ENDF report

G.P.A. Nobre[1]

[1]National Nuclear Data Center, Brookhaven National Laboratory

@BrookhavenLab

USNDP Meeting
October 28-31, 2025

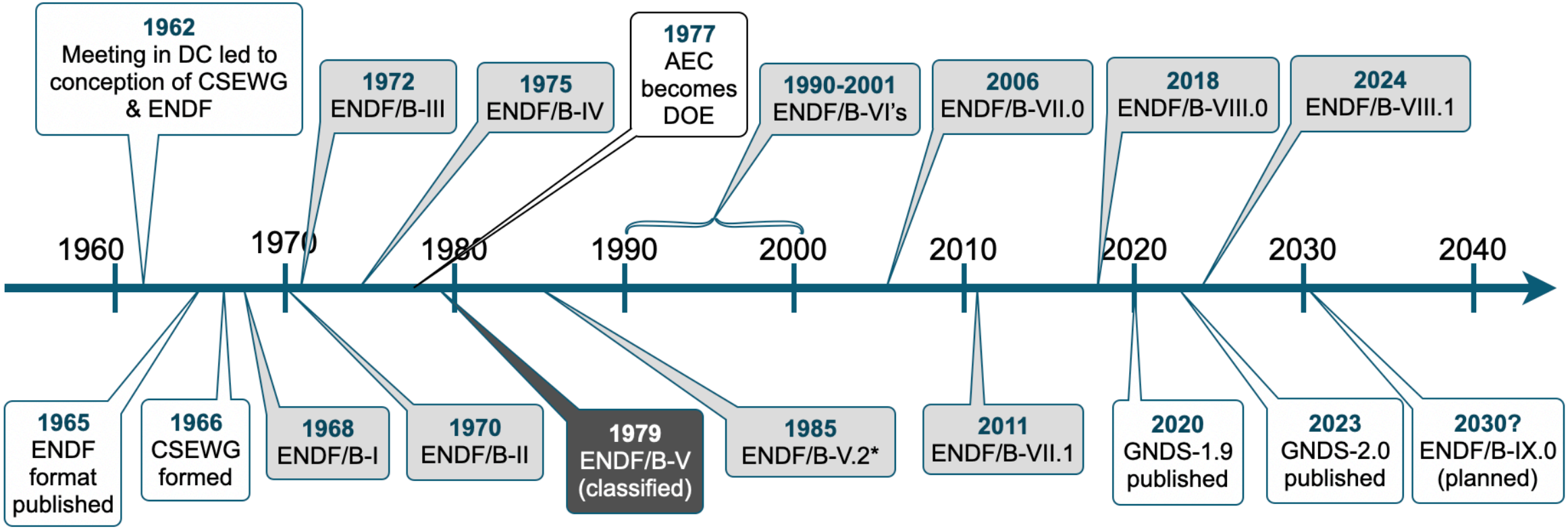
Outline

- ENDF/B-VIII.1
  - Data access
  - Big paper
- ENDF Library activities
  - ReGra workshop
  - Status and plans
  - Hackathon
- Metrics

