

U.S. Nuclear Data Program

Nuclear Data Advisory Comm
September 13th, 2023

David Brown, NNDC - BNL

Lee Bernstein, UC-Berkeley/LBNL

Jun Chen, MSU

Hye Young Lee, LANL

John Kelley, TUNL

Filip Kondev, ANL

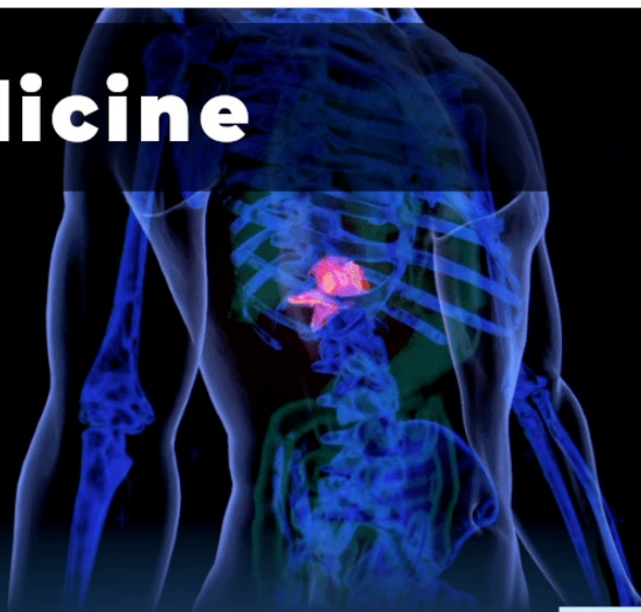
Elizabeth McCutchan, NNDC – BNL

Ninel Nica, TAMU

Michael Smith, ORNL

Ian Thompson, LLNL

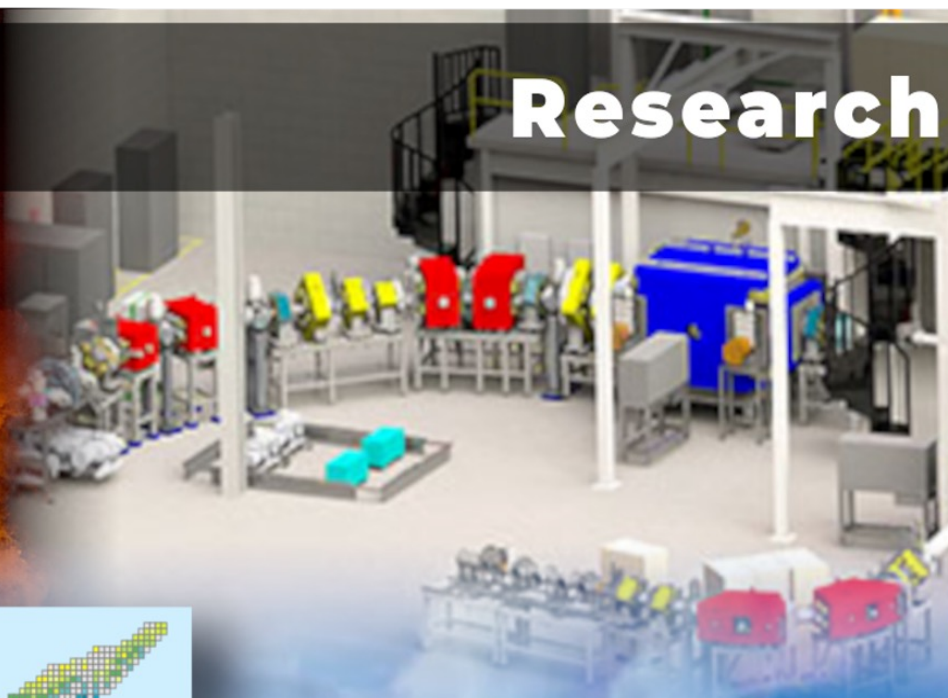
Medicine



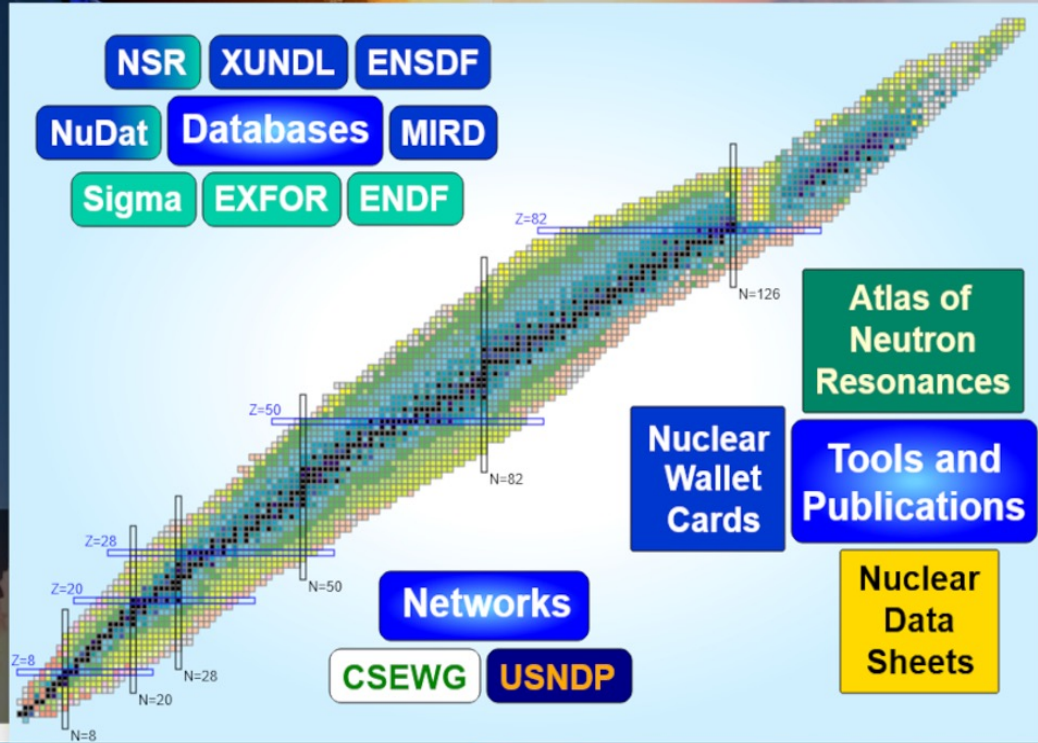
Defense



Research



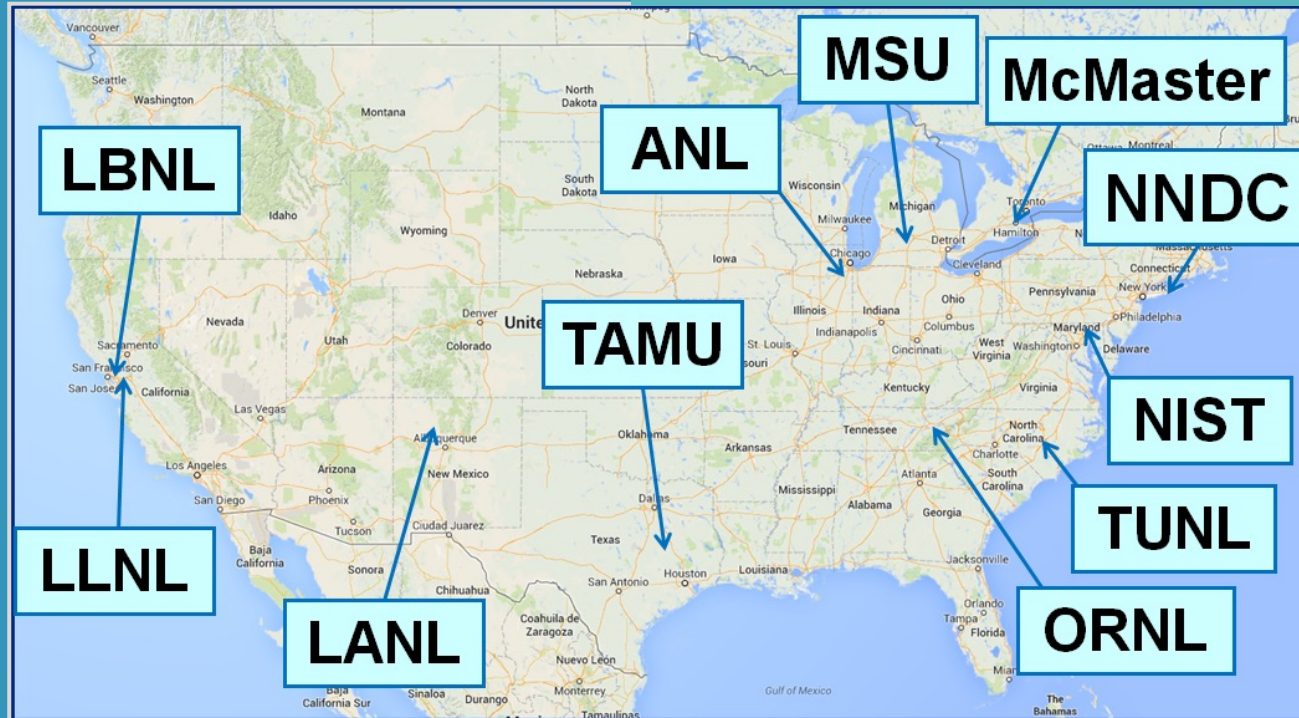
Space Exploration



Power Generation



US Nuclear Data Program



