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U.S. DEPARTMENT OF
ENERGY

ENDF report

G.P.A. Nobre[1]

@BrookhavenLab

USNDP Meeting
October 1-4, 2024

[1] *National Nuclear Data Center, Brookhaven National Laboratory*

Outline

- ENDF/B-VIII.1 release status
  - Summary
  - Changes from VIII.0
  - How to get the data
- "Big Paper"
- Other honorary mentions
- ENDF Metrics
- Backup slides in the end with A LOT of details

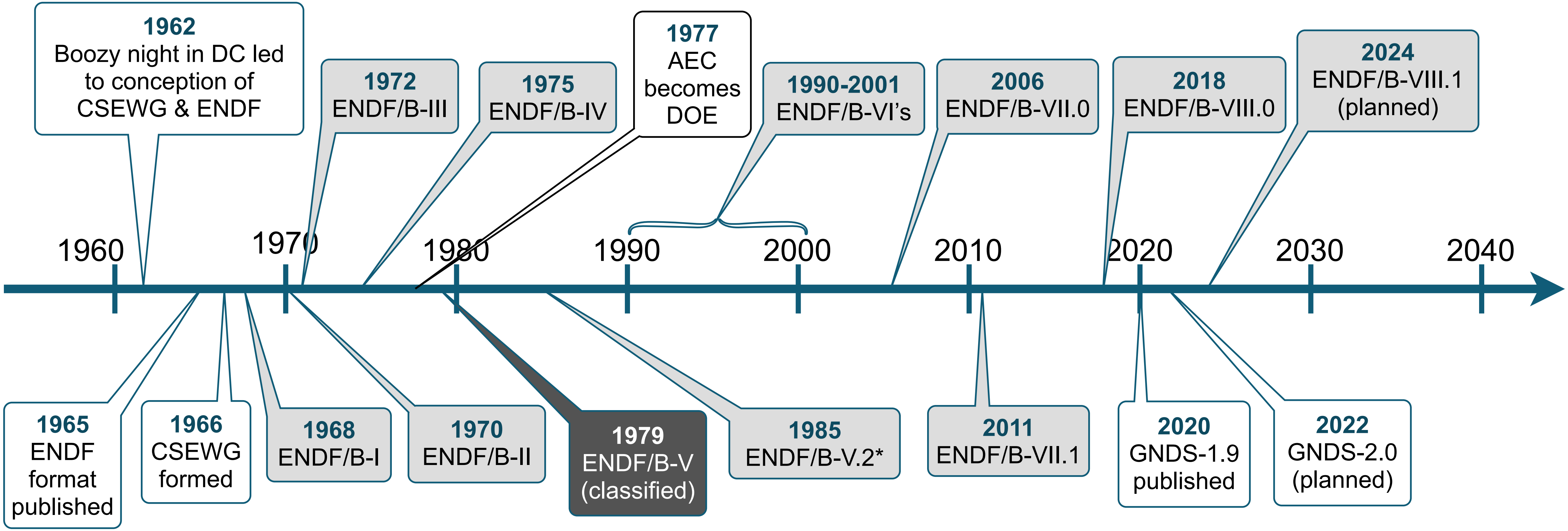
ENDF/B
VIII.1

ENDF/B-VIII.1 release status

ENDF/B-VIII.1 release status

ENDF/B-VIII.1 was released on August 30th, 2024!

ENDF Timeline



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Boozy night in DC led to conception of CSEWG & ENDF

1972
ENDF/B-III

1975
ENDF/B-IV

1977
AEC becomes DOE

1990-2001
ENDF/B-VI's

2006
ENDF/B-VII.0

2018
ENDF/B-VIII.0

2024
ENDF/B-VIII.1 (planned)

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ENDF format published

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CSEWG formed

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1979
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GNDS-2.0 (planned)

* everybody's favorite release

Timeline courtesy of Dave Brown

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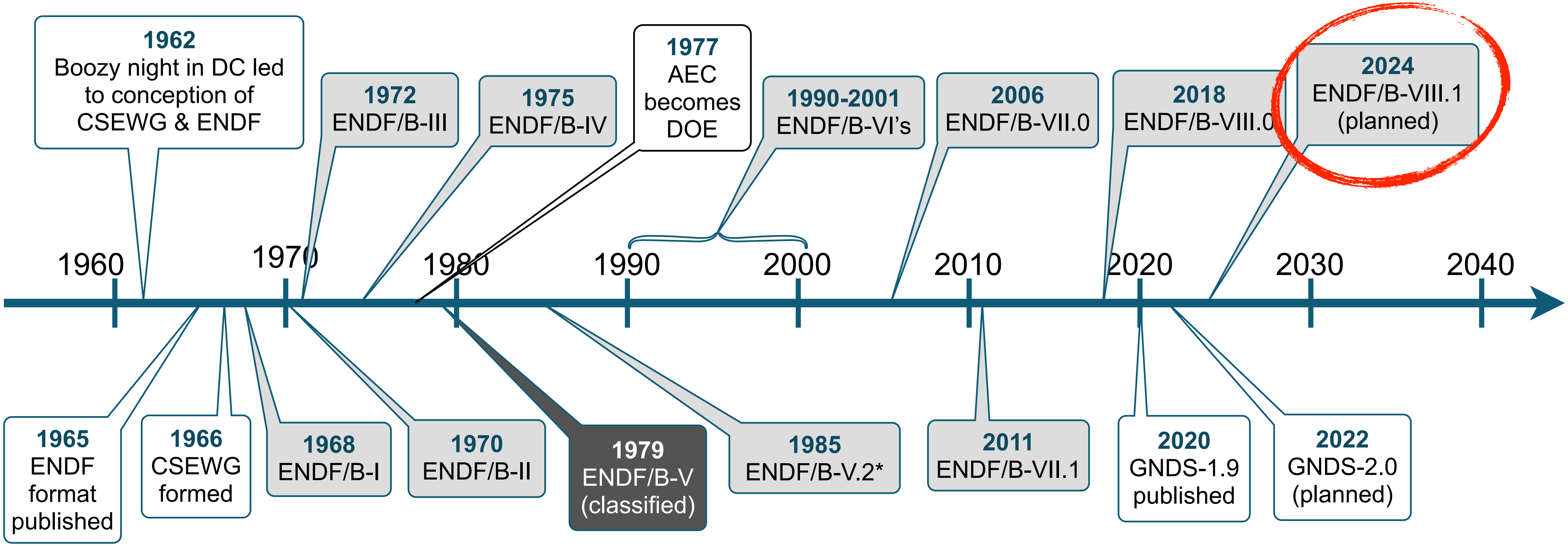

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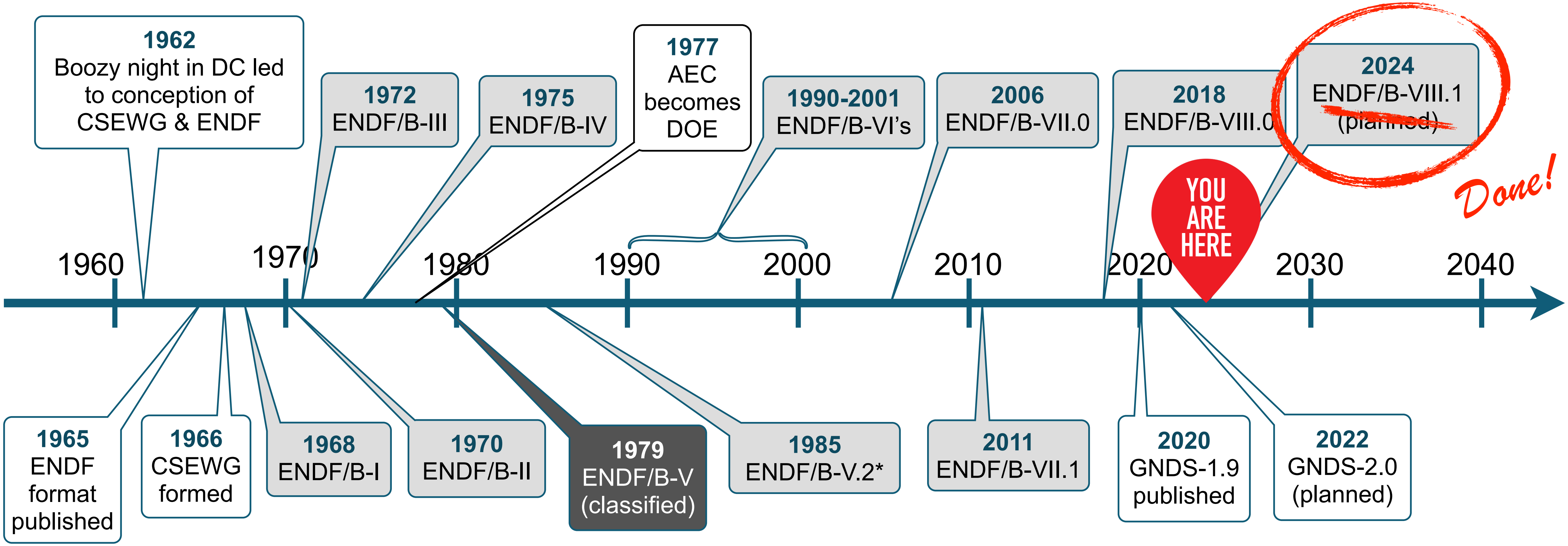

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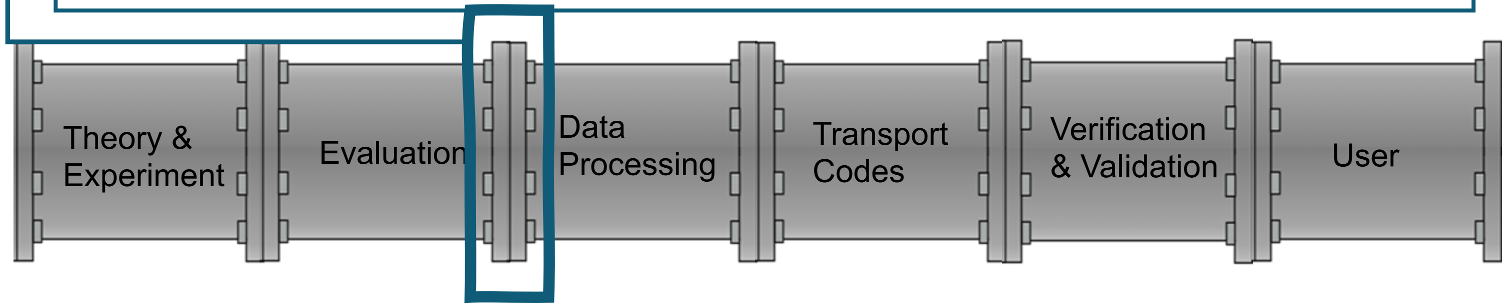

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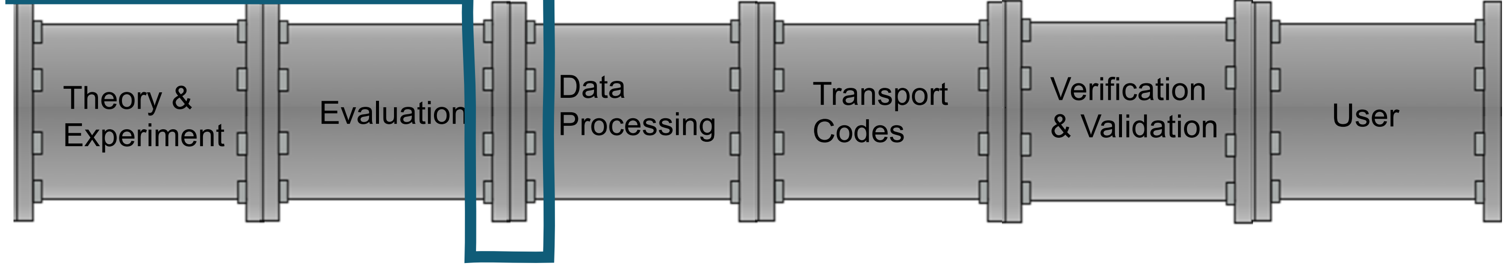

The previous release (VIII.0) was great, but…

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

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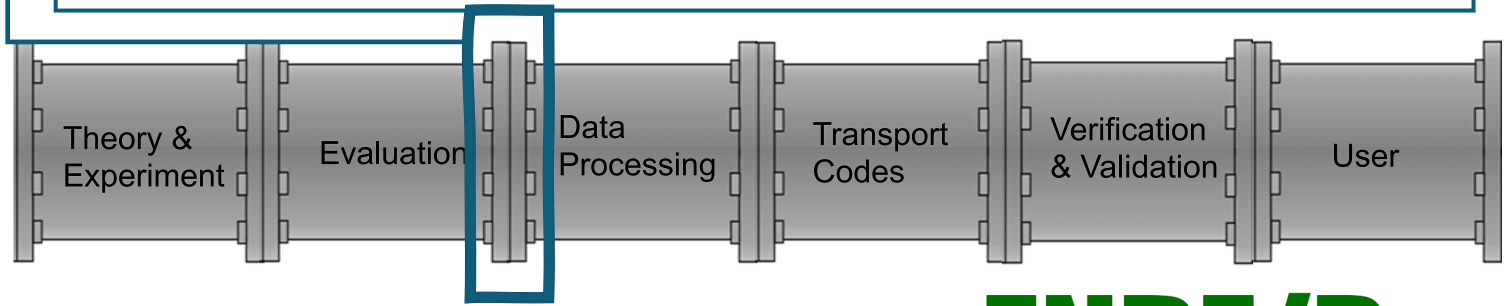

Theory & Experiment

Evaluation

Data Processing

Transport Codes

Verification & Validation

User

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ENDF/B

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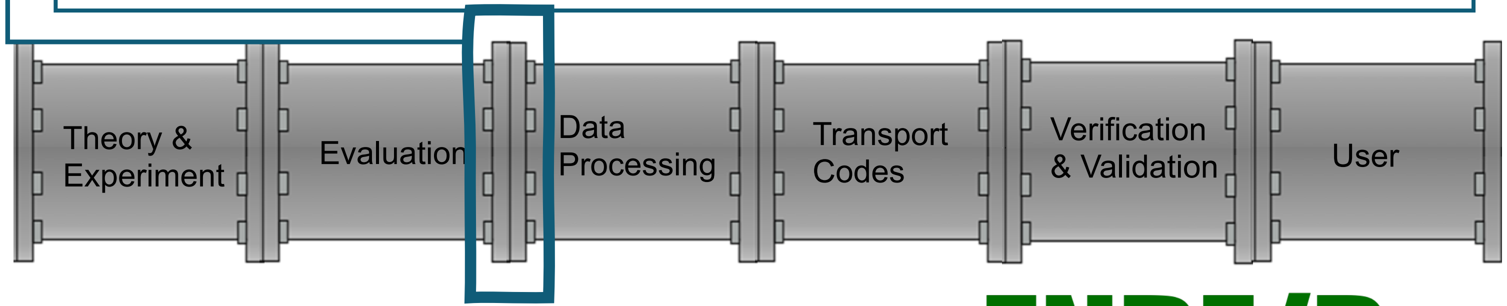

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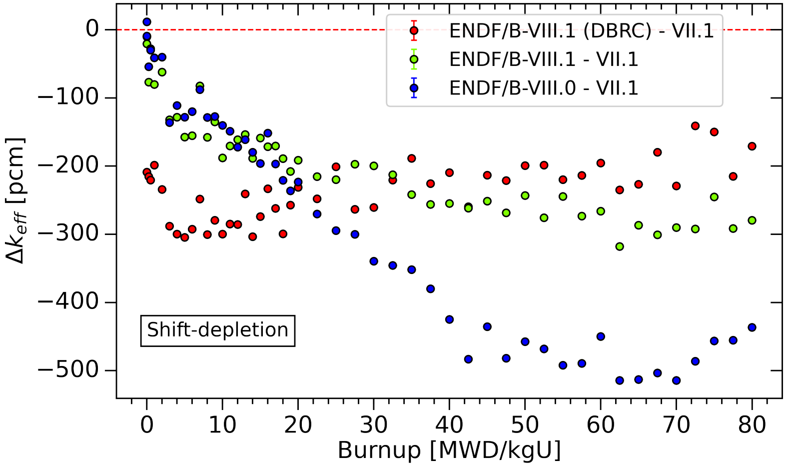

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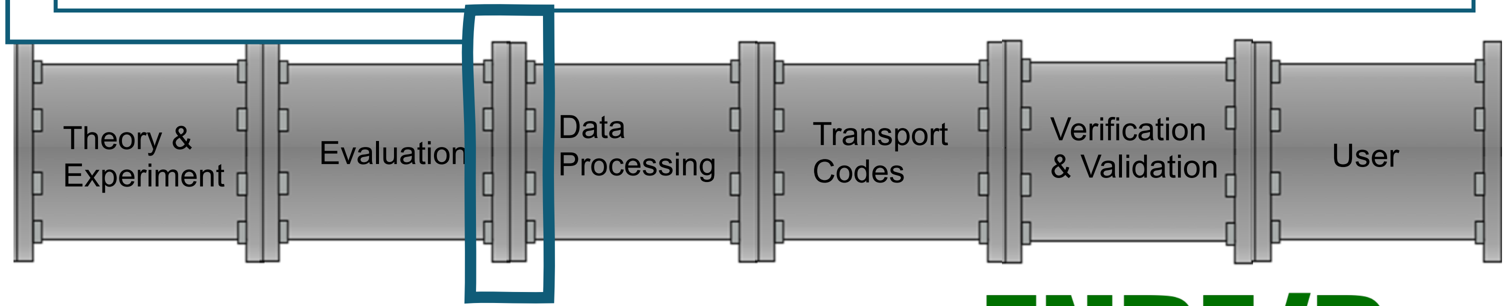

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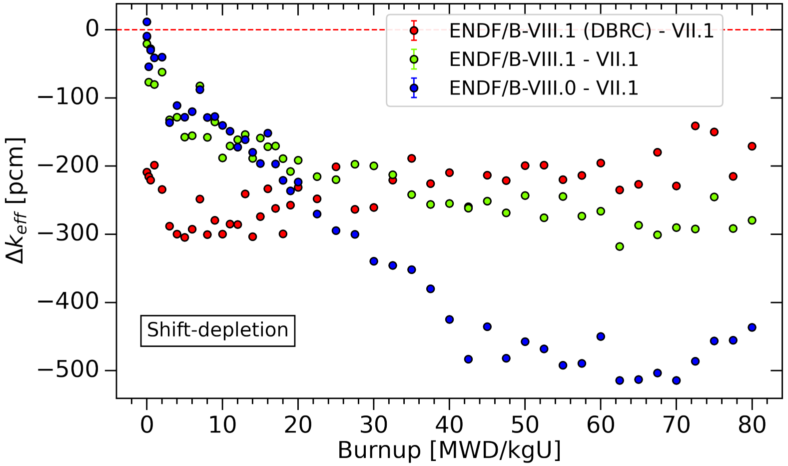