National Nuclear Data Center
A DOE PuRe Data Resource Facility

Brookhaven National Laboratory

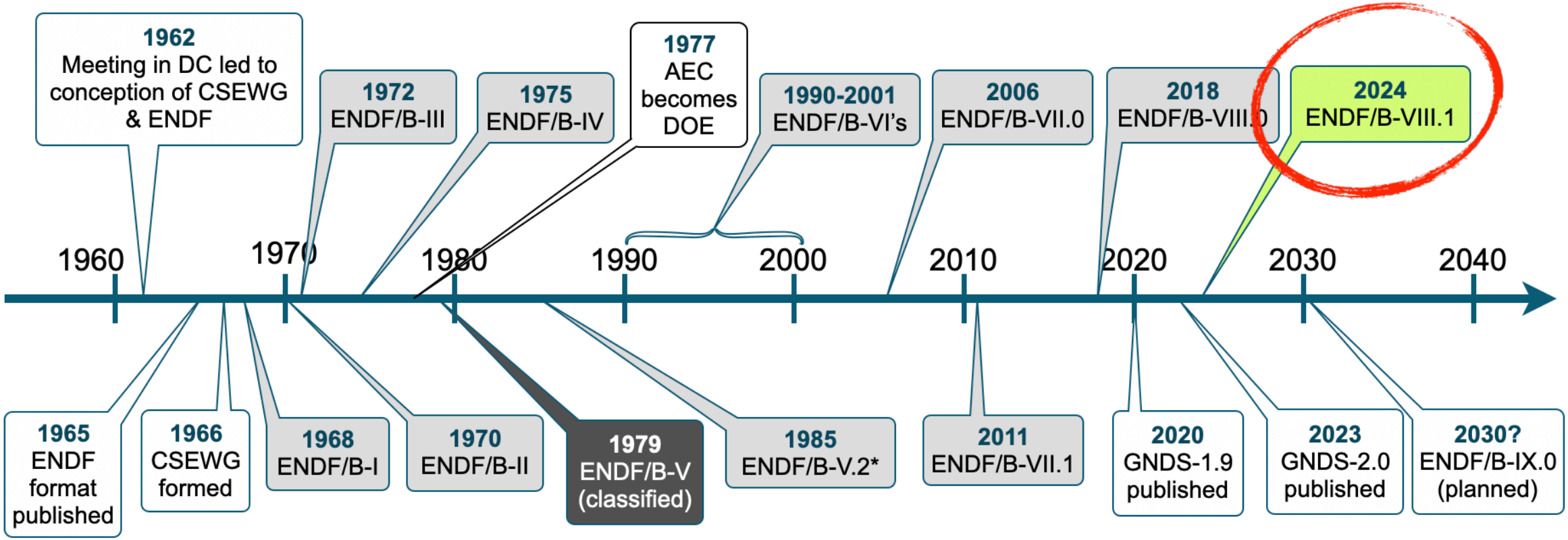
ENDF Timeline



* everybody's favorite release

Timeline courtesy of Dave Brown

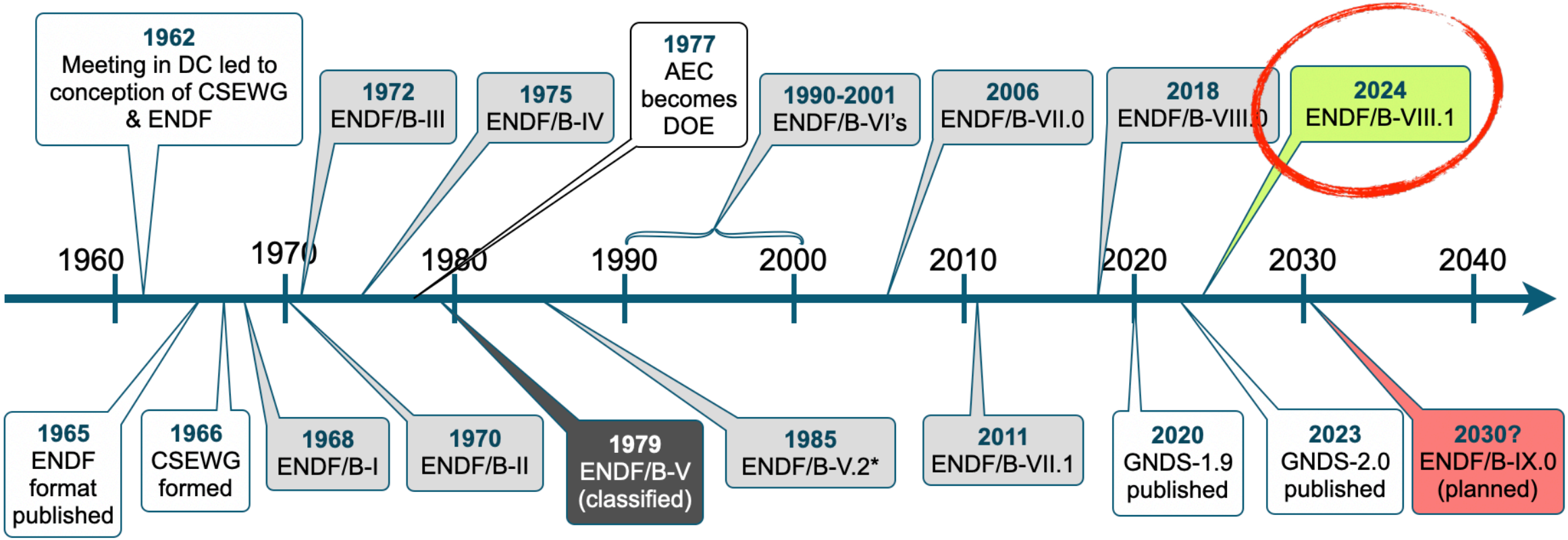
ENDF Timeline



* everybody's favorite release

Timeline courtesy of Dave Brown

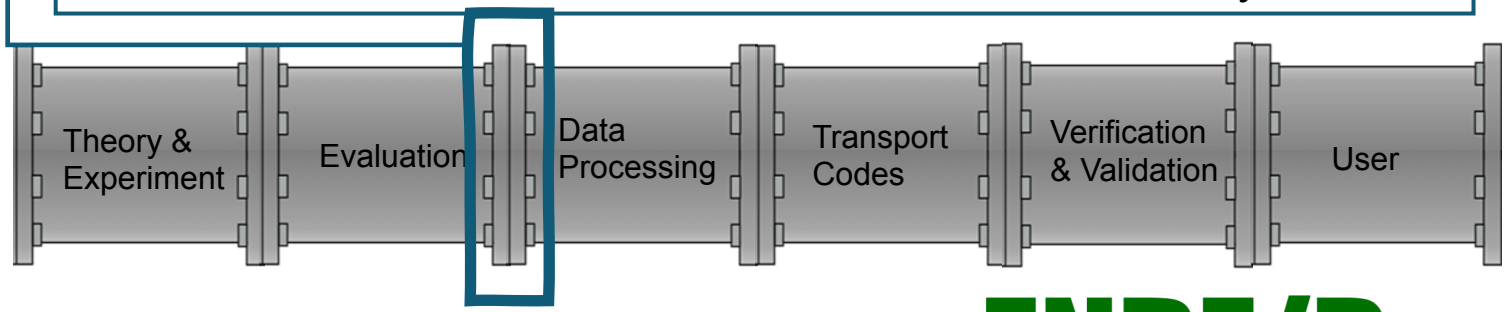
ENDF Timeline



* everybody's favorite release

Timeline courtesy of Dave Brown

ENDF/B releases are a key interface in the improvement of the nuclear data that reaches the users' community!

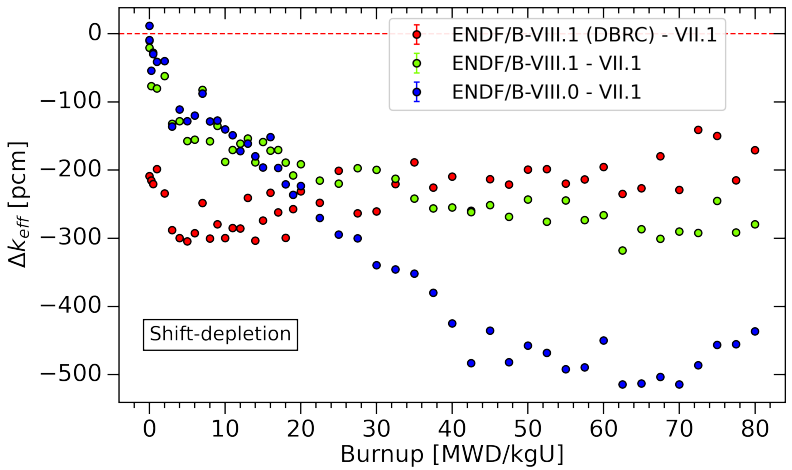


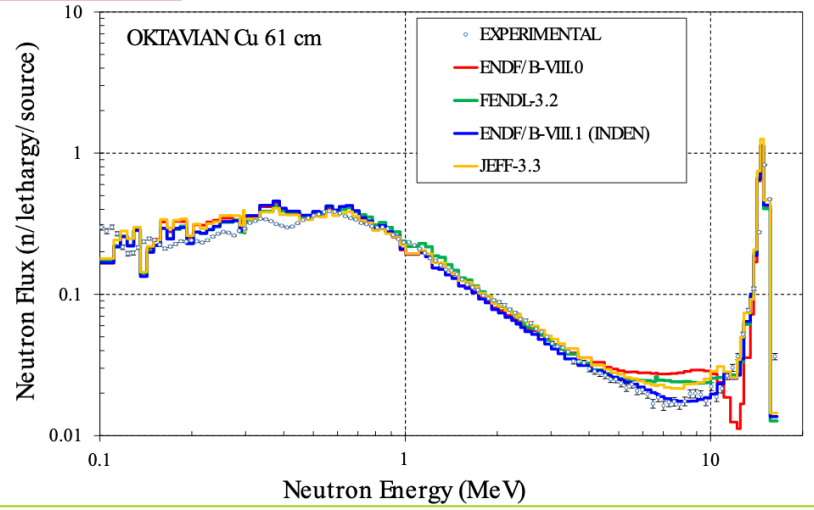
The previous release (VIII.0) was great, but…

- Underpredicted depletion at high burnup
- Had deficiencies in leakage benchmarks
- Many other contributions since then

ENDF/B VIII.1

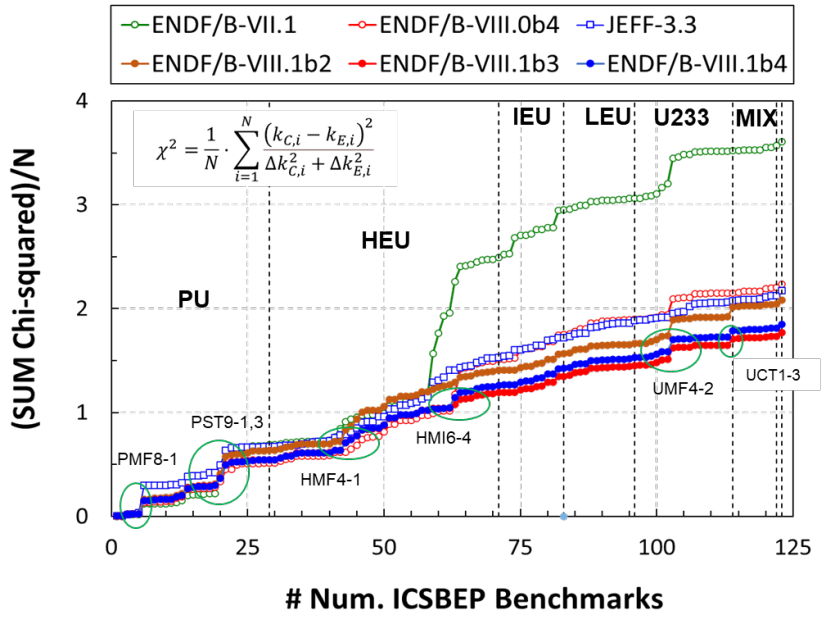
was released Aug 30, 2024!





