Diversity in nuclear physics: does it really matter?

Paul Guèye

MICHIGAN STATE UNIVERSITY

U.S. DEPARTMENT OF ENERGY | Office of Science

This material is based upon work supported by the U.S. Department of Energy Office of Science under Cooperative Agreement DE-SC0000661, the State of Michigan and Michigan State University. Michigan State University designs and establishes FRIB as a DOE Office of Science National User Facility in support of the mission of the Office of Nuclear Physics.

Disclosure

The content of this presentation is solely mine and is not the position of FRIB, NSCL, MSU or Jlab ...

Outline

- Framework
- Nuclear physics & Diversity in the US: NuHEP story
- Focus: Minority Serving Institutions
- MSI and NSF
- MSI and DoE
- Research at FRIB
- Another Future Duality: FRIB & Jlab
- Summary & Final thoughts

Color Transparency

Credit: J. Griffin (Jefferson Lab)
www.jlab.org

That

One!!

http://clipart-library.com

h-N interactions vanish

@ high energy transfer

"Daddy: She is Black!"
Yannick Guèye, Age: 5
Black hair = people are Blacks!

The Senegalese Beaches & Lakes ... Pre-College Years: Tourists vs. Locals

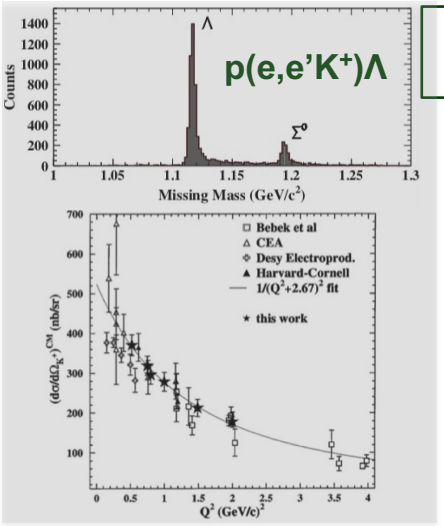
Hampton University Nuclear and High-Energy Physics (NuHEP) Center

- Funding
  - NSF Human Resources Division, 1991-1996 & 1996-2002.
  - Amount: $1M/year.
- Taking full advantage of proximity of Jefferson Lab.
- Crucial Outreach Program
- Some highlights (~2000)
  - Experimental Group meetings of 3.5 faculty, ~3 postdocs, ~8 students, ~10 undergrads, in a corridor (ex-laundry building!) with portable screen and projector. ~2/3 of the group was Afro-American, ~10% was African.
  - 15 years after establishment, the **HU program graduated over half of the doctoral degrees awarded to African-Americans annually**.
  - At one time, **the group led two experiments simultaneous in Halls A and C**. Still, the Hampton group covered 1/4 and 1/3 of all shifts, respectively!

Highly successful! – Critical Mass established!

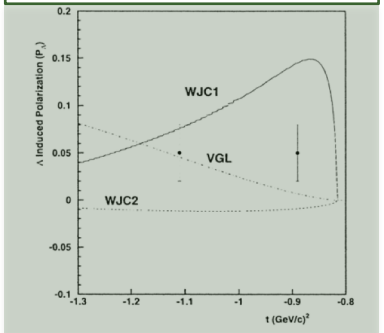
Strangeness Production at JLab

1st JLab strangeness experiment (e93-018, **K. Baker**)

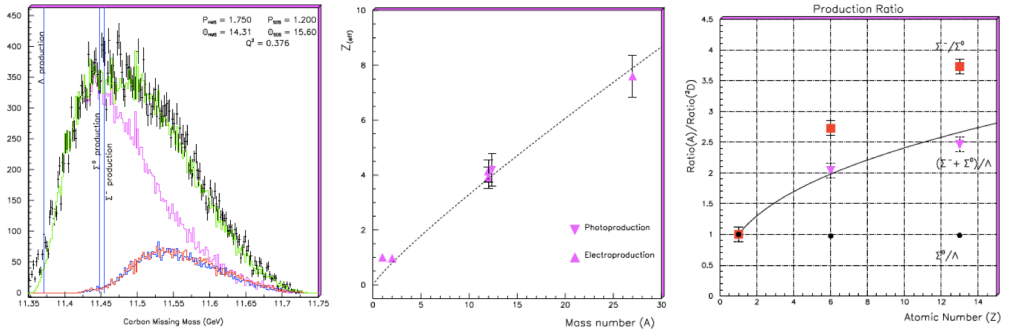


G. Niculescu et al.
PRL **81**, 1805 (1998)

L. Teodorescu et al.
Nucl. Phys. **A658** (1999)

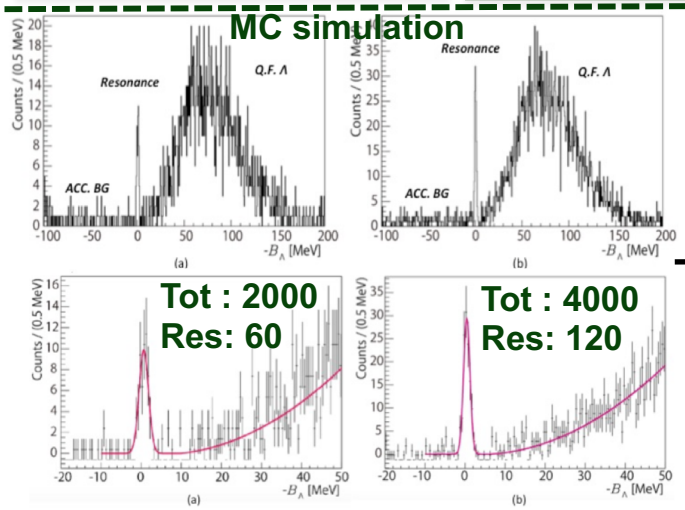


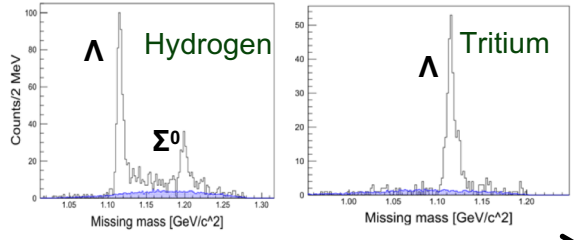
1st JLab hypernuclei experiment (e91-016, L. Tang)



