

ENDF/B-VIII: What has changed so far?

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presented by M. Herman*



So, what has changed and what hasn't?

- CIELO evaluations
- TSL evaluations
- Many other ENDF evaluations
- V&V, QA
- New format

} This is what gets us the amazing performance

So, what has changed and what hasn't?

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} But many other applications need these

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This is how we insure good performance

So, what has changed and what hasn't?

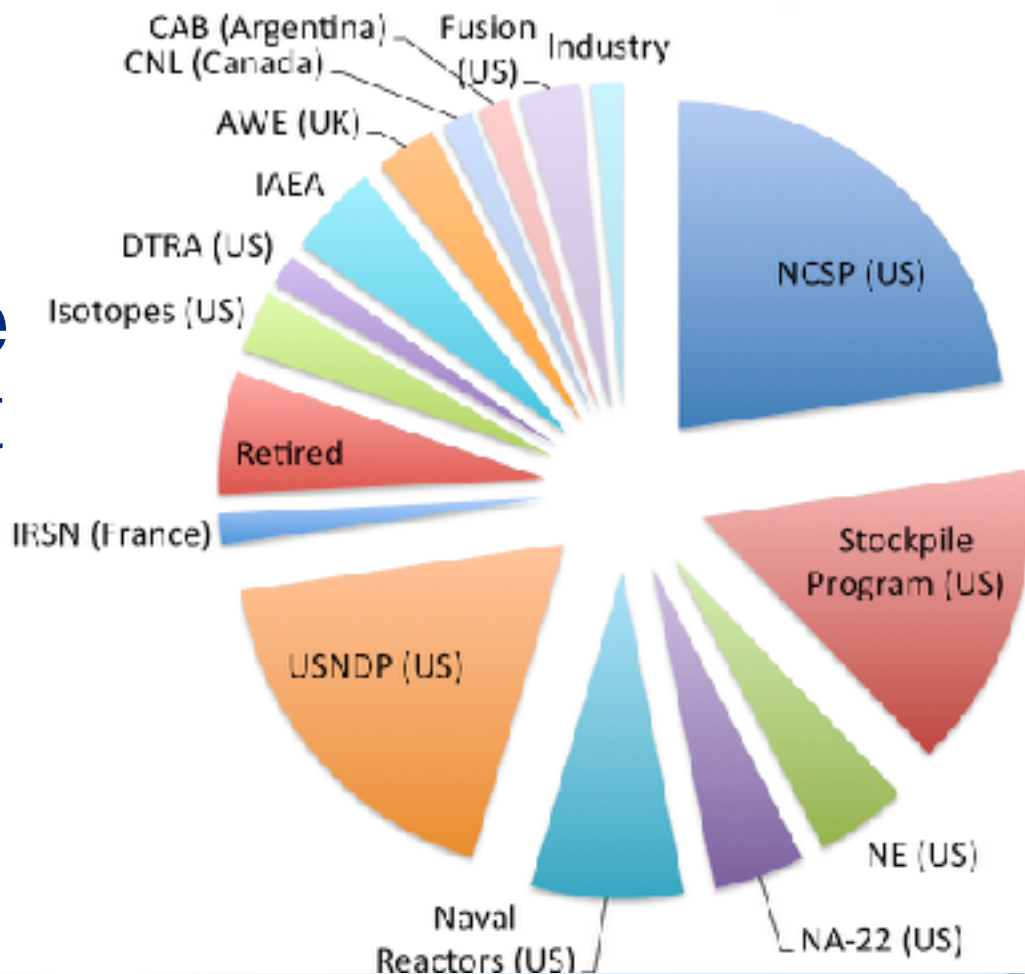
- CIELO evaluations
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- Many other ENDF evaluations
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- New format



This is how we
prepare for the
future

CSEWG is a long standing collaboration between data users who, incidentally, are also the biggest content providers

Fraction of evaluations provided for ENDF/B-VIII



ENDF/B-VIII highlights

■ CIELO:

- ^{16}O
- ^{56}Fe
- ^{235}U
- ^{238}U
- ^{239}Pu

■ Neutron standards

- ^1H
- ^6Li
- ^{10}B
- ^{197}Au

■ Structural materials:

- $^{12,13}\text{C}$
- ^{40}Ca
- ^{54}Fe , ^{57}Fe , ^{58}Fe
- $^{58-61}\text{Ni}$
- Yb, Dy, Os (JENDL4)
- $^{63,65}\text{Cu}$
- $^{182,183,184,186}\text{W}$
- $^{174,176,178,179,180}\text{Hf}$
- ^{132}Te

■ Other non-CIELO:

- n
- ^7Be
- ^{18}O (RUSFOND)
- $^{35,37}\text{Cl}$
- ^{59}Co
- $^{73,74}\text{As}$
- ^{78}Kr
- ^{124}Xe
- RQ Wright's nubar
- ^{40}Ar
- $^{236\text{m}1}\text{Np}$
- ^{240}Pu
- EGAF gammas
- Bug fixes

Bug fixes

▪ Beta4

- 35,37Cl
- 74As
- 241Am

▪ Beta5 (ENDF/A)

- 48Ti
- 10Be
- 180,181Ta
- 185,187Re

Serious changes

▪ Beta4

- 63,65Cu Covariances
- 240Pu
- Standards
- CIELO

▪ Beta5 ??

- Standards
- CIELO
- 53Cr?

