Validation results of ENDF/B.VIII.1 in GNDS 2.0 format

Nuclear Data Week
CSEWG –Validation
November 5, 2024

Marie-Anne Descalle

LLNL-PRES-2000834

ENDF/B-VIII.1 and -VIII.0 libraries

- processed in GNDS2.0 format using FUDGE
- Room temperature, T = 293.6K
- Continuous Energy cross-sections

	ENDF/B-VIII.0	ENDF/B-VIII.1
Isotopes	557	557
Metastables	22	23
TNSL	25	97
URR probability tables	327 (10 m1)	351 (12 m1)
FUDGE version	6.2	6.7.0

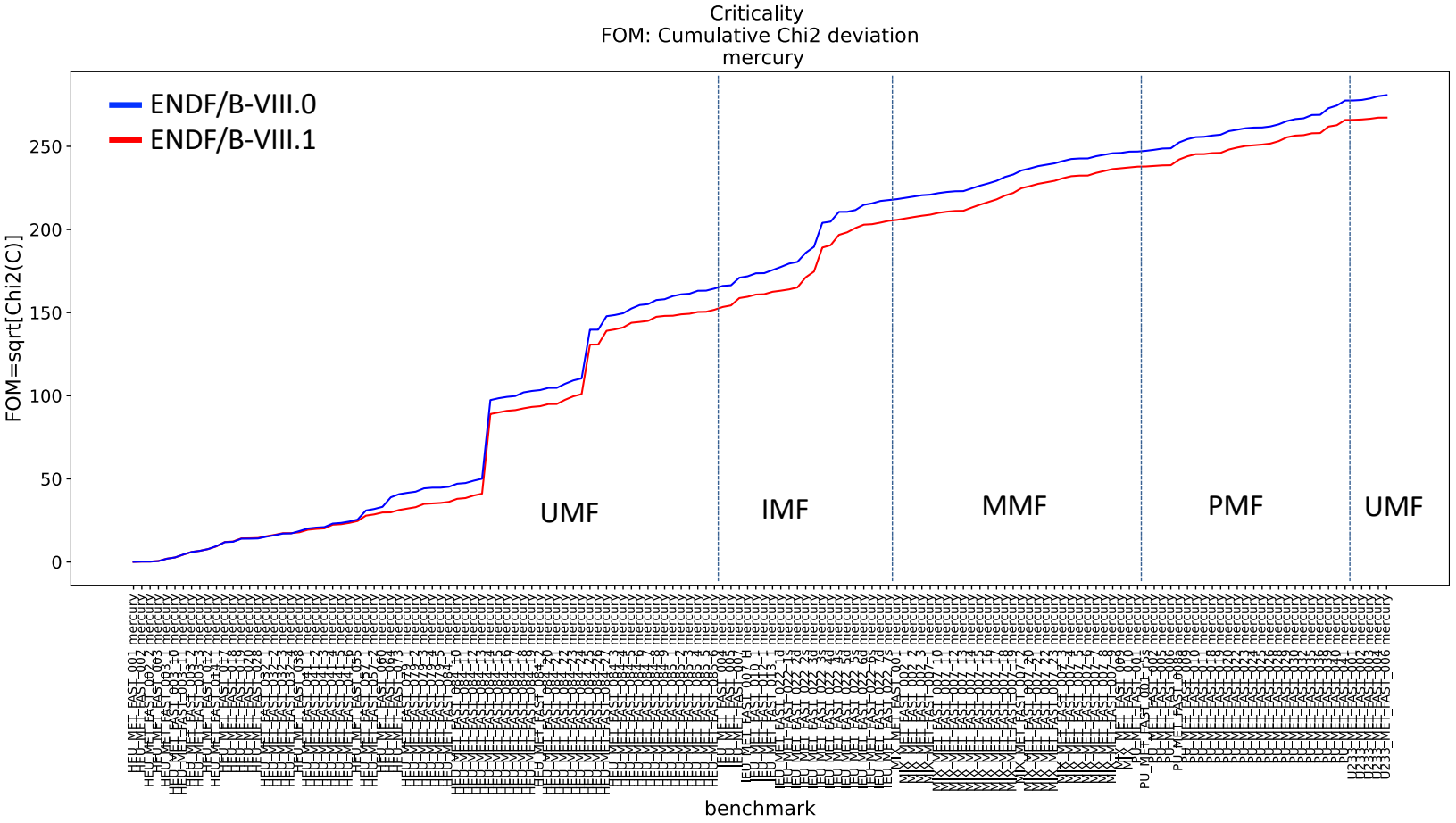
Validation with Metis suite

- Cases:
  - 158 Fast Critical Assemblies
  - Fission ratios, and reaction ratios
  - 16 pulsed spheres

