Release of the ENDF/B-VII.1 Evaluated Nuclear Data File

David Brown

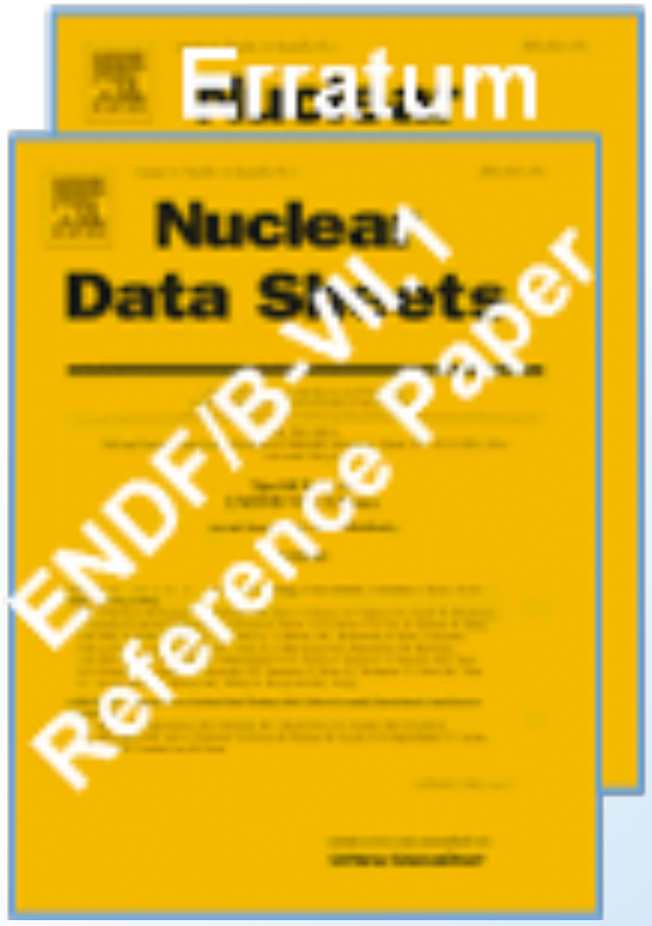
BROOKHAVEN NATIONAL LABORATORY

a passion for discovery

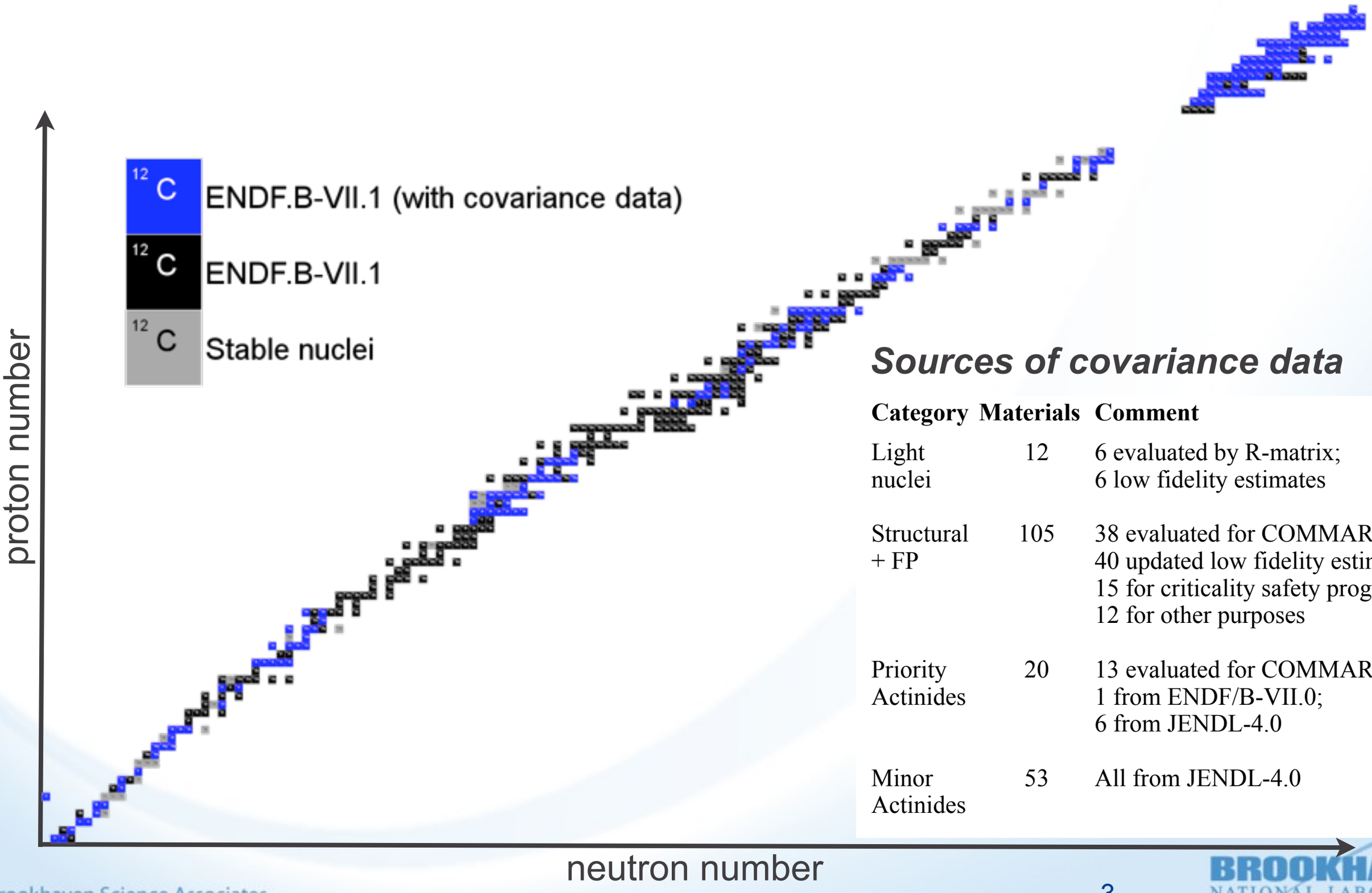
U.S. DEPARTMENT OF ENERGY | Office of Science

ENDF/B-VII.1 was released on Dec. 22, 2011

- ENDF/B is arguably most important nuclear data library for all nuclear applications
- Many more full evaluations in neutron sublibrary than in any other release
  - ENDF/B-VII.0 contains 393 evaluations
  - ENDF/B-VII.1 contains 423 evaluations
- Extensive collection of covariance data (190 evaluations)
- **Library summarized in Dec. 2011 issue of Nuclear Data Sheets**
- **See also http://www.nndc.bnl.gov/endf/b7.1/index.html**



An overview of the library



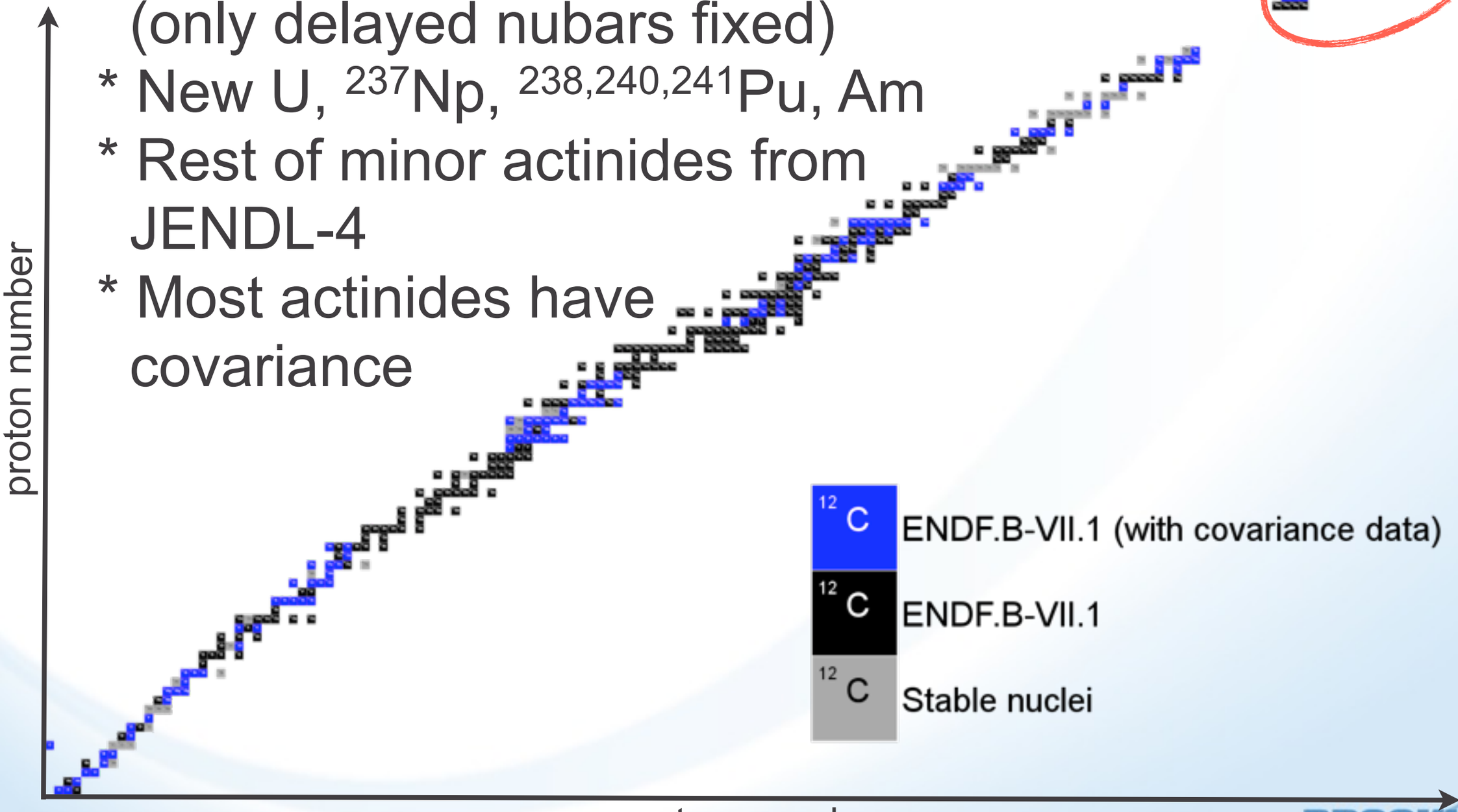
Sources of covariance data

Category	Materials	Comment
Light nuclei	12	6 evaluated by R-matrix; 6 low fidelity estimates
Structural + FP	105	38 evaluated for COMMARA-2.0; 40 updated low fidelity estimates; 15 for criticality safety programs; 12 for other purposes
Priority Actinides	20	13 evaluated for COMMARA-2.0; 1 from ENDF/B-VII.0; 6 from JENDL-4.0
Minor Actinides	53	All from JENDL-4.0

