

ENDF Update

G.P.A. Nobre¹

Topics

- ENDF/B-VIII.1 Release
 - Timeline
- 2022 Hackathon
- ENDF/B-VIII.1-Beta0
- Review status of all sub-libraries

ENDF/B-VIII.1 release

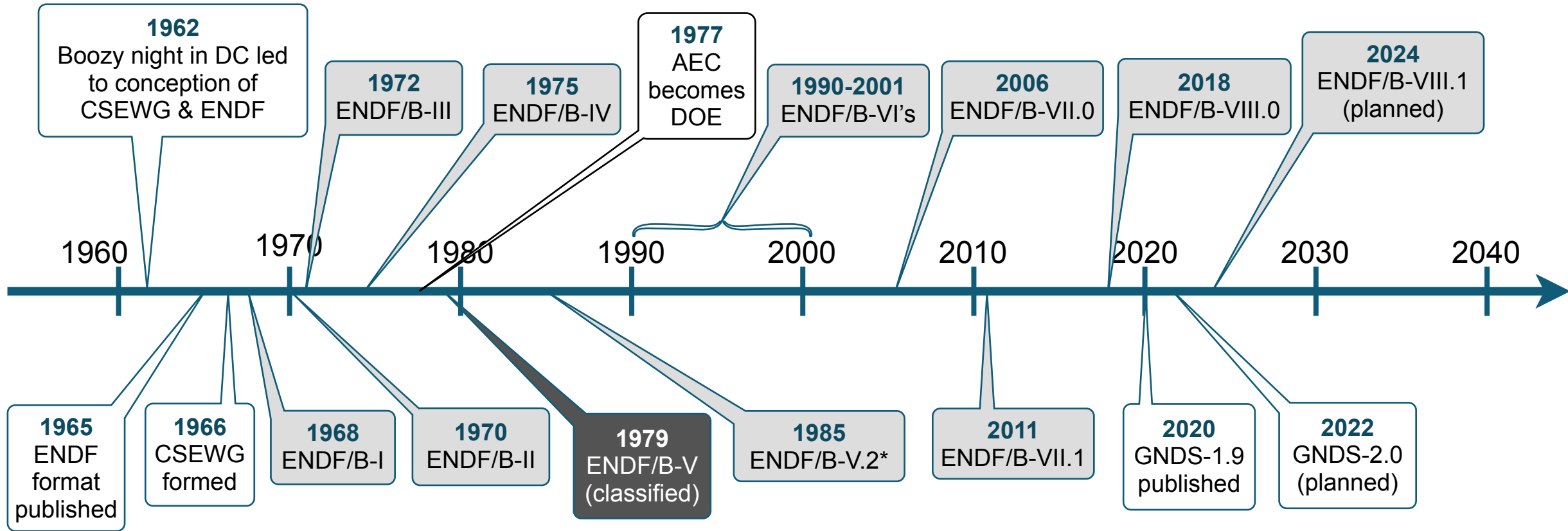
The next release of the ENDF/B library is scheduled for **February 2024!**

Although technically “minor”, it will have major impact.



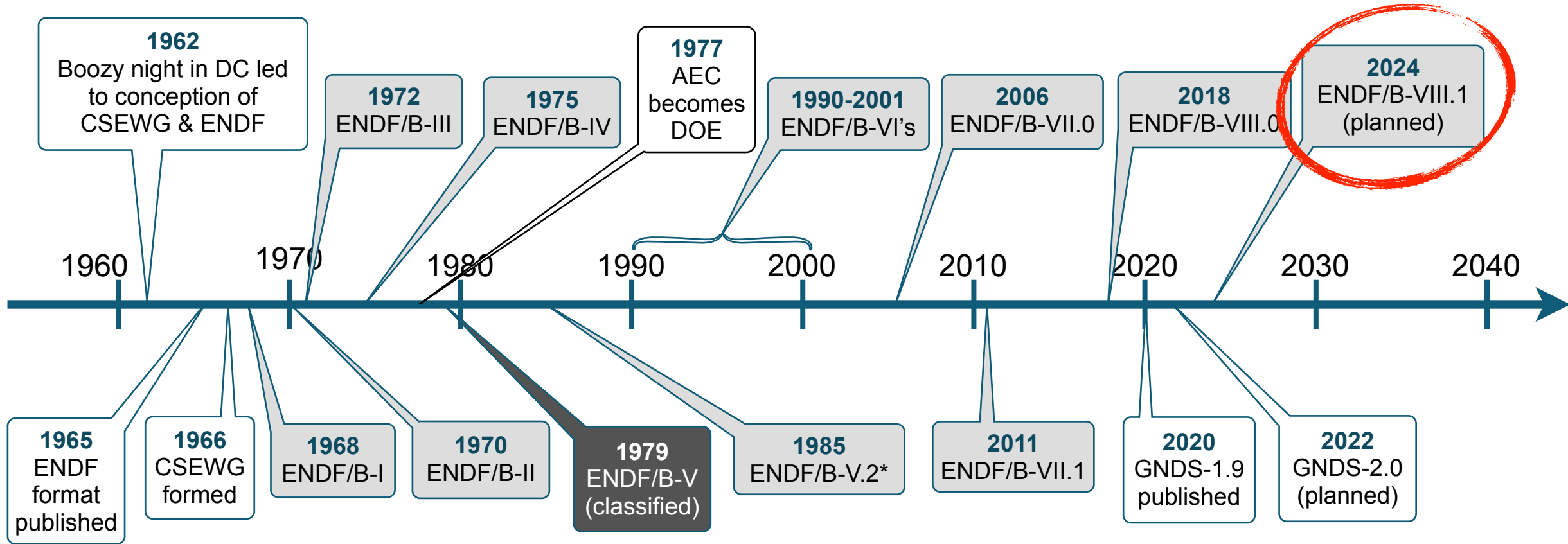
- Why VIII.1 and not IX?
 - There are no planned updates of the standards library for this release
 - However, many, many important and impactful changes are on the way!!
- Next release will be in both legacy **ENDF-6** format and **GNDS-2.0**
- Will have an accompanying “**Big Paper**”
- Important review reports are in and preliminary validation testing has begun