Mission

The mission of the United States Nuclear Data Program (USNDP) 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.

www.nndc.bnl.gov/usndp

US Nuclear Data Program Main Products

Nuclear Science References (NSR)

Nuclear physics articles indexed according to content

EXFOR

Compiled nuclear reaction data

XUNDL

Compiled nuclear structure and decay data

ENSDF

Recommended nuclear structure and decay data

ENDF

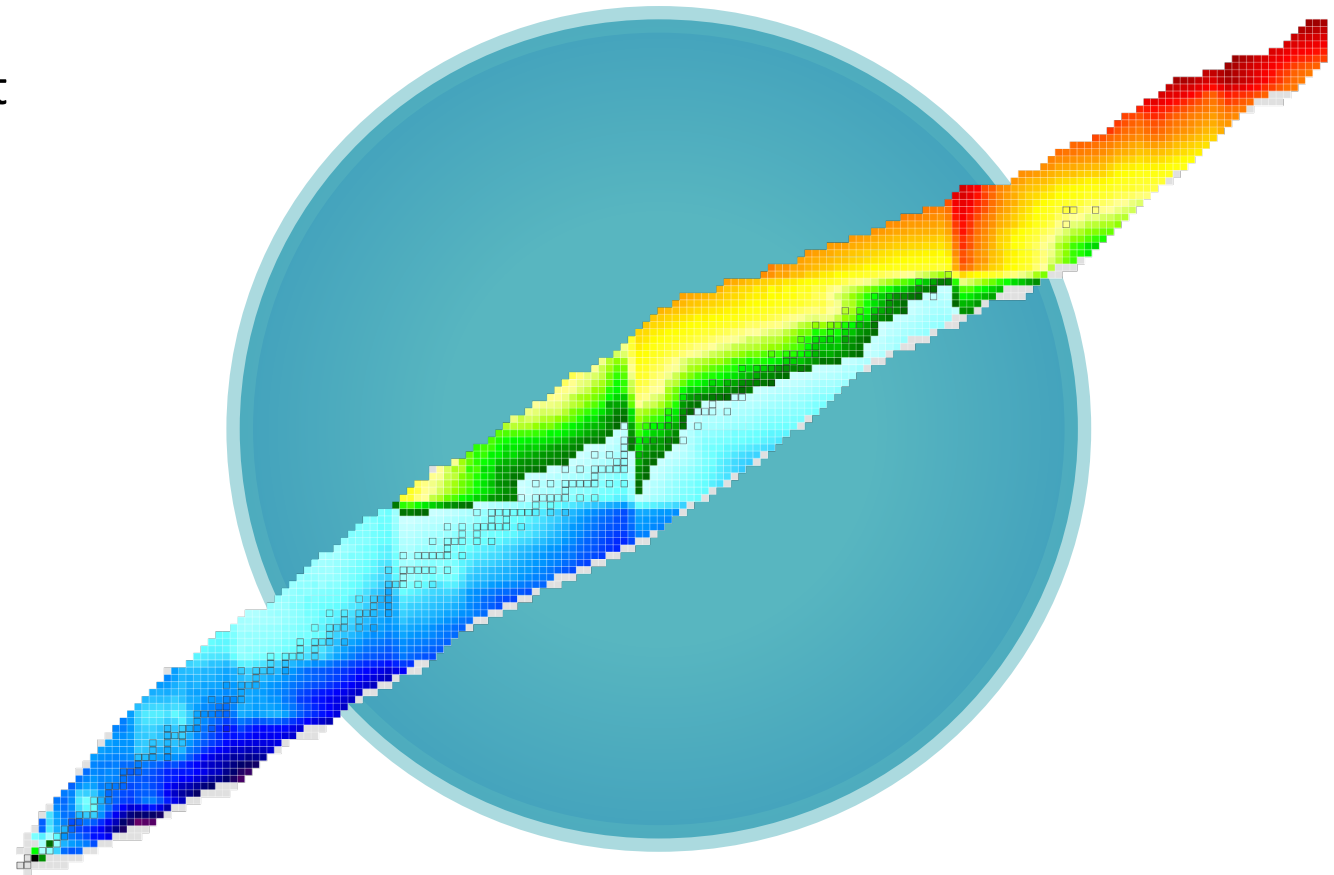
Recommended particle transport and decay data, with a strong emphasis on neutron-induced reaction data