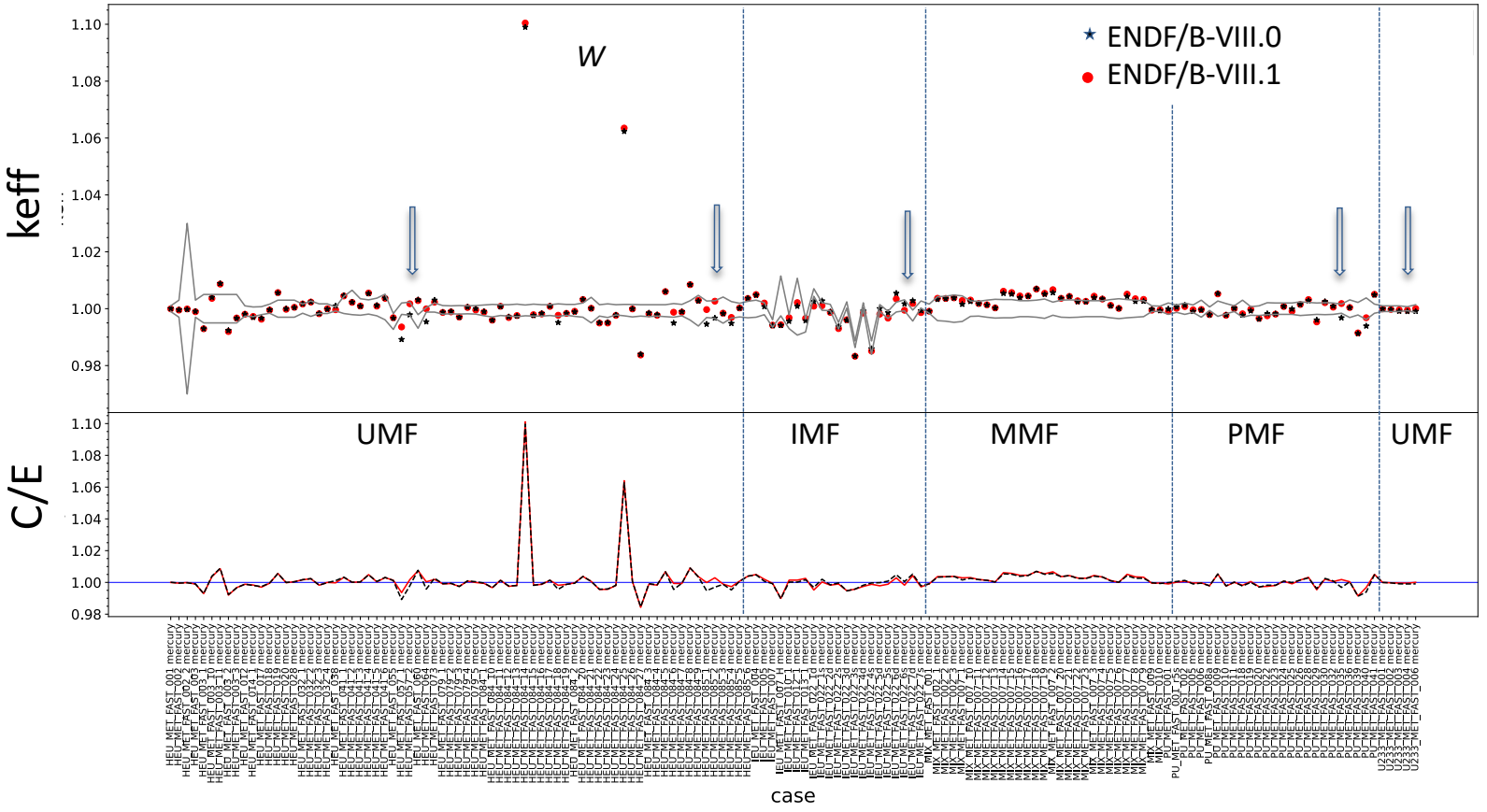
- Mercury Monte Carlo transport code
  - Version: 5.42.0
  - GIDI+: 3.31.0

