

XEM2 EMC Update

Hall C Winter Collaboration Meeting 2025

January 14, 2024

Tyler J. Hague

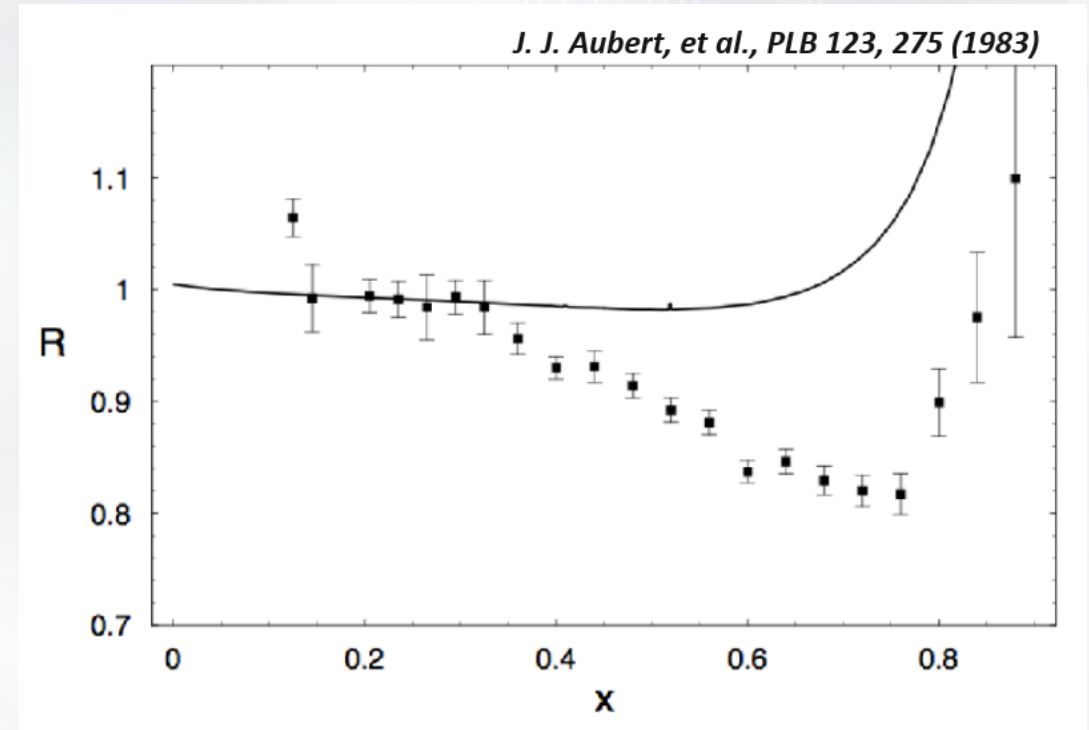
 Jefferson Lab

U.S. Department of
ENERGY



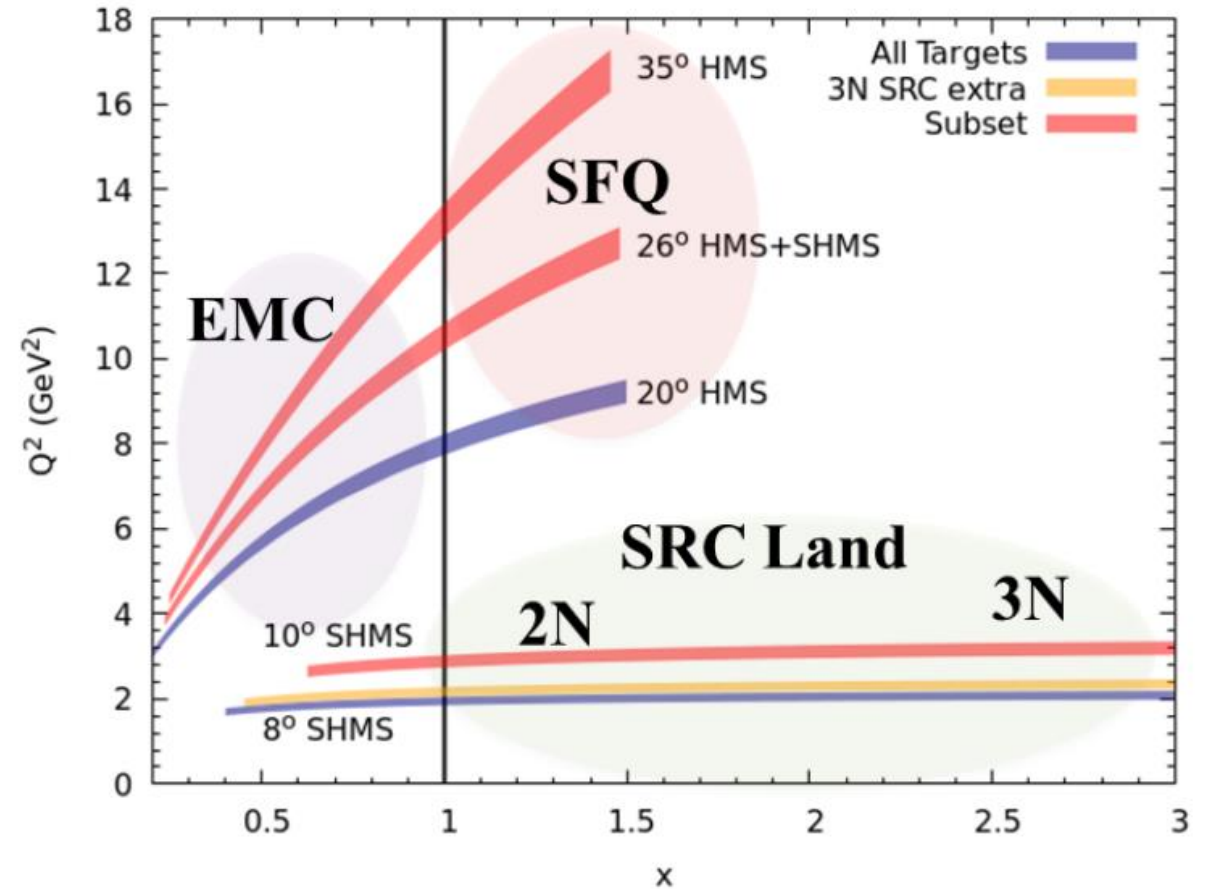
The EMC Effect

- First seen by the European Muon Collaboration (EMC)
 - Assumed that the ratio of two nuclear targets would be unity + Fermi smearing
 - Intended to use this “property” as a check of luminosity
 - When checking this, a stark deviation that couldn't be explained by luminosity was seen
- Kicked off many studies to better characterize this behavior
- The “strength” of the EMC effect is typically described as the slope of the data in the region $0.3 < x < 0.7$

