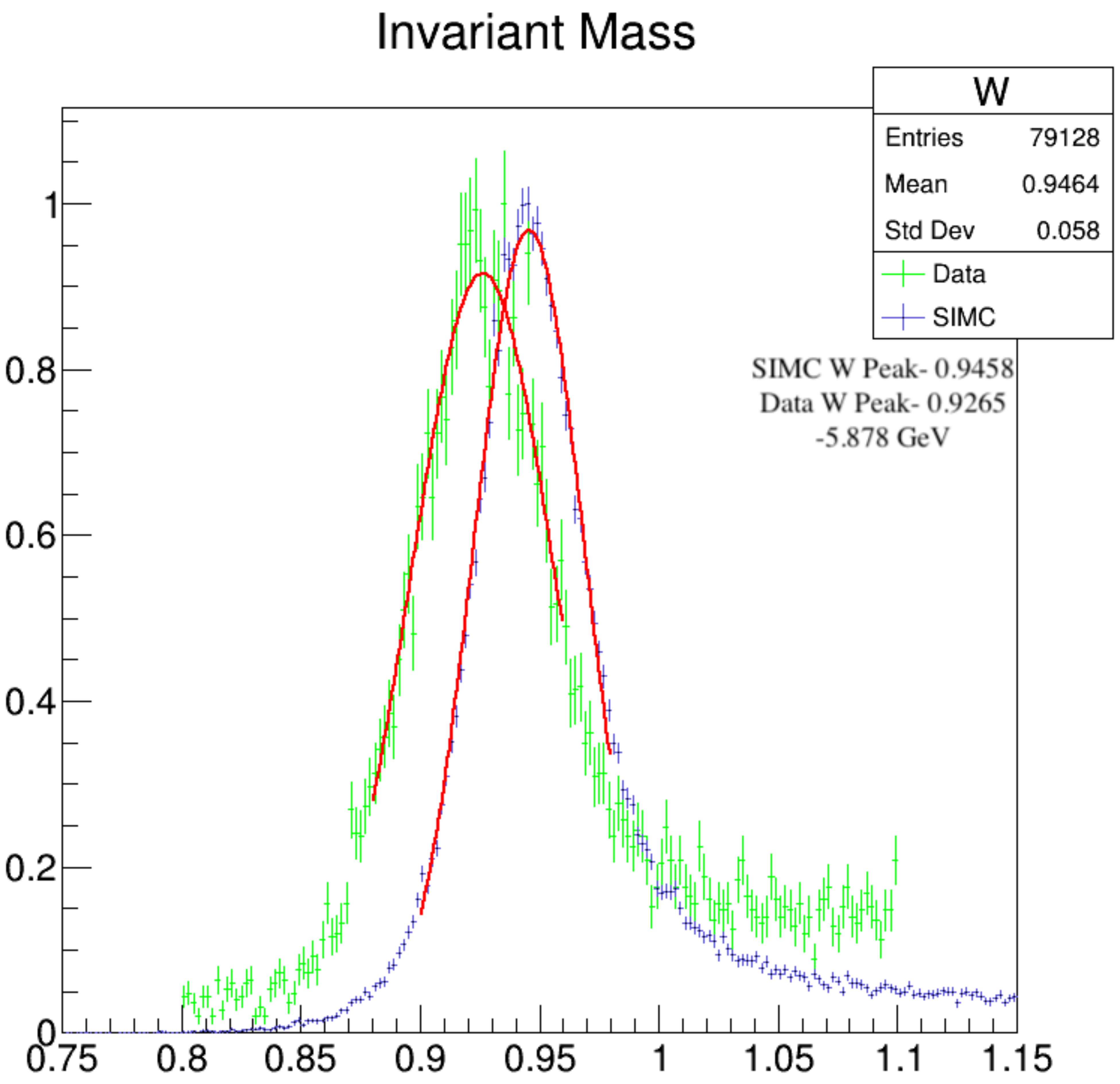


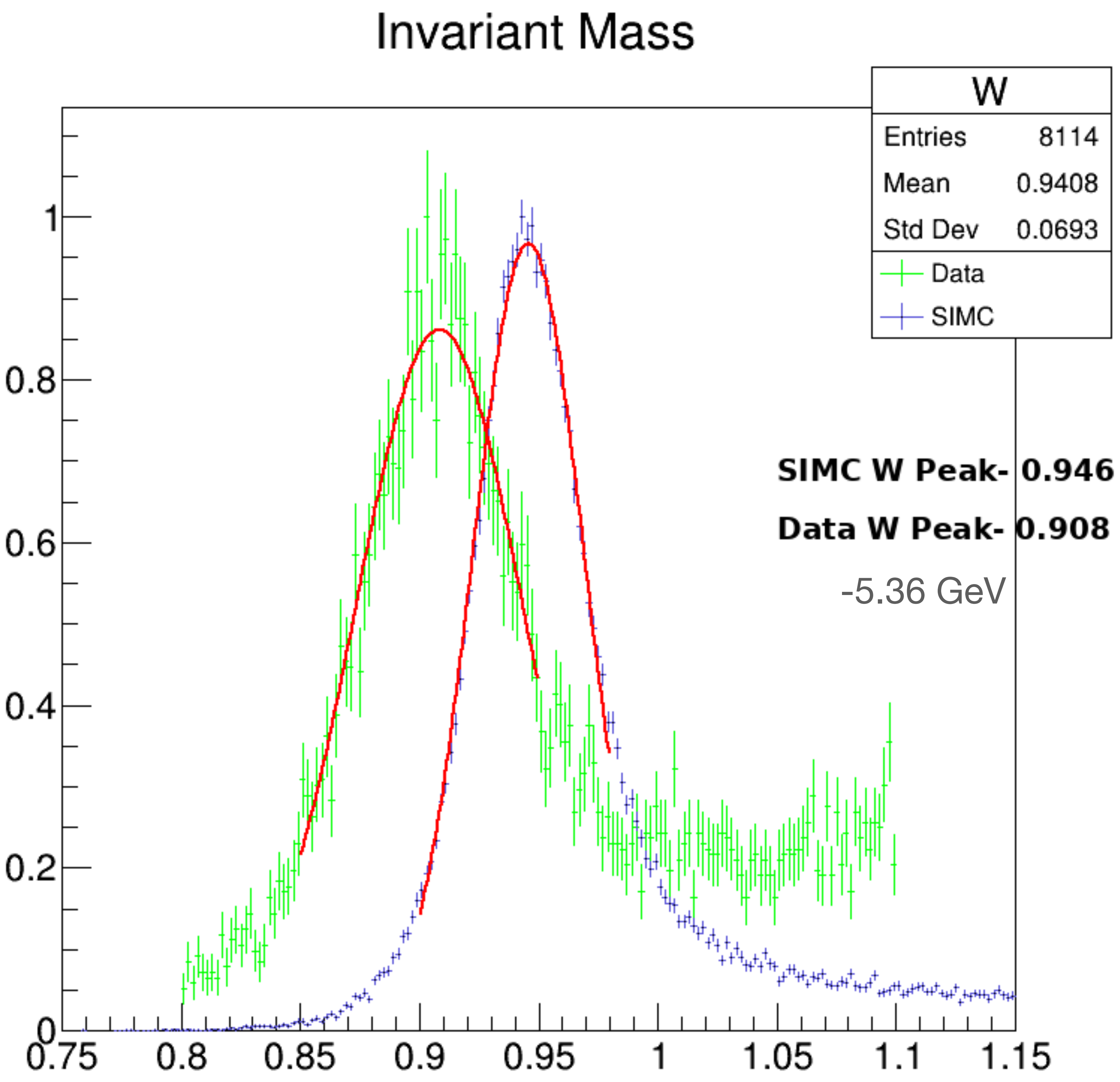
HMS Calorimeter Calibration

- A single set of gain constants don't work for the whole dataset
- Not obvious why

Credit- Penny Sofia Duran (UA)