Nuclear Data Sheets

Journal devoted to the publication of nuclear data articles

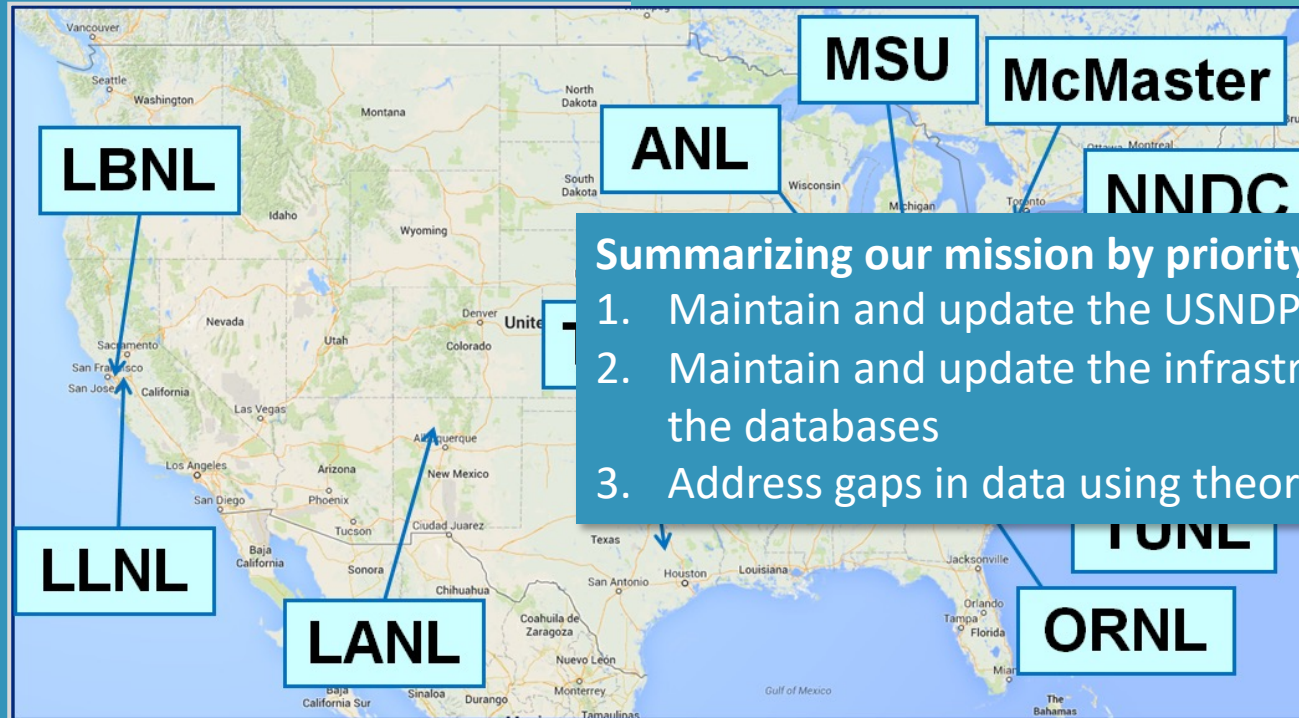
Web dissemination

www.nndc.bnl.gov, nuastrodata.org



Nuclear data science capability to support the development of new reactor concepts.

US Nuclear Data Program



Summarizing our mission by priority:

1. Maintain and update the USNDP databases
2. Maintain and update the infrastructure that supports the databases
3. Address gaps in data using theory and experiment

Mission

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www.nndc.bnl.gov/usndp

Our mission provides clear goals and guides us to new opportunities

| Goal | Challenges and/or Opportunities |
|--|--|
| Maintain and update the USNDP databases | <ul style="list-style-type: none">• Maintaining currency of libraries evaluations (either ENSDF or ENDF). Need resource either in the form of more people or better tools• New users (Fusion, space, etc.) mean more scope, but more fun projects!• New requirements challenge status quo for us and broader community: Open Data, reproducibility |
| Maintain and update the infrastructure that supports the databases | <ul style="list-style-type: none">• We are slowly replacing tools developed in the 1960's and 1970's• New requirements challenge status quo for us and broader community: Open Data, reproducibility |
| Address gaps in data using theory and experiment | <ul style="list-style-type: none">• New users (fusion, space, etc.) create new needs/gaps, but more fun projects!• New (potential) capabilities allow us to address gaps: microcalorimeters, light sources |

Nuclear Data is exciting!
Rewarding careers
Opportunities for diverse & challenging (==fun) projects

**New tools!
New opportunities!**
FRIB, Atlas, LANSCE etc. ,
Microcalorimeters, Light
sources, AI/ML
Space, Fusion, Isotopes, ...

**Building pathways for a
talented workforce**
Recruiting, DEIA & governance

Data Stewardship
More results to users
Better results to users
Open Data
Reproducibility

Modernizing workflow
Faster turnaround
Modern formats/APIs
Easier to maintain and improve
Easier (& more satisfying) to use

Five
opportunities

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A talented workforce

US Nuclear Data Program

FY22 Organizational Chart by center

Nuclear Data PM
Keith Jankowski

| | |
|--------------------------------------|---------------|
| USNDP Chair | David Brown |
| Nuclear Structure Coordinator | John Kelly |
| Nuclear Reactions Coordinator | Hye Young Lee |

| ANL | |
|-------------------------------|------|
| <u>Filip Kondev</u> | 0.70 |
| Daniel Burdette ^{pd} | 0.00 |
| Nathan Callahan ^{pd} | 0.00 |
| Soumen Nandi ^{pd} | 0.00 |

| LLNL | |
|---------------------|------|
| <u>Ian Thompson</u> | 0.25 |

| MSU | |
|----------|------|
| Jun Chen | 1.00 |

| LANL | |
|----------------------------|------|
| <u>Hye Young Lee</u> | 0.15 |
| Toshihiko Kawano | 0.20 |
| Michal Herman | 0.20 |
| Sean Kuvin | 0.15 |
| Panos Gastis ^{pd} | 1.00 |

| ORNL | |
|------------------------------|------|
| <u>Michael Smith</u> | 0.20 |
| Caroline Nesaraja | 1.00 |
| Murray Martin ^c | 0.05 |
| Eric Lingerfelt ^c | 0.05 |
| Larry Zhang ^{gs} | 0.20 |

| LBNL | |
|-----------------------------|------|
| <u>Lee Bernstein</u> | 0.75 |
| Shamsu Basunia | 0.90 |
| Bethany Goldblum | 0.75 |
| Jon Batchelder ^c | 0.75 |
| Aaron Hurst ^c | 0.20 |
| Walid Younes ^c | 0.30 |

| Texas A&M | |
|-------------------|------|
| <u>Ninel Nica</u> | 1.00 |

| TUNL | |
|--------------------------|------|
| <u>John Kelley</u> | 0.75 |
| Jim Purcell ^c | 0.10 |
| Grace Sheu ^p | 0.55 |

