Tests results of ENDF/B.VIII.1.β2 in GNDS format

CSEWG 2023

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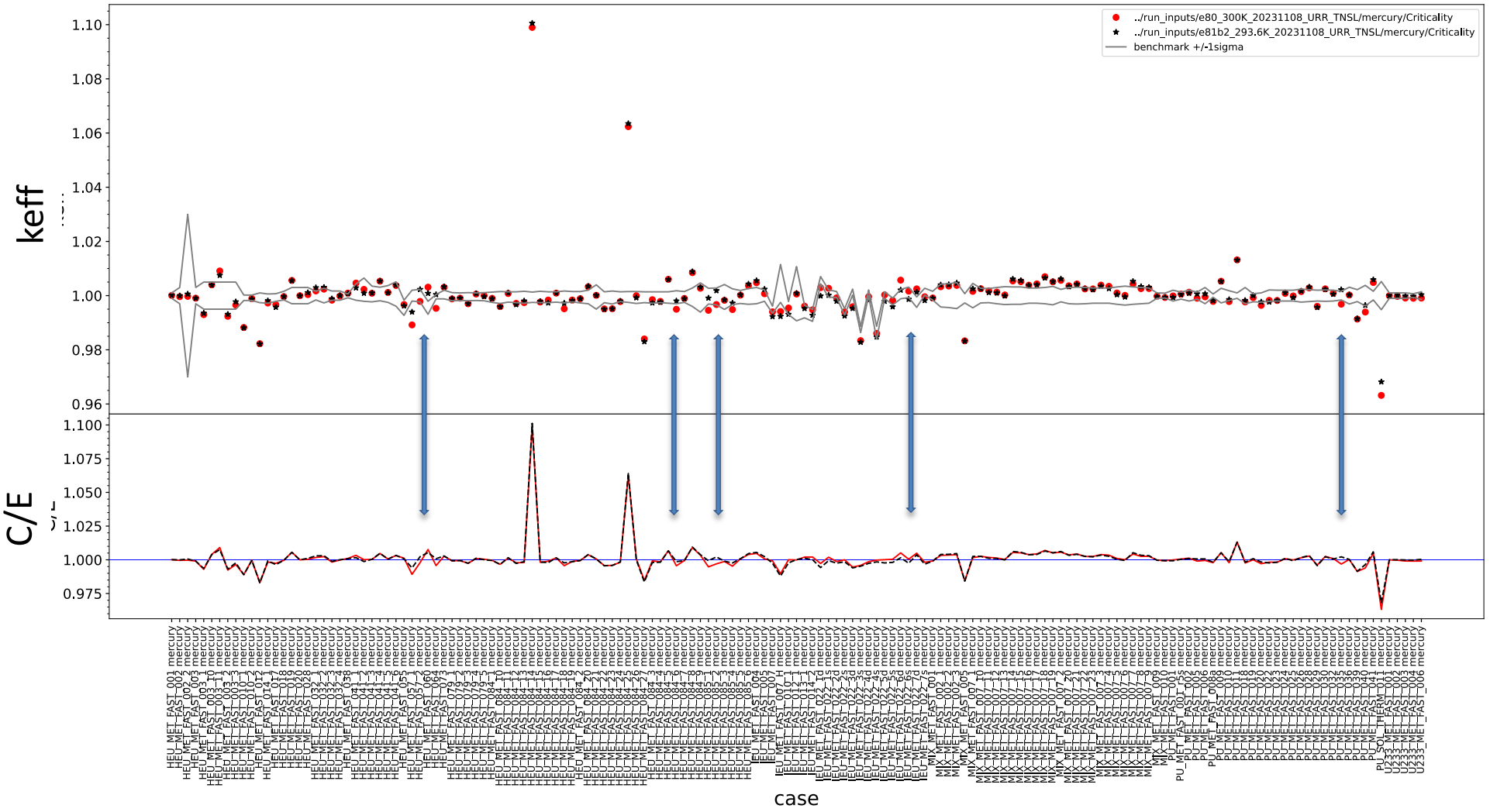
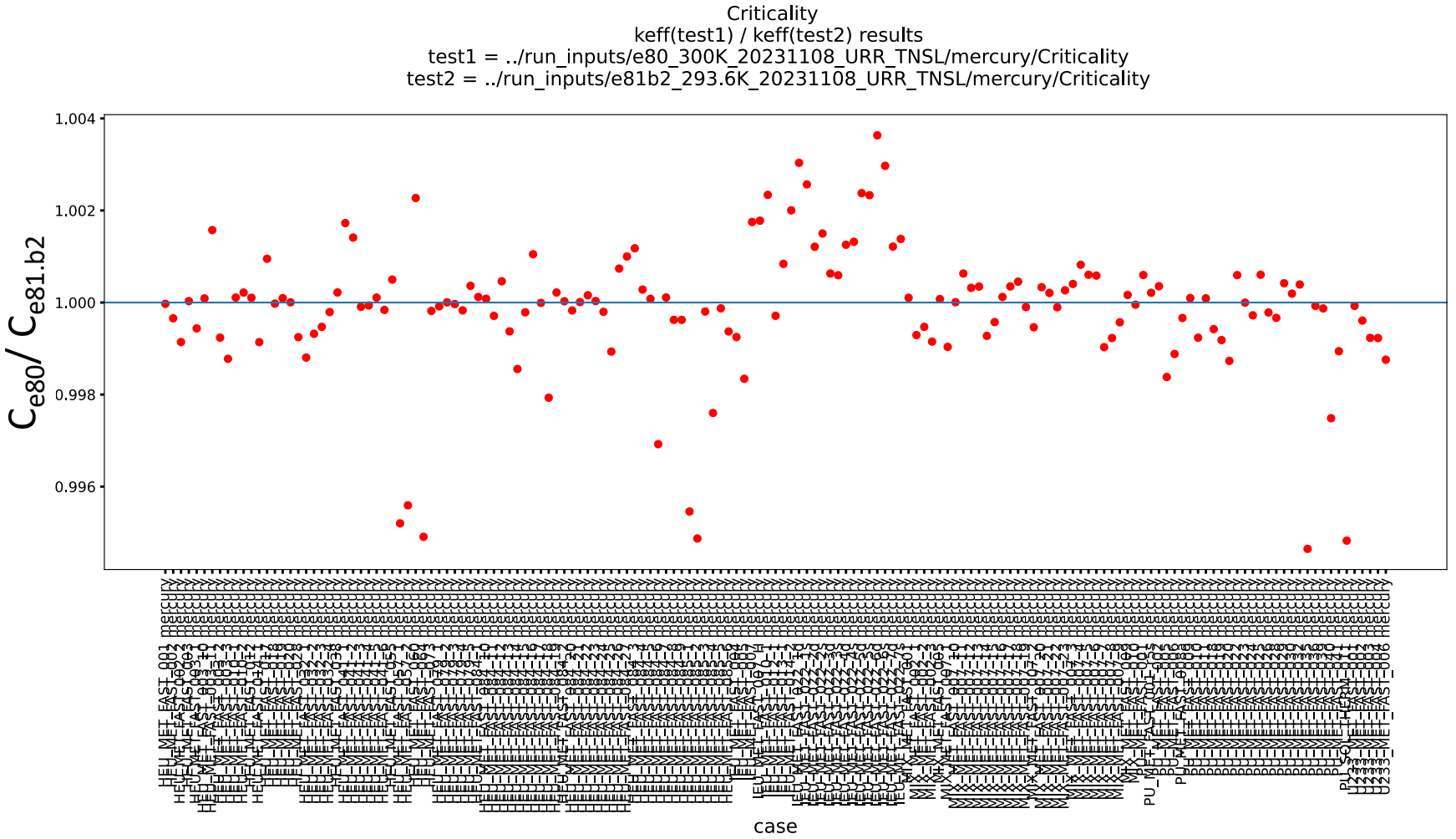
The ENDF/B-VIII.x evaluations were processed with FUDGE 6.1.0 in GNDS 2.0 format