Mosteller's Suite - 123

Case HMF4.1: Δkeff EXP=30 pcm

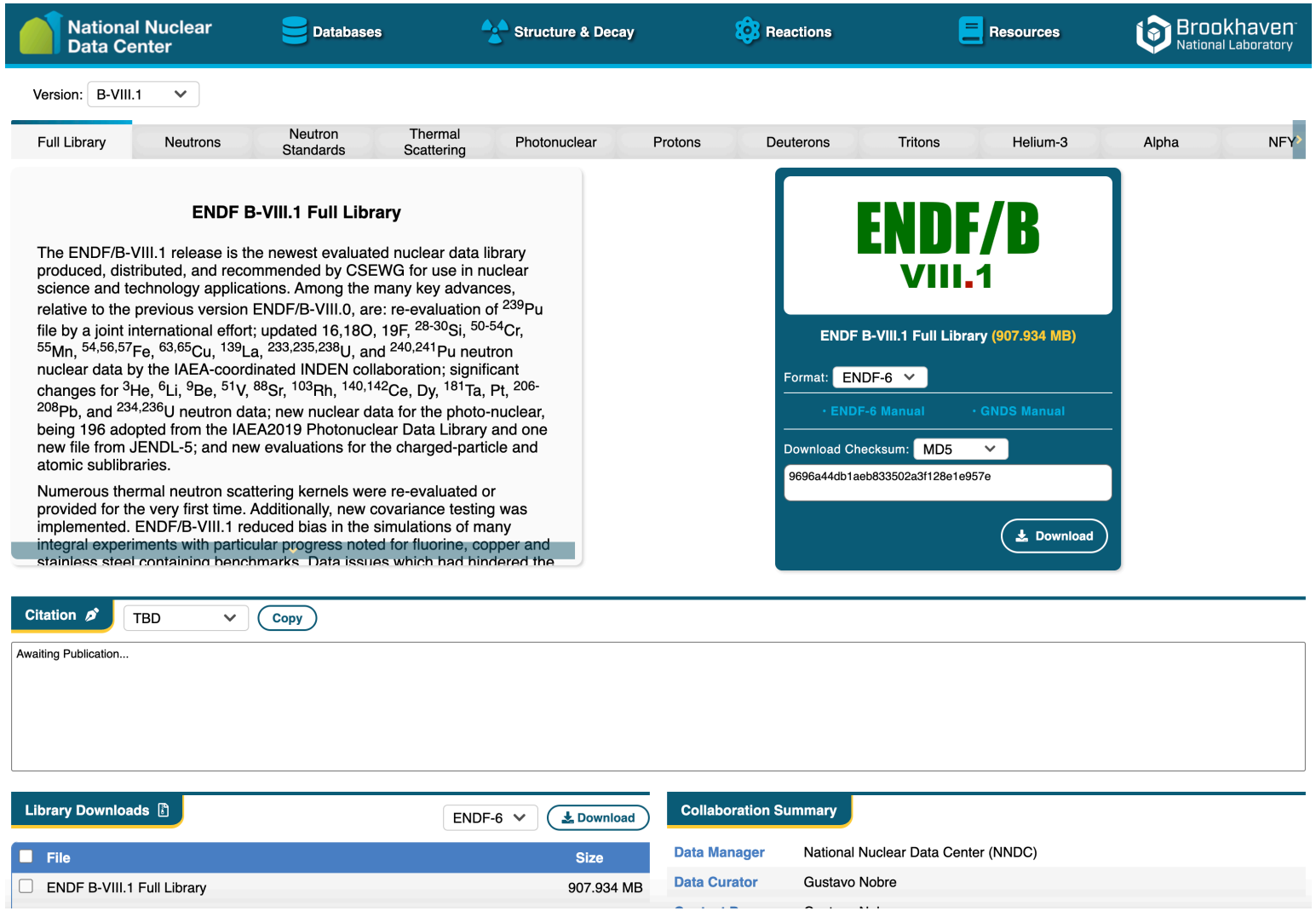


VIII.1 dramatically improves depletion performance,…

…performs much better in leakage and shielding experiments due to updates in Cu, Fe, Cr, Pb,…

…all while further improving the performance in criticality benchmarks, with updates to ^{239}Pu, ^{235,238}U, et al.!!

DOIs for ENDF/B-VIII.1 data



"ENDF/B-VIII.1 release." https://doi.org/10.11578/endf/2571019 (2024).

"ENDF/B-VIII.1 release – alphas sublibrary." https://doi.org/10.11578/endf/2571012 (2024).

"ENDF/B-VIII.1 release – atomic relaxation sublibrary." https://doi.org/10.11578/endf/2571013 (2024).

"ENDF/B-VIII.1 release – decay sublibrary." https://doi.org/10.11578/endf/2571014 (2024).

"ENDF/B-VIII.1 release – deuterons sublibrary." https://doi.org/10.11578/endf/2571015 (2024).

"ENDF/B-VIII.1 release – electrons sublibrary." https://doi.org/10.11578/endf/2571016 (2024).

"ENDF/B-VIII.1 release – photonuclear sublibrary." https://doi.org/10.11578/endf/2571020 (2024).

"ENDF/B-VIII.1 release – helions sublibrary." https://doi.org/10.11578/endf/2571021 (2024).

"ENDF/B-VIII.1 release – neutrons sublibrary." https://doi.org/10.11578/endf/2571022 (2024).

"ENDF/B-VIII.1 release – neutron-induced fission product yields sublibrary." https://doi.org/10.11578/endf/2571023 (2024).

"ENDF/B-VIII.1 release – photo-atomic sublibrary." https://doi.org/10.11578/endf/2571024 (2024).

"ENDF/B-VIII.1 release – protons sublibrary." https://doi.org/10.11578/endf/2571025 (2024).

"ENDF/B-VIII.1 release – spontaneous fission product yields sublibrary." https://doi.org/10.11578/endf/2571026 (2024).

"ENDF/B-VIII.1 release – standards sublibrary." https://doi.org/10.11578/endf/2571027 (2024).

"ENDF/B-VIII.1 release – thermal scattering law sublibrary." https://doi.org/10.11578/endf/2571028 (2024).

"ENDF/B-VIII.1 release – tritons sublibrary." https://doi.org/10.11578/endf/2584305 (2024).

DOIs for ENDF/B-VIII.1 data

Library Downloads ENDF-6 Download

File	Size
ENDF B-VIII.1 Full Library	907.934 MB
Alpha Reaction Sublibrary	181 KB
Atomic Relaxation Reaction Sublibrary	1.397 MB
Decay Reaction Sublibrary	10.358 MB
Deuteron Reaction Sublibrary	208 KB
Electron Reaction Sublibrary	7.544 MB
Photonuclear Sublibrary	141.016 MB
Helium-3 Reaction Sublibrary	203 KB
Neutron Reaction Sublibrary	343.487 MB
Neutron Induced Fission Product Yields Sublibrary	1.502 MB
Photoatomic Reaction Sublibrary	33.635 MB

Collaboration Summary

Data Manager	National Nuclear Data Center (NNDC)
Data Curator	Gustavo Nobre
Contact Person	Gustavo Nobre
Project Leader	David Brown
Hosting Institution	Brookhaven National Laboratory (BNL)
Producer	Cross Section Evaluation Working Group (CSEWG)

Deposition Summary

Depositor	Gustavo Nobre
Contact	gnobre@bnl.gov
Deposition Date	10/21/2024
Last Modified	10/21/2024
DOI	10.11578/endf/2571019

Resources

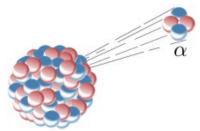
ENDF-6 Manual | GNDS Manual | Summary | GNDS | POINT | Criticality Validation

ENDF/B VIII.1

ENDF B-VIII.1 Full Library (907.934 MB)

Format: ENDF-6

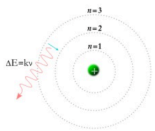
• ENDF-6 Manual • GNDS Manual



Alpha Reaction Sublibrary (181 KB)

Format: ENDF-6

• Release Notes • Changelog • Material List



Atomic Relaxation Reaction Sublibrary (1.397 MB)