ENDF/B-VIII.1 χ^2 for criticality benchmarks is improved

- Number of cases: 158

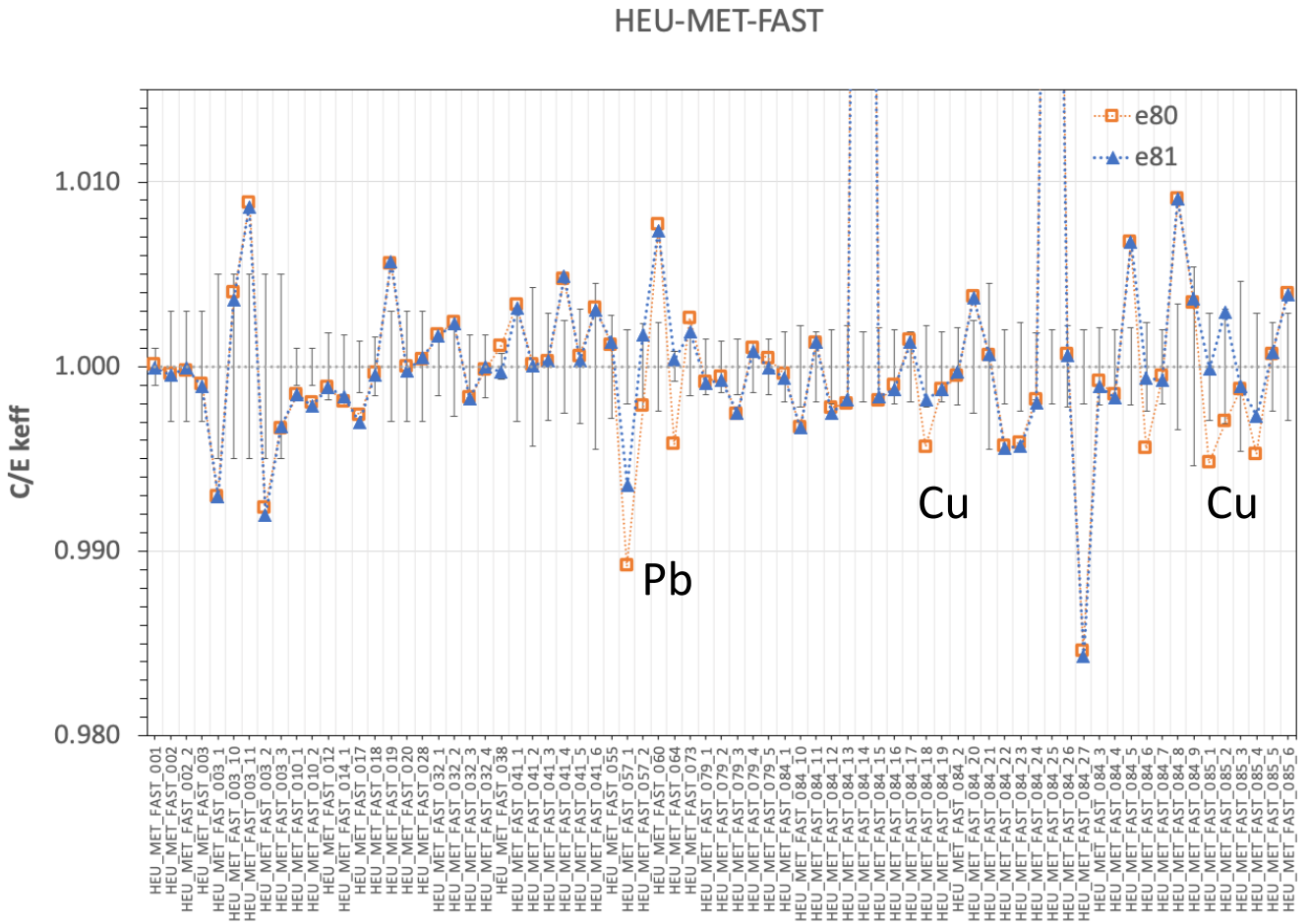


Criticality: C and C_{e81}



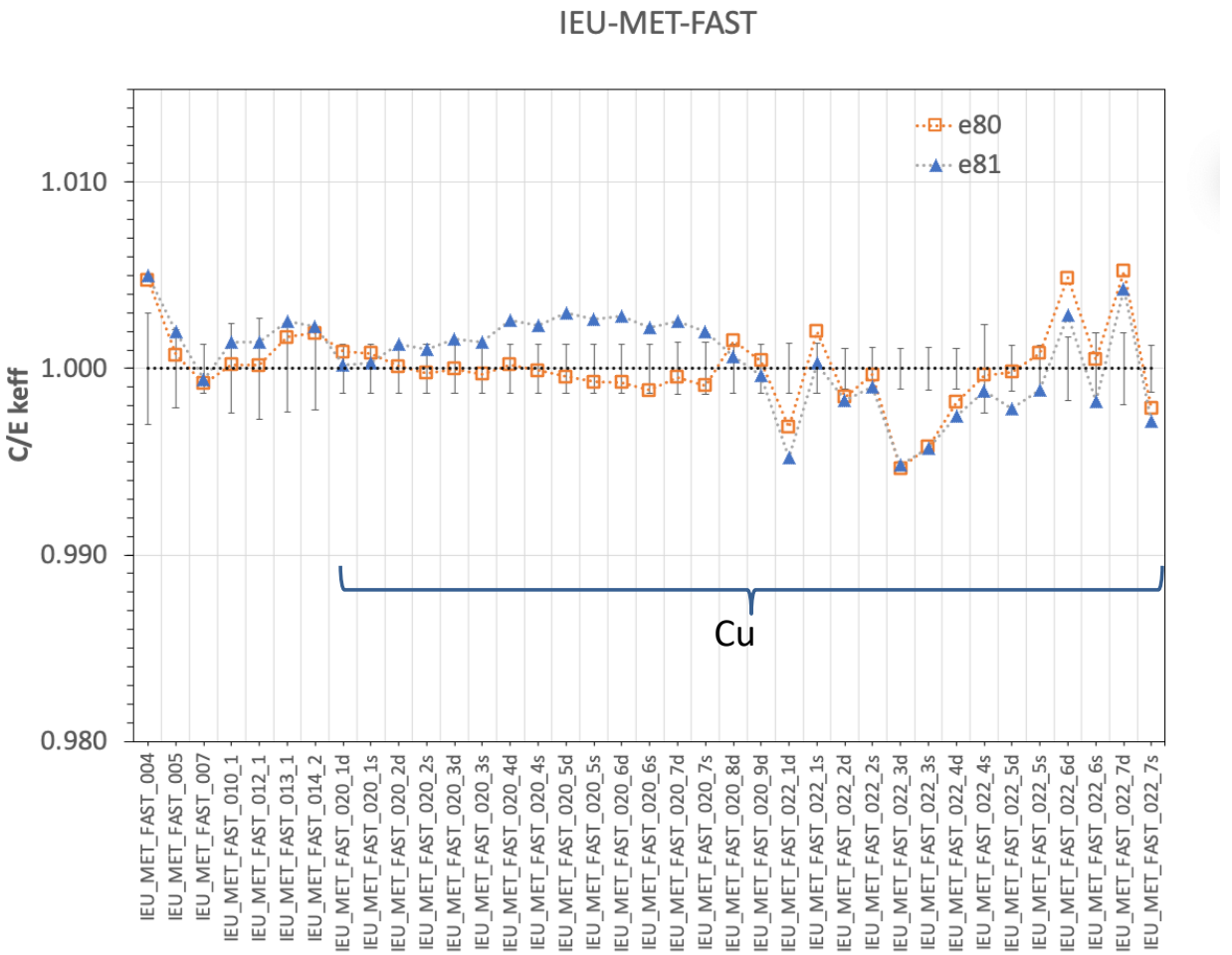
Criticality by core: HEU

- Overall, small changes from e80 to e81
- Improvements for benchmarks with Cu, and Pb reflectors.