W. Hinton, PhD thesis (2001) – unpublished
Feasibility study of Λ and Σ hypernuclei @ JLab

MC simulation

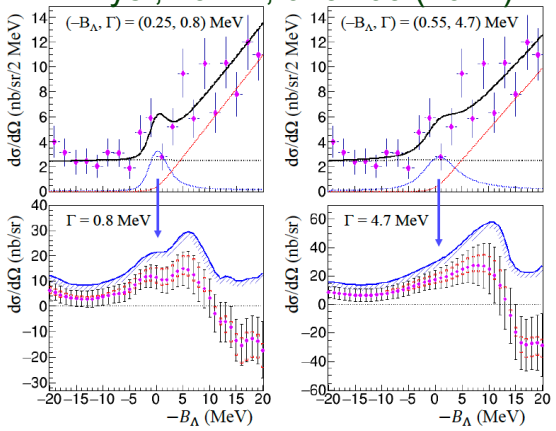




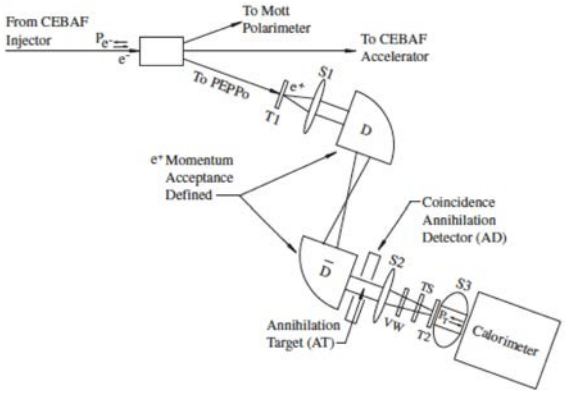
L. Tang, JLab/e1217003
(last strangeness experiment so far)
Λnn resonance [neutron-stars]
Hall A/C Collaboration: January 2022

B. Pandey et al.,PRC **105**, L051001 (2022)

K. N. Suzuki et al., Prog. Theo. Exp. Phys., vol 22, 013D03 (2022)

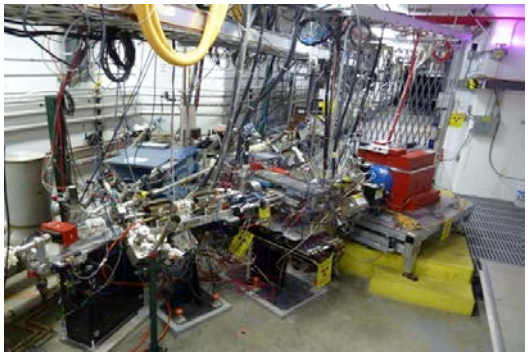


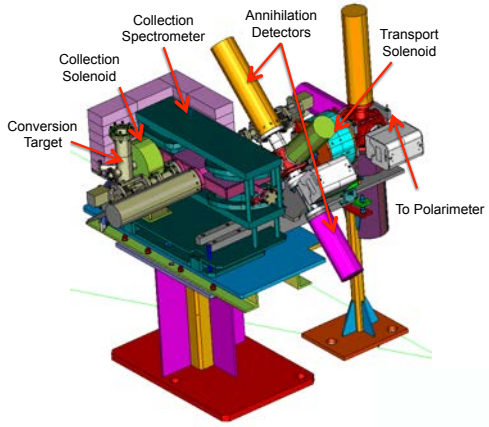
Polarized Positron Beams – 20 years later! (... possible scheme for the EIC)

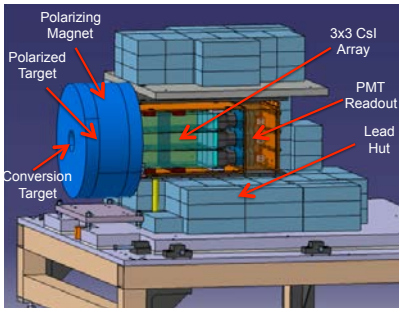


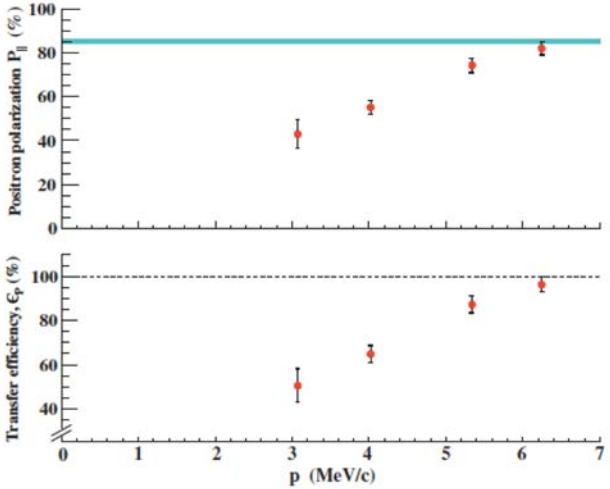
Polarized Electrons for Polarized Positrons
D. Abbott *et al.*, PRL **116**, 214801 (2016)

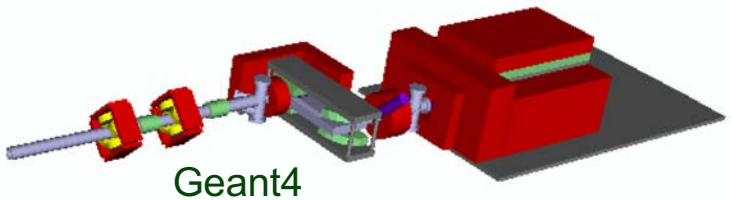
- Experiment in the CEBAF injector
- Highly polarized positrons
- 80% @ 6.5 MeV
- R&D for EIC
- **Last PhD @ HU (A. Adeyemi, 2016)**







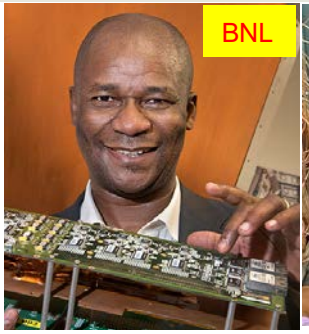




Geant4

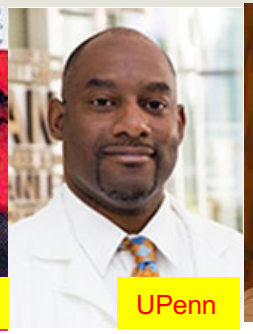
(Some) NuHEP Impacts


Yale


BNL

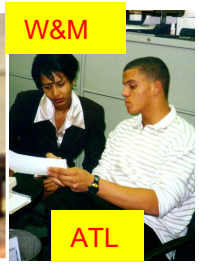

FRIB


NSU


UPenn


TSU


DC


W&M
ATL


JMU

Hampton University graduate students, Gabriel Niculescu (left) and Wendy Hinton (right), monitor an electroproduction of the kaon experiment completed in November 1996.