- Beta 2: 557 isotopes
- URR Probability Tables except for
  - ENDF/B-VIII.0 timeout: 17; fail: Sn112, Pt192 T=300.0K
  - ENDF/B-VIII.1.beta1, long processing time Pa231, Pa 233, Eu; no fail T=293.6K
  - ENDF/B-VIII.1.beta2 T=293.6K
- TNSL processed, 25/88 TNSL files accessed by Mercury,
  - cases with H2O,D2O,CH2, Be, BeO
- Metis: 147 Fast Critical Assemblies/ 73 Thermal
- Mercury MC transport code
  - Version: 5.36.1
  - GIDI+: 3.27.9

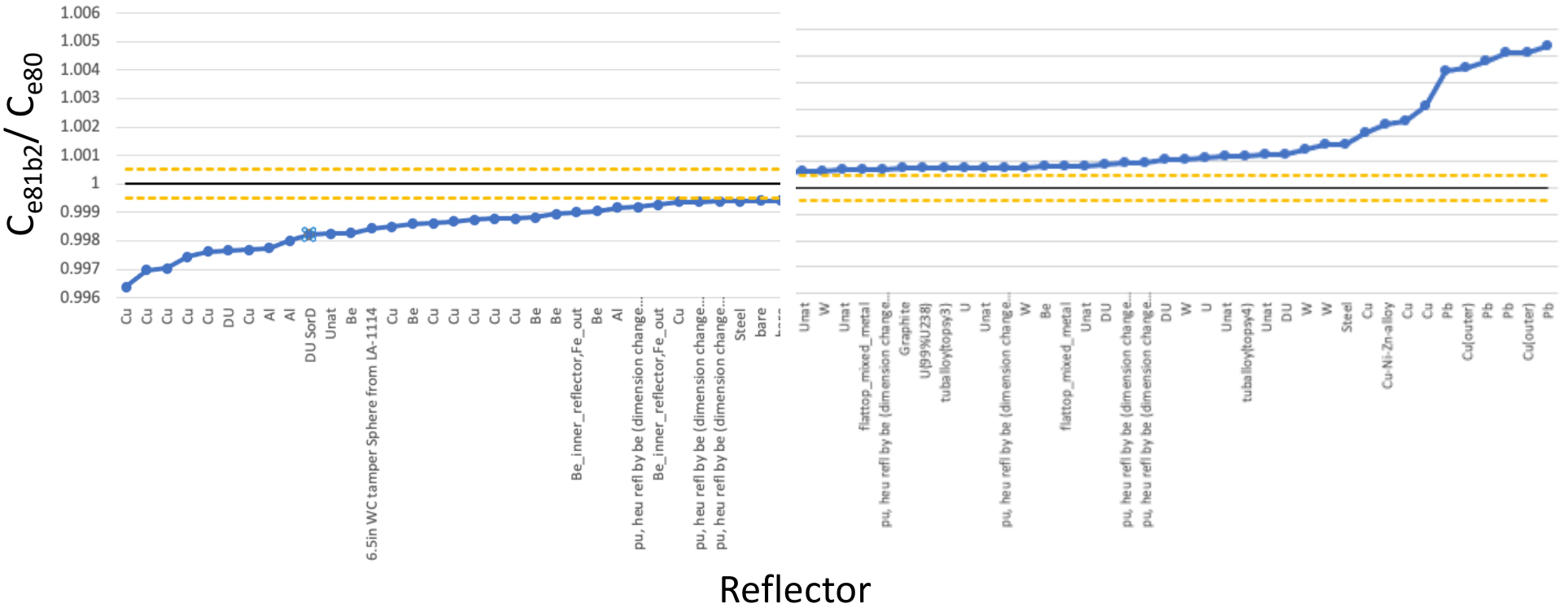
Criticality: comparison to ENDF/B-VIII.0 $C_{e81beta2}$ and C_{e80}



