



ENDF developments beyond ENDF/B-VIII.1

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R. Coles and R. Arcilla

National Nuclear Data Center, Brookhaven National Laboratory

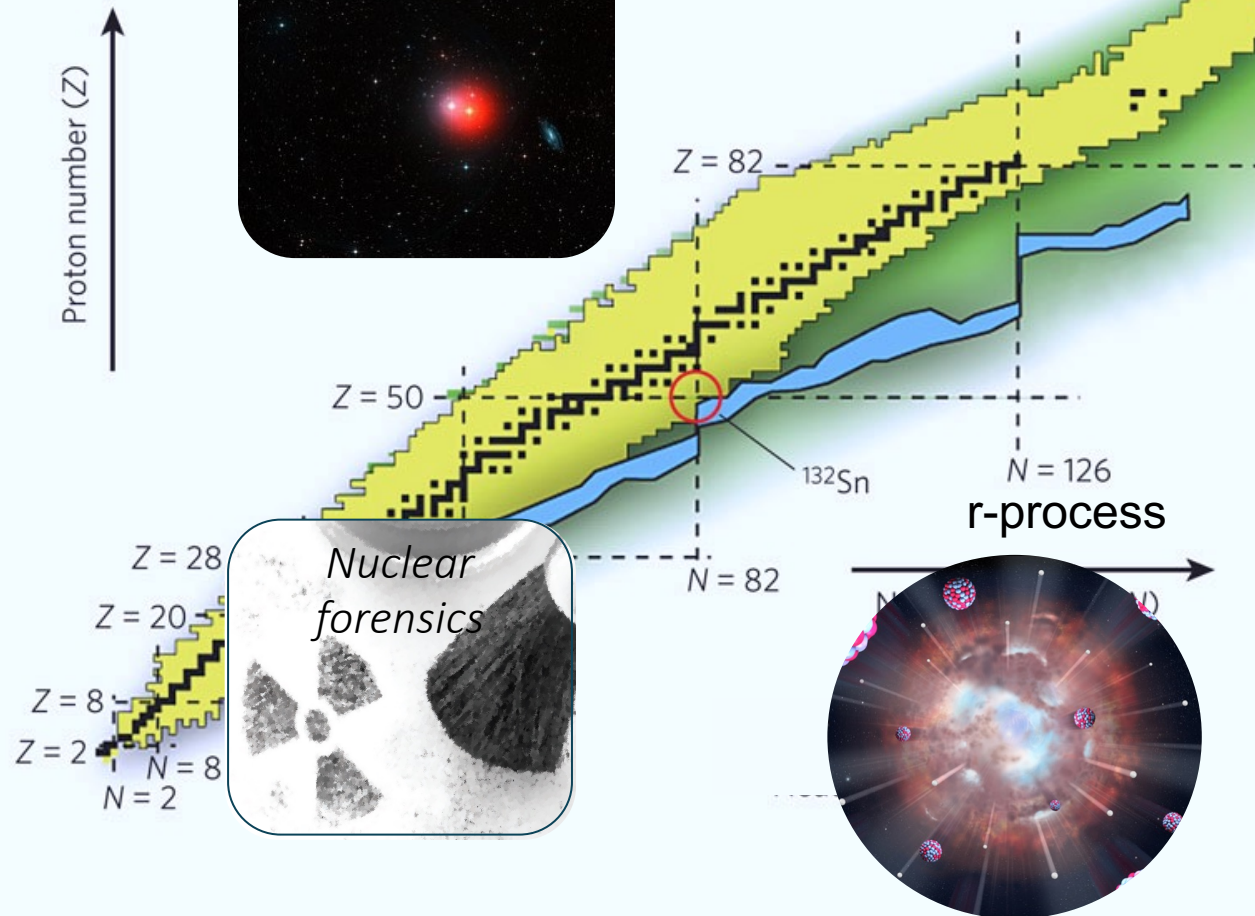
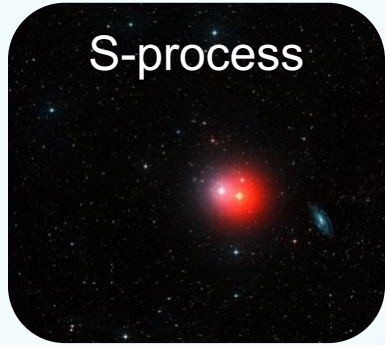
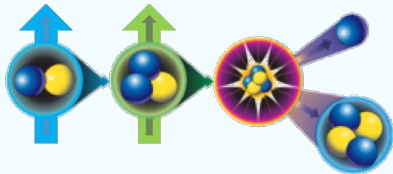
7th International Workshop on Nuclear Data Evaluation
for Reactor Applications (WONDER-2026),
Aix-en-Provence, France
June 29 to July 3, 2026

BNL-8270931

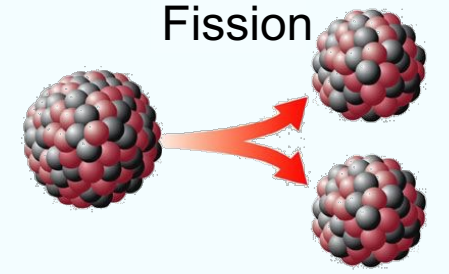


Nuclear Data is the interface between nuclear physics and science, and technical nuclear applications on which they depend

Thermonuclear Fusion



Fission



Main news: The ENDF/B-VIII.1 “Big Paper” has been published!

“Big Paper” Timeline

- **October 23, 2024:** Text finalized, only tables and plots needed to be updated from last beta version to final VIII.1
- **December 23, 2024:** Final manuscript submitted to Nuclear Data Sheets
- **August 11, 2025:** Referee reports received
- **October 21, 2025:** Revised manuscript resubmitted
- **November 5, 2025:** Posted in arXiv
- **April 7, 2026:** Accepted for publication
- **May 6, 2026:** Published online
- **May 18, 2026:** Printed journal shipped

Nuclear Data Sheets, 210 (2026) 1-224
<https://doi.org/10.1016/j.nds.2026.04.001>

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ENDF/B-VIII.1: Updated Nuclear Reaction Data Library for Science and Applications

[G.P.A. Nobre](#)^a, [R. Capote](#)^b, [M.T. Pigni](#)^c, [A. Trkov](#)^d, [C.M. Mattoon](#)^e, [D. Neudecker](#)^f, [D.A. Brown](#)^g, [M.B. Chadwick](#)^f, [A.C. Kahler](#)^f, [N.A. Kleeckte](#)^f, [M. Zerle](#)^g, [A.I. Hawari](#)^h, [C.W. Chapman](#)^c, [N.C. Fleming](#)^h, [J.L. Wormald](#)^g, [K. Ramić](#)^c, [Y. Danon](#)ⁱ, [N.A. Gibson](#)^f, [P. Brain](#)ⁱ, [M.W. Paris](#)^f, [R.Q. Wright](#)^{c1} [Show more](#)

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Article Special issue articles

Abstract

The ENDF/B-VIII.1 library is the newest recommended evaluated nuclear data file by the Cross Section Evaluation Working Group (CSEWG) for use in nuclear science and technology applications, and incorporates advances made in the six years since the release of ENDF/B-VIII.0. Among key advances made are that the ²³⁹Pu file was reevaluated by a joint international effort and that updated ^{16,18}O, ¹⁹F, ²⁸⁻³⁰Si, ⁵⁰⁻⁵⁴Cr, ⁵⁵Mn, ^{54,56,57}Fe, ^{63,65}Cu, ¹³⁹La, ^{233,235,238}U, and ^{240,241}Pu neutron nuclear data from the IAEA coordinated INDEN collaboration were adopted. Over 60 neutron dosimetry cross sections were adopted from the IAEA's IRDFF-II library. In addition, the new library includes significant changes for ³He, ⁶Li, ⁹Be, ⁵¹V, ⁸⁸Sr, ¹⁰³Rh, ^{140,142}Ce, Dy, ¹⁸¹Ta, Pt, ²⁰⁶⁻²⁰⁸Pb, and ^{234,236}U neutron data, and new nuclear data for the photonuclear, charged-particle and atomic sublibraries. Numerous thermal neutron scattering kernels were