Hidden stories of NP: from [??] to professionals

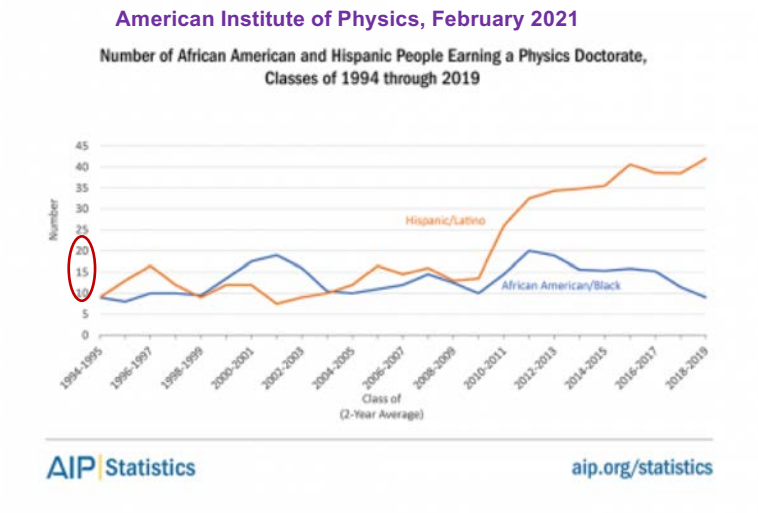
Focus: Minority Serving Institutions
Some Definitions

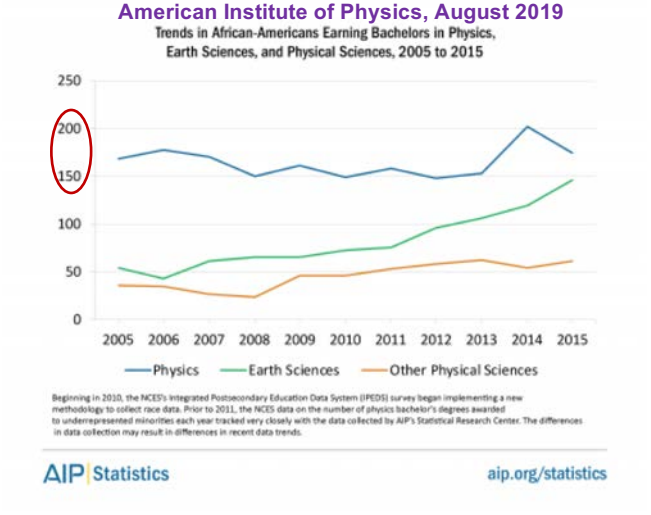
- U.S. Department of Labor
  https://www.doi.gov/pmb/eeo/doi-minority-serving-institutions-program

- Minority Serving Institutions
  *"MSIs are institutions of higher education that **serve minority populations** … Some are only **a few decades old**, whereas others, have been **striving for more than a century** to give their constituents the **social and educational skills needed to overcome racial discrimination and limited economic opportunities**."*

U.S. DoEd **7,175 institutions**	**Physical Sciences: 1,476** 2,033 [MS/PhD]; 797 [BS] 2,305 [AD]; 1,566 [CD]; 474 [ND]
Historically Black Colleges & Universities **102 institutions**	**Physics Departments: 33 (33/444 ≈ 7%)** MS: 13 PhD: 5 (Howard, Hampton, FAMU, DESU, AAMU) **MS/PhD in nuclear physics: 3 (Hampton, Howard, FAMU)**

Focus: Minority Serving Institutions
Some Graphs





	Focus	Total
Historically Black Colleges and Universities (HBCUs)	African-Americans	108
Hispanic Serving Institutions (HSIs)	Hispanics	274
Tribal Colleges and Universities (TCUs)	Native Americans	35

Need a critical mass = pipeline from Pre-College to Professionals!

Dedicated MSI Programs @ FRIB

NSF Award – PHY 2012040

HS → BS → PhD → Faculty

PING

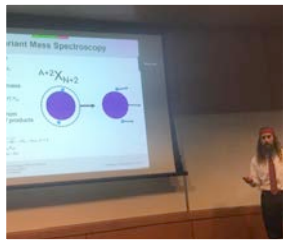
High school

PEGASUS/DRS [D. Lee]

Undergrads

MSI Research

Grad Students



MSI Fellowship

Faculty

Physicists Inspiring the Next Generation
Campus Research + Professional Physics Societies Meetings

→ **Two-Day Visit**
Interest to MSU/FRIB

→ Thesis Research

→ MSU/FRIB-MSI Bridge

Student Training and Engagement Program for Undergraduates in Physics (STEP-UP)

Institute for Nuclear Science to Inspire the next Generation of a Highly Trained workforce (INSIGHT)

FRIB Facility for Rare Isotope Beams
U.S. Department of Energy Office of Science
Michigan State University

(Note: website coming soon …)

One-person Impact & Sustainability?

- PING: Exploring the Nuclear Matter (www.frib.msu.edu)
  - 2019: 4 high school students + 2 undergraduate students
  - 2022: 20 high school students + 8 undergraduate students

- PhD/Professionals @ FRIB/MSU
  - 2018: 2 AA
  - 2022: +12

There are great people everywhere but not everyone looks like you and that is OK!

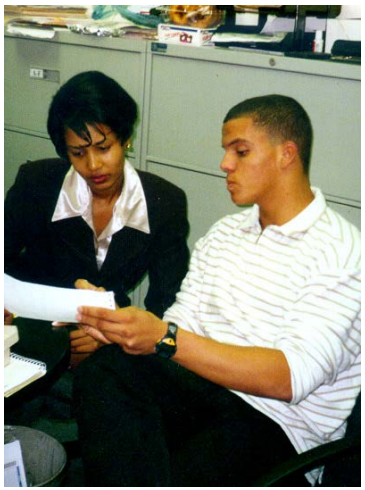
MSI and NSF

- NSF-PHY Program Managers
  - Special Thanks: Allena Opper

- Overlooking funding and logistics …
  - Focusing on students success = no time for grants
  - **REALLY** focusing on students success = **NEED** grants

Students Training and Engagement Program for Undergraduates in Physics (STEP-UP)