An overview of the library

ENDF B-VII.1

* Major actinides essentially unchanged, (only delayed nubars fixed)
* New U, ^{237}Np, ^{238,240,241}Pu, Am
* Rest of minor actinides from JENDL-4
* Most actinides have covariance



Key fast and thermal benchmarks are unchanged

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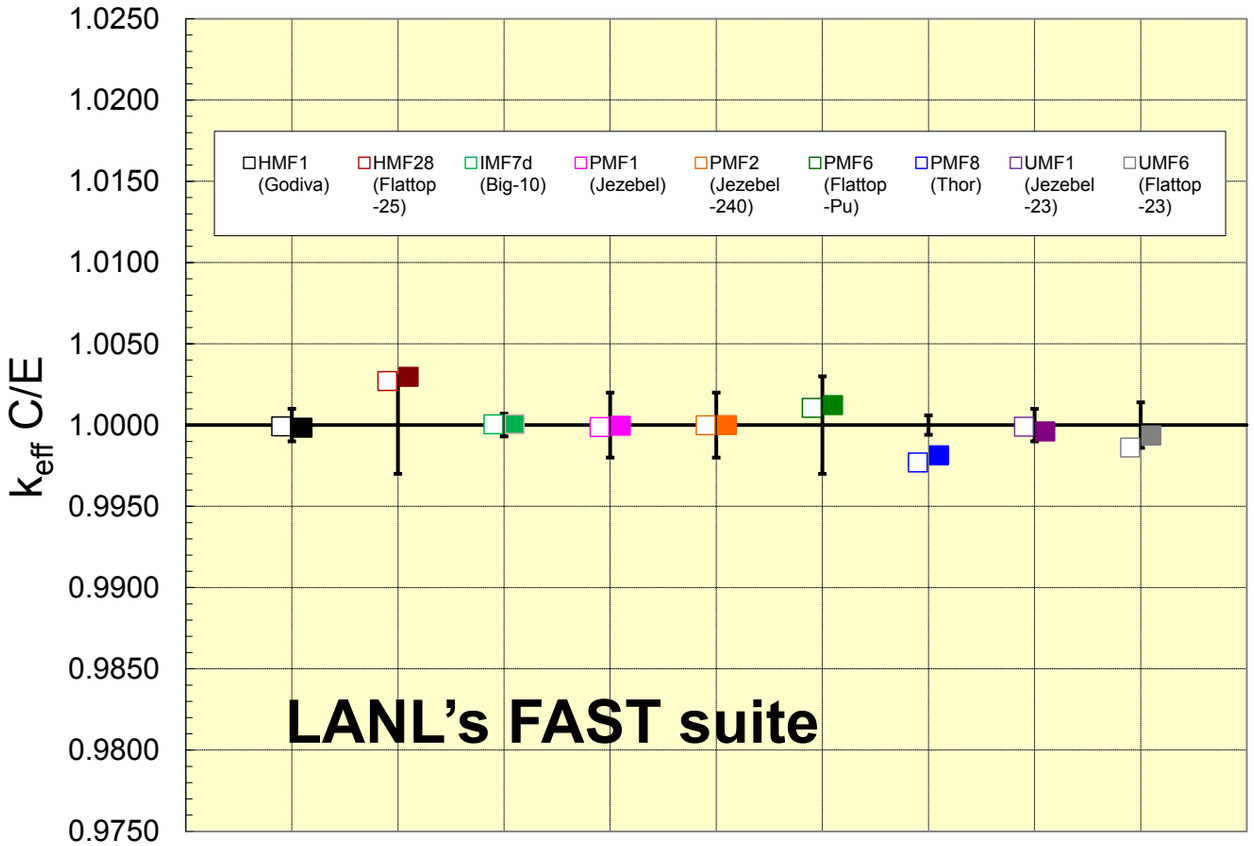

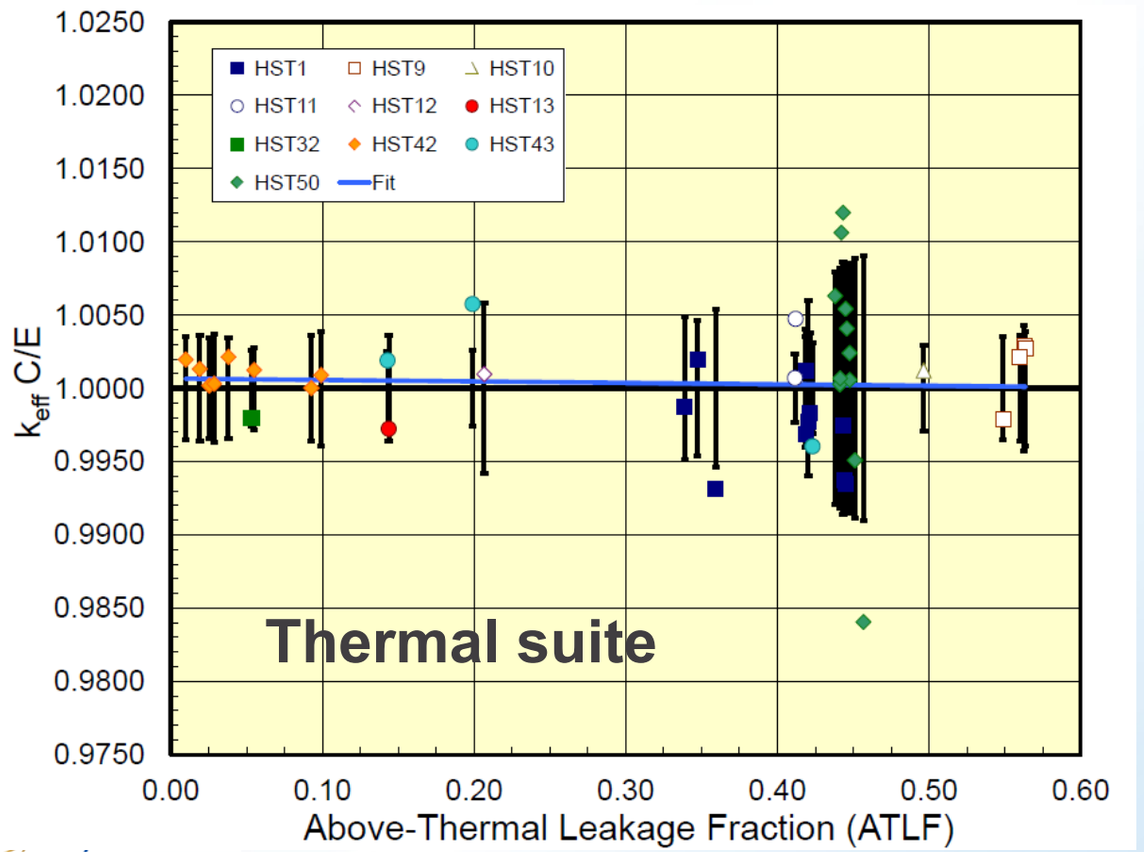

- These tests are taken from the ICSBEP benchmark book
- Data processed with NJOY into ACE format
- Tests run with MCNP by A. Kahler, et al.
- See Skip's talk next for more details...

