

Progress towards ENDF/B-VII.1

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Nuclear Criticality Safety Program

Technical Program Review

Riverhead, NY - February 20-22, 2024

ENDF/B-VIII.1-Beta0

Released October 2022

ENDF/B-VIII.1 Beta0 released

(Plural!) ✓

ENDF/B VIII.1

- Needed a Beta version for preliminary validation ahead of 2022 CSEWG
- No time yet for full review: Focused on neutron sub library and materials from INDEN collaboration (some degree of internal review)
- Indicate what should be the general trend of the VIII.1 release
- 3 “sub-releases”: Different ^{239}Pu candidates
- Planned Beta1: December 2022
 - Single Pu file
 - Fully reviewed files
 - All sub libraries
 - Substantial testing
 - CSEWG
 - Internal validation
- Beta2: tested against crits, LPS, by LANL and LLNL users, to ensure performance is as expected.

Changes* in VIII.1 Beta0 from VIII.0:

- $^{28,29,30}\text{Si}$
- $^{50,52,53,54}\text{Cr}$
- $^{54,56,57}\text{Fe}$
- $^{63,65}\text{Cu}$
- $^{233,235,238}\text{U}$
- ^{239}Pu
 - Beta0a: INDEN
 - Beta0b: LANL
 - Beta0c: LLNL

Small fixes in Beta0.1:

- Release readme and change log
- ^{239}Pu MF1/MT458
 - Beta0a.1: INDEN
 - Beta0b.1: LANL

Changes* in VIII.1 Beta0.2 from VIII.0:

- ^{19}F
- $^{28,29,30}\text{Si}$
- $^{50,52,53,54}\text{Cr}$
- $^{54,56,57}\text{Fe}$
- $^{63,65}\text{Cu}$
- $^{233,235,238}\text{U}$
- ^{239}Pu
 - Beta0a.2: INDEN
 - Beta0b.2: LANL (10/17)
 - Beta0c.2: LLNL

■ = Changed from Beta0.1

**There were additional changes done shortly after the VIII.0 release, but before the whole evaluated file repository was migrated to GitLab, which are now part of ENDF/B-VIII.1Beta0:*

- ^{10}B : ENDF/B-VIII.0 errata
- $^{156,158,160,161,162,163,164}\text{Dy}$: Set of ORNL evaluations
- ^{192}Pt : Tweaked energy of first resonance
- ^{240}Pu : Fix of unitarity issue by LANL

ENDF/B-VIII.1-Beta1

Released March 1, 2023

Make-It-Happen list! ✓

ENDF/B-VIII.1-Beta1

Released March 1, 2023

Main updates for VIII.1 - neutron sub library

ENDF/B
VIII.1-β1

INDEN

- 235U
- 239Pu
- 238U
- 233U
- 54,56,57Fe
- 28,29,30Si
- 55Mn
- 50,52,53,54Cr
- 63,65Cu
- 18O - 16O
- 10B
- 11B
- 139La
- 19F

- = Submitted
- = Under review
- = Not submitted
- = Approved

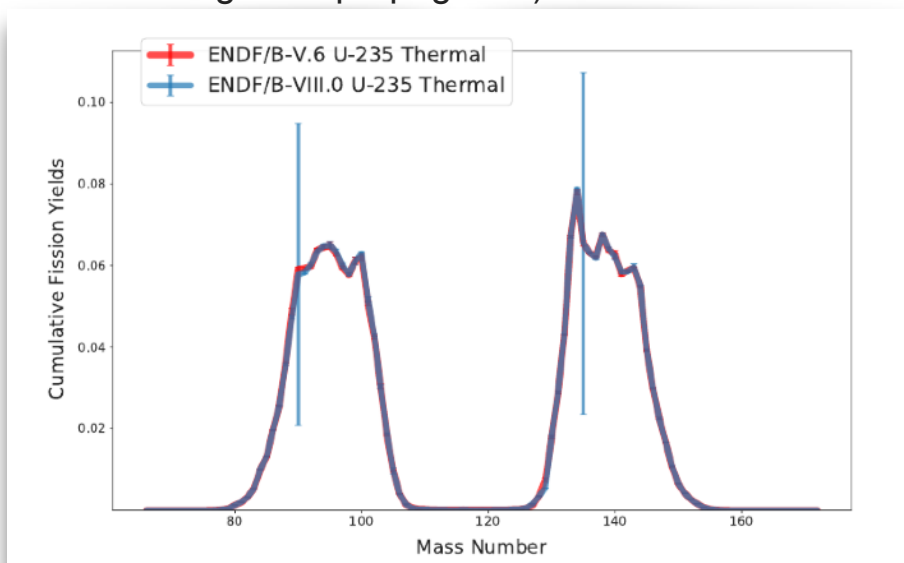


Non-INDEN

- 140,142Ce (ORNL)
- 103Rh (RPI/IRSN)
- 86Kr (BNL)
- 6Li, 9Be (LANL)
- 234,236U (LANL)
- 181Ta (RPI/ORNL/LANL)
- 95Mo (IRSN/LANL)
- 206,208Pb (RPI)
- Fission products (RQW+BNL): 78Se, 84Kr, 85Rb, 97Mo, 99Tc, 102Pd, 109Ag, 113,115In, 115,119Sn, 127I, 122,124Te, 133,134Cs, 130,134,137Ba, 138La, 143Pr, 147Pm, 148,150Nd, 153Sm, 155Eu, 160Gd, 159Tb, 166,168,170Er, 175,176Lu, 168,176Yb, 174,176,177,178,179,180Hf
- Fixes/improvements: 2H, 23Na, 37Cl, 58Co, 58,60Ni, 107Ag, 106,108,110,111,112,114,116Cd (LANL scatt. rad. fix), 170Tm, 243Pu, 10B
- Other small fixes: 1H, 7Li, 12,13C, 17O, 20,21,22Ne, 26m1Al, 31,32Si, 35S, 36Cl, 37,38,39,41Ar, 41,45,47Ca, 49V, 54Mn, 55Fe, 58m1Co, 63Ni, 64Cu, 69Zn, 70Ga, 71,75Ge, 74As, 75,81Se, 80Br, 79,81Kr, 85Sr, 91,95Zr, 93Mo, 98Tc, 97,105Ru, 104Rh, 103,109Pd, 108,112,113,114,115,116,117,118m1Ag, 107,109Cd, 114In, 121m1,126Sn, 122Sb, 121,121m1,131,131m1Te, 128,132,132m1,133,134I, 125,127Xe, 131,139Ba, 137,137m1Ce, 143,149Nd, 143,144,145,146,150Pm, 145,146Sm, 159Gd, 158,161Tb, 155,156,157,158,160,161,162,163,164Dy, 163,165,167,169Er, 168,169,171Tm, 169,175Yb, 175Hf, 181,182,183,185,186W, 186m1,187Re, 185,191Os, 192,194m1Ir, 190,193,194,196,198Pt, 197,197m1,203Hg, 203,204Tl, 204,205,206Pb, 210m1Bi, 208,209,210Po, 223,226Ra, 225,226,227Ac, 227,228,229,230,231,232,233,234Th, 229,230,231,232,233Pa, 230,231,232,237,239,240,241U, 234,235,236,236m1,237,238,239Np, 236,237,238,240,241,242,244,245,246Pu, 240,241,242,242m1,243,244,244m1Am, 240,241,242,243,244,245,246,247,248,249,250Cm, 245,246,247,248,249,250Bk, 246,247,248,249,250,251,252,253,254Cf, 251,252,253,254,254m1,255Es
- Legacy changes: 10B (ENDF/B-VIII.0 errata), 156,158,160,161,162,163,164Dy (ORNL), 192Pt (tweaked first resonance), 240Pu (LANL unitarity fix)

Spontaneous and Induced Fission Yields sub libraries

A. Mattera & A. Sonzogni noticed some cumulative yields had **huge** unphysical uncertainty (coming from wrong error propagation) and recalculated them and updated the values: **BNL-220804-2021-INRE**



Spontaneous Fission Yields

- sfy-092_U_238.endf
- sfy-096_Cm_244.endf
- sfy-096_Cm_246.endf
- sfy-096_Cm_248.endf
- sfy-098_Cf_250.endf
- sfy-098_Cf_252.endf
- sfy-099_Es_253.endf
- sfy-100_Fm_254.endf
- sfy-100_Fm_256.endf

n-induced Fission Yields

- nfy-090_Th_227.endf
- nfy-090_Th_229.endf
- nfy-090_Th_232.endf
- nfy-091_Pa_231.endf
- nfy-092_U_232.endf
- nfy-092_U_233.endf
- nfy-092_U_234.endf
- nfy-092_U_235.endf
- nfy-092_U_236.endf
- nfy-092_U_237.endf
- nfy-092_U_238.endf
- nfy-093_Np_237.endf
- nfy-093_Np_238.endf
- nfy-094_Pu_238.endf
- nfy-094_Pu_239.endf
- nfy-094_Pu_240.endf
- nfy-094_Pu_241.endf
- nfy-094_Pu_242.endf
- nfy-095_Am_241.endf
- nfy-095_Am_242m1.endf
- nfy-095_Am_243.endf
- nfy-096_Cm_242.endf
- nfy-096_Cm_243.endf
- nfy-096_Cm_244.endf
- nfy-096_Cm_245.endf
- nfy-096_Cm_246.endf
- nfy-096_Cm_248.endf
- nfy-098_Cf_249.endf
- nfy-098_Cf_251.endf
- nfy-099_Es_254.endf
- nfy-100_Fm_255.endf