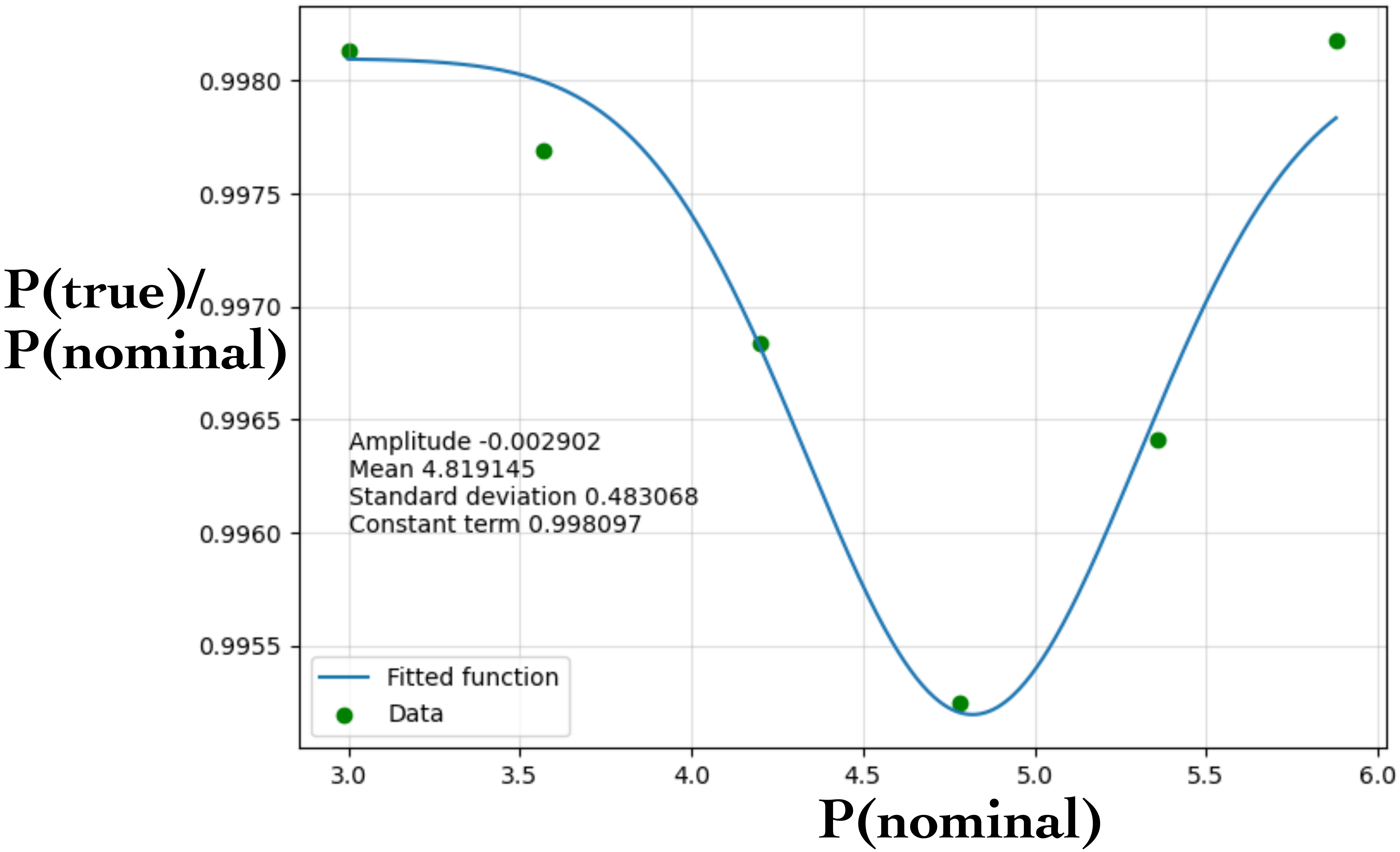
HMS Momentum offset





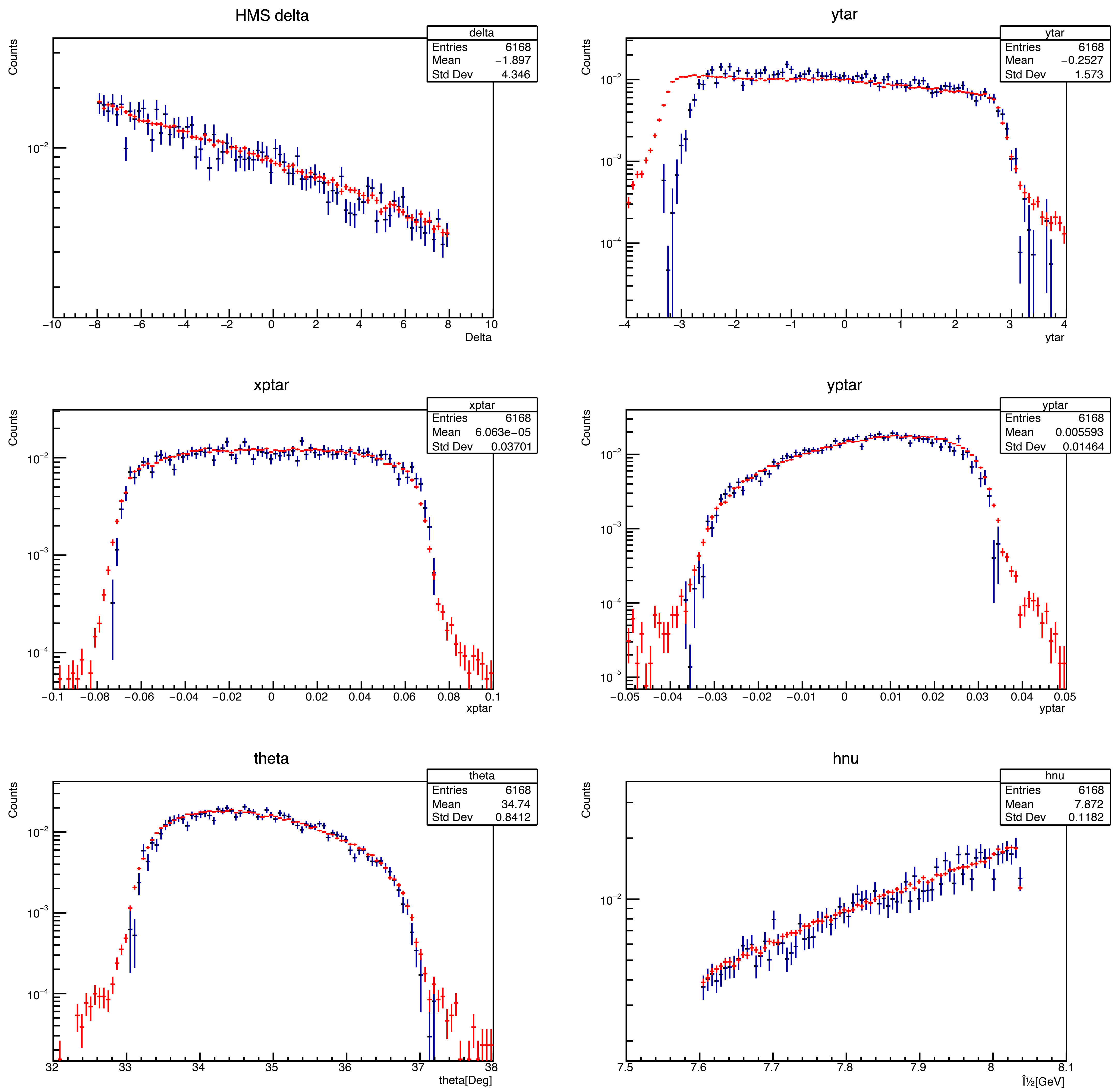
HMS Momentum offset

- Gaussian fitted



Data to Simulation Comparison

- Simulation: Single-arm Monte Carlo
- Simulation agrees well with the data
- Deuterium target, -2.72 GeV@35°