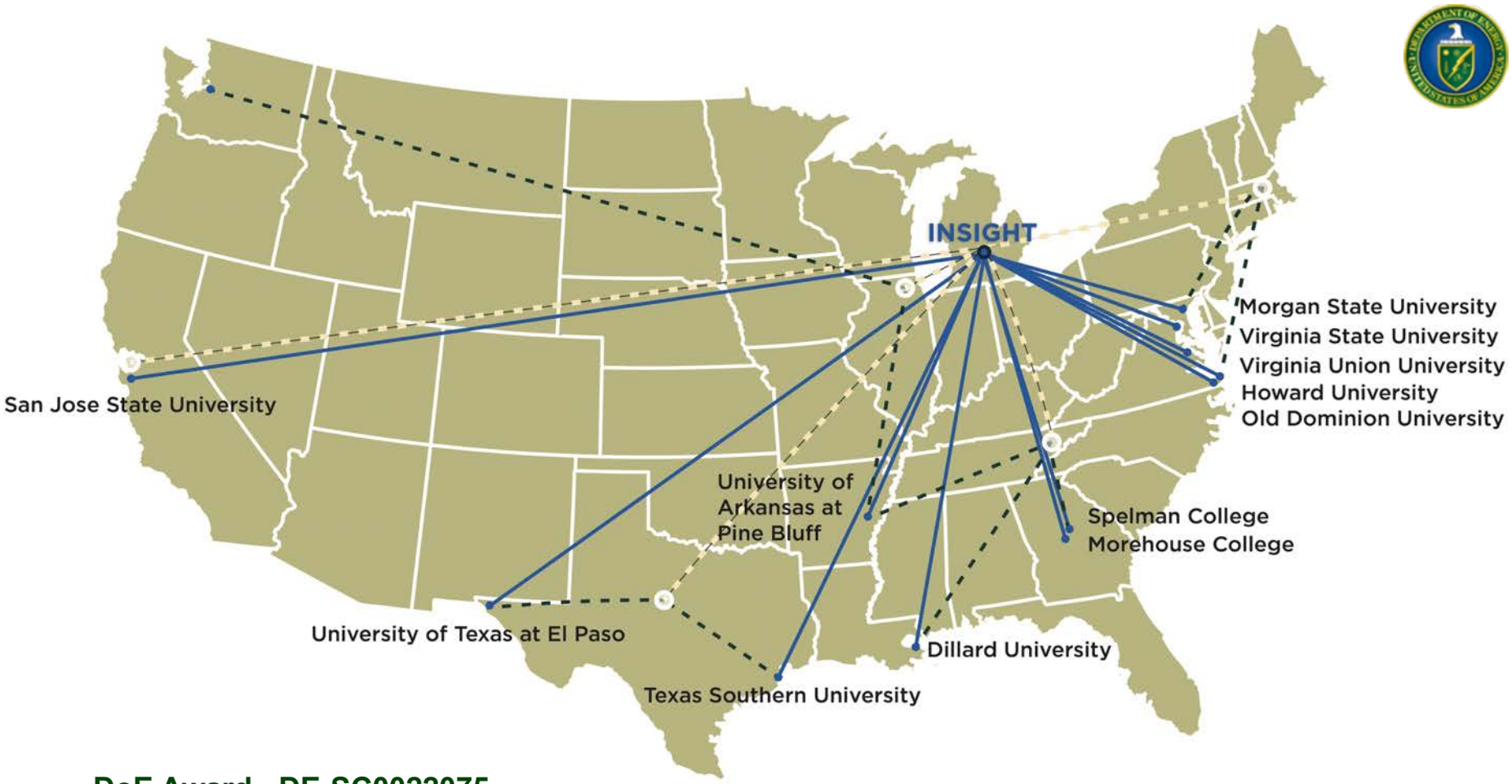
		2018-2019	2019-2020	Cummulative
Total		**161**	**205**	**366**
Students in contact		**147**	**120**	**267**
Middle school			83	83
Highschool		20	9	29
Undergraduate (HBCUs + NSBP)		87	23	110
Graduate (HBCUs + NSBP)		40	5	45
MSU Application		**7**	**2**	**9**
Graduate school (from HBCUs)		2	0	2
Undergrad school (from high school)		4	2	6
Undergrad from PING		1		1
MSU programs		**7**	**83**	**90**
PING (high school + undergraduate)		6	17	23
PEGASUS (undergraduate)		1		1
Extended Collaboration			29	29
JINA Lecture series			37	37



Need dedicated team that can immersed itself within the targeted group

- **STEP-UP Program: joint effort from FRIB & JLab**
- **The HU "behind the door" team: Carlane, Vevelyn … then … Monique, Edna …**

INSIGHT: Institute for Nuclear Science to Inspire the next Generation of a Highly Trained workforce



DoE Award - DE-SC0022075

FRIB INSIGHT RESOURCE CENTER

EDUCATION RECRUITMENT MENTORING COMMUNITY RESEARCH MINORITY SERVING INSTITUTIONS

(Note: website coming soon …)

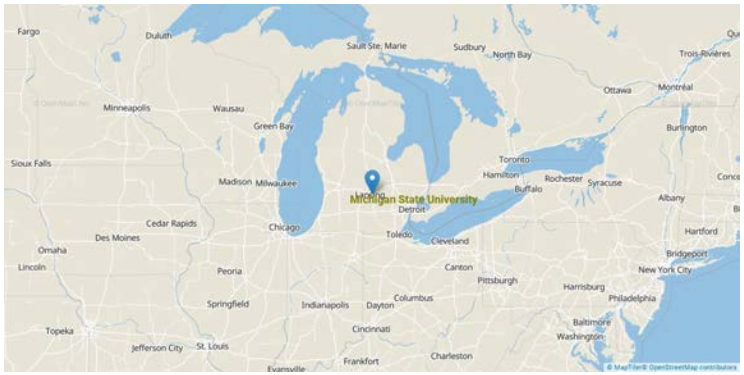
MSI and DoE

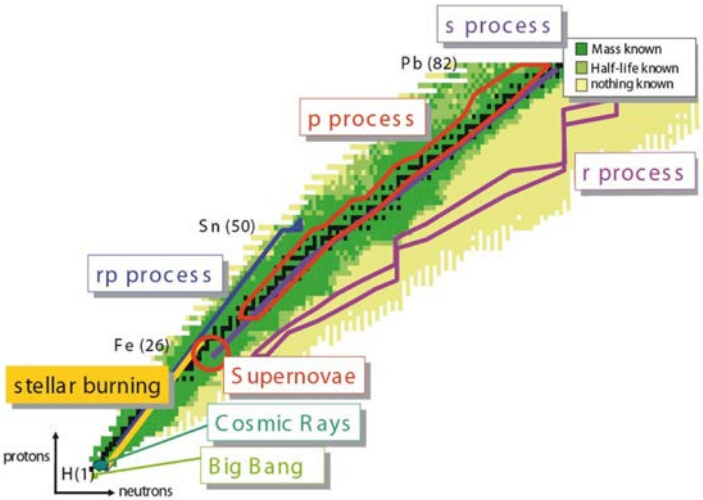
- DoE/SC Program Managers
  - Special Thanks: Paul Sorensen and Sharon Stephenson