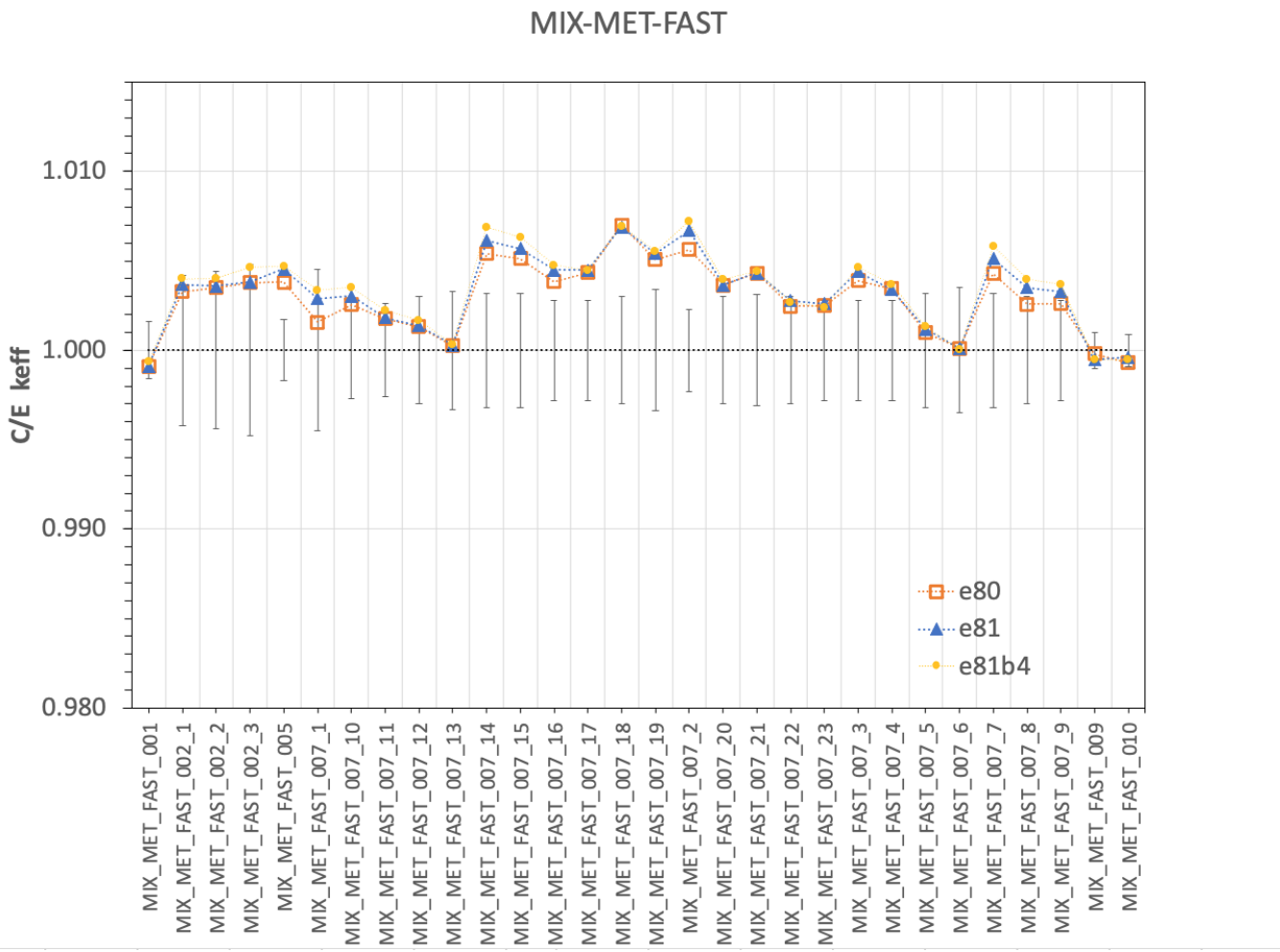
Criticality by core: IEU

- IMF20, IMF22 are Cu reflected benchmarks
- e81 results higher than e80 for cases other than IMF20-1 and IMF22 cases