Criticality: comparison to ENDF/B-VIII.0 $C_{e80}/C_{e81.beta2}$

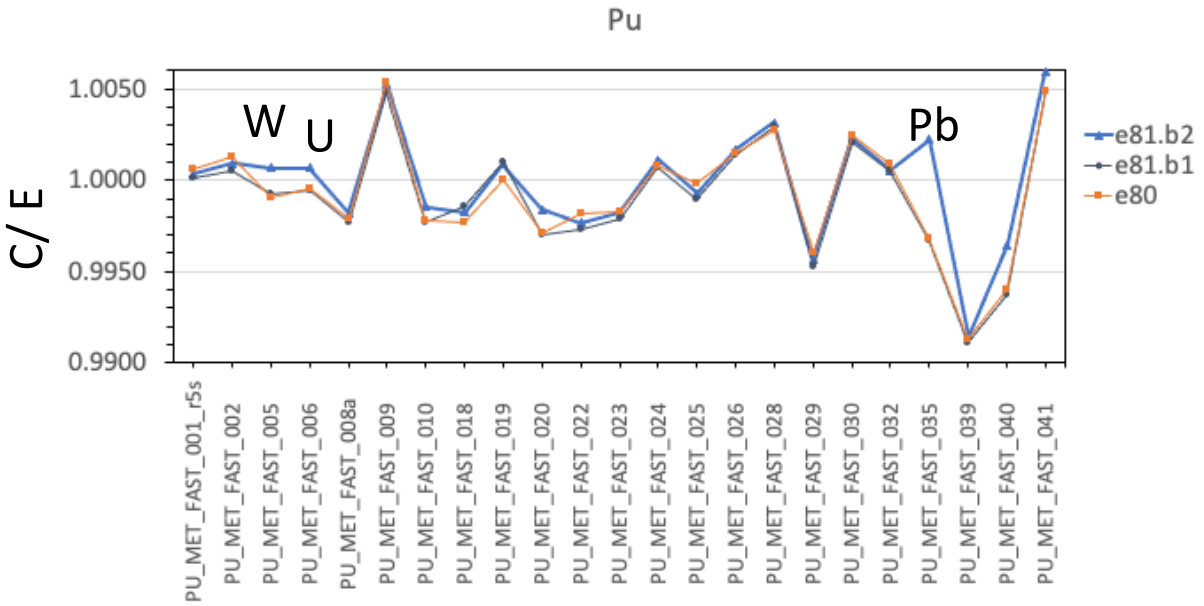


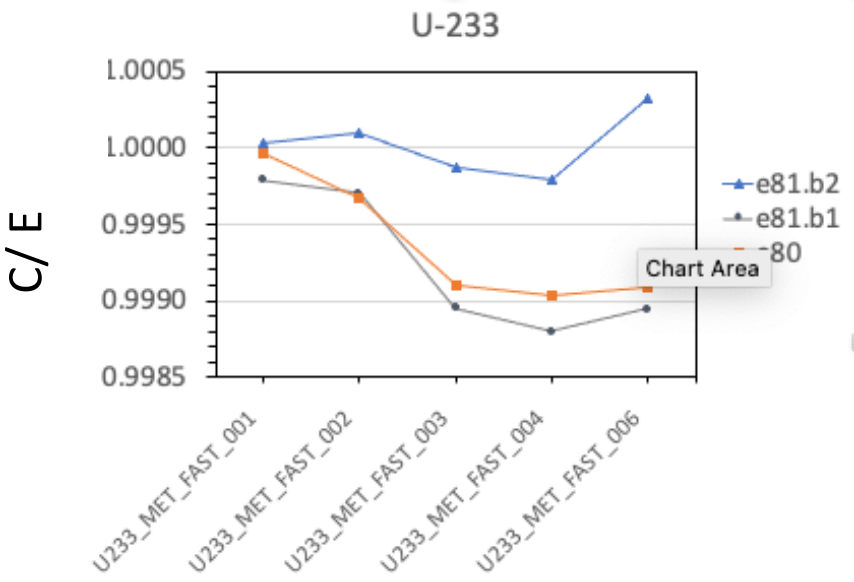
Now, Criticality: C_{e81b2}/C_{e80}



Cases with IMF22(Cu) reflectors and Pb show largest differences; Al, Du and U nat & W