Part of special issue
Special Issue on Nuclear Reaction Data
Edited by E.A. McCutchan, C. Morse
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Outline
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DOIs for ENDF/B-VIII.1 data

“ENDF/B-VIII.1 release.” <https://doi.org/10.11578/endl/2571019> (2024).
“ENDF/B-VIII.1 release – alphas sublibrary.” <https://doi.org/10.11578/endl/2571012> (2024).
“ENDF/B-VIII.1 release – atomic relaxation sublibrary.” <https://doi.org/10.11578/endl/2571013> (2024).
“ENDF/B-VIII.1 release – decay sublibrary.” <https://doi.org/10.11578/endl/2571014> (2024).
“ENDF/B-VIII.1 release – deuterons sublibrary.” <https://doi.org/10.11578/endl/2571015> (2024).
“ENDF/B-VIII.1 release – electrons sublibrary.” <https://doi.org/10.11578/endl/2571016> (2024).
“ENDF/B-VIII.1 release – photonuclear sublibrary.” <https://doi.org/10.11578/endl/2571020> (2024).
“ENDF/B-VIII.1 release – helions sublibrary.” <https://doi.org/10.11578/endl/2571021> (2024).
“ENDF/B-VIII.1 release – neutrons sublibrary.” <https://doi.org/10.11578/endl/2571022> (2024).
“ENDF/B-VIII.1 release – neutron-induced fission product yields sublibrary.” <https://doi.org/10.11578/endl/2571023> (2024).
“ENDF/B-VIII.1 release – photo-atomic sublibrary.” <https://doi.org/10.11578/endl/2571024> (2024).
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“ENDF/B-VIII.1 release – standards sublibrary.” <https://doi.org/10.11578/endl/2571027> (2024).
“ENDF/B-VIII.1 release – thermal scattering law sublibrary.” <https://doi.org/10.11578/endl/2571028> (2024).
“ENDF/B-VIII.1 release – tritons sublibrary.” <https://doi.org/10.11578/endl/2584305> (2024).



In addition to citing the library through the main publication, one can also cite and make reference to the actual data: individual sublibrary or whole release

New ENDF release webpage

National Nuclear Data Center | Databases | Structure & Decay | Reactions | Resources | Brookhaven National Laboratory

Version: B-VIII.1

Full Library | Neutrons | Neutron Standards | Thermal Scattering | Photonuclear | Protons | Deuterons | Tritons | Helium-3 | Alpha | NFY

ENDF B-VIII.1 Full Library

The ENDF/B-VIII.1 release is the newest evaluated nuclear data library produced, distributed, and recommended by CSEWG for use in nuclear science and technology applications. Among the many key advances, relative to the previous version ENDF/B-VIII.0, are: re-evaluation of ^{239}Pu file by a joint international effort; updated $^{16,18}\text{O}$, ^{19}F , $^{28-30}\text{Si}$, $^{50-54}\text{Cr}$, ^{55}Mn , $^{54,56,57}\text{Fe}$, $^{63,65}\text{Cu}$, ^{139}La , $^{233,235,238}\text{U}$, and $^{240,241}\text{Pu}$ neutron nuclear data by the IAEA-coordinated INDEN collaboration; significant changes for ^3He , ^6Li , ^9Be , ^{51}V , ^{88}Sr , ^{103}Rh , $^{140,142}\text{Ce}$, ^{181}Ta , $^{206-208}\text{Pb}$, and $^{234,236}\text{U}$ neutron data; new nuclear data for the photo-nuclear, being 196 adopted from the IAEA2019 Photonuclear Data Library and one new file from JENDL-5; and new evaluations for the charged-particle and atomic sublibraries.

Numerous thermal neutron scattering kernels were re-evaluated or provided for the very first time. Additionally, new covariance testing was implemented. ENDF/B-VIII.1 reduced bias in the simulations of many integral experiments with particular progress noted for fluorine, copper and stainless steel containing benchmarks. Data issues which had hindered the

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ENDF B-VIII.1 Full Library (1.058 GB)

Format: ENDF-6

• ENDF-6 Manual • GNDS Manual

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Library Downloads | ENDF-6 | Download

File	Size
ENDF B-VIII.1 Full Library	1.058 GB

Collaboration Summary

Data Manager: National Nuclear Data Center (NNDC)
Data Curator: Gustavo Nobre

New ENDF release webpage

National Nuclear Data Center | Databases | Structure & Decay | Reactions | Resources | Brookhaven National Laboratory

Version: **B-VIII.1** (Toggle between library versions)

Full Library | Neutrons | Neutron Standards | Thermal Scattering | Deuterons | Tritons | Helium-3 | Alpha | NFY

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ENDF B-VIII.1 Full Library (1.058 GB)

Format: **ENDF-6** (Toggle between ENDF-6 and GNDS formats)

• ENDF-6 Manual • GNDS Manual

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Library Downloads	Format	Download
<input type="checkbox"/> ENDF B-VIII.1 Full Library	ENDF-6	Download

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Data Curator: Gustavo Nobre

New ENDF release webpage

<input type="checkbox"/>	Alpha Reaction Sublibrary	169 KB	Contact Person	Gustavo Nobre
<input type="checkbox"/>	Atomic Relaxation Reaction Sublibrary	1.346 MB	Project Leader	David Brown
<input type="checkbox"/>	Decay Reaction Sublibrary	10.303 MB	Hosting Institution	Brookhaven National Laboratory (BNL)
<input type="checkbox"/>	Deuteron Reaction Sublibrary	197 KB	Producer	Cross Section Evaluation Working Group (CSEWG)
<input type="checkbox"/>	Electron Reaction Sublibrary	7.602 MB		
<input type="checkbox"/>	Photonuclear Sublibrary	141.735 MB		
<input type="checkbox"/>	Helium-3 Reaction Sublibrary	191 KB	Depositor	Gustavo Nobre
<input type="checkbox"/>	Neutron Reaction Sublibrary	343.725 MB	Contact	gnobre@bnl.gov
<input type="checkbox"/>	Neutron Induced Fission Product Yields Sublibrary	1.492 MB	Deposition Date	10/21/2024
<input type="checkbox"/>	Photoatomic Reaction Sublibrary	34.305 MB	Last Modified	10/21/2024
			DOI	10.11578/endl/2571019

Resources

- ENDF-6 Manual
- GNDS Manual
- Summary
- GNDS
- POINT
- Criticality Validation

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ENDF B-VIII.1 Full Library (1.058 GB)

Format:

[ENDF-6 Manual](#) [GNDS Manual](#)

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Alpha Reaction Sublibrary (169 KB)

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Redesigning the ENDF section of the NNDC website


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Evaluated Nuclear Data File (ENDF)



Library Releases

DOWNLOAD FULL RELEASES

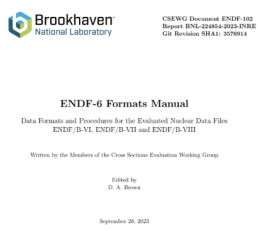
- The ENDF/B-VIII.1 release is the newest evaluated nuclear data library produced, distributed, and recommended by CSEWG for use in nuclear science and technology applications.



Cross Section Evaluation Working Group

CSEWG

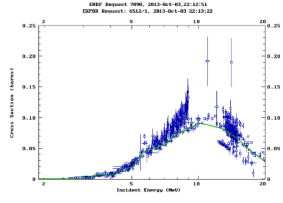
- A cooperative effort of the national laboratories, industry, and universities in the United States and Canada, responsible for the production of ENDF/B.



Reports

FORMAL LABORATORY REPORTS


- The NNDC is responsible for assigning ENDF reference numbers for all formal laboratory reports associated with the ENDF system.