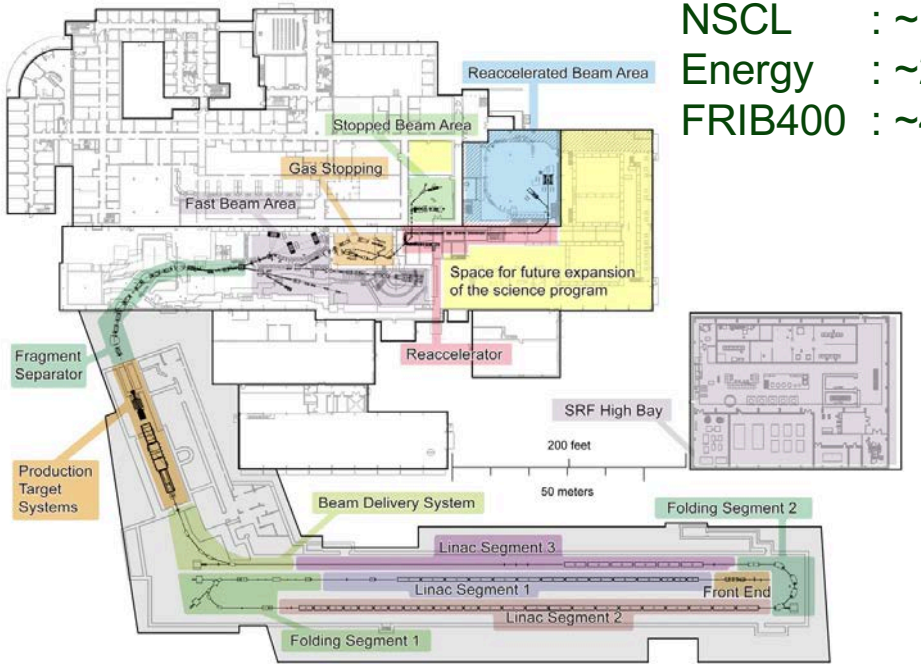
- DoE/SC
  - Special Thanks: Tim Hallman

- Overlooking funding and logistics …

Facility for Rare Isotope Beams (www.frib.msu.edu; started: May 10, 2022)



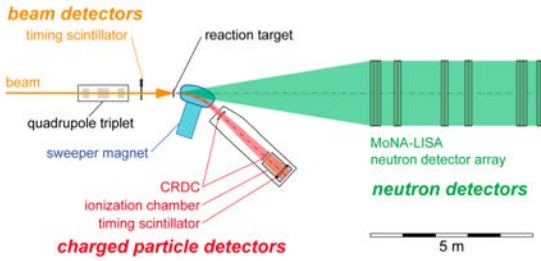


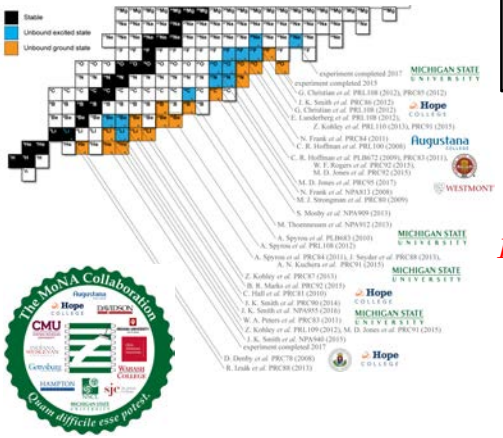


NSCL : ~100 MeV/u
Energy : ~200 MeV/u
FRIB400 : ~400 MeV/u

Invariant Mass Technique

$$\text{Beam} + \text{Target} \rightarrow \text{Unbound}(^*) \rightarrow \text{Fragments} + [1..N_n]n\ ([1..N_\gamma]\gamma)$$



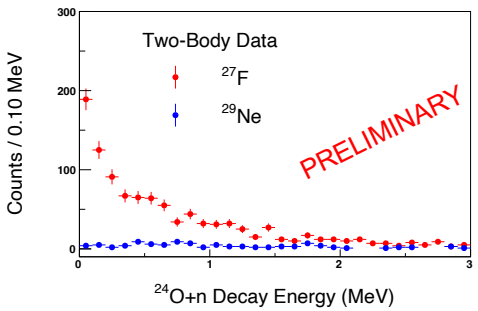


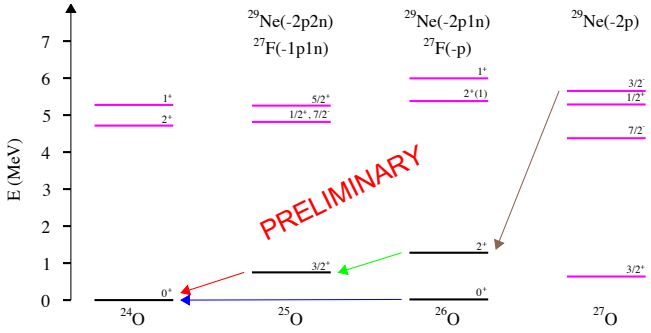
Invariant Mass Technique
Beam + Target → Unst. Isotope: X[n-rich]

X[n-rich] → Fragment + neutron(s)

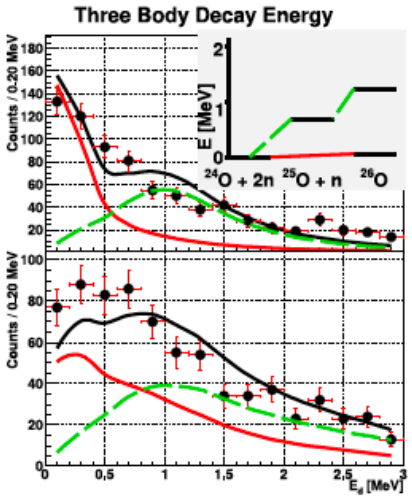
$$\left.\begin{aligned} E_U &= E_F + E_n \\ \vec{P}_U &= \vec{P}_F + \vec{P}_n \end{aligned}\right\} \rightarrow M_U = \sqrt{E_U^2 - \vec{P}_U^2}$$

$$E_{decay} = \sqrt{M_F^2 + M_n^2 + 2(E_F E_n - \vec{P}_F \cdot \vec{P}_n)} - (M_F + M_n)$$