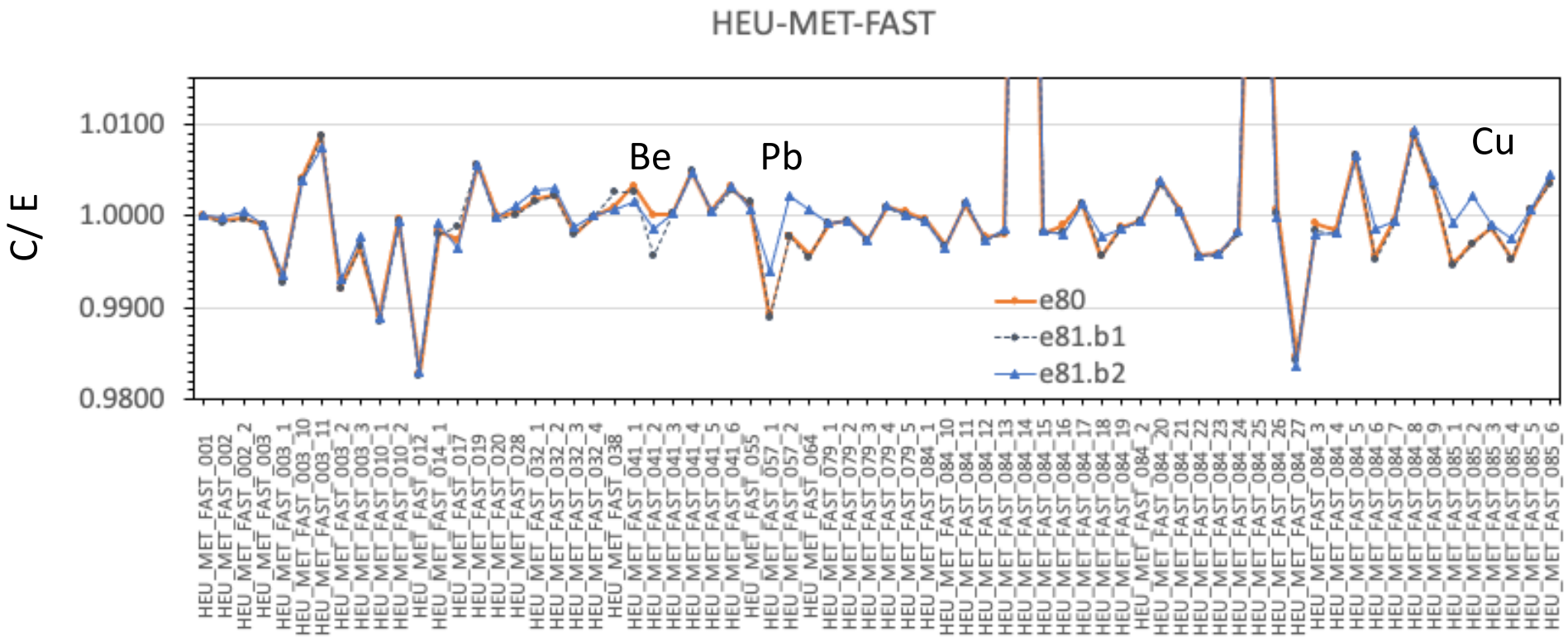
C/E Criticality: PU, U233





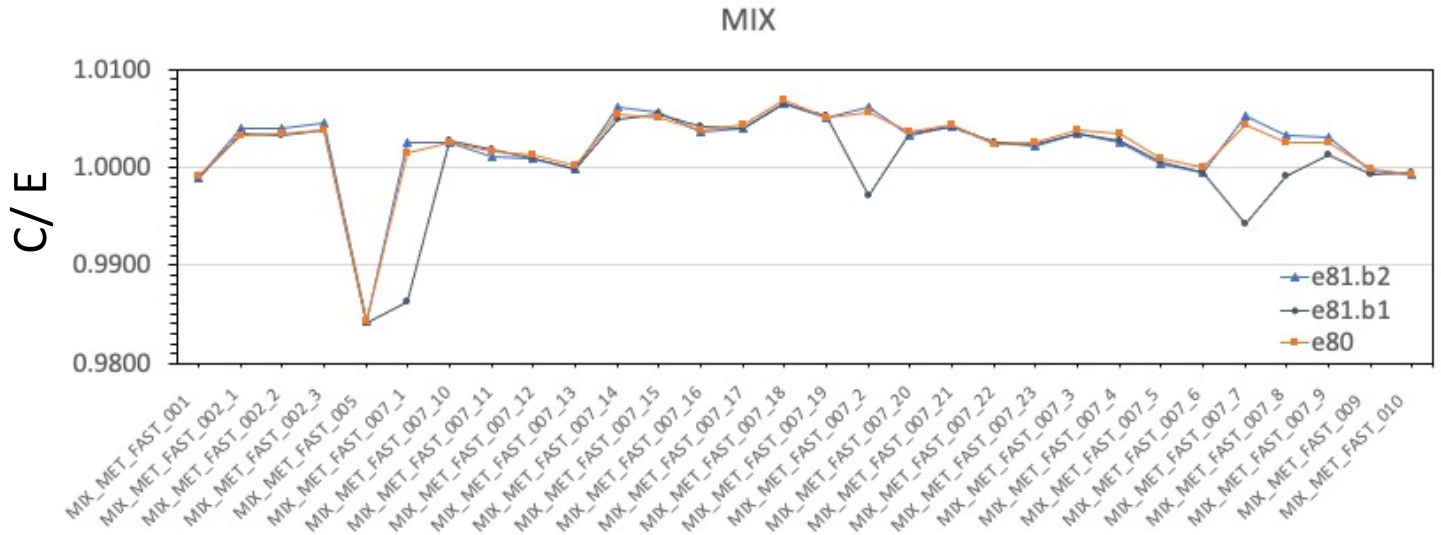
Jezebel rev 5 simplified excellent agreement, PMF good agreement
UMF overall improvement

C/E Criticality: PU, HEU, U233



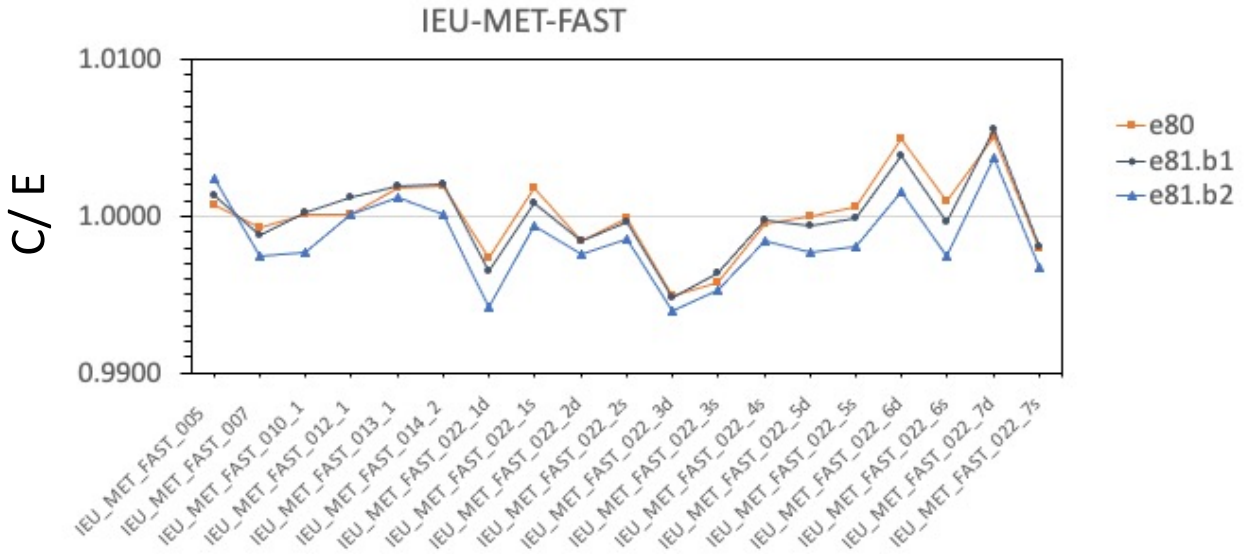
HMF improvements seem to be driven by changes to Cu, Pb, Be