Alphas sub library

Alpha sub library

- ^9Be , ^{17}O , ^{18}O
- Files existed before but many reactions are being described for the first time
- ^4He - minor fixes

ENDF/B
VIII.1- β 1

ENDF/B-VIII.1-Beta1.1

Released April 18, 2023

Updates from Beta1:

- TSL
 - 64 updated/new files from **NCSU, NNL, ORNL**
 - “Rock-paper-scissors” peer-review approach
- Fixes in neutrons sub library (which should **not** impact criticality):
 - **⁹Be**: Fixed low-energy interpolation flag
 - **⁵⁴Cr**: Beta1 was crashing NJOY due to bug. Reassembled MF=32 with proper flag.
 - **²³⁵U**: Restored MF=35 MT=18 covariances that had been accidentally lost when updating INDEN versions of the file
 - **²³⁹Pu**: Restored MF=34/MT=2 after it had been accidentally omitted from Beta1

Example of validation results from mini-CSEWG. There are many more available

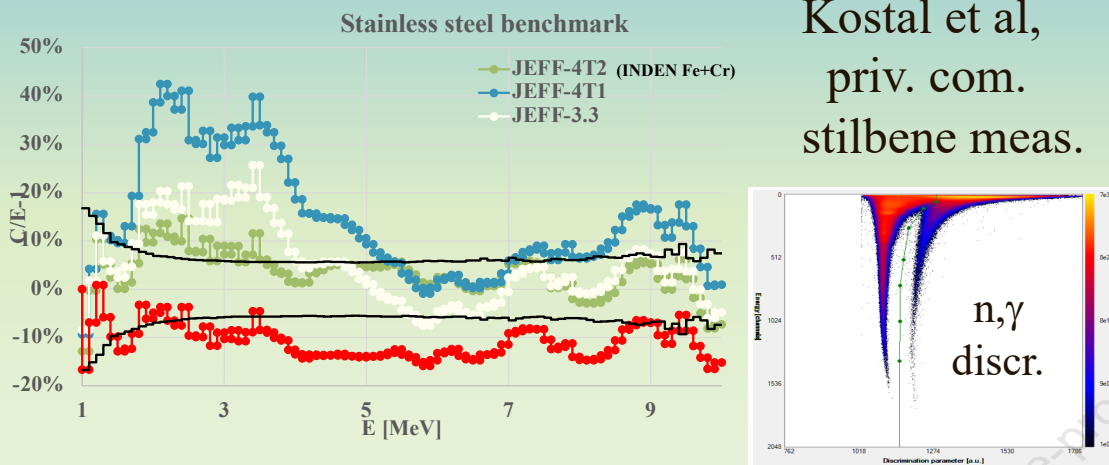
Results sensitive to stainless steel

INDEN updated “structural” evaluations:

see nds.iaea.org/INDEN/ - Validation

- ✓ Fe isotopes (IAEA/JSI), fe54e80o, fe56e80X29r41, fe54e80o
- ✓ Cr isotopes, BNL/ORNL/IAEA/JSI/CEA, v2.3.2

Kostal et al,
priv. com.
stilbene meas.



Stainless steel, neutron leakage (Rez, CZ, 11/2021)

The Pool Critical Assembly (PCA) Pressure Vessel Simulator experiment was performed in the early 1980s as part of the NRC’s LWR Pressure Vessel Surveillance Dosimetry Improvement Program (LWR-PV-SDIP)

Benchmark was recently re-analyzed with exact geometry by Dr. Kulesza (LANL/X-5), and MCNP inputs were published and available for use:
 - NUCLEAR TECHNOLOGY · VOLUME 197 · 284-295 · MARCH 2017
 - Paper: <https://doi.org/10.1080/00295450.2016.1273711>
 - MCNP Inputs: <https://doi.org/10.2172/1601379>

Pool Critical Assembly Benchmarking

- C/E Results (ENDF/B-VIII.1b1):
 - MC uncertainty ≈ 1%

Depends on U-235, water & SS

	al27a	ni48p	rh103n	in115n	u238f	np237f	avg	std dev
	0.97	0.96	1.04	1.00			0.99	3.9%
	1.02	0.98	1.08	1.01			1.02	4.3%
	1.05	1.01	1.07	1.06			1.05	2.5%
	1.03	0.96	1.00	1.01	0.98	1.03	1.00	2.7%
	1.03	0.96	0.95	1.00	0.98	1.05	0.99	4.0%
	1.04	1.02	0.93	1.03	0.98	1.03	1.00	4.1%
			0.96	0.99	0.99	1.13	1.02	7.6%
avg	1.02	0.98	1.01	1.01	0.98	1.06	1.01	
std dev	2.8%	2.9%	6.4%	2.1%	0.1%	1.0%		4.2%

Presented by Greg Fischer, Westinghouse @ miniCSWEG April 2023

4 Mini-CSWEG meeting (presented by video link)
April 2023, Livermore Valley Open Campus, CA

Roberto Capote, IAEA Nuclear Data Section
e-mail: R.CapoteNoy@iaea.org
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Slides taken from Roberto Capotes’s talk at 2023 mini-CSEWG

- Significant performance improvements in SS (Fe and Cr)
- Users are happy with new files!

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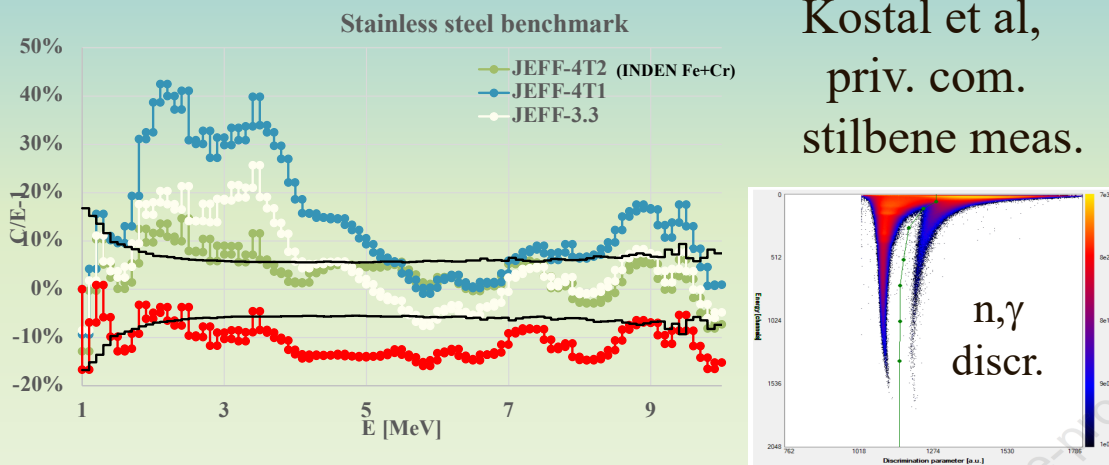
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Pool Critical Assembly Benchmarking

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– MC uncertainty $\approx 1\%$

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	1.03	0.96	1.00	1.01	0.98	1.03	1.00	2.7%
	1.03	0.96	0.95	1.00	0.98	1.05	0.99	4.0%
	1.04	1.02	0.93	1.03	0.98	1.03	1.00	4.1%
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ENDF/B-VIII.1-Beta2

Released August 4, 2023

Progress towards ENDF/B-VIII.1

- **Beta1** was released on March 1st, 2023:
 - Mostly neutrons sublibraries
 - Mostly INDEN
- **Beta1.1** was released on April 18th, 2023:
 - Mostly TSL files
 - Some few specific neutrons fixes
- Mini-CSEWG (LLNL): April 24-28, 2023
- **Beta2** was released on August 4, 2023
 - All neutrons contributions incorporated
- New ^{239}Pu that restores depletion performance, following feedback from mini-CSEWG
- Gaps in exit distributions filled
- Many dosimetry reactions consistently adopted from IRDFF-II
- Many updates on photonuclear library based on IAEA CRP
- Hackathon (LANL): August 6-8, 2023
- CSEWG Meeting: November 15-17, 2023

ENDF/B
VIII.1- β 1

ENDF/B
VIII.1- β 1.1

ENDF/B
VIII.1- β 2

Additional overall updates in neutrons sub library

ENDF/B
VIII.1- β 2

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 - Wherever it was missing, exit spectra was taken from TENDL
 - Cross sections left unchanged
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 - This tends to be more accurate than any full, self-consistent evaluation
 - 34 files had something replaced by IRDFF
 - Had to reconstruct other reactions to preserve unitarity

Updating of the ENDF/B-VIII.1b2 candidate evaluations with reaction cross sections from IRDFF-II

A. Trkov

Jozef Stefan Institute, Ljubljana, Slovenia

R. Capote

International Atomic Energy Agency, Vienna, Austria

July 2023

Introduction

In addition to the neutron cross section Standards, the dosimetry reaction cross sections are the most rigorously evaluated nuclear data that include covariance information extending to at least 60 meV. The most recent neutron dosimetry library is IRDFF-II, available from the IAEA. It is desirable that evaluated data in the new libraries would be consistent with the dosimetry cross sections so that integral reaction rates could be calculated directly from detailed Monte Carlo calculations.

