



# USNDP/NNDC Report

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National Nuclear Data Center



Technical Meeting of the International Network of Nuclear Structure and Decay Data Evaluators  
IAEA, Vienna, Austria

# NNDC Vision & Mission

The National Nuclear Data Center (NNDC) vision is to be the premier global resource for nuclear data and plan to:

- ❑ Implement AI/ML algorithms to reduce the time from data publication to integration in a recommended library to less than two years.
- ❑ Establish an open data repository for low-energy nuclear physics.
- ❑ Advance dissemination efforts with modern and efficient software tools.
- ❑ Sustain a robust nuclear physics research portfolio, including the development of an experimental program to accelerate isotope production science.

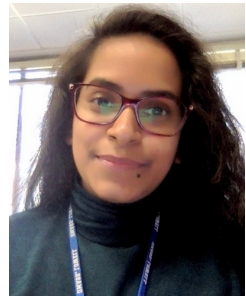


The NNDC is the lead and largest unit of the U.S. Nuclear Data Program (USNDP), whose mission is to provide current, accurate, authoritative data for workers in pure and applied areas of nuclear science and engineering. This is accomplished primarily through the compilation, evaluation, dissemination, and archiving of extensive nuclear datasets. USNDP also addresses gaps in the data, through targeted experimental studies and the use of theoretical models.

# Personnel changes at the NNDC



**Libby Ricard** became member of BNL RAP1 team in addition to her duties as deputy NNDC head and ENSDF library manager.



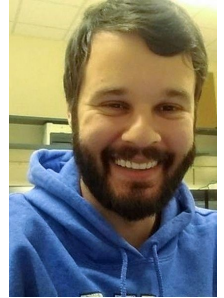
**Sanjane Waniganeththi** joined the NNDC on April 1<sup>st</sup> as a post-doc to work on the Accelerated Decay Data Evaluation project



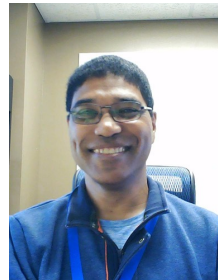
**Gulhan Gurdal** brought under NNDC contract for XUNDL compilations following a recommendation from NDAC

The NNDC currently has 9 staff scientists,  
1 post-doc, 4 professional staff and  
7 contractors

**Emanuel Chimanski** converted from postdoc to staff at BNL working on the NA-22 Gamma Rays Induced by Neutrons project.



**Sam Kim** has left the NNDC for a post-doctoral position at LANL in the isotopes production group.



**Amber Lauer-Coles** left the NNDC to begin a staff position at Savannah River National Laboratory



**JoAnn Totans** retired in December 2023 after serving as the NNDC librarian for many years



# FY23 Staffing Summary

## **For FY 23, the NNDC fully supported**

- 3 IT professionals (Arcilla, Mason and Shu),
- 1 librarian (Totans)
- 8 permanent scientists (Mattera, Morse, Ota, Pritychenko, Ricard, Wu)
- 1 postdoc (Kim)

## **Additionally, it partially supported**

- 4 permanent scientists (Brown, Nobre, Coles, Cuadra, Chimanski, Sonzogni),
- 2 post-docs (Lauer-Coles, Chimanski),
- 3 administrative staff (Dunn, Krejci and Frejka)
- 7 contractors (Carlson, Gass, Gritzay, Gurdal, Schwerer, Singh, Symochko)



# What we're up to



# NSR and EXFOR

NSR	2022	2023
New Entries	3280	3411
Corrected Entries	315	340
Keyworded	2457	2487
Database Updates	169	169

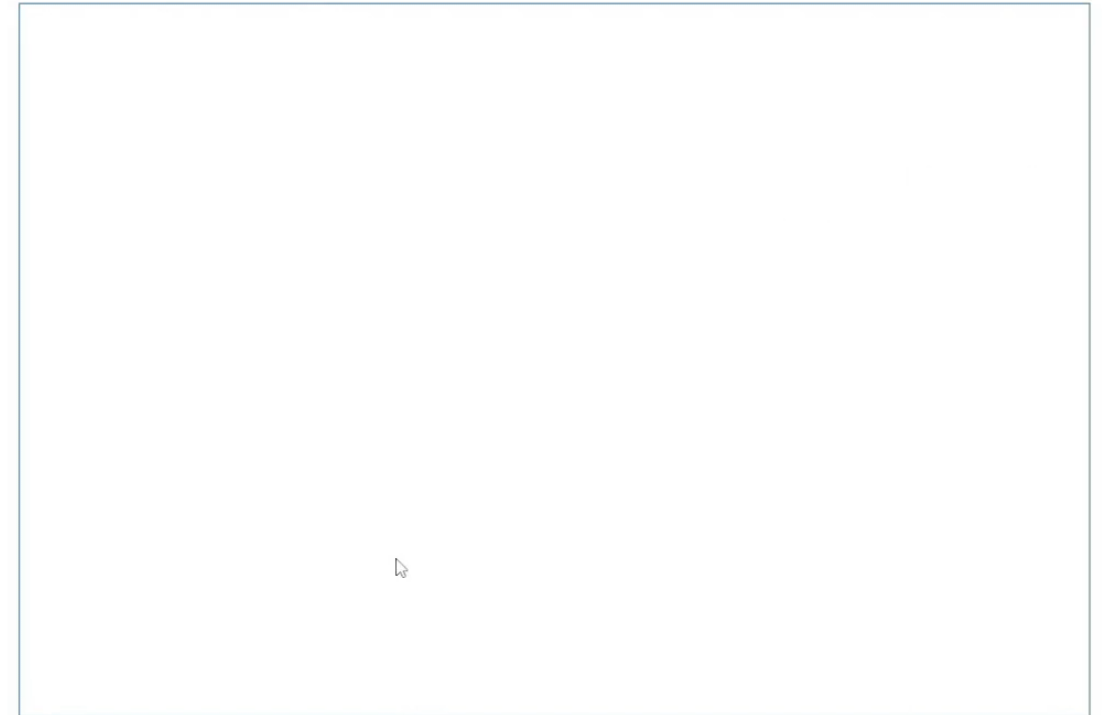
B. Pritychenko, J.Totans (BNL),  
D.Symochko, B.Singh (BNL Contractors), V.Zerkin (IAEA)

EXFOR	FY2022	FY2023
New Compilations	158	152
Updated Compilations	210	98
Preliminary Transmissions	29	19
Final Transmissions	31	22
Database Updates	41	39

B.Pritychenko (BNL), O.Schwerer, S.Hlavac,  
O.Gritsay (BNL Contractors).

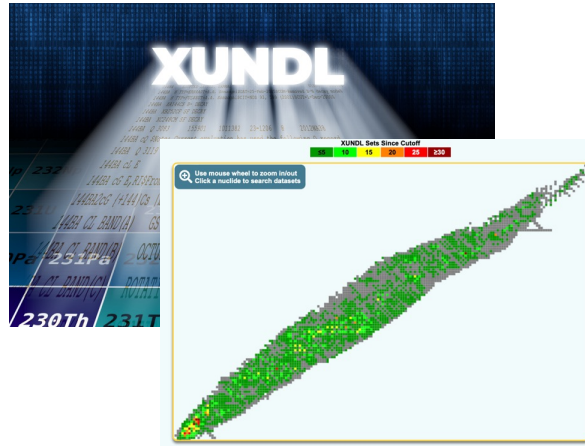
**Highlight:** NSR contents were verified against **FRIB Discovery of Nuclides Project** in collaboration with M. Thoennesen and J. Chen **200** additions and **200** fixes to NSR