Overview

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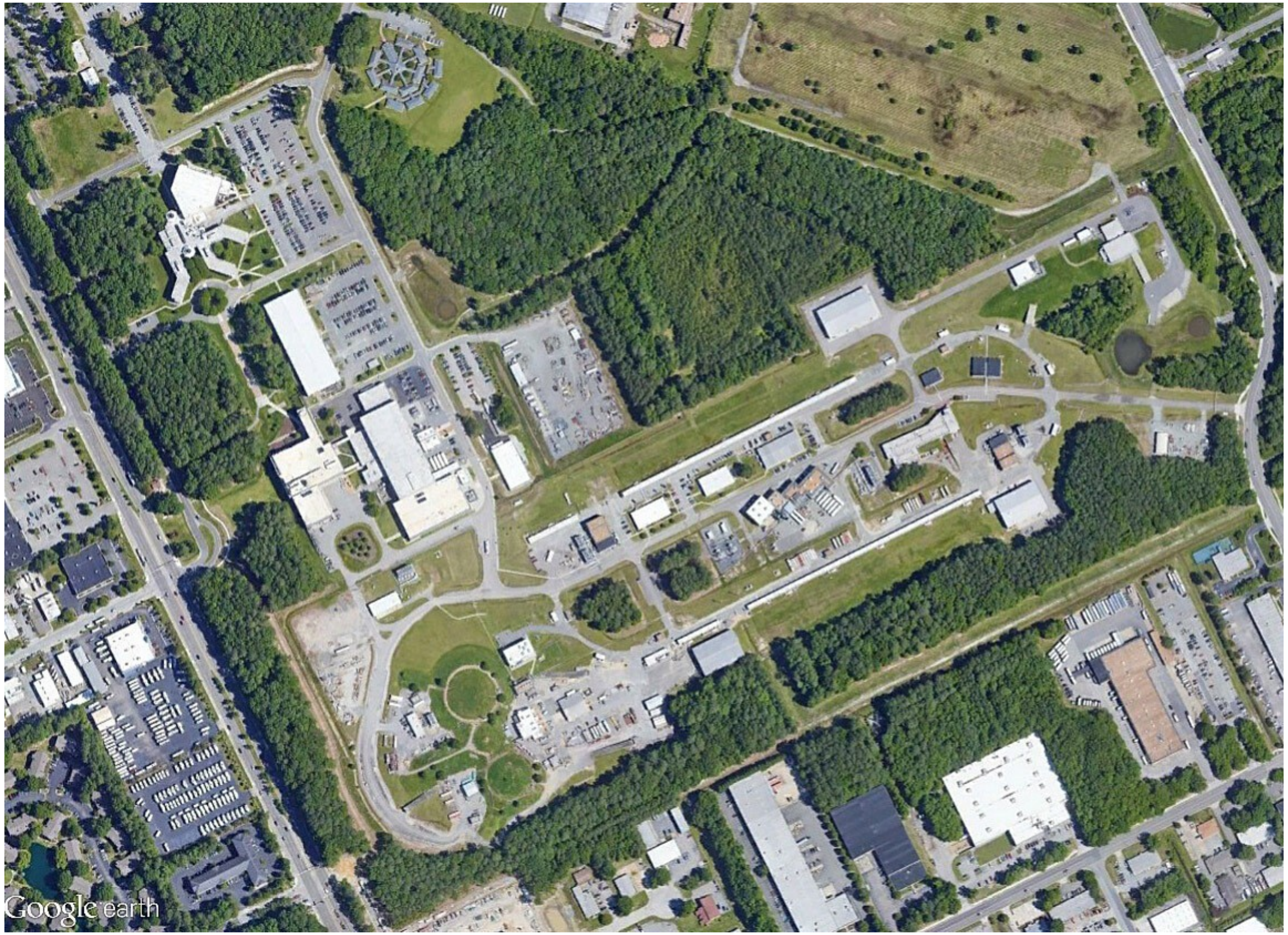
