

Current Status of the NJOY Nuclear Data Processing Code System and Initial ENDF/B-VII Data Testing Results

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NJOY Code Status

- Bob MacFarlane may be retired, but is alive & well and remains actively involved with NJOY development and data testing 😊.
- LANL is maintaining and updating NJOY99 as needed to process ENDF/B-VII.
- An f95 version has also been developed and we expect to release this version by the end of 2006.
 - The absence, until this summer, of a code sharing agreement between RSICC and the NEA has delayed release of this new version.

NJOY Code Status

- NJOY99 is distributed through the Oak Ridge (RSICC) or NEA code centers.
 - Updates are available from LANL at <http://t2.lanl.gov>.
- NJOY99.112 was the latest version available prior to the start of ENDF/B-VII “beta” testing.
 - Version **99.125** was released to the National Nuclear Data Center (NNDC) at Brookhaven National Laboratory (BNL) to support ENDF/B-VII β 2 testing (June, 2006).
 - This unofficial update is available at <http://www.nndc.bnl.gov/exfor2/4web/upn125.txt>.
 - Version **99.161** was released to the NNDC at BNL to support release of ENDF/B-VII β 3 in late September.

NJOY Code Status

- Some of the more significant changes since NJOY99.112 include:
 - Recognize β -delayed photon (MF=1, 12 & 14, MT=460) data.
 - For this MT only, no file 3 data are required.
 - These data will be present in ENDF/B-VII ^{235}U and ^{239}Pu files.
 - ACER “TYR” fix for fissile nuclides using File 6.
 - Identified at the June CSEWG data validation meeting and a corrective patch has been provided by Andre Trkov.
 - INT=22 (unit base interpolation) for File 5.
 - A long-standing feature in many JENDL fission product evaluations that will appear in the corresponding ENDF/B-VII evaluation.
 - Continuous energy/angle sampling of thermal kernel data.
 - MCNP, version 6, will be able to use these data.

NJOY Code Status

- Some of the most significant changes since NJOY99.112 include (con't):
 - Coding to read the compact covariance format in mf32.
 - Provided by Andre Trkov.
 - Corrected energy dependent fission pseudo-Q formula.
 - Previously used formula did not reflect the energy dependency equations specified in the ENDF format manual for mf1, mt458.
 - This change made in update #136.
 - Calculated fission energy release changes by <1% at 1 MeV incident neutron energy, and less with decreasing incident neutron energy.
 - Miscellaneous explicit variable initialization, external subroutine declarations, increased array sizes in various modules.
 - This resolves various compiler warnings, but we are not aware of any changes in answers resulting from these improvements.