In the present notes the reaction cross sections in IRDFF-II are compared to the equivalent cross sections in ENDF/B-VIII.1b1. Changes to the candidate evaluations for ENDF/B-VIII.1b2 are proposed.

Additional overall updates in neutrons sub library

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- The IRDFF-II dosimetry library contains well-measured cross-sections for specific reactions
 - This tends to be more accurate than any full, self-consistent evaluation
 - 34 files had something replaced by IRDFF
 - Had to reconstruct other reactions to preserve unitarity
- These efforts were done semi-simultaneously, independently, by different groups, often in the same file
 - Logistic challenge to coordinate all this!

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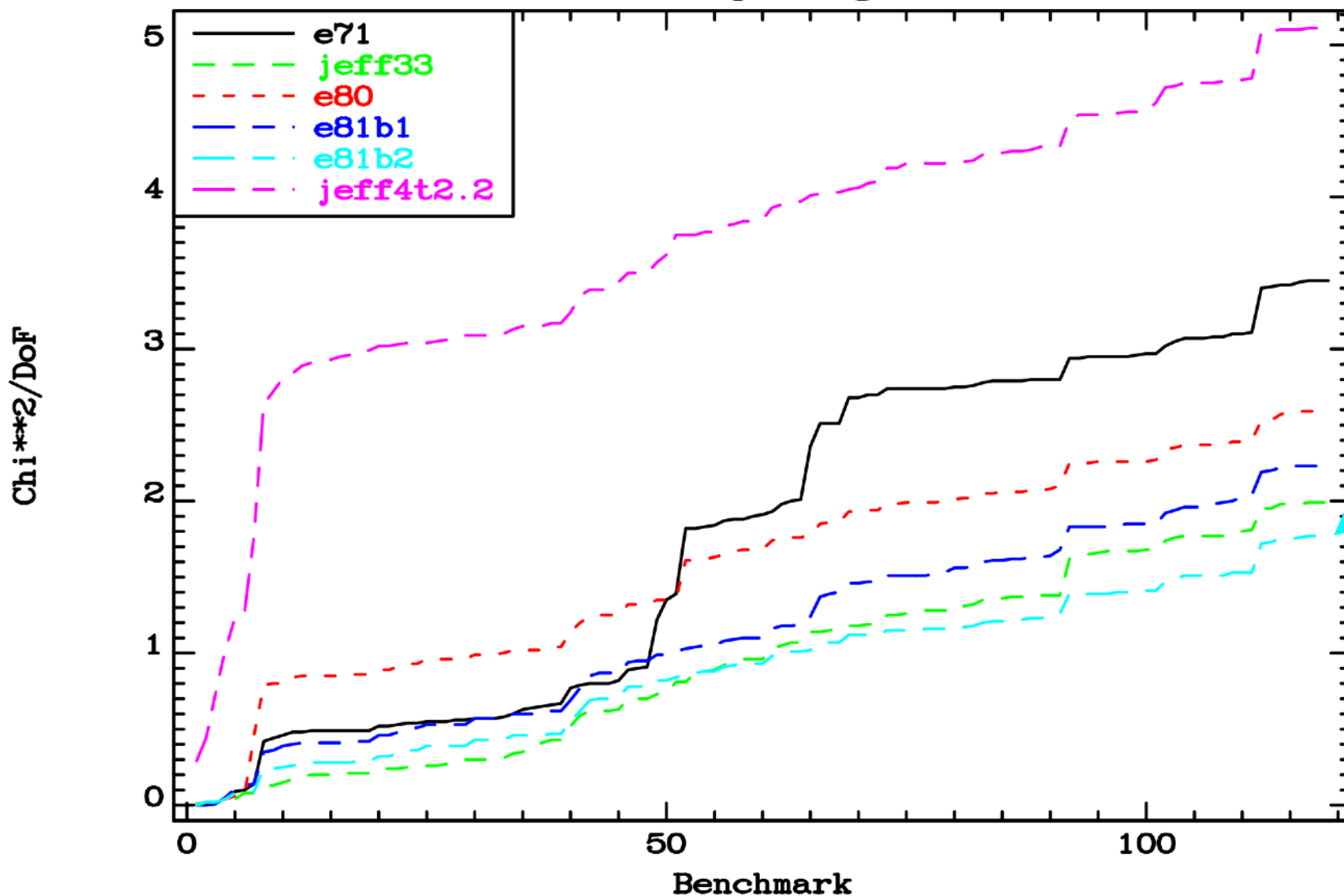
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In the present notes the reaction cross sections in IRDFF-II are compared to the equivalent cross sections in ENDF/B-VIII.1b1. Changes to the candidate evaluations for ENDF/B-VIII.1b2 are proposed.

Preliminary validation on Beta2, by Andrej Trkov (JSI)

LANL (Mosteller) suite of benchmarks
Cumulative χ^2 per degree of freedom



ENDF/BVIII.1 is on track to be the best-performing library to-date!

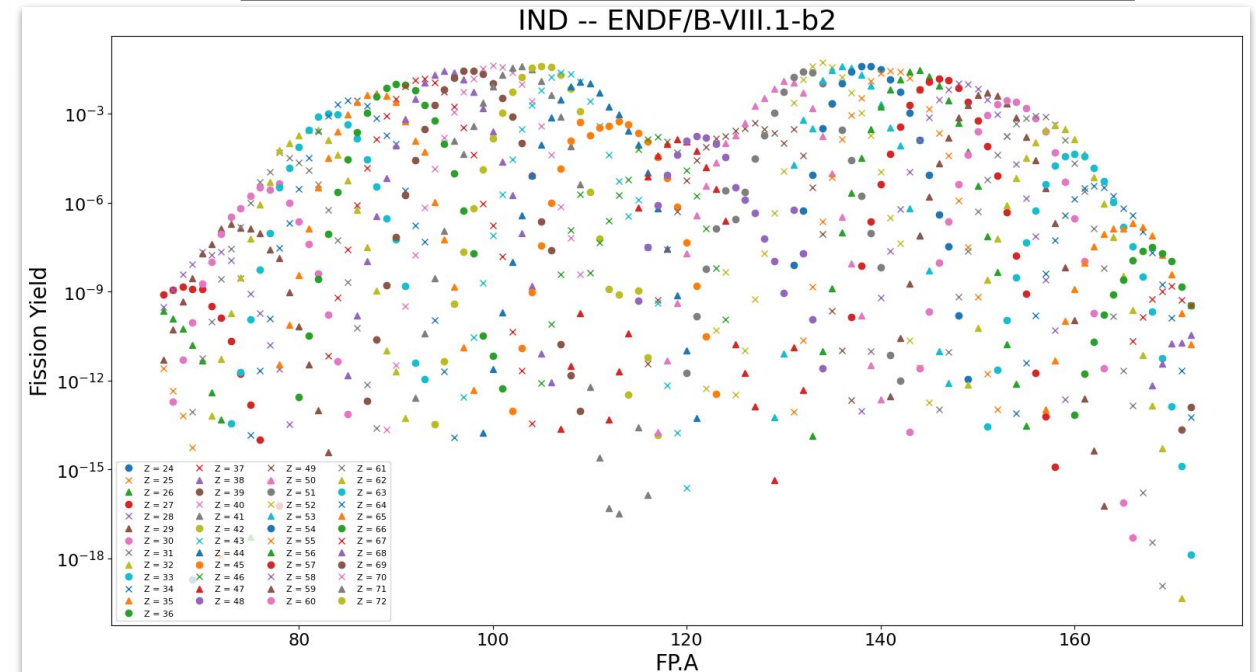
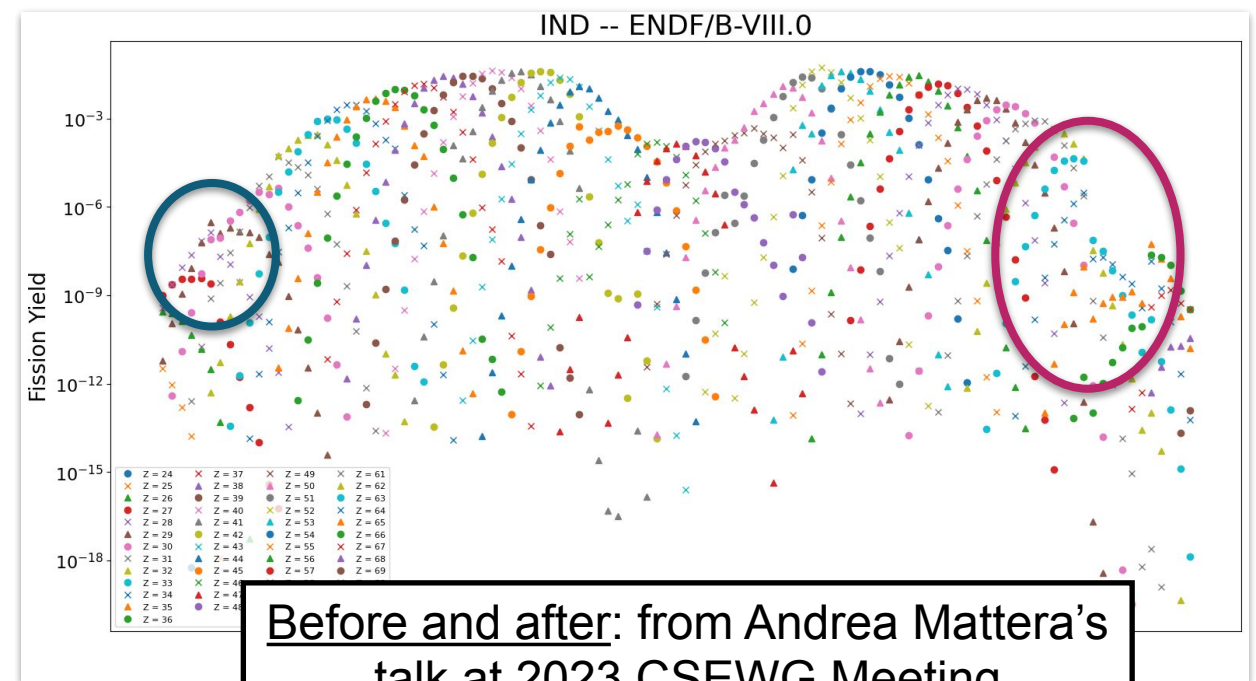
Caveat: Cumulative χ^2 of benchmarks provide only a global view. Detailed investigation of performance on specific benchmark are also important.