Only change to ^{239}Pu: addition of prompt fission neutron spectrum covariance

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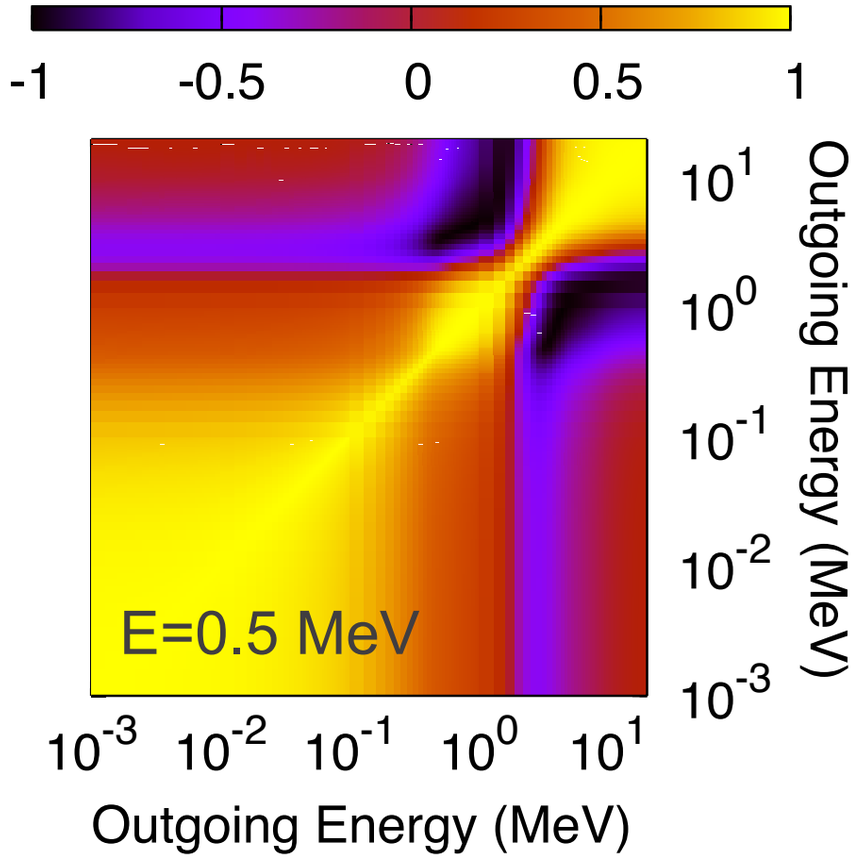
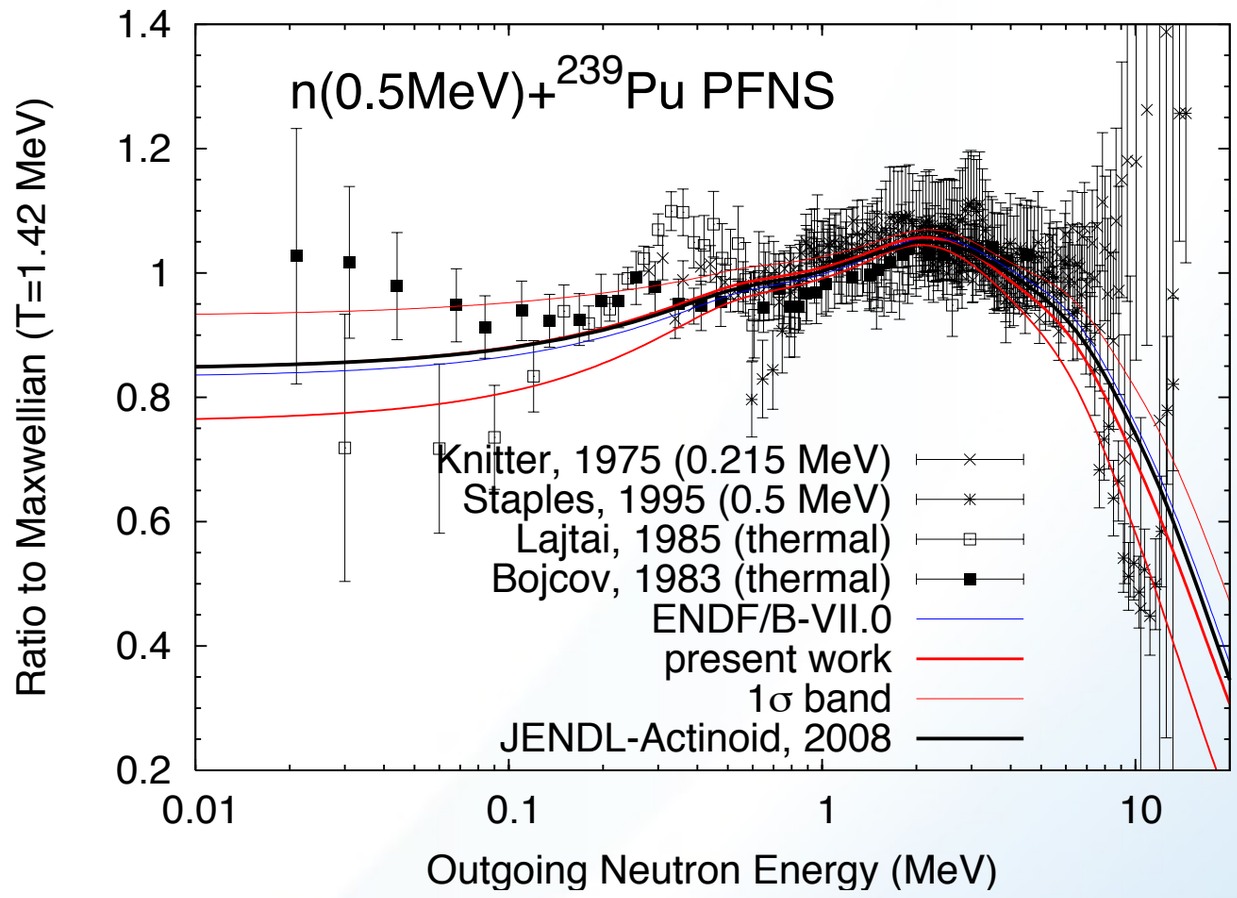


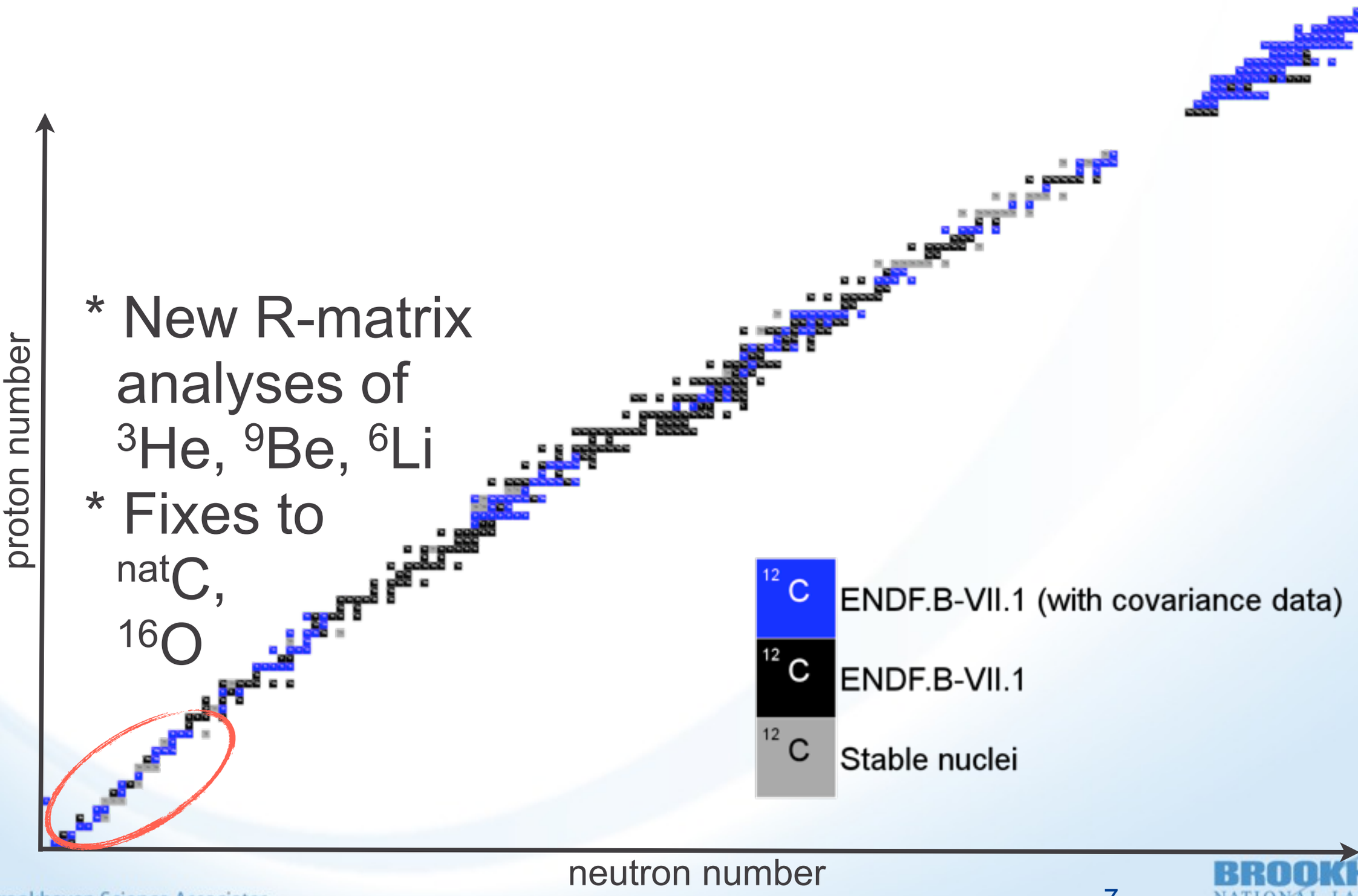


- Talou et al (LANL) retrofitted using Madland-Nix model
- Valuable contribution enabling full QMU studies in Pu systems (previously only nubar and cross section covariance available)