Format: ENDF-6

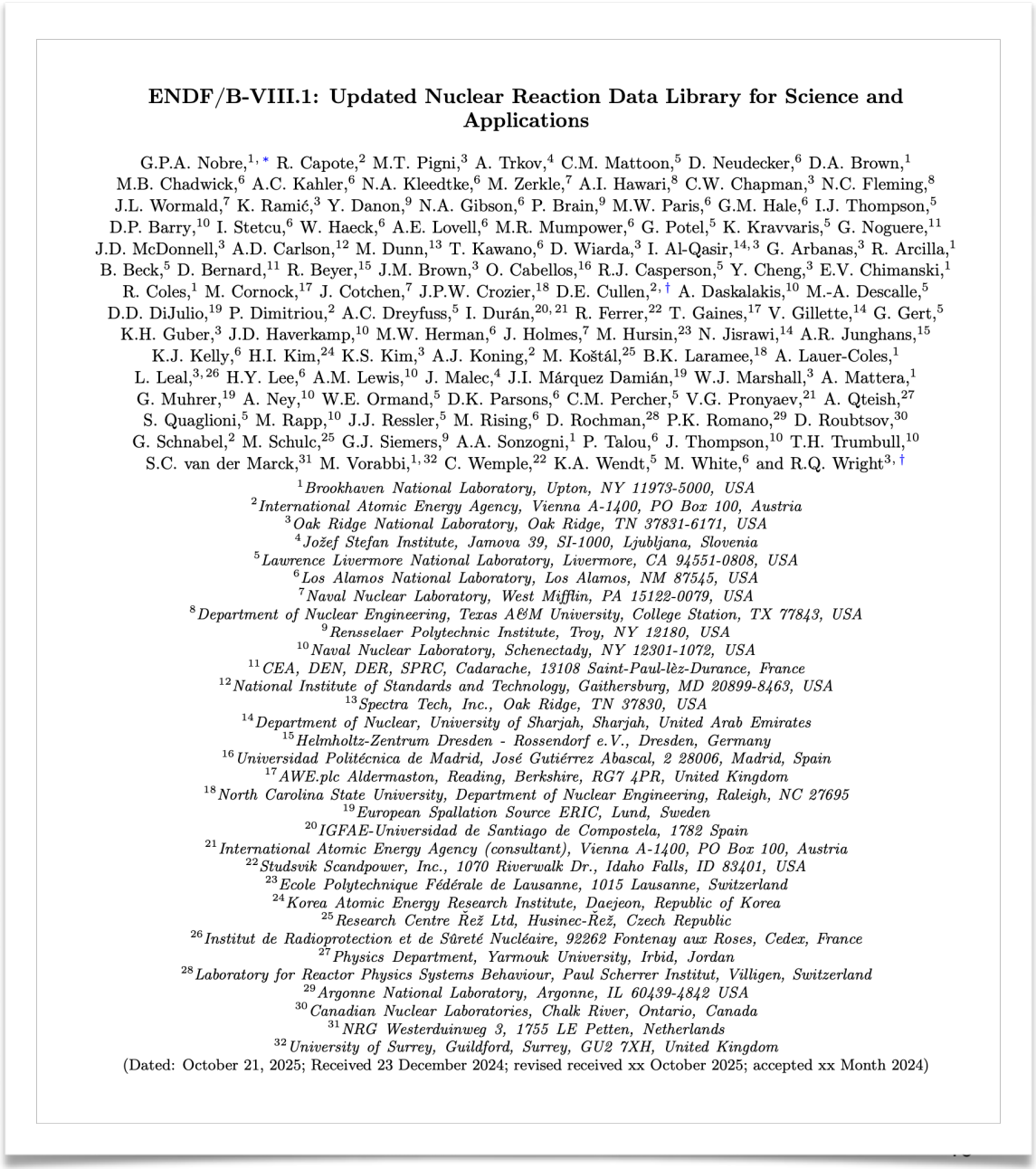
• Release Notes • Changelog • Material List

"ENDF/B-VIII.1 release." https://doi.org/10.11578/endf/2571019 (2024).
"ENDF/B-VIII.1 release – alphas sublibrary." https://doi.org/10.11578/endf/2571012 (2024).
"ENDF/B-VIII.1 release – atomic relaxation sublibrary." https://doi.org/10.11578/endf/2571013 (2024).
"ENDF/B-VIII.1 release – decay sublibrary." https://doi.org/10.11578/endf/2571014 (2024).
"ENDF/B-VIII.1 release – deuterons sublibrary." https://doi.org/10.11578/endf/2571015 (2024).
"ENDF/B-VIII.1 release – electrons sublibrary." https://doi.org/10.11578/endf/2571016 (2024).
"ENDF/B-VIII.1 release – photonuclear sublibrary." https://doi.org/10.11578/endf/2571020 (2024).
"ENDF/B-VIII.1 release – helions sublibrary." https://doi.org/10.11578/endf/2571021 (2024).
"ENDF/B-VIII.1 release – neutrons sublibrary." https://doi.org/10.11578/endf/2571022 (2024).
"ENDF/B-VIII.1 release – neutron-induced fission product yields sublibrary." https://doi.org/10.11578/endf/2571023 (2024).
"ENDF/B-VIII.1 release – photo-atomic sublibrary." https://doi.org/10.11578/endf/2571024 (2024).
"ENDF/B-VIII.1 release – protons sublibrary." https://doi.org/10.11578/endf/2571025 (2024).
"ENDF/B-VIII.1 release – spontaneous fission product yields sublibrary." https://doi.org/10.11578/endf/2571026 (2024).
"ENDF/B-VIII.1 release – standards sublibrary." https://doi.org/10.11578/endf/2571027 (2024).
"ENDF/B-VIII.1 release – thermal scattering law sublibrary." https://doi.org/10.11578/endf/2571028 (2024).
"ENDF/B-VIII.1 release – tritons sublibrary." https://doi.org/10.11578/endf/2584305 (2024).

ENDF/B-VIII.1 Big Paper

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
- **Oct./Nov., 2025:** Planned posting in arXiv



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

G.P.A. Nobre,[1,*] R. Capote,[2] M.T. Pigni,[3] A. Trkov,[4] C.M. Mattoon,[5] D. Neudecker,[6] D.A. Brown,[1] M.B. Chadwick,[6] A.C. Kahler,[6] N.A. Kleedtke,[6] M. Zerkle,[7] A.I. Hawari,[8] C.W. Chapman,[3] N.C. Fleming,[8] J.L. Wormald,[7] K. Ramić,[3] Y. Danon,[9] N.A. Gibson,[6] P. Brain,[9] M.W. Paris,[6] G.M. Hale,[6] I.J. Thompson,[5] D.P. Barry,[10] I. Stetcu,[6] W. Haeck,[6] A.E. Lovell,[6] M.R. Mumpower,[6] G. Potel,[5] K. Kravvaris,[5] G. Noguere,[11] J.D. McDonnell,[3] A.D. Carlson,[12] M. Dunn,[13] T. Kawano,[6] D. Wiarda,[3] I. Al-Qasir,[14,3] G. Arbanas,[3] R. Arcilla,[1] B. Beck,[5] D. Bernard,[11] R. Beyer,[15] J.M. Brown,[3] O. Cabellos,[16] R.J. Casperson,[5] Y. Cheng,[3] E.V. Chimanski,[1] R. Coles,[1] M. Cornock,[17] J. Cotchen,[7] J.P.W. Crozier,[18] D.E. Cullen,[2,†] A. Daskalakis,[10] M.-A. Descalle,[5] D.D. DiJulio,[19] P. Dimitriou,[2] A.C. Dreyfuss,[5] I. Durán,[20,21] R. Ferrer,[22] T. Gaines,[17] V. Gillette,[14] G. Gert,[5] K.H. Guber,[3] J.D. Haverkamp,[10] M.W. Herman,[6] J. Holmes,[7] M. Hursin,[23] N. Jisrawi,[14] A.R. Junghans,[15] K.J. Kelly,[6] H.I. Kim,[24] K.S. Kim,[3] A.J. Koning,[2] M. Koštál,[25] B.K. Laramee,[18] A. Lauer-Coles,[1] L. Leal,[3,26] H.Y. Lee,[6] A.M. Lewis,[10] J. Malec,[4] J.I. Márquez Damián,[19] W.J. Marshall,[3] A. Mattera,[1] G. Muhrer,[19] A. Ney,[10] W.E. Ormand,[5] D.K. Parsons,[6] C.M. Percher,[5] V.G. Pronyaev,[21] A. Qteish,[27] S. Quaglioni,[5] M. Rapp,[10] J.J. Ressler,[5] M. Rising,[6] D. Rochman,[28] P.K. Romano,[29] D. Roubtsov,[30] G. Schnabel,[2] M. Schulc,[25] G.J. Siemers,[9] A.A. Sonzogni,[1] P. Talou,[6] J. Thompson,[10] T.H. Trumbull,[10] S.C. van der Marck,[31] M. Vorabbi,[1,32] C. Wemple,[22] K.A. Wendt,[5] M. White,[6] and R.Q. Wright[3,†]