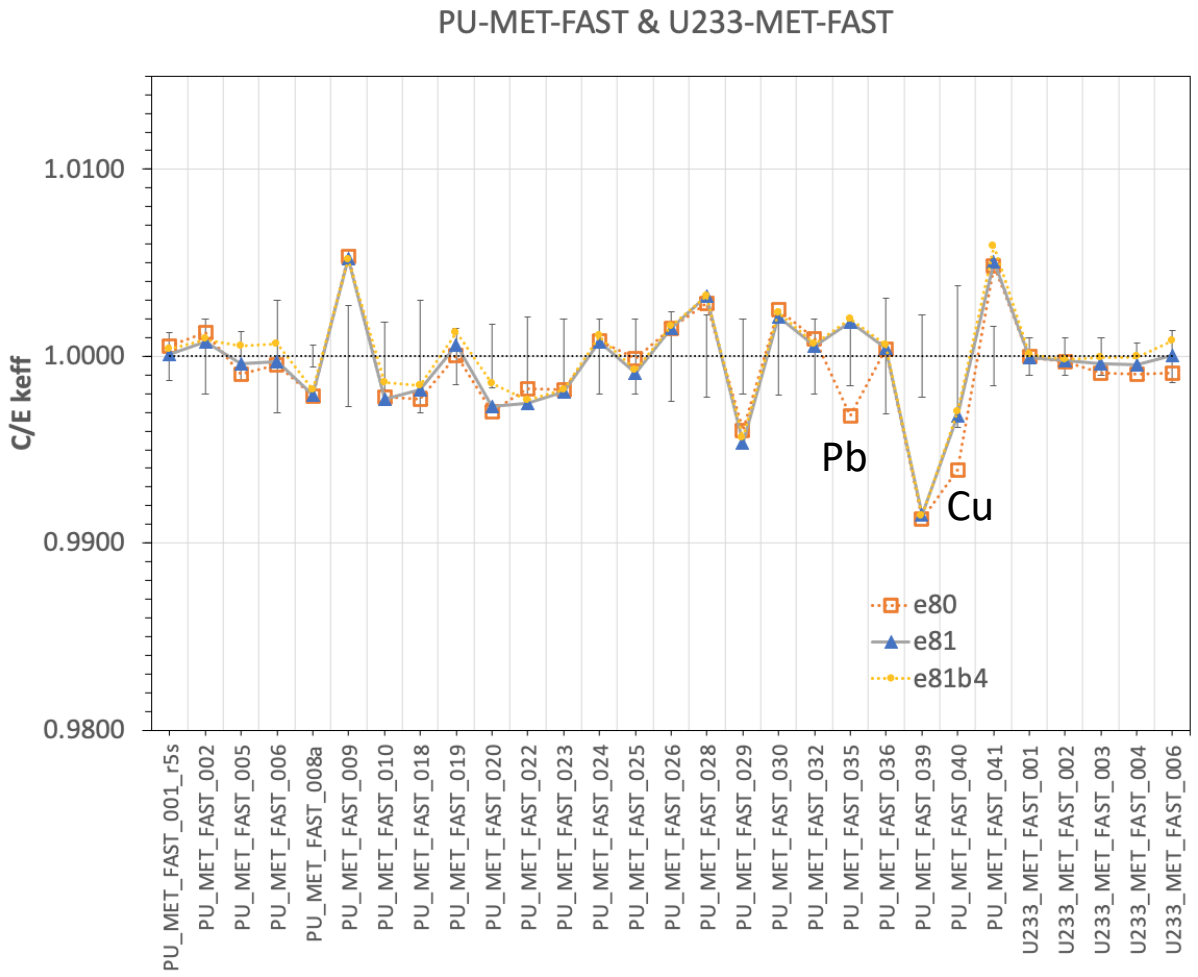
Criticality by core: Pu/U

- Lower than beta4
- e81 slightly higher than e80 for MMF7 cases (Be reflected)



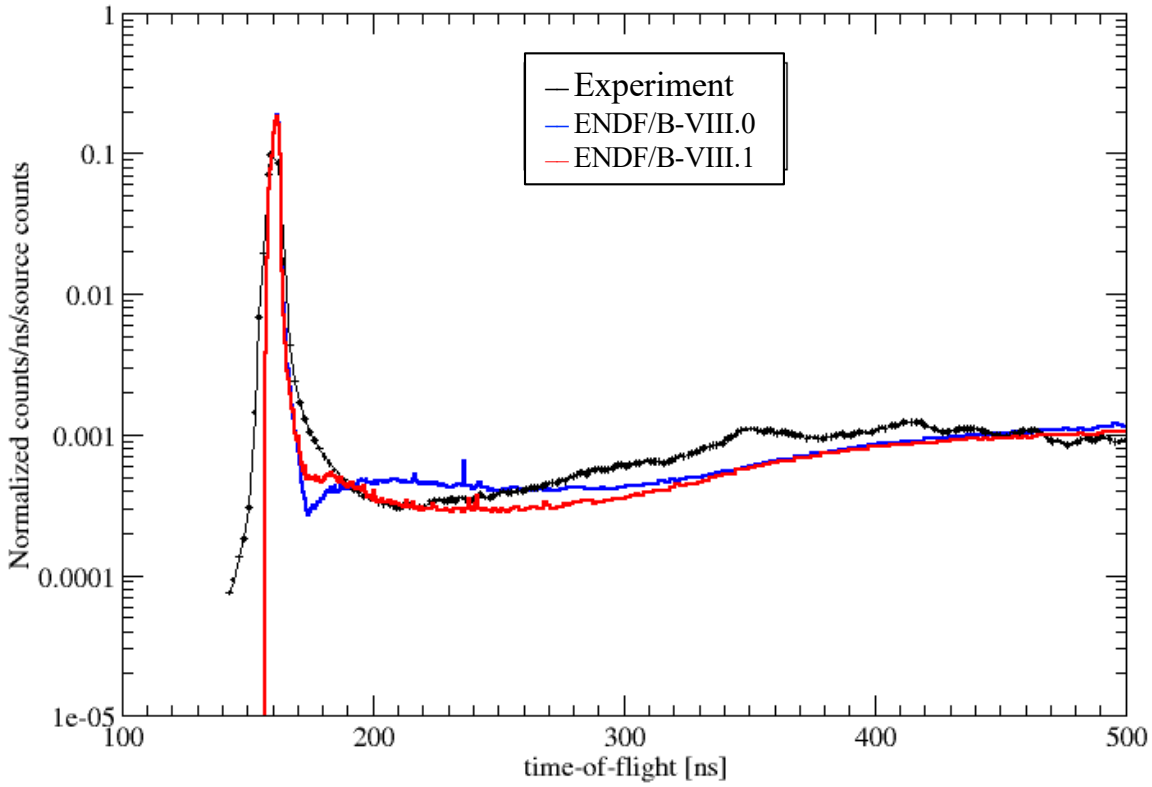
Criticality by core: Pu, U-233

- PMF: results between e80 and beta4; generally closer to e80. Good agreement for Jezebel.
- UMF: e81 U-233 evaluation seems to have reverted to beta3 (updated resonance region, prompt nubar and PFNS).