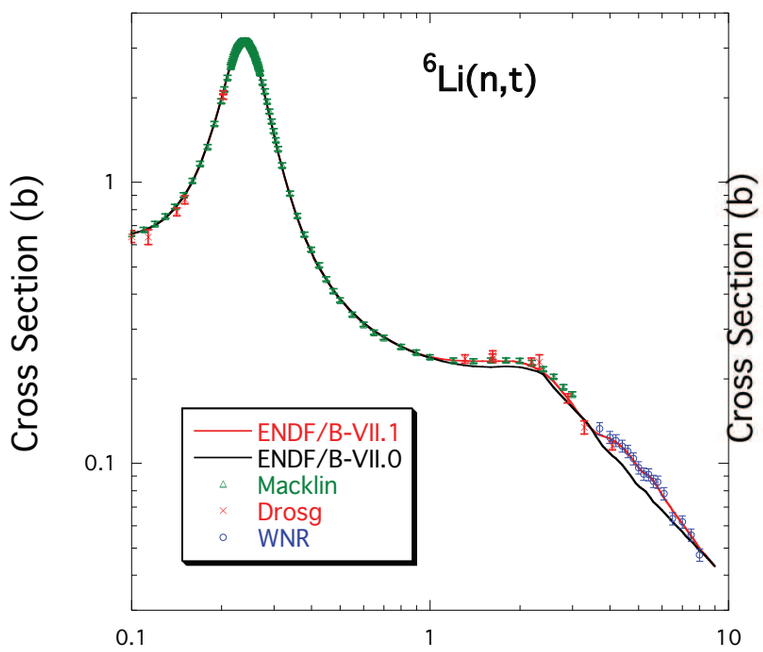
An overview of the library

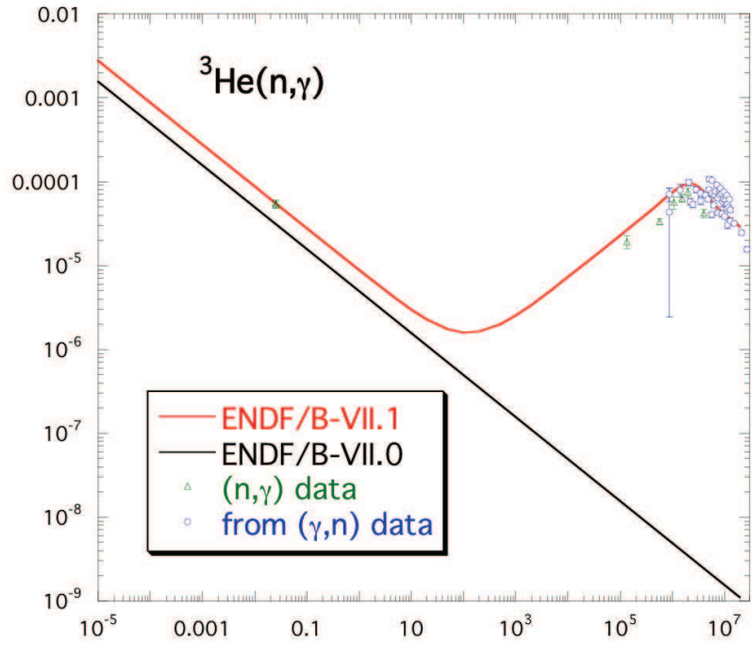
ENDF B-VII.1

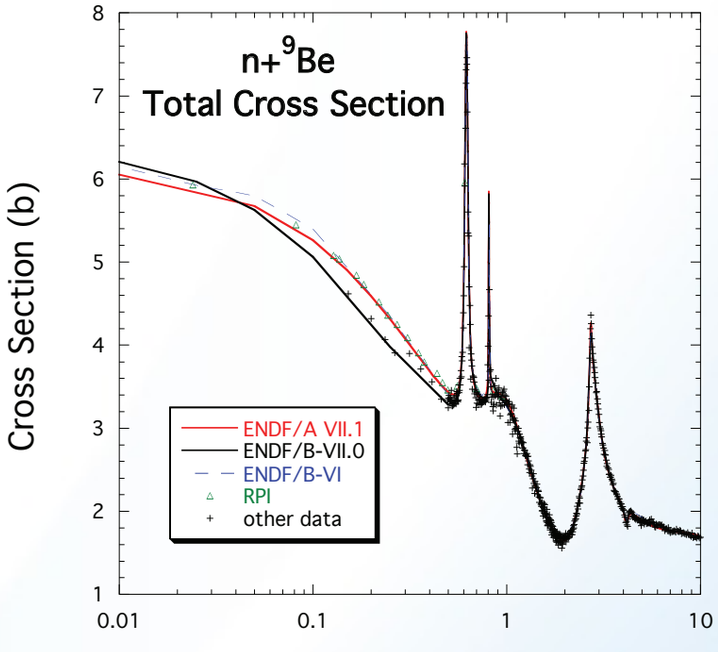
* New R-matrix analyses of ^{3}He, ^{9}Be, ^{6}Li
* Fixes to ^{nat}C, ^{16}O

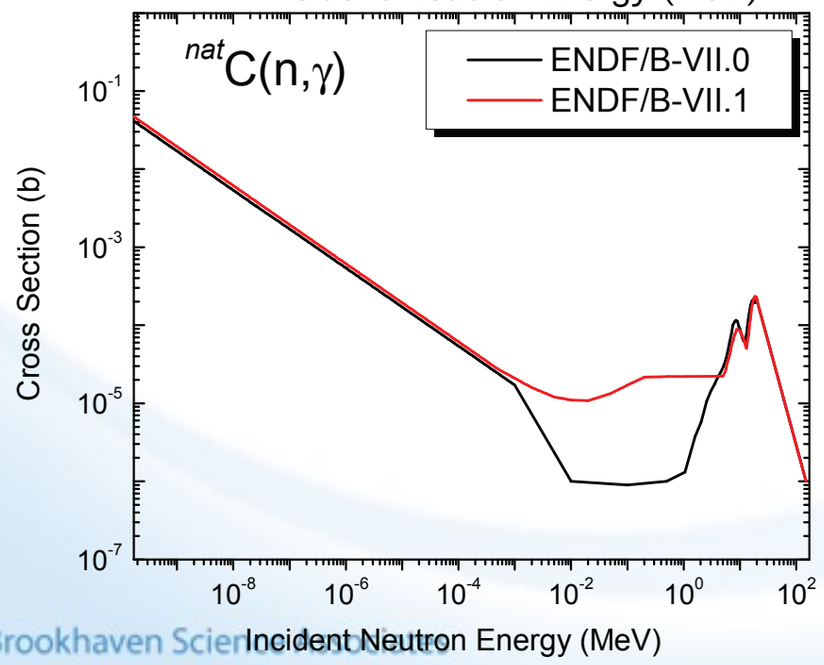


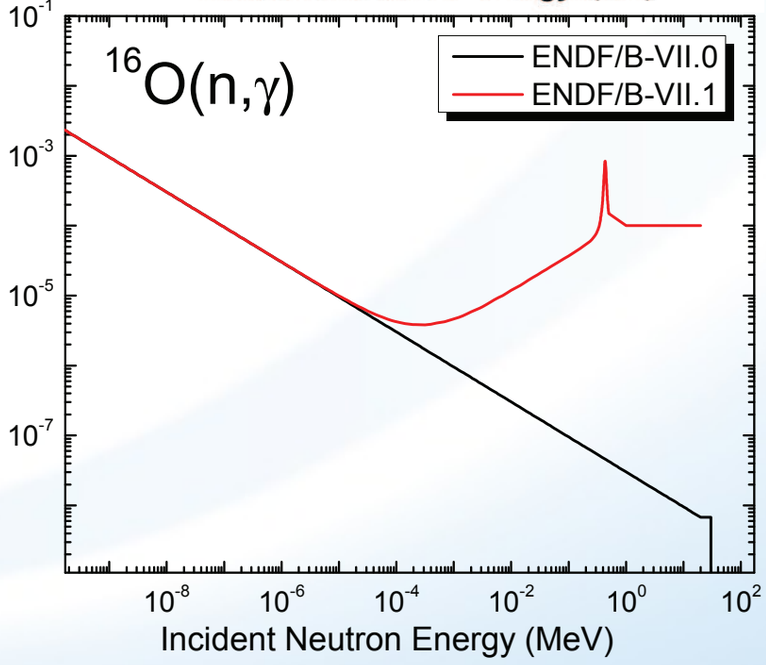
Many of the changes to the light nuclei were quite dramatic

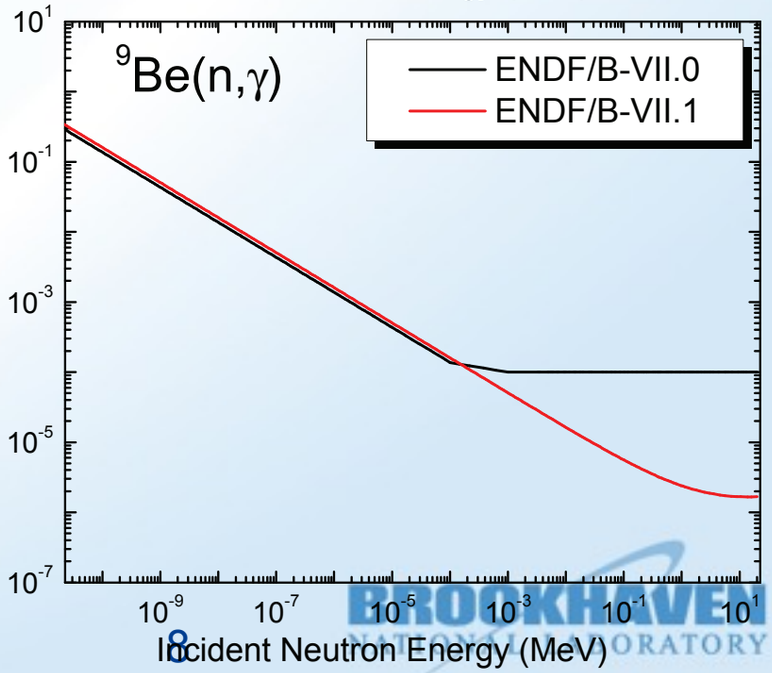












An overview of the library

ENDF B-VII.1

Fission Products and Other Evaluations

1. ^{95}Mo
2. ^{92}Mo
3. ^{99}Tc
4. ^{103}Rh
5. ^{109}Ag
6. ^{133}Cs
7. ^{143}Nd
8. ^{145}Nd
9. ^{147}Nd
10. ^{147}Sm
11. ^{149}Sm
12. ^{152}Sm
13. ^{153}Eu
14. ^{58}Co
15. ^{62}Ni
16. Zr
17. ^{113}Cd
18. ^{157}Gd

Structural Material Evaluations

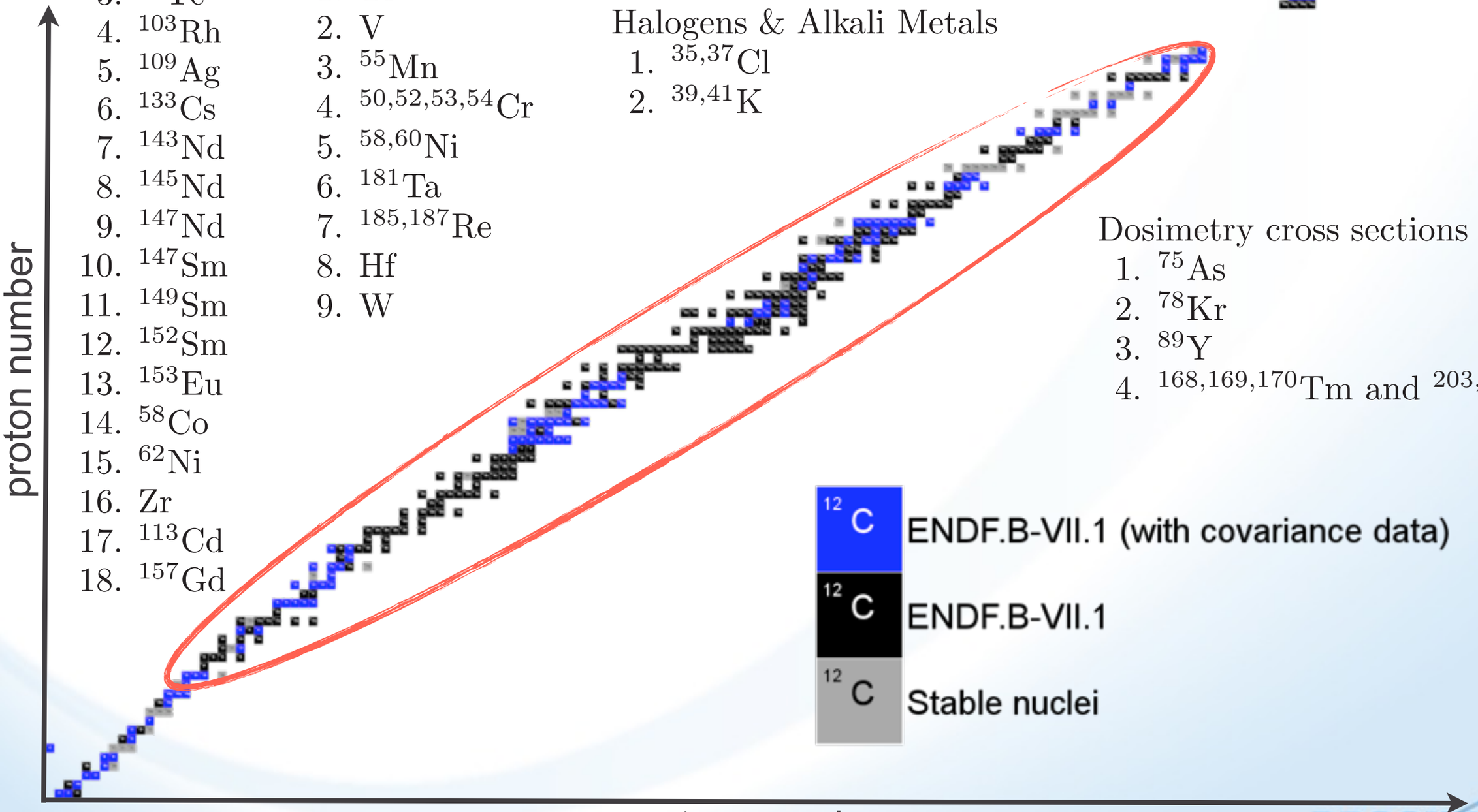
1. Ti
2. V
3. ^{55}Mn
4. ^{50,52,53,54}Cr
5. ^{58,60}Ni
6. ^{181}Ta
7. ^{185,187}Re
8. Hf
9. W