| BNL | |
|---------------------------------|------|
| <u>David Brown</u> | 0.35 |
| Ramon Arcilla ^p | 0.97 |
| Allan Carlson ^c | 0.25 |
| Emanuel Chimanski ^{pd} | 0.00 |
| Arantxa Cuadra-Gascon | 0.02 |
| Catherine Dunn ^a | 0.53 |
| Jeannie Frejka ^a | 0.22 |
| Olena Gritzay ^c | 0.10 |
| Adam Hayes | 0.06 |
| Sam Kim ^{pd} | 0.00 |
| Letty Krejci ^a | 1.00 |
| Amber Lauer-Coles ^{pd} | 0.02 |
| Donnie Mason ^p | 0.81 |
| Andrea Mattera ^{pd} | 0.00 |
| Elizabeth McCutchan | 0.55 |
| Christopher Morse | 0.78 |
| Gustavo Nobre | 0.40 |
| Shuya Ota | 0.43 |
| Boris Pritychenko | 0.98 |
| Otto Schwerer ^c | 0.25 |
| Benjamin Shu ^p | 0.72 |
| Balraj Singh ^c | 0.72 |
| Alejandro Sonzogni | 0.10 |
| Carlos Soto ^{pd} | 0.78 |
| Dmytro Symochko ^c | 0.10 |
| Joann Totans ^a | 1.00 |
| Matteo Vorabbi ^{pd} | 0.18 |
| Shinjae Yoo | 0.12 |
| Jin Wu | 0.08 |
| Shaofei Zhu | 0.06 |

PI is underlined.
SC-NP funded FTEs are given in the right column.
 a: administrative,
 c: contractor,
 p: professional,
 pd: post-doc,
 gs: graduate student.

SC-NP funded FTEs
12.82 Scientific perm. FTEs
4.02 Scientific temp. FTEs
5.28 Tech. & Admin. FTEs

US Nuclear Data Program

Organizational Chart by activity

| Nuclear Data Sheets |
|----------------------------|
| <u>Elizabeth McCutchan</u> |
| Jun Chen |
| Letty Krejci |
| Chris Morse |
| Boris Pritychenko |

| EXFOR |
|--------------------------|
| <u>Boris Pritychenko</u> |
| Andrea Mattera |
| Stanislav Hlavac |
| Olena Gritzay |
| Otto Schwerer |

| XUNDL |
|----------------------------|
| <u>Elizabeth McCutchan</u> |
| Jun Chen |
| John Kelley |
| Grace Sheu |
| Balraj Singh |
| Jin Wu |

| ENSDF |
|----------------------------|
| <u>Elizabeth McCutchan</u> |
| Shamsu Basunia |
| John Batchelder |
| Jun Chen |
| Adam Hayes |
| Aaron Hurst |
| John Kelley |
| Filip Kondev |
| Murray Martin |
| Andrea Mattera |
| Chris Morse |
| Caroline Nesaraja |
| Ninel Nica |
| Shuya Ota |
| Jim Purcell |
| Grace Sheu |
| Balraj Singh |
| Alejandro Sonzogni |
| Jin Wu |

| ENDF |
|-----------------------|
| <u>Gustavo Nobre</u> |
| Ramon Arcilla |
| David Brown |
| Allan Carlson |
| Rebecca Coles |
| Arantxa Cuadra-Gascon |
| Michal Herman |
| Toshihiko Kawano |
| Amber Lauer-Coles |
| Andrea Mattera |
| Ian Thompson |
| Matteo Vorabbi |

| NSR |
|--------------------------|
| <u>Boris Pritychenko</u> |
| Catherine Dunn |
| Balraj Singh |
| Dmitro Symochko |
| Joann Totans |
| Walid Younes |

| Web dissemination |
|---------------------|
| <u>Benjamin Shu</u> |
| Ramon Arcilla |
| Adam Hayes |
| Donnie Mason |
| Boris Pritychenko |
| Michael Smith |
| Grace Sheu |
| Alejandro Sonzogni |

| Nuclear Astrophysics |
|----------------------|
| Toshihiko Kawano |
| Amber Lauer-Coles |
| Eric LingerFelt |
| Matthew Mumpower |
| Boris Pritychenko |
| Michael Smith |
| Larry Zhang |

| Nuclear Structure Experiments |
|-------------------------------|
| Lee Bernstein |
| Shamsu Basunia |
| John Batchelder |
| Daniel Burdette |
| Nathan Callahan |
| Sam Kim |
| Filip Kondev |
| Andrea Mattera |
| <u>Elizabeth McCutchan</u> |
| Chris Morse |
| Soumen Nandi |
| Ninel Nica |
| Shuya Ota |
| Jin Wu |

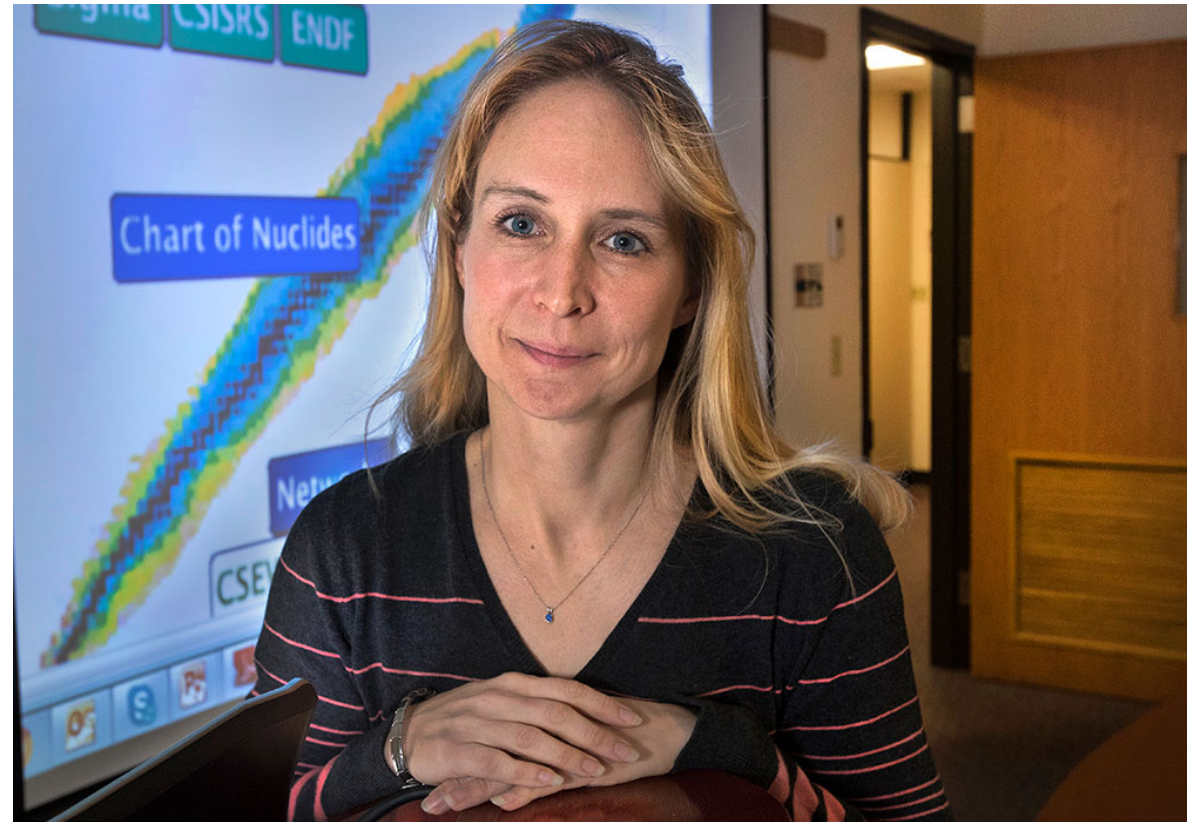
Database/Project manager is underlined when applicable.