▶ 1890 ●



# XUNDL

*Compiled  
nuclear  
structure and  
decay data*



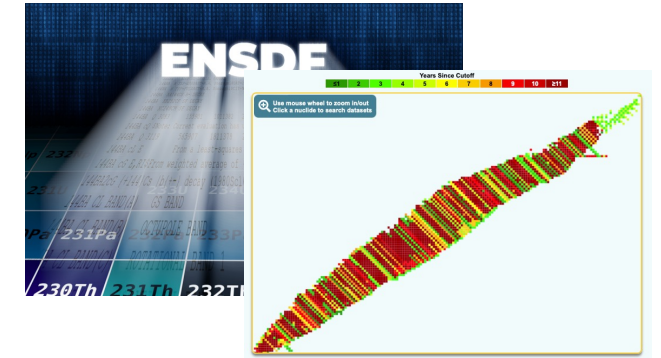
Compiled

182 papers in FY23 including  
52 papers PRC pre-check  
130 papers post-publication

Expanded XUNDL compilation network  
(see talk E. Ricard later today)

# ENSDF

*Recommended nuclear  
structure and decay data*



Submitted 4 mass chains in FY 23

234 : S. Ota

230: C. Morse

72: J. Wu and E. McCutchan

250: E. McCutchan

And ~20 single nuclide evaluations

Adopted Decay Data – funded 3 year project  
beginning FY24

4 proposals to train new ENSDF evaluators  
submitted to ND FOA

# The Cross Section Evaluation Working Group produces ENDF/B library



Formed 1966 & Chaired by BNL

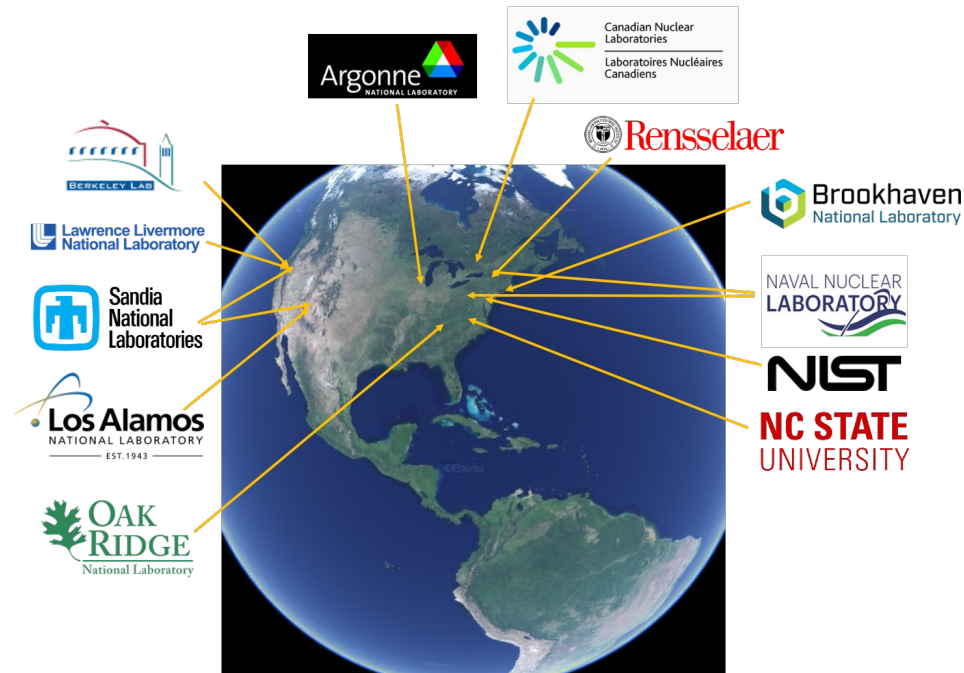
Currently ~200 members of the collaboration from 25 institutions

- US programs, industry and international partners
- If you see something in the library, at some point a sponsor somewhere wanted it

All steps of nuclear data pipeline coordinated through CSEWG

**USNDP (& BNL) have a central role in CSEWG**

- BNL chairs CSEWG
- BNL manages the library
- BNL provides the collaboration infrastructure
- USNDP covers all the evaluations not covered by other programs, leveraging structure-reaction cooperation



November 2023 CSEWG collaboration meeting



# ENDF/B-VII.1 release

Recommended cross sections and distributions for all nuclear applications

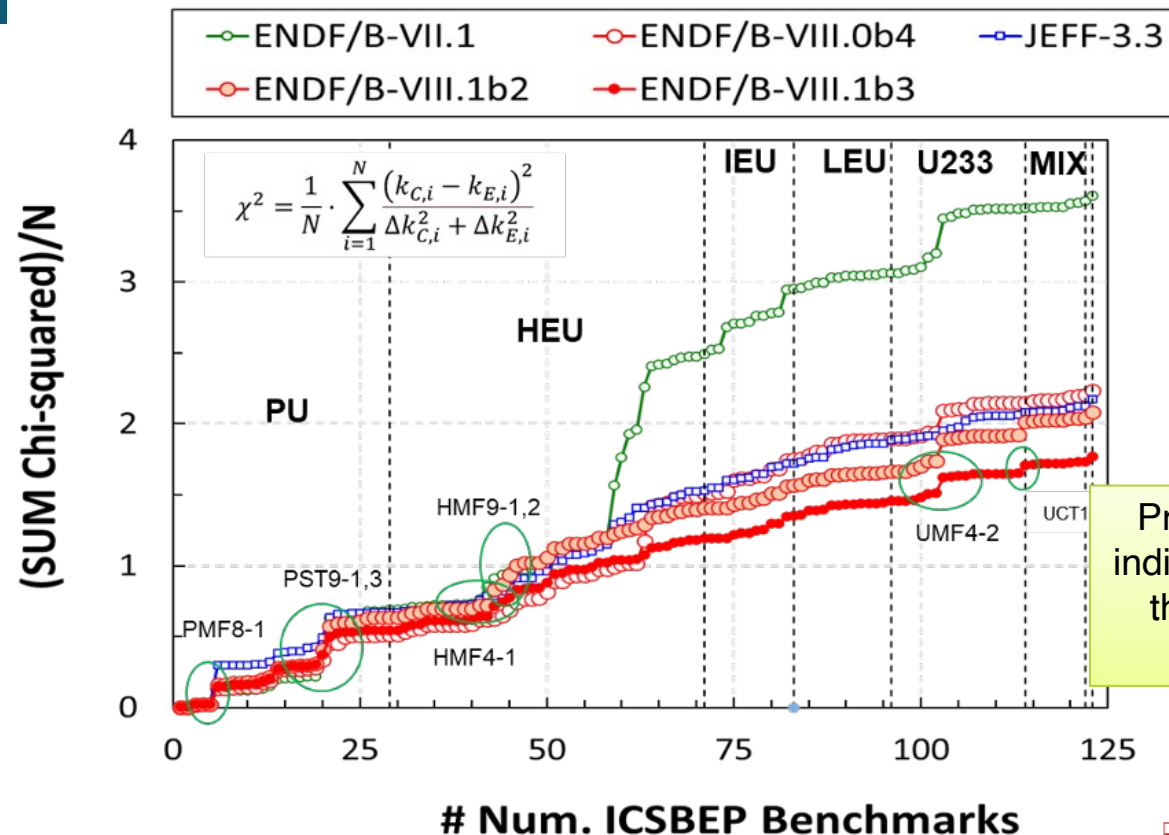
# ENDF/B VIII.1-β3

Multiple Beta versions released in FY23!

The next release is scheduled for May 2024! It will have major impact in the whole community!.

- Many, many important and substantial changes are on the way!!
  - Updates to all **major** and some **minor actinides**
  - Updates and new evaluations for **structural materials**, and **many others**
  - Corrects degraded performance on depletion benchmarks from VIII.0
  - Many new and updated evaluations for thermal neutron scattering
  - Updates to photonuclear, charged particle, atomic libraries, etc.