Halogens & Alkali Metals

1. ^{35,37}Cl
2. ^{39,41}K

Dosimetry cross sections

1. ^{75}As
2. ^{78}Kr
3. ^{89}Y
4. ^{168,169,170}Tm and ^{203,205}Tl



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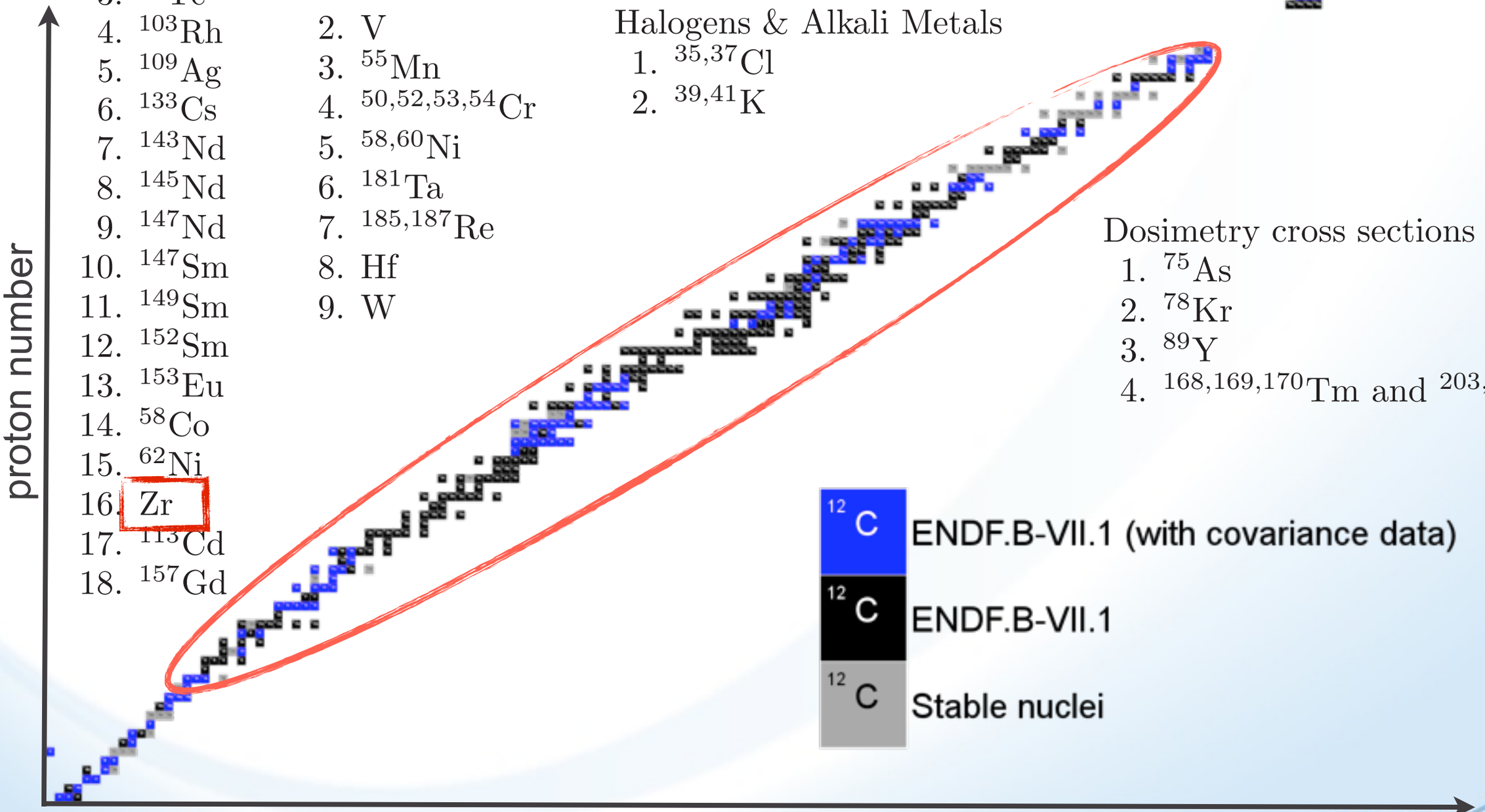
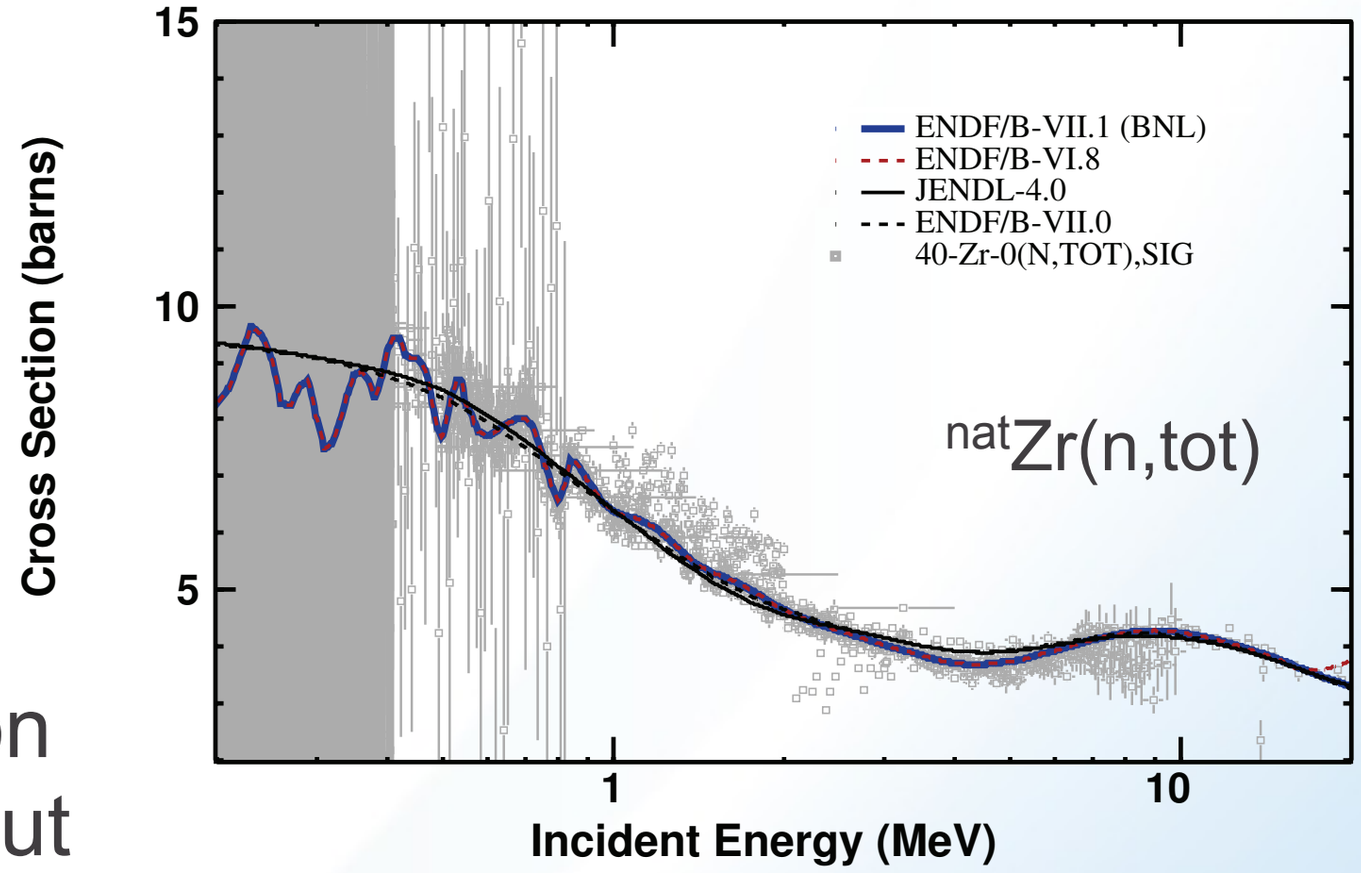


Zr needed to be reworked for ENDF/B-VII.1

- ENDF/B-VI.8 fitted ^{nat}Zr(n,tot), but missed outgoing dists.
- ENDF/B-VII.0 is EMPIRE evaluation, but not fitted
- Attempted re-evaluation for ENDF/B-VII beta, but that version tested poorly
  - Leakage problems (not leaky enough!)
  - Suspected problem (n,el) angular distributions
  - Lead evaluator had health issues that prevented him from fixing evaluation