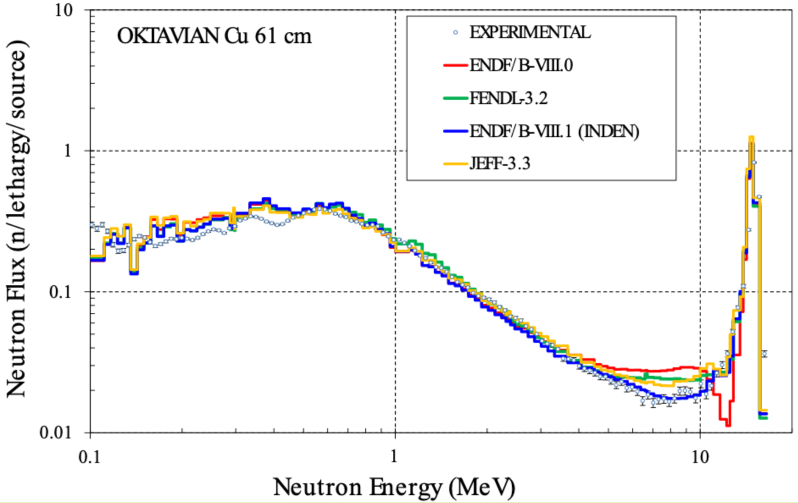

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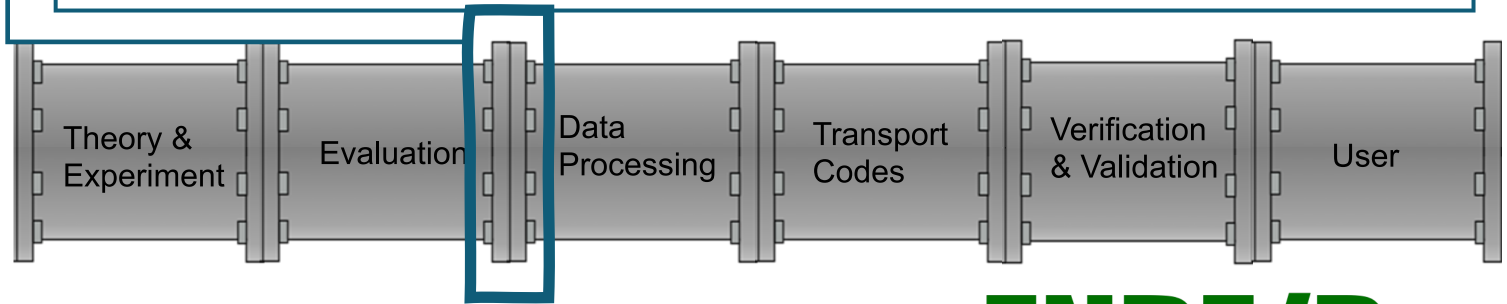

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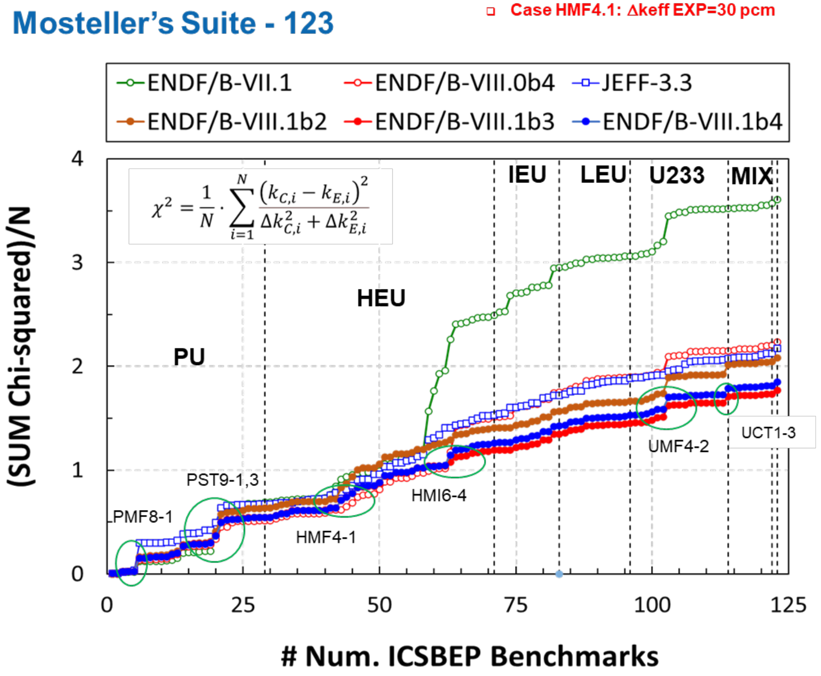
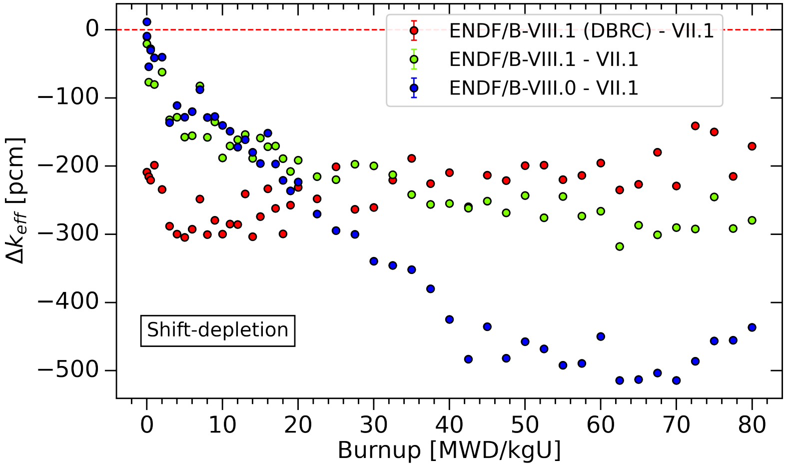
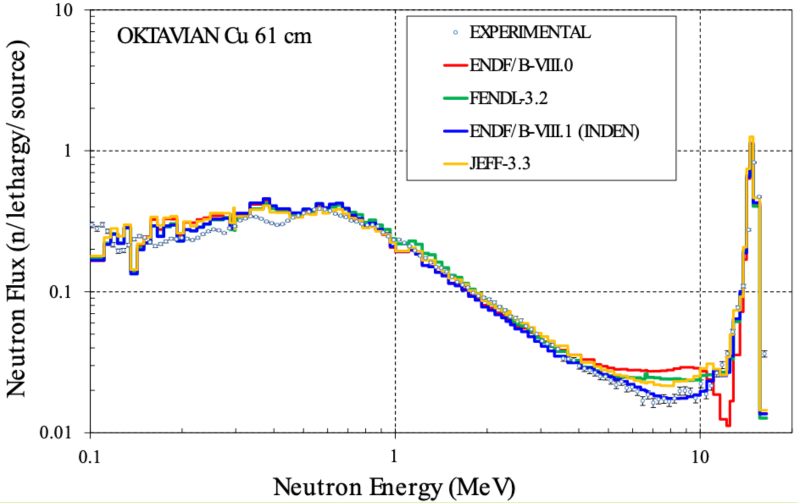
ENDF/B VIII.1

was released Aug 30, 2024!







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…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.!!

So, what’s changed since ENDF/B-VIII.0?

Well,… a lot!

ENDF/B

VIII.1

Well,… a lot!

- Summary
- I will avoid going into too many details
- Will have some highlights as backup slides in the end:
  - Neutrons sub library
    - Actinides
    - Structural materials
  - A few other highlights in other sublibraries

ENDF/B

VIII.1

What to expect in ENDF/B-VIII.1

Neutrons:

- Actinides:
  - **^{239}Pu**: multi-institution effort, with important updates to fission, nubar, PFNS, capture, URR, RRR, (n,2n)
  - **^{235}U**: resonances, nubar, covariances,
  - **^{238}U**: resonance update to improve performance on depletion benchmarks
  - **^{240,241}Pu**: work in concert with changes in ^{239}Pu and ^{238}U to recover burnup performance
  - ^{234,236}U: New fast-region evaluations (LANL)
- Stainless steel & other structure materials:
  - **^{54,56,57}Fe**: Corrects leakage deficiency from ENDF/B-VIII.0
  - **^{50,52,53,54}Cr**: Thorough re-evaluation, impact in criticality and leakage benchmarks
  - **^{206,207,208}Pb**: complete evaluations (RPI/LANL)
  - **^{63,65}Cu**: improved performance
  - **^{55}Mn**: Gamma spectra
  - **^{28,29,30}Si**: resonance evaluations
- Others:
  - ^{19}F (INDEN)
  - **^{6}Li, ^{9}Be** (LANL)
  - **^{234,236}U** (LANL)
  - **^{140,142}Ce** (ORNL)
  - **^{103}Rh** (RPI/IRSN)
  - **^{86}Kr** (BNL)
  - **^{181}Ta** (RPI/ORNL/LANL)
  - **Pt isotopes** (LANL)
  - Many, many, many more…

What to expect in ENDF/B-VIII.1

TSL:

- 70+ new updated/files
- **Polystyrene**, **zirconium hydride**, **UC**, **UN**, **UO_2**, **sapphire**, **lucite**, **FLiBe**, **etc…**
- Fuel materials with different enrichments
- So many new evaluations that we had to re-think how to identify them.
- Low-temperature extrapolations to light water
- Community-wide review and validation

Fission Yields:

- Many fixes
- …but no changes to the actual yields

Photo-nuclear:

- **~200** updates coming from IAEA CRP

Charged particles:

- A few improvements and fixes

How to get the data?

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

"How do I access these new nuclear data?"

ENDF/B
VIII.1

National Nuclear Data Center
A DOE PuRe Data Resource Facility

Brookhaven National Laboratory

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ENDF/B

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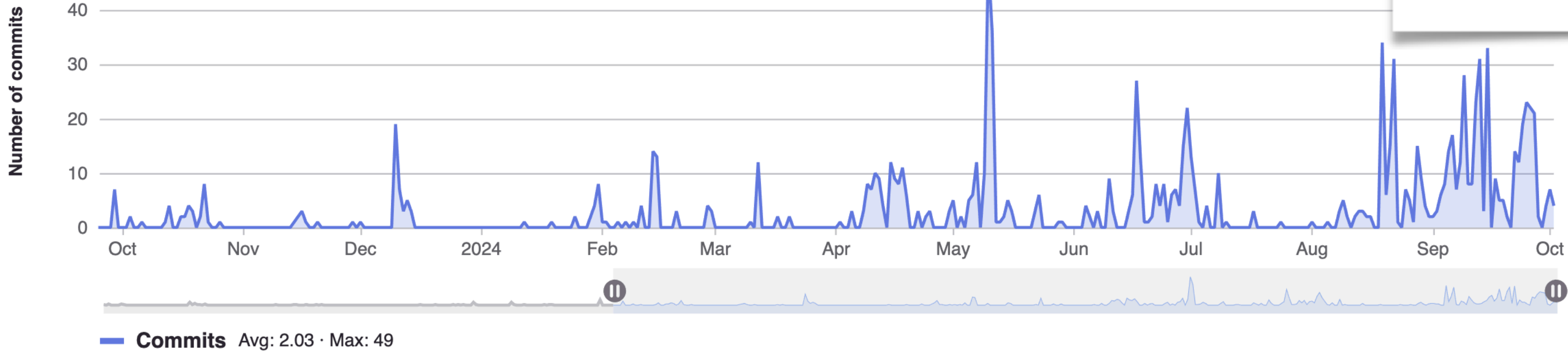
Status of Big Paper

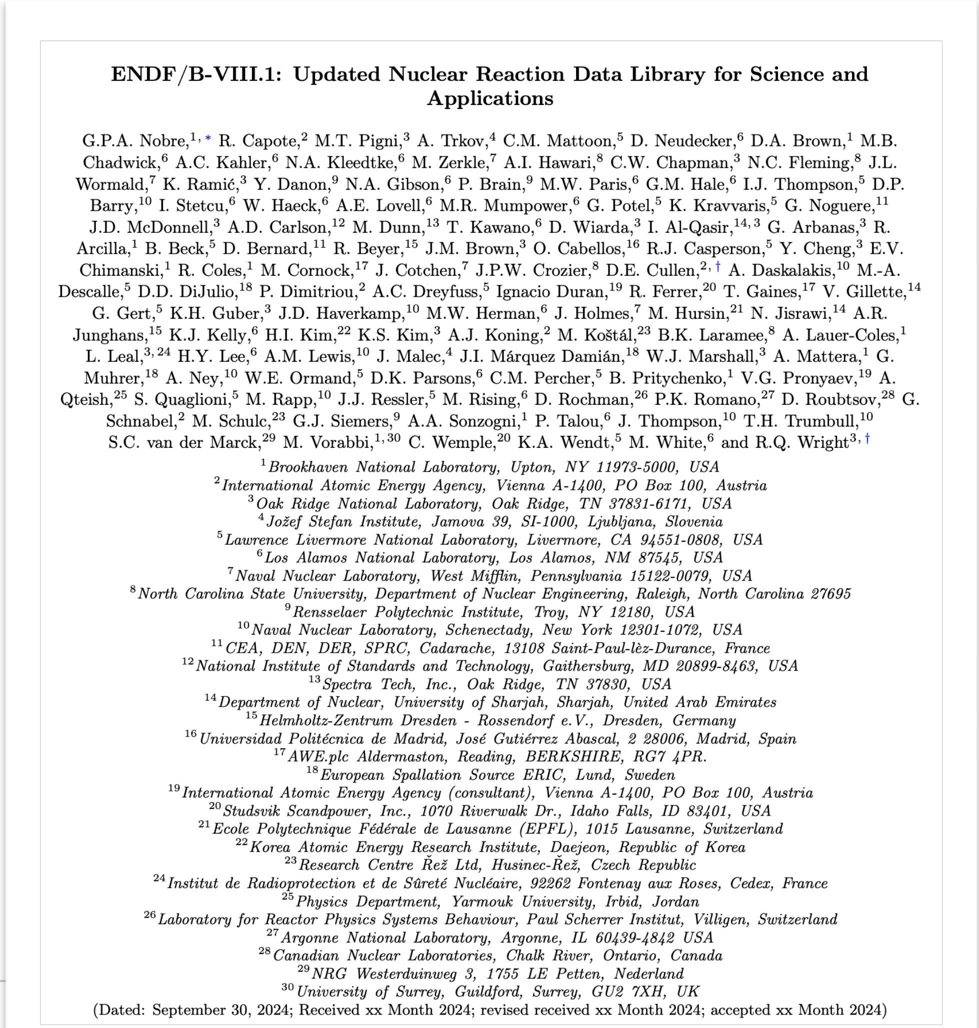
Big Paper updates

- Got all contributions and corrections in: No “FIXMEs” left!
- Submitted to LANL/LLNL/NNL for **final review** regarding export control and public utterance
- In meantime, authors are submitting very minor typo/ grammar fixes
- Should submit to Nuclear Data Sheets *still this week*
- Hoping to make it Open Access

Commits to `development`

Excluding merge commits. Limited to 6,000 commits.





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,[8] D.E. Cullen,[2,†] A. Daskalakis,[10] M.-A. Descalle,[5] D.D. DiJulio,[18] P. Dimitriou,[2] A.C. Dreyfuss,[5] Ignacio Duran,[19] R. Ferrer,[20] 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,[21] N. Jisrawi,[14] A.R. Junghans,[15] K.J. Kelly,[6] H.I. Kim,[22] K.S. Kim,[3] A.J. Koning,[2] M. Koštál,[23] B.K. Laramee,[8] A. Lauer-Coles,[1] L. Leal,[3,24] H.Y. Lee,[6] A.M. Lewis,[10] J. Malec,[4] J.I. Márquez Damián,[18] W.J. Marshall,[3] A. Mattera,[1] G. Muhrer,[18] A. Ney,[10] W.E. Ormand,[5] D.K. Parsons,[6] C.M. Percher,[5] B. Pritychenko,[1] V.G. Pronyaev,[19] A. Qteish,[25] S. Quaglioni,[5] M. Rapp,[10] J.J. Ressler,[5] M. Rising,[6] D. Rochman,[26] P.K. Romano,[27] D. Roubtsov,[28] G. Schnabel,[2] M. Schulc,[23] G.J. Siemers,[9] A.A. Sonzogni,[1] P. Talou,[6] J. Thompson,[10] T.H. Trumbull,[10] S.C. van der Marck,[29] M. Vorabbi,[1,30] C. Wemple,[20] K.A. Wendt,[5] M. White,[6] and R.Q. Wright[3,†]

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[28] *Canadian Nuclear Laboratories, Chalk River, Ontario, Canada*
[29] *NRG Westerduinweg 3, 1755 LE Petten, Nederland*
[30] *University of Surrey, Guildford, Surrey, GU2 7XH, UK*

(Dated: September 30, 2024; Received xx Month 2024; revised received xx Month 2024; accepted xx Month 2024)

Some honorary mentions in FY24

Other highlights

- ENDF/B-VIII.1-Beta3 released January 11, 2024
- ENDF/B-VIII.1-Beta4 released June 28, 2024
- Many checks, reviews, tests and validations within the community
- LANL/BNL organized mini-CSEWG in Los Alamos, August 13-15, 2024
  - Lessons learned from ENDF/B-VIII.1
  - Preparation for ENDF/B-IX.0

Mini-CSEWG

Aug 13 – 15, 2024
Fuller Lodge
US/Mountain timezone

THANK YOU EVERYONE! HAPPY ENDF/B-VIII.1!