[1] *Brookhaven National Laboratory, Upton, NY 11973-5000, USA*
[2] *International Atomic Energy Agency, Vienna A-1400, PO Box 100, Austria*
[3] *Oak Ridge National Laboratory, Oak Ridge, TN 37831-6171, USA*
[4] *Jožef Stefan Institute, Jamova 39, SI-1000, Ljubljana, Slovenia*
[5] *Lawrence Livermore National Laboratory, Livermore, CA 94551-0808, USA*
[6] *Los Alamos National Laboratory, Los Alamos, NM 87545, USA*
[7] *Naval Nuclear Laboratory, West Mifflin, PA 15122-0079, USA*
[8] *Department of Nuclear Engineering, Texas A&M University, College Station, TX 77843, USA*
[9] *Rensselaer Polytechnic Institute, Troy, NY 12180, USA*
[10] *Naval Nuclear Laboratory, Schenectady, NY 12301-1072, USA*
[11] *CEA, DEN, DER, SPRC, Cadarache, 13108 Saint-Paul-lèz-Durance, France*
[12] *National Institute of Standards and Technology, Gaithersburg, MD 20899-8463, USA*
[13] *Spectra Tech, Inc., Oak Ridge, TN 37830, USA*
[14] *Department of Nuclear, University of Sharjah, Sharjah, United Arab Emirates*
[15] *Helmholtz-Zentrum Dresden - Rossendorf e.V., Dresden, Germany*
[16] *Universidad Politécnica de Madrid, José Gutiérrez Abascal, 2 28006, Madrid, Spain*
[17] *AWE.plc Aldermaston, Reading, Berkshire, RG7 4PR, United Kingdom*
[18] *North Carolina State University, Department of Nuclear Engineering, Raleigh, NC 27695*
[19] *European Spallation Source ERIC, Lund, Sweden*
[20] *IGFAE-Universidad de Santiago de Compostela, 1782 Spain*
[21] *International Atomic Energy Agency (consultant), Vienna A-1400, PO Box 100, Austria*
[22] *Studsvik Scandpower, Inc., 1070 Riverwalk Dr., Idaho Falls, ID 83401, USA*
[23] *Ecole Polytechnique Fédérale de Lausanne, 1015 Lausanne, Switzerland*
[24] *Korea Atomic Energy Research Institute, Daejeon, Republic of Korea*
[25] *Research Centre Řež Ltd, Husinec-Řež, Czech Republic*
[26] *Institut de Radioprotection et de Sûreté Nucléaire, 92262 Fontenay aux Roses, Cedex, France*
[27] *Physics Department, Yarmouk University, Irbid, Jordan*
[28] *Laboratory for Reactor Physics Systems Behaviour, Paul Scherrer Institut, Villigen, Switzerland*
[29] *Argonne National Laboratory, Argonne, IL 60439-4842 USA*
[30] *Canadian Nuclear Laboratories, Chalk River, Ontario, Canada*
[31] *NRG Westerduinweg 3, 1755 LE Petten, Netherlands*
[32] *University of Surrey, Guildford, Surrey, GU2 7XH, United Kingdom*

(Dated: October 21, 2025; Received 23 December 2024; revised received xx October 2025; accepted xx Month 2024)

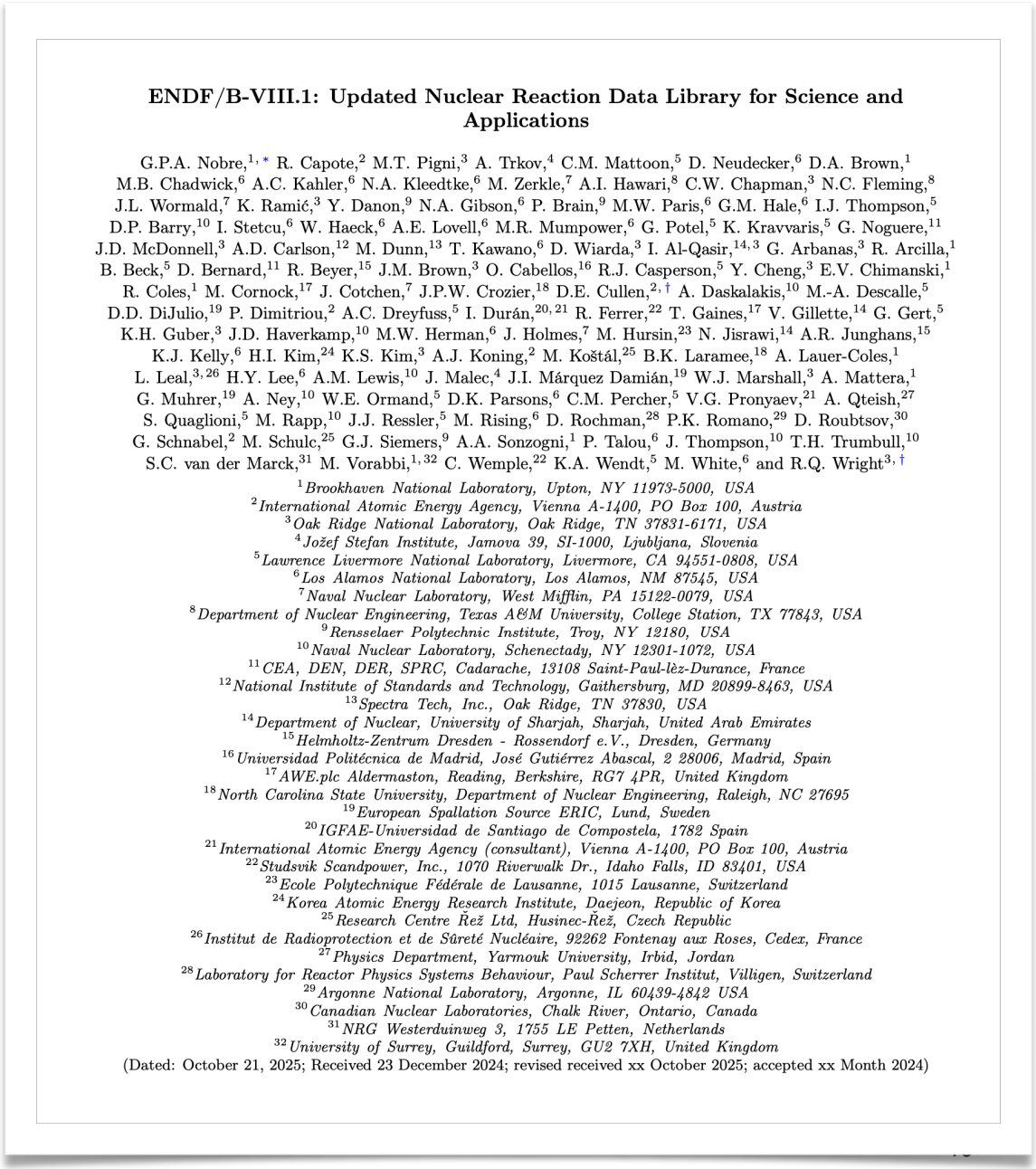
Brookhaven National Laboratory

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
- **Oct./Nov., 2025:** Planned posting in arXiv

Hopefully it will get published early 2026!