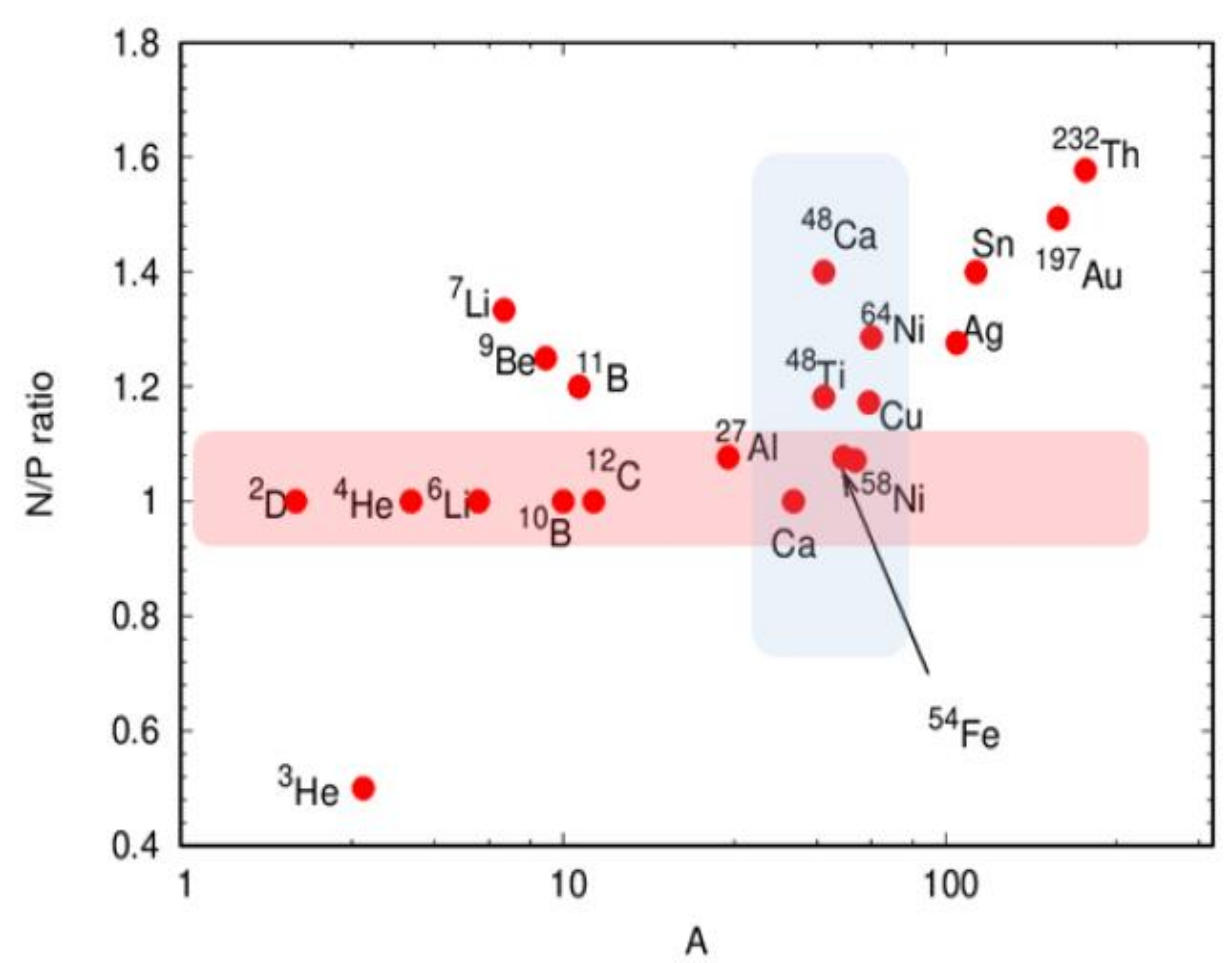
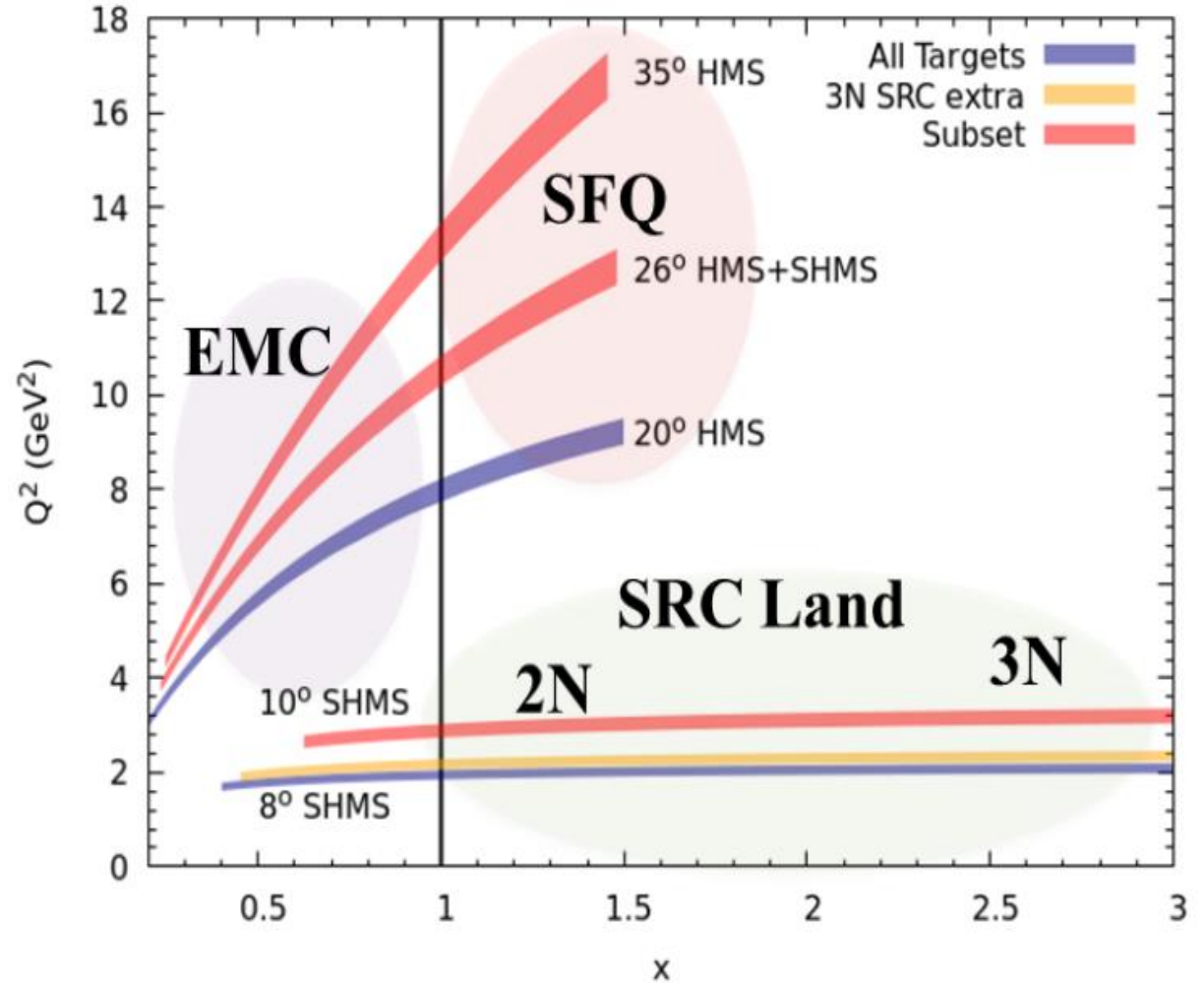


XEM2 Experiments

- E12-06-105: (SHMS)
 - Studies of Short Range Correlations (SRCs)
 - Super fast quarks
 - (See Jordan O’Kronley’s talk prior to this)
- E12-10-008: (HMS)
 - Studies of the EMC effect



Experimental Landscape

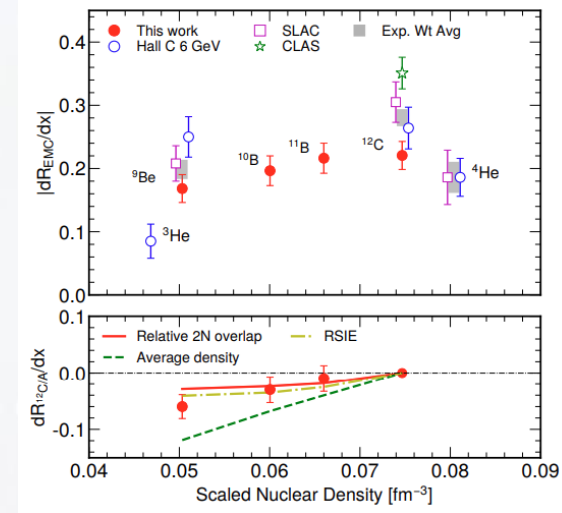
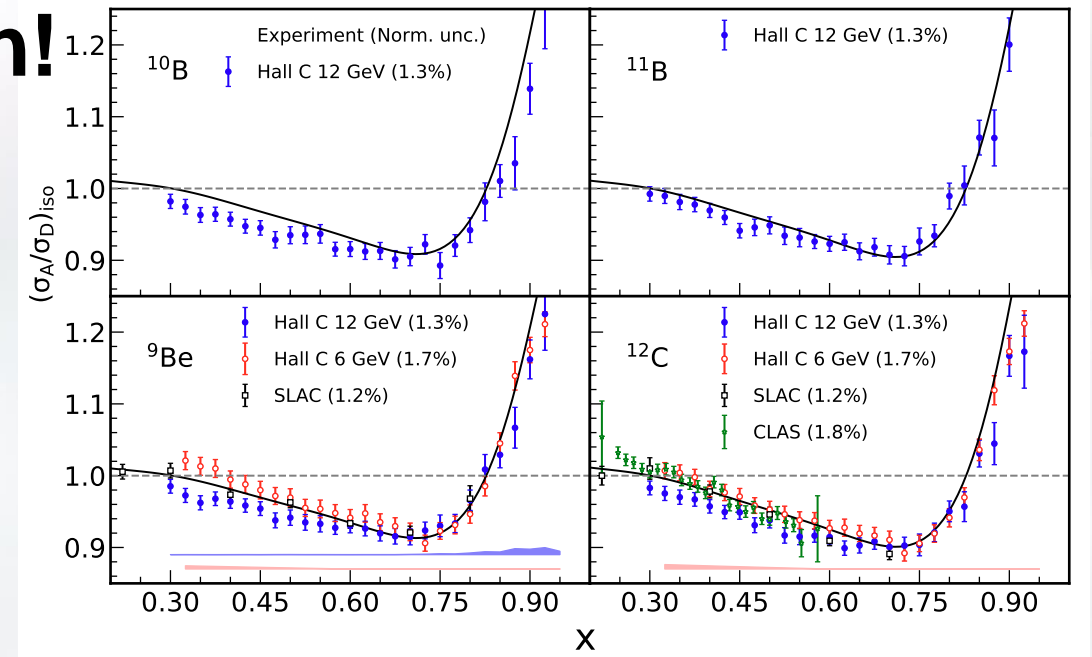


Current Status

- 3 students graduated *so far*
 - Abishek Karki
 - Casey Morean
 - Cameron Cotton
 - *Who's next?*
- 1 Publication from commissioning data
 - A. Karki *et al.* First Measurement of the EMC Effect in ^{10}B and ^{11}B . *Phys. Rev. C* (2023).
- *Lots of analysis underway*

Commissioning Run Publication!