240Pu

■ Resonances

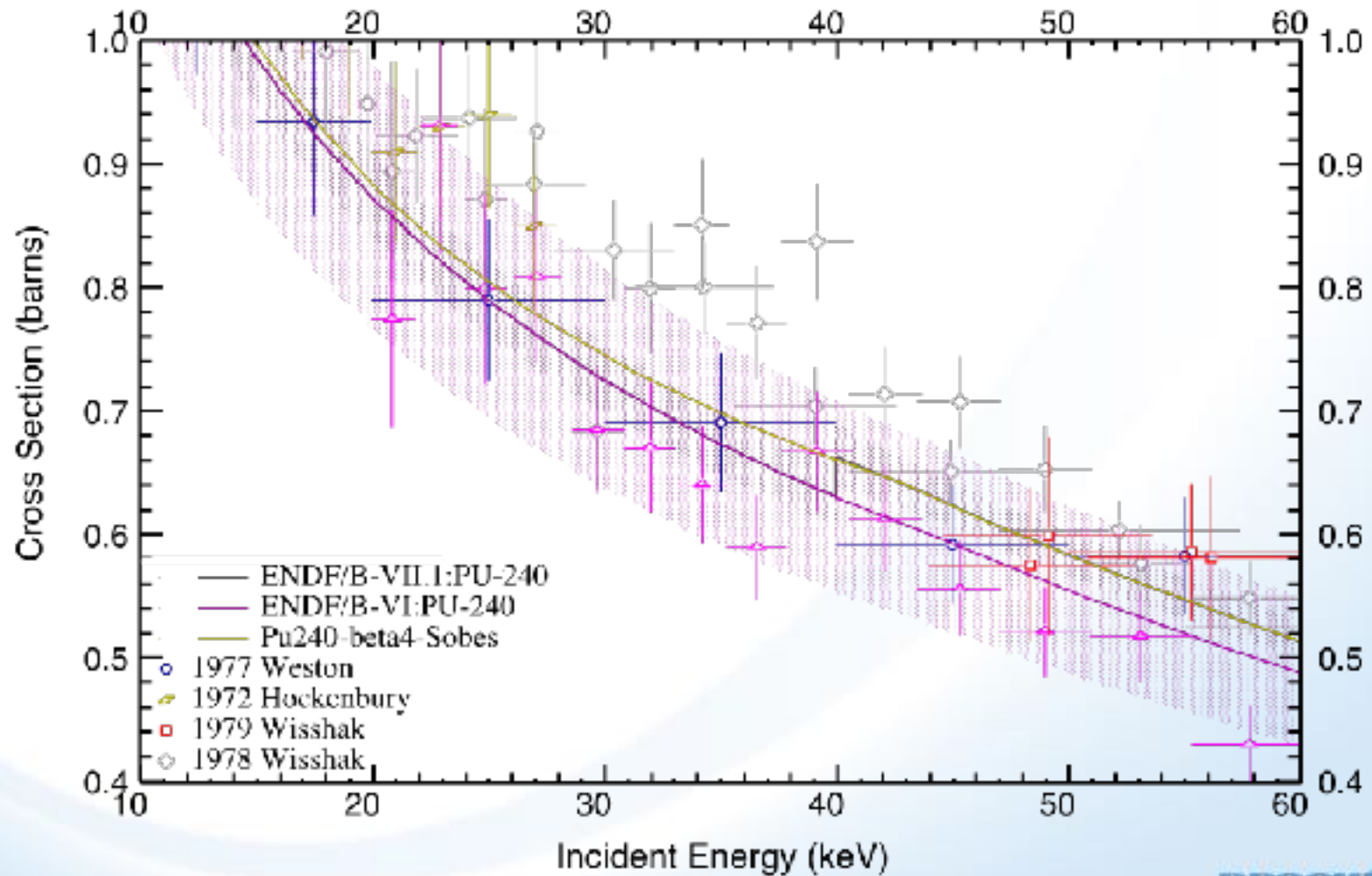
- 2010 ORNL evaluation did not perform well, was rejected, but minor fix to bound level needed, V. Sobes made correction

■ Fast Region

- Fission cross section updated: Replaced by Tovesson 2009 data from 5.7keV to 40 keV (URR), Weston 40keV - 190keV.
- Capture cross section taken from ENDF/B-VII.0 (=ENDF-B/VI.8), with an additional 2% reduction above 42 keV to improve
- Elastic cross section taken from ENDF/B-VII.0 (=ENDF-B/VI.8). IAEA noted problem in URR, ave. capture restored to VI.1

Capture in URR

94-Pu-240(N,G),SIG



Final thermal constants

| Quantity | Atlas | ENDF/B-VIII.0 | ENDF/B-VII.1 |
|--------------------------|---------------------|---------------|--------------|
| σ_{γ} | 289.5 ± 1.4 b | 289.4 b | 287.5 b |
| σ_s | 1.73 ± 0.10 b | 1.73 b | 0.95 b |
| σ_f | 0.056 ± 0.030 b | 0.056 b | 0.064 b |
| σ_B | 18.8 b | 17.96 b | 3.02 |
| Wescott's g -factor | 1.0264 | 1.0259 | 1.0278 |

ENDF/B-VIII highlights, continued

▪ Charged particles:

- p+d, p+⁷Li, p+a, p+¹³C, p+²⁰⁷Pb
- d+⁷Li
- t+a, t+⁷Li
- ³He+a, ³He+³He
- a+a

▪ EPICS2014:

- photoat
- electrons
- atomic_relax

▪ Decay data:

- ^{93,95,96}Rb
- ⁹⁵Sr
- ^{82,83}Ge
- ^{95,98,98m,99}Y
- ^{88,89,90,91}Br
- ⁹⁰Kr
- ^{140,141}Cs
- ¹⁴³Ba
- ^{143,144,145}La
- ¹³⁴Sb
- ¹³⁸I

▪ Thermal Scattering:

- Be(metal)
- UO₂ (x2)
- Regular & reactor graphite
- BeO (x2)
- Polyethylene
- SiO₂ (x2)
- SiC
- Lucite
- UN
- *Water: H₂O & D₂O (x2)*
- Water Ice Ih (x2)
- YH₂ (x2)

Bug fixes

- **Beta4**

- Be(metal)

- **Beta5 (ENDF/A)**

- p+2H
- D2O (D, O)
- H2O (H)

Serious changes

- **Beta4**

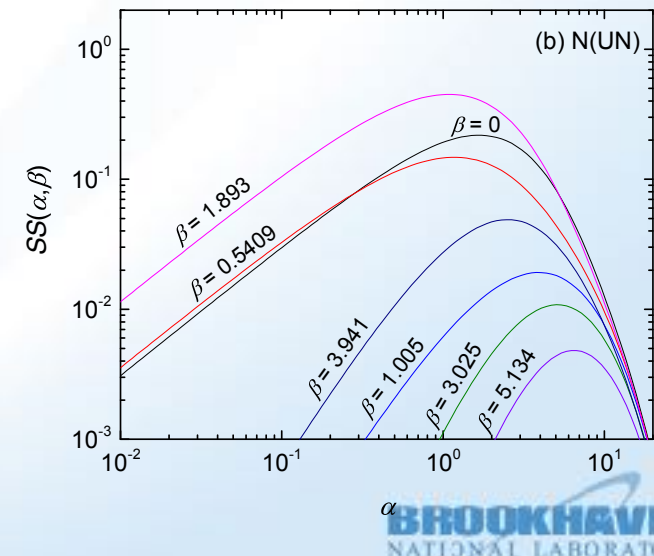
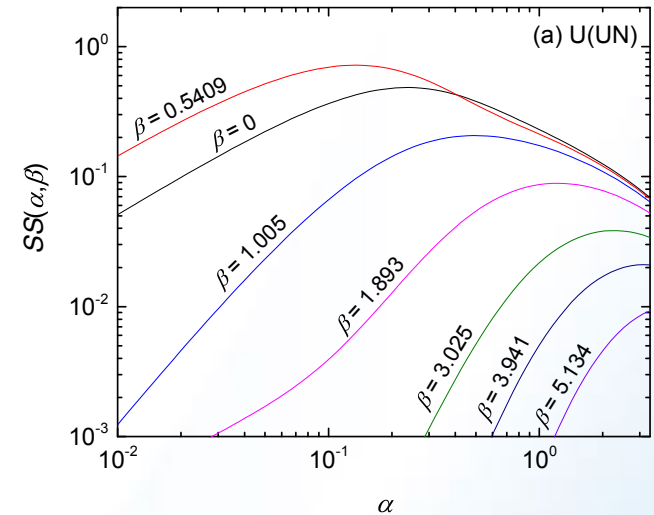
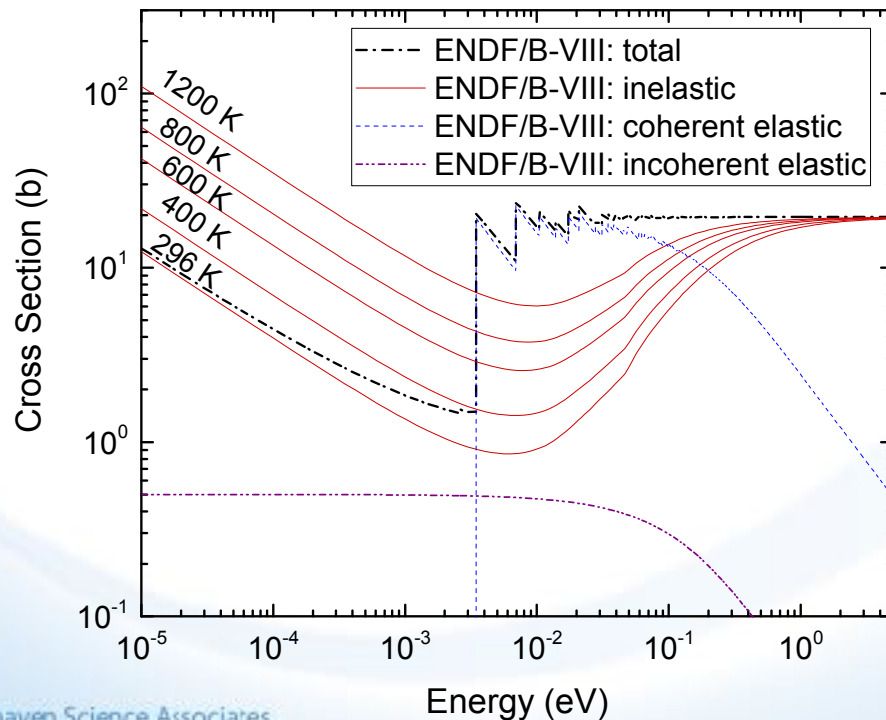
- Light charged particles
- UN