C/E Criticality: MIX, IEU

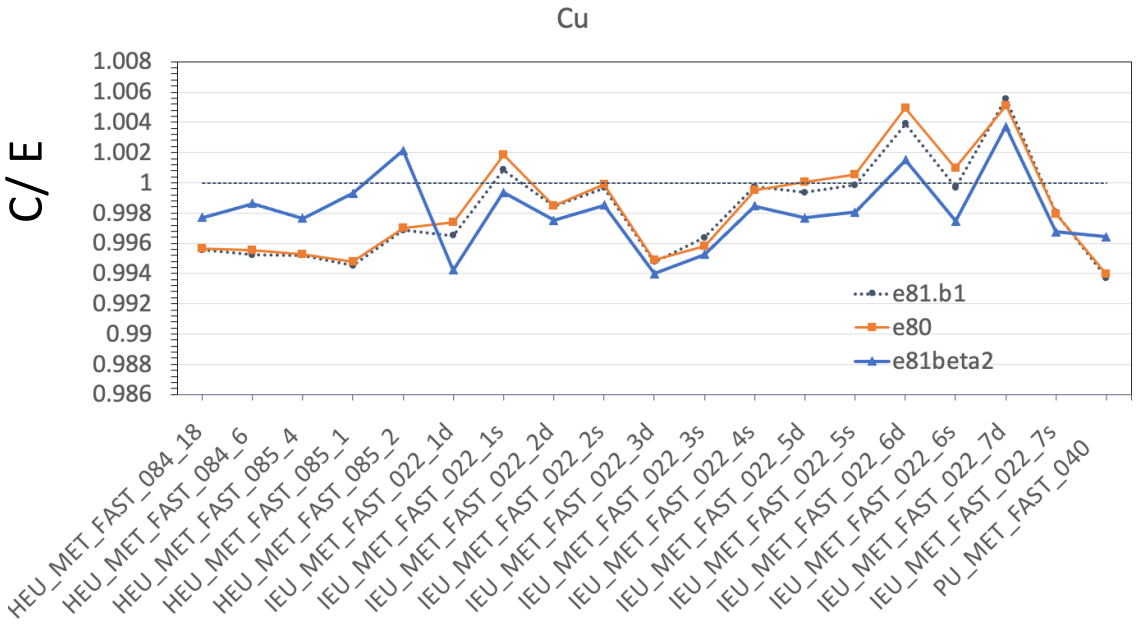


E81.b1 low k_{eff} :Be

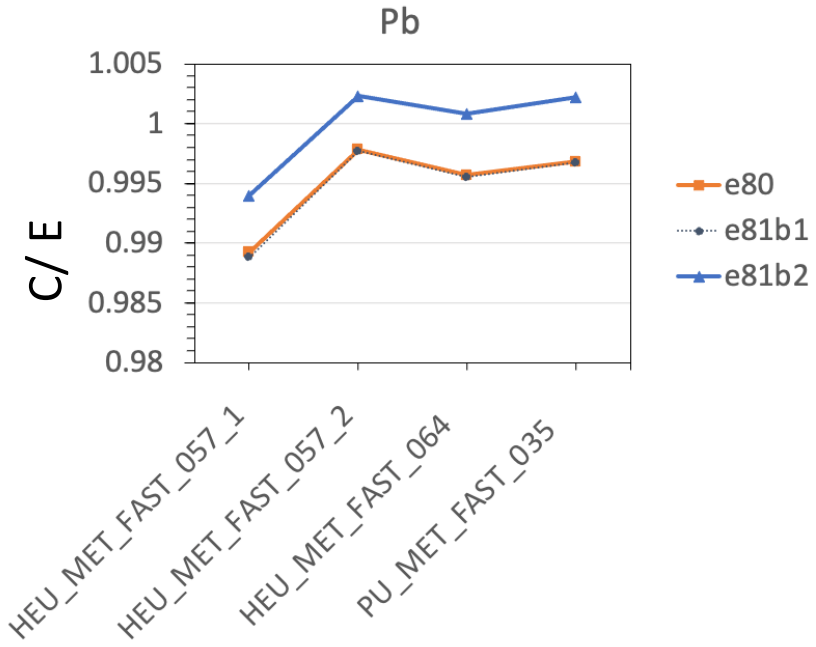
IMF overall decrease in k_{eff}, overall poorer agreement when including IMF022 (Cu)