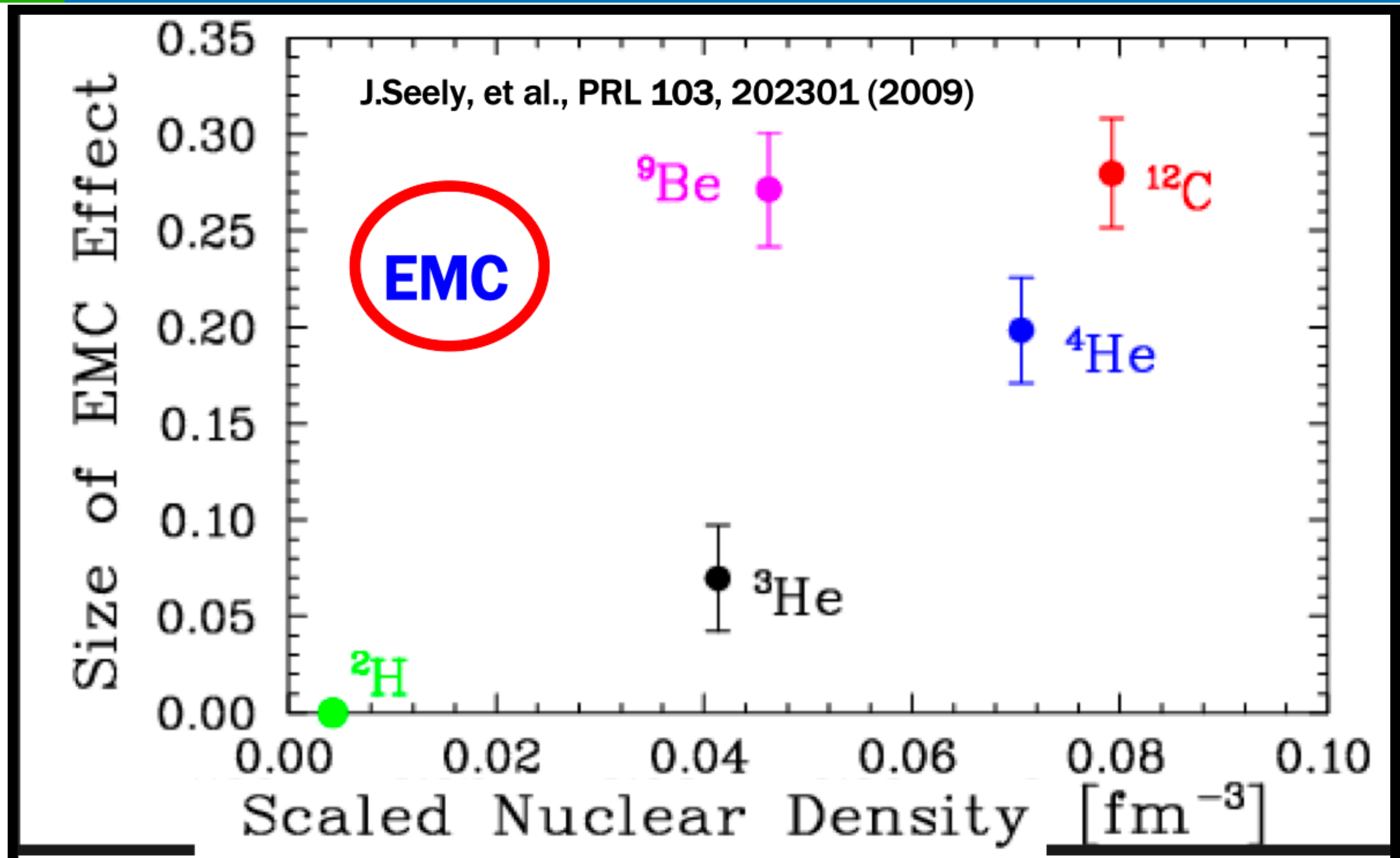
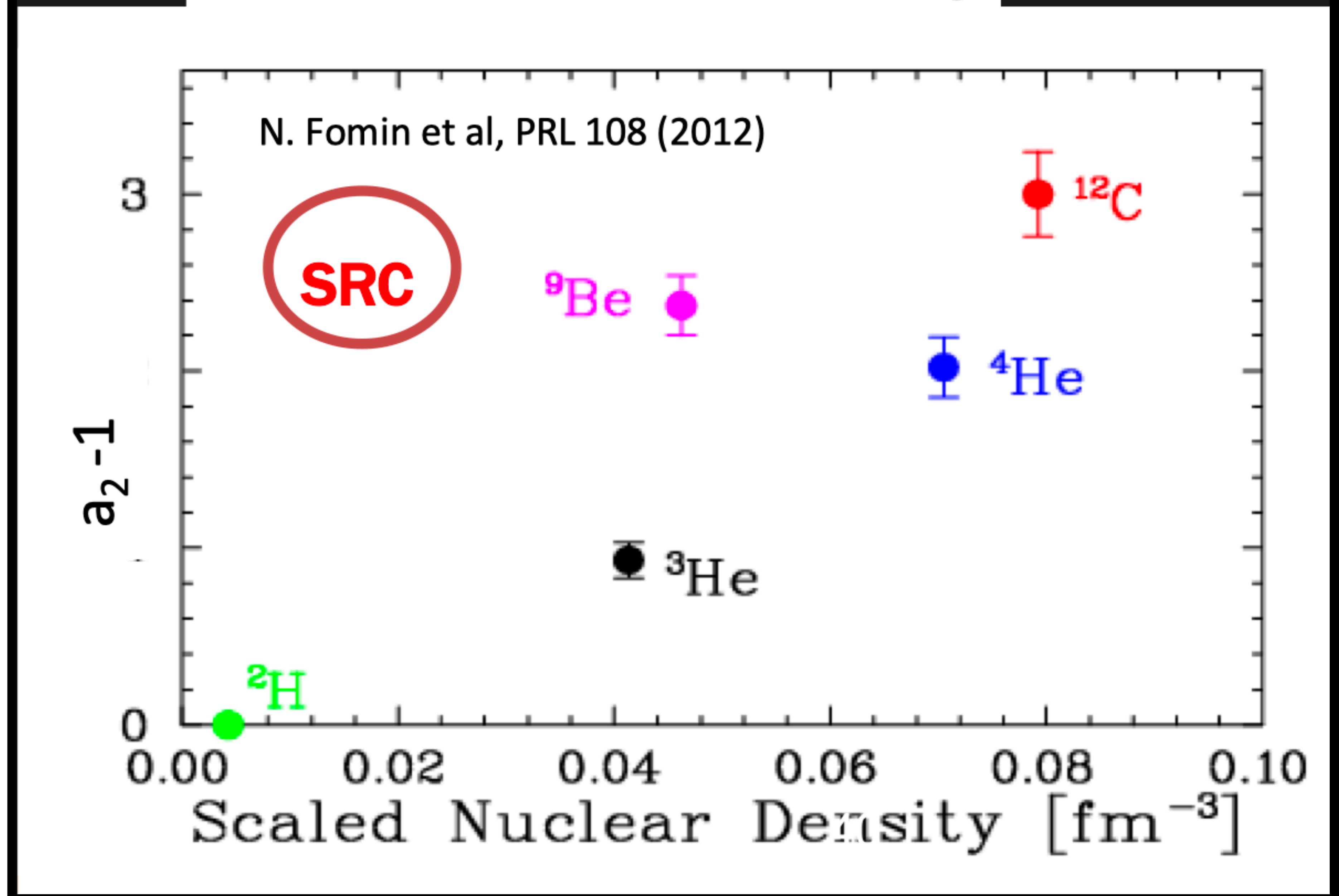
- Detector Calibrations
- ***Preliminary results***