- **Beta5 ??**

- nothing planned

UN: New TSL evaluation from NCSU

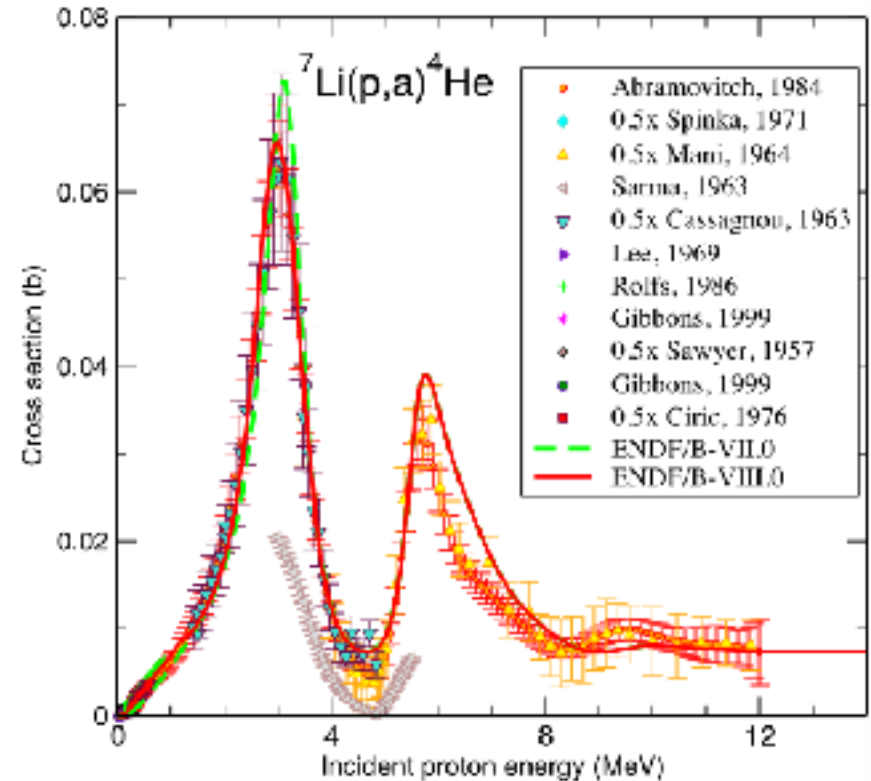
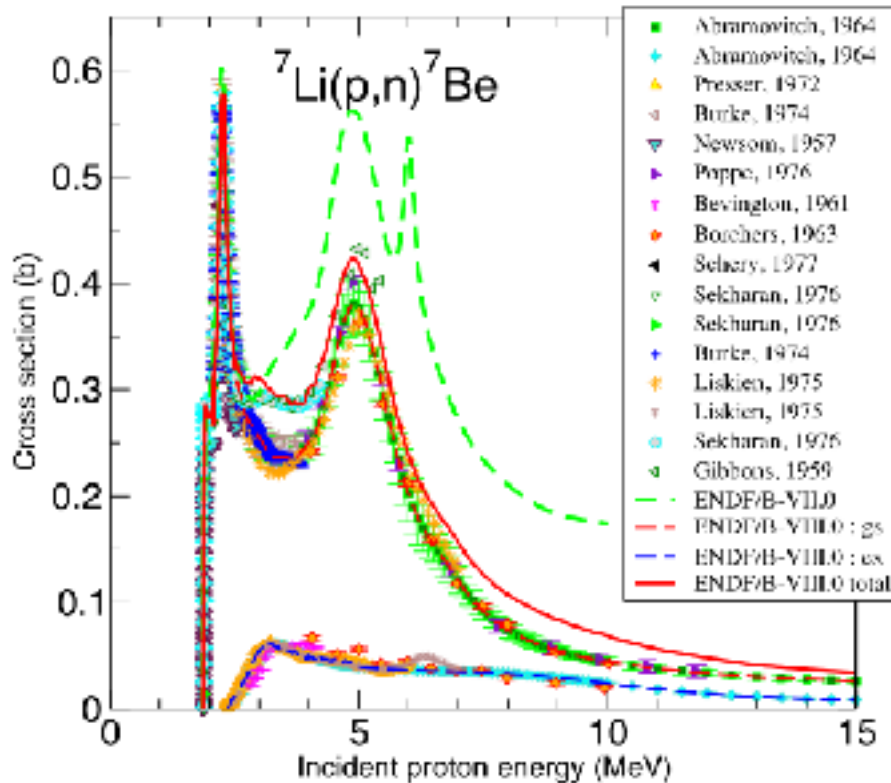
- LEAPR from NJOY99.396
- 7 temps. (296K-120K)
- Inelastic uses Incoherent approx.
- Elastic uses generalized coherent approx. with modified LEAPR



