ENDF/B-IX phase 2 Preliminary Validation Results

CSEWG

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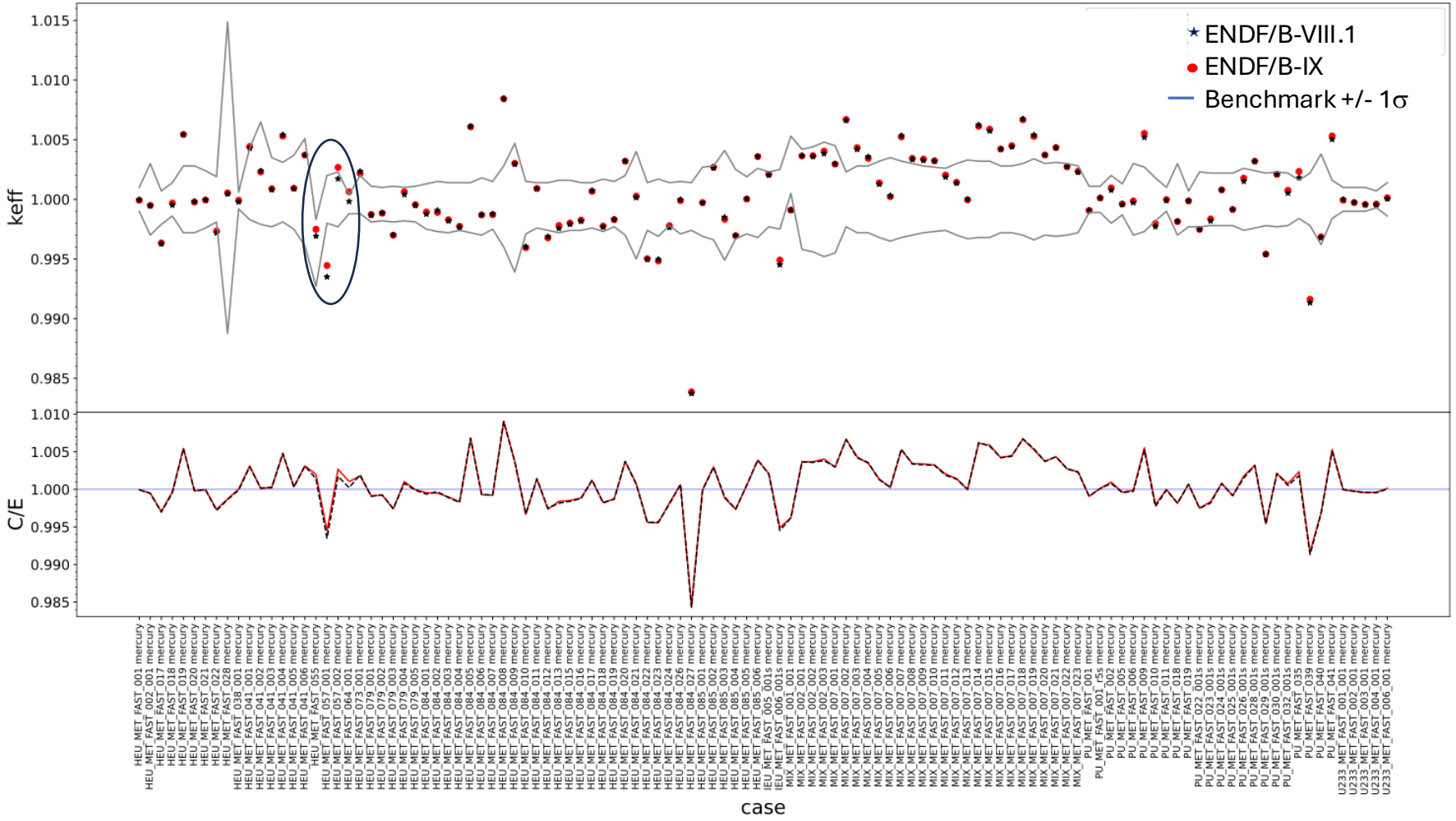
Prepared by LLNL under Contract DE-AC52-07NA27344.