LLNL pulsed sphere: Ta

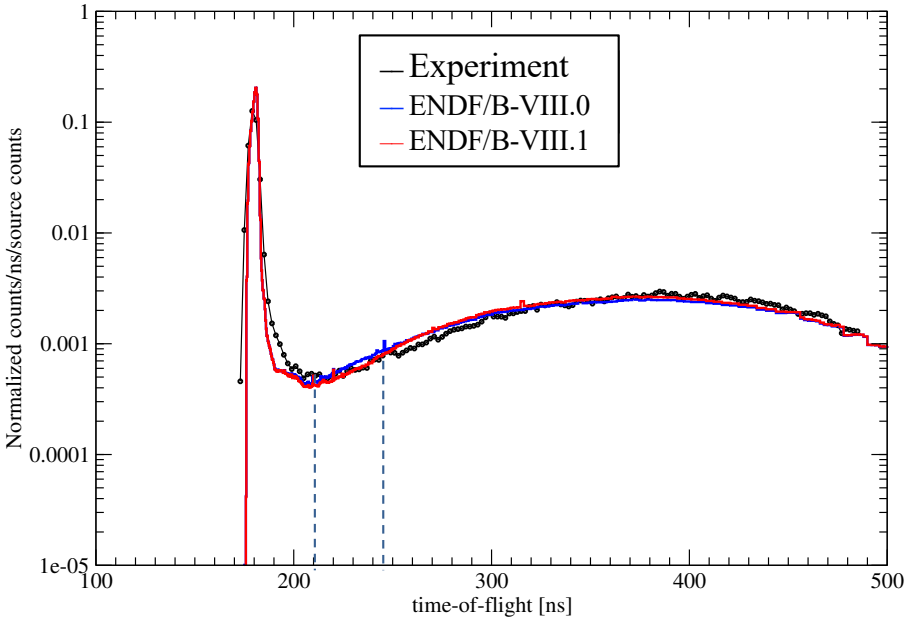
Ta



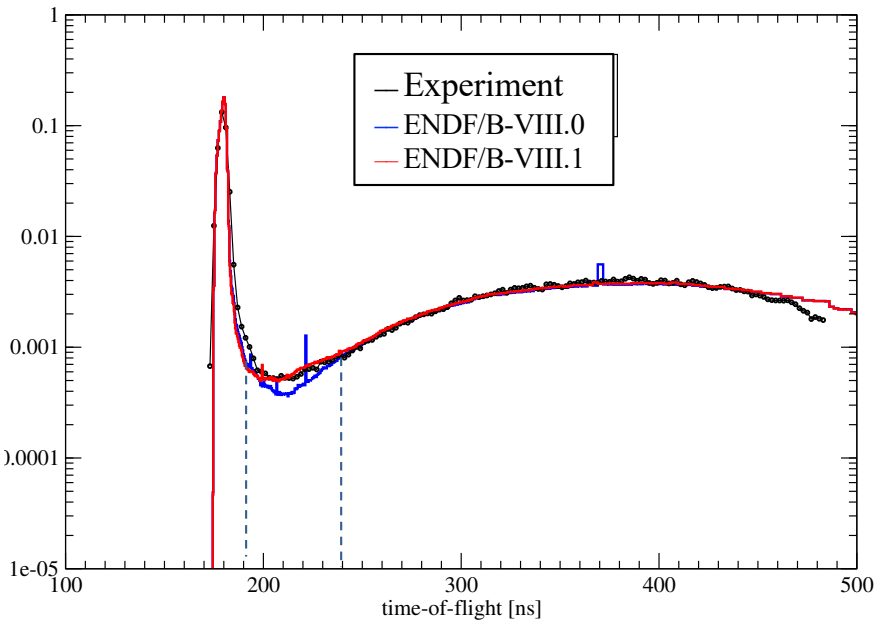
Ta : improved TOF spectrum between 180-210 ns, underestimated at lower energies.
No changes between e80 and e81 for Al, Au, C, H2O, Fe, N2, Si, Ta, Teflon, Ti, ^{232}Th, ^{238}U, W