Light charged particle evaluations

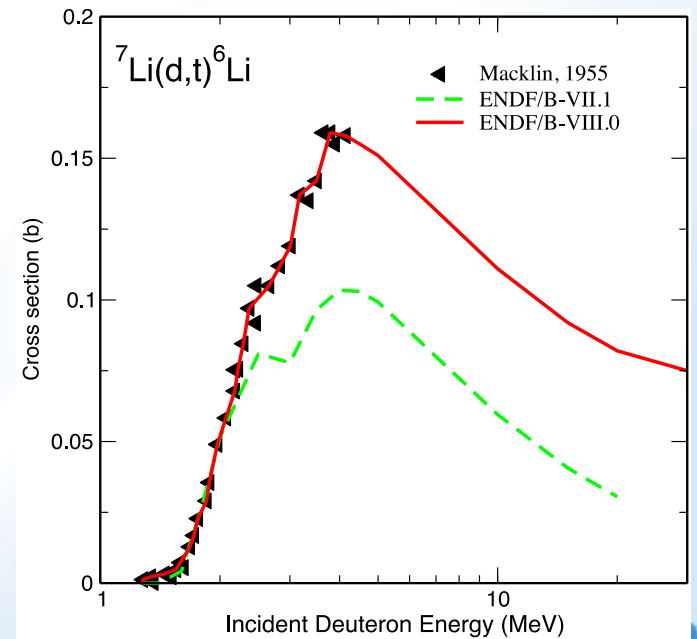
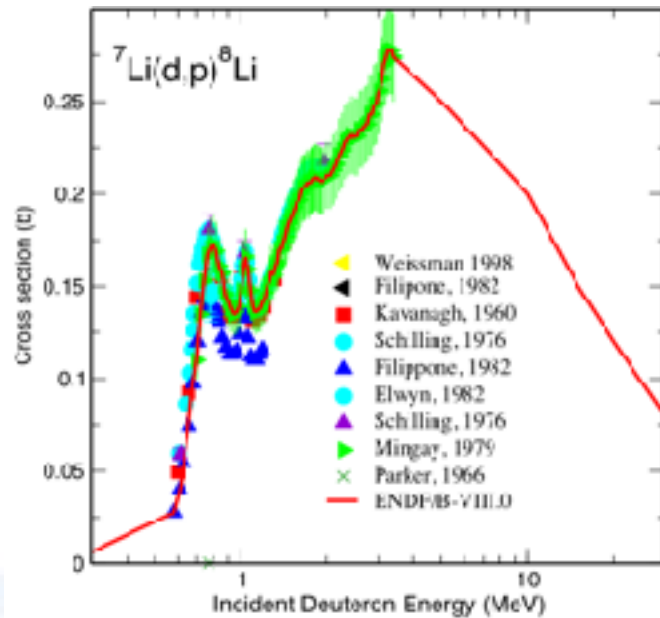
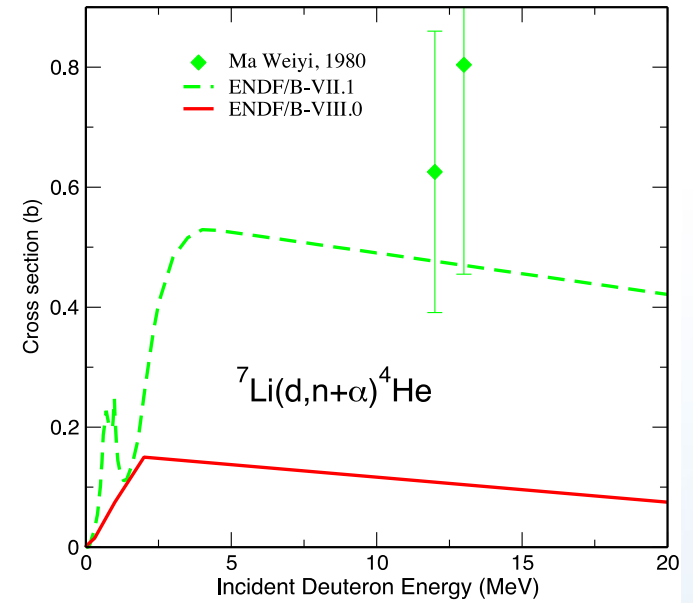
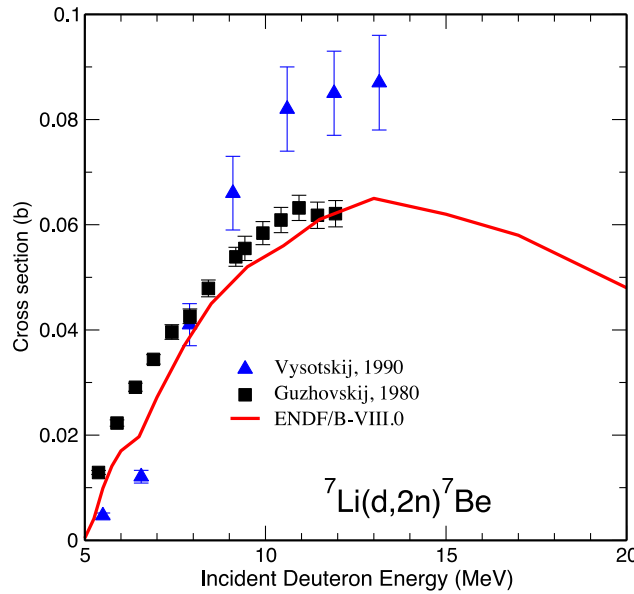
| Target: | p | d | t | h | α | ${}^6\text{Li}$ | ${}^7\text{Li}$ | Projectile: |
|----------------------------|-------|------------|------------|------------|------------|-----------------|-----------------|-------------|
| | Black | Black | Light Blue | Light Blue | Dark Blue | Light Blue | Dark Blue | p |
| | | Light Blue | Light Blue | Light Blue | Light Blue | Light Blue | Dark Blue | d |
| Keep ENDF/B-VII.0 | | | Black | Black | Dark Blue | Light Blue | Dark Blue | t |
| Recommend ECPL in future | | | | Dark Blue | Dark Blue | Black | Light Blue | h |
| Here ECPL to ENDF/B-VIII.0 | | | | | Dark Blue | Light Blue | White | α |