For more details on the ENDF-VIII.1-Beta2 performance, see talks in the **Validation** session of **2023 CSEWG Meeting!**

neutron-induced fission yields

The only change relative to the previous release for the neutron-induced fission yields sublibrary is for ^{241}Pu . 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



TSL

- tsl-HinC8H8 (Polystyrene) - ORNL
- tsl-CinC8H8 (Polystyrene) - ORNL
- tsl-AlinAl2O3 - NCSU (documentation fixes)
- tsl-OlinAl2O3 - NCSU (documentation fixes)
- tsl-BeinFLiBe - NCSU (documentation fixes)
- tsl-FinFLiBe - NCSU (documentation fixes)
- tsl-LiinFLiBe - NCSU (documentation fixes)
- tsl-FinHF - NCSU (documentation fixes)
- tsl-HinHF - NCSU (documentation fixes)
- tsl-HinParaffinicOil - NCSU (documentation and other fixes)

Recommendation from M.Chadwick @ mini-CSEWG

Need more time to assess and review these files. So, for now, keeping them from VIII.0

- Consider ^9Be from NNL
- Adopt evaluations from 2019 IAEA CRP for (almost) all nuclei: 200+ files
- Except for 16 select mission-critical materials:

• ^2H	• ^{27}Al	• ^{184}W	• ^{237}Np
• ^{12}C	• ^{28}Si	• ^{206}Pb	• ^{235}U
• ^{14}N	• ^{40}Ca	• ^{207}Pb	• ^{238}U
• ^{16}O	• ^{63}Cu	• ^{208}Pb	• ^{239}Pu

- For those, for now, keep older LANL evaluations present in ENDF/B-VIII.0

Adopted for Beta2

Alphas

- a-003_Li_006 (Fix: *Remove intermediate Be8 products from $MT=650$ and 651 since they break up*)

Protons

Only one file has been updated since ENDF/B-VIII.0, only to correct minor issues. The list of changed files is:

* p-002_He_004.endf

spontaneous fission yields

There are no changes in the VIII.1-Beta2 release relative to VIII.1-Beta1.1 for the spontaneous fission yields sublibrary.

tritons

The only changes relative to ENDF/B-VIII.0 are:

- t-002_He_004.endf (minor fix)
- t-003_Li_006 (Fix: "Move MT=22 (3-body outputChannel) to MT=50 (2-body + breakup), and remove intermediate Be8 from MF=6 product list.")

ENDF/B-VIII.1-Beta3

Released January 11, 2024

What to expect for Beta3

- **TSL:**

- New MAT number assignments
- Reviewed and new files
- Extension of light water to low temperatures

- **Neutrons:**

- Exit distributions from LANL/KAERI
- Many fixes
- Improved $^{239,240,241}\text{Pu}$ set with better criticality/depletion performance

- **Photonuclear:**

- Reverted $^{180,182,183}\text{W}$ to VIII.0
- ^{242}Pu from JENDL-5.0
- ^9Be from IAEA CRP

- **Atomic sublibraries:**

- Taken from EPICS-2023
 - Atomic relaxation sublibrary (EADL)
 - Electrons sublibrary (EEDL)
 - Photoatomic sublibrary (EPDL)

TSL MAT numbers

- Many, many new contributions: MAT number overload!
- Approved format change allow direct MAT assignments in the range of 1 to 9999
- New assignments were made, according to new guidelines:

Table C.1: Set of general rules used to assign MAT numbers for new materials in the TSL sublibrary.

MAT range	Description
1-10	legacy hydrogen (except organics) assignments
11-20	legacy deuterium assignments
21-25	legacy lithium assignments
26-29	legacy beryllium assignments
30-44	legacy carbon (including organics) assignments
45-50	legacy oxygen assignments
51-70	legacy metal assignments
71-99	legacy fuel assignments
100-299	single element (100 + Z for natural element and 200+Z for alternative form whenever possible)
300-999	graphite/diamond variations
1000-2999	carbon including organics
3000-3999	two-element inorganic compounds
4000-4999	three-element inorganic compounds
5000-5999	four-element inorganic compounds
6000-6499	five-element inorganic compounds
6500-6999	free slots
7000-7999	fuel compounds with plutonium
8000-8999	fuel compounds with uranium
9000-9999	free slots

```
TSL_MAT_numbers.csv (~/Calculations/ENDF/thermal_scatt) - VIM
#####
##
##          TSL MAT numbers          ##
## associated with the ENDF/B-VIII.1-BetaX release ##
##
## Note: empty file field means MAT number is reserved. ##
##
##
#####
##
## MAT number, ENDF-6 file name      ,      Description
##
##      1 , tsl-HinH20.endf           ,      H in H20 (liquid)
##      2 , tsl-para-H.endf           ,      para-Hydrogen
##      3 , tsl-ortho-H.endf          ,      ortho-Hydrogen
##      5 , tsl-HinYH2.endf           ,      H in YH2
##      7 , tsl-HinZrH.endf           ,      H in ZrH
##     10 , tsl-HinIceIh.endf         ,      H in H20 (ice (Ih))
##     11 , tsl-DinD20.endf           ,      D in D20 (liquid)
##     12 , tsl-para-D.endf           ,      para-Deuterium
##     13 , tsl-ortho-D.endf          ,      ortho-Deuterium
##     14 ,                           ,      D in D20 (ice)
TSL_MAT_numbers.csv 1,1 Top
3002 , tsl-HinZrH2.endf              ,      H in ZrH2
3006 , tsl-ZrinZrHx.endf             ,      Zr in ZrHx
3007 , tsl-HinZrHx.endf              ,      H in ZrHx
3011 , tsl-CainCaH2.endf             ,      Ca in CaH2
3013 , tsl-H1inCaH2.endf            ,      H1 in CaH2
3014 , tsl-H2inCaH2.endf            ,      H2 in CaH2
3016 , tsl-SiinSiO2-alpha.endf      ,      Si in SiO2-alpha
3017 , tsl-OinSiO2-alpha.endf       ,      O in SiO2-alpha
3021 ,                               ,      Si in SiO2-beta
3022 ,                               ,      O in SiO2-beta
3031 , tsl-7Liin7LiH-mixed.endf     ,      7Li in 7LiH-mixed
3032 , tsl-Hin7LiH-mixed.endf       ,      H in 7LiH-mixed
3034 , tsl-7Liin7LiD-mixed.endf     ,      7Li in 7LiD-mixed
3035 , tsl-Din7LiD-mixed.endf       ,      D in 7LiD-mixed
3037 ,                               ,      Mg in MgH2
3038 ,                               ,      H in MgH2
3042 ,                               ,      Mg in MgD2
3043 ,                               ,      D in MgD2
3047 , tsl-FinHF.endf               ,      F in HF
3048 , tsl-HinHF.endf               ,      H in HF
3052 , tsl-AlinAl203.endf           ,      Al in Al203
3053 , tsl-OinAl203.endf           ,      O in Al203
3060 ,                               ,      Pb in PbF2
TSL_MAT_numbers.csv 128,24 37%
```

TSL updates since Beta2 (in addition to new MAT assignments)