NJOY Code Status

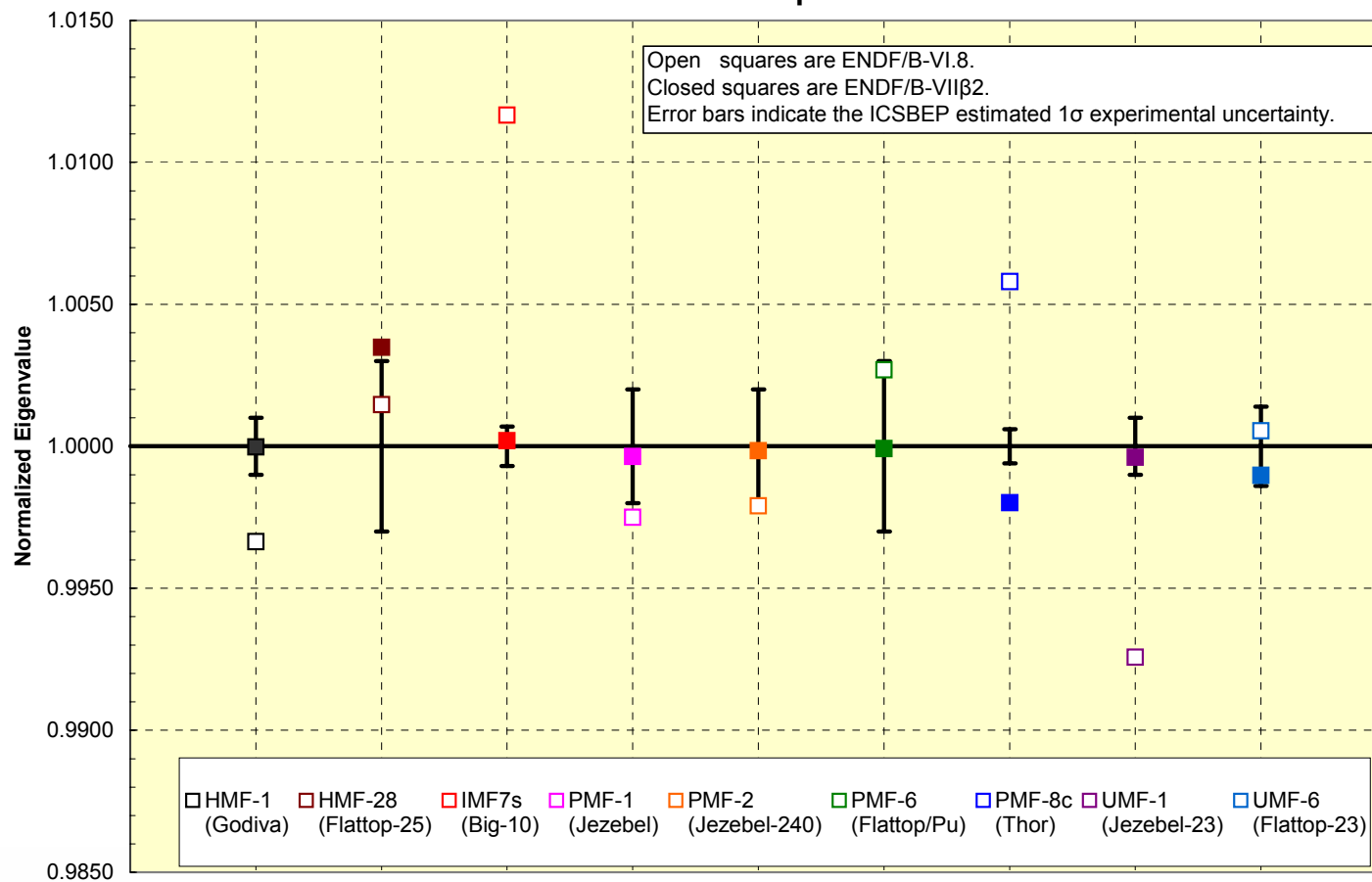
- In-house testing with different compilers and different optimization levels continues.
 - No differences were seen when the standard suite of test problems was run on a LINUX PC and NJOY99.161 was compiled with either the Intel 9.0 compiler or the g77 compiler.
 - Four reconr output files (from 393 ENDF/B-VII β 2 input files) differ when NJOY99.161 was run on a Windows PC and compiled with the Intel 9.0 compiler and either O0 or O3.
 - All energy mesh were identical, but in each of these files one to three cross sections differed in the least significant digit.
 - User's compiling their own versions should continue to use O0.
- Final updates will be posted to the t2.lanl.gov website prior to the official release of ENDF/B-VII.

ENDF/B-VII Data Testing

- Criticality Testing Using Benchmarks Defined in the ICSBEP Handbook.
 - Testing for HEU, LEU, Pu and ^{233}U Benchmarks
 - Spectra are “FAST”, “INTERmediate” or “THERMal”.
 - Materials are “METal”, “COMPOund” and “SOLution”
- More than 1000 critical configurations have been calculated.
 - >700 by S. van der Marck.
 - Several dozen by J. C. Sublet.
 - Several dozen at Bettis, KAPL and ANL.
 - Several hundred at LANL.
- Representative LANL results follow.