Sigma

PLOT ENDF DATA


- Retrieving and plotting reaction evaluation data from multiple libraries (e.g., ENDF).



ENDF Formats

VIEW FORMAT MANUALS

- View and download format manuals for ENDF-6 from the current release ENDF-102 (2023) to ENDF/A BNL-8381 (1965). GNDS specifications are also provided.



History

ENDF HISTORY & NAMING

- Discover the history and naming of the Evaluated Nuclear Data File (ENDF).

8

Strong connection with user needs!

- Shortly after the ENDF/B-VIII.0 release, it was reported that a loss reactivity was found at high burnup, which discouraged its adoption by the nuclear reactor community
- This depletion issue was taken seriously in validation efforts during VIII.1 development

Article

Neutronic Characteristics of ENDF/B-VIII.0 Compared to ENDF/B-VII.1 for Light-Water Reactor Analysis

 OAK RIDGE
National Laboratory

Kang-Seog Kim * and William A. Wieselquist

Investigation on the Reactivity Underestimation of ENDF/B-VIII.0 Compared to ENDF/B-VII.1 for Thermal Reactor Analysis

2020 CSEWG Meeting
December 2, 2020

SCALE XSProc Team

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Discussion & Conclusion

- **ENDF/B-VII.1 vs. ENDF/B-VIII.0**

- **Most influencing nuclides**
 - U-238, Pu-239, O-16 and U-235
 - U-238: +300 pcm at 0 burnup & getting decreased at high burnup
 - O-16: -150 pcm at all burnup steps
 - U-235: -150 pcm at all burnup steps
 - Pu-239: -200 pcm at high burnups
- **Error cancellation**
 - U-238 (positive) vs. U-235 + O-16 (negative)
- **Decay data & F.P. yield data**
 - No impact
- **Thermal reactor analysis**
 - Generally accepted that even ENDF/B-VII.1 underestimates keff at high burnup
 - No epithermal upscattering
 - Considering epithermal upscattering would make it more negative
 - ENDF/B-VIII.0 may not be used for thermal reactor (PWR & BWR) analysis
- **ENDF/B release**
 - May need to perform a sensitivity study for depletion effect

Strong connection with user needs!

- Shortly after the ENDF/B-VIII.0 release, it was reported that a loss reactivity was found at high burnup, which discouraged its adoption by the nuclear reactor community
- This depletion issue was taken seriously in validation efforts during VIII.1 development
- As shown by multiple independent sets of calculations, the depletion performance was **dramatically improved in ENDF/B-VIII.1**

Article

Neutronic Characteristics of ENDF/B-VIII.0 Compared to ENDF/B-VII.1 for Light-Water Reactor Analysis

Kang-Seog Kim * and William A. Wieselquist

Investigation on the Reactivity Underestimation of ENDF/B-VIII.0 Compared to ENDF/B-VII.1 for Thermal Reactor Analysis

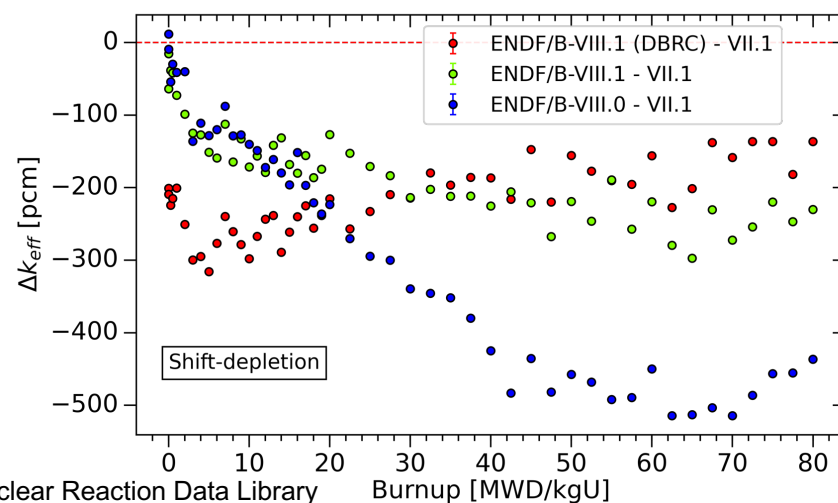
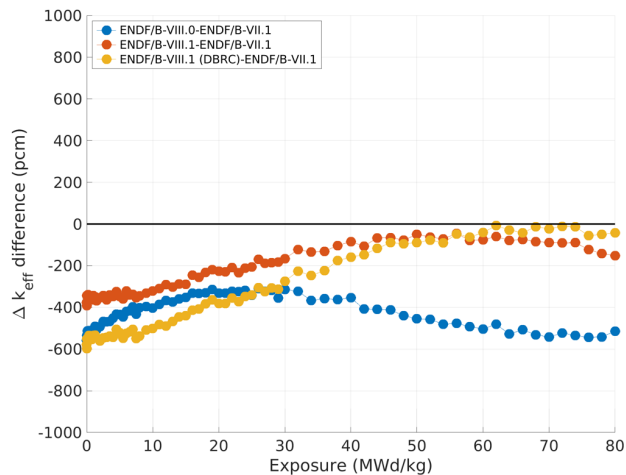
2020 CSEWG Meeting
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Discussion & Conclusion

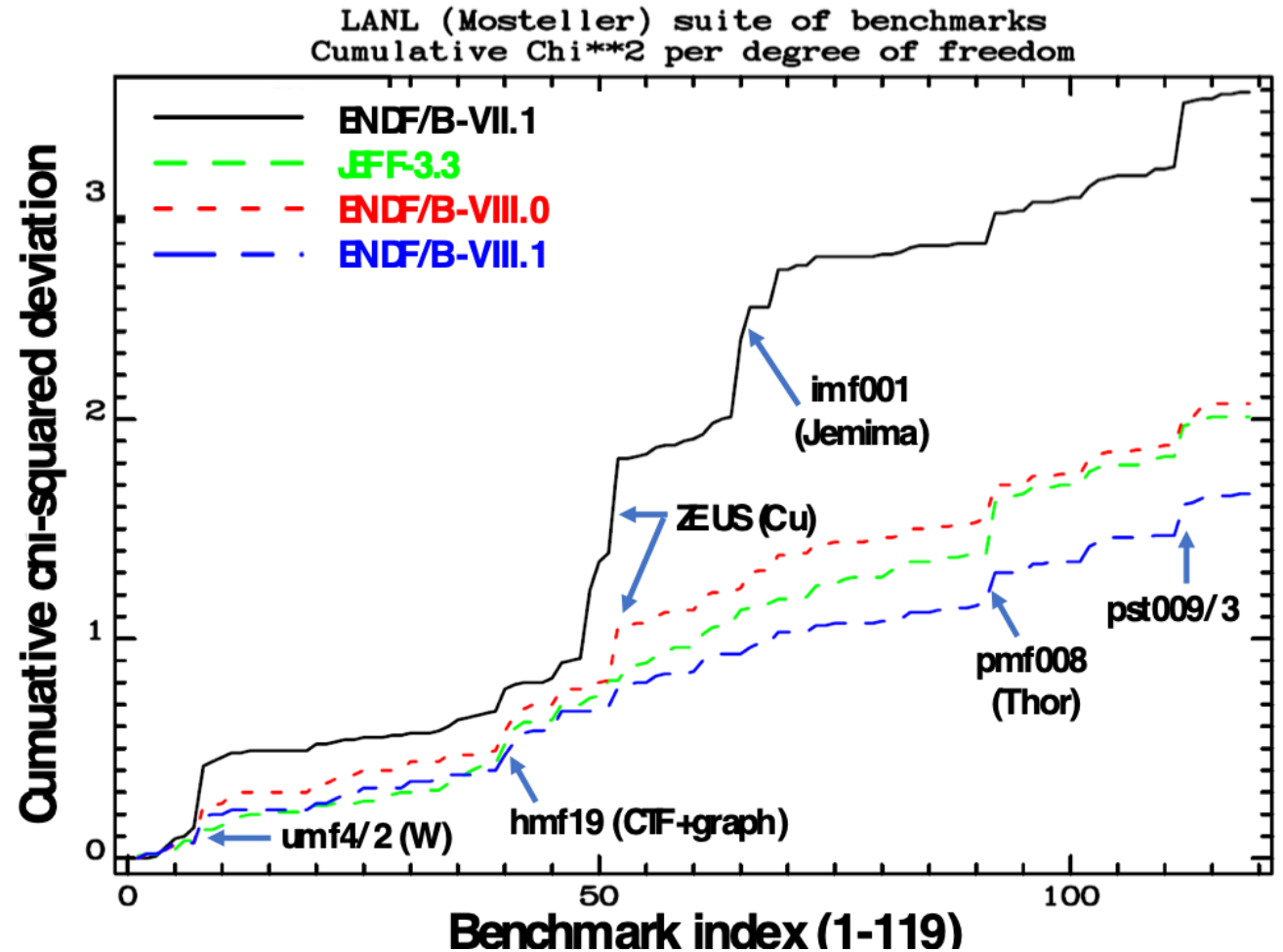
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G. P. A. NOBRE et al., "ENDF/B-VIII.1: Updated Nuclear Reaction Data Library for Science and Applications," Nucl. Data Sheets (2024) (submitted for publication).