Results from the 6 GeV era (XEM)

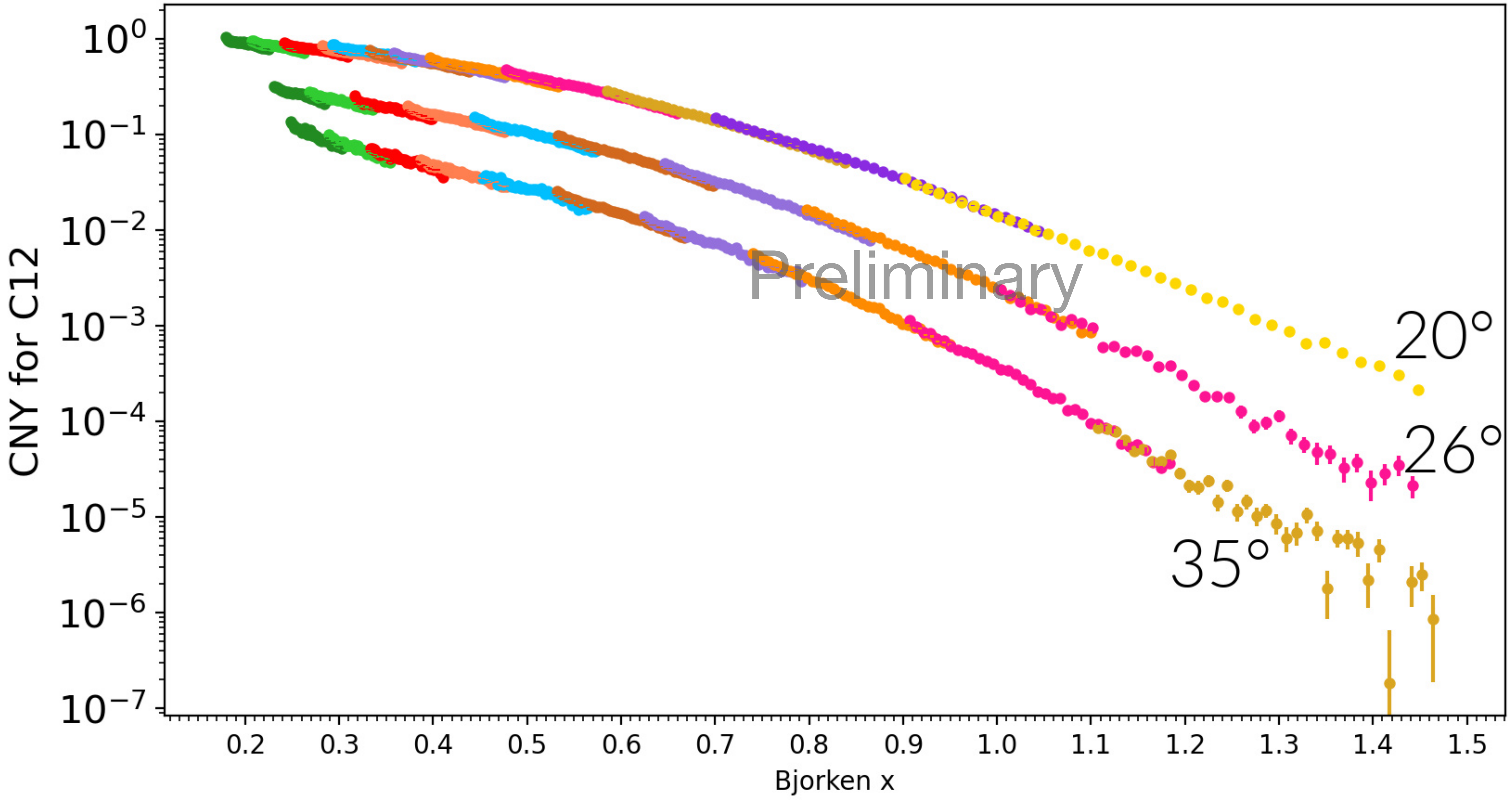
- Ran in Hall C@JLab in 2004
- EMC Effect and SRCs closely correlated
- This experiment will add much more data