Historic Fuller Lodge in springtime. Courtesy/Los Alamos Historical Society Archive from https://losalamoshistory.org/fuller-lodge-centerpiece-of-community/

Brookhaven National Laboratory

ENDF metrics for FY24

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 FY24, separated by lab and “weighed” the contributions

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	“number of evaluations”
BNL	24.483
LLNL	11.965
LANL	13.18
ORNL	12.5

Conclusion

- ENDF/B-VIII.1 has been released!!
  - Hooray!
  - Big thanks to the whole community who contributed in all steps of this huge effort!
- Big Paper:
  - Submitted for final export control review
  - Should submit to NDS soon
- (Somewhat subjective) metrics: High productivity in ENDF-world

Acknowledgements

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NCSP
NUCLEAR CRITICALITY SAFETY PROGRAM

Brookhaven
National Laboratory

Office of Science
U.S. Department of Energy

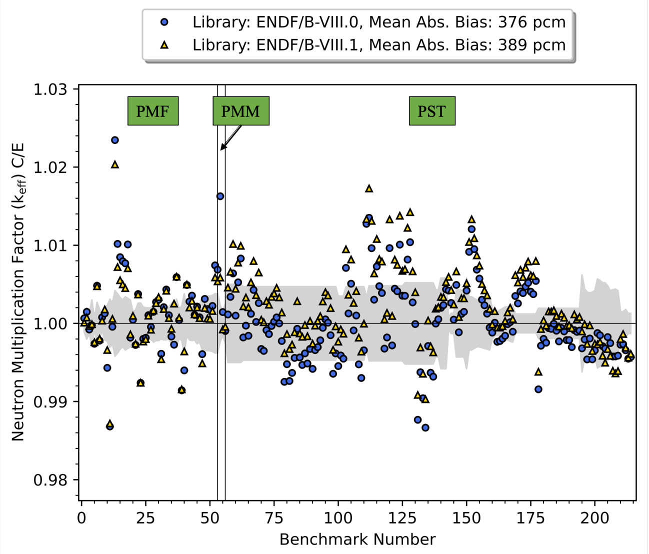
Backup slides

Actinides

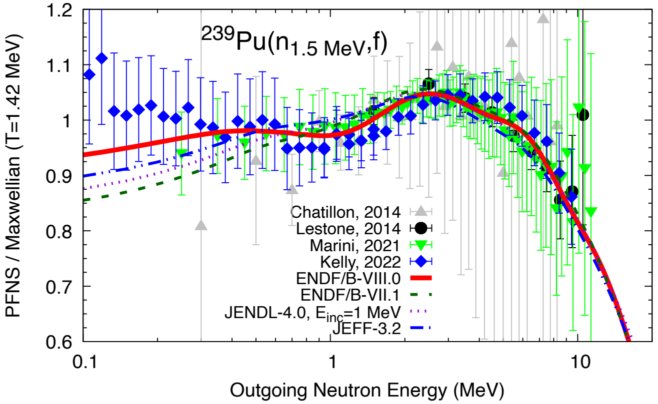
Fuel-isotope example: Substantial change to ^{239}Pu via (inter)national contributions.

Updates:

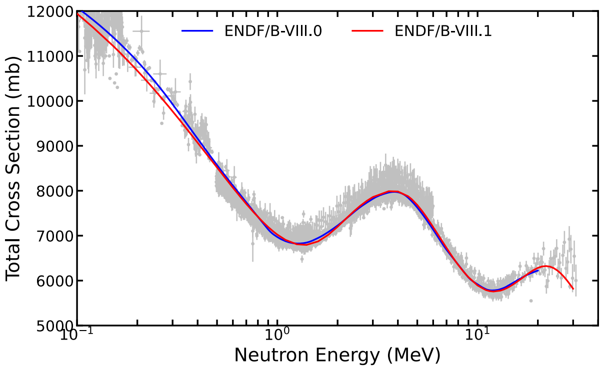
- New prompt neutron multiplicities (ORNL, INDEN, LANL)
- New cross sections in the RRR (ORNL).
- New cross sections in the fast (INDEN, LANL).
- New PFNS from thermal-30 MeV (INDEN, LANL).
- Despite substantial changes, good performance maintained in simulating critical assemblies.



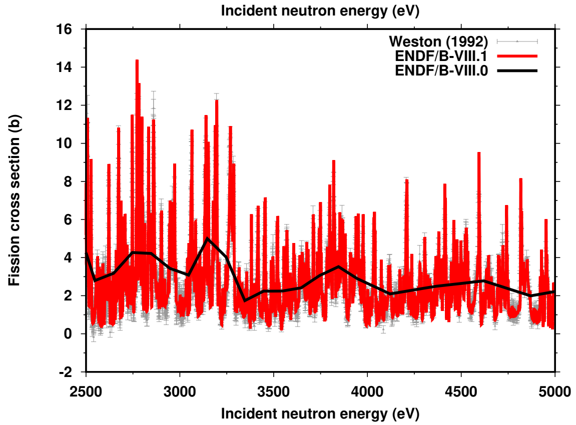
From N. Kleedtke/ LANL.



LANL eval. (D. Neudecker) Including LANL/ LLNL Chi-Nu and CEA PFNS data.



LANL eval. (M. Mumpower).

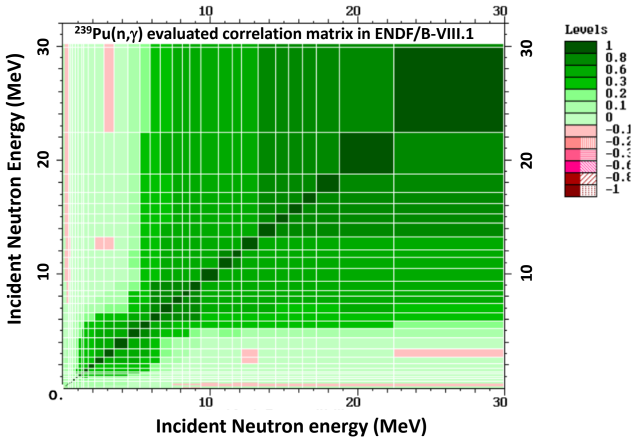


ORNL eval. (M. Pigni).

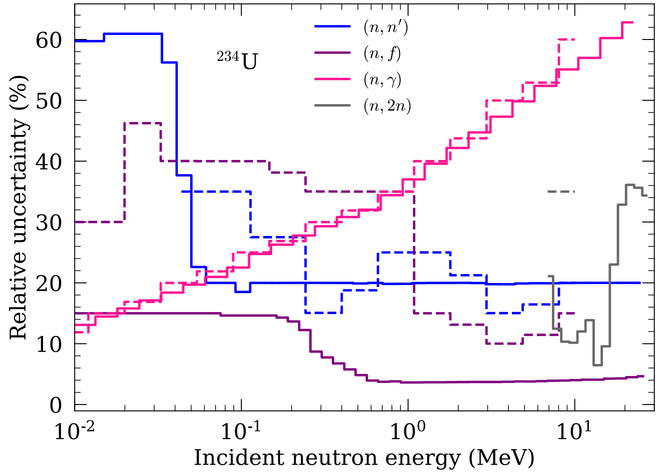
Work by INDEN, LANL, LLNL, ORNL.

Borrowed slide from D. Neudecker

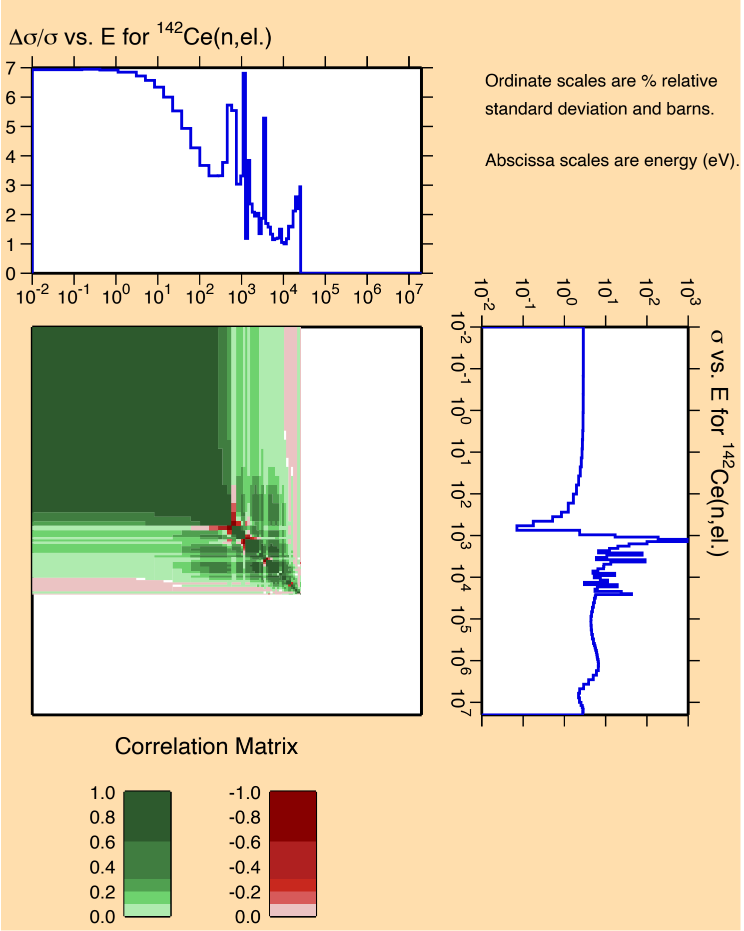
For Whisper users: New covariances provided among them for ^{239}Pu, $^{234\text{-}236}$U, Ce, Pb, Ta, etc.!



By INDEN collaboration (Capote).



By LANL (Lovell, Stetcu).



By ORNL (Pigni).

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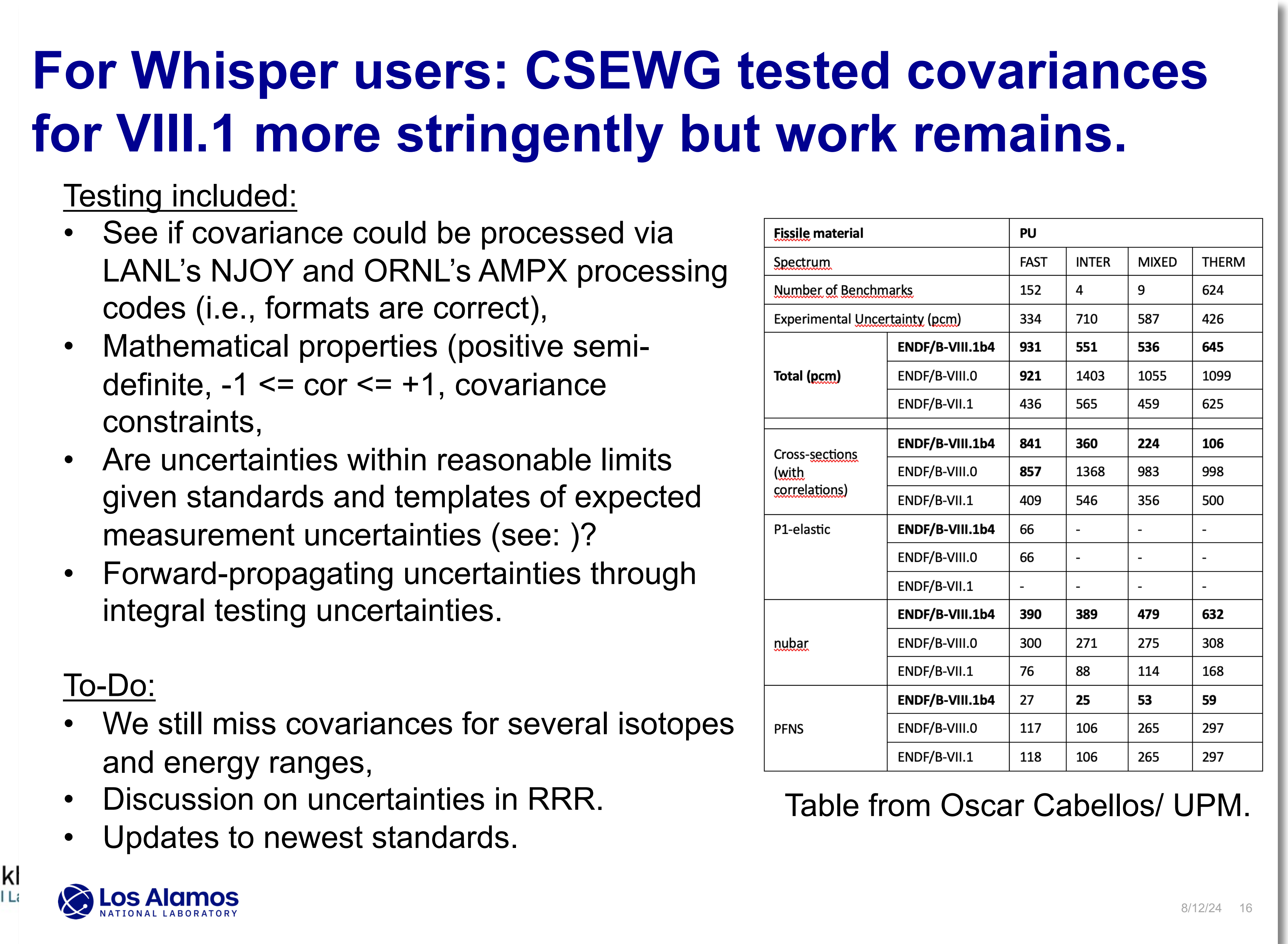


For Whisper users: CSEWG tested covariances for VIII.1 more stringently but work remains.

Testing included:

- See if covariance could be processed via LANL's NJOY and ORNL's AMPX processing codes (i.e., formats are correct),
- Mathematical properties (positive semi-definite, -1 <= cor <= +1, covariance constraints,
- Are uncertainties within reasonable limits given standards and templates of expected measurement uncertainties (see:)?
- Forward-propagating uncertainties through integral testing uncertainties.

To-Do:

- We still miss covariances for several isotopes and energy ranges,
- Discussion on uncertainties in RRR.
- Updates to newest standards.

Fissile material		**PU**			
Spectrum		FAST	INTER	MIXED	THERM
Number of Benchmarks		152	4	9	624
Experimental Uncertainty (pcm)		334	710	587	426
Total (pcm)	**ENDF/B-VIII.1b4**	**931**	**551**	**536**	**645**
	ENDF/B-VIII.0	**921**	1403	1055	1099
	ENDF/B-VII.1	436	565	459	625
Cross-sections (with correlations)	**ENDF/B-VIII.1b4**	**841**	**360**	**224**	**106**
	ENDF/B-VIII.0	**857**	1368	983	998
	ENDF/B-VII.1	409	546	356	500
P1-elastic	**ENDF/B-VIII.1b4**	66	-	-	-
	ENDF/B-VIII.0	66	-	-	-
	ENDF/B-VII.1	-	-	-	-
nubar	**ENDF/B-VIII.1b4**	**390**	**389**	**479**	**632**
	ENDF/B-VIII.0	300	271	275	308
	ENDF/B-VII.1	76	88	114	168
PFNS	**ENDF/B-VIII.1b4**	27	**25**	**53**	**59**
	ENDF/B-VIII.0	117	106	265	297
	ENDF/B-VII.1	118	106	265	297

Table from Oscar Cabellos/ UPM.

Borrowed slide from D. Neudecker

^{239}Pu

- Community-wide collaboration to provide unique recommended file
- Updates to
  - fission
  - nubar
  - PFNS
  - capture
  - URR
  - RRR
  - (n,2n)
  - Other fast-region reactions
- Covariance evaluations were submitted for final release
- Key ingredient to improve burn-up performance

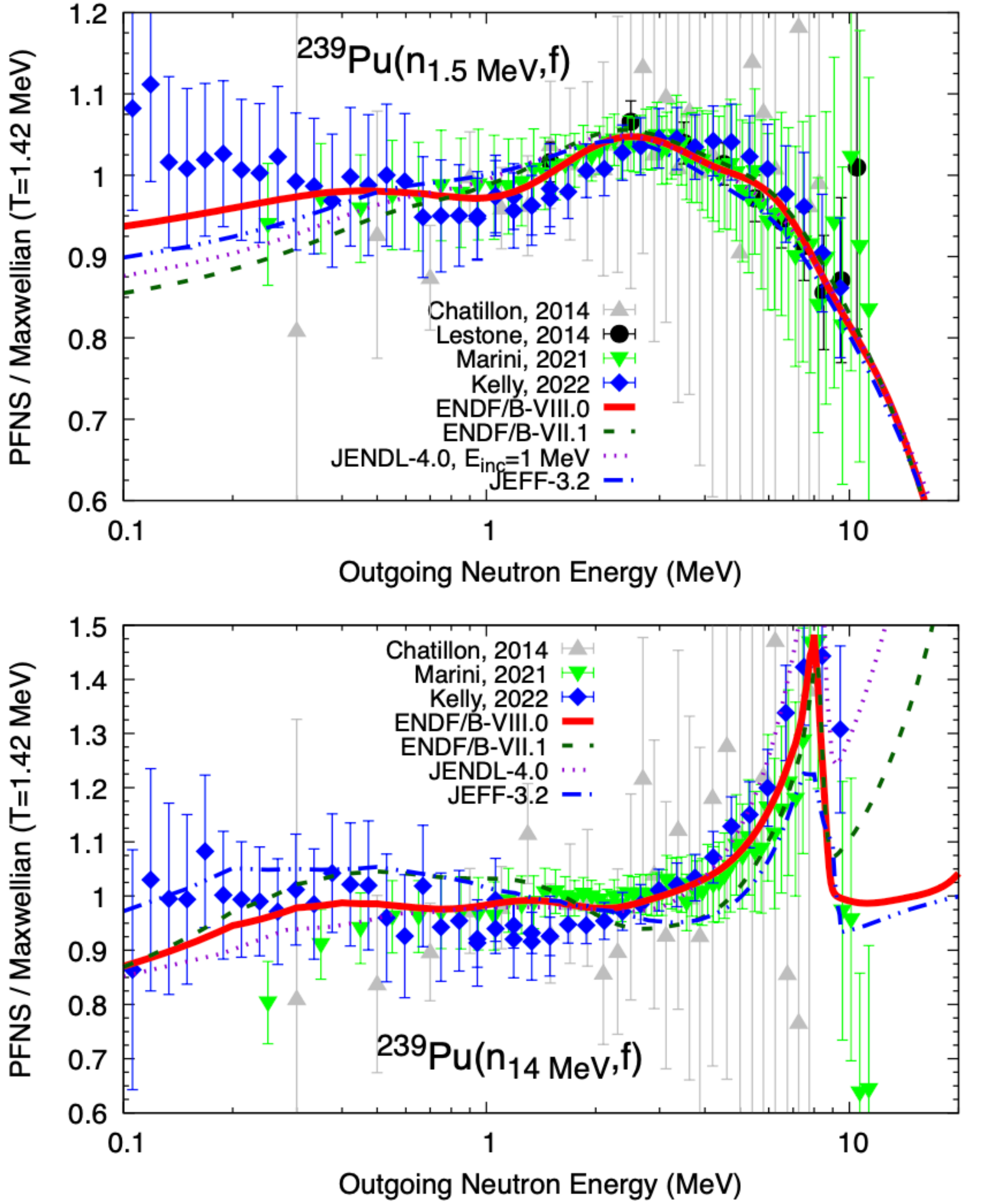


FIG. 7. Experimental and evaluated ^{239}Pu PFNS for E_{inc}=1.5 (top) and 14 MeV (bottom).

^{235}U

- Updates to
  - Resonance evaluation below 20 eV
  - Updated Unresolved Resonance Range (URR): detailed shape of the fission cross section follows better the measured data in the URR and above.
  - Fission cross section
  - nubar: LANL evaluation (above 200keV) and additional changes from 40eV up to 500eV
  - PFNS (above thermal): Chi-Nu based evaluation
  - Covariance data: Spurious cross-reaction covariance elements between the resonance and the fast energy ranges were removed because they gave rise to negative eigenvalues. Cross-covariances between nu-bar and fission cross section were removed for the same reason.