- tsl-Be-metal+Sd
- tsl-Be-metal
- tsl-BeinBeO
- tsl-CainCaH2
- tsl-CinC5O2H8.endf (fixes)
- tsl-CinC8H8 (fixes)
- tsl-CinC8H8 (minor fix)
- tsl-CinCF2.endf (fixes)
- tsl-CinSiC
- tsl-CinUC-100P (new file)
- tsl-CinUC-10P
- tsl-CinUC-5P
- tsl-CinUC-HALEU (new file)
- tsl-CinUC-HEU
- tsl-CinUC
- tsl-CinZrC (minor fix)
- tsl-DinD2O (minor fix)
- tsl-FinCF2 (minor fix)
- tsl-H1inCaH2
- tsl-H2inCaH2
- tsl-HinC5O2H8.endf (ORNL)
- tsl-HinC8H8 (minor fixes)
- tsl-HinH2O.endf (ESS)
- tsl-HinC8H8.endf (minor fix)
- tsl-HinIcelh.endf (minor fix)
- tsl-HinParaffinicOil (minor fix)
- tsl-HinYH2 (minor fix)
- tsl-HinZrH2 (minor fix)
- tsl-HinZrHx (minor fix)
- tsl-NinUN-100P
- tsl-NinUN-10P
- tsl-NinUN-5P
- tsl-NinUN-HALEU
- tsl-NinUN-HEU
- tsl-NinUN
- tsl-OinBeO
- tsl-OinC5O2H8.endf (fixes)
- tsl-OinD2O
- OinIcelh
- tsl-OinPuO2
- tsl-OinSiO2-alpha
- tsl-OinUO2-100P
- tsl-OinUO2-10P
- tsl-OinUO2-5P
- OinUO2-HALEU
- tsl-OinUO2-HEU
- tsl-OinUO2
- tsl-PuinPuO2
- tsl-SiinSiC
- tsl-SiinSiO2-alpha
- tsl-U-metal-10P
- tsl-U-metal-5P
- tsl-U-metal-HEU
- tsl-U-metal
- tsl-U-metal-HALEU
- tsl-U-metal-100P
- tsl-UinUC-100P
- tsl-UinUC-10P
- tsl-UinUC-5P
- tsl-UinUC-HALEU
- tsl-UinUC-HEU
- tsl-UinUC
- tsl-UinUN-100P
- tsl-UinUN-10P
- tsl-UinUN-5P
- tsl-UinUN-HALEU
- tsl-UinUN-HEU
- tsl-UinUN
- tsl-UinUO2-100P
- tsl-UinUO2-10P
- tsl-UinUO2-5P
- tsl-UinUO2-HALEU
- tsl-UinUO2-HEU
- tsl-UinUO2
- tsl-YinYH2
- tsl-ZrinZrC (minor fix)
- tsl-ZrinZrH2 (minor fix)
- tsl-ZrinZrHx (minor fix)
- tsl-graphiteSd
- tsl-reactor-graphite-10P
- tsl-reactor-graphite-20P
- tsl-reactor-graphite-30P
- tsl-s-CH4
- tsl-CinZrC
- tsl-ZrinZrC
- tsl-ortho-D
- tsl-ortho-H
- tsl-para-H

Additional changes from Beta2

- n-001_H_002 (minor fix)
- n-004_Be_009 (problems above 2.8 MeV)
- n-005_B_011 (fix of wrong gamma flagging)
- n-006_C_012 (minor fix)
- n-006_C_013 (primary gammas & minor fix)
- n-008_O_016 (minor fix plus flagging of primary gammas, branching ratios added)
- n-008_O_018 (fix by removing 21MeV point in capture)
- n-009_F_019 (flagged primary gammas)
- n-014_Si_028 (flagged primary gammas)
- n-016_S_032 (added inelastic gammas)
- n-016_S_033 (added inelastic gammas)
- n-016_S_034 (added inelastic gammas)
- n-024_Cr_050 (added VIII.0 covariances and KAERI exit dist.)
- n-024_Cr_051 (KAERI exit dist.)
- n-024_Cr_052 (added VIII.0 covariances and KAERI exit dist., select resonances taken from BROND)
- n-024_Cr_053 (added VIII.0 covariances and KAERI exit dist.)
- n-024_Cr_054 (KAERI exit dist., minor fixes)
- 029_Cu_063 (fixes and KAERI exit dist.)
- 029_Cu_065 (fixes and KAERI exit dist.)
- n-038_Sr_088 (ORNL evaluation)
- n-045_Rh_103 (minor fixes)
- n-046_Pd_110 (minor fixes)
- n-049_In_113 (MT=3 fix)
- n-049_In_115 (format fixes that were breaking NJOY)
- n-058_Ce_140 (updated covariances, fixes)
- n-058_Ce_142 (updated covariances, fixes)
- n-059_Pr_141 (processing fixes)
- n-066_Dy_161 (minor fixes)
- n-066_Dy_164 (minor fixes)
- n-073-Ta_180m1 (new file based on JENDL-5)
- n-073-Ta_181 (updated URR and doc.)
- n-074_W_182 (minor fix)
- n-074_W_183 (minor fix)
- n-074_W_184 (minor fix)
- n-074_W_186 (minor fix)
- n-082_Pb_206 (fixes by evaluator)
- n-082_Pb_207 (fixes by evaluator)
- n-082_Pb_208 (fixes by evaluator)
- n-092_U_233 (minor fixes, new RRR evaluation)
- n-092_U_234 (uncertainty and other fixes by evaluator)
- n-092_U_235 (Restored MF=6 MT=18 P(nu), fixed typo in 232TH yield)
- n-092_U_238 (Fixed typo in p-wave resonance)
- n-092_U_236 (uncertainty and other fixes by evaluator)
- n-094_Pu_239 (new criticality vs burn-up compromise solution)
- n-094_Pu_242 (covariance fix)
- n-078_Pt_190
- n-078_Pt_191
- n-078_Pt_192
- n-078_Pt_193
- n-078_Pt_194
- n-078_Pt_195
- n-078_Pt_196
- n-078_Pt_197
- n-078_Pt_198
- n-023_V_051
- Prompt nuubar of 20 nuclides

Additional changes from Beta2

Prompt nubar from RQW

- Maslov, INDC(BLR) reports:
 - Pa-230
 - Pa-232
 - U-230
 - U-231
 - U-232
 - Am-240
 - Am-244
 - Cm-240
- Madland-Nix calculations:
 - Cf-246
 - Cf-248
 - Cf-249
 - Cf-250
 - Cf-251
 - Cf-252
 - Cf-253
 - Cf-254
 - Pu-237
- Input for Cf isotopes was revised relative to the values used for VIII.0 R. Q. Wright evaluations:
 - ~~Np-234~~ (too similar to VIII.0)
 - ~~Np-235~~ (too similar to VIII.0)
 - Es-254m1 is the same as Es-254

Photonuclear sublibrary

- 180,182,183,186W: reverted to VIII.0
- 242Pu: inexistent, taken from JENDL-5.0
- 9Be: ~~NNL evaluation~~ Taken from CRP
- 241Am (minor fix)
- 241Pu (minor fix)
- 240Pu (minor fix)
- 238Pu (minor fix)
- 236U (minor fix)
- 234U (minor fix)
- 233U (minor fix)
- 232Th (minor fix)
- 226Ra (minor fix)
- 197Au (minor fix)
- 194Pt (minor fix)
- 187Re (minor fix)
- 185Re (minor fix)
- 40Ca (Fix to discrepant masses)
- 14N (added missing photon distributions to N14 MT=102 with energies and branching ratios taken from ENSDF).

Additional changes from Beta2 - tritons

- t-002_He_003 (fixes) - there are remaining problems
- t-002_He_004 (LANL evaluation) - there are remaining problems

Additional changes from Beta2 - alphas

- a-002_He_004 (fixes)
- a-004_Be_009 (fixes) - Still has a problem with evaluation stopping at 15MeV
- a-008_O_017 (fixes) - Still has a problem with evaluation stopping at 15MeV and energy balances
- a-008_O_018 (fixes) - Still has a problem with evaluation stopping at 15MeV

Additional changes from Beta2 - deuterons

- d-001_H_003.endf (LANL evaluation) - still has issues
- d-002_He_003.endf (LANL evaluation)
- d-002_He_004.endf (fixes)
- d-003_Li_006.endf (LANL evaluation update) - still has issues:
 - MT5, 600 and 800 distributions stop at 5 MeV
 - n + p + a exit channel as no exit distributions for any particle!
Neither angular or energy distributions!
- d-003_Li_007.endf (fixes)

Additional changes from Beta2 - helions

- h-002_He_004.endf (LLNL/INDEN)
- h-003_Li_007.endf (LLNL evaluation; there are still problems though)

Additional changes from Beta2 - protons

- p-002_He_004.endf (LANL evaluation, fixes)
- p-006_C_013.endf (minor fixes)

Atomic sub libraries

Red Cullen submitted the 2023 version of EPICS leading to updates to:

- Atomic relaxation sublibrary (EADL)
- Electrons sublibrary (EEDL)
 - This did NOT overwrite ZAP format fix done by Bret Beck for VIII.1-Beta2
- Photoatomic sublibrary (EPDL)