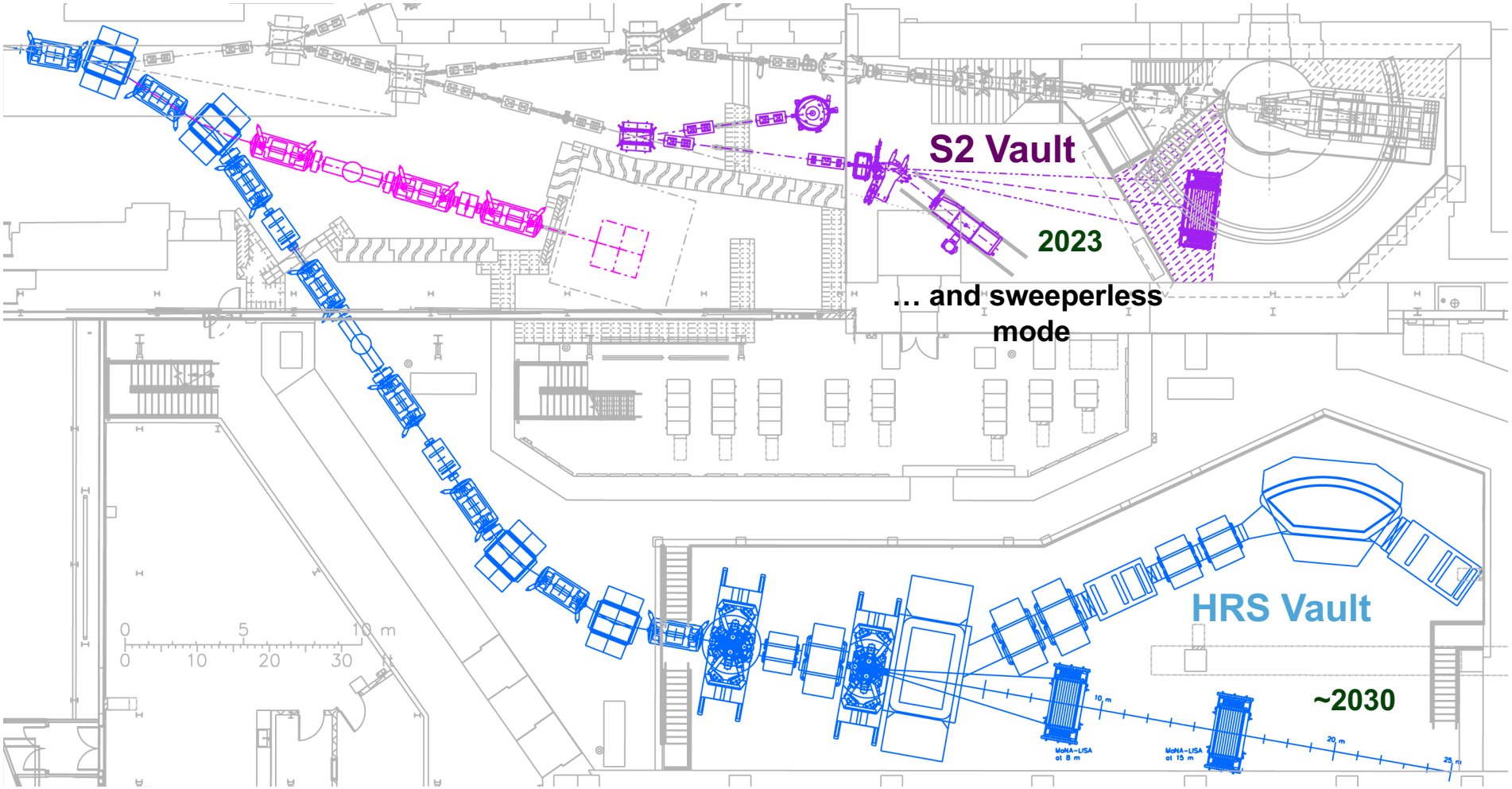


P. Gueye, in progress (2022)



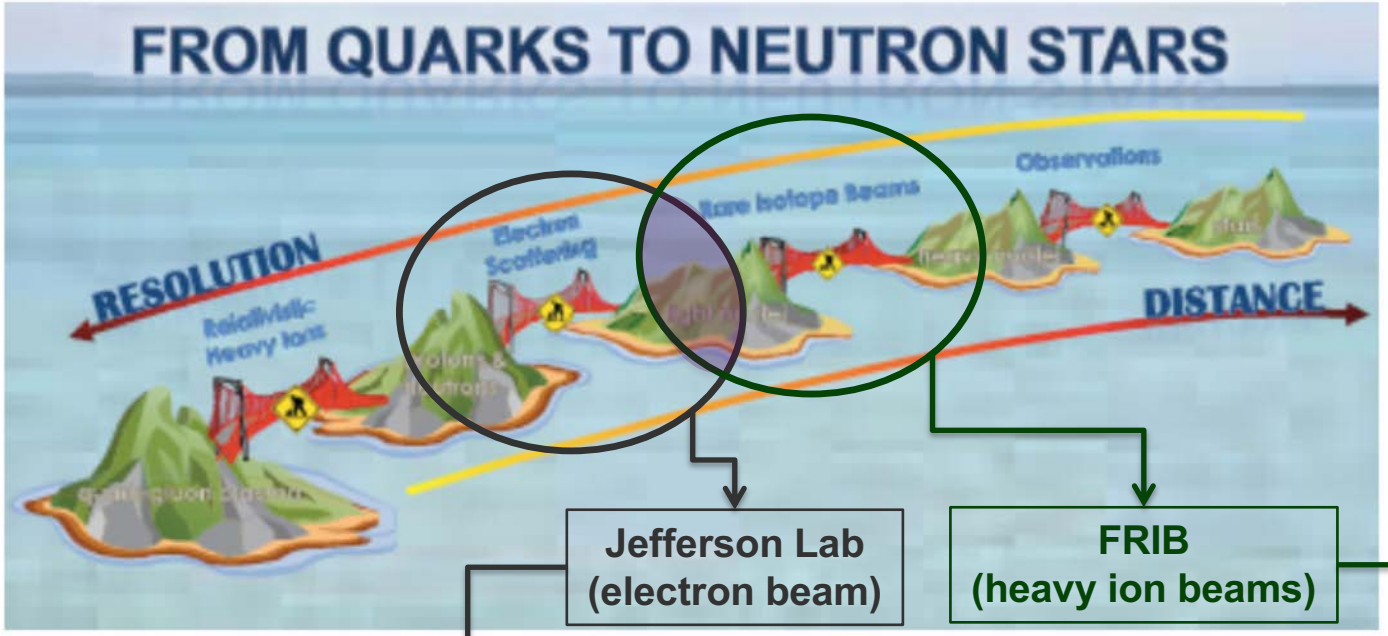
T. Redpath et al, NIMA (2020)

The Facility for Rare Isotope Beams (and the MoNA-LISA System)



Another Future Duality: FRIB & JLab

The National Academies of Science, 2013



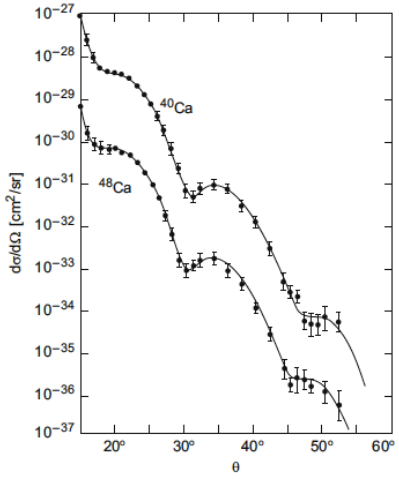
Nucleons Structure
4 GeV→ 6 GeV → 12 GeV