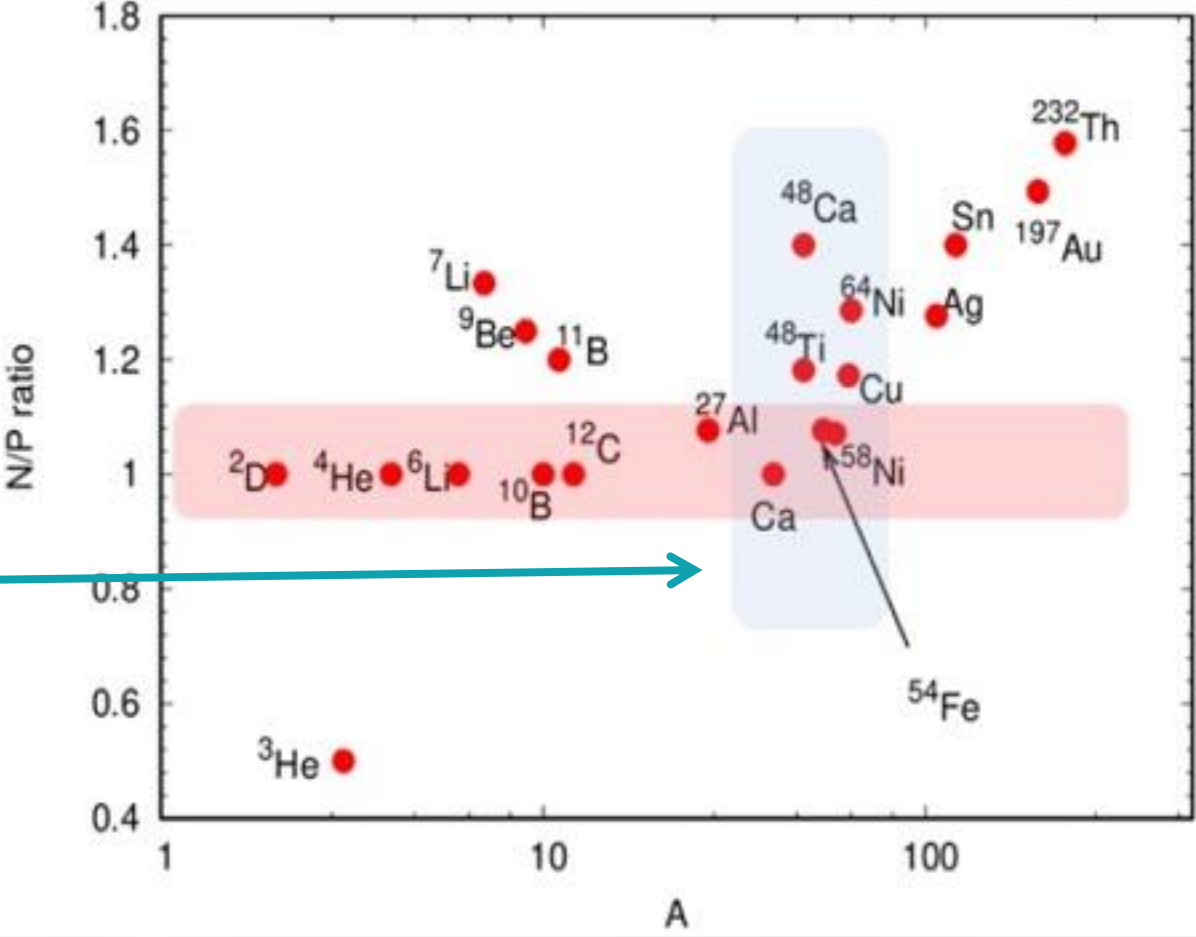
- First study of EMC effect in Boron 10 and 11
- Data recorded with SHMS at 21° with three momentum settings (3.3, 4.1, and 5.0 GeV)
- Carbon and Beryllium have approximately 2σ smaller effect than previous measurements
 - No clear cause at the moment
 - More data coming from production run
 - Beryllium difference at low x may be due to reduced radiated quasi-elastic tail contributions



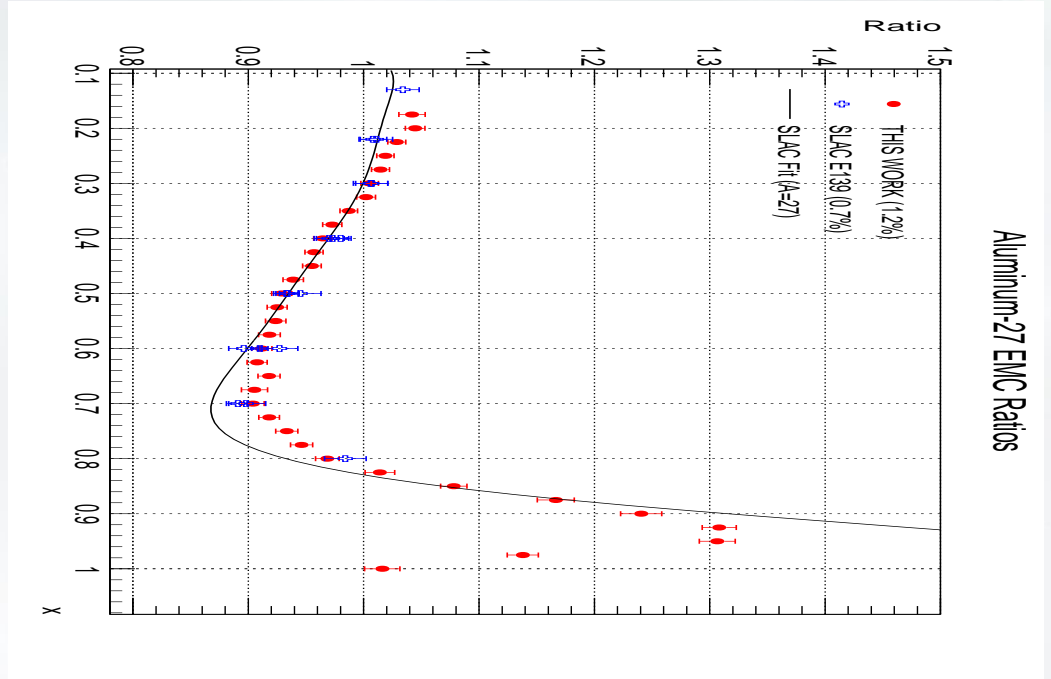
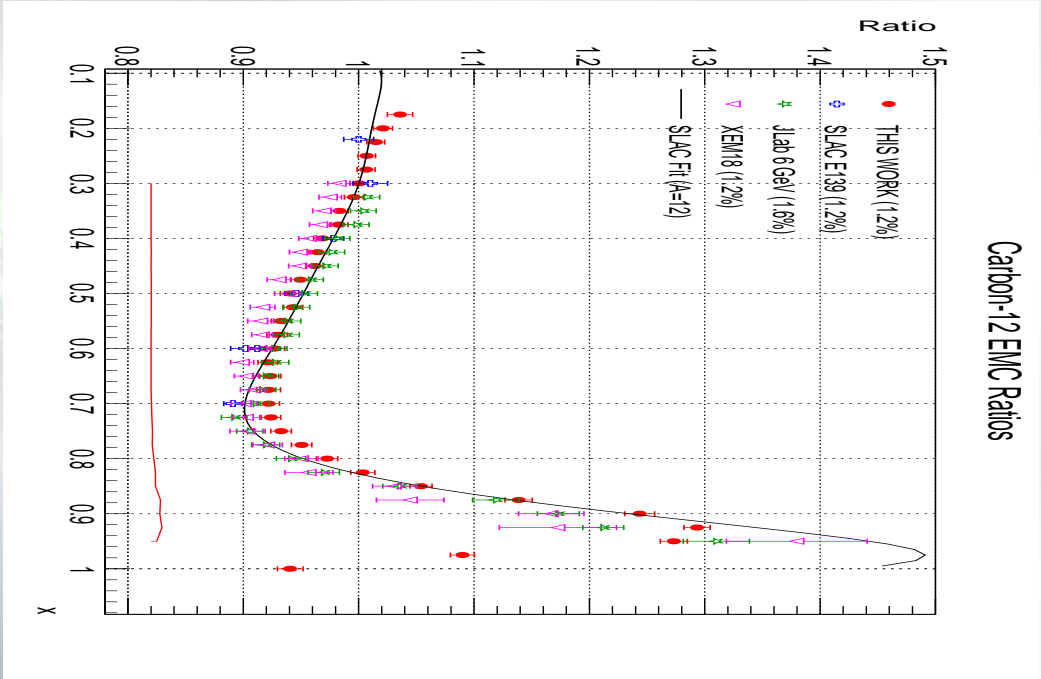
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First Production Data Thesis!