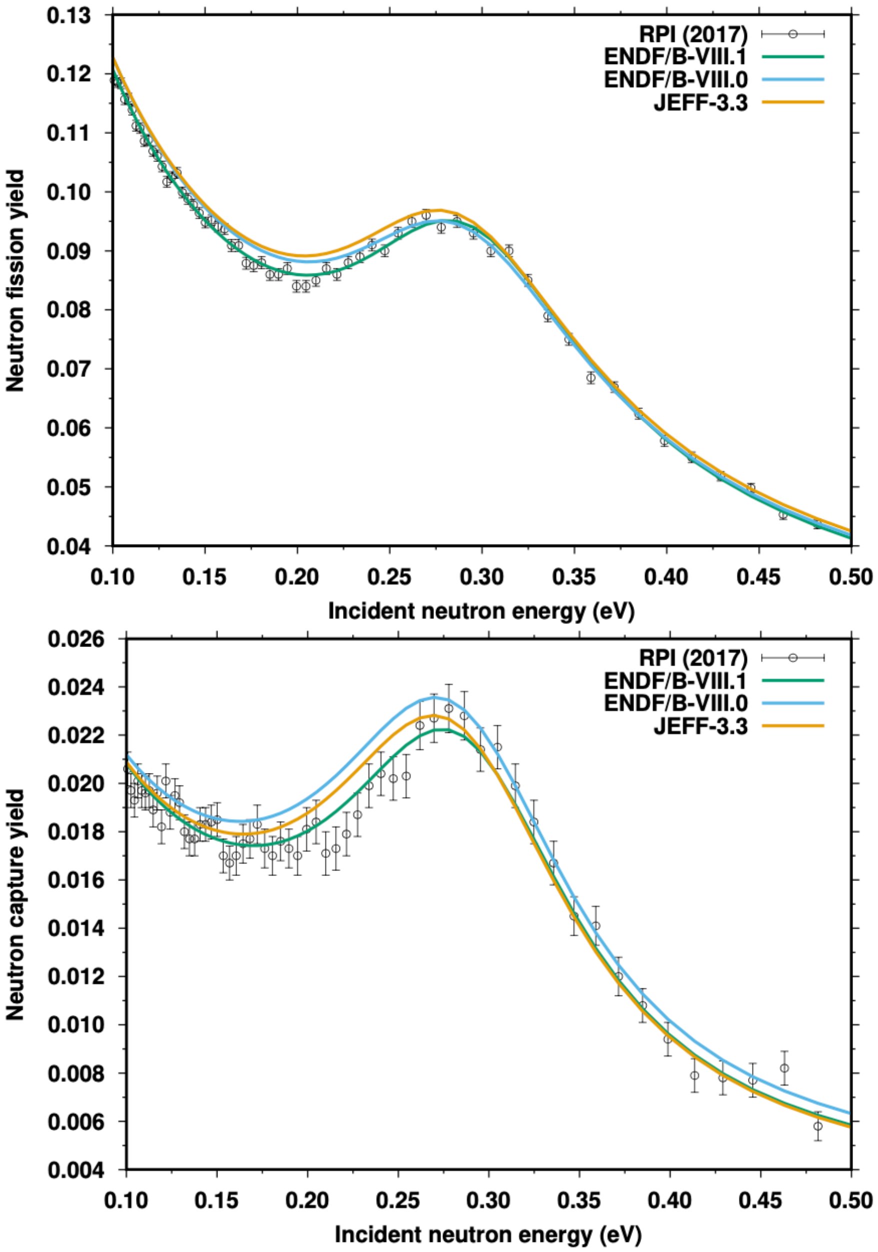


FIG. 60. n+^{235}U fission and capture neutron yield data calculated for three nuclear data libraries are compared with the RPI measured data [177] below 0.5 eV.

^{238}U

- Updates to
  - RRR: evaluation taken from JENDL-5 above 100eV, and from VIII.0 below 100eV. Also, increased capture from 100 eV up to 20keV
  - nubar: LANL-INDEN collaboration. Adopted JENDL-5 evaluation from 1 up to 5 MeV, new LANL evaluation above 5 MeV
  - Important component in the burn-up issue

^{240,241}Pu

- A compromise: better for depletion (not perfect) but worse for PST benchmarks
- Recommended ^{239,240,241}Pu files combined with recommended ^{238}U solve the burnup problem.
- Updates to
  - Resolved Resonance Region (RRR): CEA evaluations

^{234,236}U

- Model calculation using CoH3 with Souhkoviskii 2005 potential
- Fission: below 500 keV (234U) keep ENDF/B-VIII.0; above that: new fit to include Tovesson 2014 data for 234U
- Calculation: fission transmission adjusted so that the calculation reproduces the fission data. Point-by-point fit to determine an energy-dependent adjustment
- Capture: calculation-based evaluation that reproduces very well the latest measurement by DANCE below 100 keV (234U) and other existing data (236U) . The gamma-gamma width is consistent with the resonance analysis.
- All the other channels have been taken from CoH3 calculations
- LSSF flag set to 1 for MT=1,18,102. Background cross section in the replaced by full
- cross section in the URR.
  - PFNS taken from JENDL-4
  - PFG properties taken from BeOH calculations

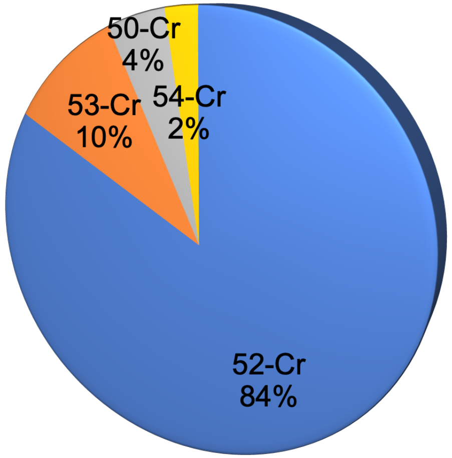
^{233}U

- Updates to
  - PFNS: Use of the IAEA U-233 PFNS for thermal neutrons with average energy Eav=2.030 MeV (ENDF/B-VIII.0 value ~2.074 MeV). Talou et al PFNS evaluation (IAEA PFNS CRP) is used in the fast region.
- Adjustment of thermal cross sections to agree with TNC from IAEA Standards 2017.
- Introduction of energy dependence for nubar below 30eV from Reed et al data.
- Introduction of energy dependence for nubar from 500eV up to 300keV from Gwin et al data measured relative to Cf-252(sf).
- Resonance parameters were completely refitted (M. Pigni) adding new experimental data (Berthomieux, Calviani, Tarrio, Leal-Cidoncha). Capture resonance yields renormalized to be close to Weston data.
- Criticality was improved compared to ENDF/B-VIII.0 (see solution benchmarks as a function of FEPIT, Mosteller U-233 benchmarks, and UCT (LWBR) benchmarks).

Structural materials

Cr, Fe, Pb, Cu, Ta…

Summary of Cr evaluations



Isotope and reactions updated:

- ^{50,53}Cr: thermal and up to 10 keV; all reactions in fast region.
- ^{52,54}Cr: all reactions in fast region.
- Reconstructed isotopic angular distributions in resonance region.

Motivation and deficiencies in ENDF/B-VIII.0:

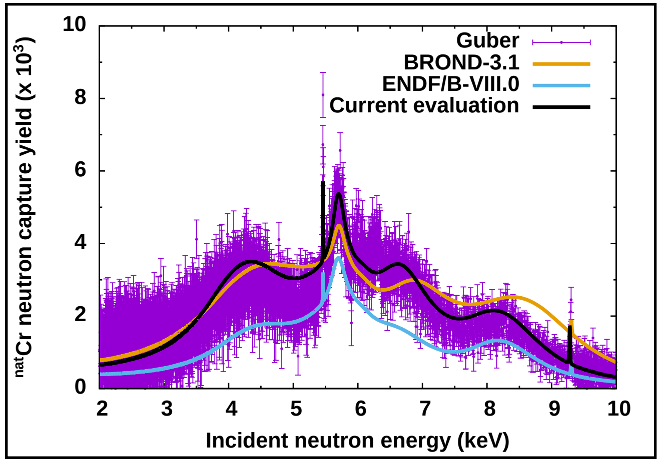
- Chromium is an important alloy in stainless steel. After VIII.0 evaluation of iron, it is essential to better constrain Cr files.
- ^{50,53}Cr: Cluster of capture resonances in the region 1-10 keV drive criticality in Cr-sensitive benchmarks. ENDF/B-VIII.0 followed data with inaccurate correction determination in this region (e.g., MS)

What new data/theory motivated the new evaluation/update:

- Appropriate normalization of Guber ^{53}Cr(n,g) data (ORNL) in the 1-10 keV region
- Neutron and gamma ^{52}Cr inelastic data from Mihailescu (GEEL)
- New soft-rotor dispersive optical potential for ^{50,52,54}Cr, interpolated as rigid rotor for ^{53}Cr

What validation testing has been be done

- Chromium-sensitive benchmarks identified, in particular KBR-15 (HEU-COMP-INTER-005 k_∞) and ZPR-6/10 (PU-MET-INTER-002) with strong sensitivity to Cr – both are big outliers (11% and 2% in k, respectively)
- Oktavian-Cr 14 MeV leakage: Not in SINBAD, new model developed in JSI
- New evaluation greatly improves reactivity prediction and performs well for the 14 MeV benchmark



Used ^{Nat}Cr transmission data to constrain the normalization of isotopic capture data

- Model calculations extended to 65 MeV (for fusion applications).
- Model- extrapolation to unstable 51Cr.

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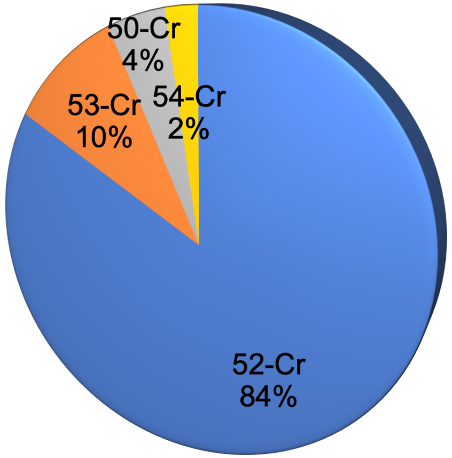
Summary of Cr evaluations



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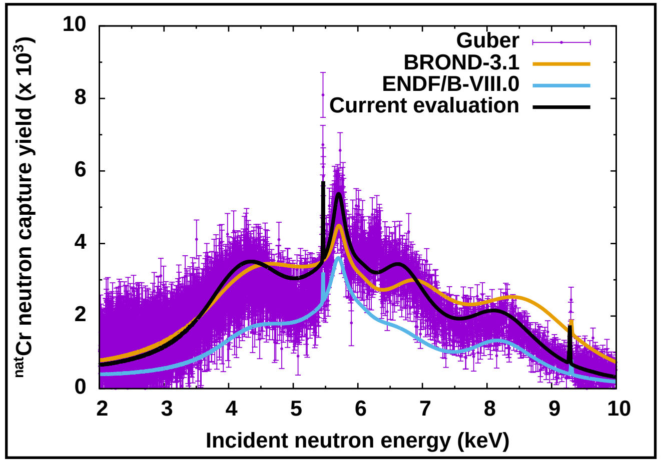

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Summary of Fe evaluations

- Complete evaluations for all Fe isotopes had been done for VIII.0
- However,…
    - Inelastic was too high
    - 30% underestimation of the fast neutron transmission through thick iron shells
- New evaluations:
    - New resolved resonances for ^{54,57}Fe
    - Adopted IRDFF reactions for ^{54}Fe
    - For ^{56}Fe:
        - adopted mostly VIII.0 resonances, with one important change in the capture width of the 27.7 keV resonance
        - Some typos in the original evaluation were corrected (one resonance energy was changed from 767.240 keV to 766.724 keV and the spurious resonance at 59.5 keV was deleted).

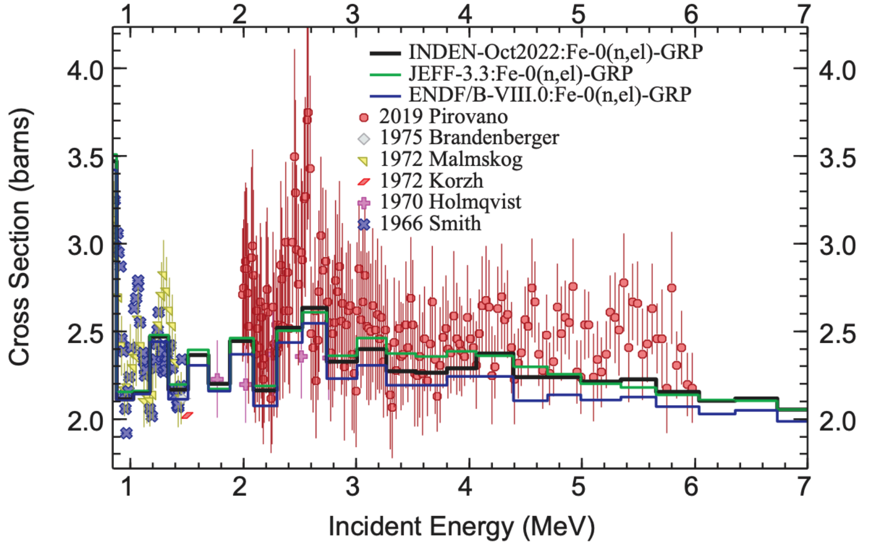

Figure 1. Comparison of the ^{nat}Fe measured elastic cross sections below 7 MeV vs ENDF/B-VIII.0, JEFF-3.1.1, and current INDEN evaluation.

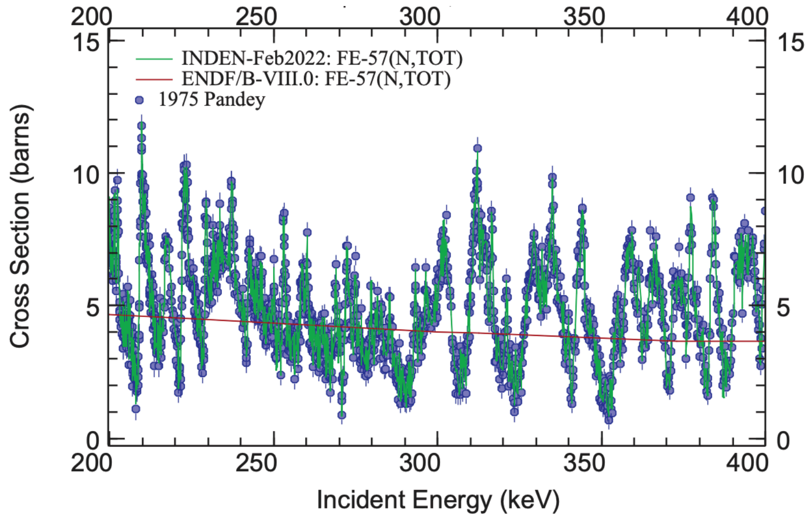

Figure 9. Comparison of the updated ^{57}Fe total cross sections (green line) with the data by Pandey (blue circles) and the original ENDF/B-VIII.0 averaged cross sections (red line).

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Figures taken from EPJ 284, 12002 (2023)

Summary of Fe evaluations

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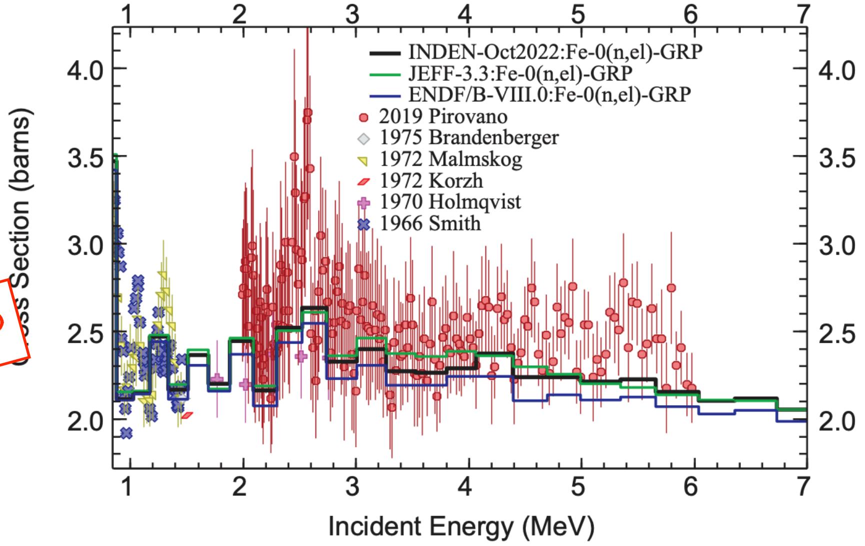

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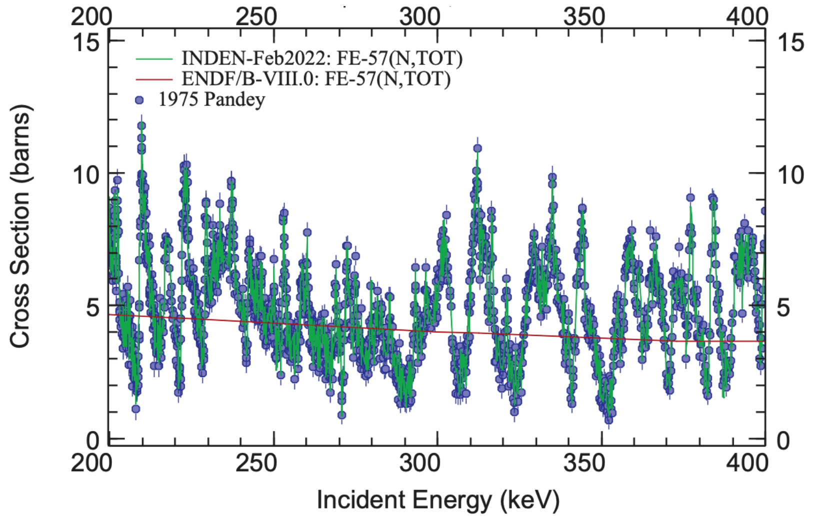

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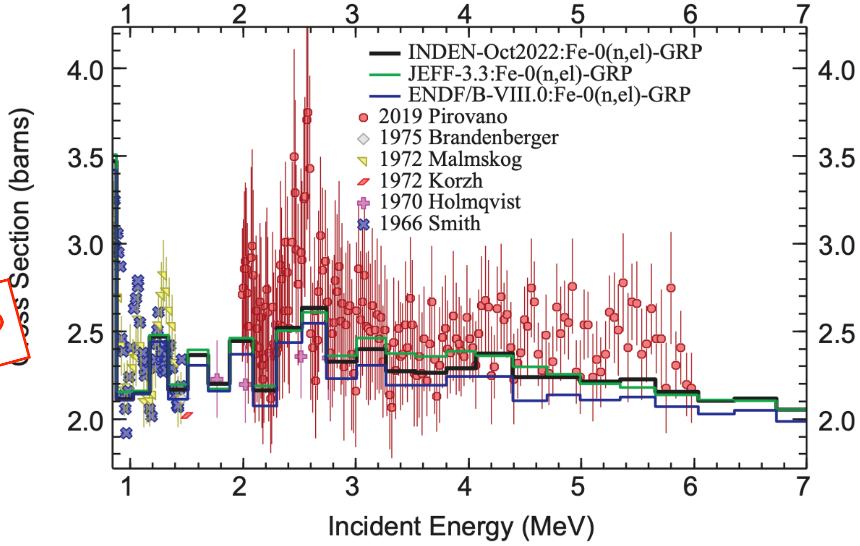
There were problems in VIII.0

We solved them!