Charge Normalized Yield vs Bjorken-x

- CNY vs x at different angles
- Excellent Statistics



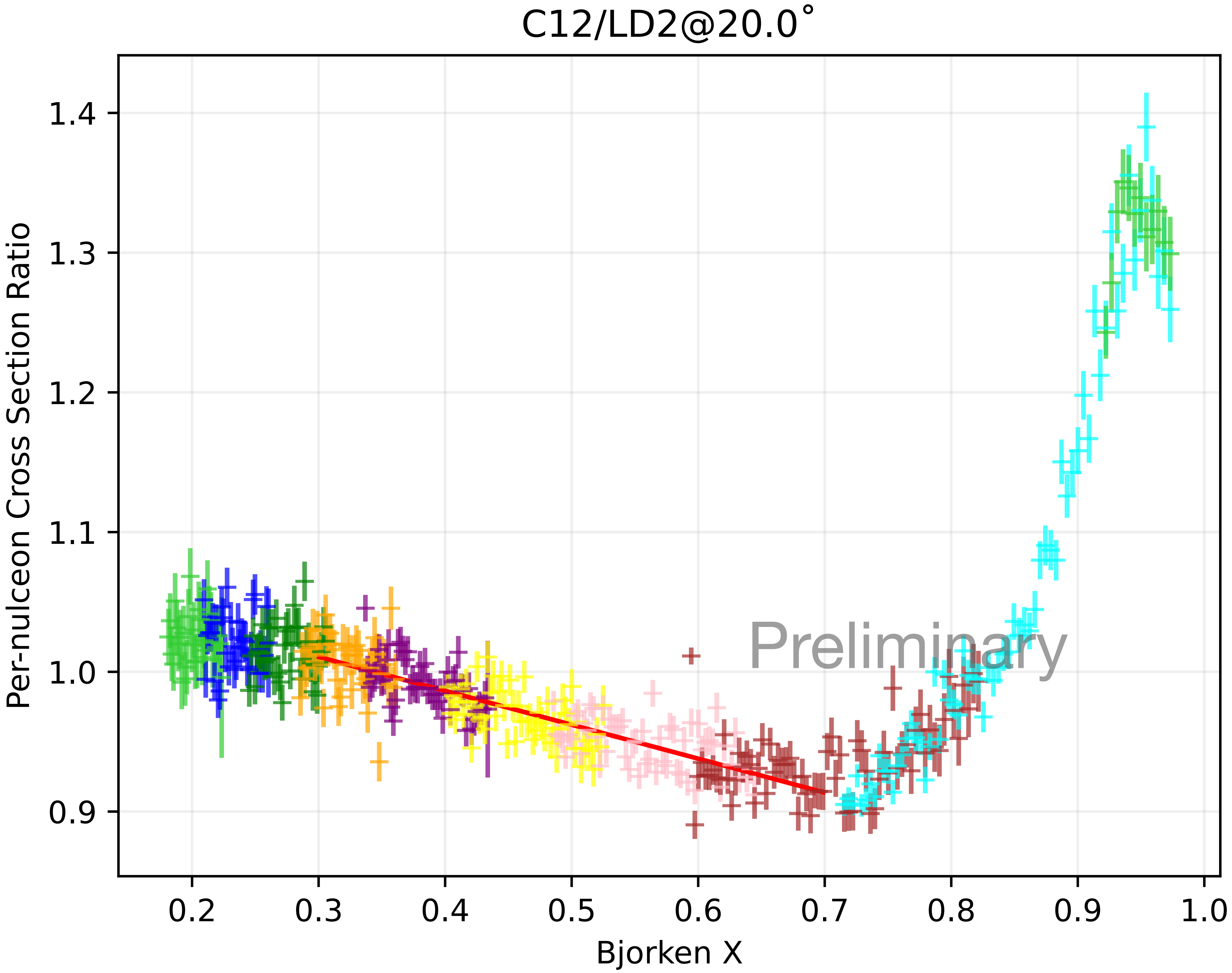
	20°	26°	35°
Q^2 at x=0.5	6	7	8

How preliminary are they?

- Only a single pass of calibrations for the detectors has been finished
- Some corrections for offset and detector efficiency are yet to be implemented
- Iteration of the cross section model is required to account for radiative corrections
- Data quality check is in progress

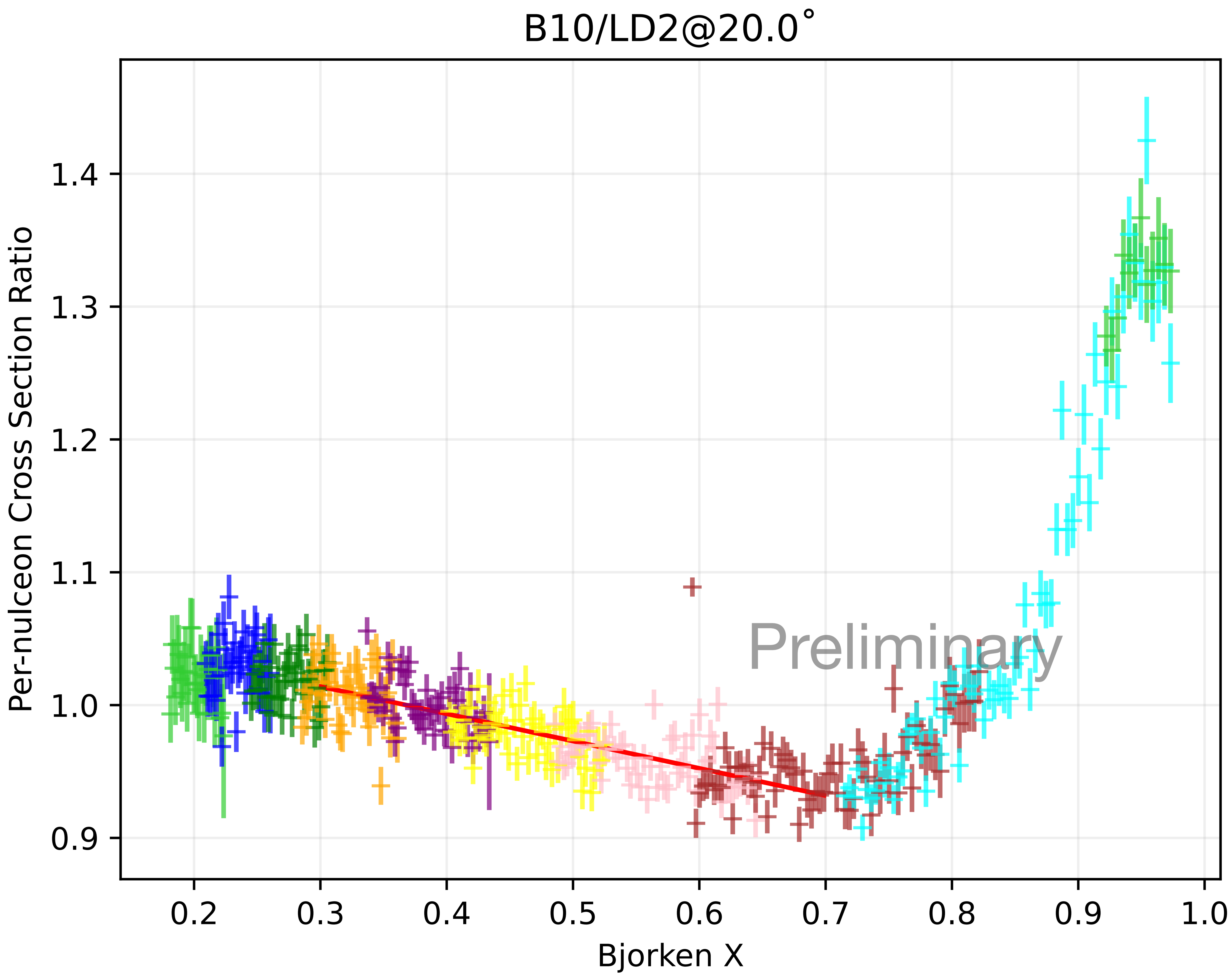
EMC effect- Carbon

- Only statistical uncertainties shown
- Each color represents data at a particular central momentum