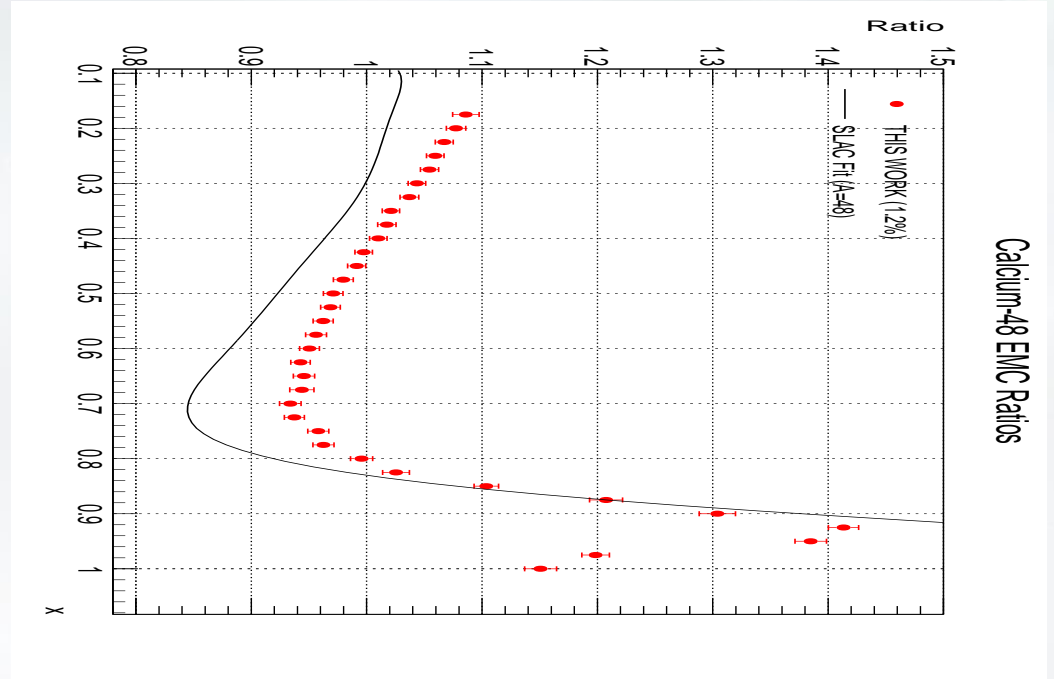
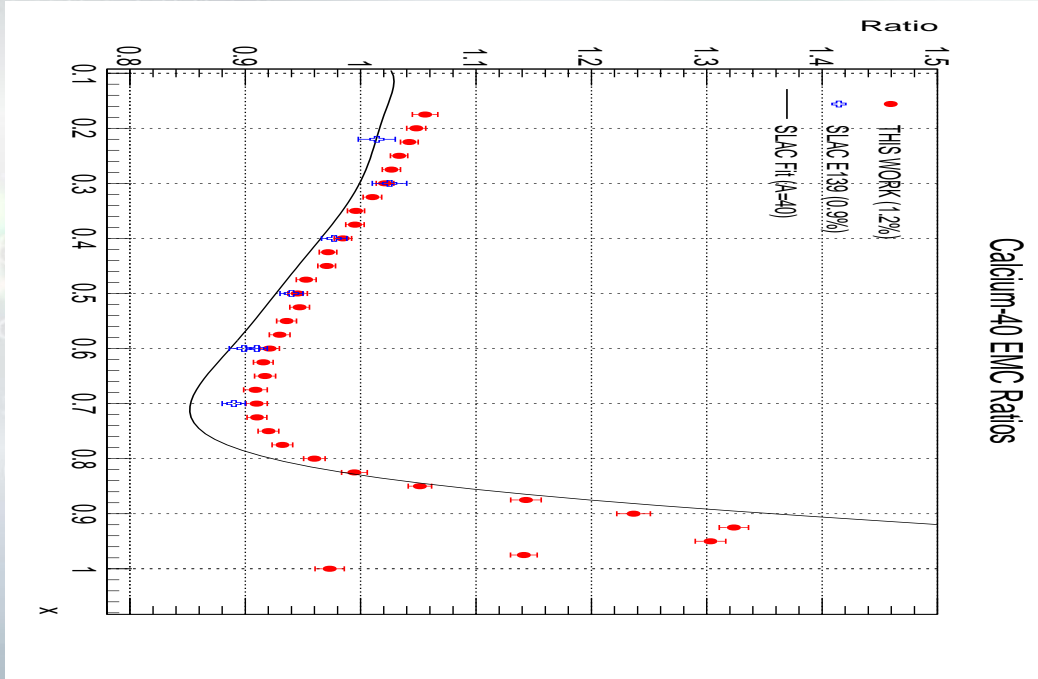
- Dr. Cameron Cotton – University of Virginia
 - First Measurement of the Isospin-Dependence of Nuclear Structure Functions at 12 GeV Jefferson Lab
- HMS data at 20°
 - 0.18 <math>x < 1</math>
 - Many momentum settings
- Focus on targets with similar mass number A but varying N/Z ratios
 - Looking at the blue band



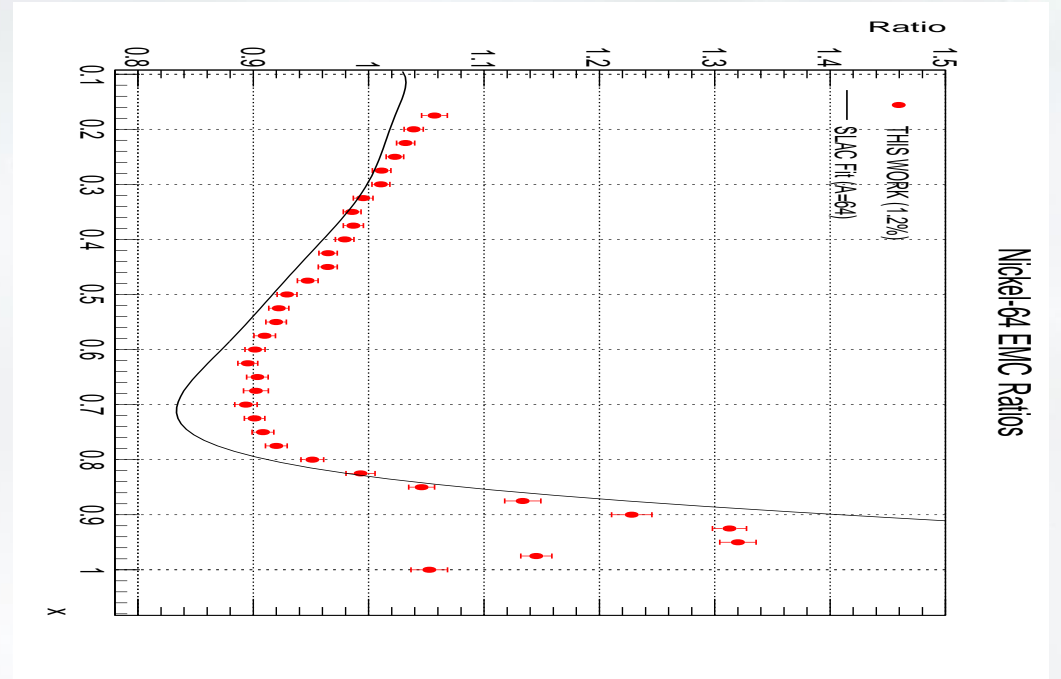
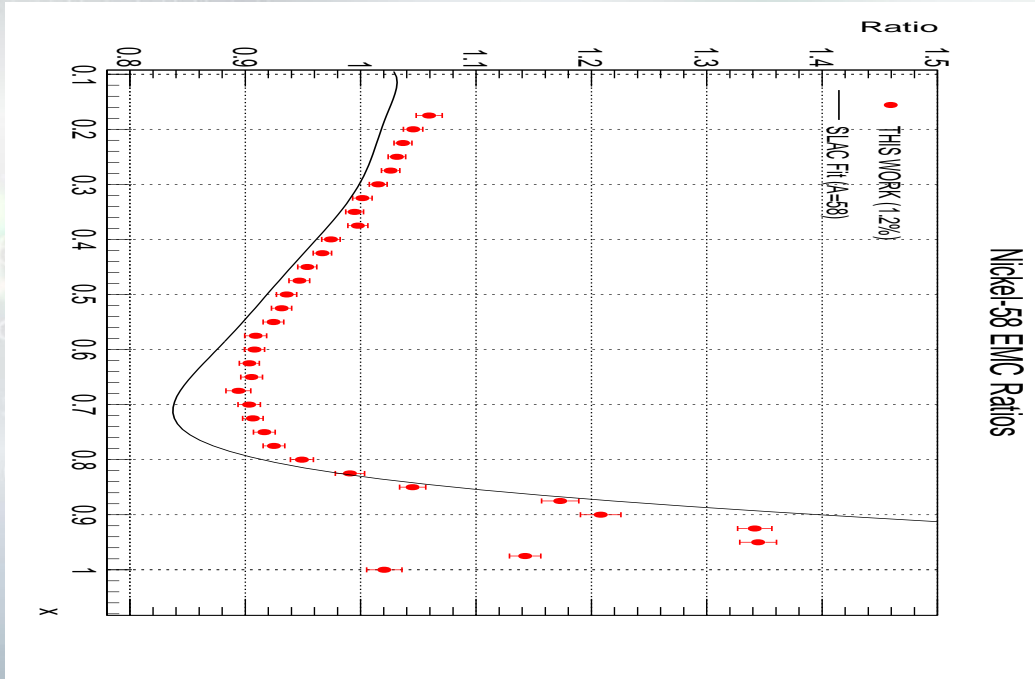
Plots