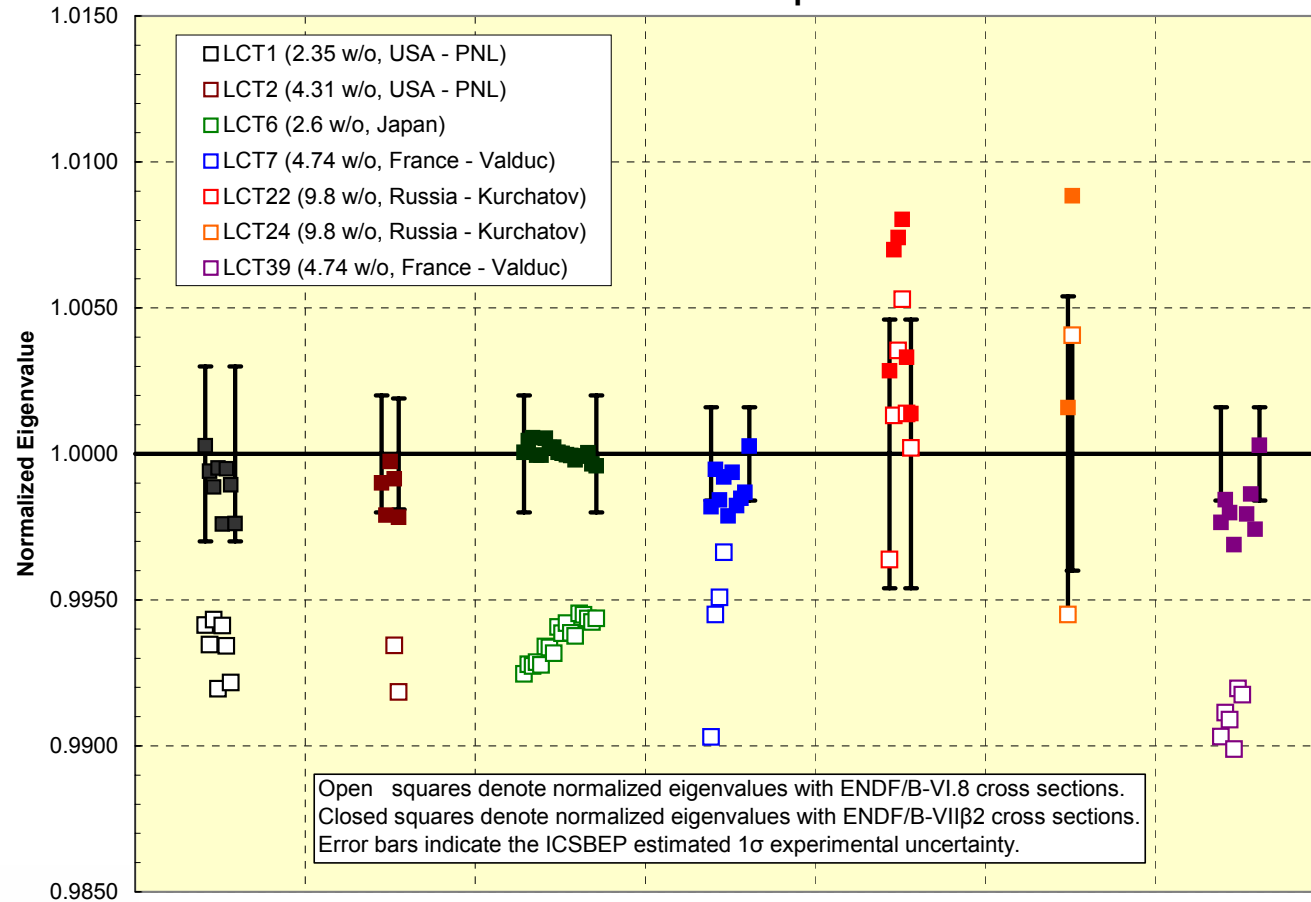
ENDF/B-VII Data Testing

Calculated Eigenvalues for LANL HEU, Pu and ^{233}U Unmoderated Benchmarks with ENDF/B-VI.8 and ENDF/B-VII β 2 Cross Section Data Sets