LLNL pulsed spheres: Pu239 and U235

^{235}U



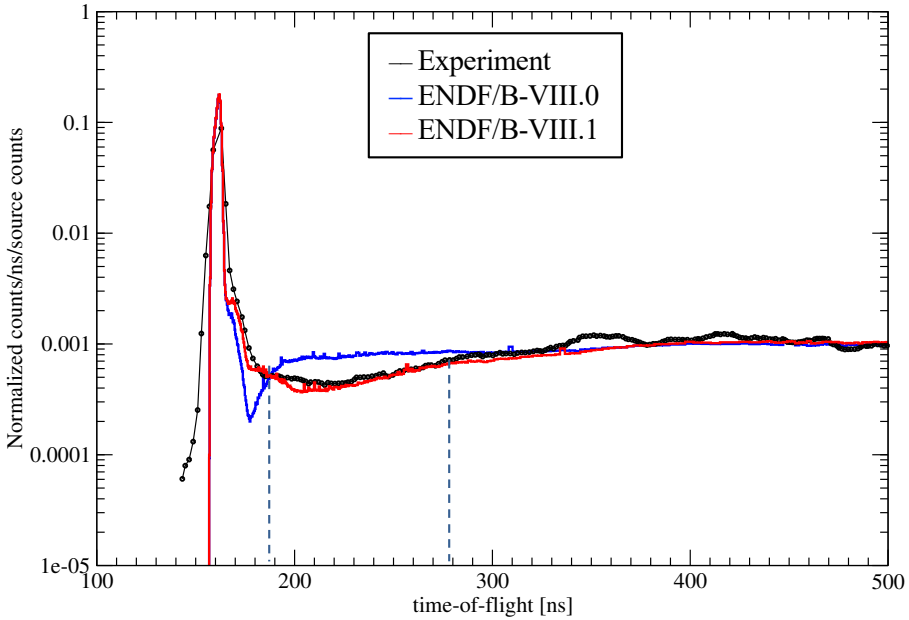
^{239}Pu



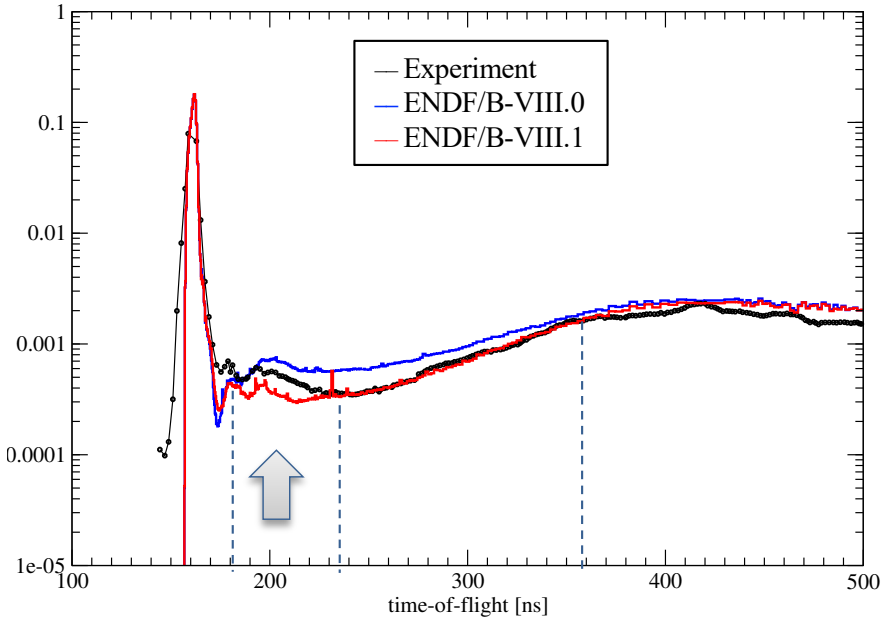
The Pu239 spectrum simulated with e81 shows improved agreement with experiment in the 190-240ns. Slight improvement for U235.

LLNL pulsed spheres: Cu and Pb

Cu



Pb



Cu: improved agreement with experiment compared to e80's.
Pb: improved agreement with experiment compared to e80's; the neutron count between 180-190 ns is lower than for e81b3 and the 'dip' observed for e81b3 between 190-215 ns is now partially filled.

Fission Ratios: comparison to e80

- Mercury/GNDS – MCNP6.2/ACE
- Reaction rates are normalized by ^{235}U(n,f)

Benchmark	Reaction Ratio	238U(n,f)	237Np(n,f)	233U(n,f)	239Pu(n,f)
Godiva	Mercury e81	*0.1581*	*0.8307*	*1.5794*	*1.3830*
	Mercury e80	0.1583	0.8315	1.5796	1.3846
	MCNP e80 *	0.1583	0.8318	1.5793	1.3846
	Mercury e81/e80	*0.9990*	*0.9990*	*0.9999*	*0.9988*
Jezebel	Mercury e81	*0.2109*	*0.9714*	*1.5663*	*1.4244*
	Mercury e80	0.2120	0.9768	1.5661	1.4271
	MCNP e80 *	*0.2121*	0.9770	1.5660	1.4273
	Mercury e81/e80	*0.9947*	*0.9945*	*1.0001*	*0.9981*
Flattop25	Mercury e81	*0.1447*	*0.7719*	*1.5779*	*1.3603*
	Mercury e80	0.1451	0.7731	1.5778	1.3620
	MCNP e80 *	0.1451	0.7735	*1.5664*	1.3622
	Mercury e81/e80	*0.9976*	*0.9985*	*1.0000*	*0.9987*

* Brown et al. NDS 148 (2018)