ENDF Timeline



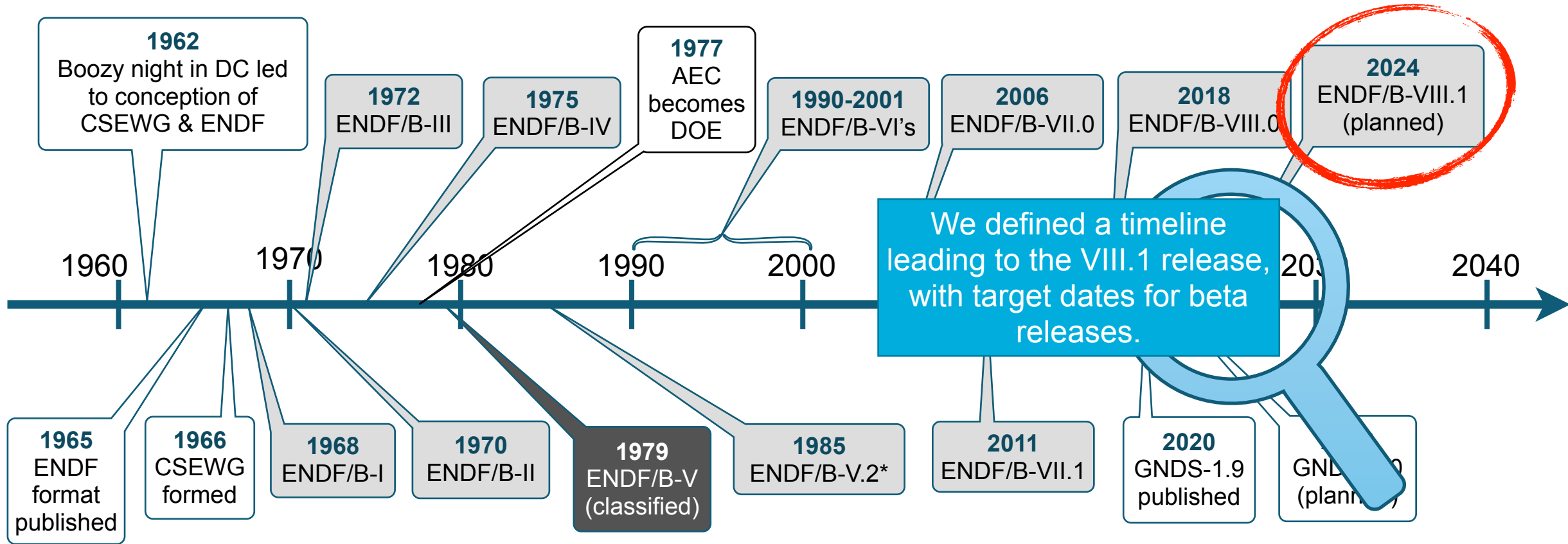
* everybody's favorite release

ENDF Timeline



* everybody's favorite release