Further improvement in criticality performance

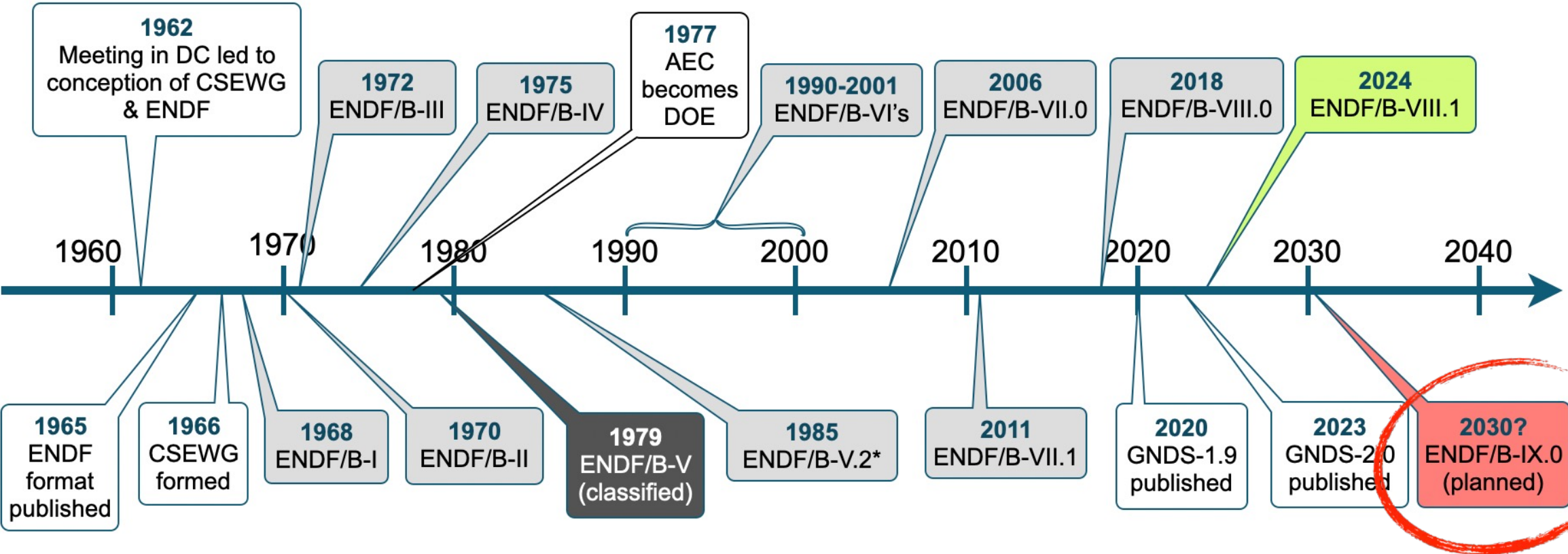
- Performance of the library assessed thoroughly and consistently throughout the development against complete suite of benchmarks
- Final set further improves agreement with integral data!!
- **Not perfect**, still room for improvements



G. P. A. NOBRE et al., "ENDF/B-VIII.1: Updated Nuclear Reaction Data Library for Science and Applications," Nucl. Data Sheets (2024) (submitted for publication).

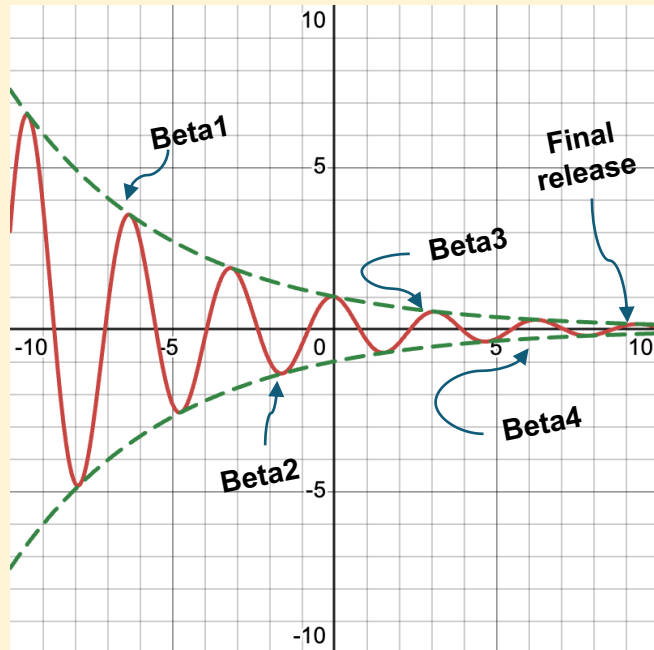
Beyond ENDF/B-VIII.1, towards ENDF/B-IX.0

ENDF Timeline



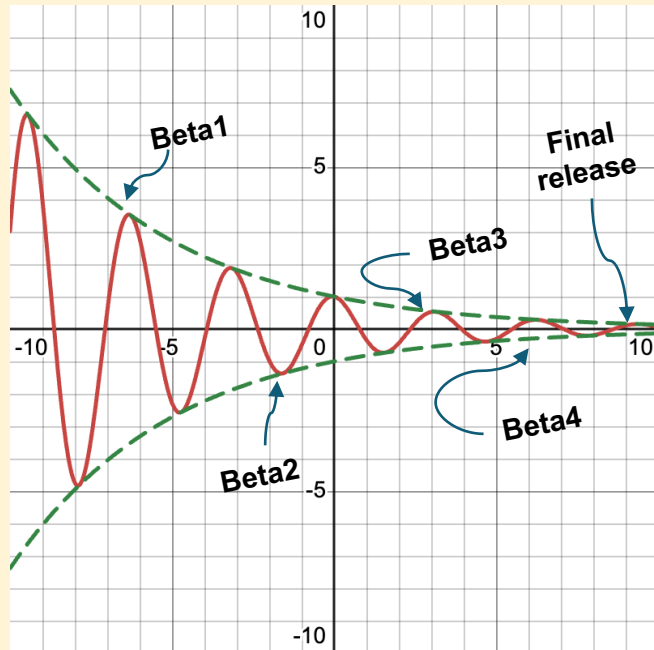
Importance of review process

Allied with consistent validation, **review system** allows for a **predictable, progressively-convergent** path towards a **final ENDF release!**