ENDF/B-VIII.1 release

Recommended cross sections and distributions for all nuclear applications

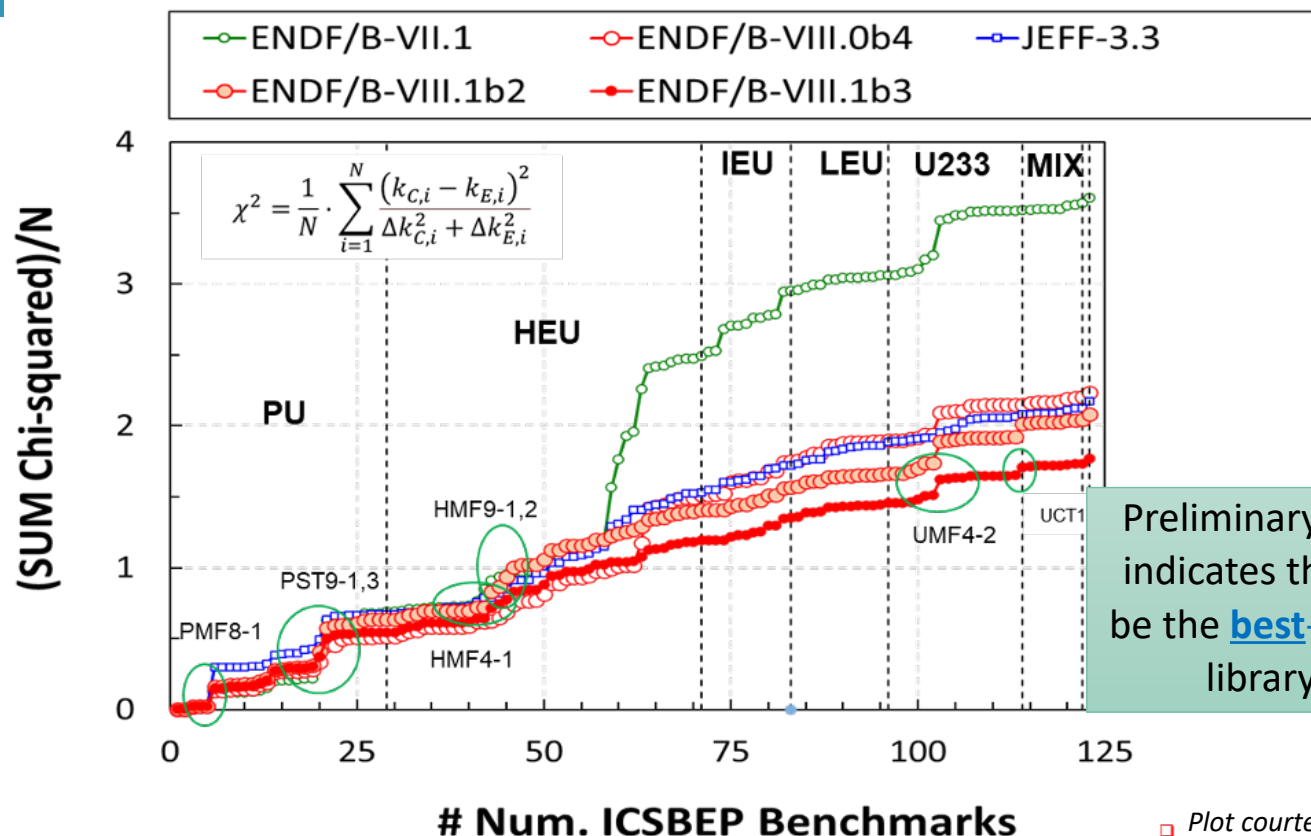
ENDF/B VIII.1-β3

Multiple Beta versions released in FY23!

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

Mosteller's Suite - 123

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





Plot courtesy of O. Cabellos

Coordination and infrastructure efforts in FY23

ENDF versioned repository: GitLab

USNDP Collaboration Platform

 **National Nuclear Data Center**


The U.S. nuclear data community working together to continuously advance the state of nuclear data for science and technology applications.

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ENDF/B library

- Subgroup information
- Epics 0
- Issues 176
- Merge requests 623
- Security & Compliance
- CI/CD
- Packages and registries
- Analytics
- Wiki
- Settings

ENDF > library

































 **library**  Group ID: 8 [Leave group](#)

The ENDF library project itself. At the time of creation of this project area, ENDF comprises 15 sublibraries. The full ENDF/B history is available as an archived project named "svn-export". See the "README" in each project for more information.

Recent activity Last 30 days

Merge requests created	327	Issues created	12	Members added	0
------------------------	-----	----------------	----	---------------	---


Subgroups and projects Shared projects Archived projects Updated

 neutrons  ENDF/B neutron sublibrary ★ 2 55 minutes ago
 sfy  ENDF/B spontaneous FPY sublibrary ★ 0 4 days ago
 nfy  ENDF/B neutron FPY sublibrary ★ 0 4 days ago
 gammas  ENDF/B gamma sublibrary ★ 0 2 weeks ago
 thermal_scatt  ENDF/B thermal neutron scattering sublibrary ★ 1 2 weeks ago
 helium3s  ENDF/B 3He sublibrary ★ 0 2 months ago
 deuterons  ENDF/B deuteron sublibrary ★ 0 3 months ago
 decay  ENDF/B decay sublibrary ★ 2 4 months ago
 protons  ENDF/B proton sublibrary ★ 0 4 months ago
 alphas  ENDF/B alphas sublibrary ★ 1 4 months ago
 tritons  ENDF/B triton sublibrary ★ 0 4 months ago
 standards  ENDF/B nuclear data standards sublibrary ★ 0 5 months ago
 atomic_relax  ENDF/B atomic relaxation sublibrary ★ 0 8 months ago
 electrons  ENDF/B electron sublibrary ★ 1 8 months ago
 super  Super project for the entire ENDF library. ★ 0 1 year ago
 photoat  ENDF/B photo-atomic sublibrary ★ 0 2 years ago

- Constantly updated and maintained
- Keeps track of
 - Any changes
 - Development, **review** and release branches
 - Issue trackers
 - etc...
- Usage is growing! Currently ~60 active members in ENDF library group (unfortunately there's a seat limit: victims of our own success)
- Integration of library repository in GitLab with a **Continuous Integration system: ADVANCE** (R. Arcilla, R. Coles, B. Shu, D. Brown)

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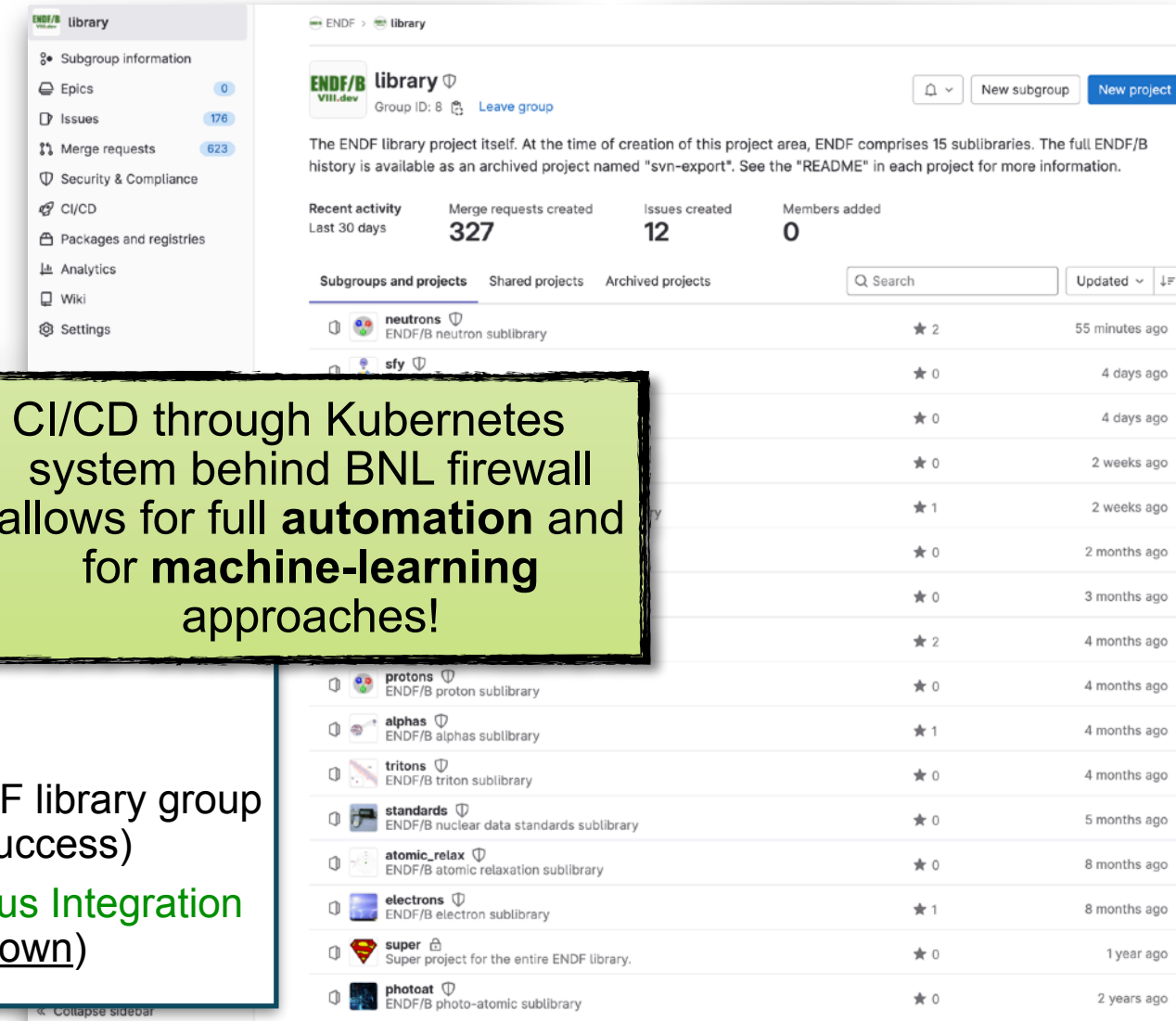
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ENDF/B library

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ENDF/B library

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------------------------	-----	----------------	----	---------------	---

Subgroups and projects

Subgroup	Stars	Updated
neutrons	2	55 minutes ago
sfy	0	4 days ago
	0	4 days ago
	0	4 days ago
	0	2 weeks ago
	1	2 weeks ago
	0	2 months ago
	0	3 months ago
	2	4 months ago
protons	0	4 months ago
alphas	1	4 months ago
tritons	0	4 months ago
standards	0	5 months ago
atomic_relax	0	8 months ago
electrons	1	8 months ago
super	0	1 year ago
photoat	0	2 years ago

- Constantly updated and maintained
- Keeps track of
 - Any changes
 - Development, **review** and release branches
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 - etc...
- Usage is growing! Currently ~60 active members in ENDF library group (unfortunately there's a seat limit: victims of our own success)
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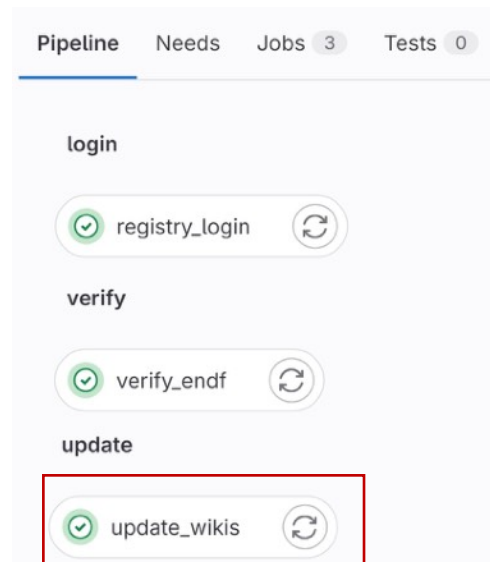
CI/CD through Kubernetes system behind BNL firewall allows for full **automation** and for **machine-learning** approaches!