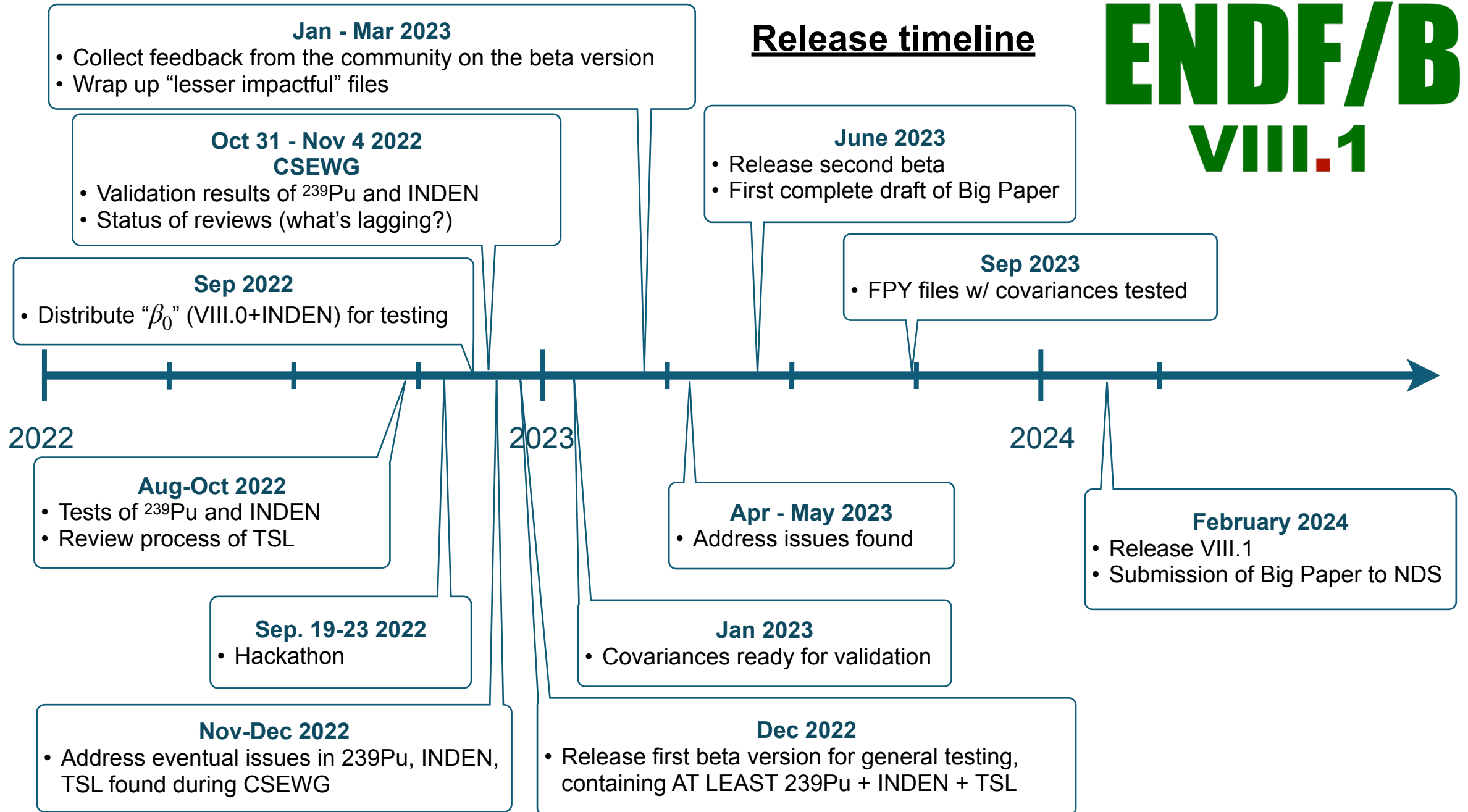
ENDF Timeline



* everybody's favorite release

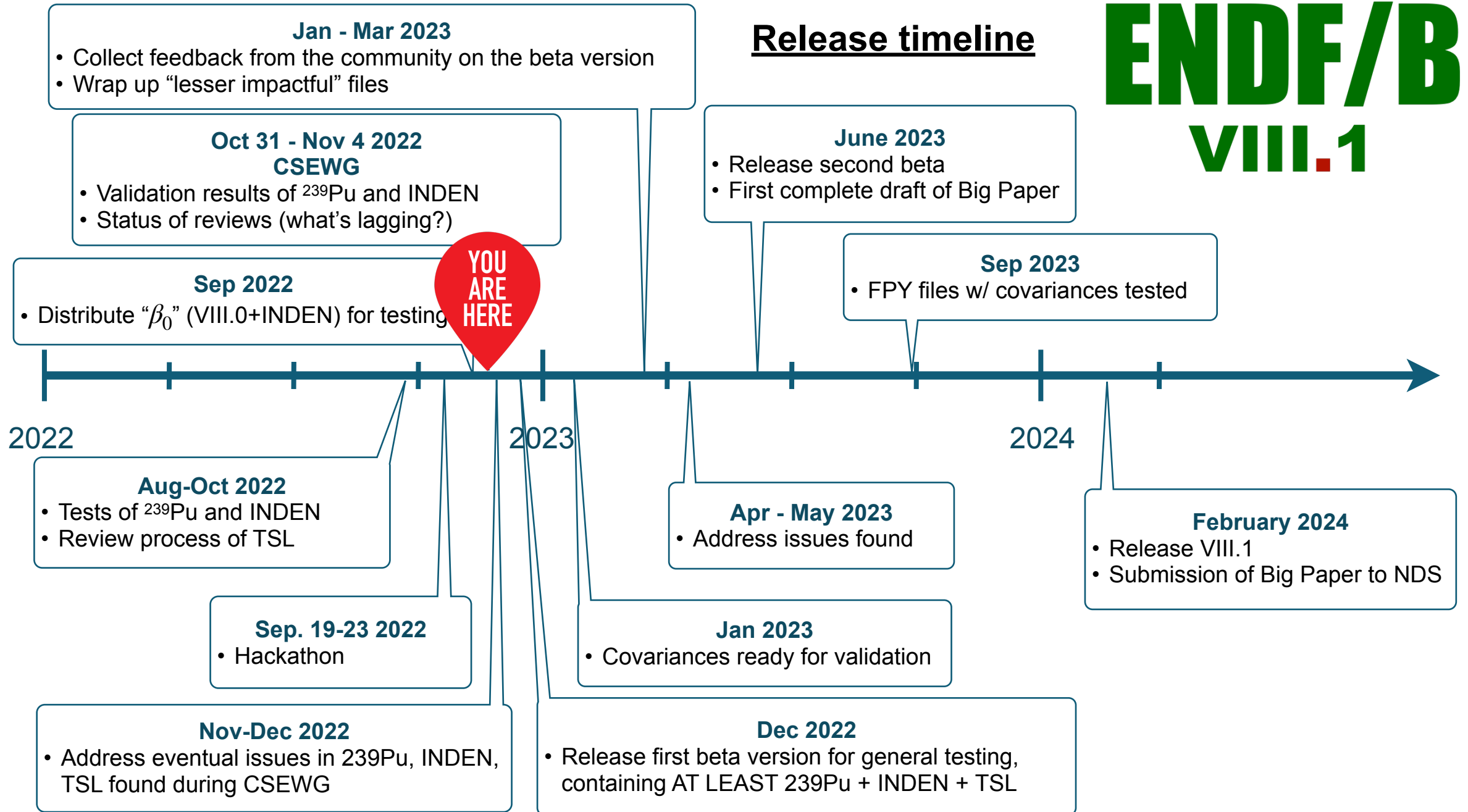
ENDF/B VIII.1

Release timeline