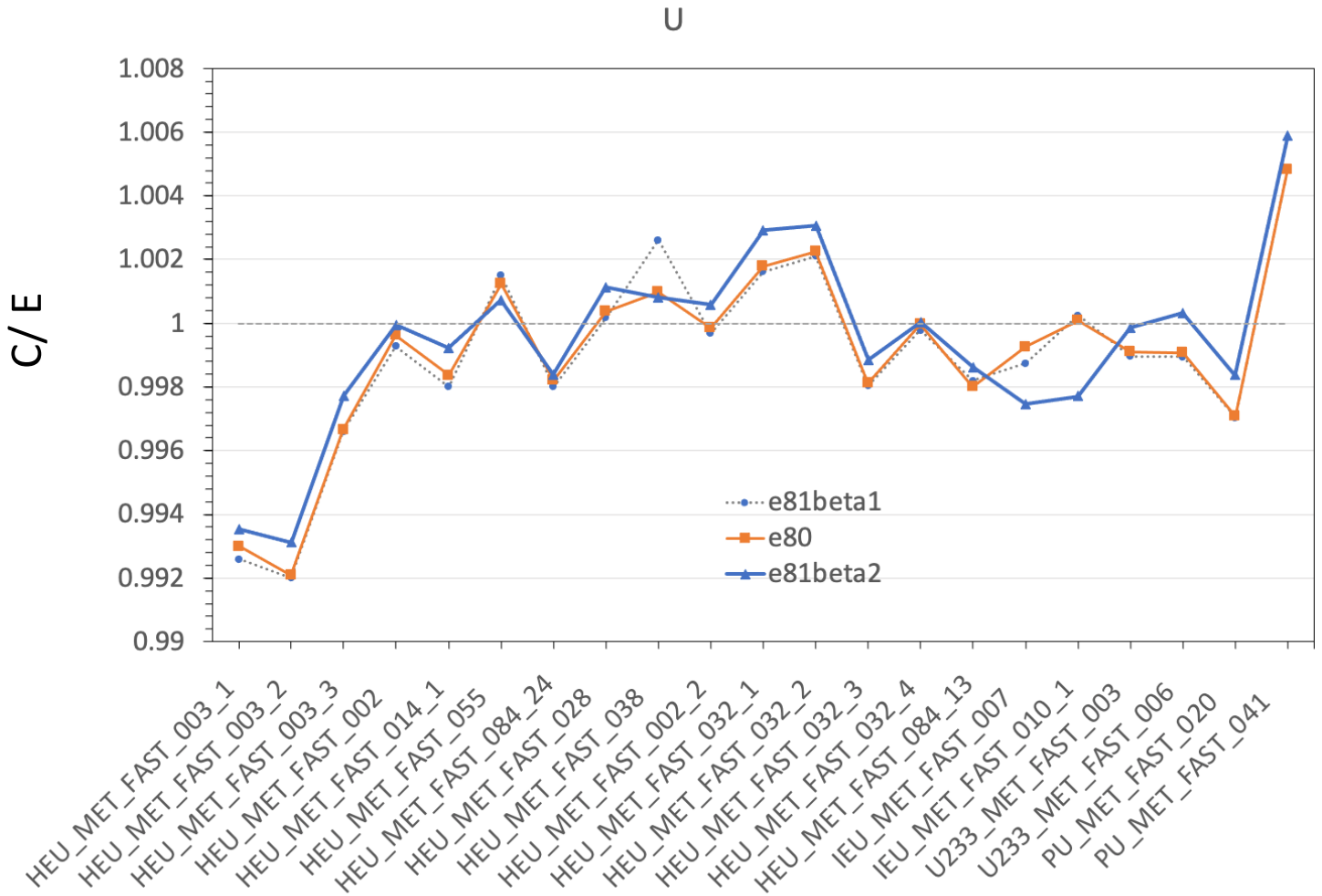
Reflector: Cu, Pb



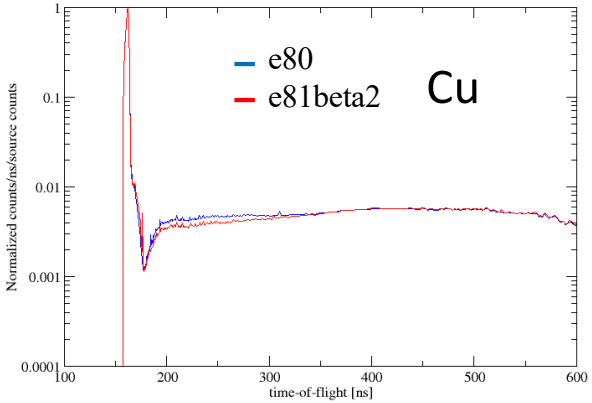
Cu: HMF better agreement while for IMF agreement is worse
Pb: C/E improved