| Nuclear Reaction Experiments |
|------------------------------|
| John Batchelder |
| Lee Bernstein |
| Joshua Brown |
| Panos Gastis |
| Bethany Goldblum |
| Aaron Hurst |
| Sean Kuvin |
| Hye Young Lee |

| Coordination |
|---------------------|
| Lee Bernstein |
| David Brown |
| John Kelly |
| Hye Young Lee |
| Elizabeth McCutchan |
| Gustavo Nobre |

Elizabeth (Libby) McCutchan

- APS Fellow 2022
- Citation: *“For innovative and distinguished contributions to understanding the evolution of collectivity in heavy nuclei, critical precision experiments to test ab initio methods in light nuclei, seminal analyses of antineutrino spectra, and the development of new database tools to understand nuclear data.”*



<https://www.bnl.gov/newsroom/news.php?a=120865>

28 Students in FY22!



Half of students from traditionally underserved groups

Andrea Mattera will continue the discussion this afternoon on DEIA

Each lab will present a personnel update as part of their lab summary

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Microcalorimeters, Light sources, AI/ML
Space, Fusion, Isotopes, ...

Building pathways for a talented workforce
Recruiting, DEIA & governance

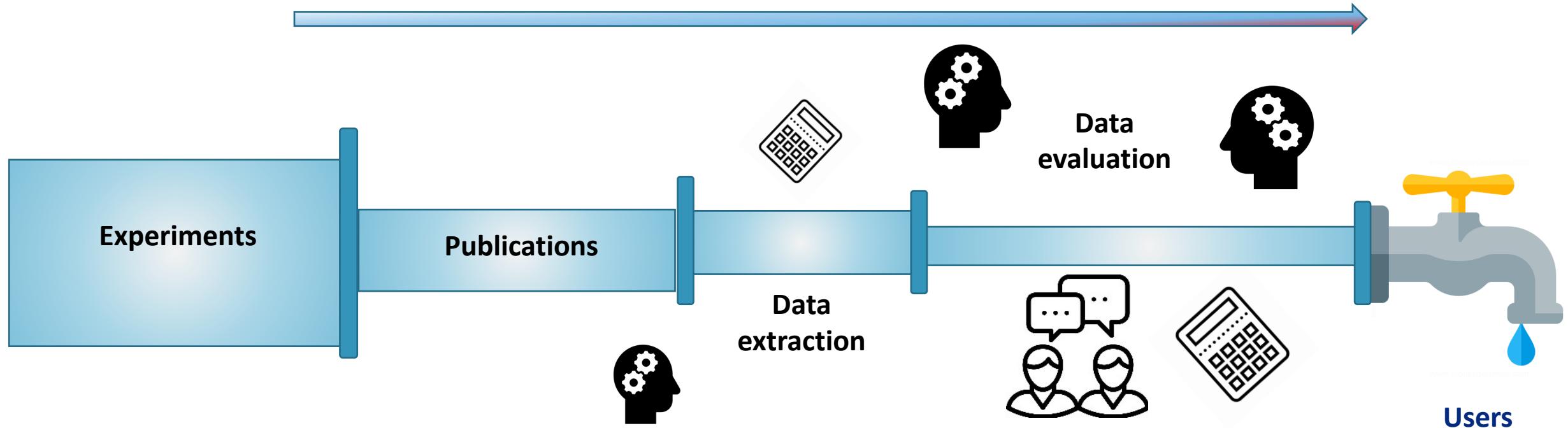
Data Stewardship
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Open Data
Reproducibility

Modernizing workflow
Faster turnaround
Modern formats/APIs
Easier to maintain and improve
Easier (& more satisfying) to use

Modernizing workflow

Nuclear Data Pipeline, now

Current timeline of about **5 – 10 years**

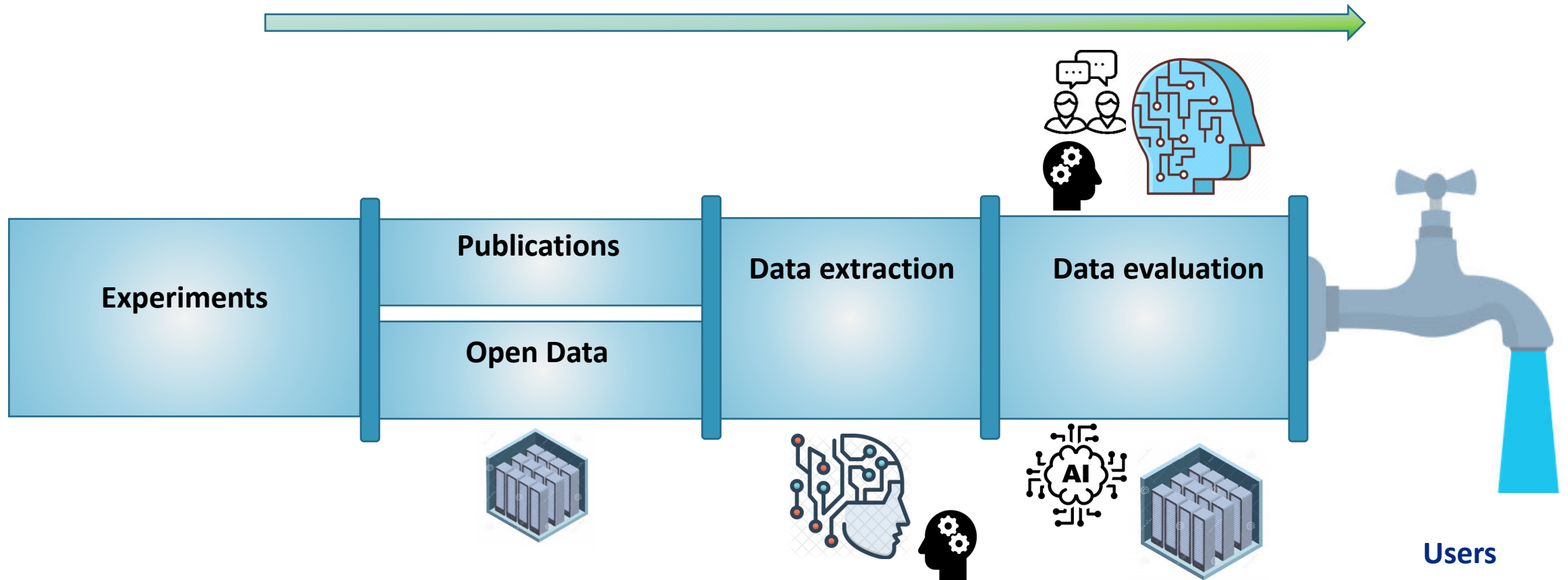


Our product's impact is limited by:

- Outdated formats
- Outdated evaluation procedures
- Often publications only contain a portion of all data measured

Nuclear Data Pipeline, 2028

Proposed timeline of about 1 – 2 years



This new paradigm will address bottlenecks, ensure that results of expensive experiments are properly stored, and address stakeholders' feedback in a timely manner.