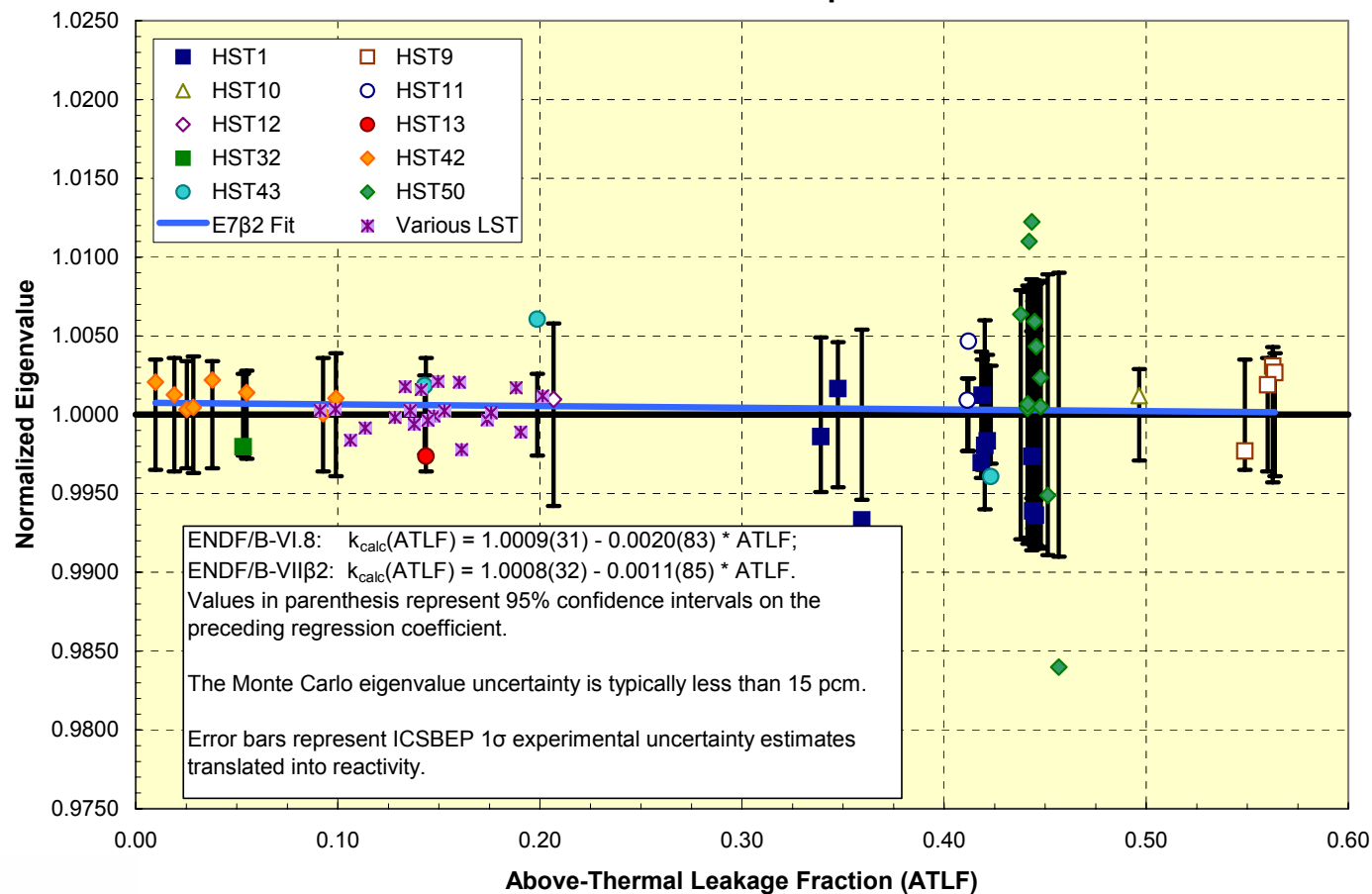
ENDF/B-VII Data Testing

Calculated Eigenvalues for LEU-COMP-THERM Benchmarks
with ENDF/B-VI.8 and ENDF/B-VII β 2 Cross Section Data Sets