## Mosteller's Suite - 123



Preliminary validation indicates that this will be the **best-performing** library ever!

□ Plot courtesy of O. Cabellos

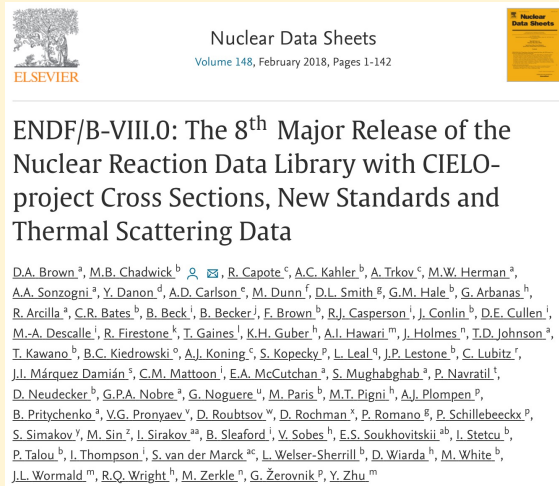
# ENDF/B-VIII.1 accompanying paper

"Big Paper" to be published together with library release

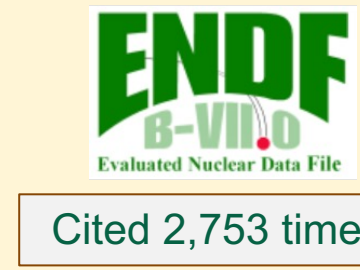
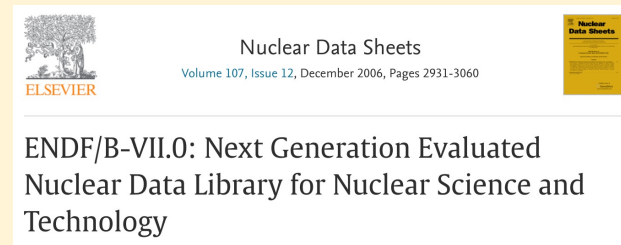
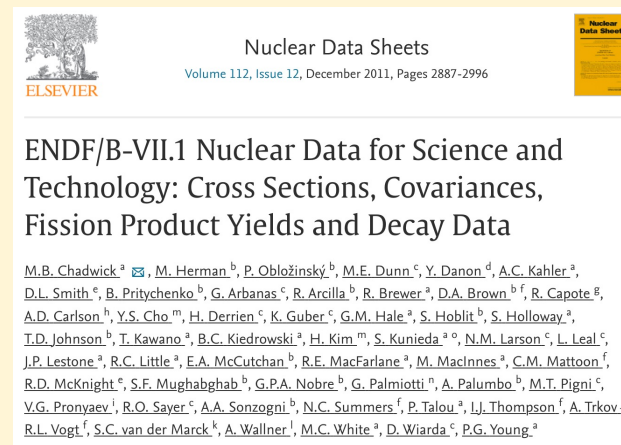
Past ENDF/B releases published accompanying article in **Nuclear Data Sheets**



# ENDF B-VIII.0



Cited 1,658 times!



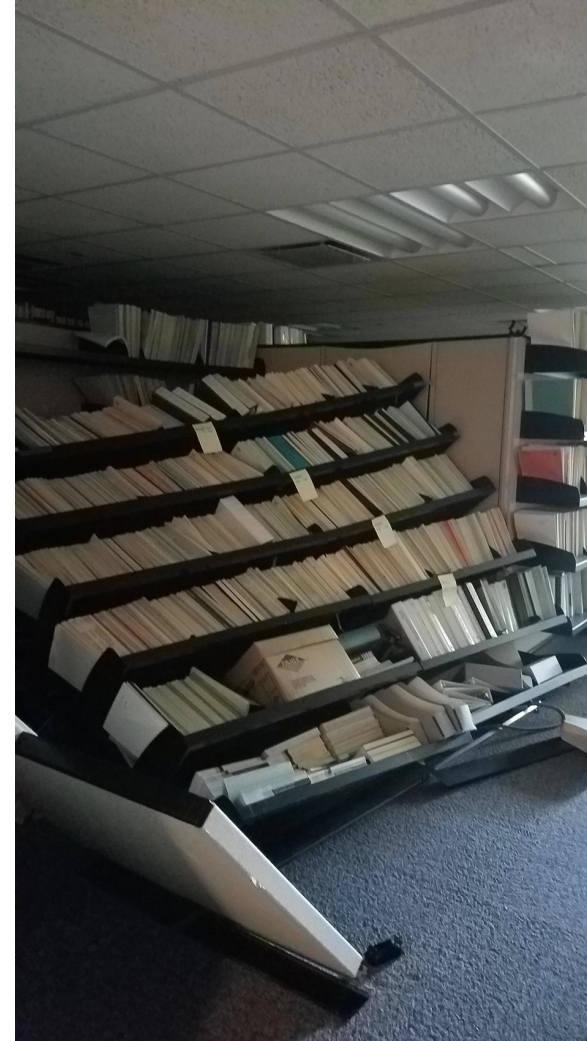
This is really, **really** impactful!!

# NNDC Library Transformation

Pre-COVID



During COVID



# Optimal Downsizing of Library



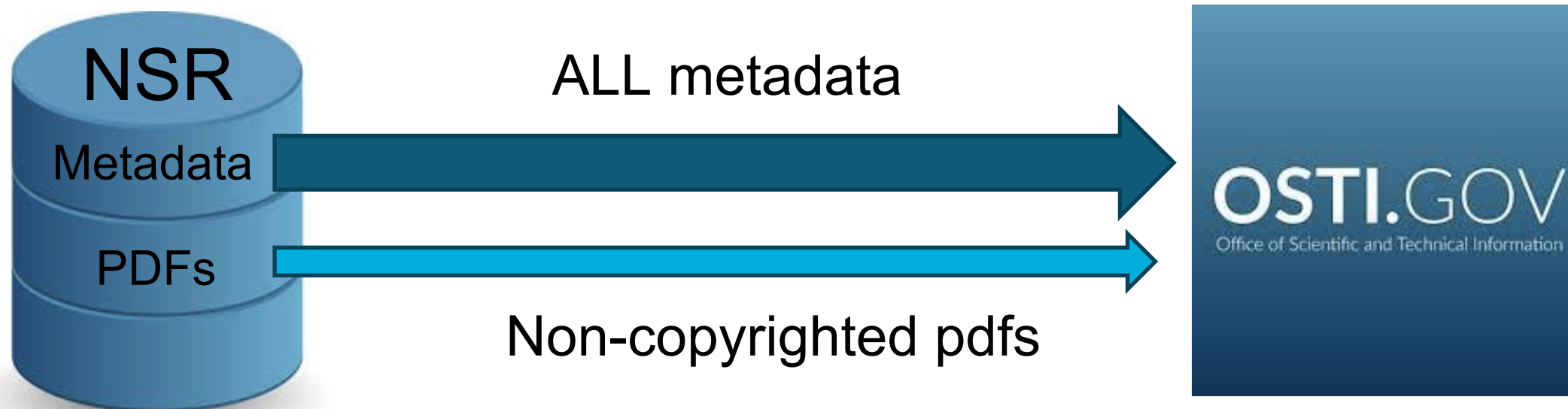
Cat Dunn

- Cross referenced paper material with online availability
- Downloaded pdfs of material available on-line, added to NSR
- Scanned missing NSR refs