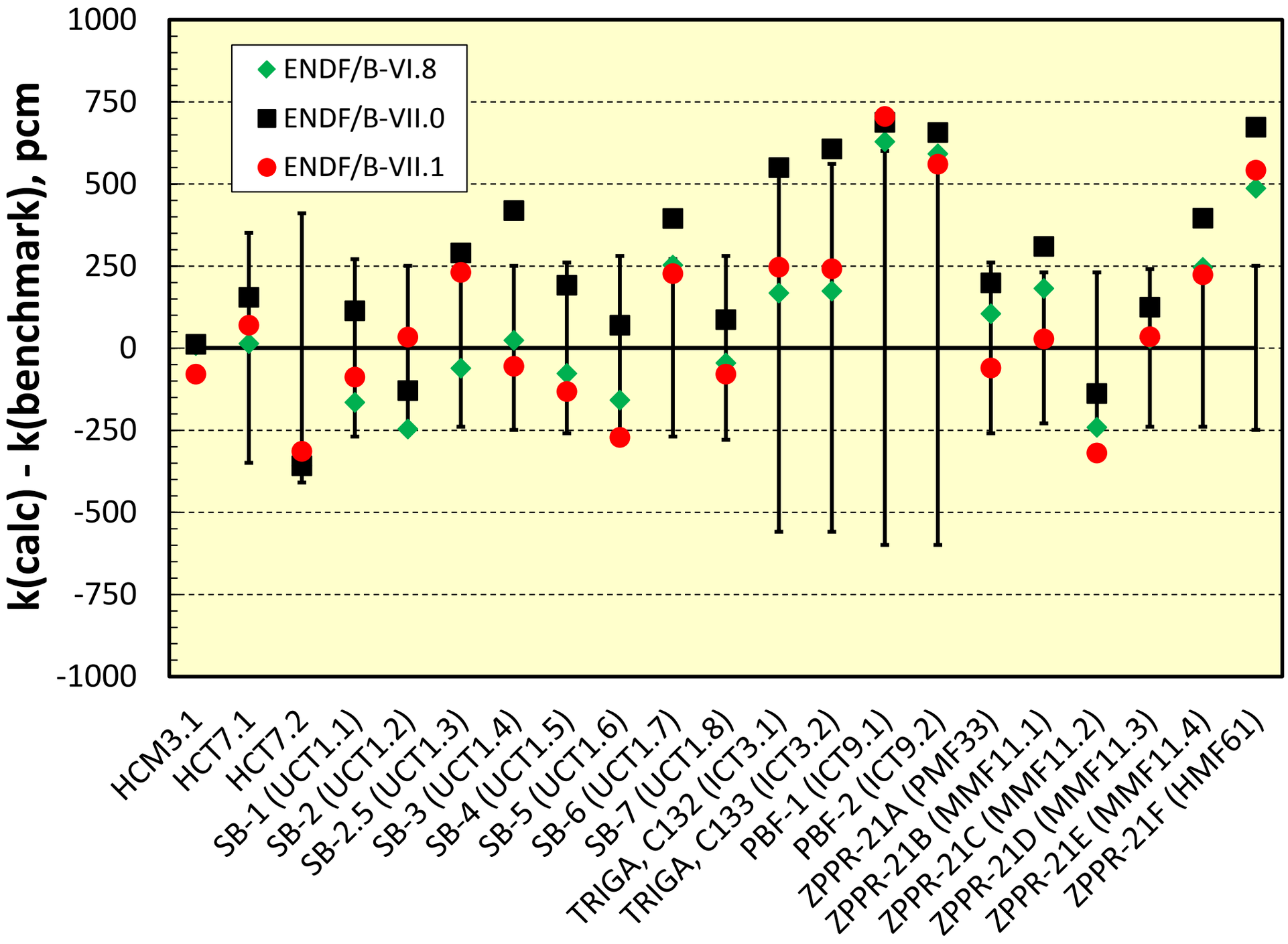
We took over the evaluation and made a few key changes

ENDF B-VII.1

- Found backward peaked low energy neutron dists. - now patched using JENDL-4
- S. Mughabghab reevaluated the RRR:
  - ^{90}Zr all new
  - ^{91}Zr first pass at fixes

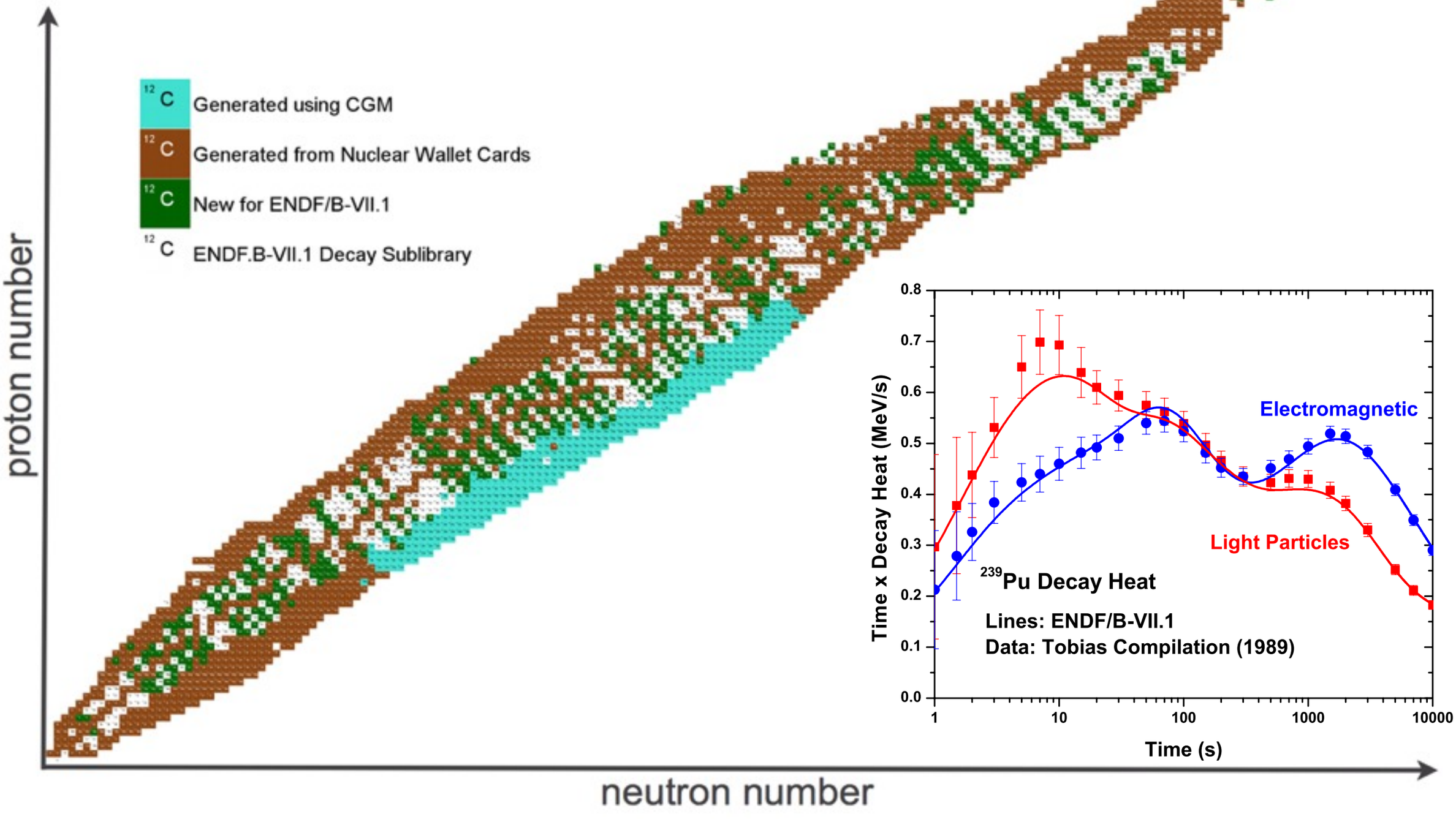
Reaction	^{90}Zr σ_T (barn)	^{90}Zr I_γ (barn)	^{91}Zr σ_T (barn)	^{91}Zr I_γ (barn)
Total	5.50762	-	11.0729	-
Elastic	5.49765	-	9.85728	-
Capture	9.97256×10^{-3}	0.132506	1.21566	6.0062