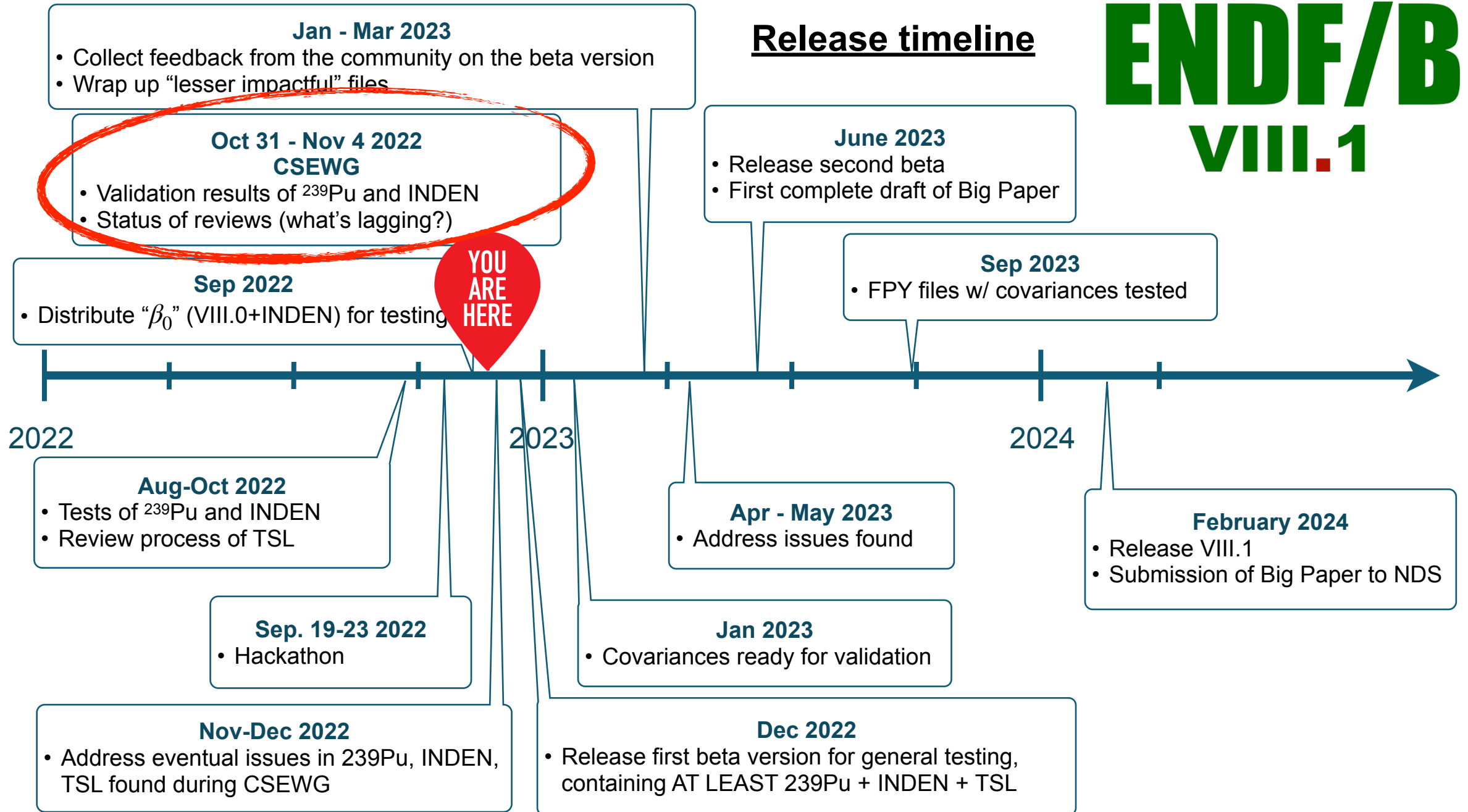
ENDF/B VIII.1

Release timeline



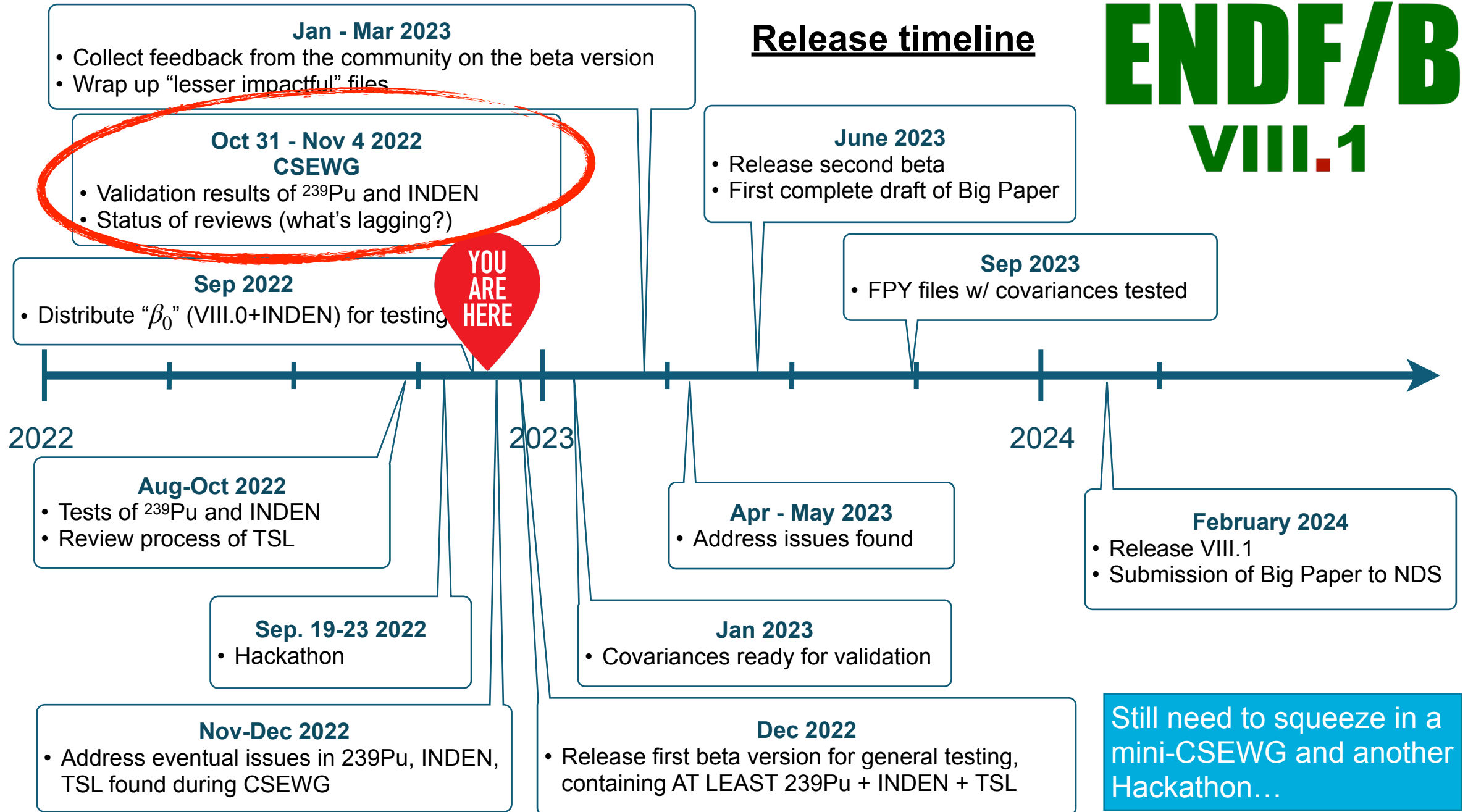
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