ENDF Repo Auto-updating Wikis

A new job is being added to GitLab ENDF repositories to auto-update the repo's wiki with useful information about job and artifact status.

Example: <https://git.nndc.bnl.gov/endl/library/neutrons/-/wikis/Neutron-Artifacts>

1) update_wikis job runs after verify_endf



2) Use Wiki table of contents to find your data

Neutron Artifacts

Atomic Number (Z)	Symbol	Atomic Mass (A)
000	n	001
001	H	001, 002, 003
002	He	003, 004
003	Li	006, 007
004	Be	007, 009
005	B	010, 011
006	C	012, 013
007	N	014, 015
008	O	016, 017, 018
009	F	019
010	Ne	020, 021, 022
011	Na	022, 023

3) Enjoy a record of job and artifact data all in one place

n 000_n_001

Last updated: 2023-11-09 19:06:57.358348

Legend: success = 🟢, failed = 🚫, warning = ⚠️, canceled = ✖️, pending = ⏳, running = 🔄, emoji for unknown status

🟢 verify_endf 2023-11-09 19:06:57.358383
Job Status: [Job Details](#)
Artifacts created by this job: <https://git.nndc.bnl.gov/api/v4/projects/27/jobs/10305/artifacts>

🟢 verify_endf 2023-11-09 18:30:02.626032
Job Status: [Job Details](#)
Artifacts created by this job: <https://git.nndc.bnl.gov/api/v4/projects/27/jobs/10299/artifacts>

🟢 verify_endf 2023-11-06 14:41:16.202000
Job Status: [Job Details](#)
Artifacts created by this job: <https://git.nndc.bnl.gov/api/v4/projects/27/jobs/10122/artifacts>

🟢 verify_endf 2023-11-06 14:54:46.259000
Job Status: [Job Details](#)
Artifacts created by this job: None

🟢 verify_endf 2023-11-06 16:21:16.366000
Job Status: [Job Details](#)
Artifacts created by this job: None