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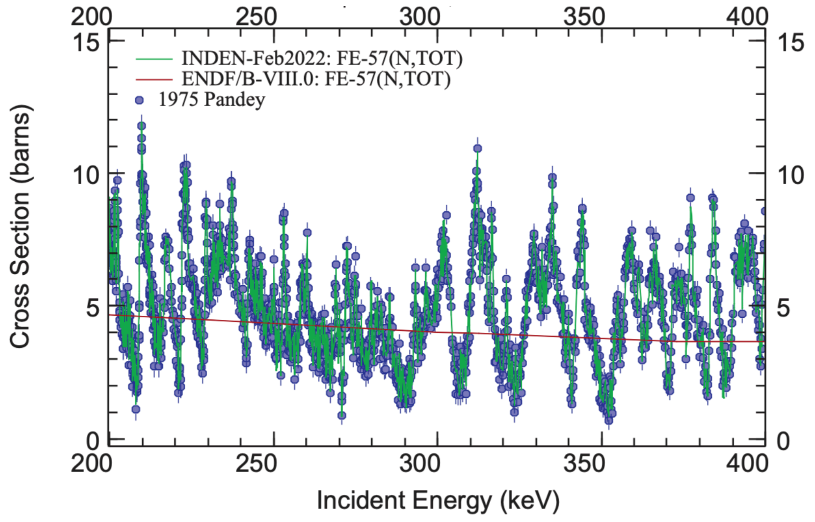

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Performance in Stainless Steel benchmarks

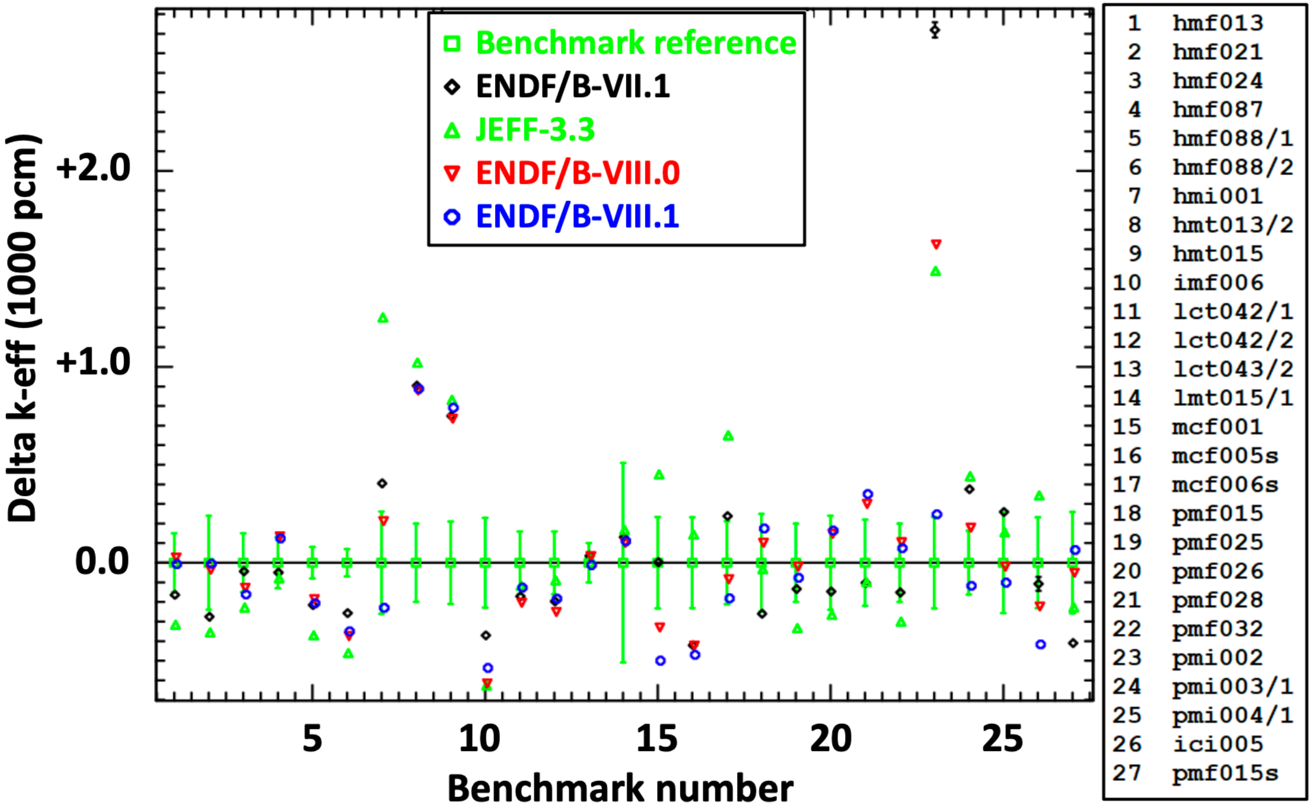


FIG. 41. Criticality differences to the experimental benchmark values C/E of selected stainless steel ICSBEP benchmarks. Experimental benchmark values are compared to JEFF-3.3, ENDF/B-VII.1, ENDF/B-VIII.0 and the new INDEN evaluation of iron isotopes adopted for the ENDF/B-VIII.1 library (INDEN r61).

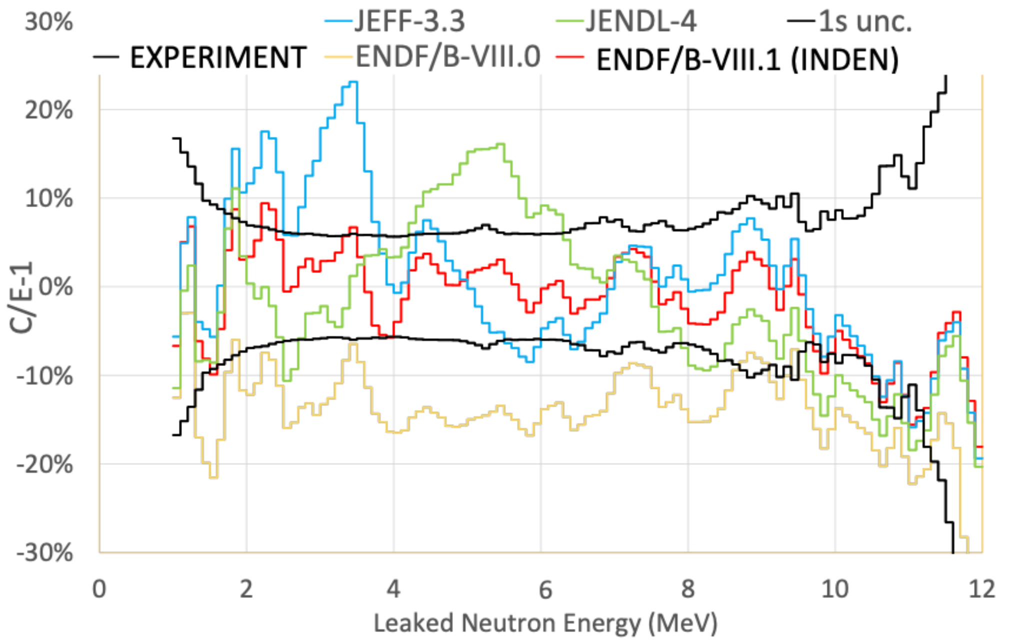
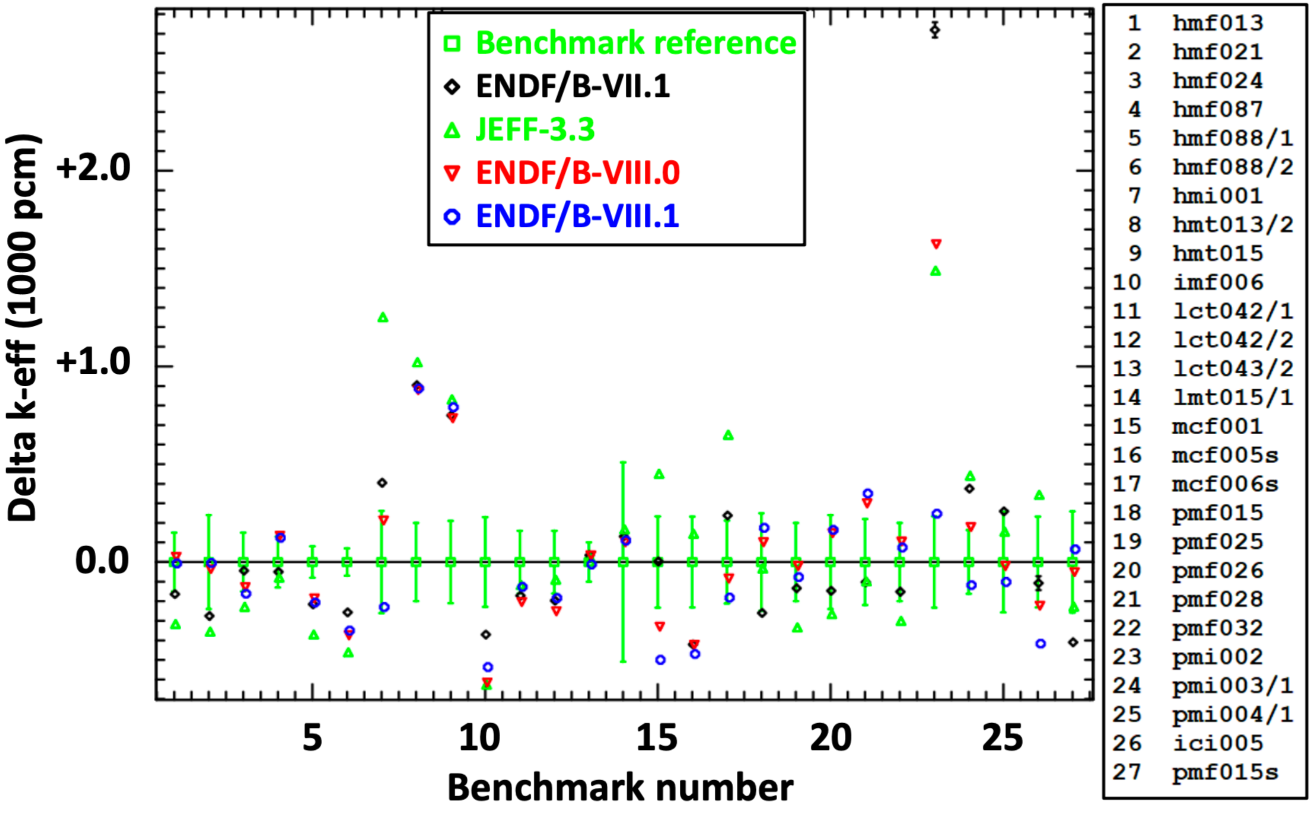


FIG. 43. Measured neutron leakage of the ^{252}Cf(sf) neutron source measured at 1 m distance from a 50.2x50.2x50.4 cm^3 stainless steel block [139]. Experimental benchmark values $C/E-1$ are compared with transport calculations using JEFF-3.3, JENDL-4.0, ENDF/B-VIII.0 and the new ENDF/B-VIII.1 library that adopted the INDEN Fe and Cr evaluations.

Performance in Stainless Steel benchmarks



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2	hmf021
3	hmf024
4	hmf087
5	hmf088/1
6	hmf088/2
7	hmi001
8	hmt013/2
9	hmt015
10	imf006
11	lct042/1
12	lct042/2
13	lct043/2
14	lmt015/1
15	mcf001
16	mcf005s
17	mcf006s
18	pmf015
19	pmf025
20	pmf026
21	pmf028
22	pmf032
23	pmi002
24	pmi003/1
25	pmi004/1
26	ici005
27	pmf015s

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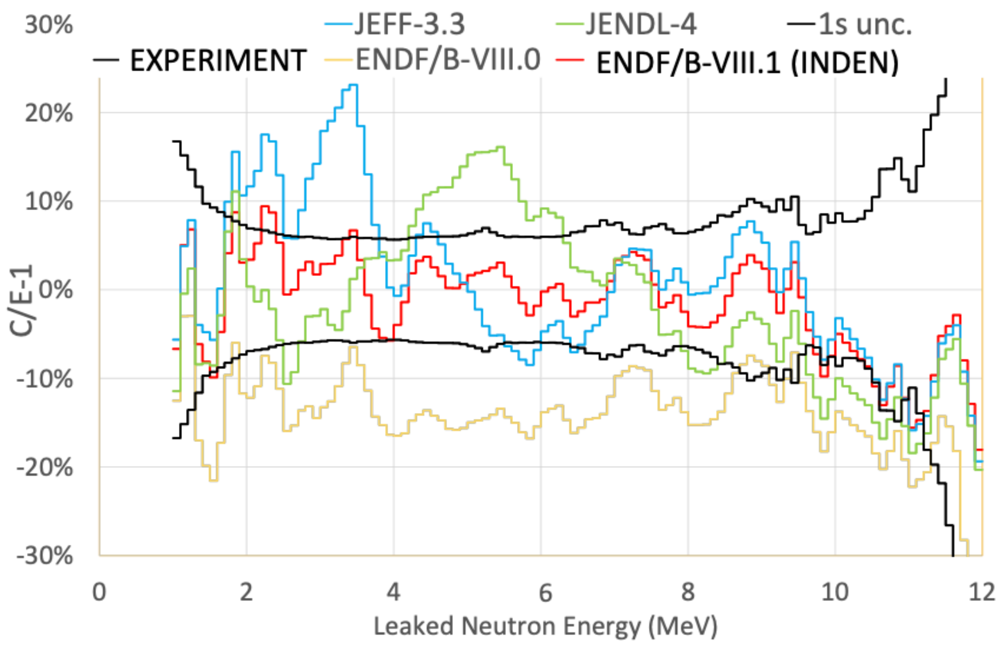

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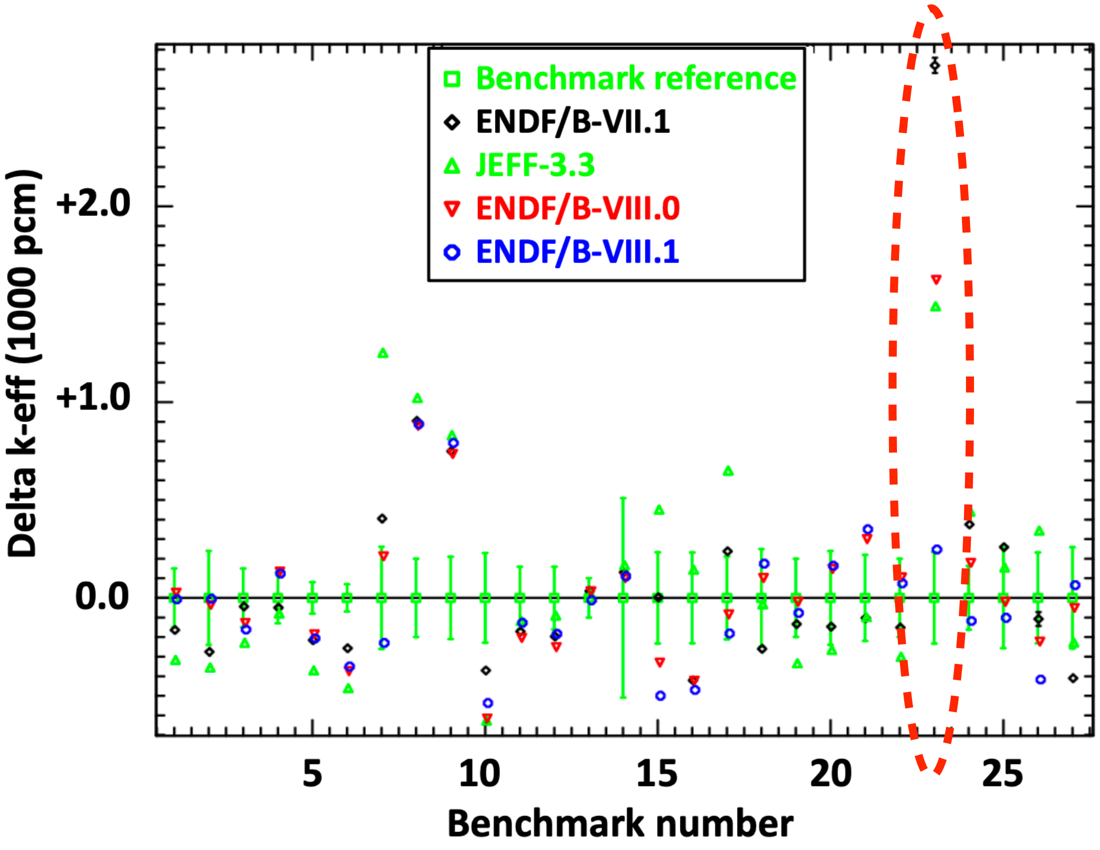

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6	hmf088/2
7	hmi001
8	hmt013/2
9	hmt015
10	imf006
11	lct042/1
12	lct042/2
13	lct043/2
14	lmt015/1
15	mcf001
16	mcf005s
17	mcf006s
18	pmf015
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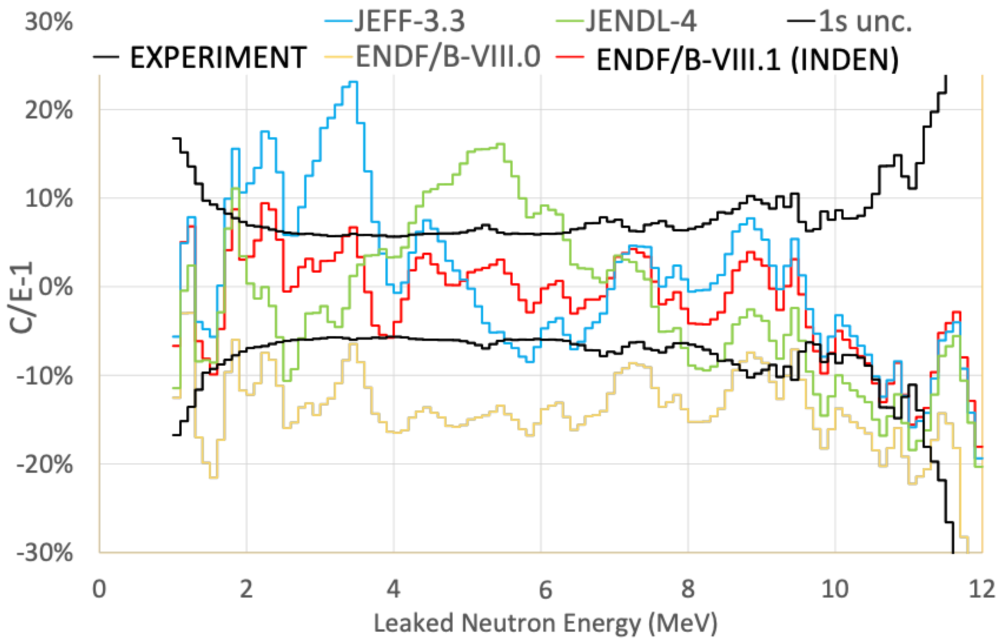