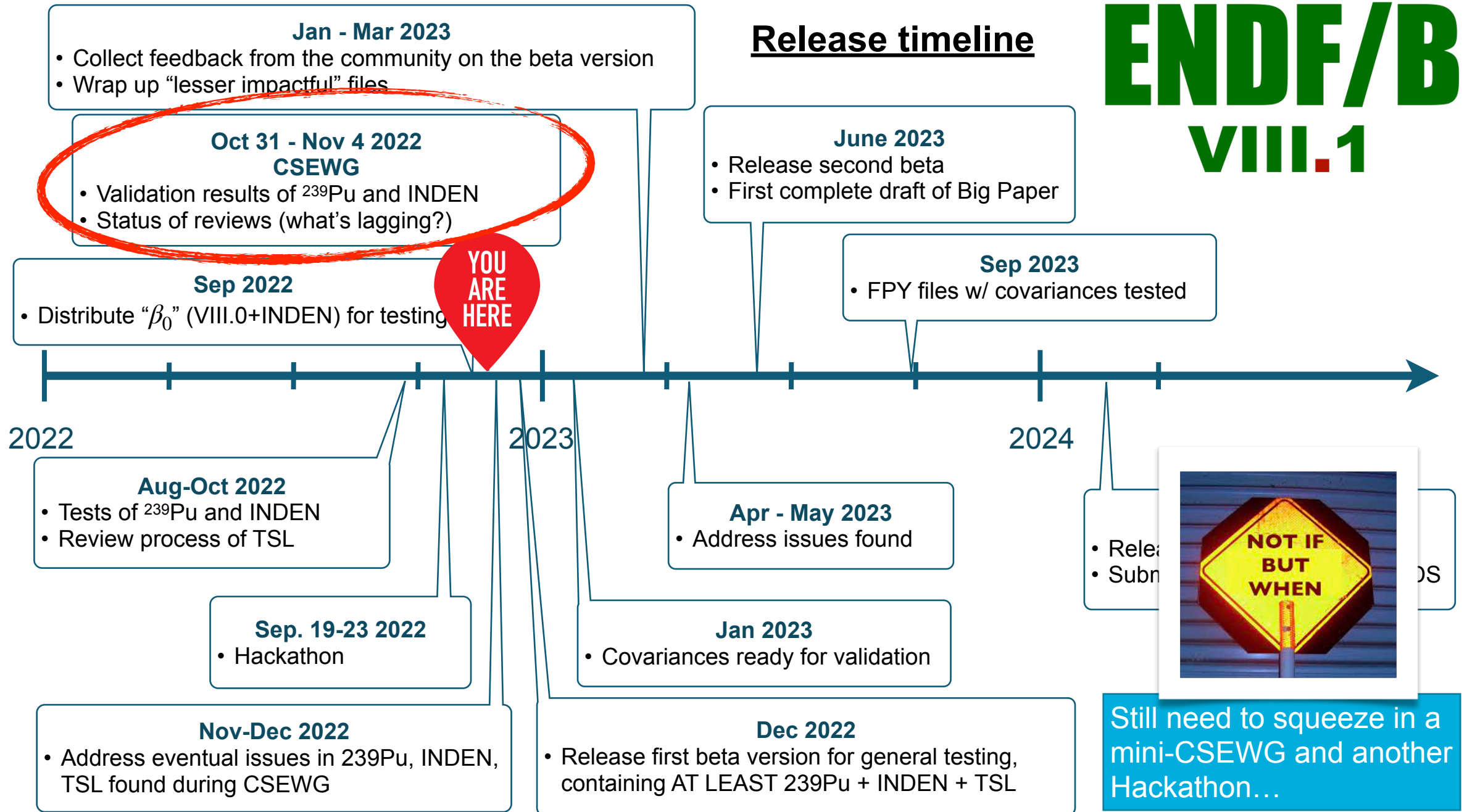
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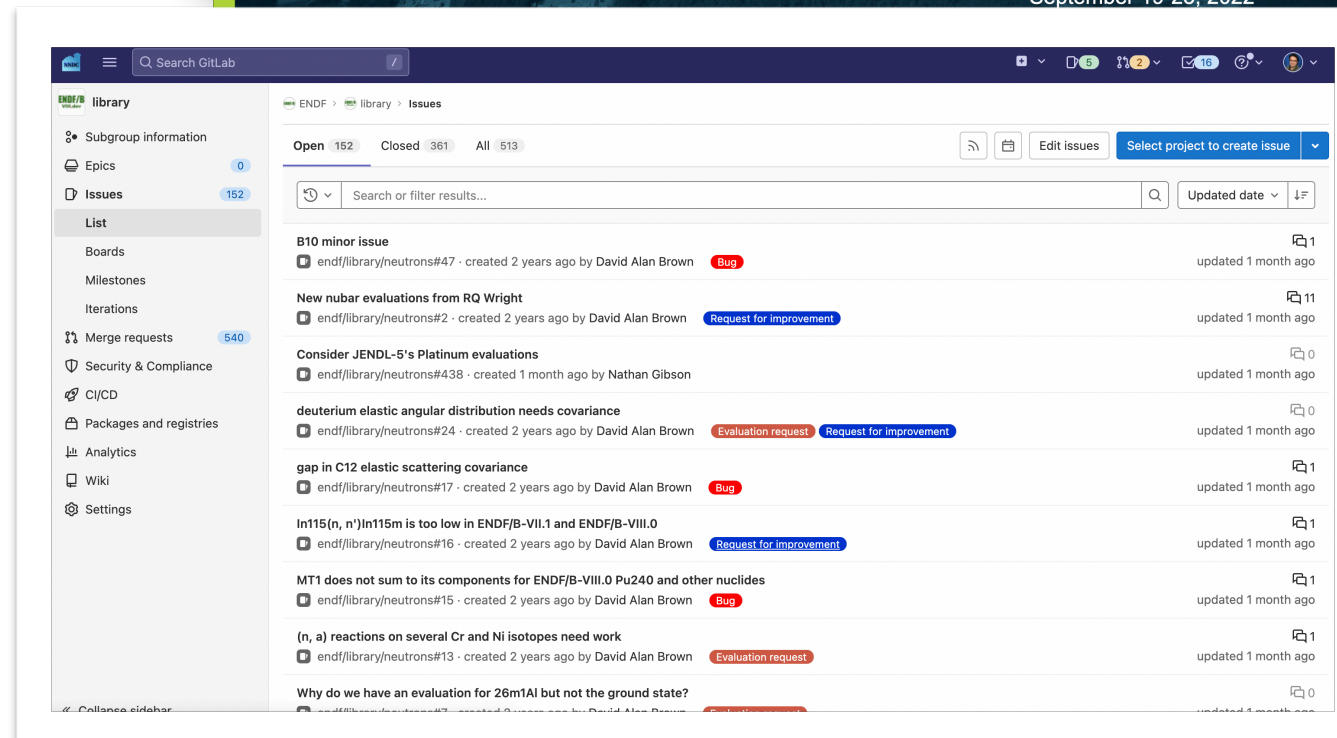
ENDF/B VIII.1