Importance of review process

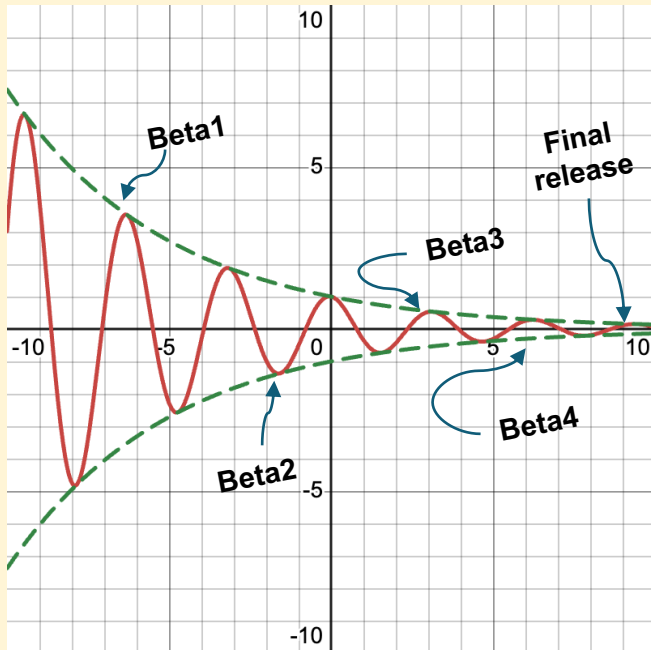
Allied with consistent validation, **review system** allows for a **predictable, progressively-convergent** path towards a **final ENDF release!**



- We learned many lessons from the VIII.1 review process:
 - Identified several issues:
 - Current **review form** is **not very useful**
 - Wiki page and **report tarballs** are **not very helpful** either
 - **Issues** with integration with **processing codes**
 - On the **positive side**:
 - GitLab's **merge request GUI environment** for review was **great** for discussions, documentation, tracking of updates, etc., **all integrated with commits and issue trackers**

Importance of review process

Allied with consistent validation, **review system** allows for a **predictable, progressively-convergent** path towards a **final ENDF release!**



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 - Identified several issues:
 - Current **review form** is **not very useful**
 - Wiki page and **report tarballs** are **not very helpful** either
 - **Issues** with integration with **processing codes**
 - On the **positive side**:
 - GitLab's **merge request GUI environment** for review was **great** for discussions, documentation, tracking of updates, etc., **all integrated with commits and issue trackers**

For the ENDF/B-IX.0 cycle, we are planning a **complete re-work** of the review process through a **working group**, aiming to make it more user-friendly

- In the meantime, we will keep working as we have been doing...

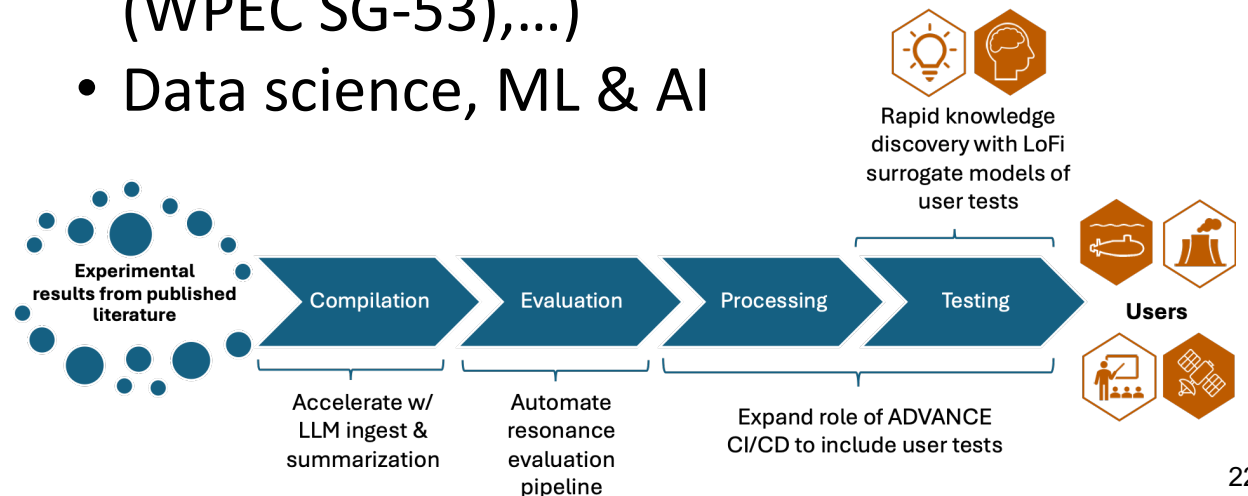
It's hard to know what exactly will be in the release, but we can guess...

Known programmatic drivers

- Fusion
- HALEU & next gen. reactors
- Non-proliferation needs
- Data science
- New Standards
- **Activation library**

Anticipated foci

- **Standards**
- **Actinides:** ^{239}Pu , $^{233,235,238}\text{U}$, etc.
- Reactions on unstable fission products
- Materials for next gen. reactors (Cl, Zr (WPEC SG-53),...)
- Data science, ML & AI



Evaluations already submitted

Neutrons:

- ^{35}Cl (LANL/Terrapower/ORNL)
- ^{238}U (PFNS from Chi-Nu data)
- Nubar: $^{238,241,242}\text{Pu}$

TSL:

- Polyethylene extended temperatures (NCSU/TAMU)
- W, V, Pb, Ni, Mo, Cu (ORNL)

Photonuclear:

- ^9Be (NNL)

Expected/planned submissions

Neutrons:

- ^{239}Pu (INDEN; updated inelastic, elastic, total)
- ^{95}Mo , Gd (ORNL)
- Zr (RPI/ORNL/BNL...)
- Gamma spectra fixes
- ...

Deuterons:

- D+T (LANL/LLNL)

Standards:

- ^{252}Cf sf
- Etc...

TSL

- Reactor graphite discussion

FPY

Decay

Neutron Data Standards

- Standards are cross sections for specific reactions, in specific energy ranges, that are so well-known that they are often used as reference in other measurements
- New experimental data has prompted the need of reevaluation of the Standards
- For details see A. Carlson's talks in 2025 CSEWG: <https://indico.bnl.gov/event/29405/>
- IAEA project: <https://nds.iaea.org/standards/>

TABLE XLV. Neutron Data Standards.

Neutron cross section standards	
Reaction	Standards incident neutron energy range
H(n,n)	1 keV to 20 MeV
³ He(n,p)	0.0253 eV to 50 keV
⁶ Li(n,t)	0.0253 eV to 1.0 MeV
¹⁰ B(n,α)	0.0253 eV to 1 MeV
¹⁰ B(n,α ₁ γ)	0.0253 eV to 1 MeV
C(n,n)	10 eV to 1.8 MeV ^a
Au(n,γ)	0.0253 eV, 0.2 to 2.5 MeV, 30 keV MACS
²³⁵ U(n,f)	8–11eV (integral) 0.15 to 200 MeV
²³⁸ U(n,f)	2 MeV to 200 MeV
High energy reference fission cross sections	
Reaction	Reference incident neutron energy range
^{Nat} Pb(n,f)	≈ 34 MeV up to 1 GeV
²⁰⁹ Bi(n,f)	≈ 34 MeV up to 1 GeV
²³⁵ U(n,f)	200 MeV to 1 GeV
²³⁸ U(n,f)	200 MeV to 1 GeV
²³⁹ Pu(n,f)	200 MeV to 1 GeV
Prompt γ-ray production reference cross sections	
Reaction	Reference incident neutron energy range
¹⁰ B(n,α ₁ γ)	0.0253 eV to 1 MeV
⁷ Li(n,n'γ)	0.9 MeV to 8 MeV
⁴⁸ Ti(n,n'γ)	2.8 MeV to 16 MeV
Thermal neutron constants at E=0.0253 eV (2200 m/s)	
Prompt fission neutron spectra (PFNS)	
Reaction	Reference outgoing neutron energy range
²³⁵ U(n _{th} ,f)	0.00001 eV to 30 MeV
²⁵² Cf(sf)	0.00001 eV to 30 MeV

^a The angular distributions at these incident energies are declared standard

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There will be updates to standards, so...