Several of us will continue the discussion today and tomorrow:

- Lee Bernstein - NucScholar
- Chris Morse – ENSDF modernization
- Boris Pritychenko – EXFOR modernization
- Ben Shu & Donnie Mason – Web modernization

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Data stewardship

NSR

Nuclear physics articles indexed according to content

- Compilations: 3,284 (new), 2,391 (keyworded)
- NSR Dictionaries: 2,317 new authors, 14 new journals, 123 new decays, 123 new reactions, 573 new nuclides
- NSR Web (October-June): 301,455 retrievals, 79 references/retrieval
- Dr. D. Symochko replaced Dr. B. Singh as a PR/C compiler. D. Symochko was trained by B. Singh and B. Pritychenko.
- Raw NSR entries were prepared by Joann Totans (NNDC).

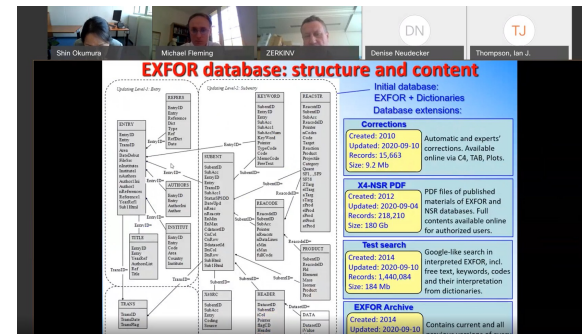
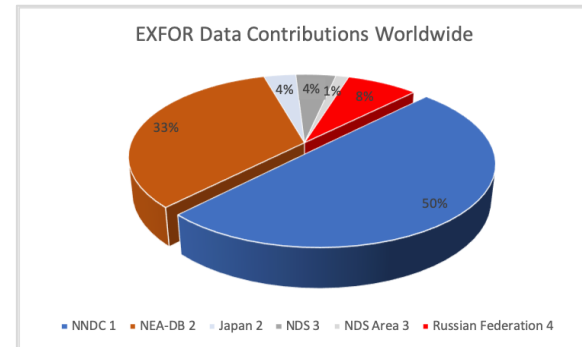
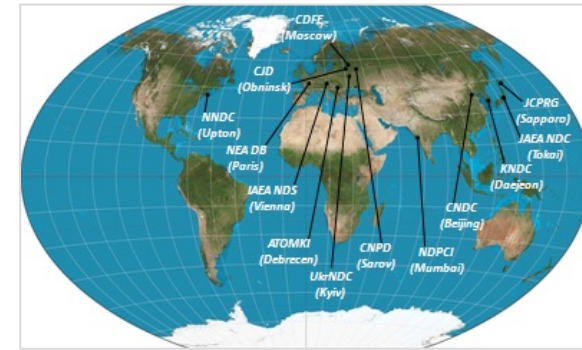
B. Pritychenko is the library manager for NSR & the EXFOR Area 1 representative



EXFOR

Compiled nuclear reaction data

- NNDC responsible for Area #1 (US & Canada)
- Compilations: 158 (new), 210 (updated)
- 29 preliminary and 31 final compiled data transmissions to the IAEA/NRDC (Refereed compilations).
- Fixed deficient Karlsruhe entries (CP-C/472).
- Finished compilations of missing Los Alamos reports, reduced by 50% old unobtainable (UNOBT) data entries with digitization and compilations.
- Working Party on International Nuclear Data Evaluation Co-operation (WPEC) – SubGroup 50



ENSDF

Recommended nuclear structure and decay data

| Center | Nuclides | Adopted Levels | Adopted Gammas | Mass Chains |
|--------|----------|----------------|----------------|-------------|
| ANL | 12 | 489 | 603 | 1 |
| BNL | 139 | 3560 | 5300 | 5 |
| LBNL | 22 | 1574 | 1878 | 2 |
| MSU | 24 | 1878 | 2636 | 2 |
| ORNL | 9 | 119 | 252 | 1 |
| TAMU | 17 | 1256 | 2604 | 1 |
| TUNL | 7 | | | 1 |

Evaluated **230** nuclides, **13** mass chains

FY21 was 263 nuclides, 14 mass chains

In 2020 , 2021 & 2022 :

1 nuclide from an international center

XUNDL

Compiled nuclear structure and decay data

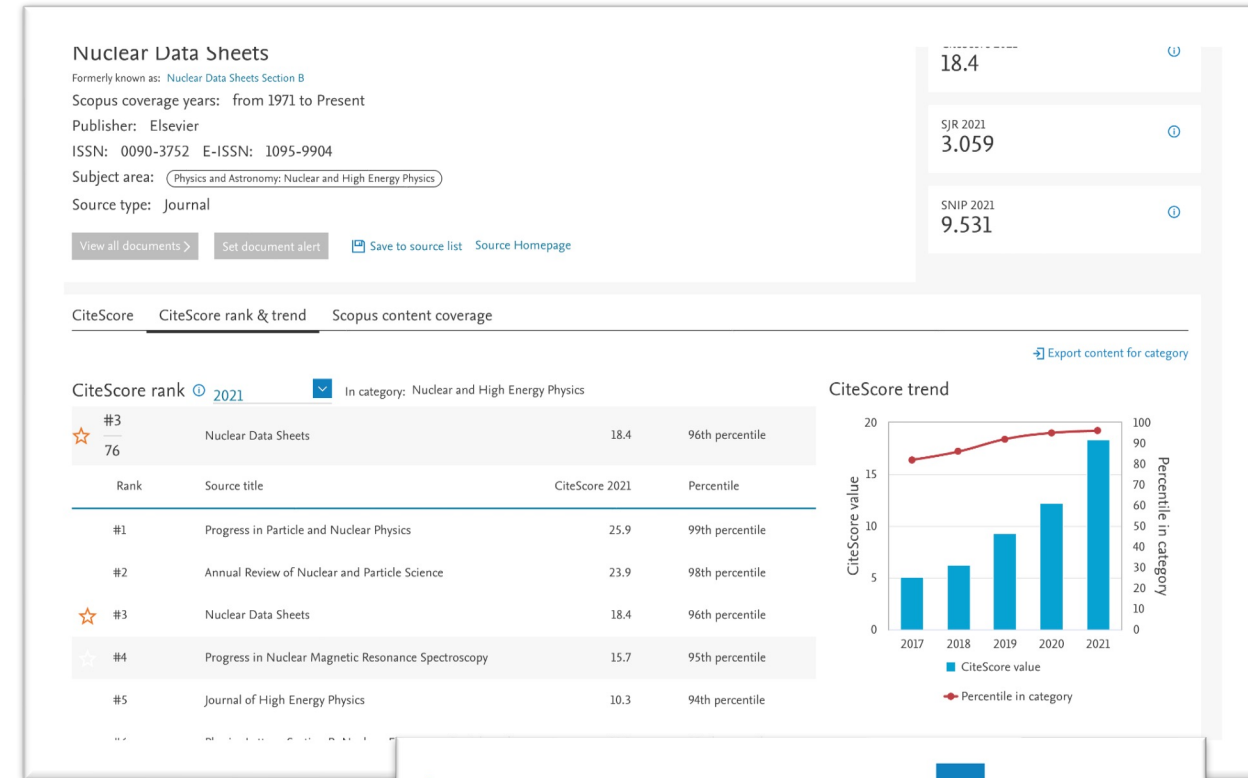
| Center | Papers | Datasets |
|--------|--------|----------|
| BNL | 255 | 464 |
| MSU | 40 | 95 |
| TUNL | 40 | 49 |