$p+{}^7\text{Li}$

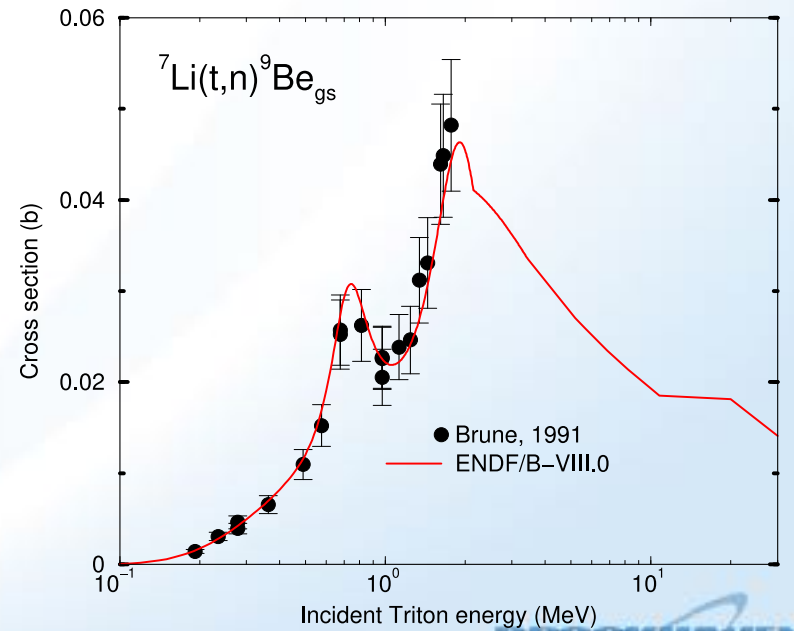
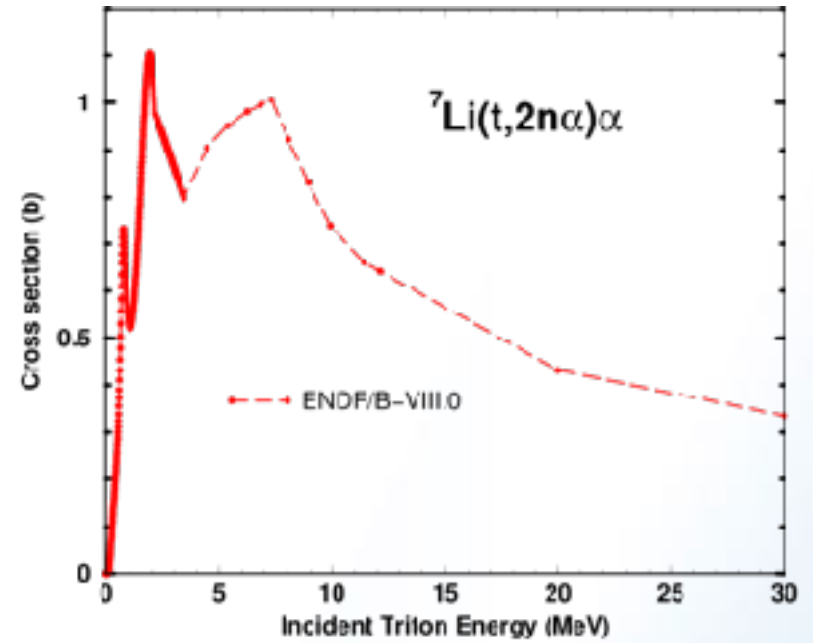
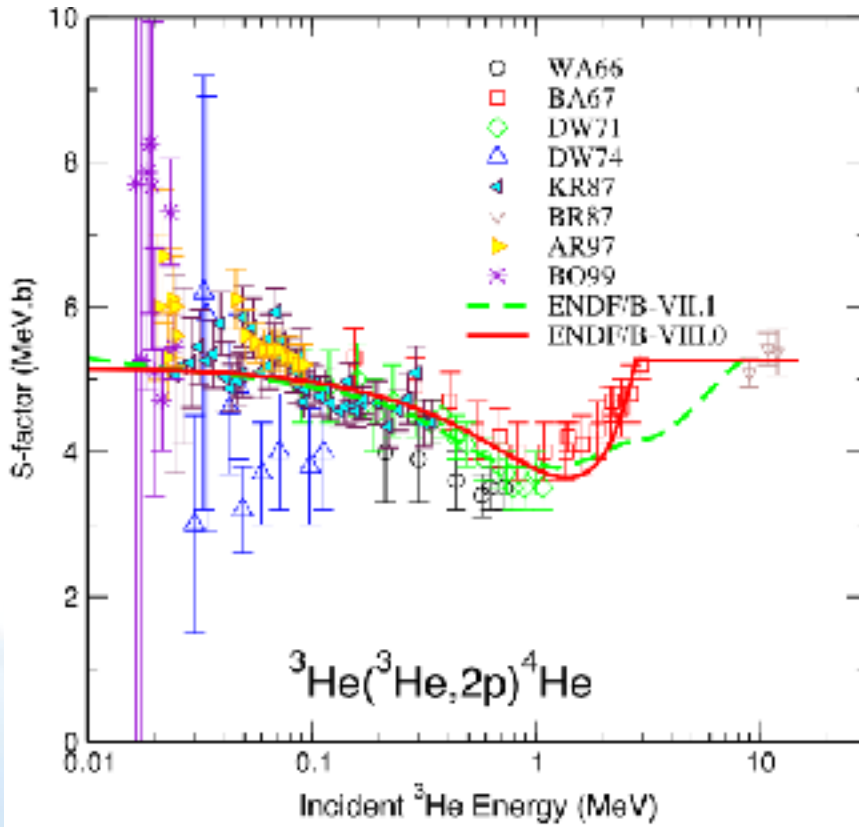