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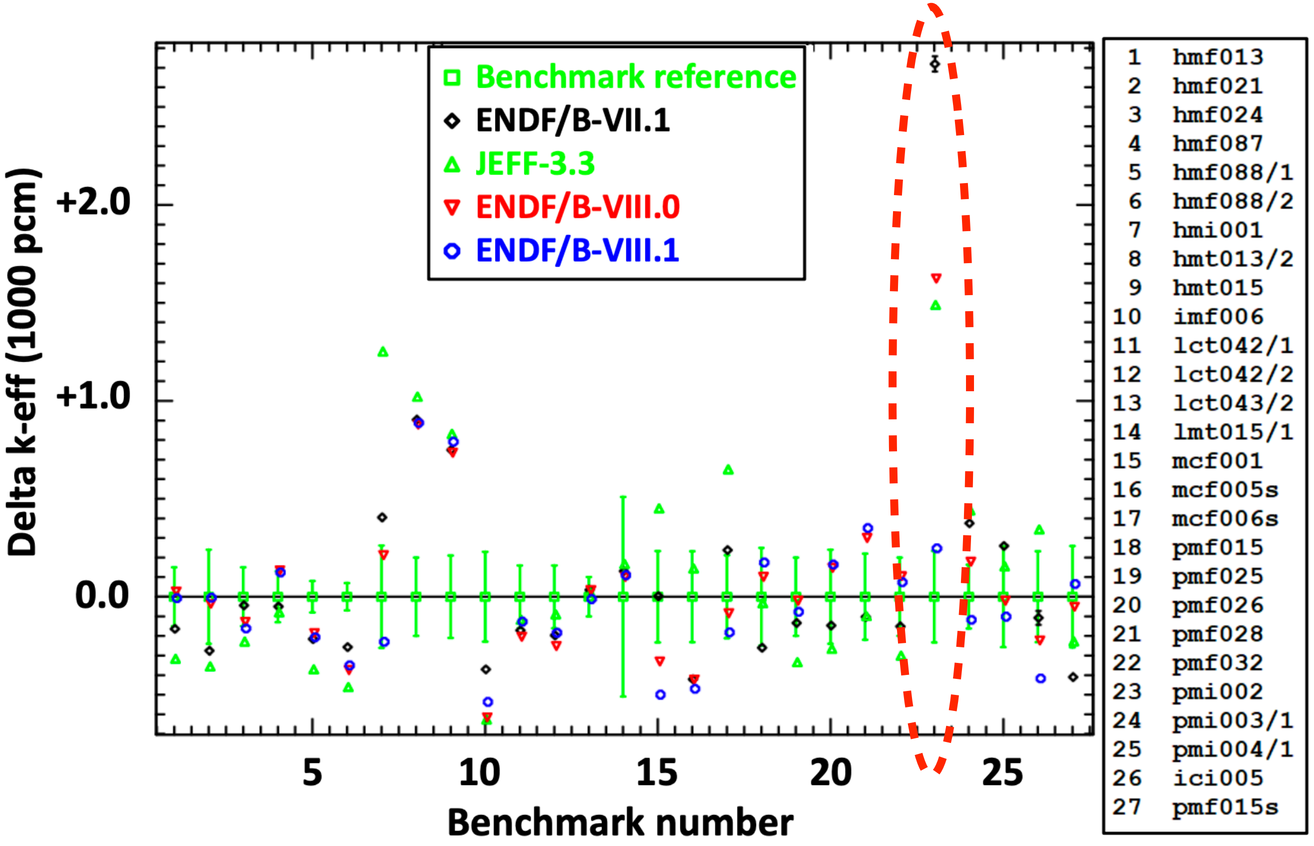
Performance in Stainless Steel benchmarks



1	hmf013
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3	hmf024
4	hmf087
5	hmf088/1
6	hmf088/2
7	hmi001
8	hmt013/2
9	hmt015
10	imf006
11	lct042/1
12	lct042/2
13	lct043/2
14	lmt015/1
15	mcf001
16	mcf005s
17	mcf006s
18	pmf015
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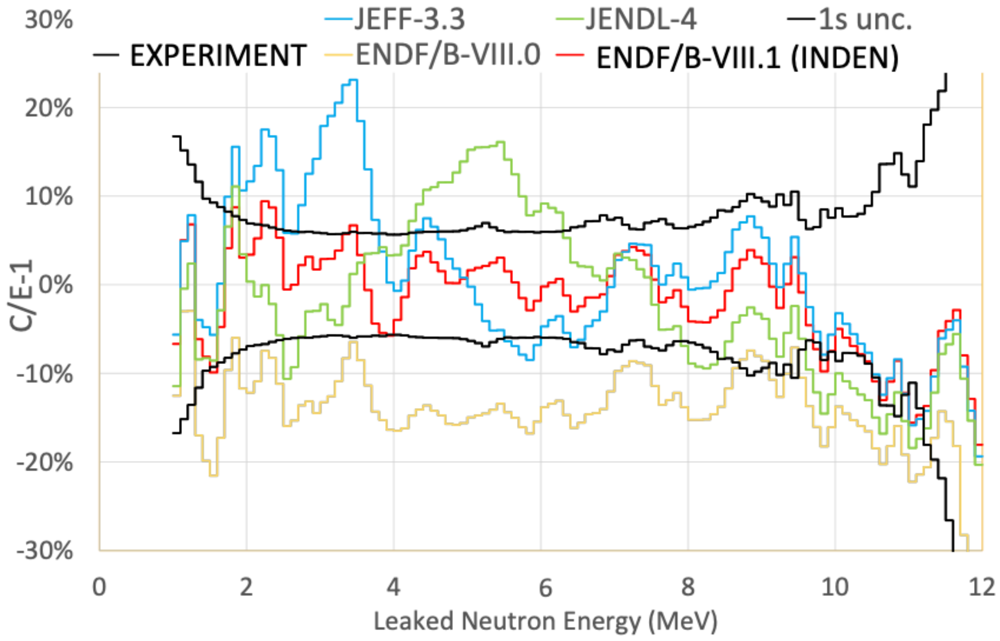

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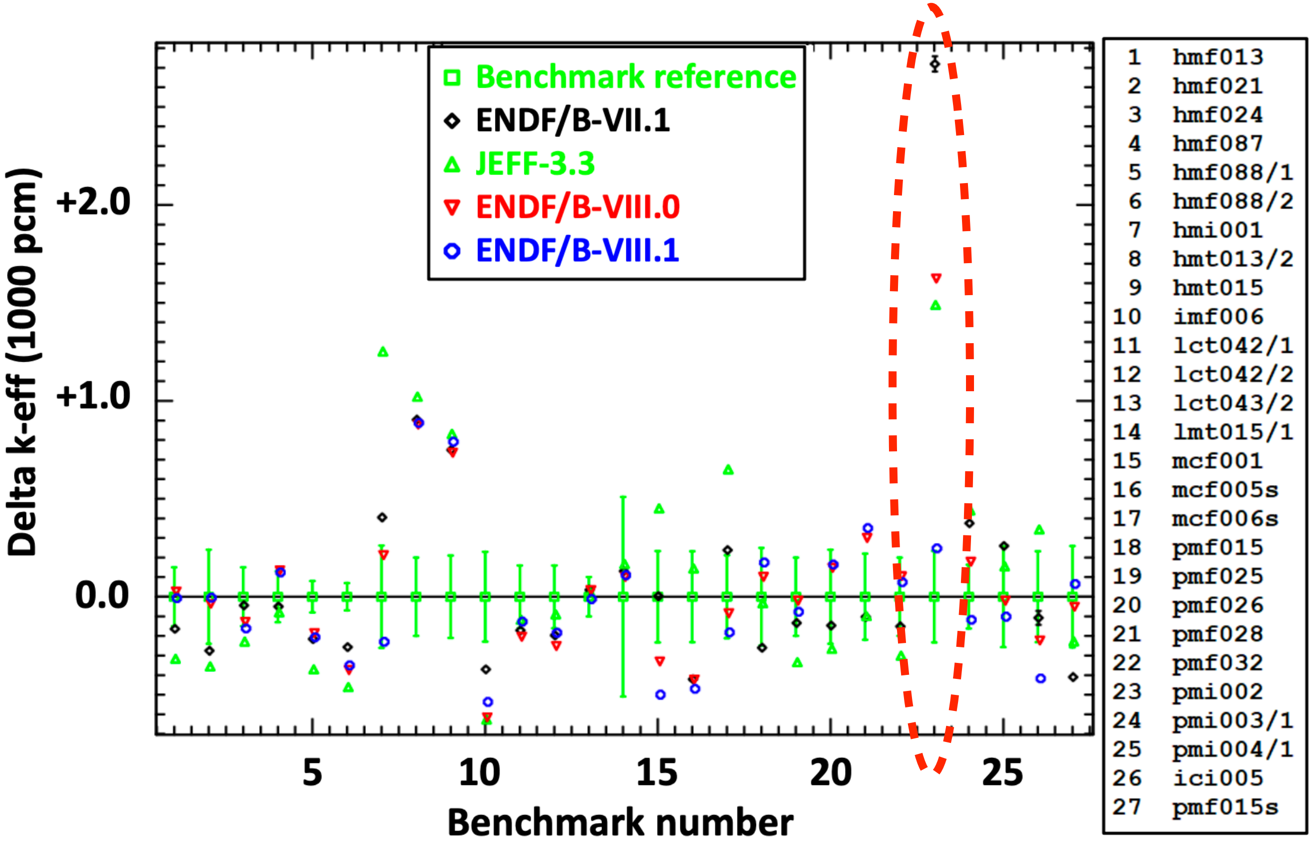


1	hmf013
2	hmf021
3	hmf024
4	hmf087
5	hmf088/1
6	hmf088/2
7	hmi001
8	hmt013/2
9	hmt015
10	imf006
11	lct042/1
12	lct042/2
13	lct043/2
14	lmt015/1
15	mcf001
16	mcf005s
17	mcf006s
18	pmf015
19	pmf025
20	pmf026
21	pmf028
22	pmf032
23	pmi002
24	pmi003/1
25	pmi004/1
26	ici005
27	pmf015s

FIG. 41. Criticality differences to the experimental benchmark values C/E of selected stainless steel ICSBEP benchmarks. Experimental benchmark values are compared to JEFF-3.3, ENDF/B-VII.1, ENDF/B-VIII.0 and the new INDEN evaluation of iron isotopes adopted for the ENDF/B-VIII.1 library (INDEN r61).

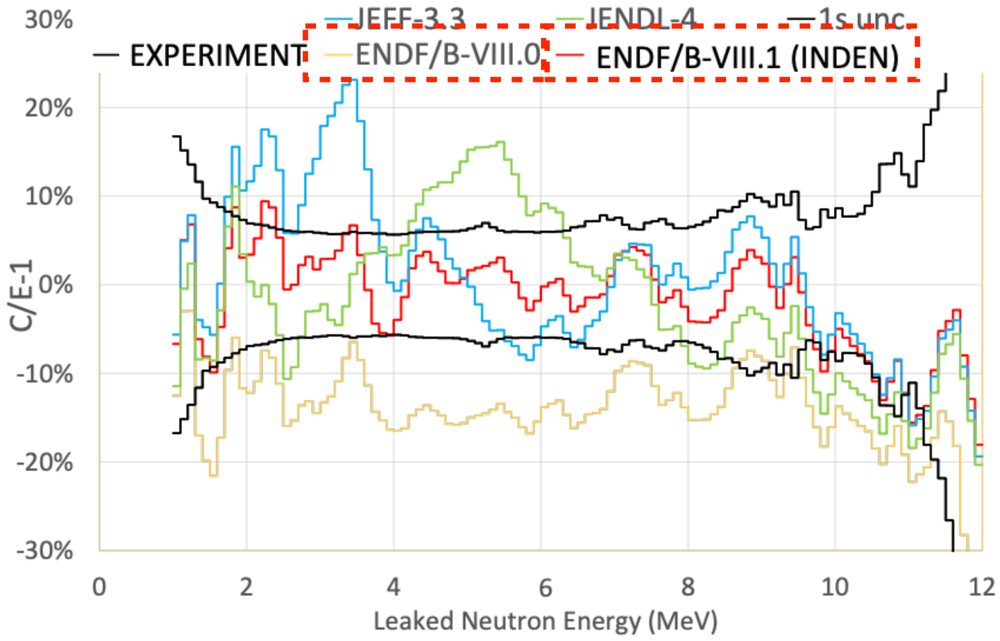
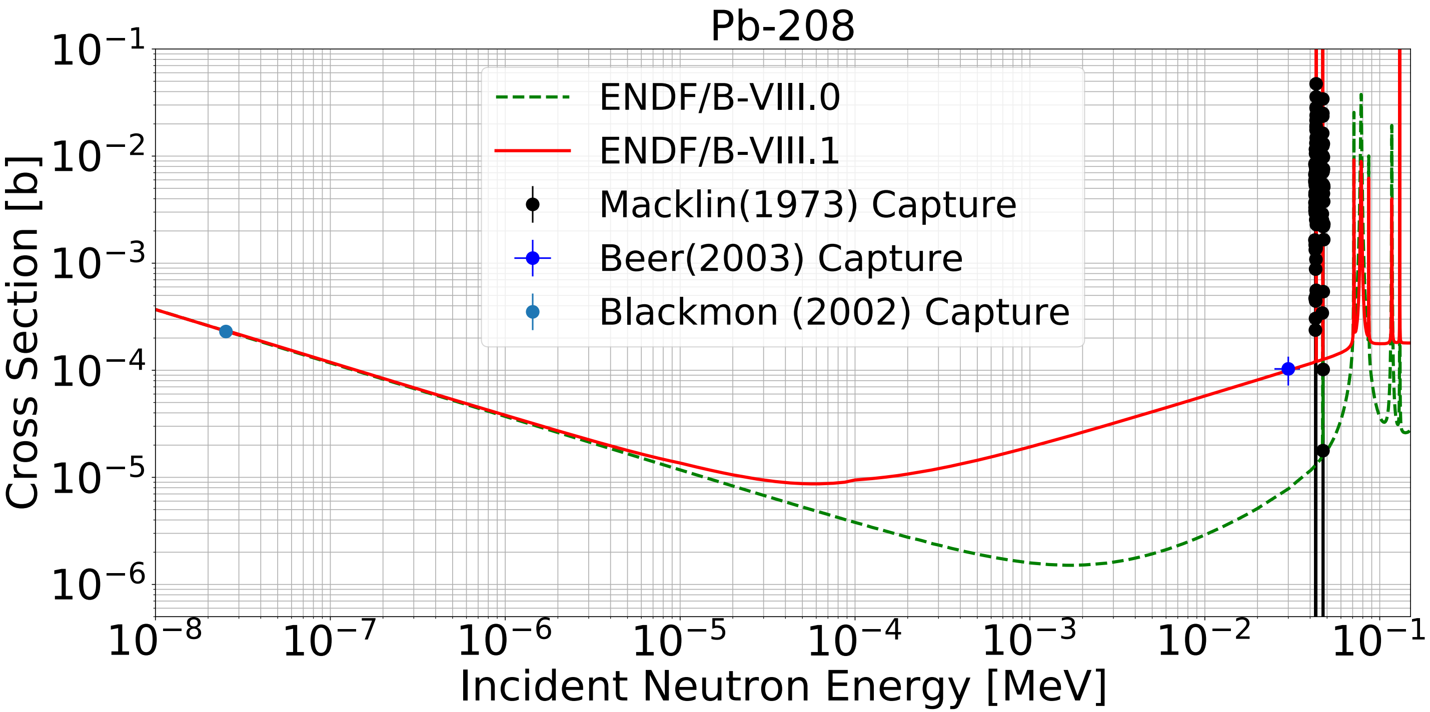
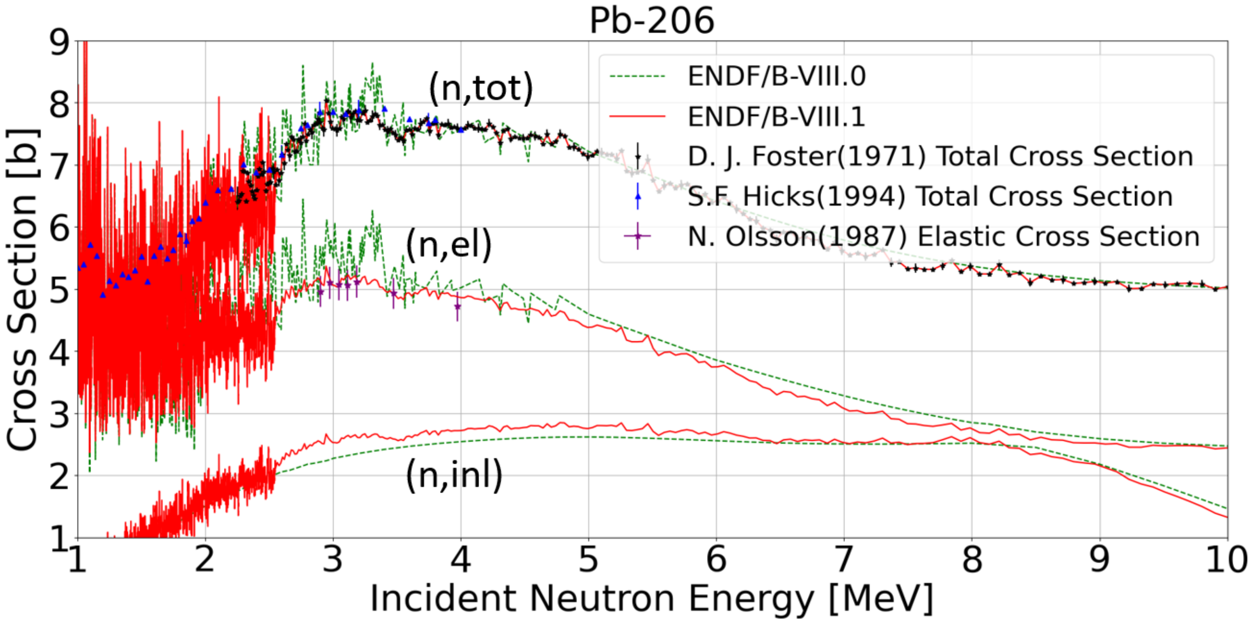