- **Compiled 608 datasets from 335 papers**
- (FY21 was 689 datasets from 356 papers)
- Full database is **10,158** datasets for **2827** nuclides

Nuclear Data Sheets

- Nuclear Data Sheets for A=194
- Nuclear Data Sheets for A=203
- [Measurement of \(n,f\) Cross Section Ratio with NIFFTE](#)
- Nuclear Data Sheets for A=64
- Nuclear Data Sheets for A=48
- Nuclear Data Sheets for A=126
- Nuclear Data Sheets for A=147
- Nuclear Data Sheets for A=213
- Nuclear Data Sheets for A=236
- Nuclear Data Sheets for A=267,271,275 ...
- Nuclear Data Sheets for A=269,273,277,...
- Nuclear Data Sheets for A=186
- [Stopping Force Analysis for NIFFTE](#)
- Nuclear Structure and Decay Data for A=31

J. Chen, B. Singh
 F. Kondev
 L. Snyder
 B. Singh, J. Chen
 J. Chen
 H. Imura et al.,
 N. Nica, B. Singh
 M.S. Basunia
 S. Zhu
 C. Morse
 C. Morse
 J.C. Batchelder et al.,
 M.E. Moore
 J. Chen, B. Singh



Good news !!!

- Lots of mass chains waiting in the queue
- Several traditional manuscripts: FY measurements, standards cross sections, high energy cross sections for space/medical applications

Several of us will continue the discussion today and tomorrow:

- Gustavo Nobre – ENDF
- Filip Kondev - AME & NUBASE
- Elizabeth McCutchan - PuRe
- Jin Wu, Elizabeth McCutchan, and all of the USNDP – Open Data

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Rewarding careers
Opportunities for diverse & challenging (==fun) projects

**New tools!
New opportunities!**
FRIB, Atlas, LANSCE etc. ,
Microcalorimeters, Light sources, AI/ML
Space, Fusion, Isotopes, ...

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Recruiting, DEIA & governance

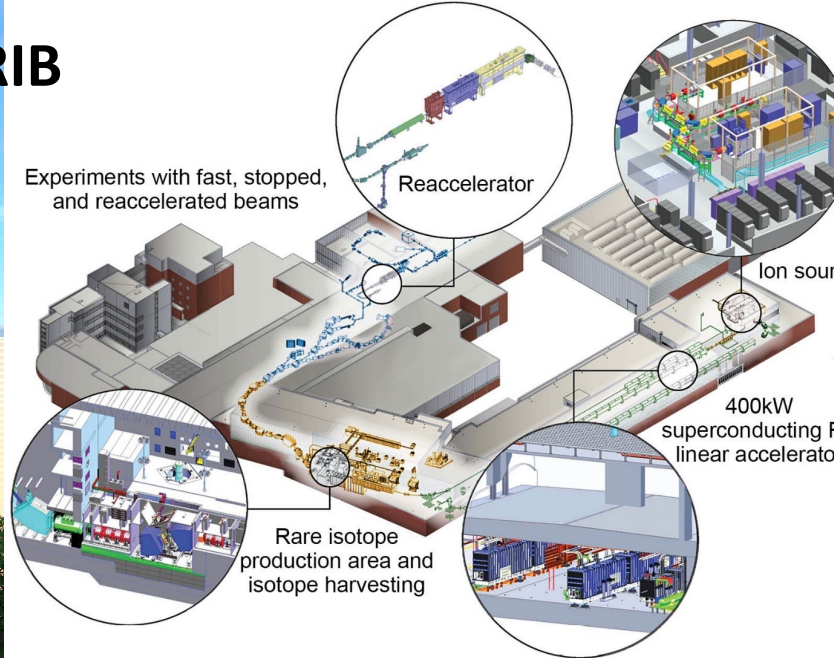
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Easier (& more satisfying) to use