ENDF/B-VIII.2 ENDF/B-IX.0

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There are many efforts in the community regarding measuring, modeling, evaluating unstable nuclei: **Activation library?**

Nuclear Data Week 2025

Jan 6–9, 2026
Building 555, Hamilton Conference Room
JS/Eastern timezone

Enter your search term

Overview

Meeting Registration

Meeting Access for Non-U.S. Citizens

Timetable

Co

Ex

Nuclear Data Week has been rescheduled to 6-9 January 2026

Special Topic: Inventory Library

Welcome	<i>Andre Sieverding</i>
<i>Building 555, Hamilton Conference Room</i>	13:15 - 13:25
Activation Library Use in Target Design and Analysis for Radioisotope Production at ORNL	<i>William Marshall</i>
<i>Building 555, Hamilton Conference Room</i>	13:25 - 13:40
Nuclide inventory validation: effect of nuclear data libraries	<i>Germina Procop</i>
<i>Building 555, Hamilton Conference Room</i>	13:40 - 13:55
Impact of cross section and fission yield uncertainties on fuel inventory for a molten salt fast reactors	<i>Germina Procop</i>
<i>Building 555, Hamilton Conference Room</i>	13:55 - 14:10
Reaction theory and workflow developments at LLNL	<i>Jeff Berryman</i>
<i>Building 555, Hamilton Conference Room</i>	14:10 - 14:25
Reaction theory developments at LANL	<i>Amy Lovell</i>
<i>Building 555, Hamilton Conference Room</i>	14:25 - 14:40
Discussion	
<i>Building 555, Hamilton Conference Room</i>	14:40 - 15:00

14:00

15:00

Workshop for Applied Nuclear Data Activities (WANDA) 2026

9 Feb 2026, 00:00 → 12 Feb 2026, 20:00 US/Eastern

Hilton Arlington National Landing, 2399 Richmond Hwy, Arlington, VA, 22202

Ellen O'Brien (Los Alamos National Laboratory), Stephanie Lyons (Pacific Northwest National Laboratory)

Description: Nonproliferation and Safeguards for Advanced Reactors

Creating an Inventory Sub-Library

Session Chairs: Richard Saldanha (PNNL), Andre Sieverding (LLNL)

NDWG POCs: David Brown (BNL), Pat Griffin (SNL)

A nuclear sub-library for inventory, activation, or dosimetry contains the nuclear data for processes that generally change the isotopic composition (transmutation) and lead to radioactive products as well as the reactions on the radioactive products themselves and their decay. In recent years, the development of fast-neutron reactor concepts, advances in fusion energy, and other applications have increased the need for extending and improving the nuclear data for inventory calculations, which are crucial to assess the safety of reactors, predict radioactive waste classification, or validate experimental testing data. Among the emerging needs is not only the increased coverage of radioactive isotopes but also charged-particle

for a useful inventory sub-library and
ation with dedicated experiments,

, predict radioactive waste classification, o

14:00	14:00 → 18:00	Session IV: Creating an Inventory Sub-Library
14:00	Welcome	Speakers: Dr Andre Sieverding (LLNL), Richard Saldanha (Pacific Northwest National Laboratory)
	activation_sessio...	
14:05	Introduction: The nuclear observables of the less	Speaker: jean-christophe sublet (United Kingdom Atomic Energy Authority)
	WANDA-2026_Jc...	WANDA-2026_Jc...
14:30	Nuclear Data Sensitivity and Uncertainty Analysis	Speaker: Bamidele Ebiwonjumi
	WANDA2026 Nucl...	
14:45	Examination of ENDF/B-VIII.1-Based Nuclear Data Applications	Speaker: Greg Fischer (Westinghouse)
	WAAP-13633_Rev...	
15:00	CINDER module within MCNP	Speaker: Colin Josey (LANL)
	LA-UR-25-32234.p...	
15:20		
15:40	Impact of cross section and fission yield uncertainties on reactor fuel inventories	Speaker: Germina Procop (Oak Ridge National Laboratory)
	WANDA2026_inve...	
15:55	Uncertainties in Power Coupling Factors and Uranium Fissile Split in the Transient Reactor Test (TREAT) Facility	Speaker: Thomas Holschuh (INEL)
	WANDA2026_Hol...	
16:10	Benchmarking and validating cosmogenic activation models (NDIAWG project)	Speaker: Richard Saldanha (Pacific Northwest National Laboratory)
	2026_02_WANDA...	
16:25	Constraining Cross Sections on Unstable Nuclei	Speaker: Andrew Ratkiewicz (Lawrence Livermore National Lab)
16:40	Reaction theory for radioactive isotopes	Speaker: Toshihiko Kawano (LANL)
	WANDA_Kawano...	
16:55	Session Break	
17:10	One brick after another: Solid foundations for accelerated progress in FENDL and TENDL	Speaker: Georg Schnabel (AEA)
	2026_02_WANDA...	
17:25	Discussion & Close	

There are many efforts in the community regarding measuring, modeling, evaluating unstable nuclei: **Activation library?**

Realistic Reaction Evaluations for Fission Products Off Stability

- Funded project to develop reaction evaluations for fission products off stability
- Leveraging **machine-learning** and **microscopic models**
- Expected to impact depletion, waste management, etc.
- Looking for ways to validate this effort

16TH NUCLEAR DATA FOR SCIENCE AND TECHNOLOGY CONFERENCE
JUNE 22ND – 27TH | MADRID (SPAIN) | 2025

Nuclear Reaction Data for Fission Products Off Stability
G.P.A. Nobre¹, K. Wendt¹, D.A. Brown¹, A.V. Voinov¹, E.V. Chimanski¹, S. Liu², A. Sharma³
¹Brookhaven National Laboratory, ²Lawrence Livermore National Laboratory, ³Ohio University

Nuclear applications such as nonproliferation, post-detonation forensics, spent-fuel assay, reactor burnup and design, as well as astrophysics, rely on the accurate description of the neutron interaction with unstable fission products. However, current cross-section descriptions of these nuclei are either non-existent or based on simplified assumptions, leading to unquantified impacts on predicted cross-sections. In this work we will discuss a newly funded project aiming to address these issues through predictive modeling, leveraging machine-learning methods, with an experimental component to help constrain model parameters. We will show details of the approach as well as preliminary results, focusing on the most produced nuclei off stability in the fission process of ²³⁵U. When completed, when the methods are well-established, the project should be able to provide realistic evaluated files for the whole isotopic chain of all off-stability fission products of ²³⁵U, ²³⁹Pu, and ²⁴¹Pu. The evaluated files will be submitted to ENDF/B for consideration in the future ENDF/B-X release.

Project Goals:

- To develop a robust, reproducible method to produce realistic neutron evaluations for fission-product nuclei off-stability
- To provide evaluated files for the main off-stability fission products of ²³⁵U and submit them to the ENDF/B nuclear data library
- **Stretch goal:** develop evaluated files for all off-stability fission products from ²³⁵U, ²³⁹Pu, ²⁴¹Pu
- NNSA-NA-22 funded for FY25 - FY27

Anticipated Impact

- Applications such as nonproliferation, post-detonation forensics, spent-fuel assay, reactor burnup and design, as well as astrophysics, rely on the accurate description of the neutron interaction with unstable fission products.
- Current cross-section descriptions of these nuclei are either non-existent or based on simplified assumptions, leading to unquantified impacts on predicted cross-sections.
- By project completion, more predictive/realistic new nuclear data will be produced, improving the reliability of applications involving fission products off stability!

September 30, 2025

Methods

Capture cross-section fluctuations

- There are few many resonances.
- It is not possible to predict their position or width.
- We focus on "strong" cross-section values and associated probability distributions that capture the size of fluctuations.

Experimental level density constraints at Edwards lab, Ohio University

Summary and Outlook

We will develop realistic neutron evaluations for fission products off stability through the combination of complementary approaches including experimental measurements of level densities, positive reaction modeling, and machine-learning methods. Currently, the first experiment has been successfully completed, and its data is being analyzed. Also, first preliminary iteration of fast-neutron files have been generated and should be combined with stochastically-generated resonances based on cross-section parameter tuning.