Brookhaven National Laboratory



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

G.P.A. Nobre,[1,*] R. Capote,[2] M.T. Pigni,[3] A. Trkov,[4] C.M. Mattoon,[5] D. Neudecker,[6] D.A. Brown,[1] M.B. Chadwick,[6] A.C. Kahler,[6] N.A. Kleedtke,[6] M. Zerkle,[7] A.I. Hawari,[8] C.W. Chapman,[3] N.C. Fleming,[8] J.L. Wormald,[7] K. Ramić,[3] Y. Danon,[9] N.A. Gibson,[6] P. Brain,[9] M.W. Paris,[6] G.M. Hale,[6] I.J. Thompson,[5] D.P. Barry,[10] I. Stetcu,[6] W. Haeck,[6] A.E. Lovell,[6] M.R. Mumpower,[6] G. Potel,[5] K. Kravvaris,[5] G. Noguere,[11] J.D. McDonnell,[3] A.D. Carlson,[12] M. Dunn,[13] T. Kawano,[6] D. Wiarda,[3] I. Al-Qasir,[14,3] G. Arbanas,[3] R. Arcilla,[1] B. Beck,[5] D. Bernard,[11] R. Beyer,[15] J.M. Brown,[3] O. Cabellos,[16] R.J. Casperson,[5] Y. Cheng,[3] E.V. Chimanski,[1] R. Coles,[1] M. Cornock,[17] J. Cotchen,[7] J.P.W. Crozier,[18] D.E. Cullen,[2,†] A. Daskalakis,[10] M.-A. Descalle,[5] D.D. DiJulio,[19] P. Dimitriou,[2] A.C. Dreyfuss,[5] I. Durán,[20,21] R. Ferrer,[22] T. Gaines,[17] V. Gillette,[14] G. Gert,[5] K.H. Guber,[3] J.D. Haverkamp,[10] M.W. Herman,[6] J. Holmes,[7] M. Hursin,[23] N. Jisrawi,[14] A.R. Junghans,[15] K.J. Kelly,[6] H.I. Kim,[24] K.S. Kim,[3] A.J. Koning,[2] M. Koštál,[25] B.K. Laramee,[18] A. Lauer-Coles,[1] L. Leal,[3,26] H.Y. Lee,[6] A.M. Lewis,[10] J. Malec,[4] J.I. Márquez Damián,[19] W.J. Marshall,[3] A. Mattera,[1] G. Muhrer,[19] A. Ney,[10] W.E. Ormand,[5] D.K. Parsons,[6] C.M. Percher,[5] V.G. Pronyaev,[21] A. Qteish,[27] S. Quaglioni,[5] M. Rapp,[10] J.J. Ressler,[5] M. Rising,[6] D. Rochman,[28] P.K. Romano,[29] D. Roubtsov,[30] G. Schnabel,[2] M. Schulc,[25] G.J. Siemers,[9] A.A. Sonzogni,[1] P. Talou,[6] J. Thompson,[10] T.H. Trumbull,[10] S.C. van der Marck,[31] M. Vorabbi,[1,32] C. Wemple,[22] K.A. Wendt,[5] M. White,[6] and R.Q. Wright[3,†]

[1] *Brookhaven National Laboratory, Upton, NY 11973-5000, USA*
[2] *International Atomic Energy Agency, Vienna A-1400, PO Box 100, Austria*
[3] *Oak Ridge National Laboratory, Oak Ridge, TN 37831-6171, USA*
[4] *Jožef Stefan Institute, Jamova 39, SI-1000, Ljubljana, Slovenia*
[5] *Lawrence Livermore National Laboratory, Livermore, CA 94551-0808, USA*
[6] *Los Alamos National Laboratory, Los Alamos, NM 87545, USA*
[7] *Naval Nuclear Laboratory, West Mifflin, PA 15122-0079, USA*
[8] *Department of Nuclear Engineering, Texas A&M University, College Station, TX 77843, USA*
[9] *Rensselaer Polytechnic Institute, Troy, NY 12180, USA*
[10] *Naval Nuclear Laboratory, Schenectady, NY 12301-1072, USA*
[11] *CEA, DEN, DER, SPRC, Cadarache, 13108 Saint-Paul-lèz-Durance, France*
[12] *National Institute of Standards and Technology, Gaithersburg, MD 20899-8463, USA*
[13] *Spectra Tech, Inc., Oak Ridge, TN 37830, USA*
[14] *Department of Nuclear, University of Sharjah, Sharjah, United Arab Emirates*
[15] *Helmholtz-Zentrum Dresden - Rossendorf e.V., Dresden, Germany*
[16] *Universidad Politécnica de Madrid, José Gutiérrez Abascal, 2 28006, Madrid, Spain*
[17] *AWE.plc Aldermaston, Reading, Berkshire, RG7 4PR, United Kingdom*
[18] *North Carolina State University, Department of Nuclear Engineering, Raleigh, NC 27695*
[19] *European Spallation Source ERIC, Lund, Sweden*
[20] *IGFAE-Universidad de Santiago de Compostela, 1782 Spain*
[21] *International Atomic Energy Agency (consultant), Vienna A-1400, PO Box 100, Austria*
[22] *Studsvik Scandpower, Inc., 1070 Riverwalk Dr., Idaho Falls, ID 83401, USA*
[23] *Ecole Polytechnique Fédérale de Lausanne, 1015 Lausanne, Switzerland*
[24] *Korea Atomic Energy Research Institute, Daejeon, Republic of Korea*
[25] *Research Centre Řež Ltd, Husinec-Řež, Czech Republic*
[26] *Institut de Radioprotection et de Sûreté Nucléaire, 92262 Fontenay aux Roses, Cedex, France*
[27] *Physics Department, Yarmouk University, Irbid, Jordan*
[28] *Laboratory for Reactor Physics Systems Behaviour, Paul Scherrer Institut, Villigen, Switzerland*
[29] *Argonne National Laboratory, Argonne, IL 60439-4842 USA*
[30] *Canadian Nuclear Laboratories, Chalk River, Ontario, Canada*
[31] *NRG Westerduinweg 3, 1755 LE Petten, Netherlands*
[32] *University of Surrey, Guildford, Surrey, GU2 7XH, United Kingdom*

(Dated: October 21, 2025; Received 23 December 2024; revised received xx October 2025; accepted xx Month 2024)

1st Reactor Graphite Workshop (ReGra)

July 8-9 @ BNL

Brookhaven National Laboratory

Reactor Graphite Workshop

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

Enter your search term

- Homepage
- Overview
- Timetable
- Contribution List
- My Conference
  - My Contributions
- Registration