Stacy Kuczewski

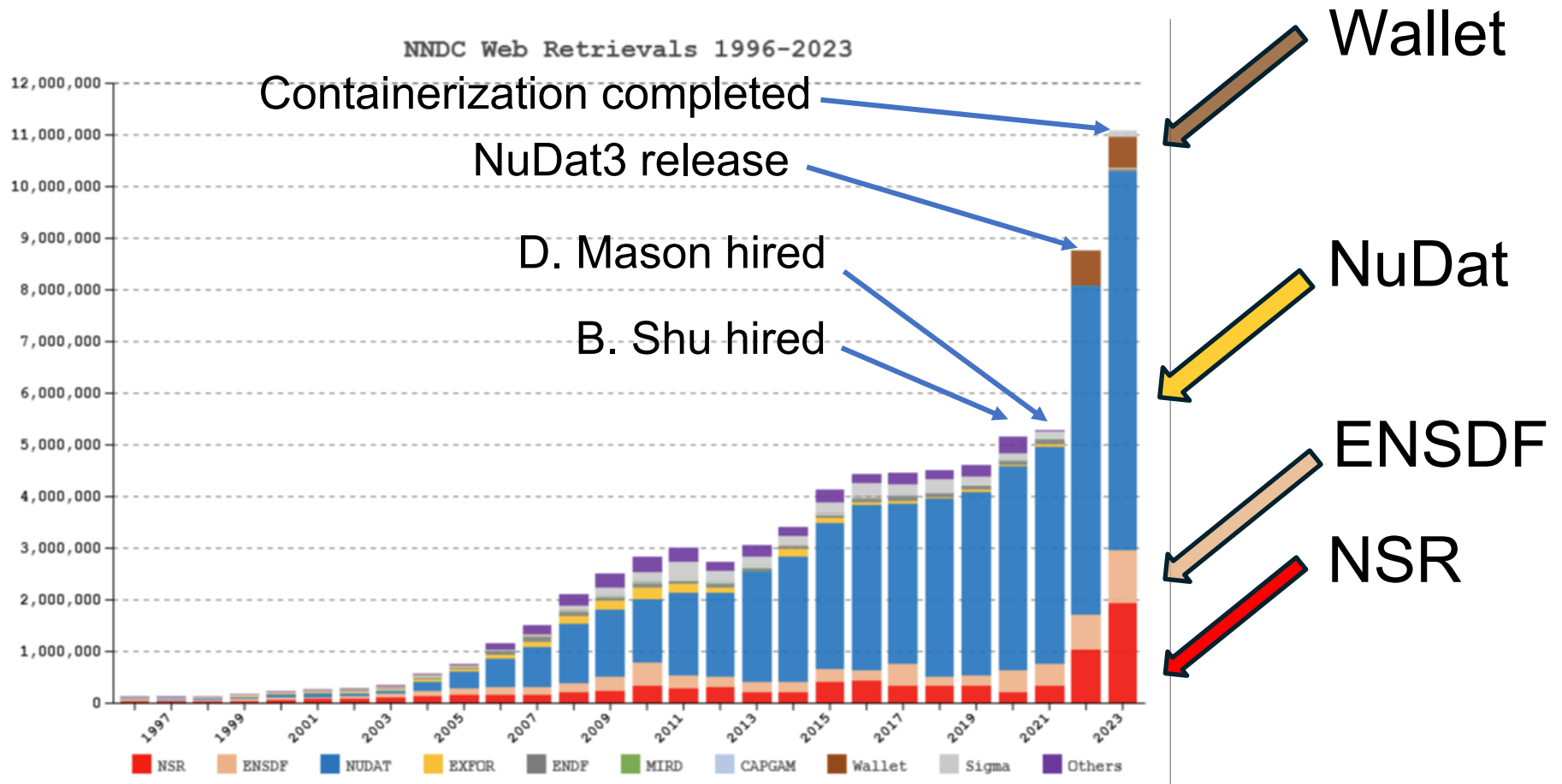
- Cataloged and searched >2,000 books and conference proceedings
- BNL librarian – effort at no cost to USNDP



More than 2 year project – highly leveraged by support from BNL main library

# Web Analytics

- Approximately **11 million** retrievals in FY23 due to modernization efforts
- All web applications had consistent growth
  - Most notably **ENSDF**, **NSR**, and **NuDat 3**



# The essential drivers behind web dissemination

## A dedicated team

- Ramon Arcilla – System Administrator
- Ben Shu – Webmaster, software development
- Donnie Mason – Web and software development



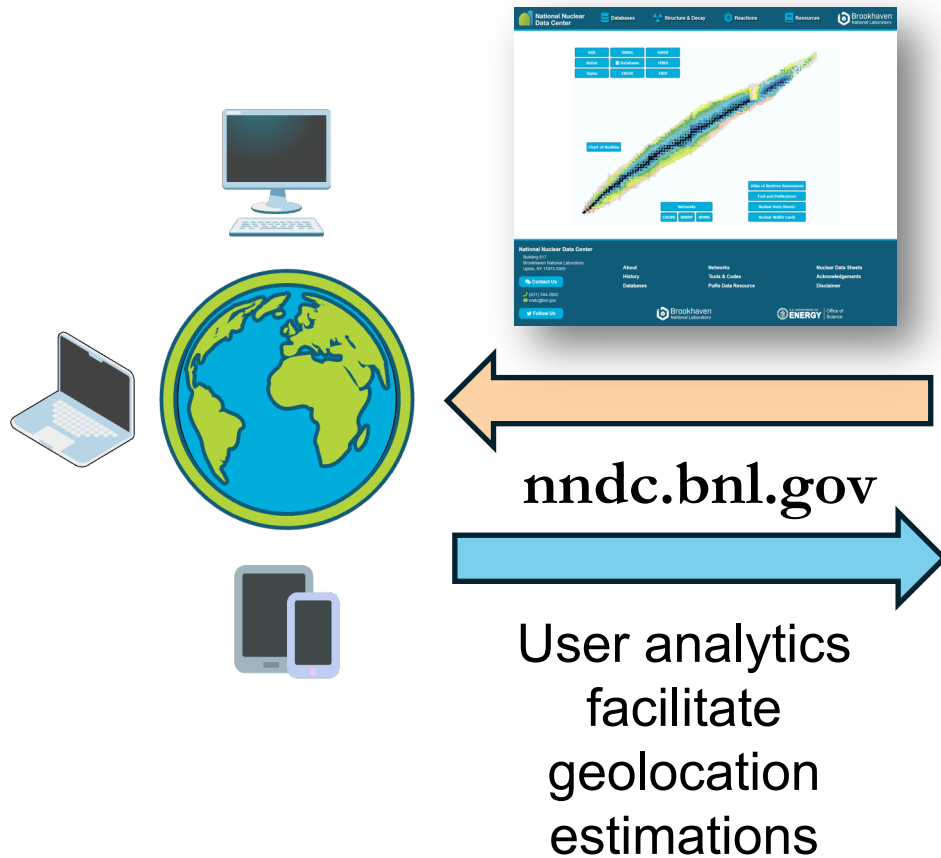
## Web servers upgraded after 5-year lifecycle

- **Machines** : 5 → 3
- **Cores**: 10 → 28
- **RAM**: 192GB → 384GB
- **Storage**: 4.2 TB → 14 TB
- Total cost under budget of \$75k