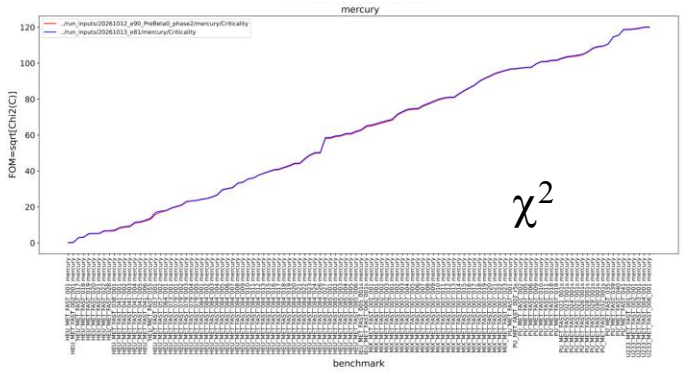
ENDF/B-IX phase 2 evaluations

- ENDF/B-IX Phase 2 was processed with FUDGE 6.14
  - 32 evaluation files
  - does not include Phase 1 evaluation files for ^{35,37}Cl, ^{234}U, ^{239}Pu
- Other isotopic evaluations are taken from ENDF/B-VIII.1 including ^{139}La and ^{29}Si
- TNSL and URR also from ENDF/B-VIII.1, at T=293.6K
- Simulations using the Mercury Monte Carlo transport code version 5.51.0 and continuous energy cross sections. Statistical error <1e-4
- Mercury tests:
  - 175 fast criticality benchmarks; fission ratios, 17 LLNL pulsed spheres.
  - no covariance testing.

Phase 2 evaluations	
n-004_Be_009.endf	n-016_S_032.endf
n-006_C_012.endf	n-016_S_035.endf
n-007_N_014.endf	n-020_Ca_040.endf
n-007_N_015.endf	n-020_Ca_041.endf
n-008_O_016.endf	n-025_Mn_055.endf
n-008_O_017.endf	n-026_Fe_054.endf
n-009_F_019.endf	n-050_Sn_126.endf
n-011_Na_022.endf	~~*n-057_La_139.endf*~~
n-011_Na_023.endf	n-060_Nd_150.endf
n-012_Mg_024.endf	n-073_Ta_181.endf
n-012_Mg_025.endf	n-082_Pb_207.endf
n-013_Al_027.endf	n-082_Pb_208.endf
n-014_Si_028.endf	n-092_U_238.endf
~~*n-014_Si_029.endf*~~	n-094_Pu_238.endf
n-014_Si_030.endf	n-094_Pu_240.endf
n-014_Si_031.endf	n-094_Pu_241.endf
n-014_Si_032.endf	n-094_Pu_242.endf

”Standard” Mercury suite: No major differences observed between ENDF/B-VIII.1 and –IX phase 2





Mean absolute bias: $\Sigma_i|C_i-E_i|/N$

<u>Mercury</u>

ENDF/B-VIII.1 = 247 pcm

ENDF/B-IX = 249 pcm

Results are similar for the newly implemented Modern criticality suite

Mercury suite now includes 61 Modern benchmark cases (ref: *LA-UR-25-29811)*:

- Work In Progress!
- EUCLID3x2 bias ~-200 pcm
- 5 “outliers” likely related to Mercury models: HMF86, HMI13(7), PMM3 (1-3)

Mean absolute bias:

$\Sigma_i|C_i-E_i|/N$

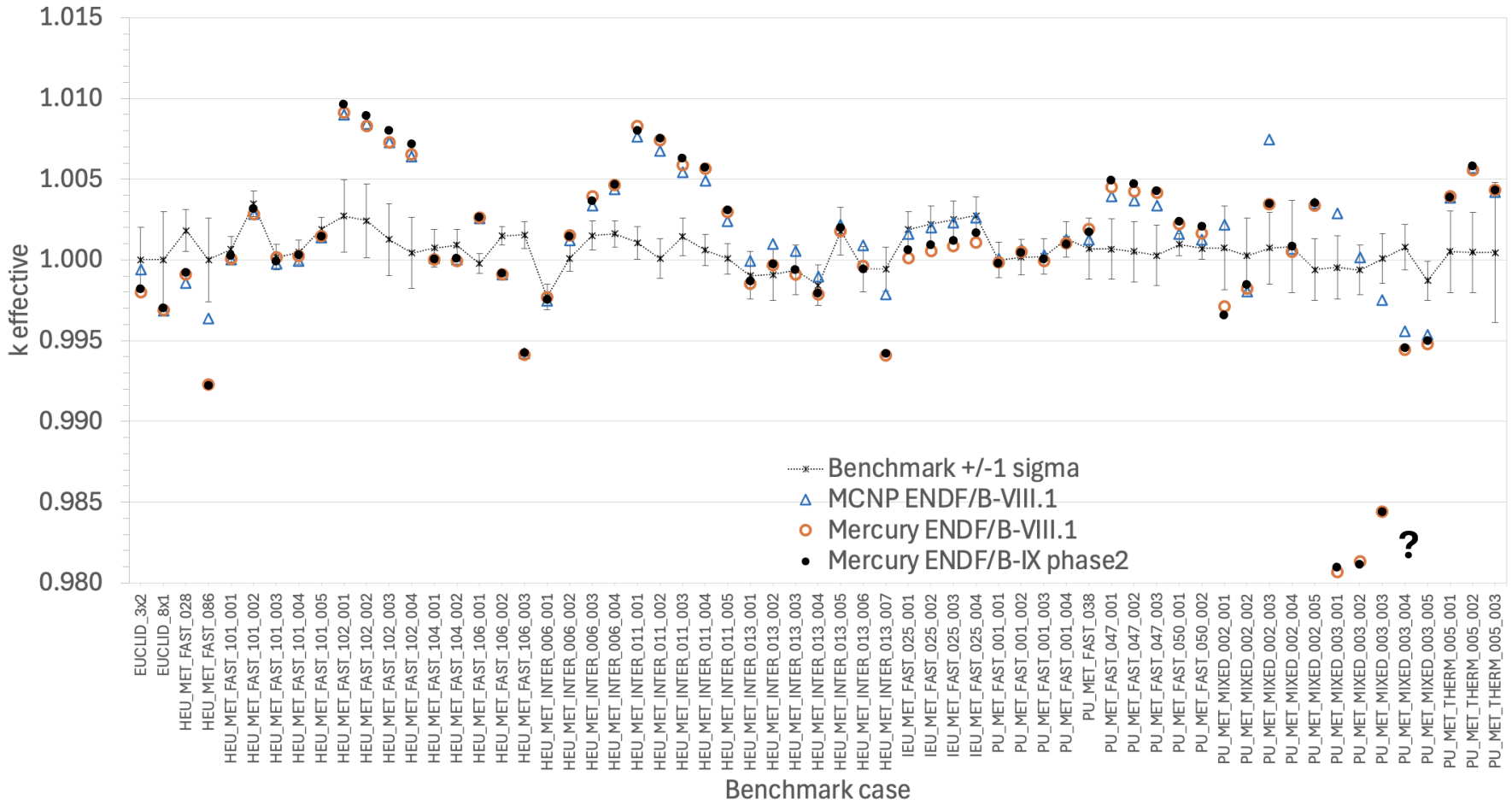
<u>MCNP</u>

ENDF/B-VIII.1 = 260 pcm

<u>Mercury w/o PMM3(1-3)</u> :