Contact
gnobre@bnl.gov

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

- 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

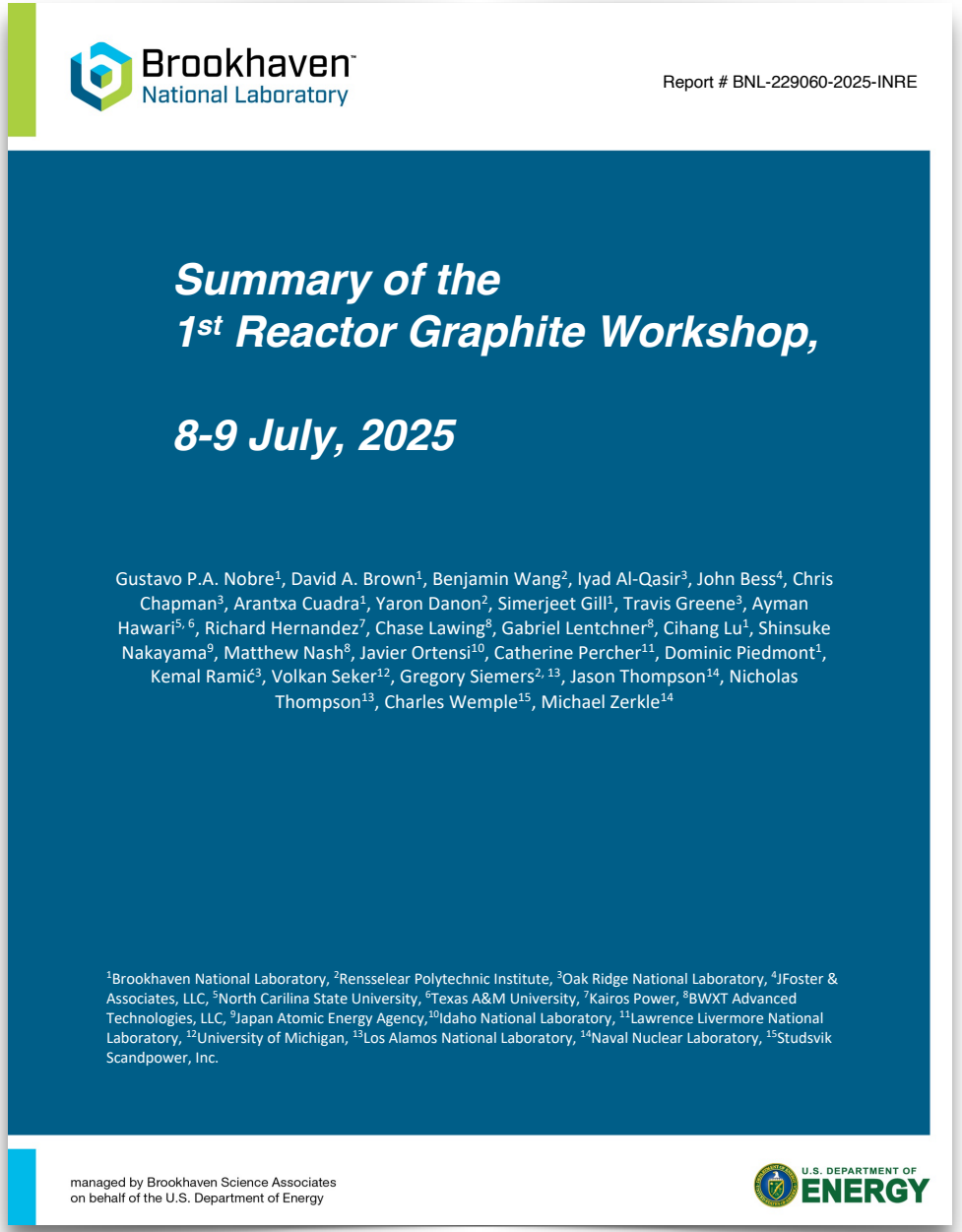
Tuesday - July 8			
Starting time	**Duration (minutes)**	**Title**	**Presenter**
9:00	0:10	BNL Welcome	Alejandro Sonzogni (BNL)
9:10	0:15	Workshop Goals	Dave Brown & Gustavo Nobre (BNL)
9:25	0:30	Qualifying Graphite for Reactor Applications: A Materials Perspective	Dominic Piedmont (BNL)
9:55	0:30	Discussion about material characterization	All
10:25	0:15	Coffee break	
10:40	0:20	NNL Perspective of Reactor-grade Graphite	Mike Zerkle (NNL)
11:00	0:30	Updates to the HTR-PROTEUS HALEU Benchmark Using Modern Analysis Methodologies	Javier Ortensi, Volkan Seker and John Bess (INL)
11:30	0:30	Thermal Scattering Law Impact on BWXT Advanced Nuclear Reactor	Chase Lawing, Matthew Nash and Gabriel Lentchner (BWXT)
12:00	1:20	Lunch	
13:20	0:30	Discussion about users' perspectives	All
13:50	0:20	Physics of Phonons in Graphite: Integrating Inelastic Neutron Scattering Measurements and First-Principles Calculations	Iyad Al-Qasir (ORNL)
14:10	0:30	Machine learned atomistic modeling of porosity in nuclear graphite	Kemal Ramic (ORNL)
14:40	0:30	Investigation and Evaluation of Thermal Neutron Scattering in Nuclear Graphite	Ayman Hawari (TAMU)
15:10	0:20	Coffee break	
15:30	0:20	Overview of historical and new transmission measurements of nuclear graphite	Chris Chapman (ORNL)
15:50	0:20	Investigating the Impact of Fast Neutron Radiation Damage on Graphite Lattice Dynamics	Iyad Al-Qasir (ORNL)
16:10	1:10	Discussion about modeling and evaluation approaches	All
17:20	0:05	Closing of Day 1	
18:30		No-host dinner	

Wednesday - July 9			
Starting time	**Duration (minutes)**	**Title**	**Presenter**
9:00	0:30	Integral Benchmarks for Graphite TSL Validation	Catherine Percher (LLNL)
9:30	0:20	Deimos and Graphite TSLs	Nick Thompson (LANL)
9:50	0:20	Modernization of Historical Graphite Measurements and Techniques	Benjamin Wang (RPI)
10:10	0:20	ORNL testing of multiple graphite benchmarks	Travis Greene (ORNL)
10:30	0:20	Coffee break	
10:50	0:30	Benchmark and Validation of Thermal Neutron Scattering in Nuclear Graphite	Ayman Hawari
11:20	0:10	Discussion about Validation	All
11:30	0:10	Group picture	
11:40	0:30	Discussion about Validation	All
12:10	1:20	Lunch	
13:30	1:00	Discussion about validated graphite library requirements to fulfill user needs	All
14:30	1:00	Discussion about path forward	All
15:30	0:30	Coffee break	
16:00	1:20	Discussion about action items	All
17:20	0:10	Closing	Gustavo Nobre and Dave Brown (BNL)

- “Mini-sessions” on Materials characterization, Users’ perspectives, Differential data, modeling & evaluation, and Validation.
- Plenty of time for discussions
- During the workshop, we finalized an agreed-upon “key takeaways” from the meeting

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?)


Brookhaven National Laboratory

Report # BNL-229060-2025-INRE

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

Gustavo P.A. Nobre[1], David A. Brown[1], Benjamin Wang[2], Iyad Al-Qasir[3], John Bess[4], Chris Chapman[3], Arantxa Cuadra[1], Yaron Danon[2], Simerjeet Gill[1], Travis Greene[3], Ayman Hawari[5, 6], Richard Hernandez[7], Chase Lawing[8], Gabriel Lentchner[8], Cihang Lu[1], Shinsuke Nakayama[9], Matthew Nash[8], Javier Ortensi[10], Catherine Percher[11], Dominic Piedmont[1], Kemal Ramić[3], Volkan Seker[12], Gregory Siemers[2, 13], Jason Thompson[14], Nicholas Thompson[13], Charles Wemple[15], Michael Zerkle[14]

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

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

U.S. DEPARTMENT OF ENERGY

What's next for ENDF/B?

Why already talk about ENDF/B-IX?

ENDF release

ENDF release

Why already talk about ENDF/B-IX?

ENDF release

ENDF release

There will be updates to standards, so…

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

Why already talk about ENDF/B-IX?