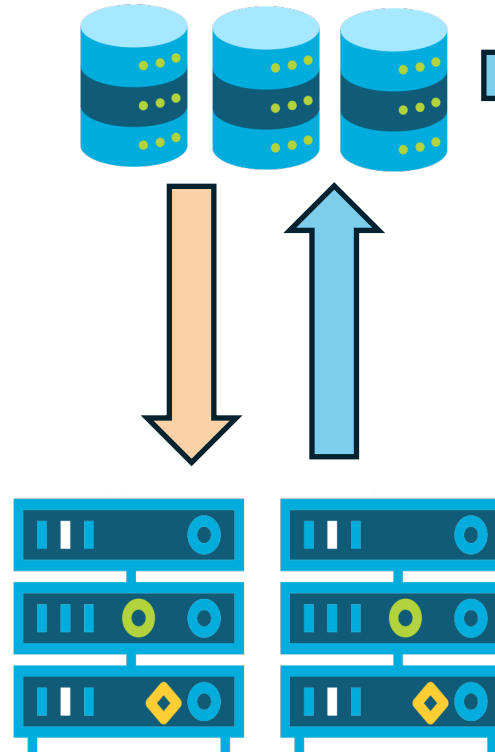


# Web Analytics

Global users from  
1000s of locations

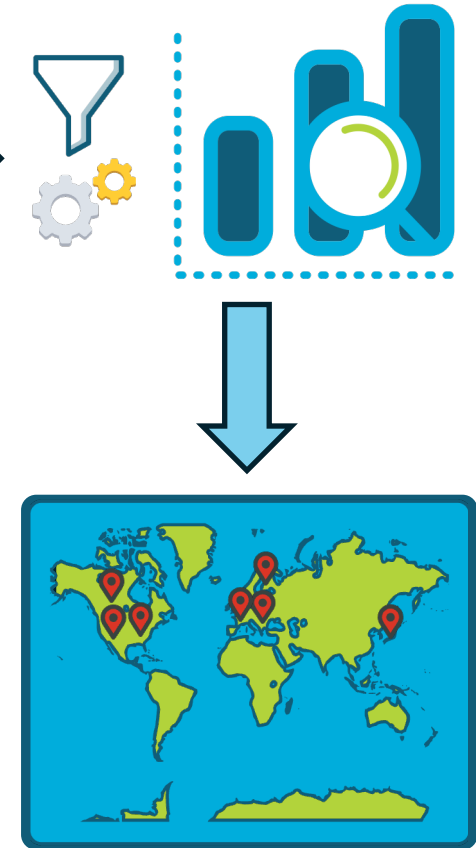


Databases handle  
dynamic content  
and analytics.



Robust servers  
reliably deliver web  
content

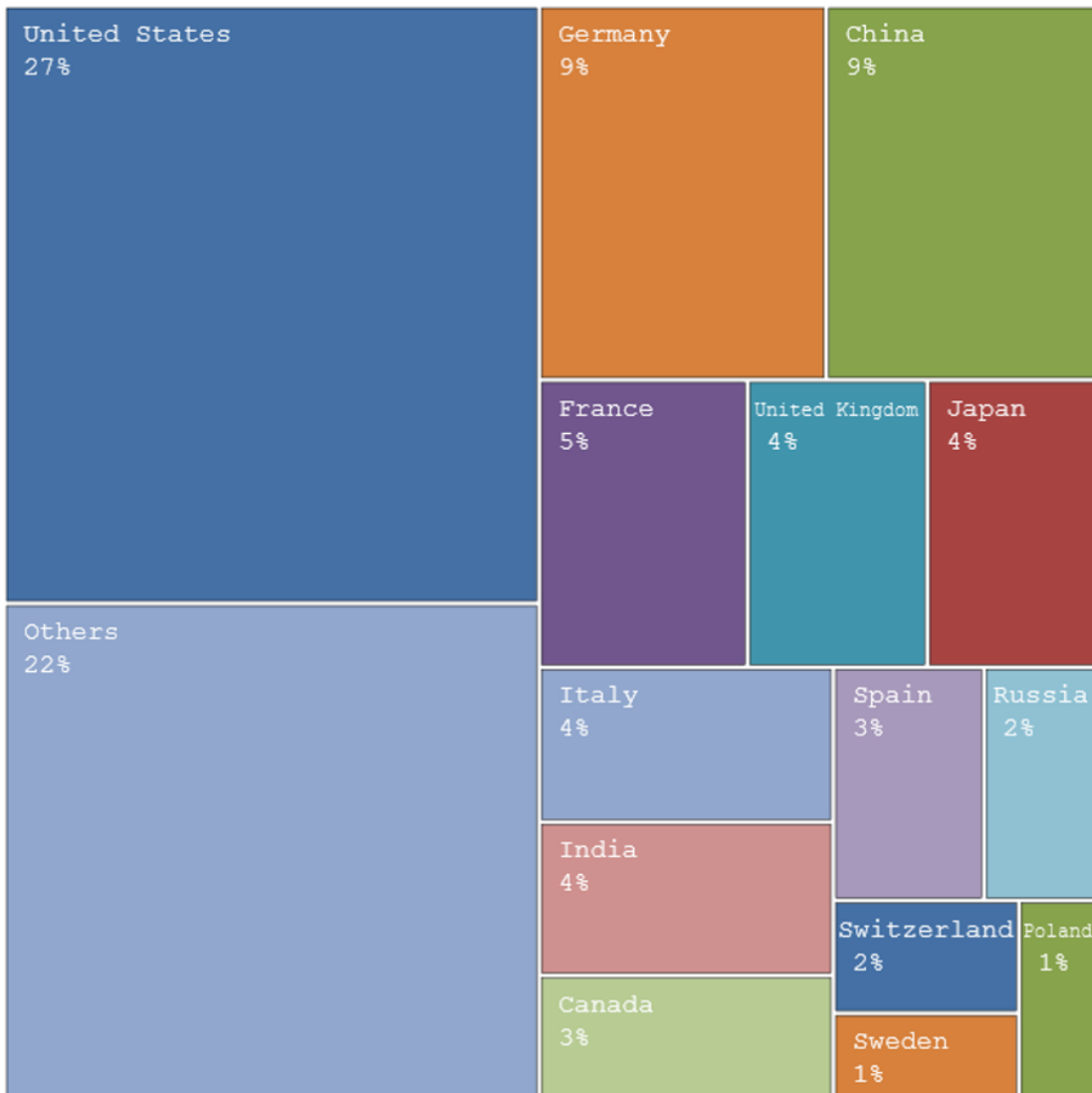
Only a fraction of  
IPs are mappable



No single city makes  
up for more than **2%** of  
total retrievals

# Web Analytics

## NuDat Web Retrievals By Country (FY 2023)



## Top US Cities





# Top Non-US Cities

0.88%

**PADUA, ITALY**  
**((INFN LEGNARO))**

0.35%

**DAEJEON,**  
**SOUTH KOREA**  
**((KAERI))**

0.27%

**SAITAMA, JAPAN**  
**((RIKEN))**

0.1%

**KESKI-SUOMI,**  
**FINLAND**  
**((JYVÄSKYLÄ))**

0.09%

**VANCOUVER,**  
**CANADA**  
**((TRIUMF))**

0.08%

**DARMSTADT,**  
**GERMANY**  
**((GSI))**



# Student highlights



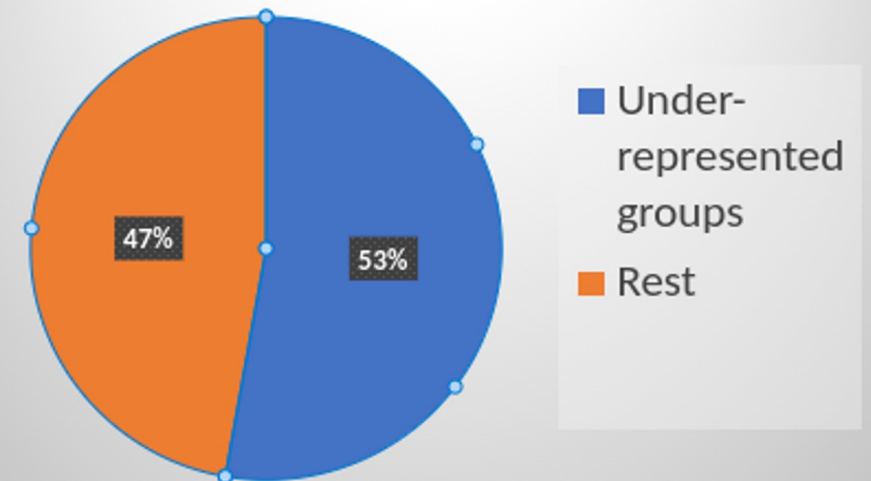
# Training the next generation workforce