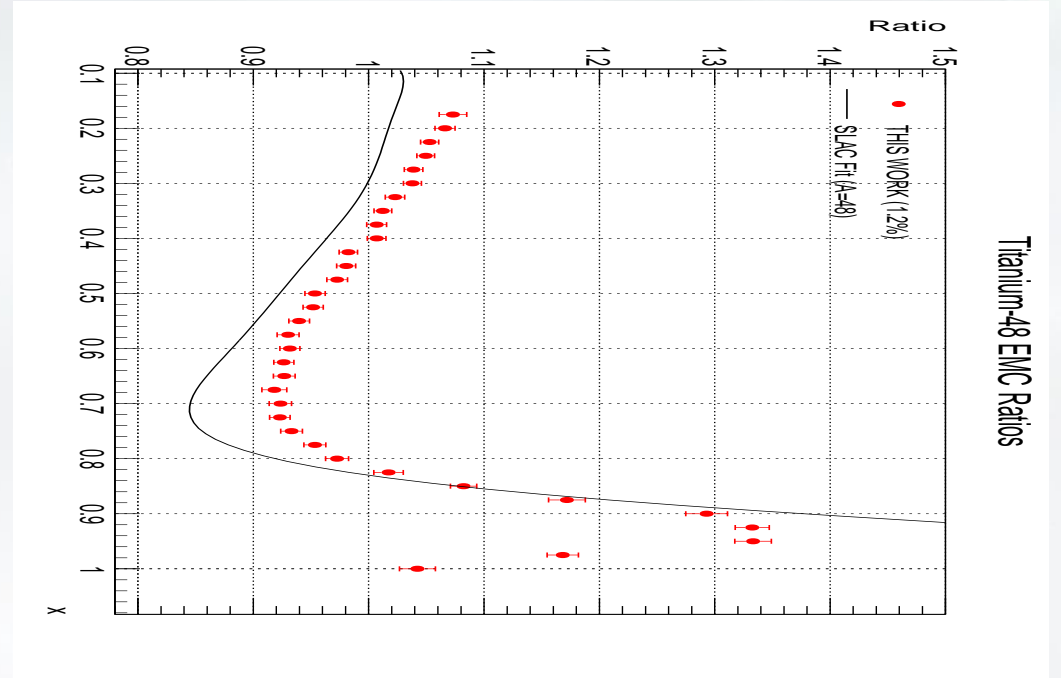
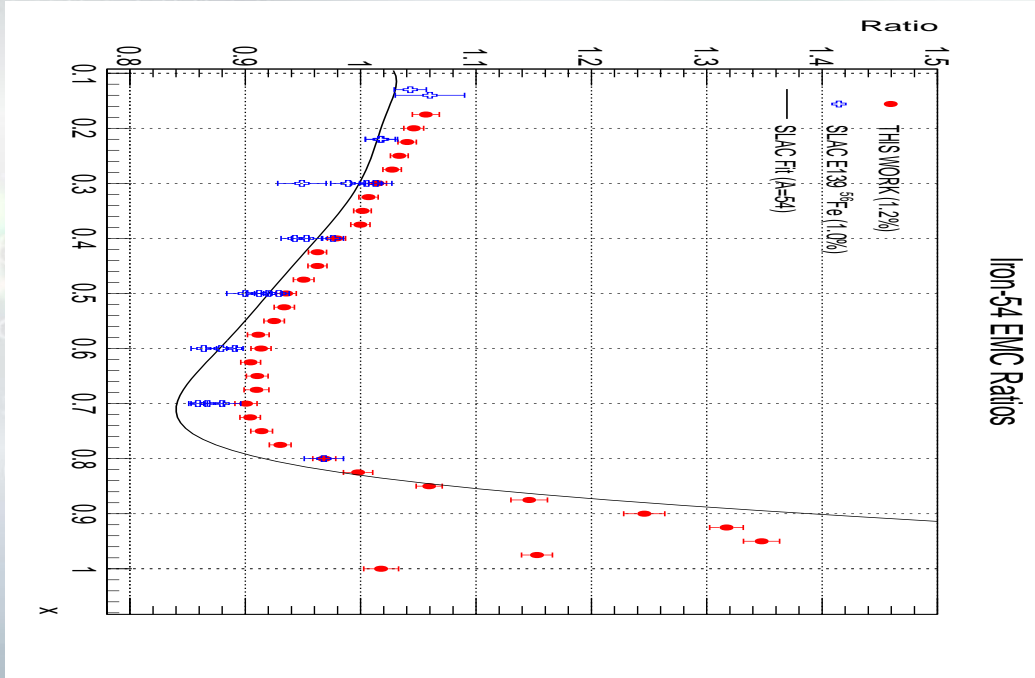
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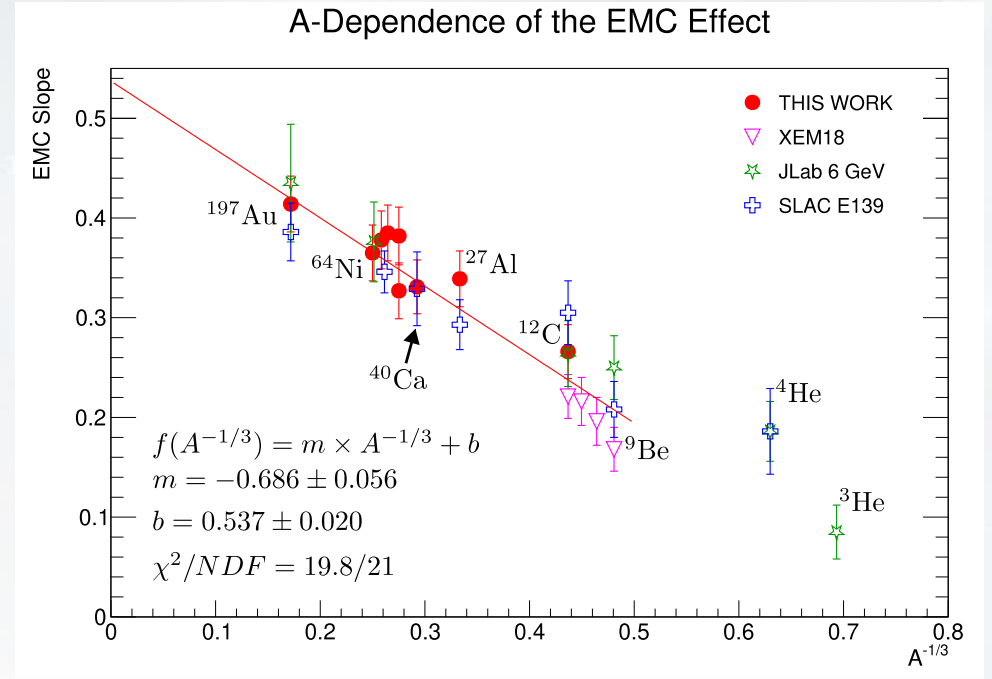
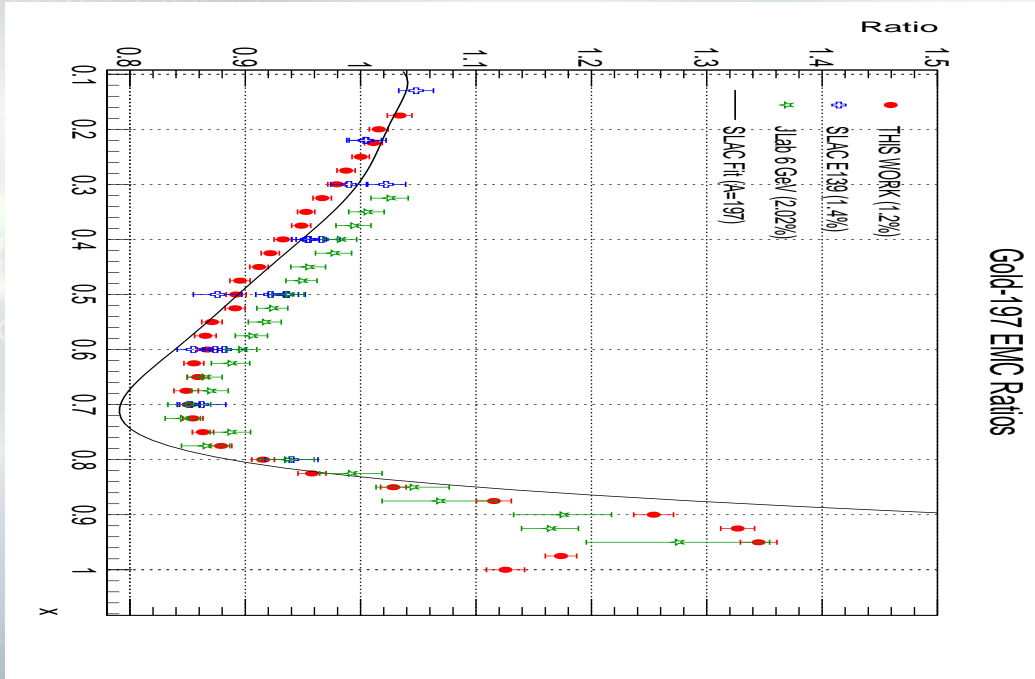
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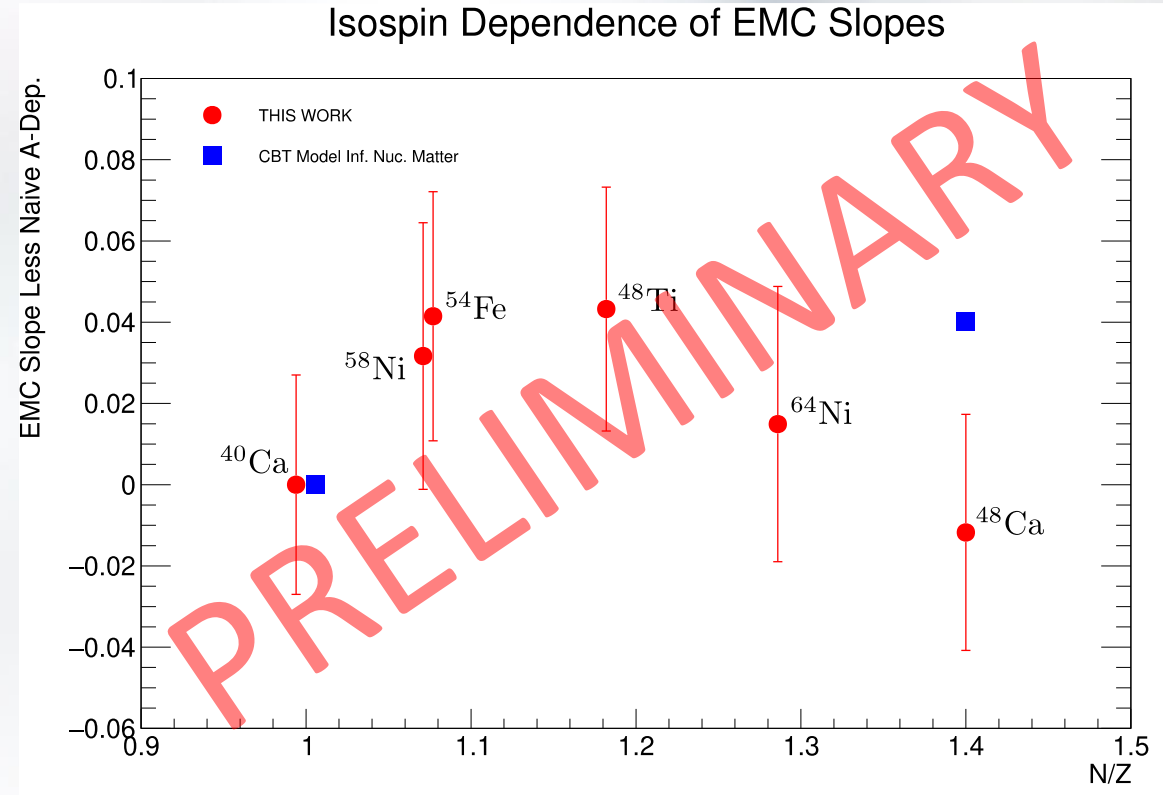