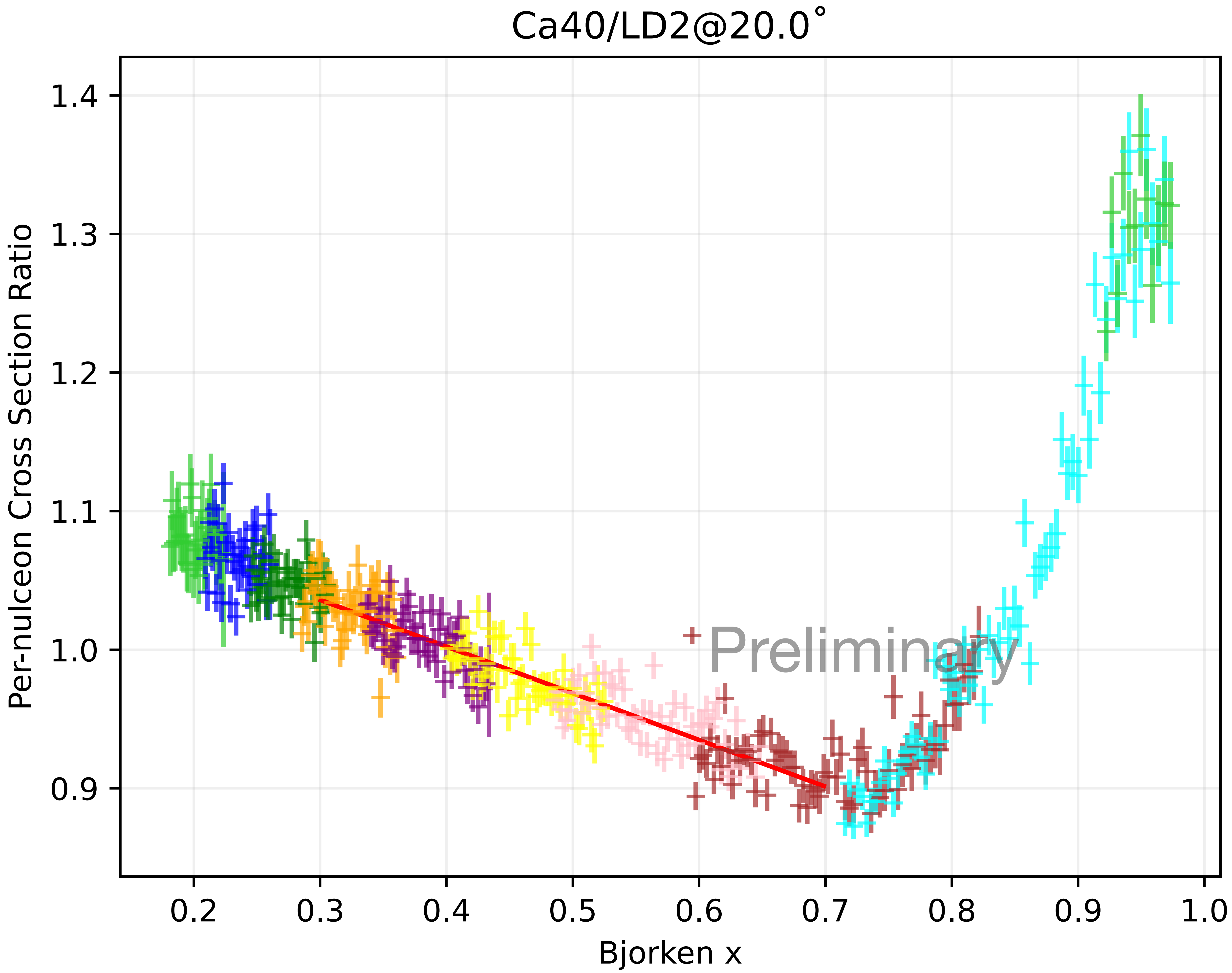
EMC effect- Boron-10

- Only statistical uncertainties shown



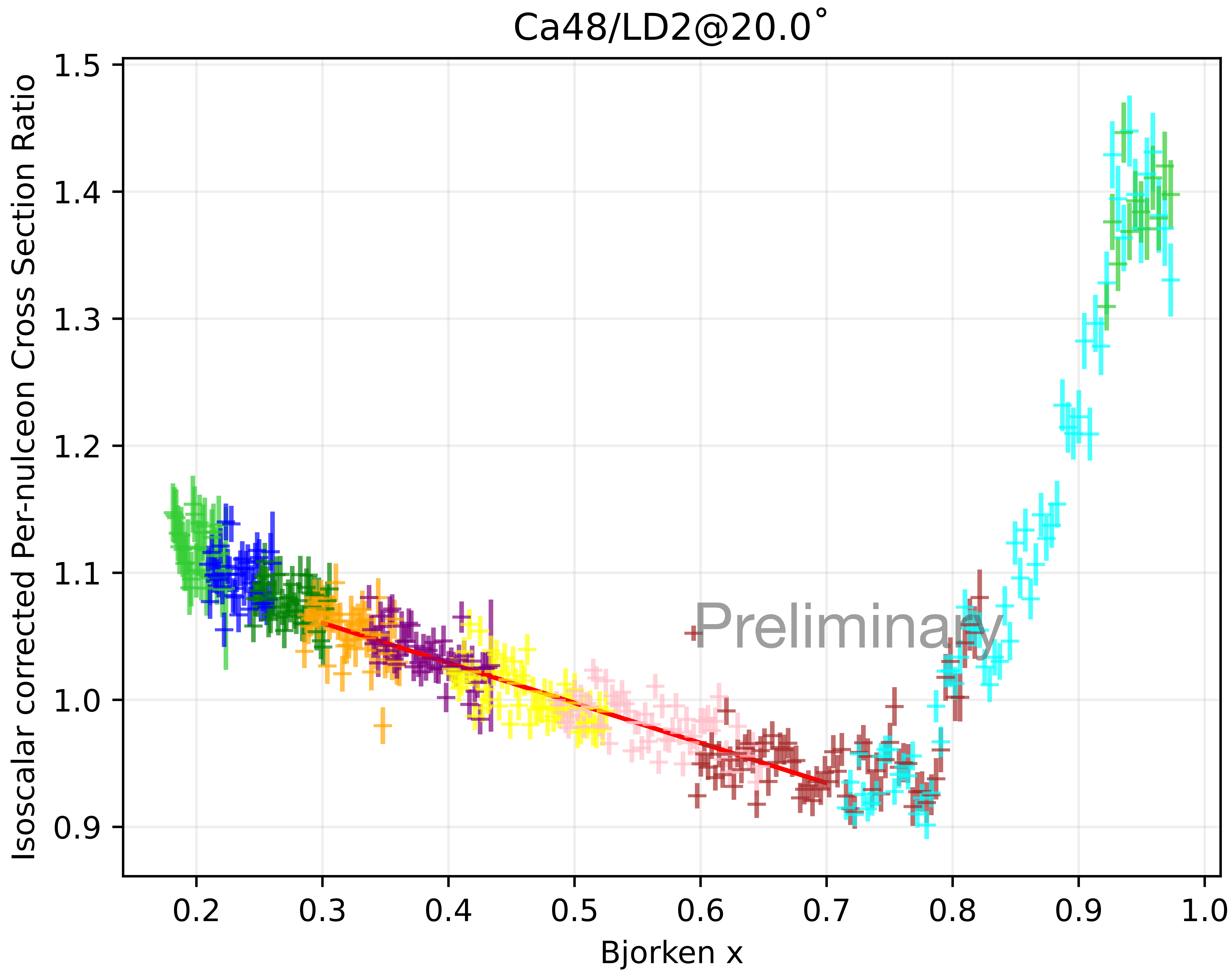
EMC effect- Calcium-40

- Only statistical uncertainties shown



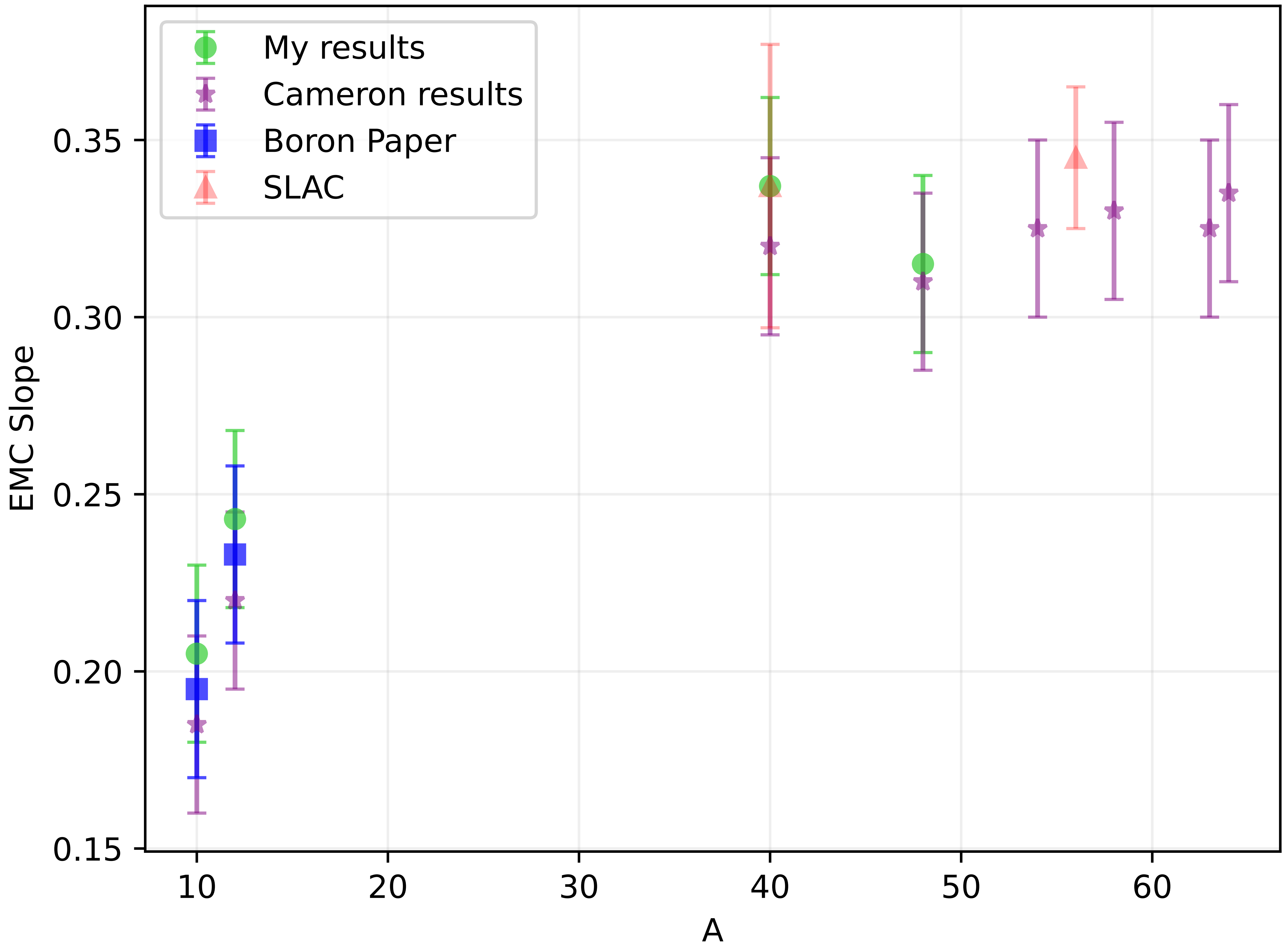
EMC Effect- Calcium-48

- Only statistical uncertainties shown



Comparison with existing data

- Error bars are estimated



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 $^{3}He/(^{2}H+^{1}H)$ without relying heavily on large isoscalar corrections
- We have some results and much more to come

Acknowledgement

Spokespeople and Senior Collaborators:

John Arrington(LBL), Nadia Fomin(UTK) & Dave Gaskell(JLab)

Postdocs:

Burcu Duran(UTK) & Tyler Hague(LBL)

Graduate Students:

Cameron Cotton (UVA), Ryan Goodman(UTK), Abishek Karki* (MSU), Casey Morean* (UTK), Ramon Ogaz (UTK), Abhyuday Sharda (UTK), Sebastian Vasquez(UCR), Zoe Wolters (UNH)

* = Graduated

Other Collaborators:

Miguel Arratia (UCR), Dipangkar Dutta (MSU), Shujie Li (LBL), Dien Nguyen(UTK), Nathaly Santiesteban (UNH), Xiaochao Zheng (UVA)