NNDC interns and mentors in Summer 2022

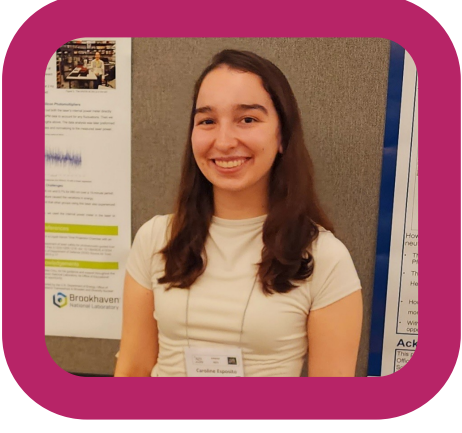
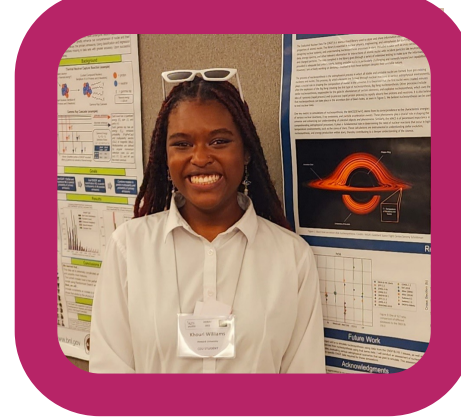
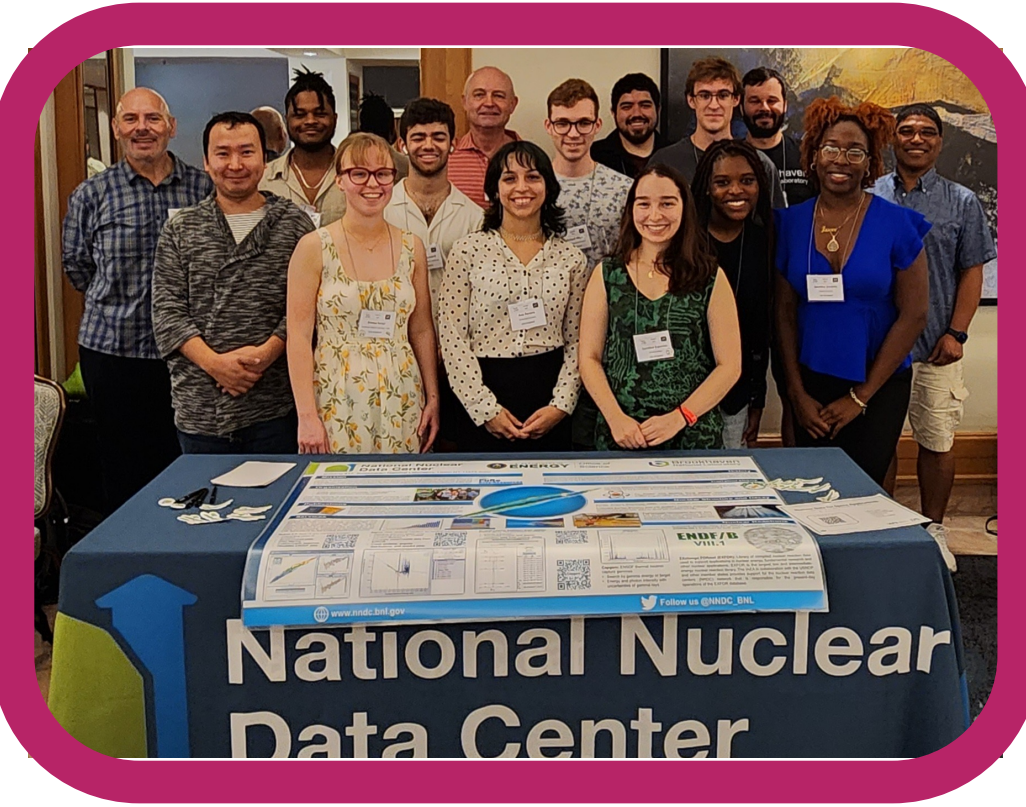
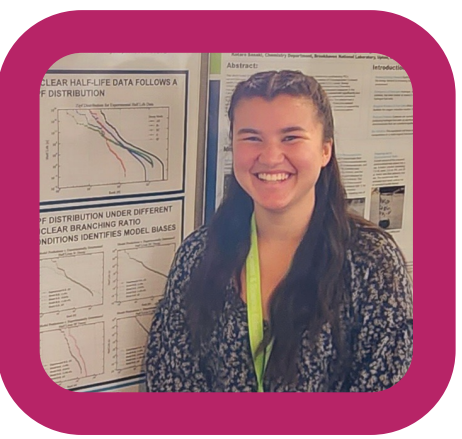
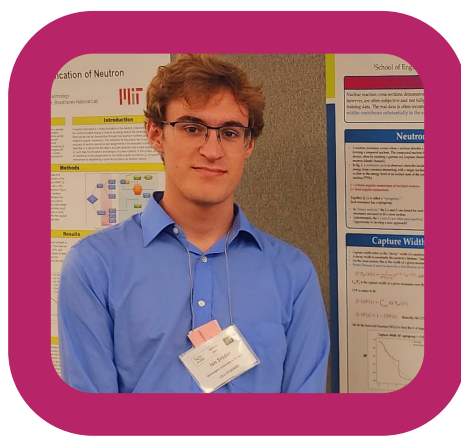