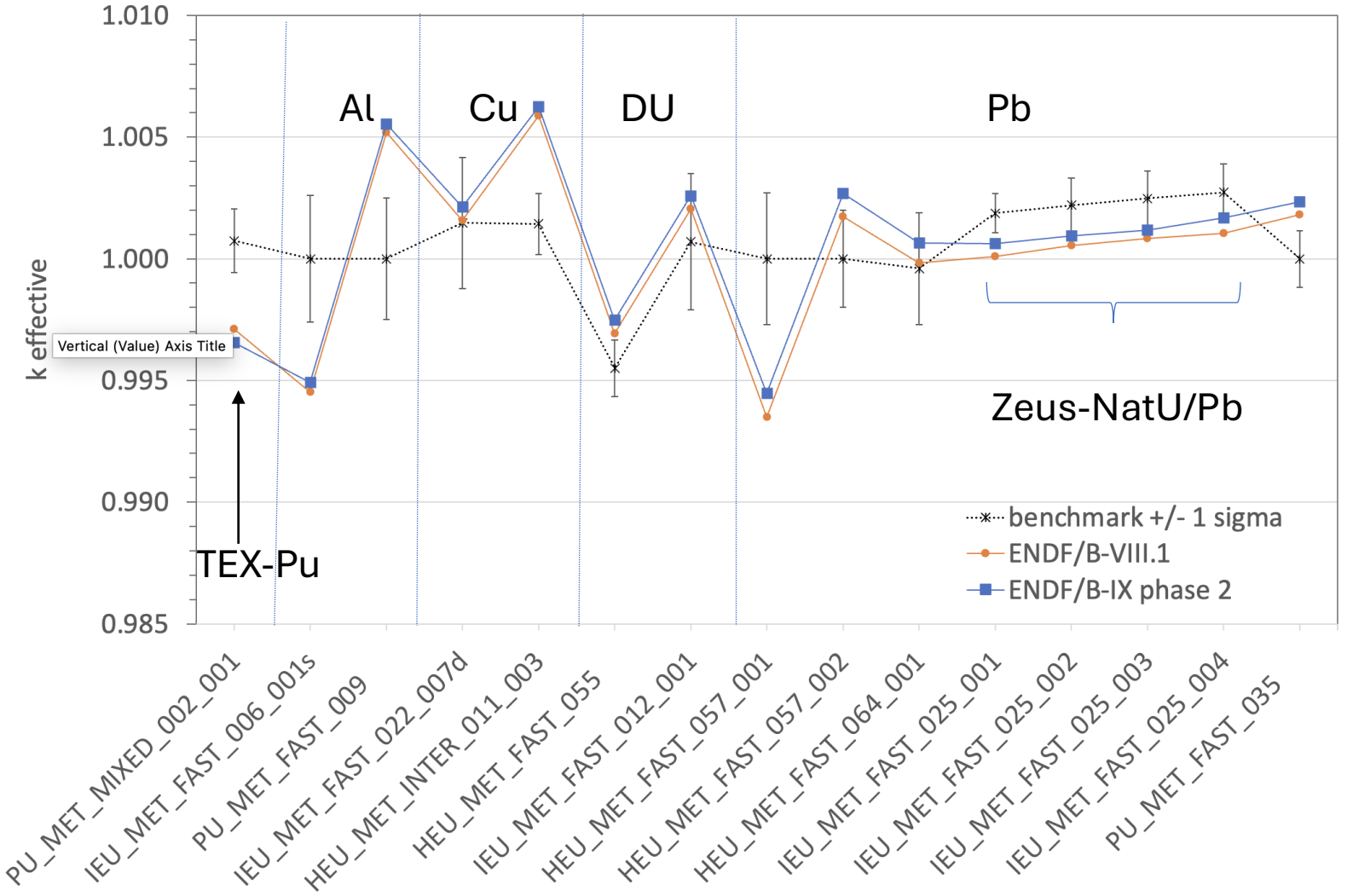
ENDF/B-VIII.1 = 265 pcm

ENDF/B-IX ph2 = 269 pcm



15 of 175 criticality simulations differ by > 3e-4

- 'Largest' differences between the 2 libraries are still small
- ENDF/B-IX yields lower keff for TEX_Pu (case 1)
- ENDF/B-IX yields higher k effective for 14 benchmarks including cases with Pb reflectors
- ENDF/B-IX ^{208}Pb: changes in angular distribution for elastic scattering