Release timeline



2022 Hackathon

- Held on September 19-23, 2022 at BNL
- About 10 participants in person and ~5 remote
- Tracked issues resolved:
 - 22 issues for neutrons
 - 7 in decay
- More issues were found and logged
 - ~55 issues updated/opened
- Exit distributions: see Ian/Hye Young's CSEWG talk
- We will plan one for 2023
 - After Beta1, before Beta2
 - Before mini-CSEWG?



ENDF/B-VIII.1 Beta0 ^(Plural!) released

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 ²³⁹Pu 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:

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

Small fixes in Beta0.1:

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

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

- ¹⁹F
- 28,29,30Si
- 50,52,53,54Cr
- 54,⁵⁶,57Fe
- 63,65Cu
- 233,235,238U
- ²³⁹Pu
 - 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:*

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

Review status - neutron sub library

Actinides

- ^{239}Pu
 - 5 initial candidate files (INDEN, LANL, LLNL)
 - Updates to fission, nubar, PFNS, capture, URR, RRR, (n,2n)
 - Pilot effort led by M. Chadwick organized a review panel with many Subject Matter Experts (SBM) that went over all aspects of all files, providing reports
 - On-going collaborative process
 - Converged to 3 improved files, then 2
 - Multiple evaluations are converging
 - CSEWG Executive Committee should decide the best course of action towards Beta1
 - Recommended evaluation in Beta1 should be better than when process started
- $^{235,238}\text{U}$: waiting for reviewer assignment and/or report
- ^{233}U : new INDEN file is expected soon

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The CSEWG Executive Committee convened last week and decided that the Beta1 file for ^{239}Pu should be a combined one built from Beta0a.2 and Beta0b.2, leveraging the strengths of each of them

Main updates for VIII.1 - neutron sub library

INDEN

- ^{235}U
- ^{239}Pu
- ^{238}U
- ^{233}U
- $^{54,56,57}\text{Fe}$
- $^{28,29,30}\text{Si}$
- ^{55}Mn
- $^{50,52,53,54}\text{Cr}$
- $^{63,65}\text{Cu}$
- ^{18}O - ^{16}O not ready for submission
- ^{10}B
- ^{11}B - not ready for submission
- ^{139}La