ENDF release

ENDF release

There will be updates to standards, so…

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

Why already talk about ENDF/B-IX?

- With ENDF/B-VIII.1 done, now is the perfect time to plan out the next cycle
- The lessons learned are still fresh, we can start off in better footing than before
- We received many contributions that could not be reviewed and tested in time to make it for VIII.1
- Tools are in place for a relatively quick turnaround for a Beta1
- It is an opportunity for the collaboration to plan out what should be in the next release

ENDF release

ENDF release

There will be updates to standards, so…

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

Evaluations already submitted

Neutrons:

- ^{35}Cl (LANL/Terrapower/ORNL)
- ^{238}U (PFNS from Chi-Nu data)

TSL:

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

Photonuclear:

- ^{9}Be (NNL)

Evaluations already submitted

Neutrons:

- ^{35}Cl (LANL/Terrapower/ORNL)
- ^{238}U (PFNS from Chi-Nu data)

TSL:

- Polye
  tem
- W, V, Pb, Ni, Mo, Cu (ORNL)

Initial tests* in Fast MSR (^{Nat}Cl, Pu, MgO reflected) indicate that new Cl file has impact of the order of **~1500pcm**; equivalent to "savings" of about **75kg of ^{239}Pu!**

Photonuclear:

- ^{9}Be (NNL)

Thanks to David Bernard (CEA) for the calculations and estimates!

Evaluations already submitted

Neutrons:

- ^{35}Cl (LANL/Terrapower/ORNL)
- ^{238}U (PFNS from Chi-Nu data)

TSL:

- Polye
  tem
- W, V, Pb, Ni, Mo, Cu (ORNL)

Initial tests* in Fast MSR (^{Nat}Cl, Pu, MgO reflected) indicate that new Cl file has impact of the order of **~1500pcm**; equivalent to "savings" of about **75kg of ^{239}Pu!**

Photonuclear:

- ^{9}Be (NNL)

Expected/planned submissions

Neutrons:

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

Deuterons:

- D+T (LANL/LLNL)

Standards:

- ^{252}Cf sf
- Etc…

FPY

Decay

*Thanks to David Bernard (CEA) for the calculations and estimates!

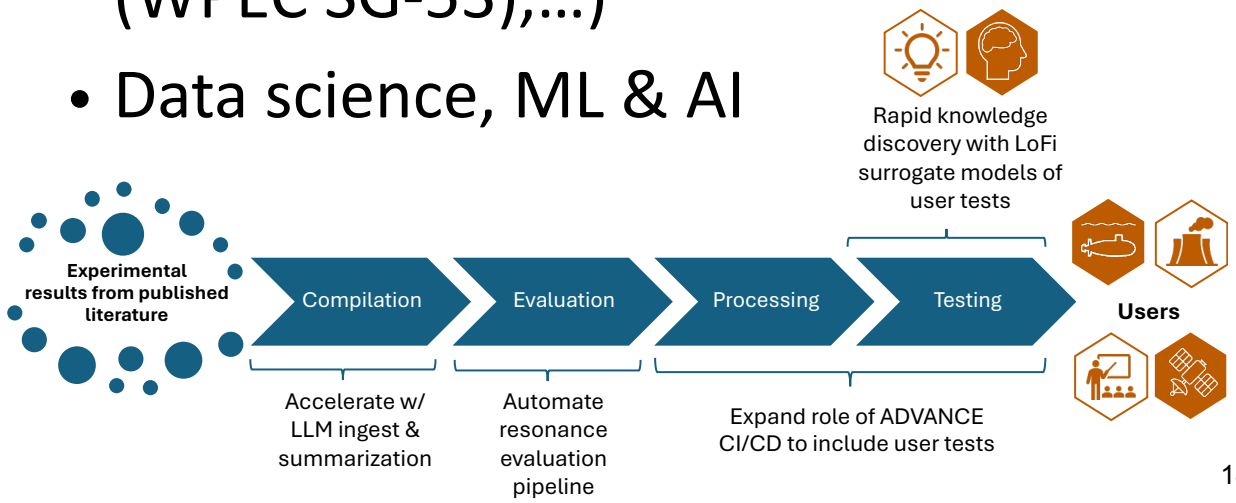
Known Drivers

Known programmatic drivers

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

Anticipated foci

- ^{239}Pu, **Standards**
- Reactions on unstable fission products
- Materials for next gen. reactors (Cl, Zr (WPEC SG-53),…)
- Data science, ML & AI



Other activities for 2025/2026

Other activities for 2025/2026

- Hackathon 5-7 Aug. 2025 at ORNL
  - There were many remaining bugs in the library
  - With the push for the VIII.1 release, Hackathon was low-priority
  - Optimal timing: Between VIII.1 and next Beta release
  - Many bugs were fixed
  - They are sitting in parallel branches waiting to be double-checked and merged
  - As expected, many new issues were found and logged

Other activities for 2025/2026

- Hackathon 5-7 Aug. 2025 at ORNL
  - There were many remaining bugs in the library
  - With the push for the VIII.1 release, Hackathon was low-priority
  - Optimal timing: Between VIII.1 and next Beta release
  - Many bugs were fixed
  - They are sitting in parallel branches waiting to be double-checked and merged
  - As expected, many new issues were found and logged
- Release a Beta1
  - Originally planned for late FY25, it will likely happen early 2026

Other activities for 2025/2026

- Hackathon 5-7 Aug. 2025 at ORNL
  - There were many remaining bugs in the library
  - With the push for the VIII.1 release, Hackathon was low-priority
  - Optimal timing: Between VIII.1 and next Beta release
  - Many bugs were fixed
  - They are sitting in parallel branches waiting to be double-checked and merged
  - As expected, many new issues were found and logged
- Release a Beta1
  - Originally planned for late FY25, it will likely happen early 2026

ENDF/B IX.0-β1

vs.

ENDF/B VIII.2-β1

will depend whether standards will be updated in time

ENDF metrics for FY25

ENDF evaluation metrics

- This is a **challenge!**
- Not all evaluation contributions are created equal
- *All* linear combinations of **“size”** and **“impact”** of contribution are possible
- There is some degree of intrinsic arbitrariness
- Looked at all* repository commits in FY25, separated by lab and “weighed” the contributions

Brookhaven National Laboratory

ENDF evaluation metrics

- This is a **challenge!**
- Not all evaluation contributions are created equal
- *All* linear combinations of **“size”** and **“impact”** of contribution are possible
- There is some degree of intrinsic arbitrariness
- Looked at all* repository commits in FY25, separated by lab and “weighed” the contributions

	“number of evaluations”
BNL	3.57
LLNL	0.22
LANL	0.85
ORNL	1.4

Brookhaven National Laboratory

ENDF evaluation metrics

- This is a **challenge!**
- Not all evaluation contributions are created equal
- *All* line
  "impa
- There
  arbitra
- Looked at all* repository commits in FY25, separated by lab and "weighed" the contributions

Big asterisk:

There are many fixes in separate branches that have not yet been cross-checked and brought to the main branch, therefore ignored in the count for now!

	"number of evaluations"
BNL	3.57
LLNL	0.22
LANL	0.85
ORNL	1.4

Conclusion

- Wrapping up ENDF/B-VIII.1 business
  - Big Paper:
    - Revised version submitted
    - Should be published in NDS early 2026
  - DOIs and landing page for data are available now
- Beginning of next ENDF cycle:
  - Organized Reactor Graphite workshop
  - Hackathon
  - Working on next Beta release
- (Somewhat subjective) metrics: Relatively lower numbers are expected since this was a post-release year

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.

Brookhaven National Laboratory

NCSP NUCLEAR CRITICALITY SAFETY PROGRAM

Brookhaven National Laboratory

U.S. DEPARTMENT of ENERGY | Office of Science

NNSA National Nuclear Security Administration