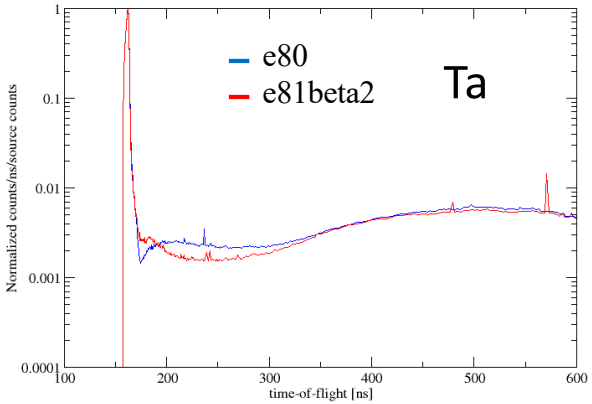


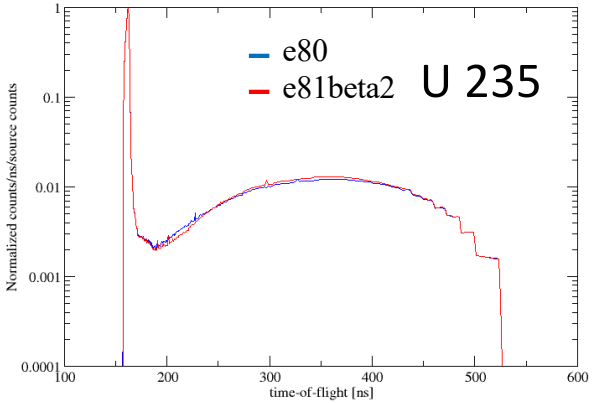
Reflector: U, DU, tuballoy

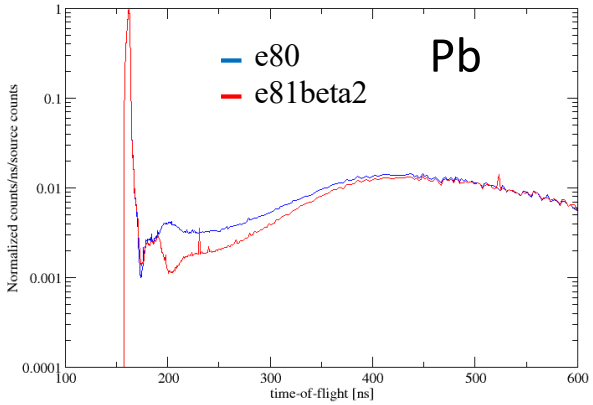


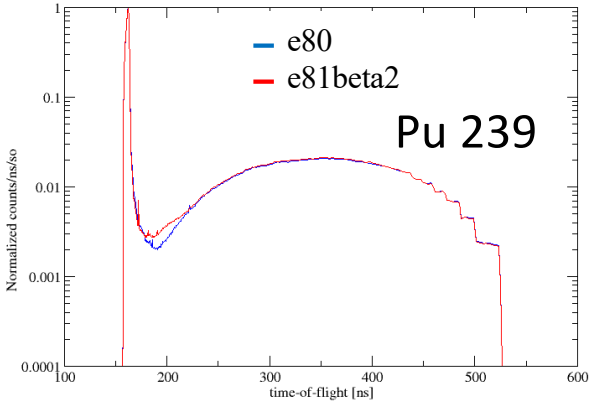
LLNL pulsed spheres





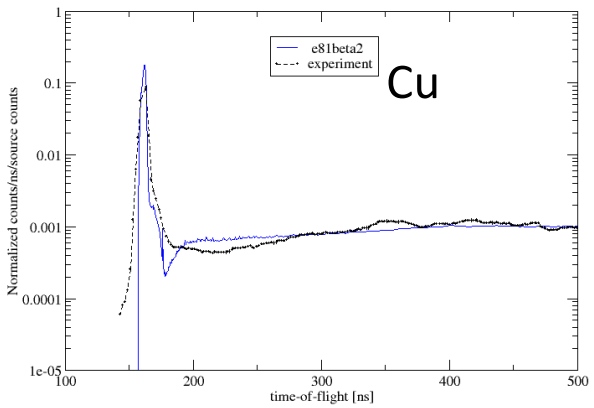


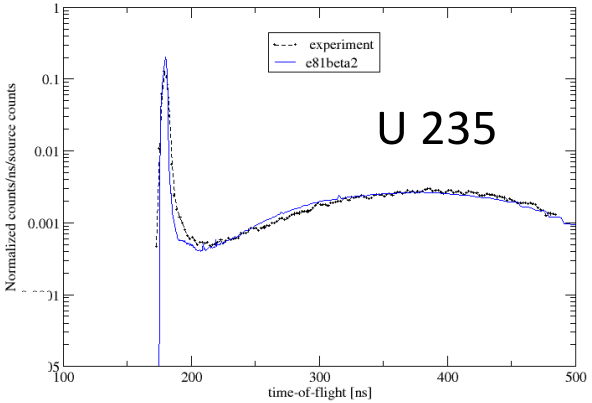


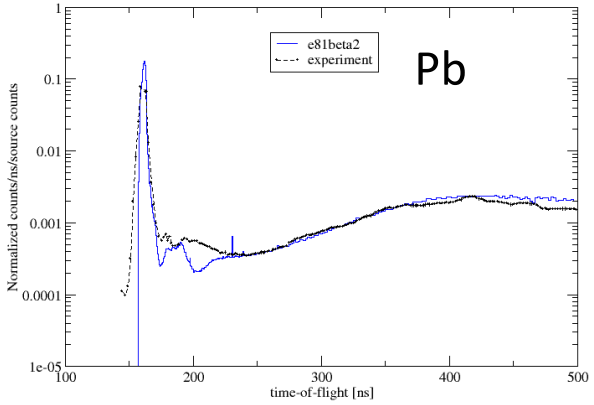


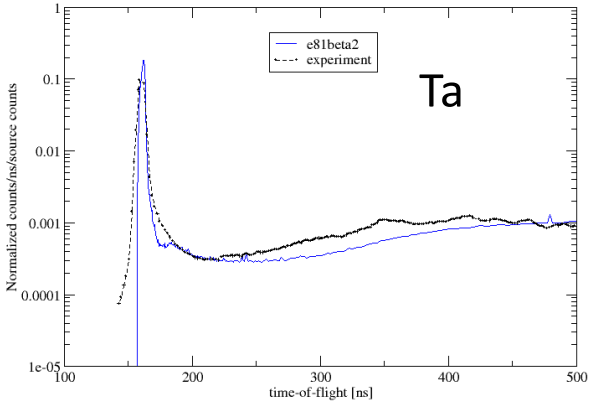
Pb, Ta, Pu239 show spectral changes, smaller effect seen for Cu and U235

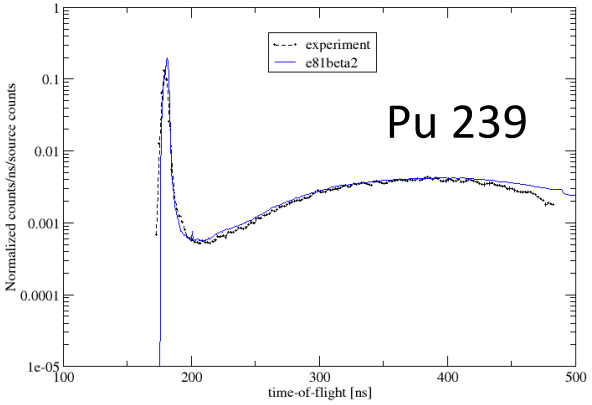
LLNL pulsed spheres











Pu239 improved; U235 and Cu similar; Ta local improvement; Pb should be reviewed

Fission Ratios: comparison to e80

- Mercury/GNDS – MCNP6.2/ACE

* Brown et al. NDS 148 (2018)

- 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 e81b2	0.1580	0.8301	1.5795	1.3831
	Mercury e80	0.1583	0.8315	1.5796	1.3846
	MCNP e80 *	0.1583	0.8318	1.5793	1.3846
	Mercury e81b2/e80	0.9980	0.9983	0.9999	0.9989
Jezebel	Mercury e81b2	0.2108	0.9711	1.5661	1.4246
	Mercury e80	0.2107	0.9768	1.5661	1.4271
	MCNP e80 *	*0.2121*	0.9770	1.5660	1.4273
	Mercury e81b2/e80	1.0005	0.9942	1.0000	0.9982
Flattop25	Mercury e81b2	0.1448	0.7726	1.5779	1.3607
	Mercury e80	0.1451	0.7732	1.5779	1.3621
	MCNP e80 *	0.1451	0.7735	*1.5664*	1.3622
	Mercury e81b2/e80	0.9979	0.9992	1.0000	0.9990