References

[1] G.P.A. Nobre, BNL-229070-2025-INRE
[2] G.P.A. Nobre et al., Phys. Rev. C, in press

Acknowledgements

This work was supported by the Office of Defense Nuclear Programs, Department of Energy and is conducted within the U.S. Department of Energy National Nuclear Security Administration. We report unclassified information.

Brookhaven National Laboratory
Lawrence Livermore National Laboratory
U.S. DEPARTMENT OF ENERGY
OHIO UNIVERSITY

Brookhaven National Laboratory
Report # BNL-229070-2025-INRE

Summary of FY25 activities on the project Realistic Reaction Evaluations for Fission Products Off Stability (RREFPOS)

September 30, 2025

Managed by Brookhaven Science Associates on behalf of the U.S. Department of Energy

For details, see:

- ND2025 poster
- BNL-229070-2025-INRE report
- 2026 WANDA talk

Brookhaven National Laboratory
U.S. DEPARTMENT OF ENERGY

Realistic Reaction Evaluations for Fission Products Off Stability

Gustavo Nobre¹, Aman Sharma², Emanuel Chimanski¹, Alexander Voinov³, Dave Brown¹, Kyle Wendt², Shusen Liu²

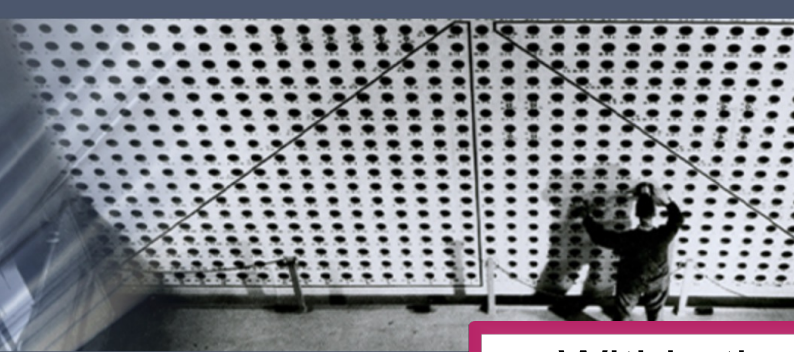
¹National Nuclear Data Center, Brookhaven National Laboratory
²Lawrence Livermore National Laboratory
³Ohio University

2026 Workshop for Applied Nuclear Data Activities (WANDA)
9-12 February 2026
BNL-7724184

1st Reactor Graphite (ReGra) Workshop

Bringing together experts in the nuclear data community

Hosted by Brookhaven National Laboratory
July 8–9, 2025



Reactor Graphite Workshop

Jul 8–9, 2025
Berkner Hall (Bldg. 488)
US/Eastern timezone

Within the community, there were different perspectives on what should be recommended for the thermal-neutron scattering law libraries associated with reactor graphite.

[Homepage](#)

[Overview](#)

[Timetable](#)

[Contribution List](#)

[My Conference](#)

[My Contributions](#)

[Registration](#)

[Contact](#)

gnoBRE@bnl.gov



- This motivated the organization of an **in-person, highly-focused workshop**.
- Participants from BNL, RPI, ORNL, NCSU, TAMU, Kairos Power, BWXT Advanced Technologies, Foster & Associates, JAEA, INL, LLNL, U. Michigan, LANL, NNL, Studsvik Scandpower

Meeting minutes published

- Published meeting minutes as a BNL lab report:
 - <https://doi.org/10.2172/2998877>
 - Report is **NOT** a scientific paper
 - Report is a description of **what happened** at the meeting:
 - What was presented
 - What was discussed: Comments, objections, replies, agreements and disagreements; past, present, future on the topic
 - Key takeaways: discussed, edited in real time, and agreed upon by ALL participants in the last session, before meeting ended
- Feedback was **positive**:
 - There will likely be a follow-up edition (2027?)

Summary of the *1st Reactor Graphite Workshop,* *8-9 July, 2025*

Gustavo P.A. Nobre¹, David A. Brown¹, Benjamin Wang², Iyad Al-Qasir³, John Bess⁴, Chris Chapman³, Arantxa Cuadra¹, Yaron Danon², Simerjeet Gill¹, Travis Greene³, Ayman Hawari⁵,⁶, Richard Hernandez⁷, Chase Lawing⁸, Gabriel Lentchner³, Cihang Lu¹, Shinsuke Nakayama⁹, Matthew Nash⁸, Javier Ortensi¹⁰, Catherine Percher¹¹, Dominic Piedmont⁴, Kemal Ramić³, Volkan Seker¹², Gregory Siemers^{2,13}, Jason Thompson¹⁴, Nicholas Thompson¹³, Charles Wemple¹⁵, Michael Zerkle¹⁴

¹Brookhaven National Laboratory, ²Rensselaer Polytechnic Institute, ³Oak Ridge National Laboratory, ⁴Foster & Associates, LLC, ⁵North Carolina State University, ⁶Texas A&M University, ⁷Kairos Power, ⁸BWXT Advanced Technologies, LLC, ⁹Japan Atomic Energy Agency, ¹⁰Idaho National Laboratory, ¹¹Lawrence Livermore National Laboratory, ¹²University of Michigan, ¹³Los Alamos National Laboratory, ¹⁴Naval Nuclear Laboratory, ¹⁵Studsvik Scandpower, Inc.

Additionally...



- There are many fixes from the 2025 Hackathon (ORNL)
 - They are gradually being incorporated with other updates
- In process of identifying **reviewers** to speed up the acceptance of the already-submitted files
- Planning Beta1 release for the Summer, hopefully in sync with the Standards

ENDF/B
IX.0-β1

vs.

ENDF/B
VIII.2-β1

will depend whether standards will be updated in time

Automation of ENDF data retrieval

- ENDF data is now retrievable through a REST API
 - Allows automation through **scripts** using **unique URLs**
 - Usage examples provided using **Jupyter Notebook**
 - Integrated with **plotting** capability
 - So far implemented for **ENDF/B-VIII.1, VIII.0, VII.1** – whole files or individual cross sections
- Website is live; “README” report:
BNL-229520-2026-INRE

<https://www.nndc.bnl.gov/endl-api>



Welcome

This is the ENDF REST API entry point. Use the links below to explore the API documentation or run interactive tutorials.

Interactive Docs (Swagger UI)

Browse endpoints, inspect schemas, and try out API calls directly from your browser.

[Open Swagger UI](#)

Reference Docs (ReDoc)

Read-only documentation view generated from the OpenAPI specification.

[Open ReDoc](#)

Tutorial Notebooks

Jupyter notebooks demonstrating how to use this API, runnable locally or in Google Colab.