New Zr evaluations perform well in TRIGA and ZPR assemblies



New decay sublibrary enables more accurate decay heat calculations

ENDF B-VII.1

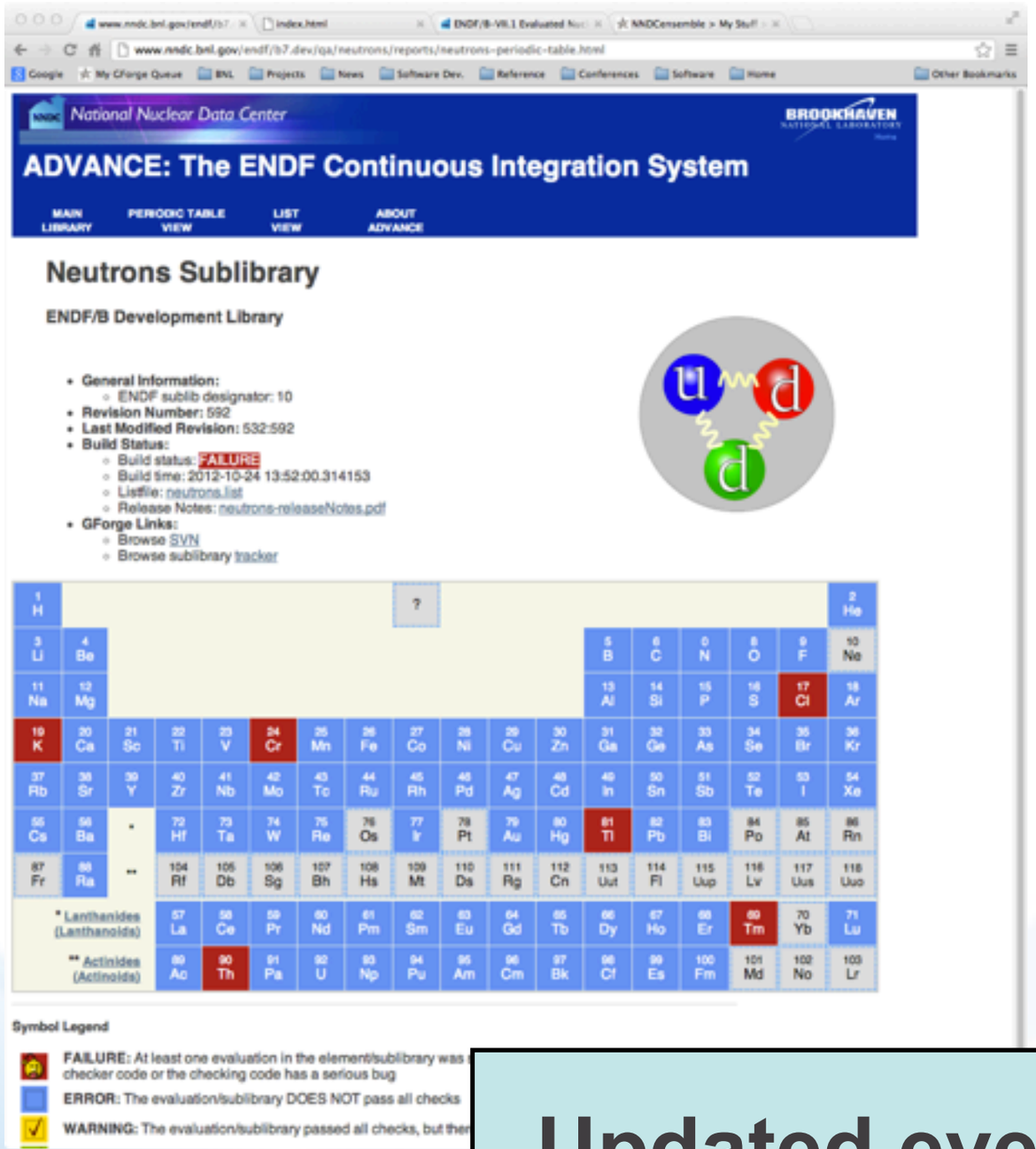


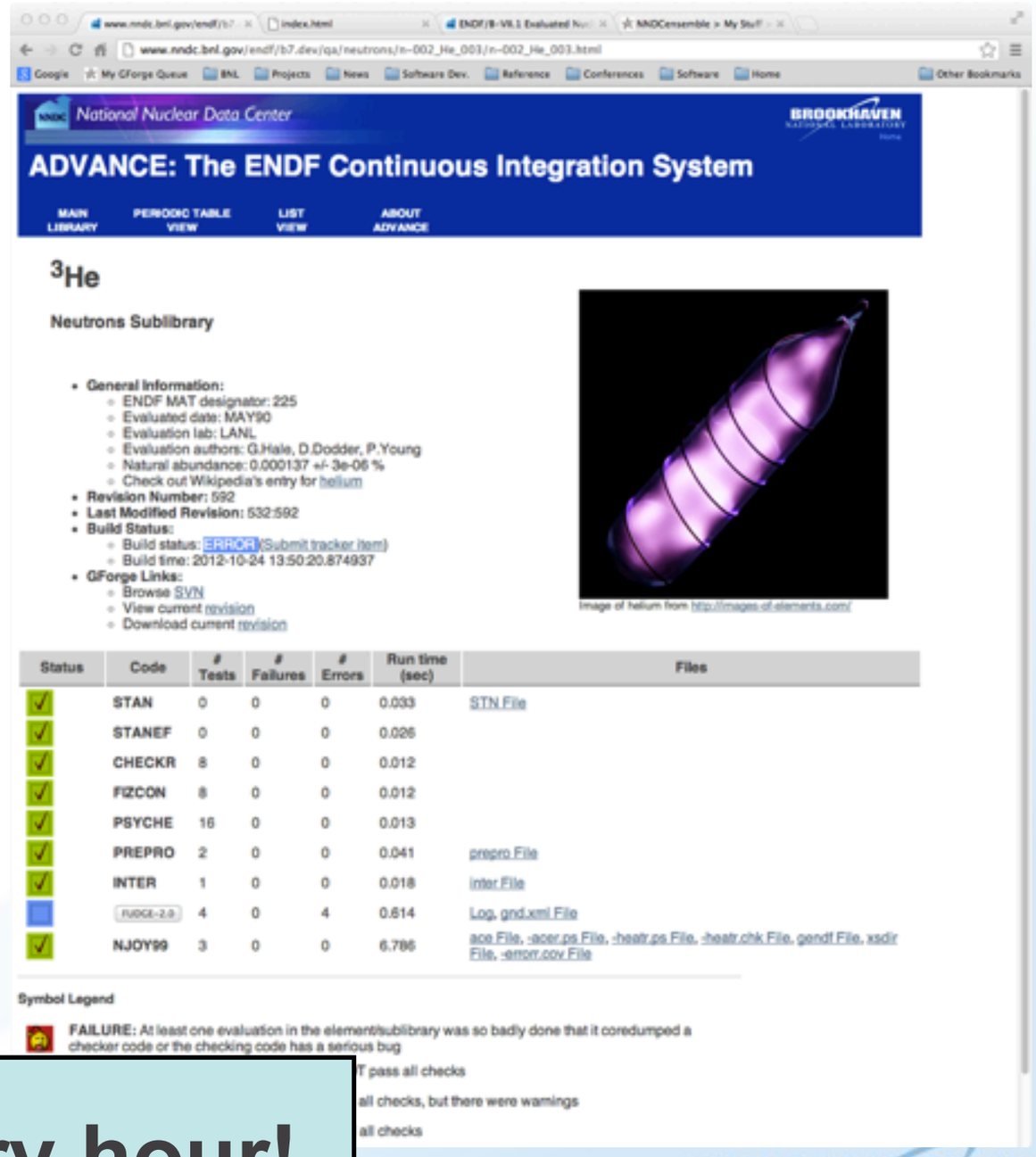
Every evaluation needs to be checked and we humans can't seem to do it right

- **The Problem:**
  - No evaluator remembers to run basic checks (CHECKR, FIZCON) on the evaluations
  - We should not have rely on users to tell us if NJOY barfed...
- **A Solution:** "continuous integration", a common practice in software development. Every commit or every hour (you pick), retest any evaluation that changed.
- As a result, bugs are discovered ***as soon as data is committed***

ADVANCE: Online Data Verification System (*A*utomated *D*ata *V*erification and *A*ssurance for *N*uclear *C*alculations *E*nhancement)

Visit http://www.nndc.bnl.gov/endf/b7.dev/qa/

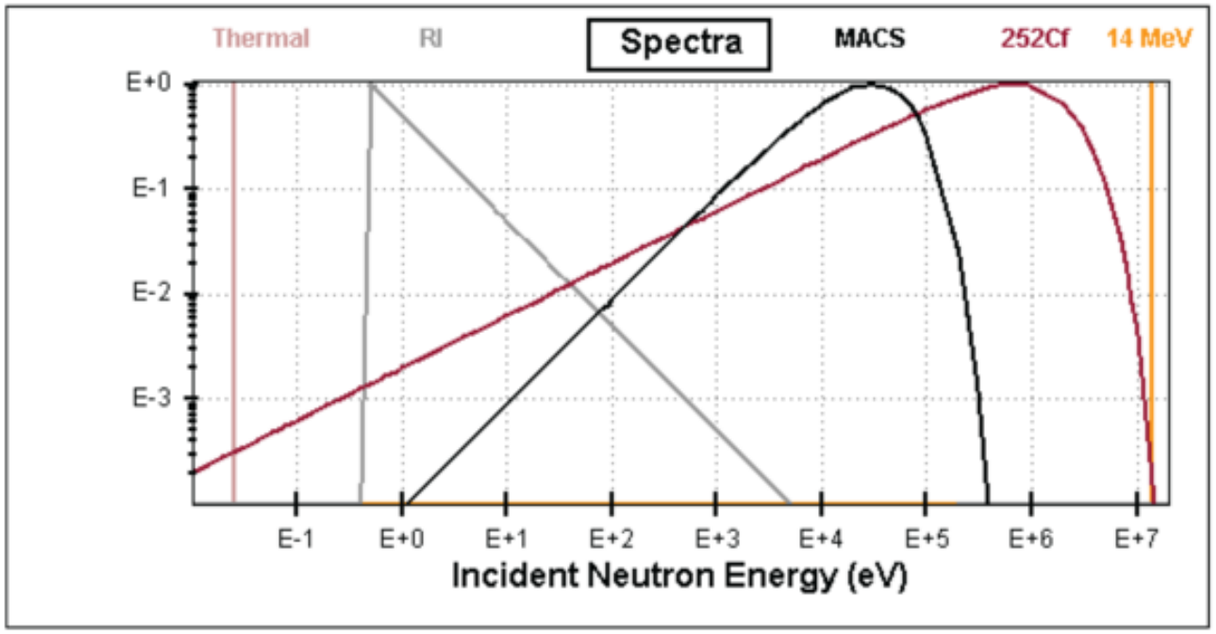


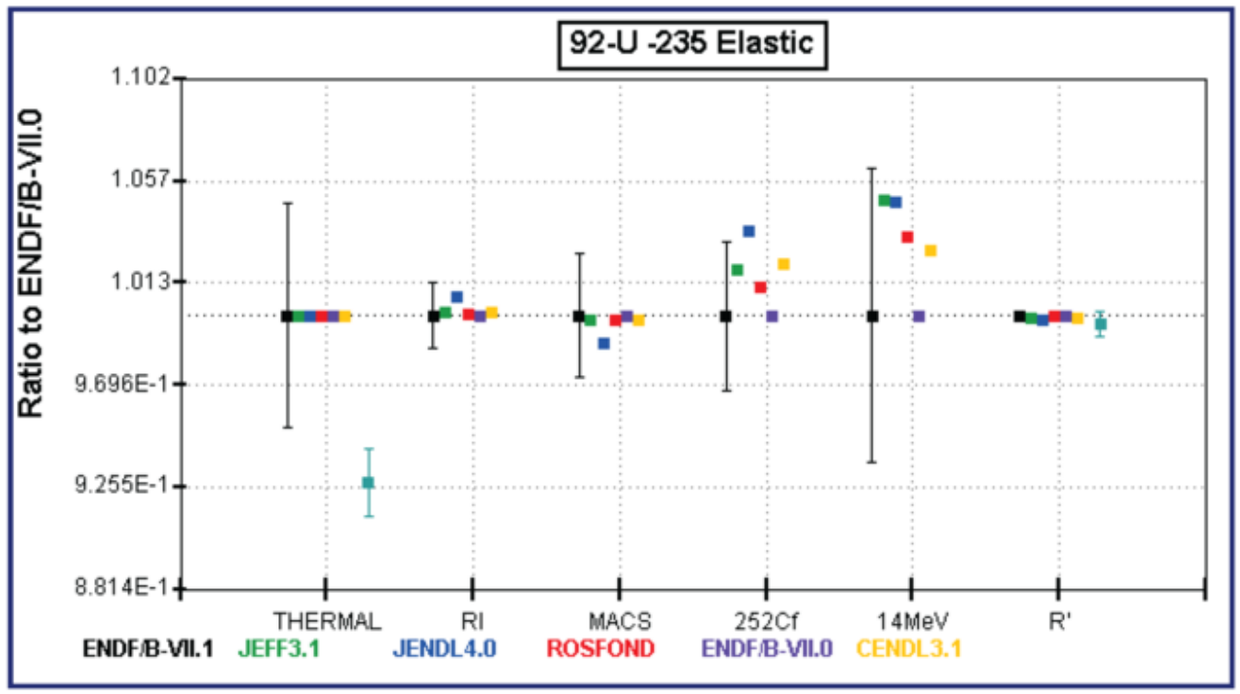


Updated every hour!