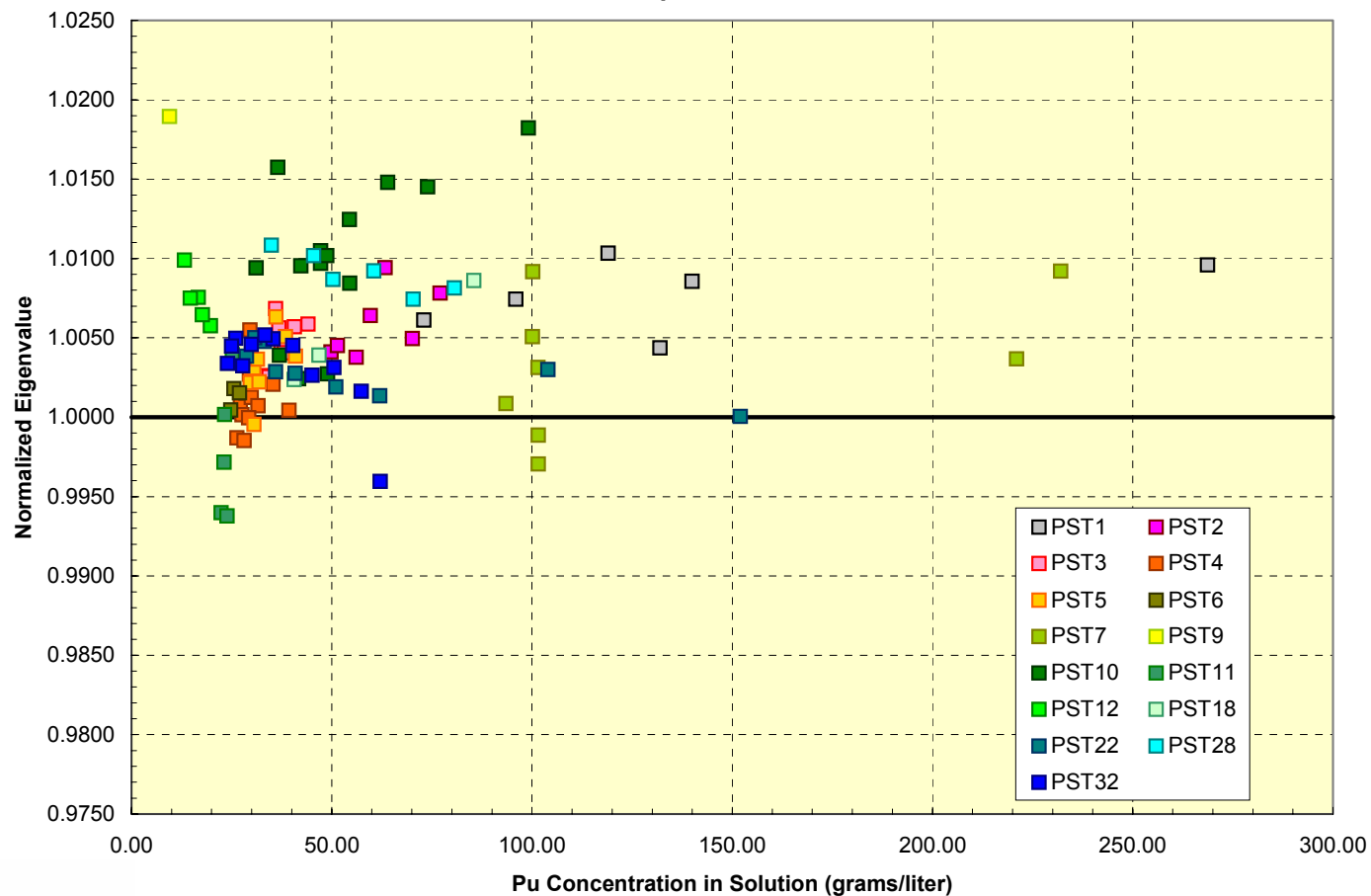
ENDF/B-VII Data Testing

Calculated Eigenvalues for HEU (or LEU)-SOL-THERM
Benchmarks with ENDF/B-VII β 2 Cross Sections



ENDF/B-VII Data Testing

Calculated Eigenvalues for PU-SOL-THERM Benchmarks
with ENDF/B-VII β 2 Cross Section Data Sets



ENDF/B-VII Data Testing

- Comparisons with LANL and Europe (Petten) for ENDF/B-VII β 2.
 - NJOY/MCNP used (independently) at both institutions.
 - 218 ICSBEP benchmarks in common.
 - Petten/LANL eigenvalue ratio varies from 0.9964 to 1.0024.
 - 2/3^{rds} of these ratios fall between 0.9990 and 1.0010.
- Comparisons with LANL and Europe (France) for ENDF/B-VII β 2.
 - NJOY/MCNP used at LANL; NJOY(CALENDF)/Tripoli used at Cadarache.
 - 43 ICSBEP benchmarks in common.
 - Tripoli/MCNP ratio varies from 0.9996 to 1.0010.
 - Common benchmarks include HEU-MET-FAST, IEU-MET-FAST, PU-MET-FAST, HEU-SOL-THERM and LEU-COMP-THERM.
- Comparison with LANL (MCNP) and Naval Reactors (RCP01/RACER).
 - Excellent agreement in calculated eigenvalues has been observed for many years (mostly HEU-SOL-THERM).

ENDF/B-VII Data Testing

- **Observations**

- Important contributions have been received world-wide and are incorporated into the ENDF/B-VII neutron library.
 - new actinide evaluations
 - new fission product evaluations
 - new light isotope evaluations
 - new scattering kernels
- Significant criticality testing has been performed world-wide.
 - various US Laboratories (LANL, Bettis, KAPL, ANL)
 - van der Marck (Petten)
 - Sublet (Cadarache)

ENDF/B-VII Data Testing

- **Observations**

- xxx-MET-FAST calculated eigenvalues are significantly improved.
- LEU-COMP-THERM calculated eigenvalues are significantly improved.
- HEU (or LEU)-SOL-THERM calculated eigenvalues remain close to unity.
- PU-SOL-THERM calculated eigenvalues are little changed and remain biased high by $\sim 0.4\%$ (approximately 0.1% higher than with ENDF/B-VI).

- **The final ENDF/B-VII neutron cross section data files represent a significant improvement over the corresponding ENDF/B-VI data files.**