= Submitted



= Under review



= Not submitted yet



= Approved

Non-INDEN

- $^{140,142}\text{Ce}$ (ORNL)
- ^{103}Rh (RPI/IRSN)
- ^{86}Kr (BNL)
- ^6Li (LANL)
- $^{106,108,110,111,112,114,116}\text{Cd}$ (LANL)
- ^6Li , $^{234,236}\text{U}$ (LANL)
- ^{181}Ta (RPI/ORNL/LANL)
- Fission products (RQW+BNL): ^{78}Se , ^{84}Kr , ^{85}Rb , ^{97}Mo , ^{99}Tc , ^{102}Pd , ^{109}Ag , $^{113,115}\text{In}$, $^{115,119}\text{Sn}$, ^{127}I , $^{122,124}\text{Te}$, $^{133,134}\text{Cs}$, $^{130,134,137}\text{Ba}$, ^{138}La , ^{143}Pr , ^{147}Pm , $^{148,150}\text{Nd}$, ^{153}Sm , ^{155}Eu , ^{160}Gd , ^{159}Tb , $^{166,168,170}\text{Er}$, $^{175,176}\text{Lu}$, $^{168,176}\text{Yb}$, $^{174,176,177,178,179,180}\text{Hf}$
- Other small fixes

Main updates for VIII.1 - TSL sublibrary

- tsl_20pGraphite, tsl-AlinAl₂O₃, tsl-Be-metal, tsl-Be-metal+Sd, tsl-BeinFLiBe.endf, tsl-CainCaH₂.endf, tsl-CinSiC, tsl-CinUC, tsl-FinFLiBe, tsl-graphiteSd, tsl-H1inCaH₂, tsl-H2inCaH₂, tsl-HinCH₂, tsl-HinHF, tsl-LiinFLiBe, tsl-OinAl₂O₃, tsl-SiinSiC, tsl-UinUC (NCSU)
- tsl-7Liin7LiD-mixed, tsl-BeinBe₂C, tsl-CinBe₂C, tsl-Din7LiD-mixed, tsl-Hin7LiH-mixed, tsl-HinZrH₂, tsl-HinZrH_x, tsl-ZrinZrH₂, tsl-ZrinZrH_x (NNL)
- tsl-CainCaH₂, tsl-HinCaH₂ (from JEFF, conflict with NCSU), tsl-HinIcelh (JEFF, conflict with RPI), tsl-HinMesitylene-Phasell, tsl-HinToluene, tsl-Mg, tsl-Si (JEFF non-conflictive)
- tsl-CinC₅O₂H₈, tsl-CinCH₂, tsl-HinC₅O₂H₈, tsl-HinCH₂, tsl-HinIcelh, tsl-OinC₅O₂H₈, tsl-OinIcelh (RPI)
- tsl-CinCH₂, tsl-HinCH₂, tsl-HinH₂O (ESS)
- tsl-HinUH₃, tsl-NinUN, tsl-UinUN (ANL)

Main updates for VIII.1 - TSL sublibrary

- tsl_20pGraphite, tsl-AlinAl2O3, tsl-Be-metal, tsl-Be-metal+Sd, tsl-BeinFLiBe.endf, tsl-CainCaH2.endf, tsl-CinSiC, FinFLiBe, tsl-graphiteSd, tsl-H2inCaH2, tsl-HinCH2, tsl-LiinFLiBe, tsl-OinAl2O3, tsl- (NCSU)
- On track to double the TSL evaluations in ENDF/B!
- Implemented format changes to accommodate the increased number of materials.
- Review process being set-up, coordinated by TSL eval. chair
- tsl-CainCaH2, tsl-HinCaH2 (from JEFF, conflict with NCSU), tsl-HinIcelh (JEFF, tsl-HinMesitylene-Phasell, Mg, tsl-Si (JEFF non- -CinCH2, tsl-HinC5O2H8, Icelh, tsl-OinC5O2H8, tsl-
- tsl-7Liin7LiD-mixed, tsl-BeinCinBe2C, tsl-Din7LiD-mixed, mixed, tsl-HinZrH2, tsl-HinZrHx, tsl-ZrinZrH2, tsl-ZrinZrHx (NNL)
- tsl-CinCH2, tsl-HinCH2, tsl-HinH2O (ESS)
- tsl-HinUH3, tsl-NinUN, tsl-UinUN (ANL)

Leveraging the experience with NCSU internal review approach

TSL (MF=7) Review Checklist

Evaluator:

Material:	MAT:	MT=2 (U/C/M)
CHECKLIST	TSL REVIEW (initial/date)	
Verify Header	Reviewer:	Date:
Verify Cross Section and Mass Inputs	Reviewer:	Date:
Verify Elastic Input File (MT=2) <ul style="list-style-type: none">• Normalization, Basis Vector/Positions, Bound Cross Sections (ENDF/NIST)	Reviewer:	Date:
Verify Inelastic Input File (MT=4) <ul style="list-style-type: none">• (α,β) Grid/Temperature List• Phonon DOS, Free Atom Cross Section (ENDF), A Ratio, Header	Reviewer:	Date:
Generate/Verify TSL <ul style="list-style-type: none">• Inelastic and Elastic Cross Section Behaviors (Energy/Temperature)• TSL File Format	Reviewer:	Date:
Benchmark TSL <ul style="list-style-type: none">• Optional at reviewer's discretion	Reviewer:	Date:
Material Evaluation Review Complete		
Reviewer:	Date:	

TSL (MF=7) Review Checklist

Overview:

To review TSL libraries submitted for inclusion to the ENDF/B libraries, an approach has been developed to test both the generated TSL and associated cross section data. This document describes the responsibilities and duties of the independent reviewer in completing the "TSL Review Checklist".

Checklist Guide:

Each section of the "TSL Review Checklist" contains check boxes for the reviewer. The evaluator should provide the following files to NNDC for the review process:

- MAT input – the input file for each element in the material named as elementincompound_input (e.g. HinCH2_input, graphite_input)
- TSL file (File 7) – the TSL for each element in compound named as tsl- elementincompound.endf (e.g. tsl-BeinBeO.endf, tsl-OinBeO.endf)
- MAT_readme – the README file describing the generation of the TSL to allow reviewer checks to verify the generation of data

The requirements for each section are described below. When applicable separate instructions may be given for solids and liquids.