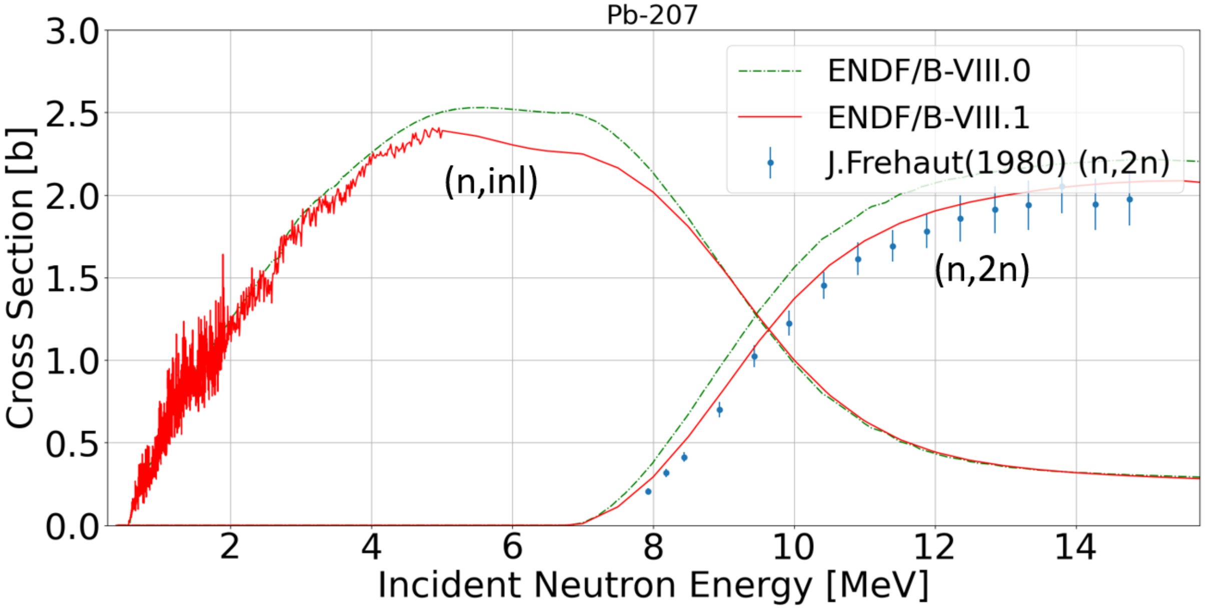
FIG. 43. Measured neutron leakage of the ^{252}Cf(sf) neutron source measured at 1 m distance from a 50.2x50.2x50.4 cm^3 stainless steel block [139]. Experimental benchmark values $C/E-1$ are compared with transport calculations using JEFF-3.3, JENDL-4.0, ENDF/B-VIII.0 and the new ENDF/B-VIII.1 library that adopted the INDEN Fe and Cr evaluations.

Lead evaluations

- Complete new evaluations for ^{206,207,208}Pb
- Good performance in pulsed spheres
- May have uncovered issues with some criticality benchmarks: Further work may be needed!

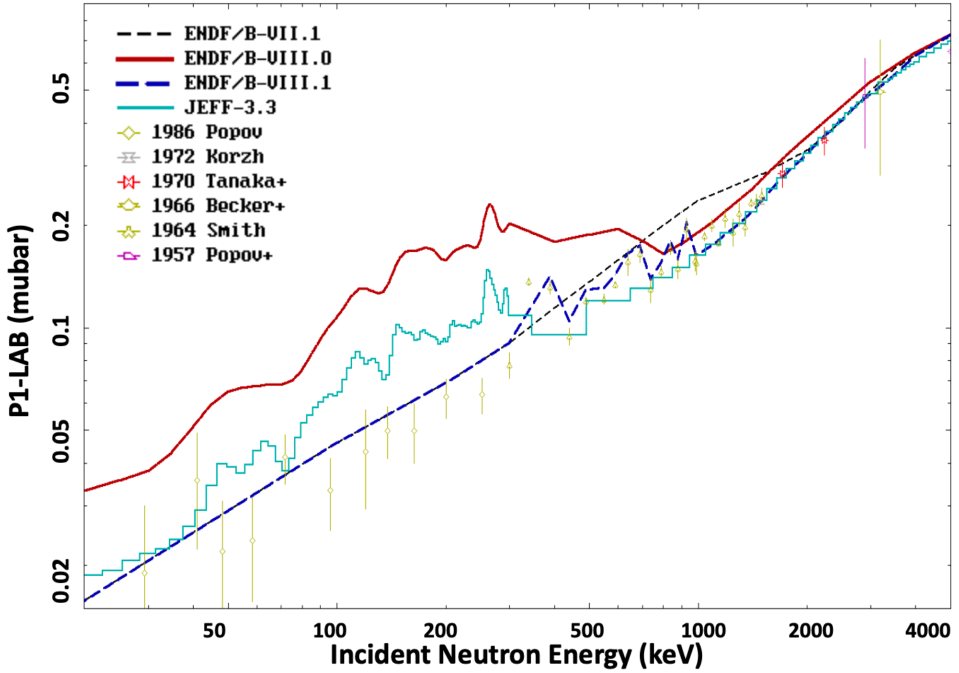


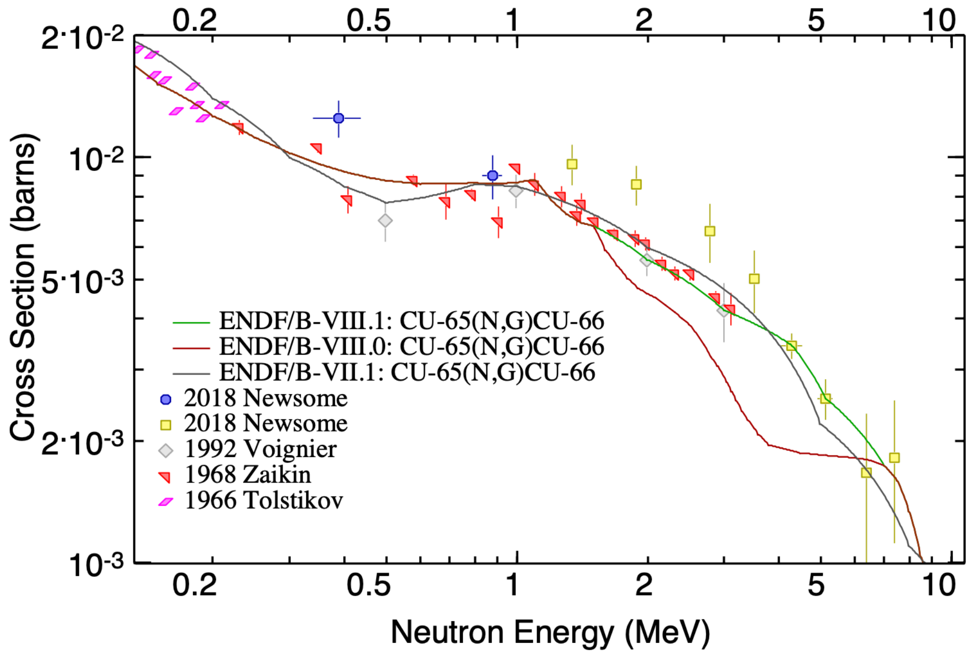


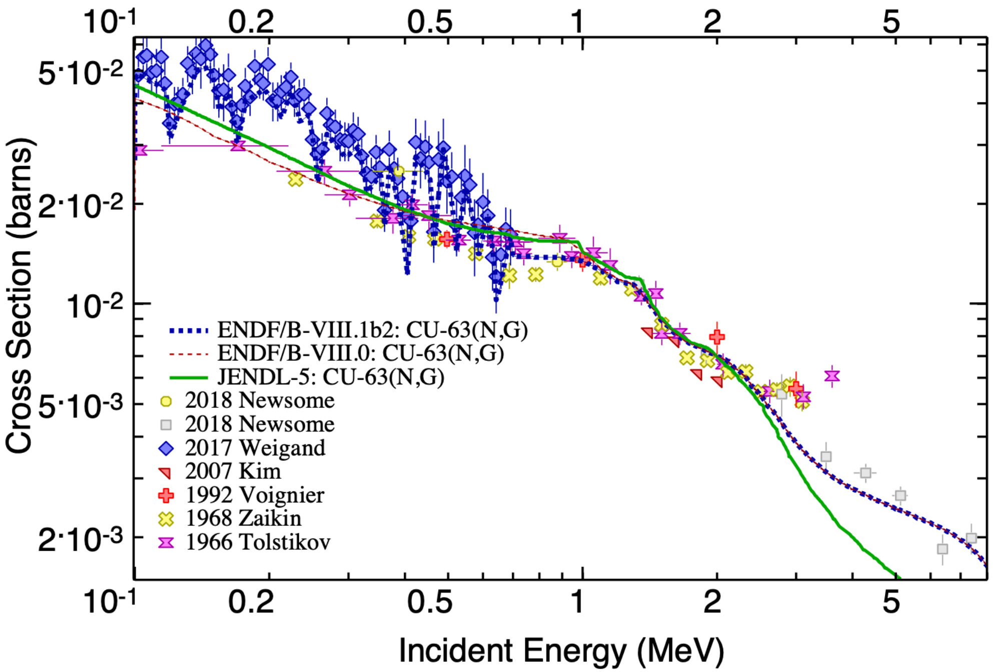


^{63,65}Cu

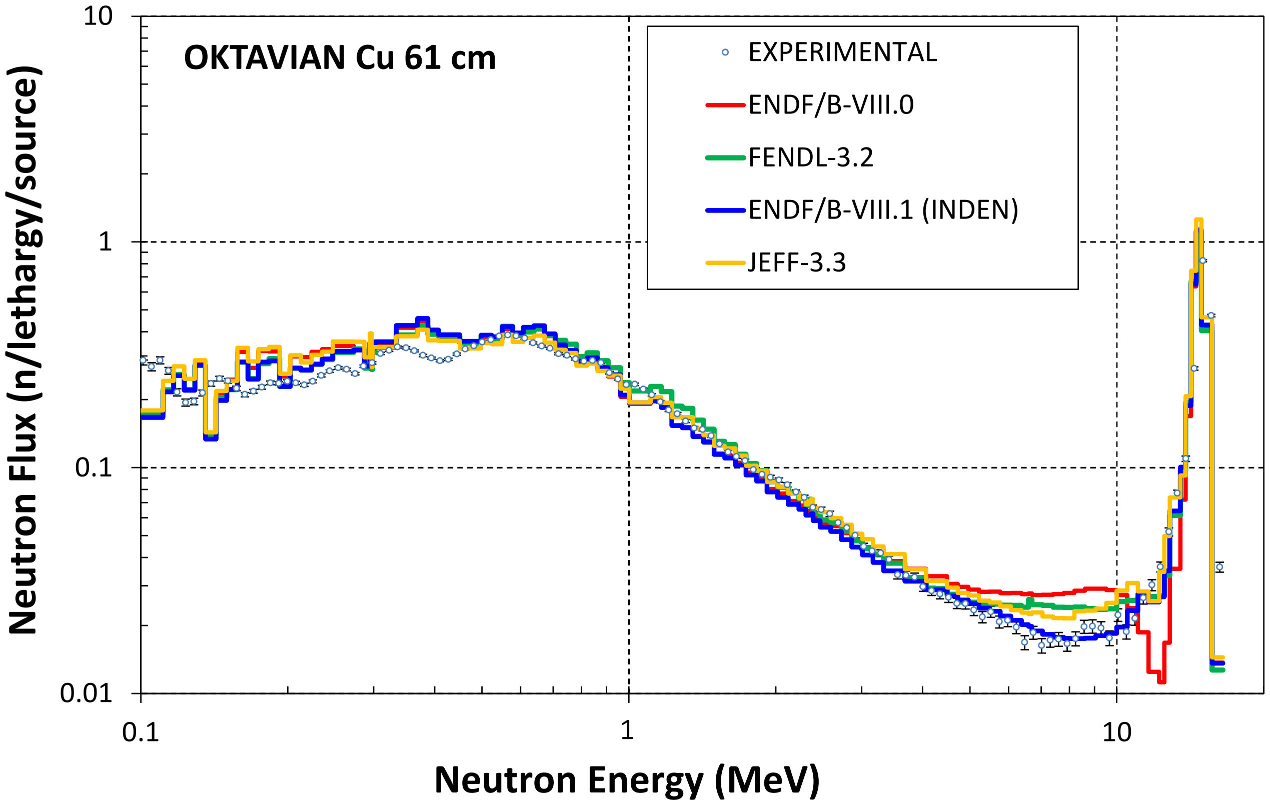
- Updated resonances and fast regions and angular distributions.