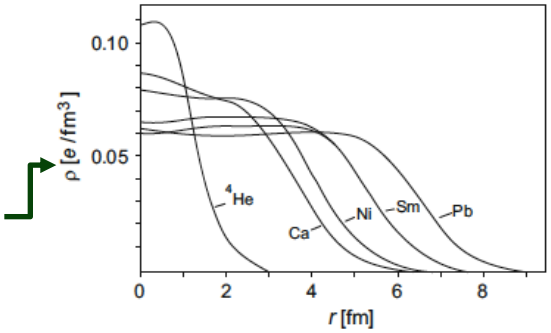
Nuclei Structure
100 MeV/u → 200 MeV/u → 400 MeV/u

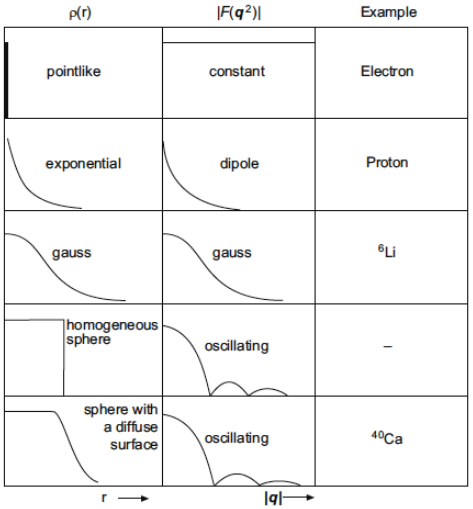
… interface …

Nuclear Radii

Bogdan Povh, Klaus Rith, Christoph Scholz, Frank Zetsche • Werner Rodejohann
Particles and Nuclei: An Introduction to the Physical Concepts





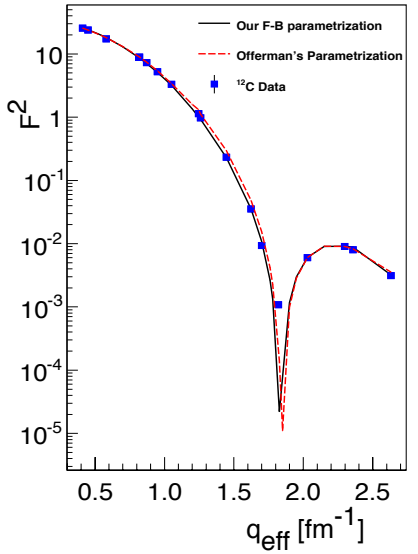


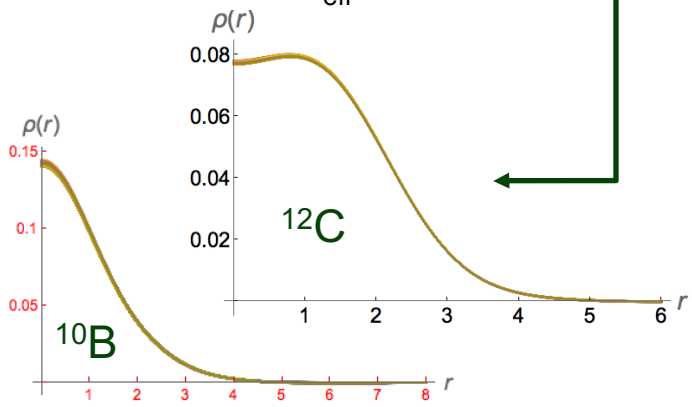
$$\frac{d\sigma}{d\Omega} = \left(\frac{d\sigma}{d\Omega}\right)_{Mott} |\, F(Q^2)\,|^2$$

$$F_p(q^2) = \frac{1}{4\pi}\int d^3r j_0(qr)\rho_p(r)$$

$$\begin{aligned} ZF_p &= 4\pi\int_0^\infty \rho_p r^2 dr \\ &= \sum_{\nu=1}^{\infty}(-1)^{\nu+1}\frac{4\pi R_p}{q_\nu^2}a_\nu \end{aligned}$$

A. Kabir, PhD Thesis (2019)
Low Energy Deuteron Experiment, JLab

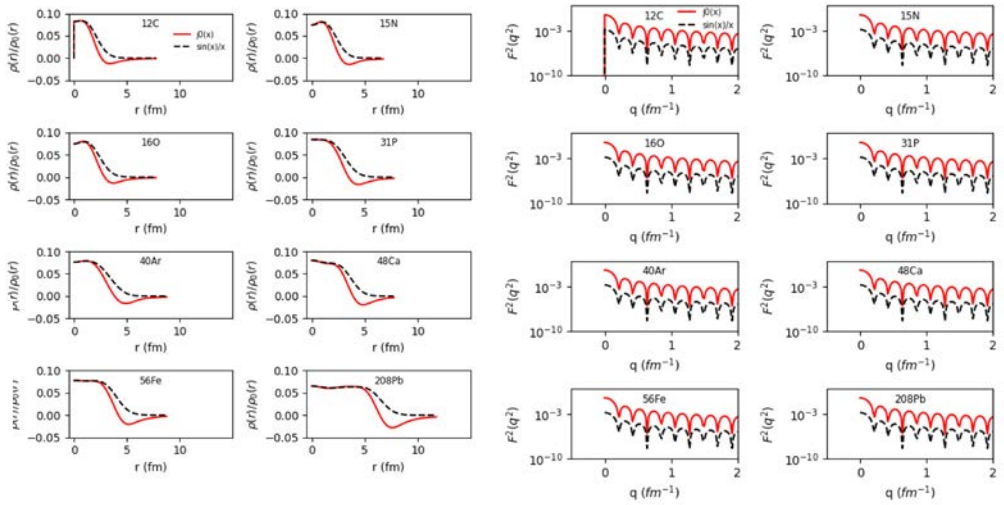




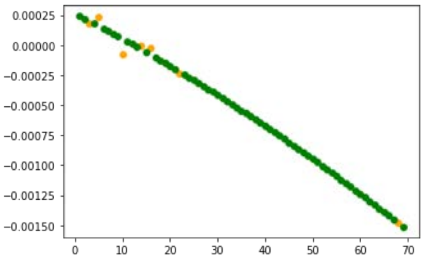
Polarized e±-RIBs

RIBs Radii
M. Wallach

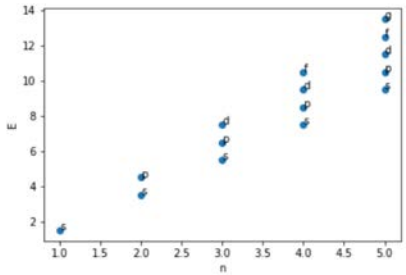
- Nuclear charge distributions
- Bessel function parameterization
  - ✓ Extrapolation of Bessel coefficients
  - ✓ Expansion to unstable isotopes