ADVANCE will be expanded and is ready for general use

- Use ControlTier for test management
- ACE quality control /w ACELST
- Other processing codes
  - AMPX, CALENDF
- Integrate covariance QA system
  - MACS, other spectrum average plots
  - plots of cross sections
- Ground work for general evaluation review system





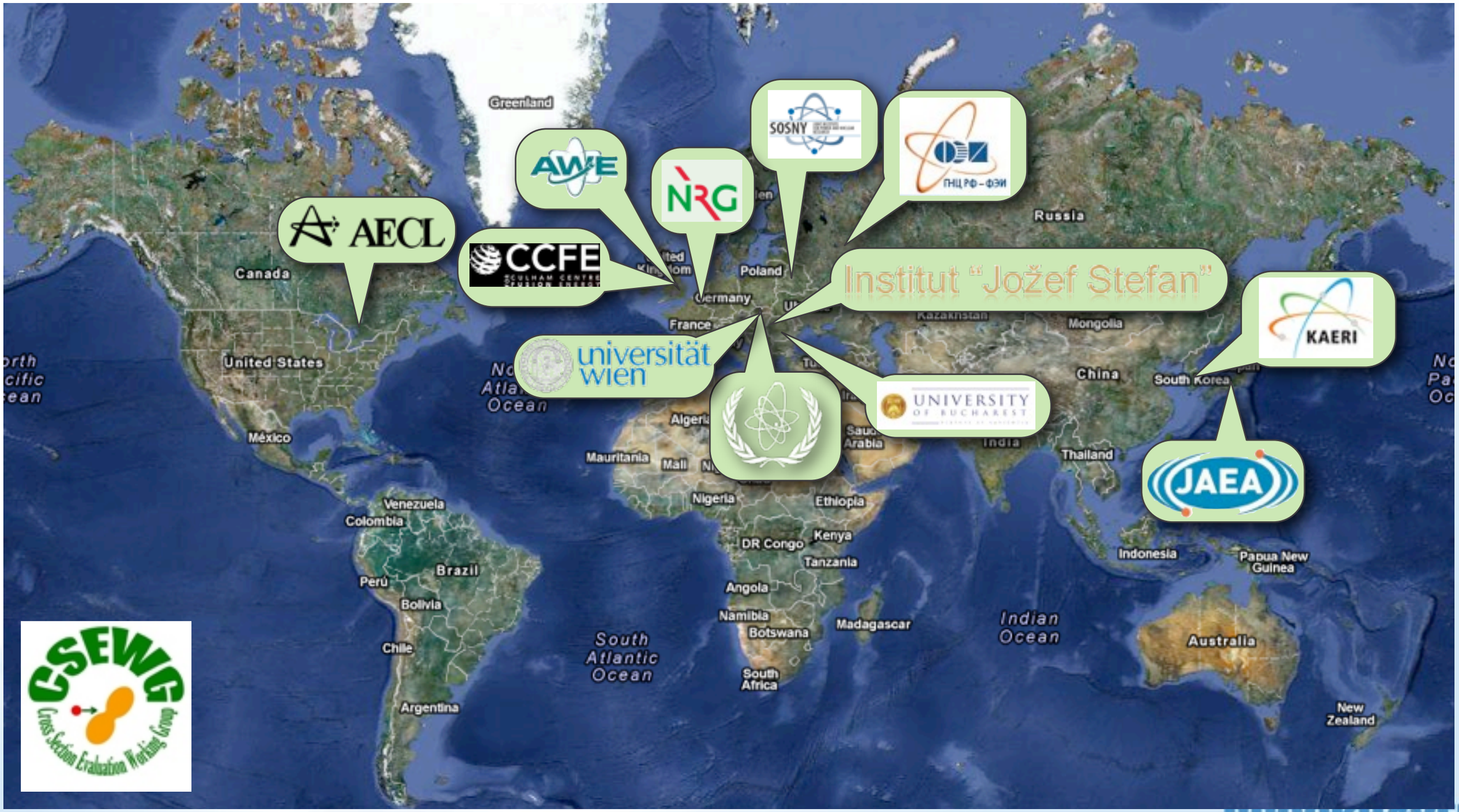
Other longer term changes are in the works

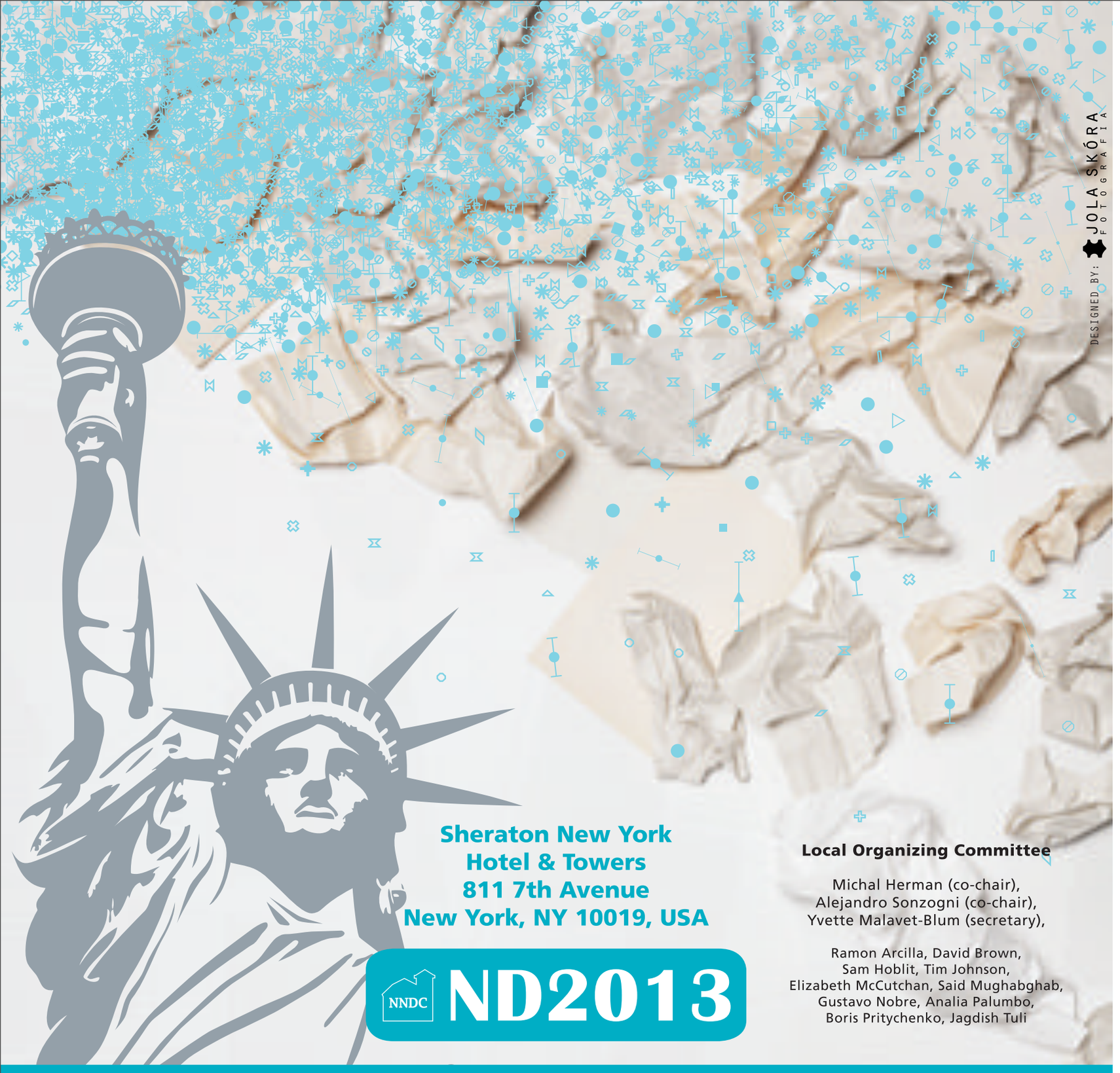
- **New data:**
  - Expanded charged particle library (porting ENDL2011 charged particle sublibrary)
  - Filling holes in reaction networks
  - Eliminate last elemental evaluation from transport library: ^{nat}C
- **New format:**
  - Most likely based on Generalized Nuclear Data format
  - USNDP/CSEWG actively participating
  - WPEC hopefully to form to collect international input
- **Investigating possibility of international, unified evaluated nuclear data library**

ENDF/B-VII.1 was the combined effort of collaborators from across the US...

... and the world.

ENDF B-VII.1





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INTERNATIONAL CONFERENCE ON NUCLEAR DATA FOR SCIENCE & TECHNOLOGY

March 4-8, 2013

www.bnl.gov/nd2013

Important Dates	
Aug. 1, 2012	Abstracts for oral/poster presentations due.
Sept. 1, 2012	Program is announced.
Feb. 10, 2013	Deadline to reserve rooms at the Sheraton at conference rates.
Mar. 4, 2013	Conference begins.
Mar. 8, 2013	Deadline for article submission.

Topics

- Nuclear reaction data
- Nuclear structure and decay data
- Delayed neutrons
- Fission yields
- Atomic masses
- Experimental facilities and detection techniques
- Nuclear data measurements and analysis
- Nuclear theories, models and data evaluation
- Uncertainty quantification and covariances
- Evaluated nuclear data libraries
- Nuclear data processing
- Nuclear data adjustment
- Validation of evaluated data
- Integral experiments
- Cross section and decay standards,
- Data dissemination and international collaboration
- Nuclear Fission (75th anniversary)
- Nuclear data for reactors
- Nuclear decay heat
- Dosimetry and shielding
- Safeguards and security
- Criticality safety
- Homeland security and safety
- Accelerator related applications
- Fusion technology
- Space, cosmic-rays, radiation effects on electronics
- Astrophysics and cosmology
- Medical and environmental applications
- Nuclear physics education

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