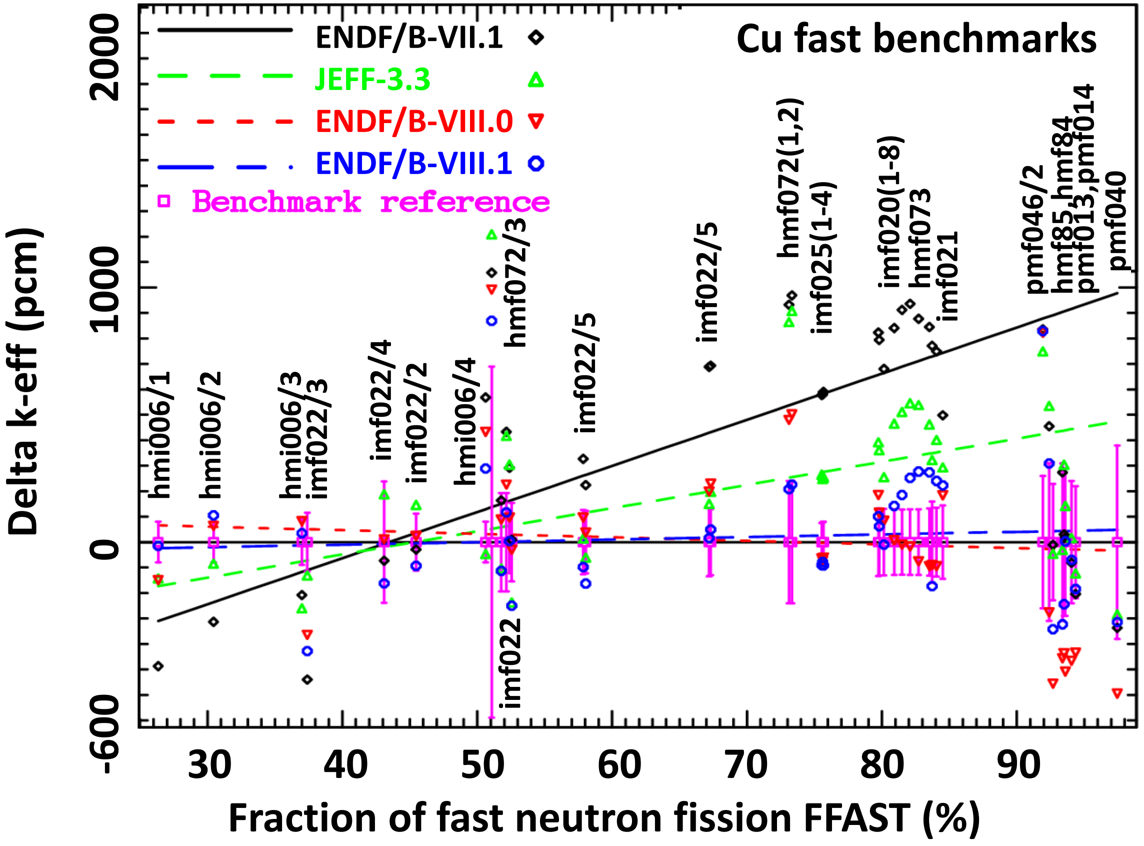




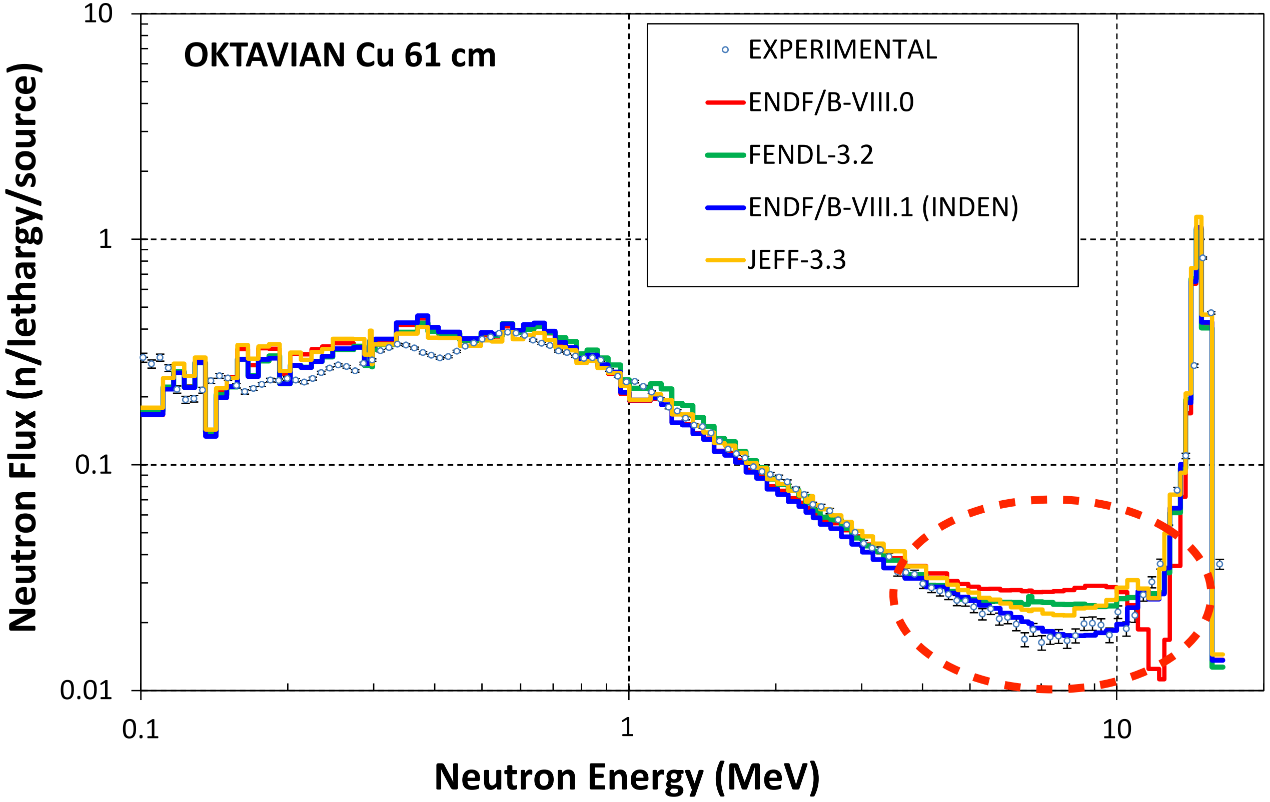


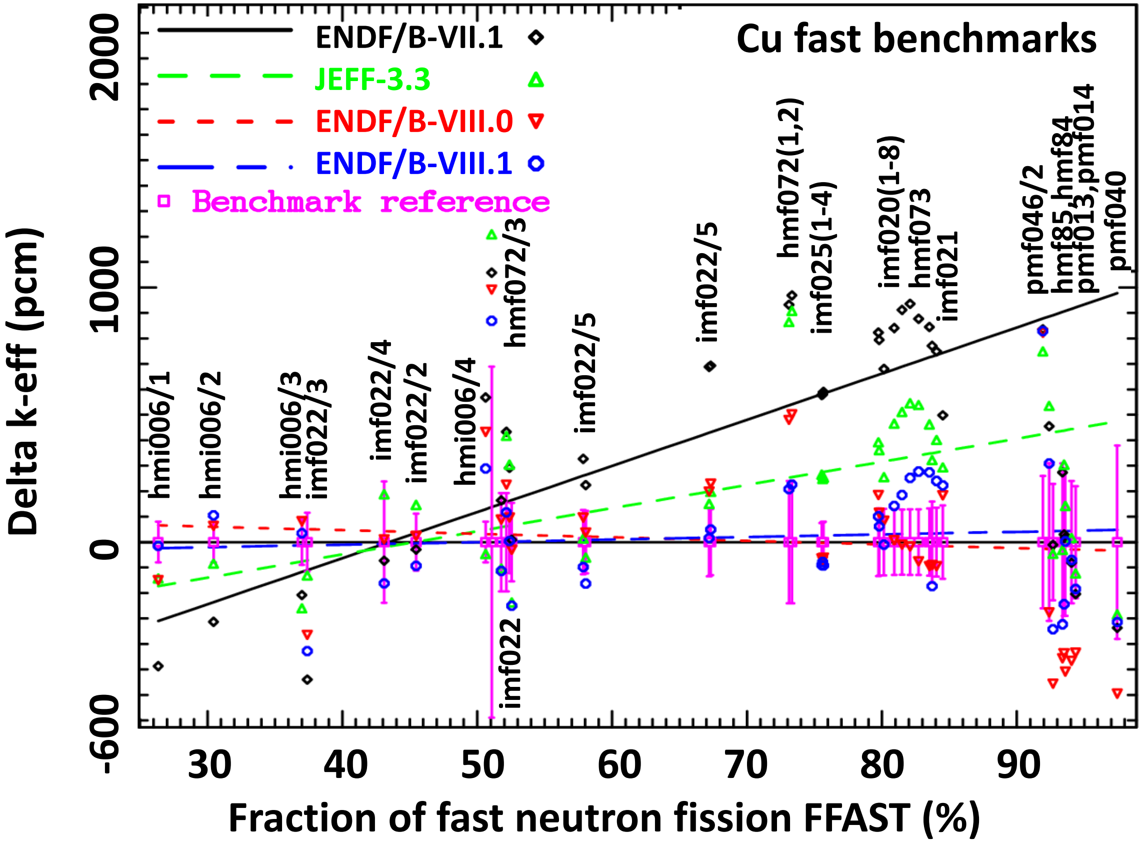
Performance improved dramatically in copper-sensitive benchmarks



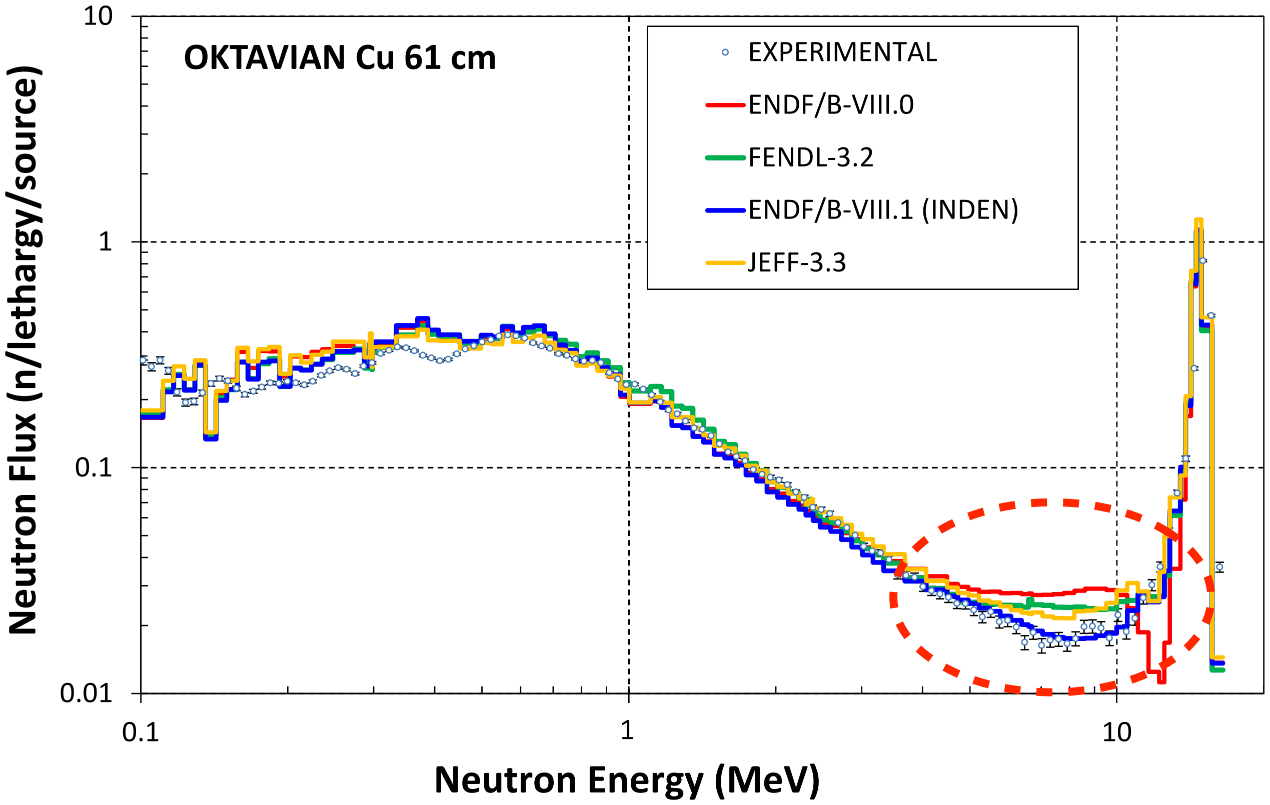


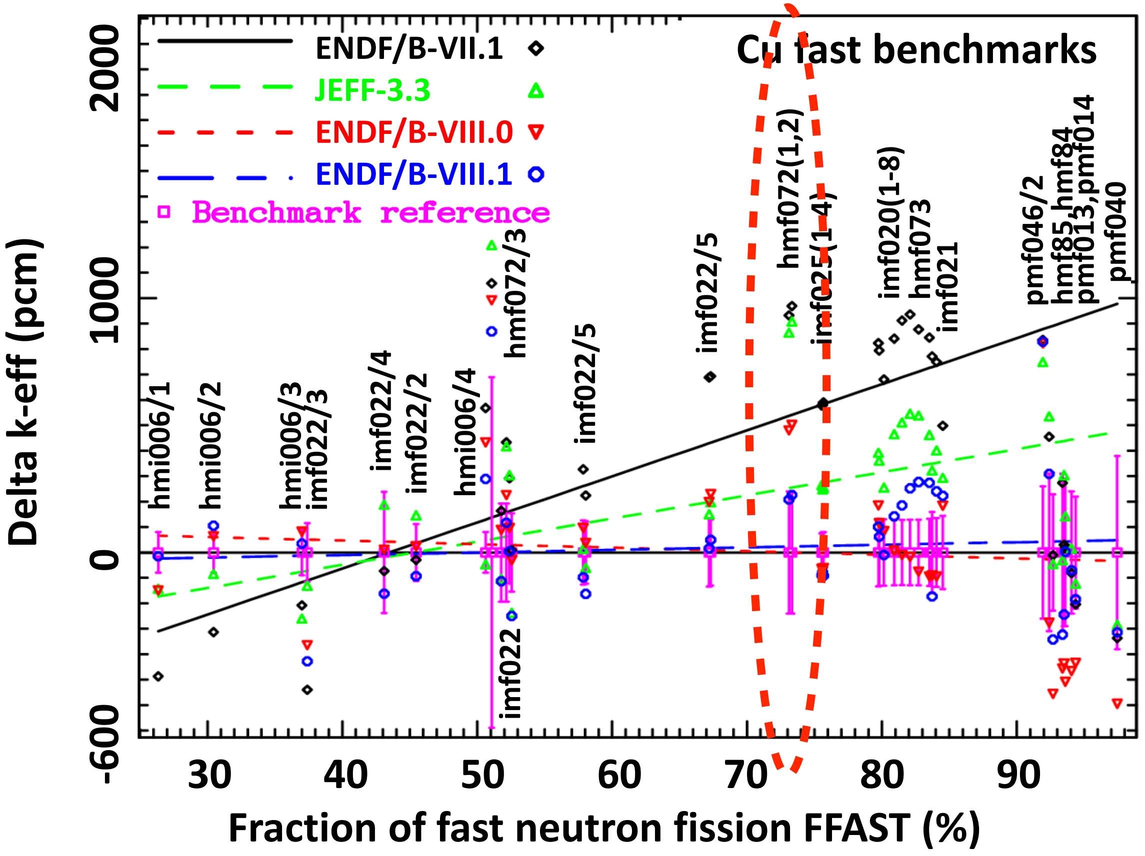
Performance improved dramatically in copper-sensitive benchmarks





Performance improved dramatically in copper-sensitive benchmarks





Other sublibraries

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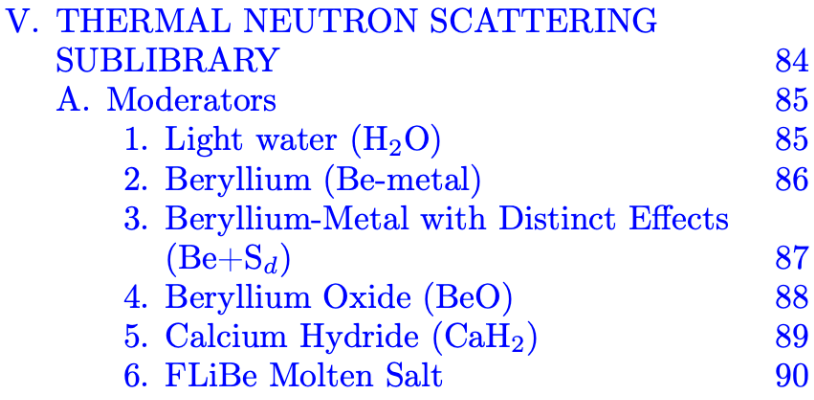
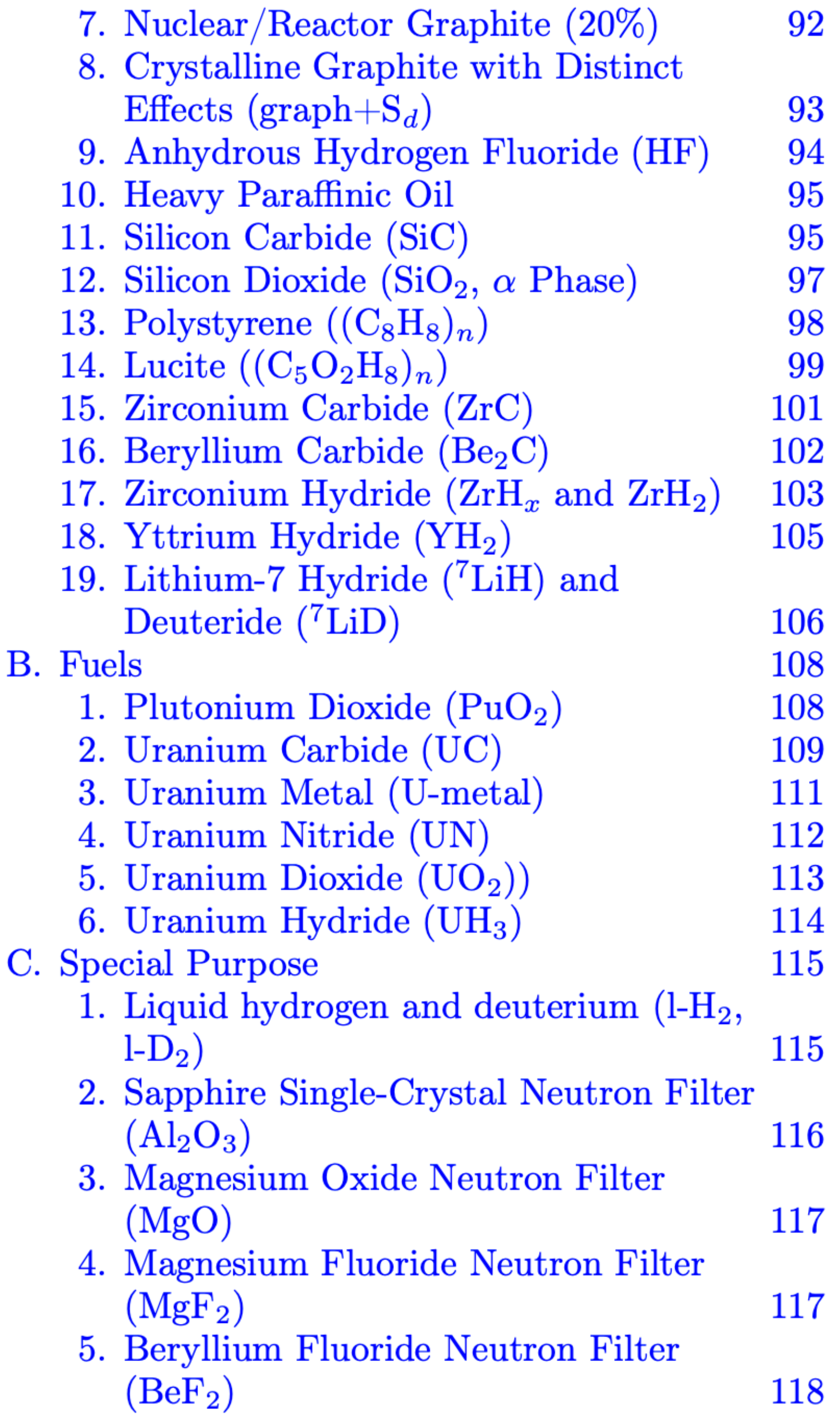
TSL

- Many, many updates and new contributions
- So much so, we had to create new way to uniquely identify materials
- Moderators, Fuels, Special Purpose

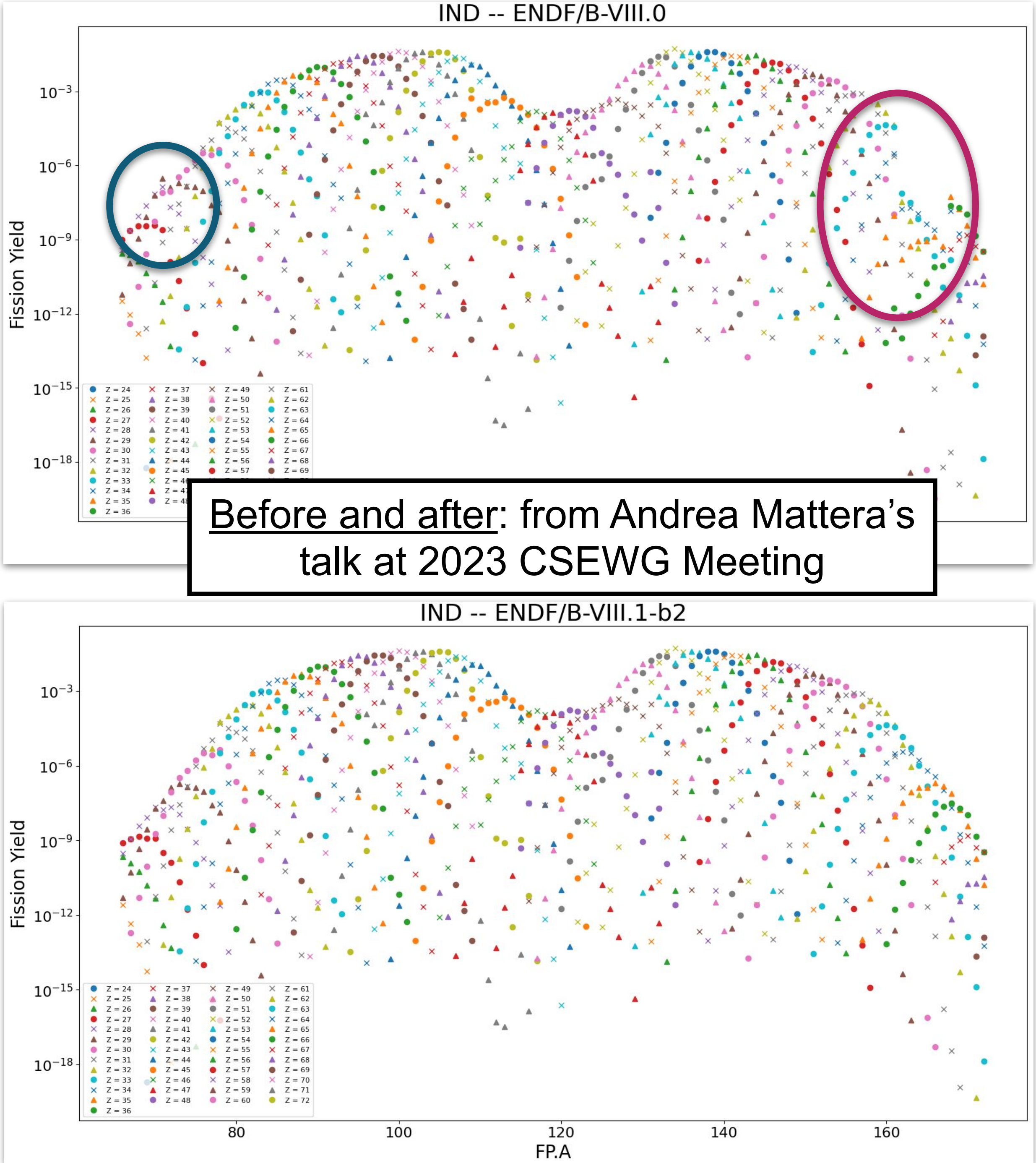




neutron-induced fission yields

The only change relative to the previous release for the neutron-induced fission yields sublibrary is for 241Pu. An important bug introduced in ENDF/B-VI.2 was fixed by A. Mattera. The list of changed files is:

- nfy-094_Pu_241.endf



<u>Before and after</u>: from Andrea Mattera’s talk at 2023 CSEWG Meeting

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