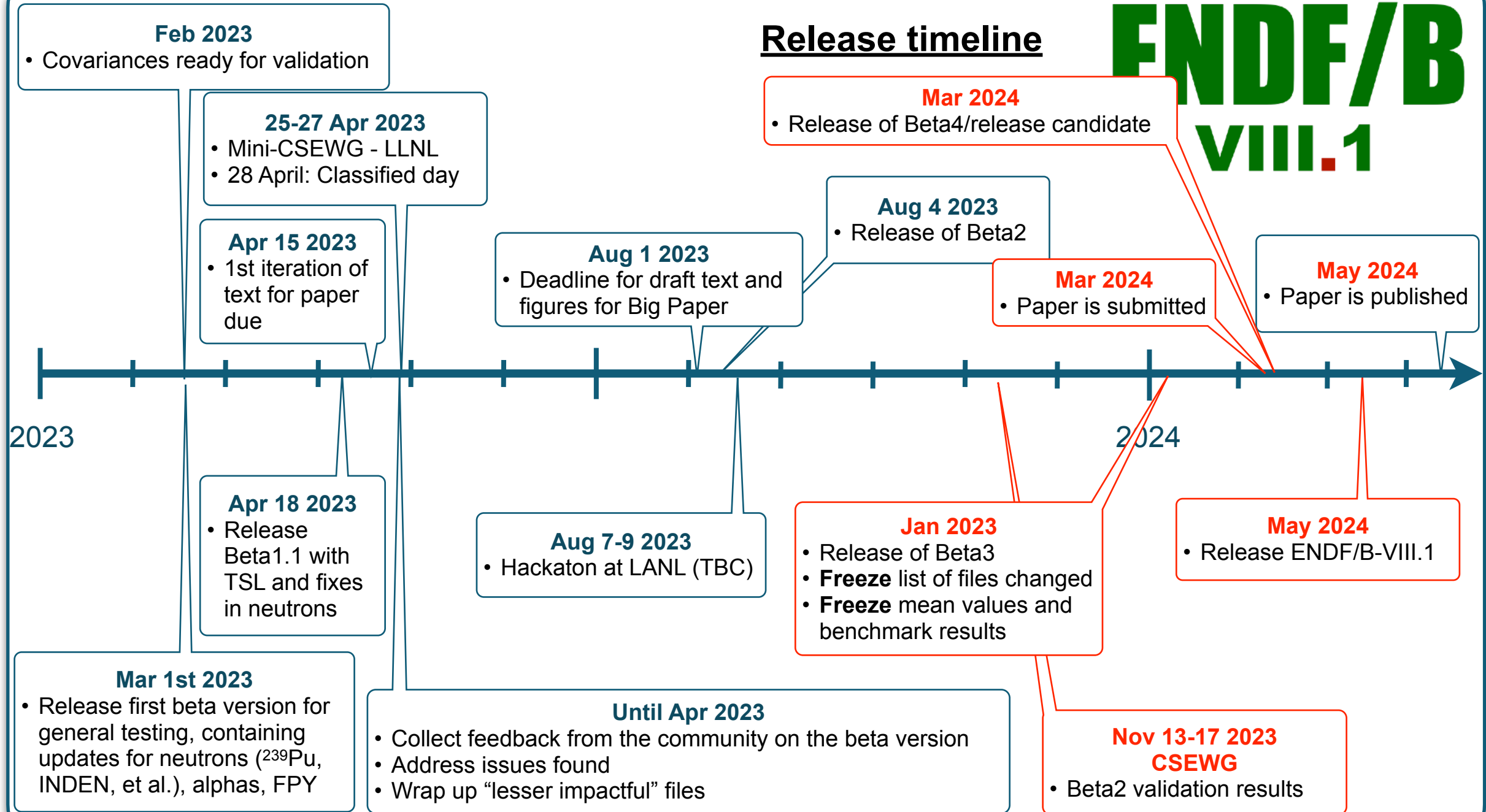
Updated

Release Timeline

... and what to expect until final release

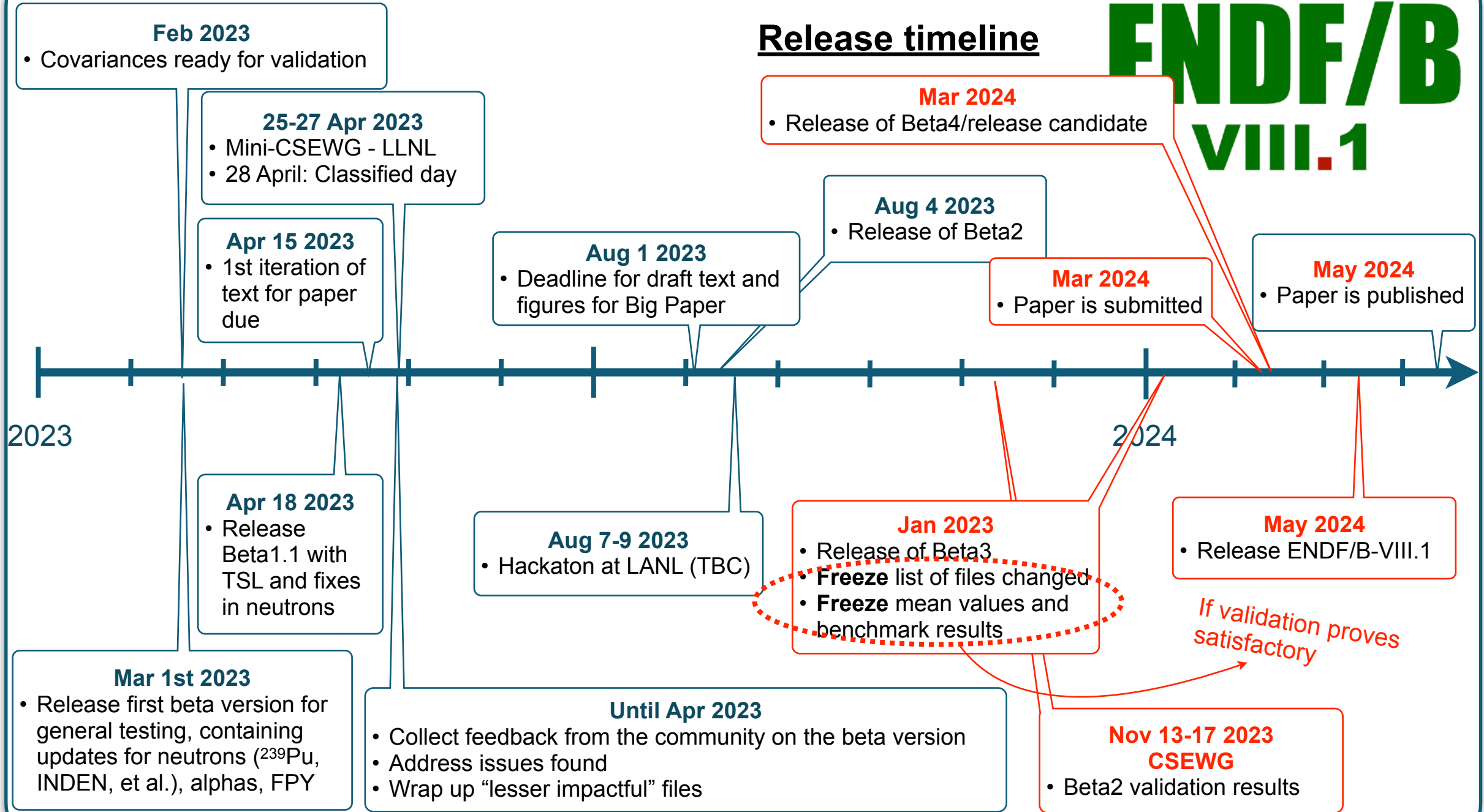
ENDF/B VIII.1

Release timeline



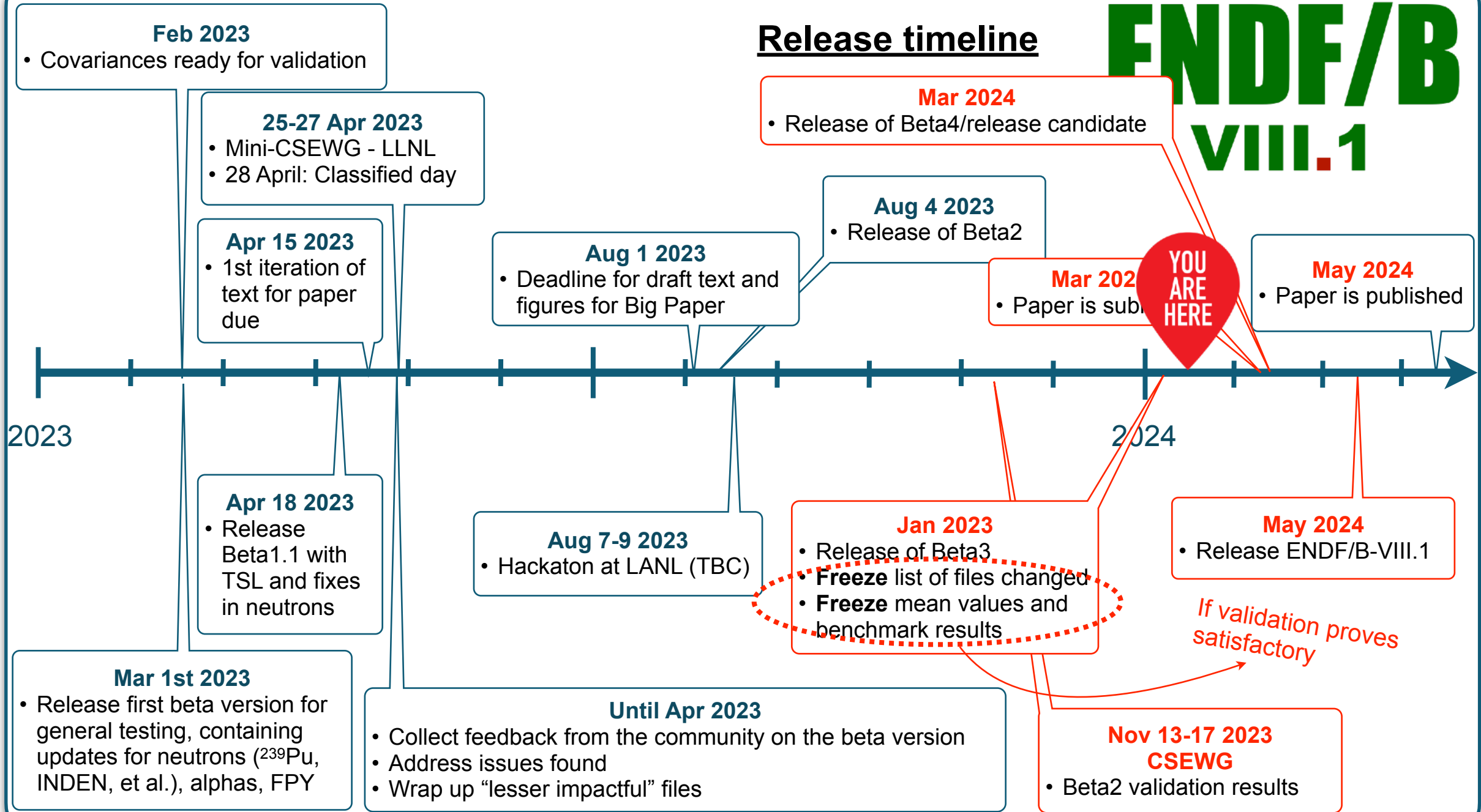
ENDF/B VIII.1

Release timeline



ENDF/B VIII.1

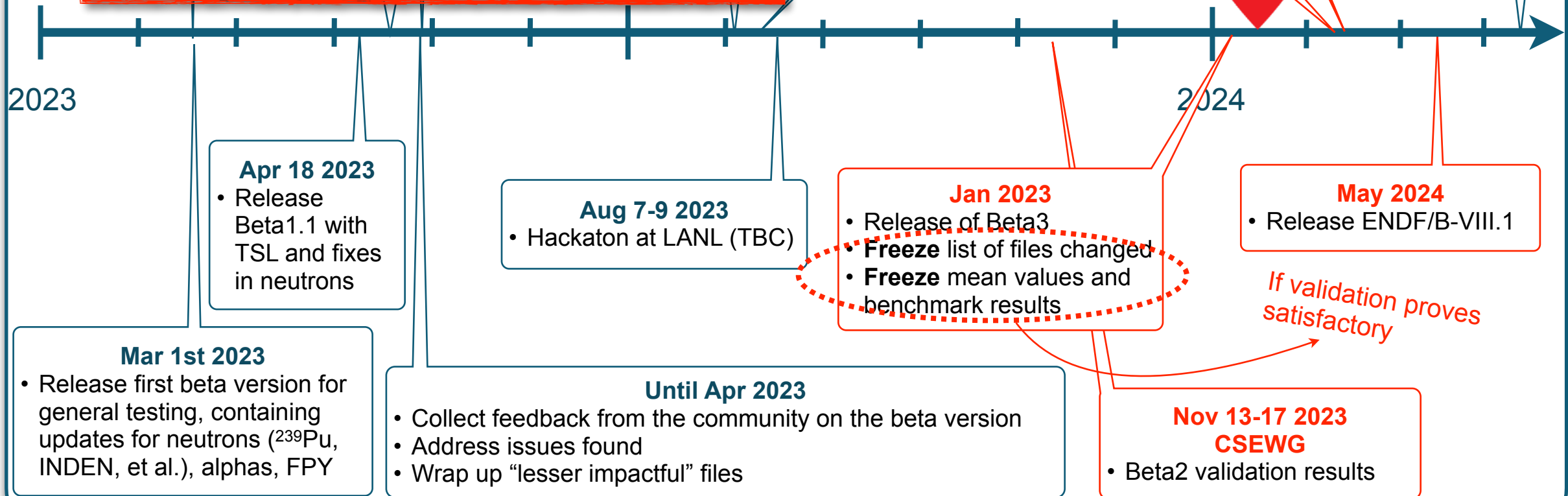
Release timeline



ENDF/B VIII.1

Release timeline

- Cov
- **Challenges:**
 - Burnup/criticality balance in Pu
 - Performance issues with Pb, ^9Be , ^{233}U
 - Conflicting evaluations
 - A few last-minute unplanned contributions
- "We're **not** in a hurry for the **wrong** answer"
- Always good to not underestimate the importance of due diligent tests:
 - Validation turnaround time of 2-3 months



Conclusion

- Infrastructure development
 - Set up evaluation review process
 - Tracking issues
 - ADVANCE CI/CD system is live
- Process for the next ENDF/B release is moving along
 - Multiple Beta versions released
 - Most recent (Beta3) released in august, being broadly tested
 - Validation feedback from Beta1.1/ Beta2 is generally positive with specific improvement needs (that are already being addressed)
- Addressed main issues in Beta3, and preliminary validation shows no surprises
- Fixing covariances, documentation and other issues for Beta4 / final release
- Collaborative effort on evaluation, review and issue fixing have been very successful
- Updated timeline to ensure the optimal quality of the final ENDF/B-VIII.1 release

Acknowledgements

This work was supported by the Nuclear Criticality Safety Program, funded and managed by the National Nuclear Security Administration for the U.S. Department of Energy. Additionally, 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-SC0012704 with Brookhaven Science Associates, LLC.