**28** NNDC interns in FY22, **24** in FY23  
108 interns since 2014 | 53% from URG

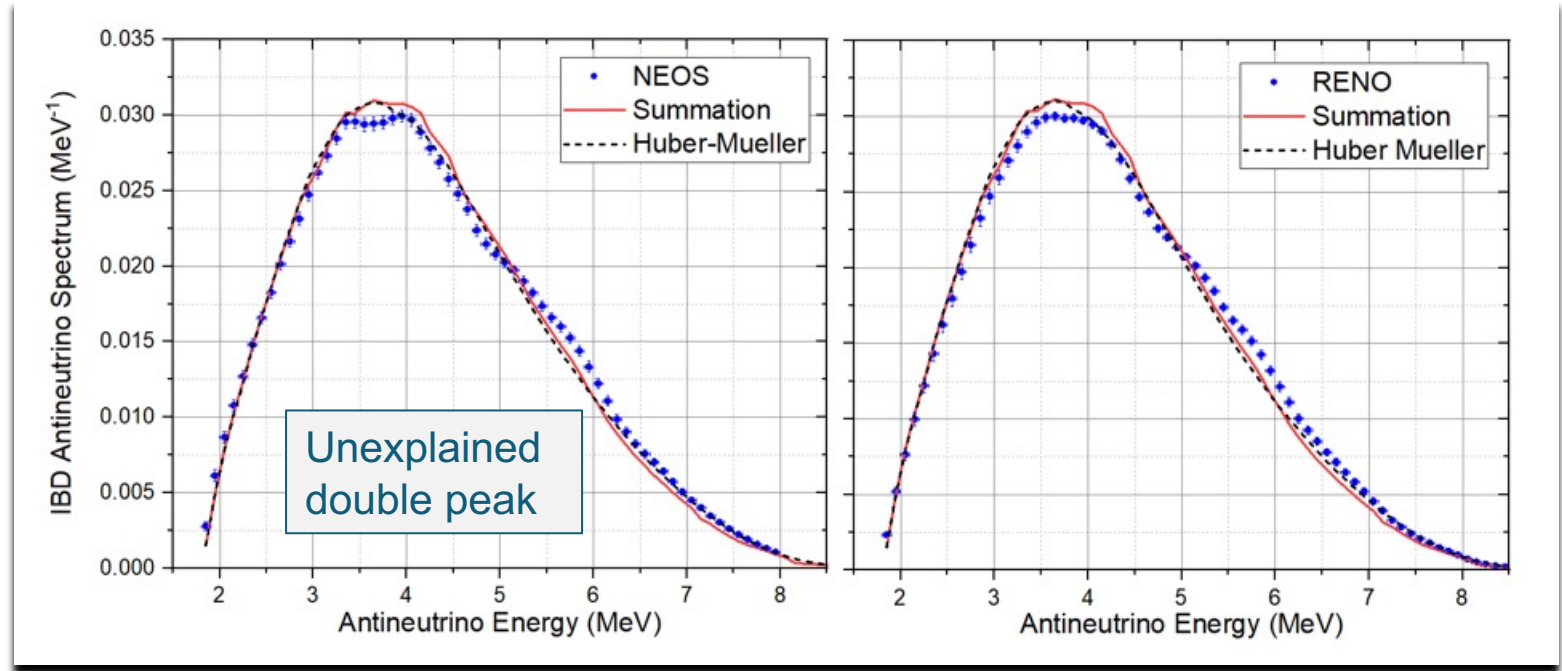
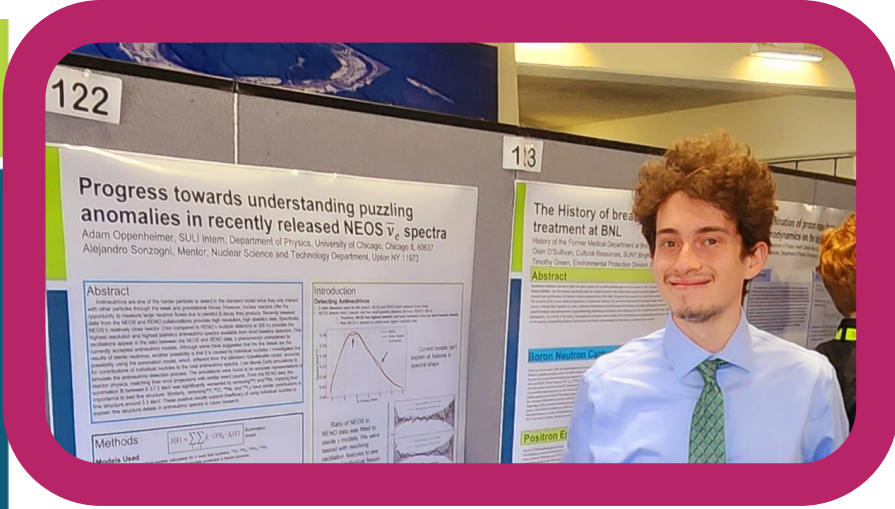
108 NNDC Interns



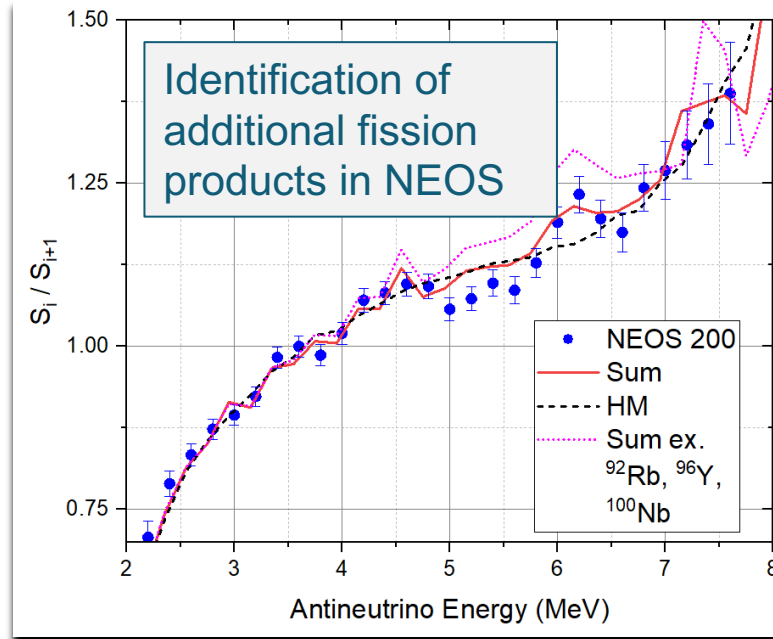
**NNDC Interns**  
 8 interns attended  
 DNP24 with partial  
 NNDC support.



# Adam Oppenheimer Winner of 2023 Ignite Off Competition!



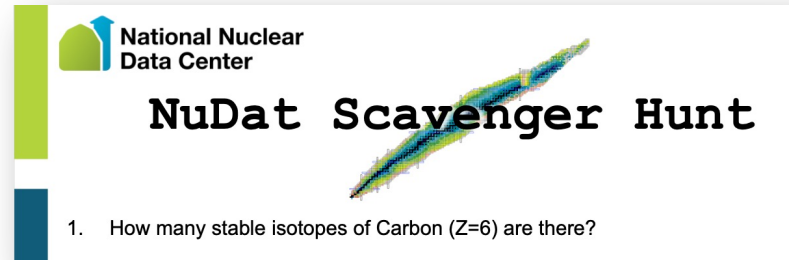
- o NEOS & RENO collaboration published together antineutrino spectra.
- o Same nuclear power plant.
- o NEOS @ 24 m from one reactor, RENO @ <420 m> from 8 reactors.
- o NEOS detector has better resolution since smaller.



# DEI focused outreach activities

## Women in Science and Engineering (WISE)

- 80+ STEM students from Stony Brook
- 2 Full Day Saturday Programs
- Hands-on labs and presentations about ND and applications



## RENEW

- 50+ URM students
- 2 week program led by Physics –  
1 day at NNDC
- WISE activities quickly deployed and adapted



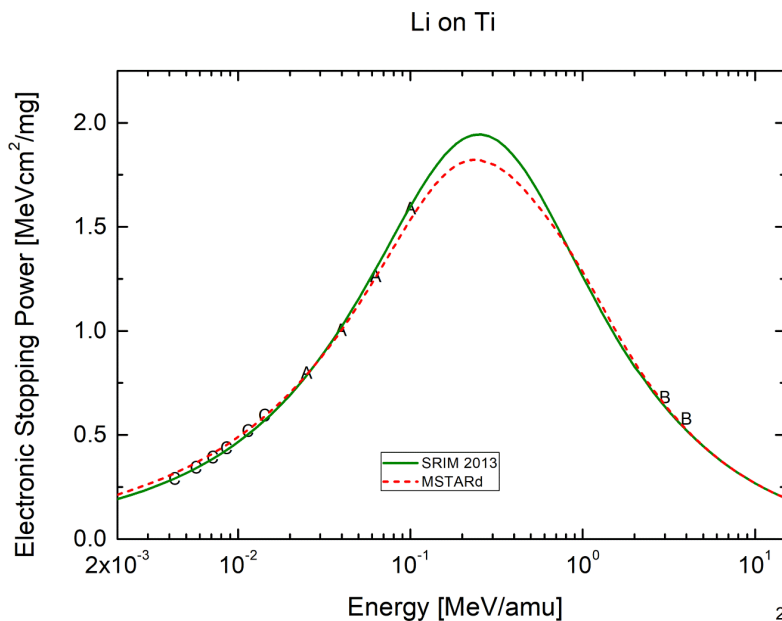


# NNDC Initiatives



# Ion stopping power measurements

- The stopping power of ions in matter is critical information for many activities, e.g. nuclear science, radiotherapeutics, radiation shielding
- Data on stopping powers are sparse or non-existent for many materials, as shown in the figure on the right
- The NNDC is setting up a program to measure stopping powers of ions in various materials to address this need



A typical stopping-power curve. The letters indicate data points while the lines are calculations. Note how the predictions of the peak height differ due to lack of data.