New capabilities & opportunities



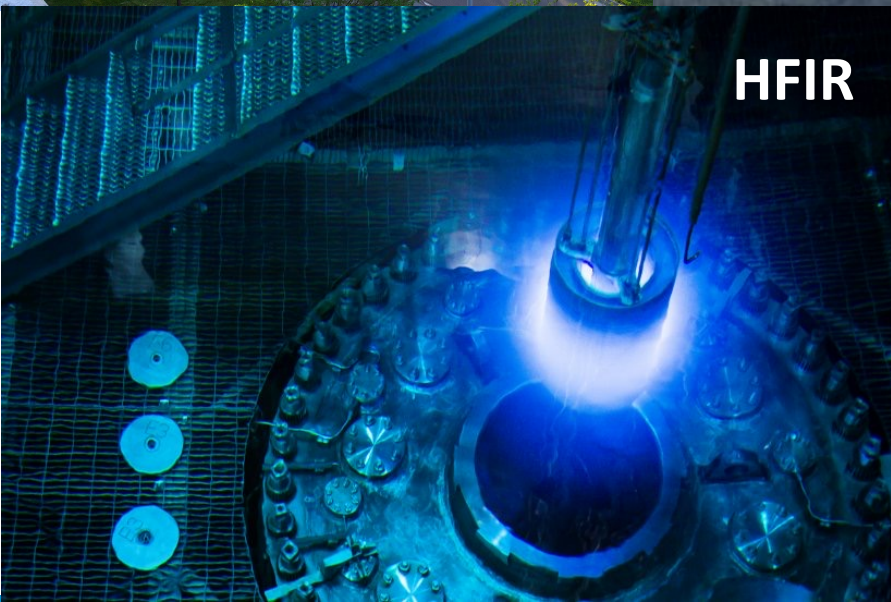
FRIB



NSLS-II



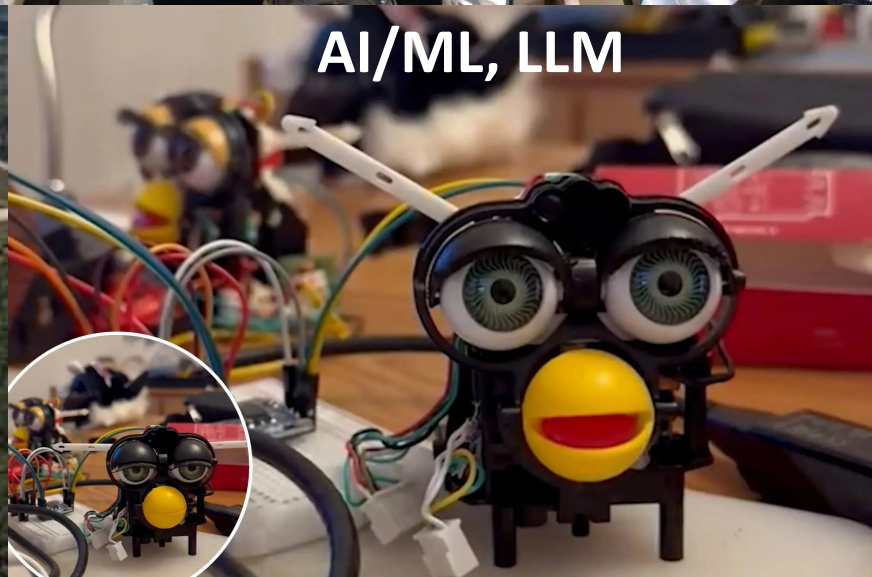
ATLAS



HFIR



SNS



AI/ML, LLM

Several of us will continue the discussion today and tomorrow:

- Alejandro Sonzogni - Microcalorimeters
- Lee Bernstein – Nuclear Data for Fusion
- Emanuel Chimanski – Nuclear Data for Space Applications

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Planning

Nuclear Data strongly endorsed at all 3 NP Town Hall Meetings!



2022 Low Energy Town Hall

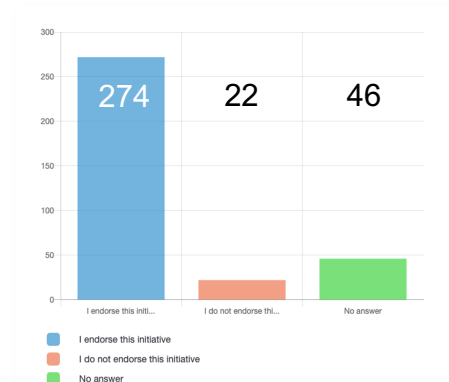
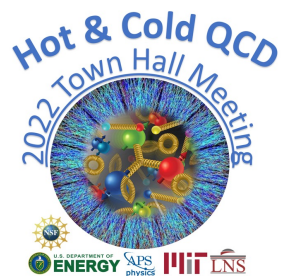
Nuclear Data Initiative

Nuclear data play an essential if sometimes unrecognized role in all facets of nuclear physics. Access to accurate, reliable nuclear data is crucial to the success of important missions such as nonproliferation and defense, nuclear forensics, homeland security, space exploration, and clean energy generation, in addition to the basic scientific research underpinning the enterprise. These data are also key to innovations leading to new medicines, automated industrial controls, energy exploration, energy security, nuclear reactor design, and isotope production. It is thus crucial to maintain effective US stewardship of nuclear data.

- We recommend identifying and prioritizing opportunities to enhance and advance stewardship of nuclear data and maximize the impact of these opportunities.
- We recommend building and sustaining the nuclear data community by recruiting, training, and retaining a diverse, equitable and inclusive workforce.
- We recommend identifying crosscutting opportunities for nuclear data with other programs, both domestically and internationally, in particular with regard to facilities and instrumentation.

Similar Nuclear Data Initiatives statements endorsed by each of

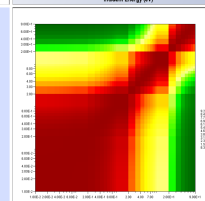
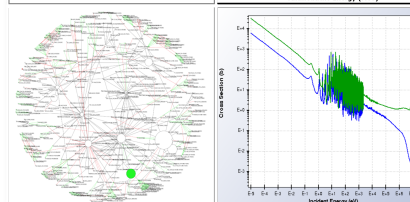
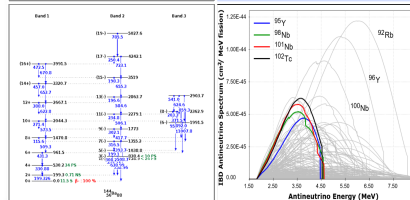
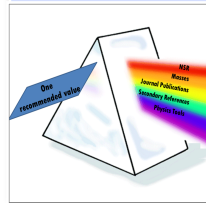
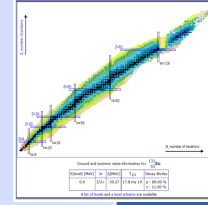
- Nuclear Structure, Reactions and Astrophysics,
- Hot & Cold QCD and
- Fundamental Symmetries town hall meetings



USNDP Annual Workplan

We will draft FY24
workplan soon

We have discussed longer
term planning



United States Nuclear Data Program

Work Plan for Fiscal Year 2023

This document describes the activities that US Nuclear Data Program members are planning to do during the Fiscal Year 2023.

Prepared by

David Brown

National Nuclear Data Center

Brookhaven National Laboratory

With contributions from

Lee Bernstein, UCB/LBNL

Jun Chen, MSU

John Kelley, TUNL

Filip G. Kondev, ANL

Hye Young Lee, LANL

Elizabeth McCutchan, BNL

Ninel Nica, TAMU

Bodies that impact planning

- **Office of Science LRP**
 - Core funding
 - Community/consensus driven (so must be plugged into basic science)
 - Science needs, as determined by community
 - 5-10 year cycle
- **NSAC – NSF, DOE coordination**
 - Advisory
 - “NSAC charge”
- **NDWIAG/NDWG**
 - 3-5 year project based funding
 - Cabal of “domain experts”
 - Cross-cutting needs only
 - WANDA
- **In house/home institution**
 - Synergies in house
 - Access in house resources (computers, experimental facilities, expertise, connections)
- **USNDP**
 - Our annual workplan
 - Tightly aligned with mission
- **International partners (no \$\$)**
 - Source of collaborators
 - WPEC is project-based, neutron reaction focused
 - IAEA if project-based, NSDD, NRDC, EXFOR
- **Specific sponsors**
 - NCSP
 - NA-22
 - NA-24
 - NA-10
 - NSF?
 - Often project based
 - Tightly aligned with that program’s mission
 - Priorities and/or needs often align with other programs

Several of us will continue the discussion after the break:

- Lee Bernstein – NSAC Nuclear Data Charge
- Hye Young Lee – NDWG and WANDA