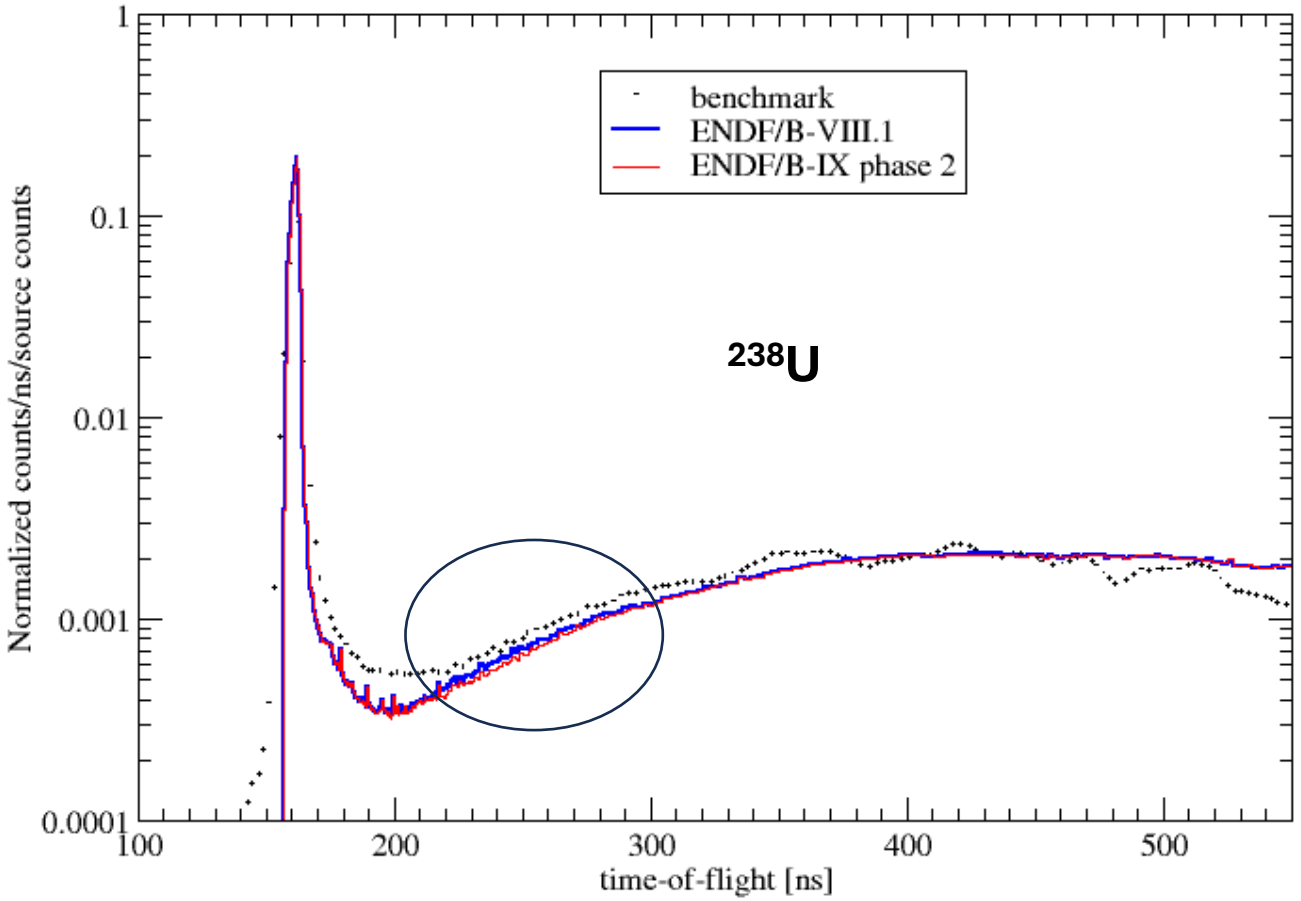


Fission Ratios: C_{e90}/Ce_{81}

- Fission ratio (FR)=fission rate normalized by ^{235}U fission rate
- Small to no variations from ENDF/B-VIII.1 to ENDF/B-IX
- ENDF/B-IX ^{238}U FR in Flattop-25 increased by 1e-3