Plots



A **PRELIMINARY** look at isospin dependence

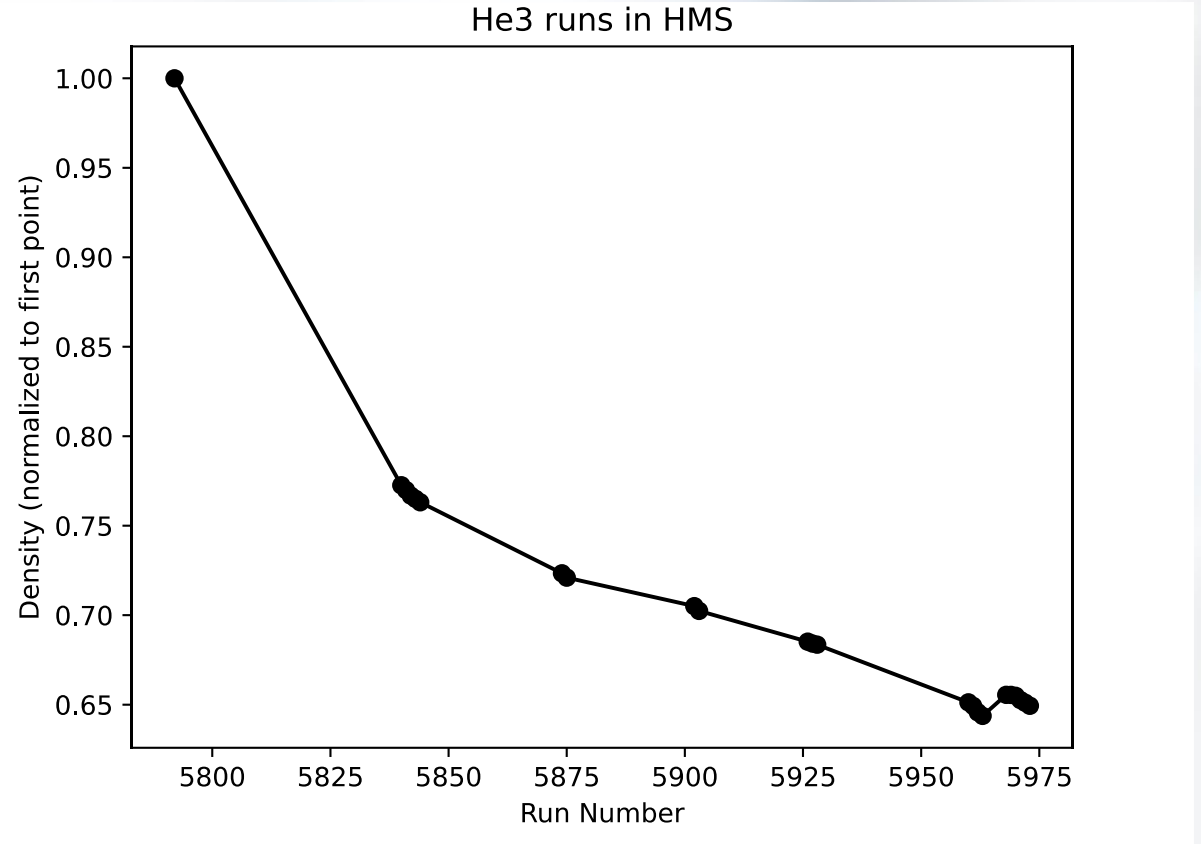
- A variety of large nuclei with varying N/Z ratios allows for a study of the isospin dependence of the EMC effect
- Plot on the right is from Cameron Cotton's thesis
- Still need to assess systematics from:
 - Other isoscalar correction models
 - Model dependence of radiative corrections
 - etc.



Investigating Target Funny Business

Helium 3 Target Leaking

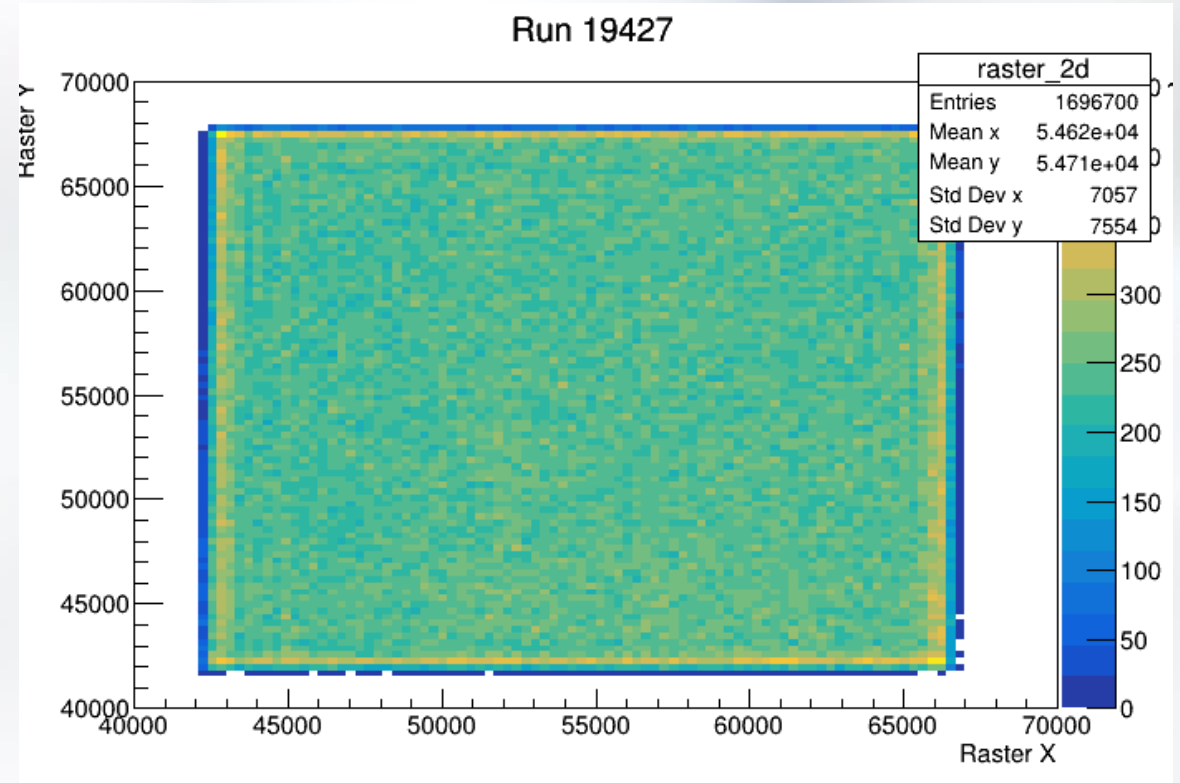
- Early after the second target ladder was installed, a leak was discovered in the ^3He target
- Around half of the target thickness was lost
- Abhyuday (UTK) has been hard at work to characterize the target thickness over time
 - A non-negligible fraction of our data was taken while the target was actively leaking
 - Will lead to a time-dependent target thickness correction
 - Will require an additional systematic uncertainty to account for this correction



Plot courtesy of Abhyuday Sharda (UTK)