1. Verify Header

- The header file should use the standard TSL format and include:
 - Complete list of all evaluated temperatures
 - MAT number
 - Last name of all evaluators
 - Date of the evaluation
- History and theory sections recommended inclusions:
 - Evaluating institution
 - Codes used to generate the TSL
 - Composition of element in evaluation
 - Range of applicability of TSL evaluation if limited by phase transitions or other material properties
- References
 - Any publications concerning the fundamental input to the TSL (e.g. phonon DOS)
 - Models used to generate the TSL
 - Codes used to evaluate the data

2. Verify Cross Section and Mass Inputs:

- Mass and free atom cross sections inputs to the TSL evaluation should be verified to originate from a reputable source (e.g. ENDF library, NIST).

When contacted about the review panel, Ayman Hawari stated:

"Yes we're discussing a TSL review panel but haven't finalized membership yet. However, the panel will aim to avoid any COI situations and will be inclusive."

If you have suggestions or questions please feel free to let me know."

Main updates for VIII.1 - Alphas, deuterons & Decay

Alpha sub library

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

Deuteron sub library

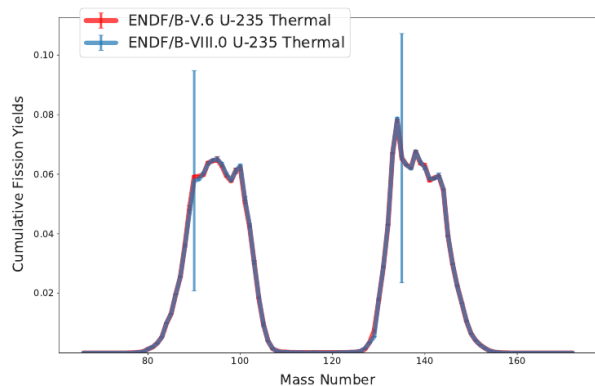
- ^3He , ^6Li
- Files have just been submitted last week by M. Paris

Decay sub library

- 520 submissions: updated half-lives and neutrino spectra
- 30 reviewed and approved already and 22 more are underway
- Andrea Mattera and Paul Romano have reviewed and found many typos and issues in documentation
- Decay files are in the process of being updated, so review has stalled while this is completed.

Fission Yields and Photo-nuclear 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
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- nfy-095_Am_243.endf
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- 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

Photo-nuclear

Taken from IAEA CRP

Nuclear Data Sheets 163 (2020) 109-162



Available online at www.sciencedirect.com

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Nuclear Data Sheets 163 (2020) 109–162

Nuclear Data Sheets

www.elsevier.com/locate/nds

IAEA Photonuclear Data Library 2019

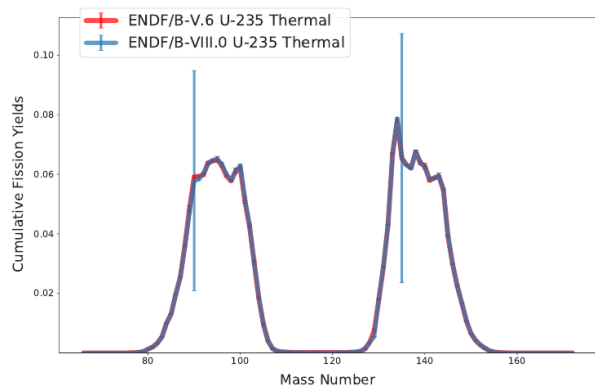
- T. Kawano,^{1,*} Y. S. Cho,² P. Dimitriou,³ D. Filipescu,⁴ N. Iwamoto,⁵ V. Plujko,⁶ X. Tao,⁷ H. Utsunomiya,⁸ V. Varlamov,⁹ R. Xu,⁷ R. Capote,³ I. Gheorghe,⁴ O. Gorbachenko,⁶ Y. L. Jin,⁷ T. Renström,¹⁰ M. Sin,¹¹ K. Stopani,⁹ Y. Tian,⁷ G. M. Tveten,¹⁰ J. M. Wang,⁷ T. Belgva,¹² R. Firestone,¹³ S. Goriely,¹⁴ J. Kopecky,¹⁵ M. Krčička,¹⁶ R. Schwengner,¹⁷ S. Siem,¹⁰ and M. Wiedeking¹⁸
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(Received 16 July 2019; revised received 15 October 2019; accepted 31 October 2019)

We report our coordinated efforts to address these data needs and present the results of the new up-to-date evaluations included in the new updated IAEA Photonuclear Data Library consisting of **219 nuclides**. The new library includes **188 new evaluations** produced by the CRP evaluators, and one evaluation taken from the JENDL/PD-2016 library, while 20 evaluations were retained from the previous 1999 IAEA Photonuclear Data Library. In most of the cases, the photon energy goes up to 200 MeV. A total of 55 nuclides are new in this library reflecting the progress in measurements but also the developing data needs. In this paper we discuss the new assessment method and make recommendations to the user community in cases where the experimental data are discrepant

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- 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
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Photo-nuclear

Taken from IAEA CRP

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IAEA Photonuclear Data Library 2019

Original plan was to simply adopt IAEA CRP, but M. Chadwick brought up that there may be US contributions. We will review on a case-by-case basis the adoption of the IAEA CRP.

Also, 3 more contributions arrived last week from LANL.

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¹⁸ Themba LABS, P.O. Box 722, Somerset West, 7129, South Africa

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No significant updates expected from...

- Atomic relaxation
- Electrons
- Gammas
- ~~Helium-3~~
- Photo-atomic
- Protons
- Tritons
- Standards

New evaluations
from LLNL!