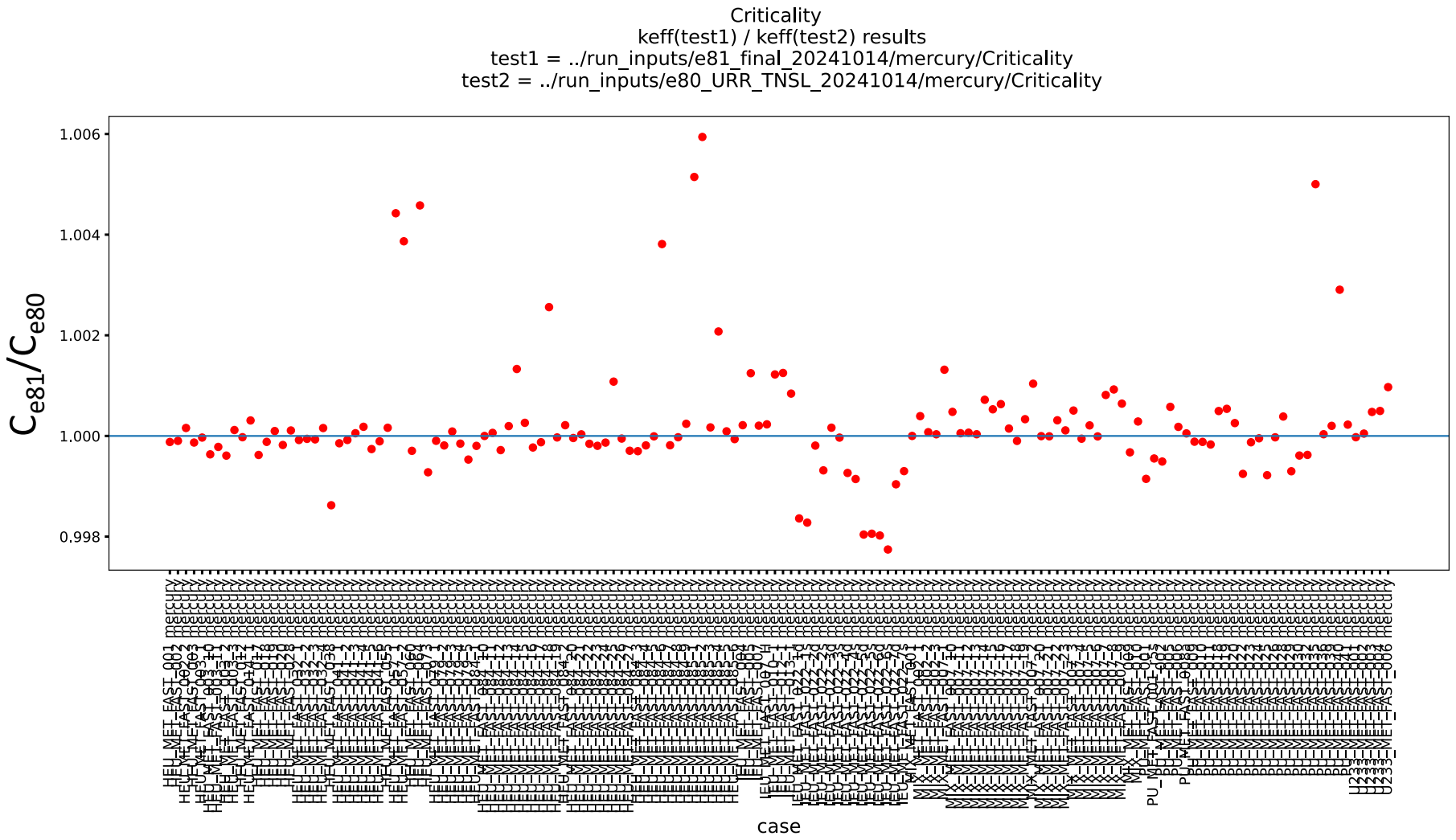
Fission Ratios: C_{e81}/E

Assembly	Quantity	U238f/U235f	Np237f/U235f	U233f/U235f	Pu239f/U235f
Godiva	Calc	*0.1581*	*0.8309 7*	*1.5794*	*1.3830*
(HMF001)	Exp-B	0.1643 ±0.0018	0.8516 ±0.012	*	1.4152 ±0.014
	Exp-A	0.1642 ±0.0018	0.8370 ±0.013	1.5900 ±0.03	1.4020 ±0.025
	Calc/Exp	***0.9623***	***0.9755***	***0.9933***	***0.9772***
Jezebel	Calc	*0.2109*	*0.9714*	*1.5663*	*1.424*
(PMF001)	Exp-B	0.2133 ±0.0023	0.9835 ±0.014	*	1.4609 ±0.013
	Exp-A	0.2137 ±0.0023	0.9620 ±0.016	1.578 ±0.027	1.448 ±0.029
	Calc/Exp	***0.9887***	***0.9877***	***0.9926***	***0.9750***
Jezebel-23	Calc	*0.2112*	*0.9842*		
(UMF001)	Exp-B	0.2131 ±0.0026	0.997 ±0.015		
	Exp-A	0.2131 ±0.0023	0.977 ±0.016		
	Calc/Exp	***0.9912***	***0.9872***		
Flattop-25	Calc	*0.1447*	*0.7719*	*1.5779*	*1.3603*
(HMF028)	Exp-B	0.1492 ±0.0016	0.7804 ±0.01	1.608 ±0.003	1.3847 ±0.012
	Exp-A	0.1490 ±0.002	0.7600 ±0.01	1.600 ±0.003	1.3700 ±0.02
	Calc/Exp	***0.9699***	***0.9892***	***0.9813***	***0.9824***
Flattop-Pu	Calc	*0.1779*	*0.8508*		
(PMF006)	Exp-B	0.1799 ±0.002	0.8561 ±0.012		
	Exp-A	0.1800 ±0.003	0.84 ±0.01		
	Calc/Exp	***0.9889***	***0.9938***		
Flattop-23	Calc	*0.1872*	*0.8992*		
(UMF006)	Exp-B	0.1916 ±0.0021	0.9103 ±0.013		
	Exp-A	0.1910 ±0.003	0.8900 ±0.01		
	Calc/Exp	***0.9771***	***0.9878***		

Summary

- Simulations of fast critical assemblies and LLNL pulsed spheres
- Cumulative Chi2 plot of criticality benchmarks indicates improvements from ENDF/B-VIII.0 and ENDF/B-VIII.1
- Small changes compared to ENDF/B-VIII.1 beta4
- Dominated by changes to Cu and Pb evaluations
- U233 evaluation = ENDF/B-VIII.1 beta3

Criticality: comparison C_{e81}/ C_{e80}



This work was performed under the auspices of the U.S. Department of Energy by Lawrence Livermore National Laboratory under contract DE-AC52-07NA27344. Lawrence Livermore National Security, LLC