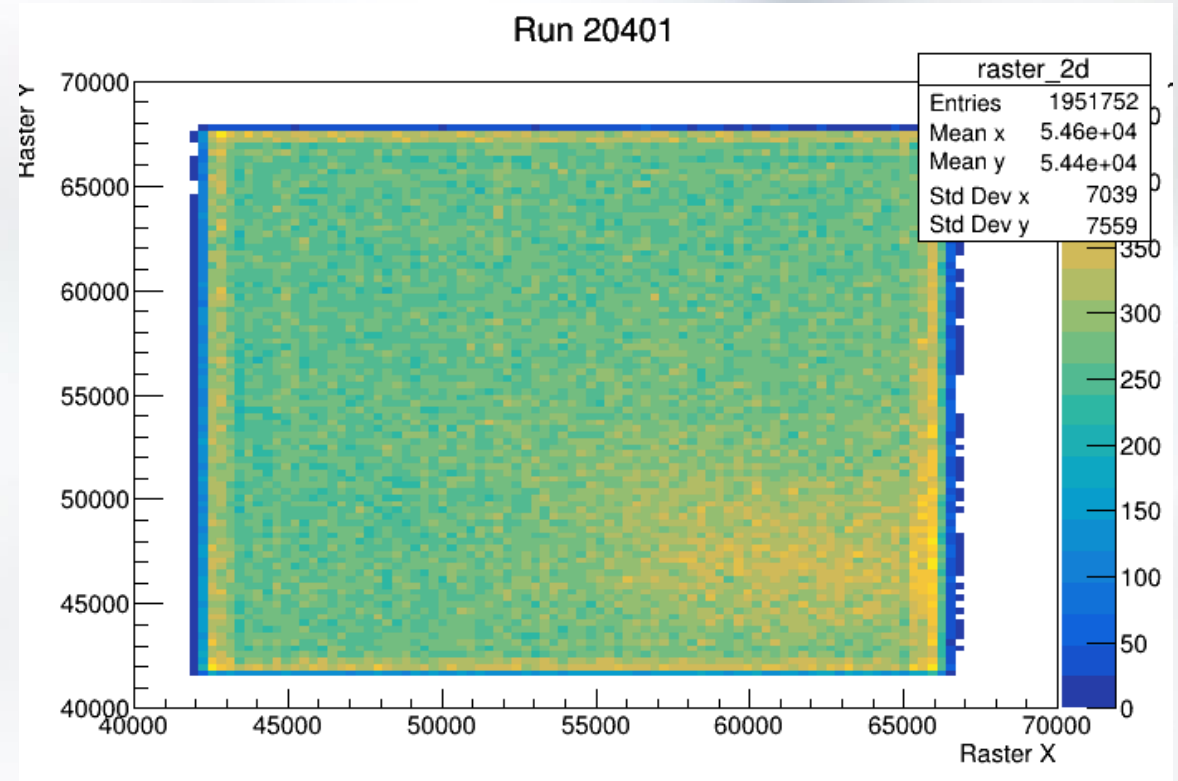
Lithium-6 – Hole-y Target!

- Partway through the run period, a “hot spot” appeared on the ${}^6\text{Li}$ target
- Investigation found no issues with the raster
 - That is, it is a target effect, not a beam position effect
- It seems that we partially melted the target causing a buildup of excess material forming a hot spot



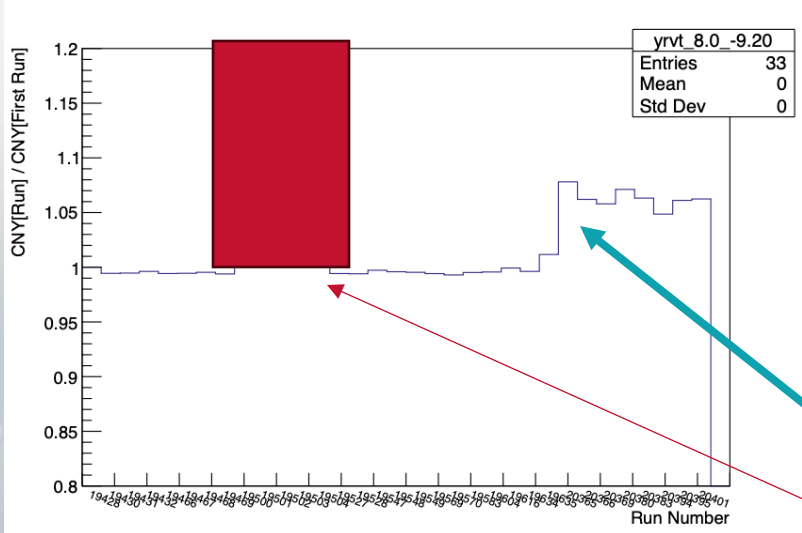
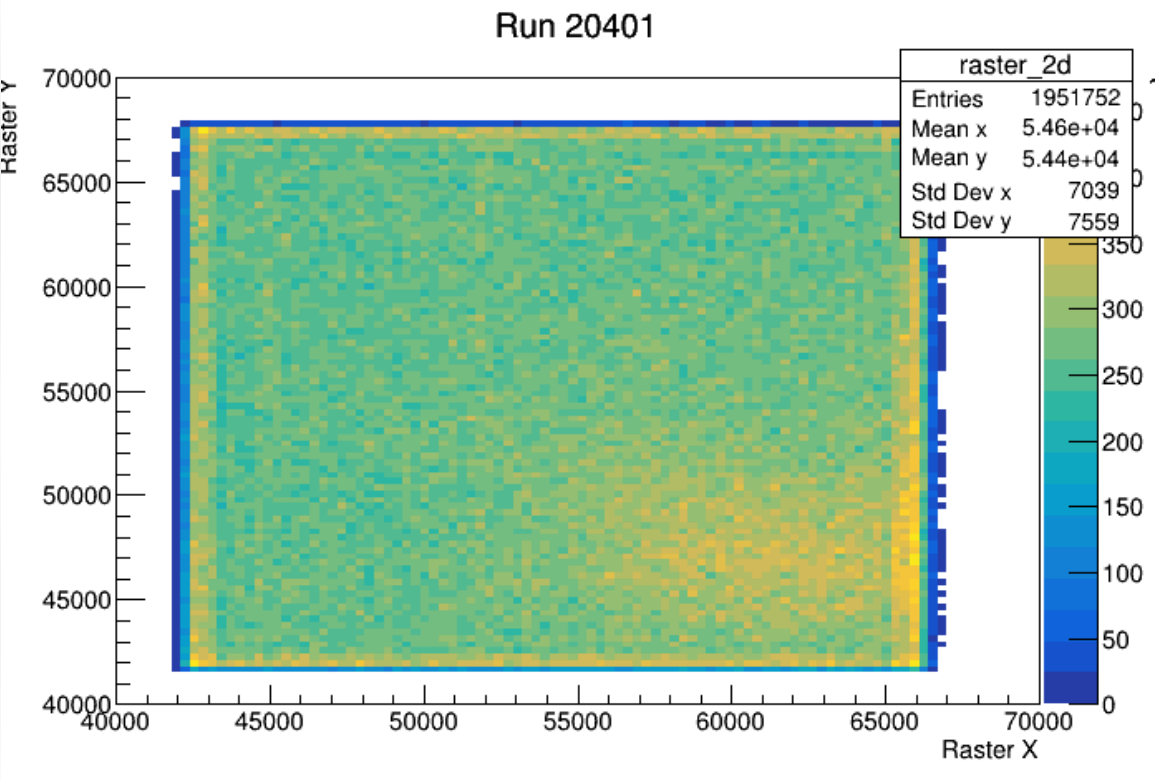
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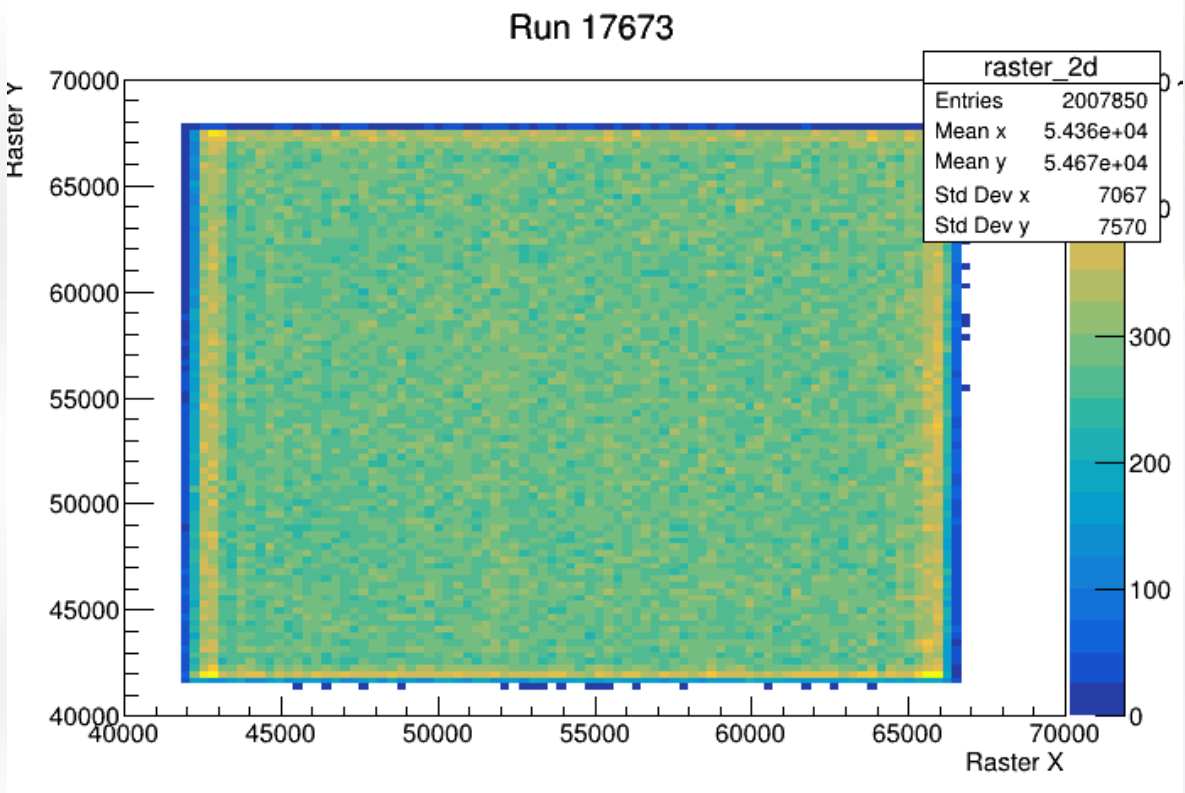
Charge Normalized Yield v. Run normalized to first run

Yield jump just as hot spot appears in data!