P. Navratil merged ECPL cross sections with fits in literature;
D. Brown added outgoing distributions from ECPL using inverse kinematics when needed

d+⁷Li

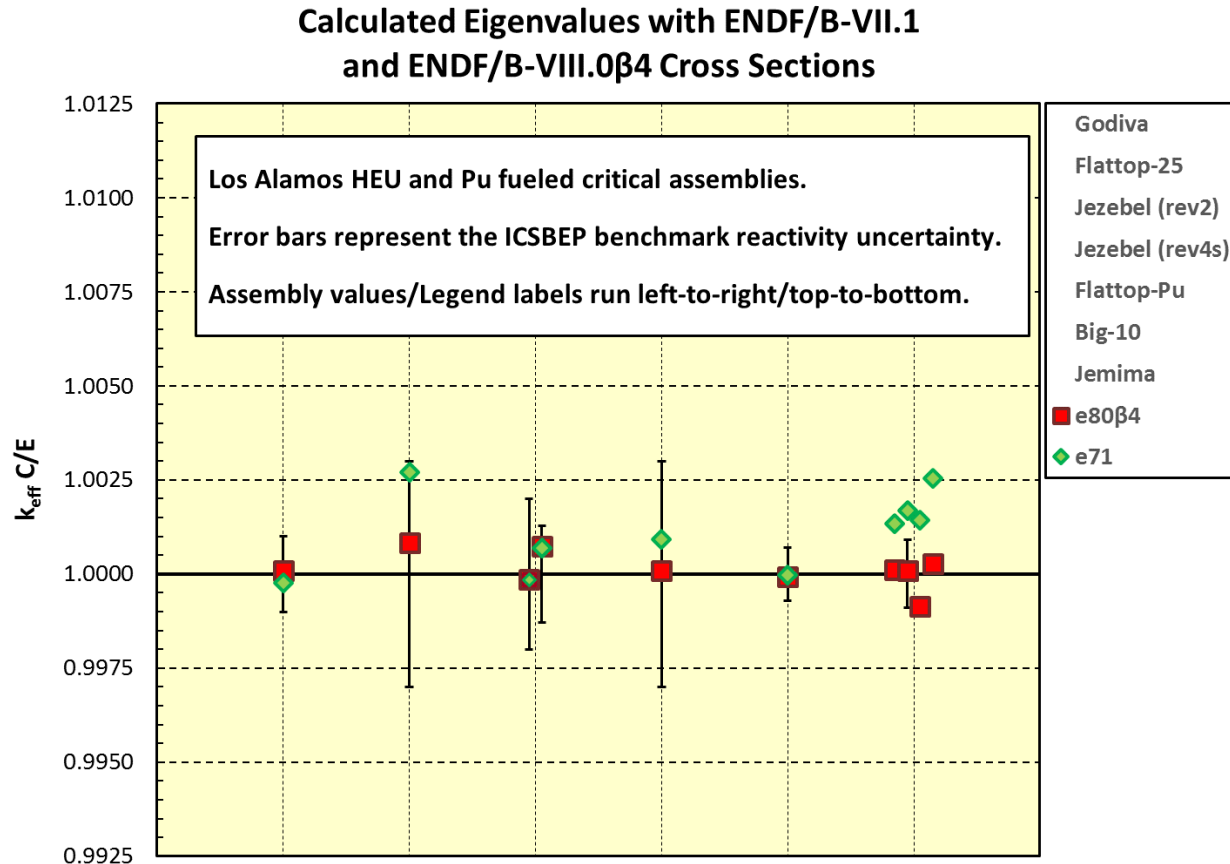


$t+{}^7\text{Li}$ & ${}^3\text{He}+{}^3\text{He}$



Criticality Data Testing – Legacy LANL Assemblies

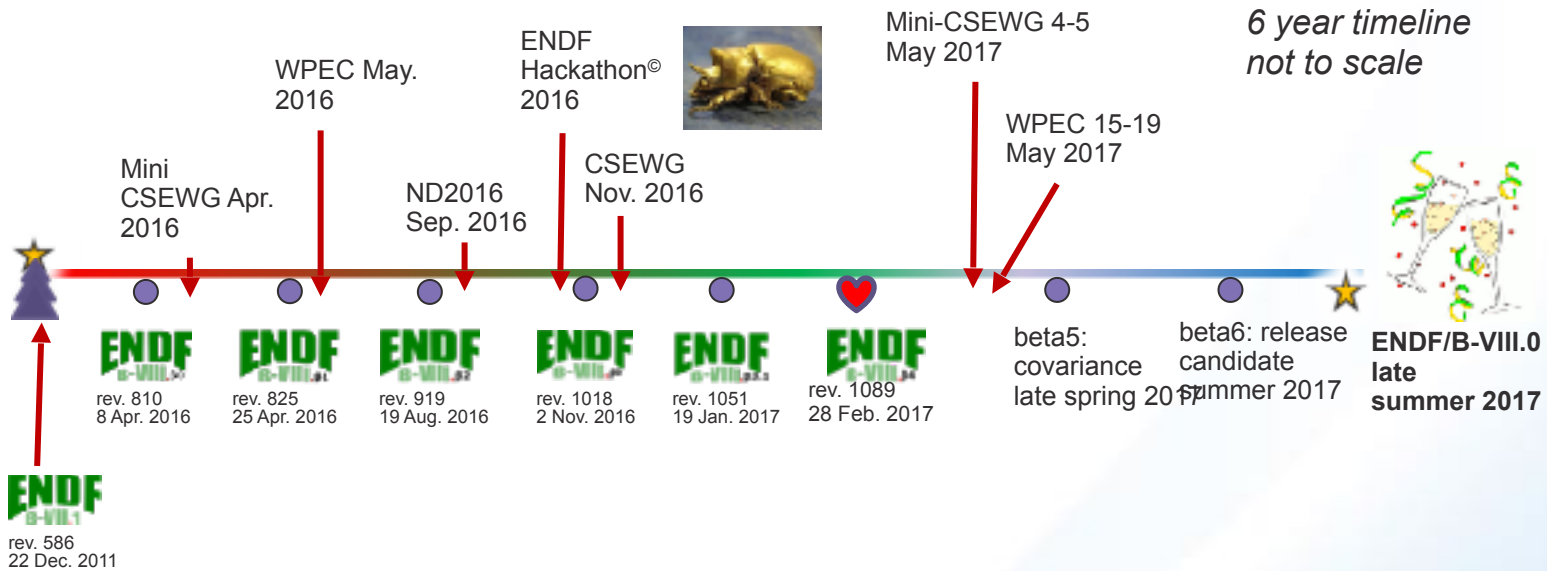
- Previous (e71) good bare assembly results are retained with e80β4 cross sections.
- Reflected assembly results are significantly improved.