26 May 2021

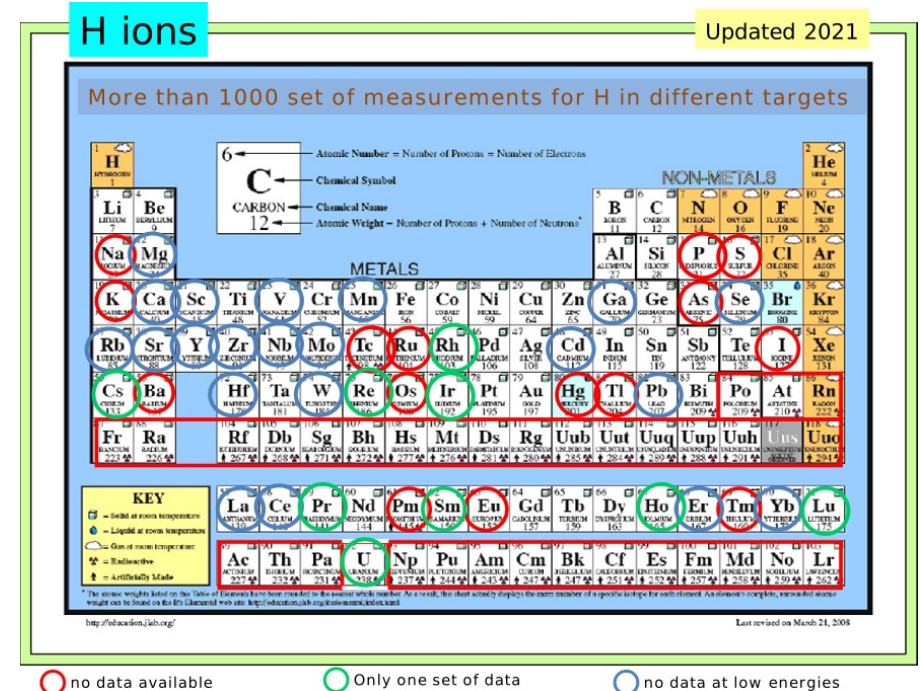
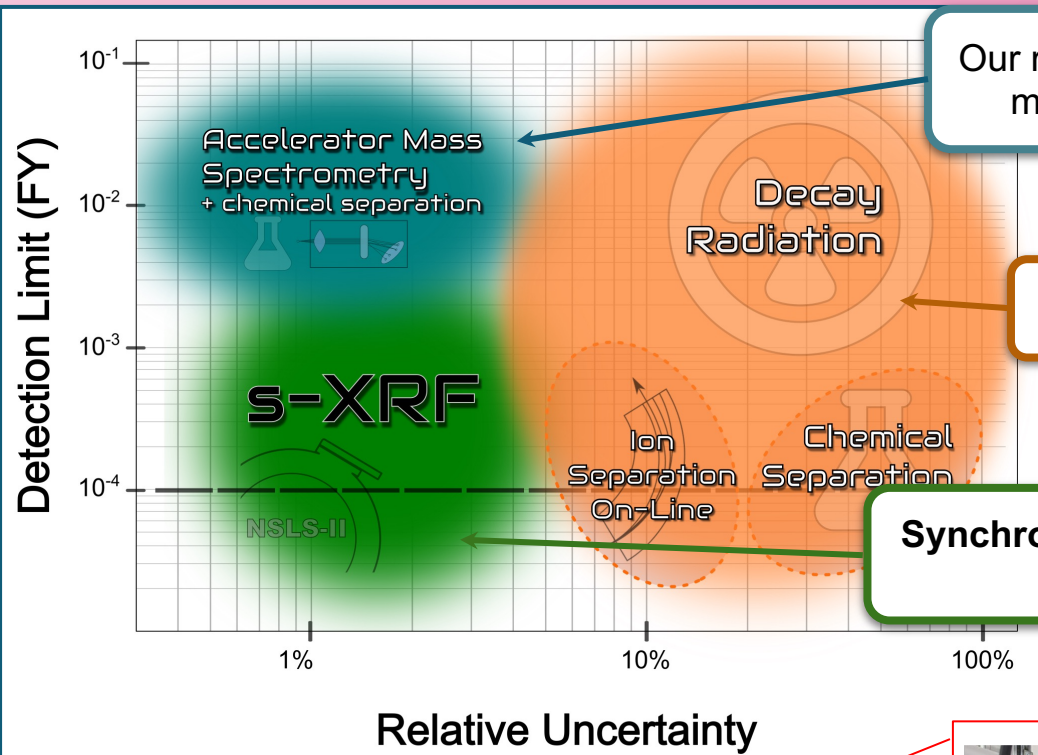


Figure from talk by Claudia Montanari at WANDA2022. Circles indicate elements for which there is little to no data for the stopping power of protons.

1 year LDRD to demonstrate feasibility of measurements.  
PI: C. Morse



# Precise fission yield measurements at NSLS-II using X-ray fluorescence, A. Mattera & M. Topsakal

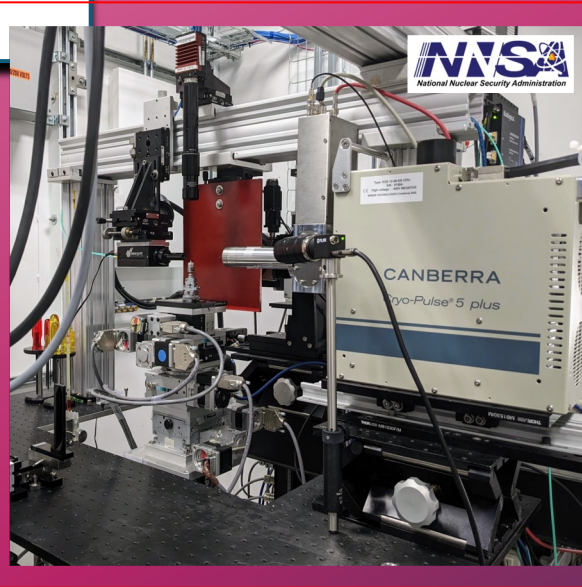


Our recommended fission yields are based on Atomic Mass Spectrometry (AMS) measurements from the 1970s never published in a peer-reviewed journal.

Activation methods rely on nuclear data which introduce additional uncertainty to the yield determination.

**Synchrotron-based x-ray fluorescence can achieve similar precision to AMS but much lower detection limit thanks to NSLS-II brightness.**

**National Synchrotron Light Source - II @ BNL**



Two-year LDRD project, taking advantage of the bright X-ray beams and advanced detectors at NSLS-II to precisely measure charge yields of long-lived fission products from neutron-induced fission of  $^{235,238}\text{U}$  and  $^{239,241}\text{Pu}$  using synchrotron-based X-ray Fluorescence (s-XRF).

Proof of concept:  
Transmutation of Rh into Pd following neutron capture.



# National Nuclear Data Center



U.S. DEPARTMENT OF  
**ENERGY**

Office of  
Science

Maintaining and improving nuclear data for world-wide use

## Nuclear Structure and Decay

### Evaluated Nuclear Structure Data File (ENSDF)

One and only database of recommended values derived from all published experimental nuclear structure and decay data.



### Experimental Unevaluated Nuclear Data List (XUNDL)

Compiled nuclear structure and decay data from recently published articles



Precision measurements of decay radiation properties

## Nuclear Reactions

### Evaluated Nuclear Data File (ENDF)

Recommended neutron reaction data for all nuclei relevant for nuclear science and technology

**ENDF/B  
VIII.1**