Benchmark	Fission Ratio+	238U(n,f)	237Np(n,f)	233U(n,f)	239Pu(n,f)
Godiva	e90	0.1581	0.8307	1.5795	1.3830
	e81	0.1581	0.8307	1.5794	1.3830
	e90/e81	***1.0000***	***1.0000***	***1.0001***	***1.0000***
Jezebel	e90	0.2110	0.9716	1.5663	1.4245
	e81	0.2109	0.9715	1.5663	1.4244
	e90/e81	***1.0000***	***1.0001***	***1.0000***	***1.0000***
Flattop25	e90	0.1446	0.7728	1.5784	1.3610
	e81	0.1448	0.7721	1.5779	1.3604
	e90/e81	***0.9986***	***1.0010***	***1.0003***	***1.0005***
Flattop-Pu (PMF006)	e90	0.1780	0.8511		
	e91	0.1780	0.8509		
	e90/e81	***1.0003***	***1.0002***		
Jezebel-23 (UMF001)	e90	0.2112	0.9843		
	e81	0.2112	0.9842		
	e90/e81	***1.0001***	***1.0001***		
Flattop-23 (UMF006)	e90	0.1873	0.8992		
	e81	0.1872	0.8992		
	e90/e81	***1.0008***	***1.0000***		

LLNL pulsed spheres



Spectra are unchanged for C, N_2, Water, Teflon, Al, Si, Ti, Fe, Cu, Ta, Pb, W, Au, ^{232}Th, ^{235}U, ^{239}Pu.
ENDF/B-IX **^{238}U** spectrum is slightly lower in the 210-290 ns region

Summary

- Validated ENDF/B-IX phase 2 in GNDS format:
  - 32 evaluations
  - Other isotopes from ENDF/B-VIII.1 processed at 296.3 K, includes TNSL and URR
- Differences with ENDF/B-VIII.1 results are small
  - Average mean bias of 175 fast criticality benchmarks increased by +4pcm

EXTRAS

Fission ratios: C/E

Assembly	Quantity	U238f/U235f	Np237f/U235f	U233f/U235f	Pu239f/U235f
Godiva (HMF001)	Calc	0.1581	0.8307	1.5795	1.3830
	Exp-B	0.1643 ±0.0018	0.8516 ±0.012	*	1.4152 ±0.014
	Exp-A	0.1642 ±0.0018	0.8370 ±0.013	1.59 ±0.03	1.402 ±0.025
	Calc/Exp	***0.9620***	***0.9755***	***0.9934***	***0.9773***
Jezebel (PMF001)	Calc	0.2110	0.9716	1.5663	1.4245
	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	***0.9890***	***0.9879***	***0.9926***	***0.9751***
Jezebel-23 (UMF001)	Calc	0.2112	0.9843		
	Exp-B	0.2131 ±0.0026	0.997 ±0.015		
	Exp-A	0.2131 ±0.0023	0.977 ±0.016		
	Calc/Exp	***0.9912***	***0.9873***		
Flattop-25 (HMF028)	Calc	0.1446	0.7728	1.5784	1.3610
	Exp-B	0.1492 ±0.0016	0.7804 ±0.01	1.608 ±0.003	1.3847 ±0.012
	Exp-A	0.149 ±0.002	0.76 ±0.01	1.6 ±0.003	1.37 ±0.02
	Calc/Exp	***0.9691***	***0.9903***	***0.9816***	***0.9829***
Flattop-Pu (PMF006)	Calc	0.1780	0.8511		
	Exp-B	0.1799 ±0.002	0.8561 ±0.012		
	Exp-A	0.18 ±0.003	0.84 ±0.01		
	Calc/Exp	***0.9894***	***0.9941***		
Flattop-23 (UMF006)	Calc	0.1873	0.8992		
	Exp-B	0.1916 ±0.0021	0.9103 ±0.013		
	Exp-A	0.191 ±0.003	0.89 ±0.01		
	Calc/Exp	***0.9778***	***0.9878***		