Interpolation/extrapolation of Bessel a1

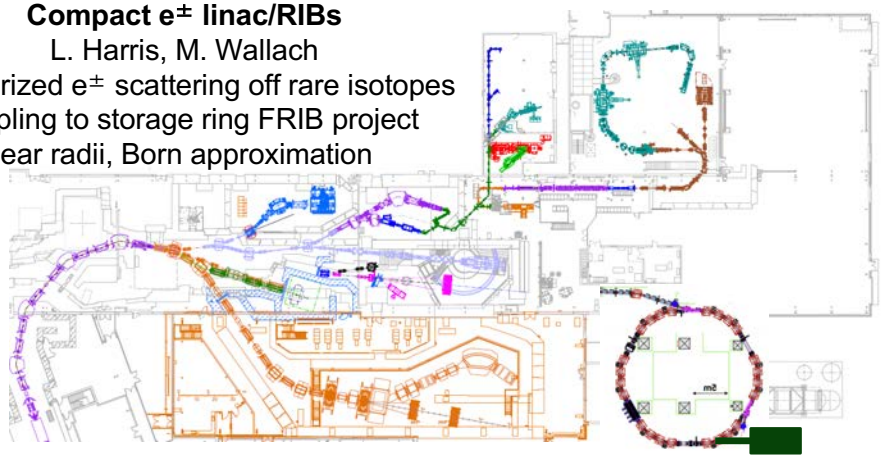


Shel model Harmonic oscillator

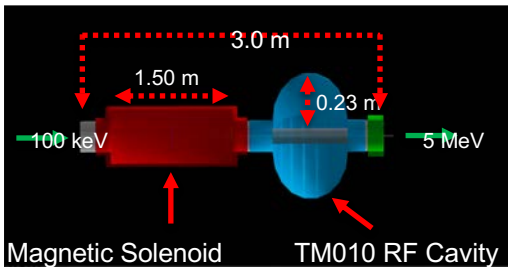


Compact e± linac/RIBs
L. Harris, M. Wallach

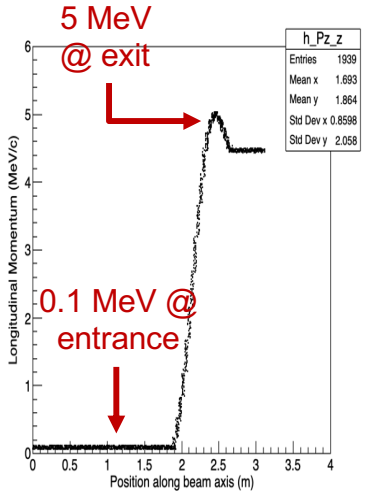
- Polarized e± scattering off rare isotopes
- Coupling to storage ring FRIB project
- Nuclear radii, Born approximation



e± linac



Had two brainstorming meetings
03/25/22 & 04/01/22



FRIB Facility for Rare Isotope Beams
U.S. Department of Energy Office of Science
Michigan State University

Back to the Future

- American Association for Physicists in Medicine (AAPM)
  - Women and Minority Recruitment Sub-Committee (WMRSC)
- American Physical Society (APS)
  - Medical Physics Section (initiated ~2005 under Bio, new option in 2009)
- American Association of Physics Teachers (AAPT)
  - Strategic Programs for Innovation in Undergraduate Physics (SPIN-UP)
  - SPIN-UP @ HBCUs (2001)
- American Institute of Physics (AIP)
  - Liaison Committee for Under-represented Minorities (LCURM): Chair for 2 terms
  - Task Force to Elevate African American Representation in Undergraduate Physics & Astronomy (TEAM-UP)
- National Radio Astronomy Observatory (NRAO)
  - National Astronomy Consortium (NAC)
  - Physicists Inspiring the Next Generation program (PING, http://nsbping.org)

Some (Personal) Thoughts

- People are good!
  - Negative attitudes = call for help
- Students
  - Engage your peers (one is enough!)
  - Find at least one person @ the lab to study, work, hang out …
  - In training to navigate life: you cannot do it on your own!
  - Racism is not acceptable but you also need to do your part
    - ✓# Black scientists, people with different abilities ... are dramatically low
- Postdocs
  - Engage your peers (one is enough!)
  - Find a senior person (faculty/scientist/engineer)
- MoNA-like Collaborations
  - Multi-institutions to tackle a common problem: team effort, networking …

Research Group (Spring 2022)

Thomas Baumann
MoNA device physicist
Experimental Physics (2020)

Thomas Redpath
MSU grad, 2019
MSI Fellow (2020)
Virginia State Ass. Prof. (2021)

Belen Monteagudo Godoy
Postdoc (2020)
Hope Faculty Fellow/FRIB
[Ass. Prof.] (2021)

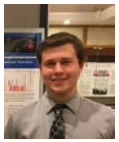
Clémentine Santamaria
Postdoc [W. Mittig] (2021)
MSI Fellow (2021)
Morgan State, Ass. Prof. (2021)

Graduate Students +2 (Fall 2022)

Dayah Chrisman
(Graduated, Spring 2022)

Xinyi Wang
(3rd year)

Andrew Wantz
(2nd year)



Georgia Votta
(1st year)

Nicholas Mendez
(1st year)

Letrell Harris
(1st year)

Other Professionals/Students

Sokhna Bineta Lo Amar
Postdoc, MSU/AAP
(2021)

Pierre Nzabahimana
(4th year)
Advisor: Pawel Danielewicz

Tracy Edwards
(2nd year)
Advisor: Greg Severin

Undergraduate/high school students
MSU: Phuonganh Pham, Paige Lyons, Maya Wallach, Jared Bloch, Anna Brandl, Emily Holman, Emma Benedek, Turuu Ariunbold, Justin Schmitz, Miles Klapthor, Sara Tatreau, Thomas Webb – ***MSI***: Toni Trail, Isaiah Marshall, Joi Malone – ***Africa:*** Faith Cherop , Yoann Gueye, Ngono Afefa Reine De Lima (Lumière), Ange Ntivuguruzwa + NSF/DoE Programs (PING [NSF], INSIGHT [DoE] …)

FRIB Facility for Rare Isotope Beams
U.S. Department of Energy Office of Science
Michigan State University

Thank You!

Paul Guèye

T: 517-908-7481

E: gueye@frib.msu.edu

2022 Edward A. Bouchet Award Recipient

Paul L. J. Guèye
Facility for Rare Isotope Beams, Michigan State University

Citation:

"*For many seminal experimental contributions to understanding the structure of nuclear particles and decades of service to physics outreach, diversity and inclusion, particularly throughout the African diaspora.*"