Summary

- **With E80 β 4 we have retained the good ENDF/B-VII.1 eigenvalue performance.**
- **The long-standing PST eigenvalue bias has been eliminated.**
- **Benchmarks with significant quantities of iron are calculated more accurately.**
- ***Small trends in calculated eigenvalues over large energy intervals remain (HMF7, PMF suite).***
- ***Reaction rate C/E values at high energy (e.g., $n, 2n$ reactions) remain poor.***

ENDF/B-VIII planned for late FY17



6 year timeline not to scale



ENDF/B-VII.0 contains 393 neutron evaluations; 1644 citations since 2006 (Google Scholar)
 ENDF/B-VII.1 contains 423 neutron evaluations; 945 citations since 2011 (Google Scholar)

Where to find the link to ADVANCE

www.nndc.bnl.gov

Reactions tab

The link

www.nndc.bnl.gov

National Nuclear Data Center

NSR XUNDL ENSDF
NuDat Databases MIRD
CSISRS ENDF

Chart of Nuclides

Empire Atlas of n Resonances
Nuclear Wallet Cards Tools and Publications
Nuclear Data Sheets

Networks
CSEWG USNDP

Mini-CSEWG 2017

INDICO
Integrated Digital Conference

Mini-CSEWG, May 4 - May 6, 2017
at Los Alamos National Lab.

ENDF6-VII beta4 Release
Nuclear Data Sheets Announcement
Nuclear Data Sheets Special Issue

Home Structure & Decay **Reactions** Bibliography Networks & Links Publications Meetings

Experimental data

- EXFOR Experimental nuclear reaction data
- The EXFOR project
- EXFOR Basics Short guide

Codes

- Checking & utility codes
- Reaction codes
- EMPIRE Nuclear Reaction Model Code

Evaluated ENDF data

- ENDF/B-VII.1 Current ENDF release
- ENDF/B-VII.0 In-development ENDF library
- The ENDF project
- Sigma ENDF Retrieval & Plotting
- Current ENDF-6 Format Manual
- In-development ENDF-6 Format Manual
- Introduction to ENDF Formats
- ADVANCE ENDF continuous integration system

Other evaluated data

- Atlas of Neutron Resonance Parameters & thermal values
- Atomic Mass Evaluation
- IRDF International Reactor Dosimetry File
- Monitor Reactions IAEA recommended charged-particle cross sections
- RIPL-3 Reference Input Parameter Library

Tools

- CapGam Thermal neutron capture γ rays
- Gamma Ray Atlas Following Inelastic Scattering of Fast Neutrons Downloadable software platform
- EXFOR/ENDF Plotting
- NucRates MACS and astrophysical reaction rates
- MyENDF Integrated web tool for evaluators
- Q-value Calculator
- USNDP/CSEWG GForge Collaboration server

To find out detailed lists of problems, go to ADVANCE, find your library's release notes

The ADVANCE Continuous Integration System

BROOKHAVEN
NATIONAL LABORATORY



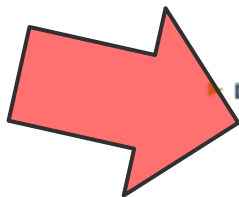
Neutrons Sublibrary

Latest Updates

ENDF/B Development Library

- ▶ **General Information:**
 - ▶ ENDF sublib designator: 10
- ▶ **Revision Number:** 1063:1064M
- ▶ **Last Modified Revision:** 741:1064M
- ▶ **Build Status:**
 - ▶ Build status: [ERROR](#)
 - ▶ Build time: 2017-02-09 19:00:04.290285
- ▶ **Downloads:**
 - ▶ Release Notes: [neutrons-releaseNotes.pdf](#)
 - ▶ Listfile: [neutrons.list](#)
 - ▶ Release Tarball: [neutrons.tar.gz](#)
 - ▶ ACE File Tarball: [neutrons-aceFiles.tar.gz](#)
- ▶ **Forge Links:**
 - ▶ Browse SVN
 - ▶ Browse sublibrary tracker

The link



ADVANCE