[View Tutorials](#)

Root path: /endl-api

A REST API for Nuclear Reaction Data Libraries

March 6, 2026



Automation of ENDF data retrieval

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A REST API for Nuclear Reaction Data Libraries

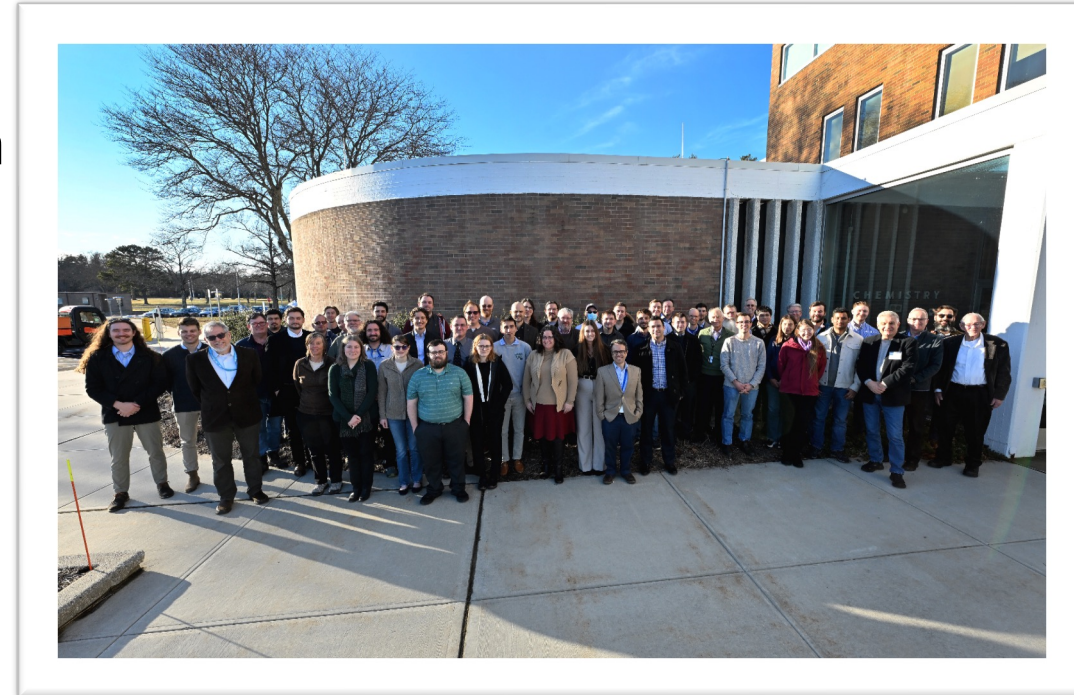
March 6, 2026

In the future, we plan to extend to other libraries and other observables (ang. dist., spectra, uncertainties/covariances, etc.), provided there is **additional support**

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**
- **Depending on what needs done, getting required data in library can be major effort**



2025 CSEWG meeting, BNL, Jan. 2026

We are always open to new users and collaborators

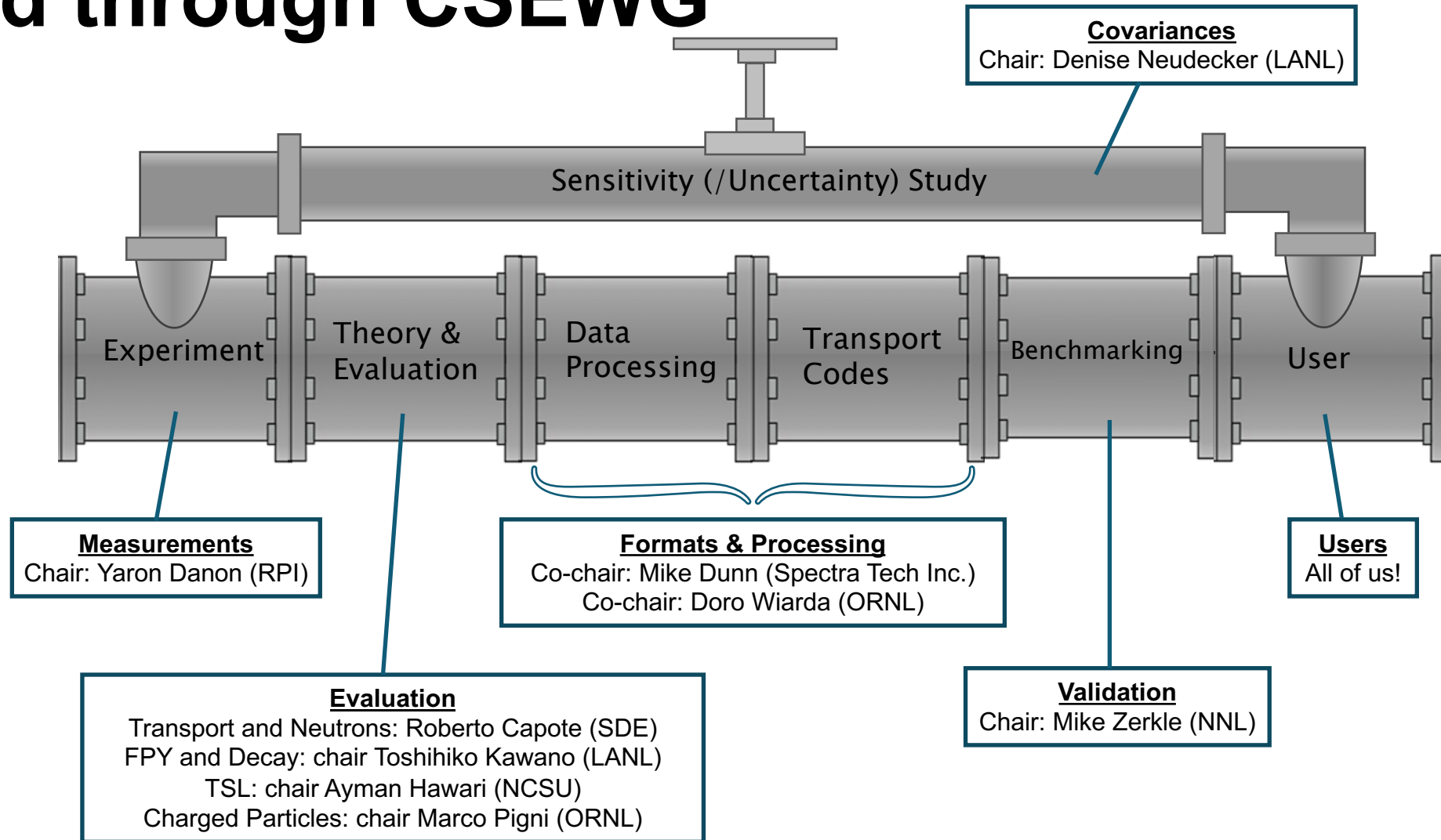
All steps of nuclear data pipeline are coordinated through CSEWG

Chair:

David Brown (BNL)
dbrown@bnl.gov

Library Manager:

Gustavo Nobre (BNL)
gnobre@bnl.gov



Conclusion

ENDF/B-VIII.1 released on *August 30, 2024* :

- Many, many important updates
- Substantial improvement in performance
 - Reactor depletion
 - Criticality systems
 - Leakage/shielding
- Accompanying “Big Paper” is finally published through OpenAccess
 - Nuclear Data Sheets, 210 (2026) 1-224
 - <https://doi.org/10.1016/j.nds.2026.04.001>
- DOIs and landing page for data are available now
- **REST API** developed for automated access to **ENDF** data

Beginning of next ENDF cycle, ENDF/B-IX.0:

- Bug fixes: Hackathon in early August at ORNL
- We expect: Standards, ^{239}Pu , $^{233,234,238}\text{U}$, chlorine, TSL graphite (1st ReGra workshop), etc.
- Improving infrastructure and evaluation & UQ methods
- Working on next Beta release: aiming for Summer, hopefully in-sync with Standards

Acknowledgements

Work at Brookhaven National Laboratory was sponsored by the Office of Nuclear Physics, Office of Science of the U.S. Department of Energy under Contract No. DE-AC02-98CH10886 with Brookhaven Science Associates, LLC. Work at Lawrence Livermore National Laboratory was performed under Contract DE-AC52-07NA27344. Work at Los Alamos National Laboratory, operated by Triad National Security, LLC, was carried out under the auspices of the National Nuclear Security Administration of the US Department of Energy under Contract No. 89233218CNA000001. Work at Oak Ridge National Laboratory was authored by UT-Battelle, LLC under Contract No. DE-AC05-00OR22725 with the U.S. Department of Energy. Work at Naval Nuclear Laboratory, operated by Fluor Marine Propulsion, LLC, was performed under contract No. 89233018CNR000004 with the U.S. Department of Energy. This work was supported by the Naval Nuclear Propulsion Program and Nuclear Criticality Safety Program, funded and managed by the National Nuclear Security Administration for the U.S. Department of Energy. This work received funding support from the NNSA Office of Defense Nuclear Nonproliferation R&D.



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