Nothing to see here... (red herring easily explainable by configuration changes)

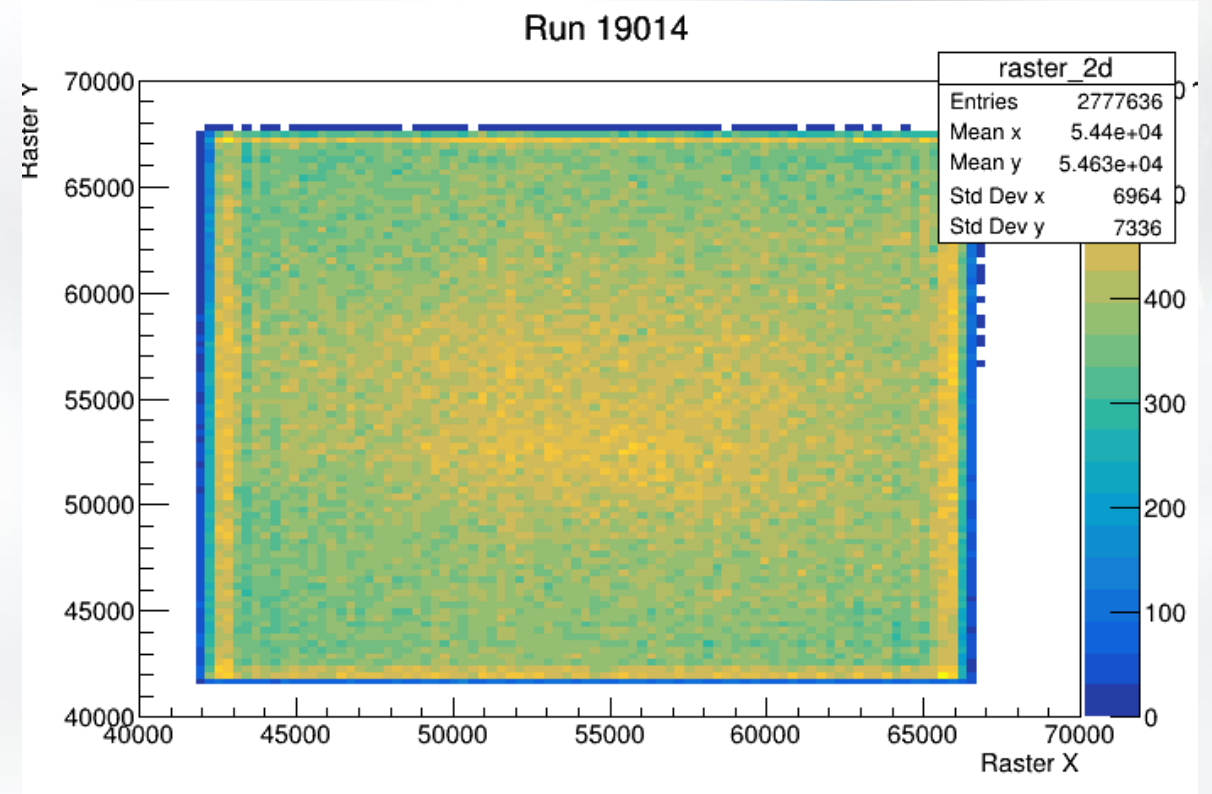
But why is the Tin gone?

- A similar melting phenomenon was seen in the Tin target



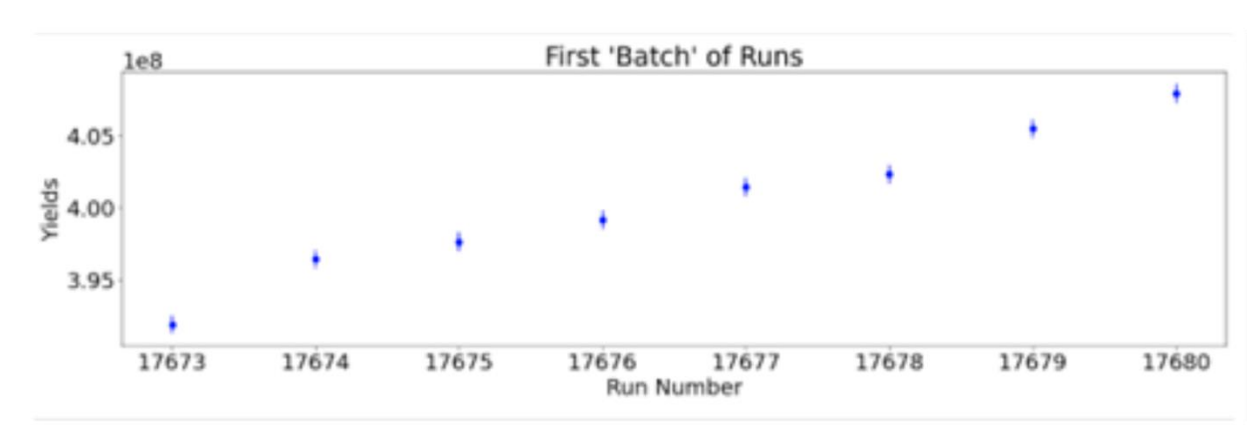
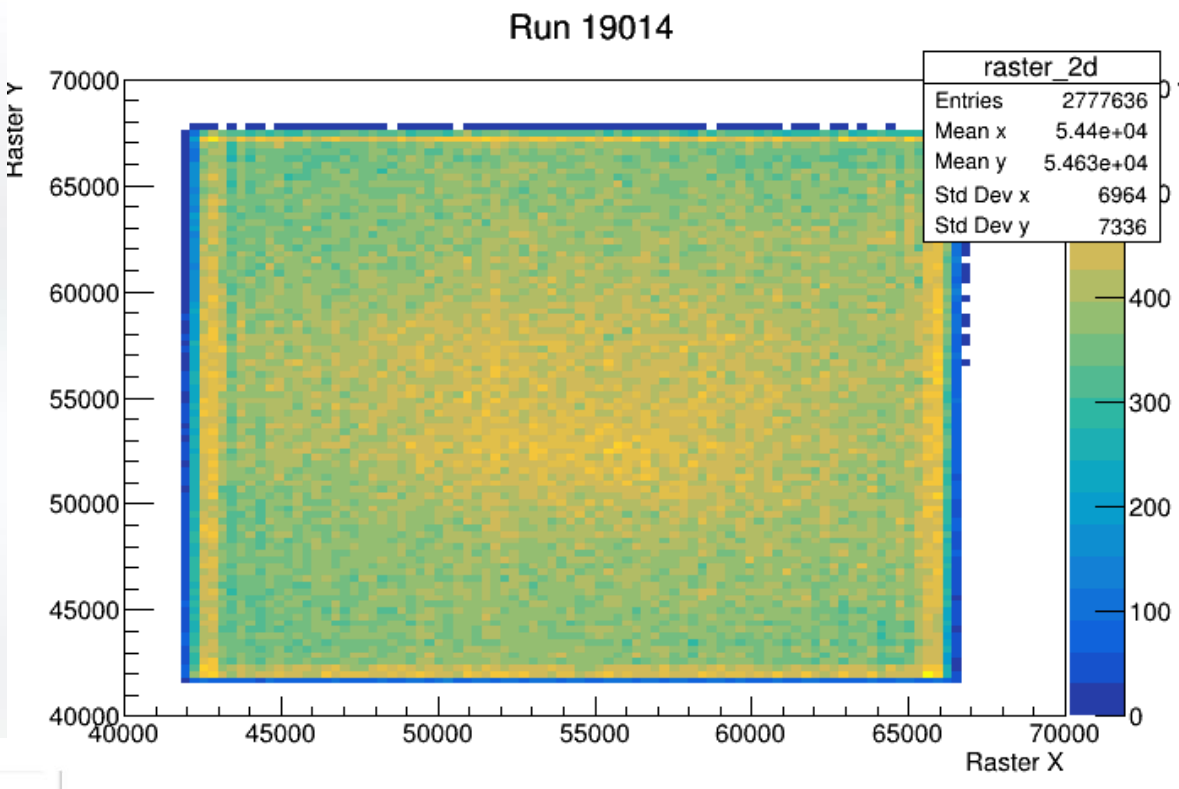
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- A similar melting phenomenon was seen in the Tin target



Tin melting over time plot courtesy of Penny Duran (University of Arizona)

Acknowledgement

Spokespeople:

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

Graduate Students:

Cameron Cotton (UVA)*, Abishek Karki* (MSU), Casey Morean* (UTK), Jordan O’Kronley (UTK), Ramon Ogaz (UTK), Abhyuday Sharda (UTK), Sebastian Vasquez (UCR), Zoe Wolters (UNH)

* = Graduated/Escaped

Other Collaborators:

Miguel Arratia (UCR), Dipankar Dutta (MSU), Shujie Li (LBL),
Dien Nguyen (UTK),
Nathaly Santiesteban (UNH), Xiaochao Zheng (UVA), Burcu Duran (NMSU), Tyler Hague (JLab)



QUESTIONS?