Fission Ratios: C_{e81b2}/E

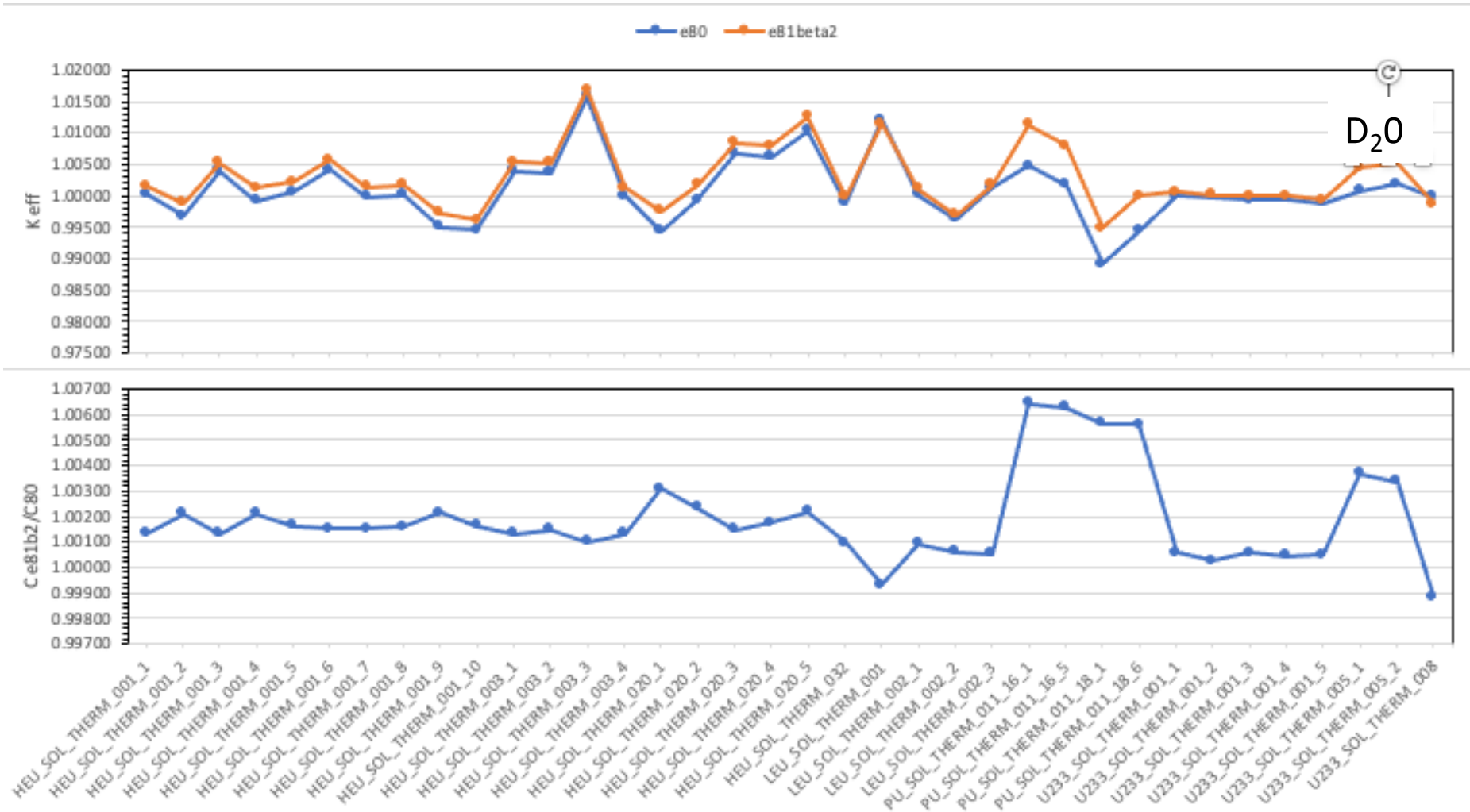
Assembly	Quantity	U238f/U235f	Np237f/U235f	U233f/U235f	Pu239f/U235f
Godiva	Calc	0.1580	0.8301	1.5795	1.3831
(HMF001)	Exp-B	0.1643 ±0.0018	0.8516 ±0.012	*	1.4152 ±0.014
	Exp-A	0.1642 ±0.0018	0.8370 ±0.013	1.5900 ±0.03	1.4020 ±0.025
	Calc/Exp	***0.9614***	***0.9748***	***0.9934***	***0.9773***
Jezebel	Calc	0.2108	0.9711	1.5661	1.4246
(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	***0.9883***	***0.9874***	***0.9925***	***0.9752***
Jezebel-23	Calc	0.2114	0.9851		
(UMF001)	Exp-B	0.2131 ±0.0026	0.997 ±0.015		
	Exp-A	0.2131 ±0.0023	0.977 ±0.016		
	Calc/Exp	***0.9922***	***0.9881***		
Flattop-25	Calc	0.1448	0.7726	1.5779	1.3607
(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	***0.9705***	***0.9900***	***0.9813***	***0.9827***
Flattop-Pu	Calc	0.1778	0.8503		
(PMF006)	Exp-B	0.1799 ±0.002	0.8561 ±0.012		
	Exp-A	0.1800 ±0.003	0.84 ±0.01		
	Calc/Exp	***0.9881***	***0.9933***		
Flattop-23	Calc	0.1873	0.8994		
(UMF006)	Exp-B	0.1916 ±0.0021	0.9103 ±0.013		
	Exp-A	0.1910 ±0.003	0.8900 ±0.01		
	Calc/Exp	***0.9776***	***0.9880***		

Summary

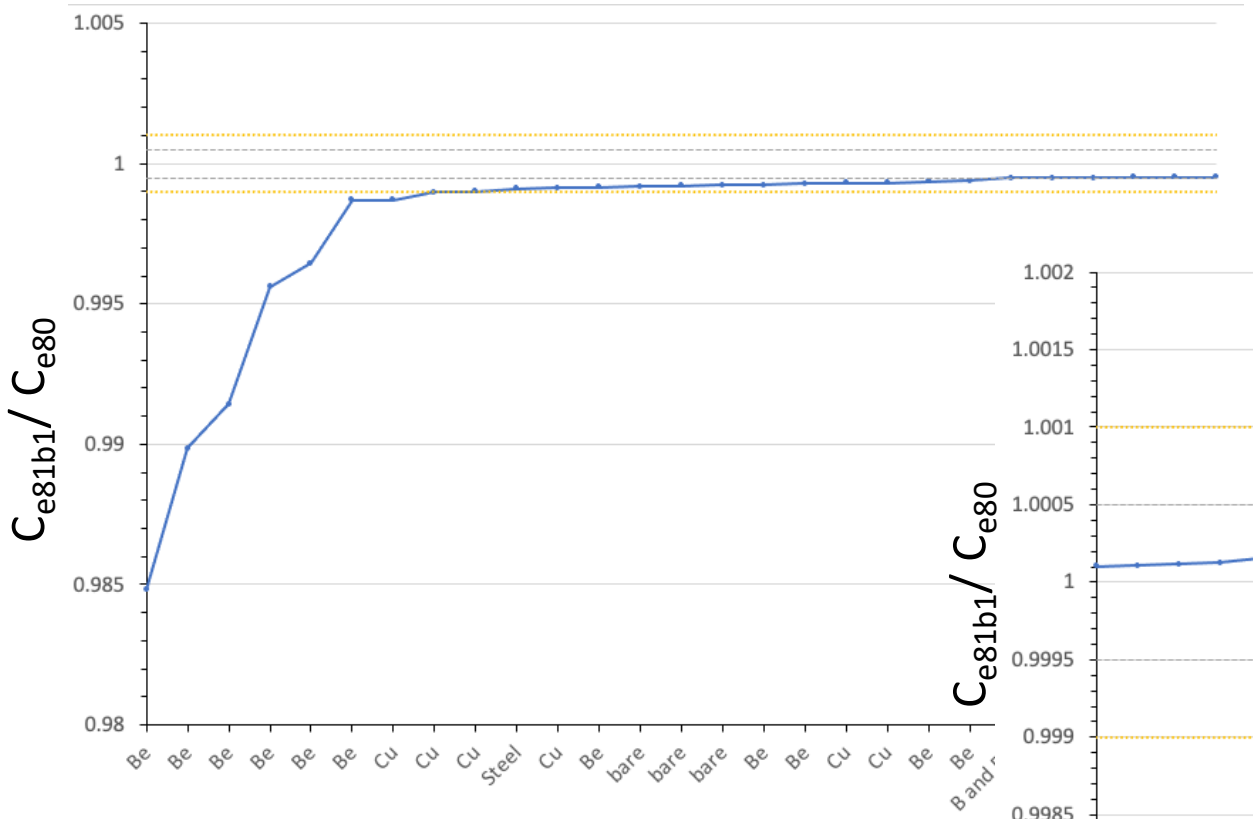
- C/E of U233-MET-FAST benchmarks were improved when using ENDF/B-VIII.1 beta2 compared to VIII.0 and VIII.1beta1
- C/E of HEU and PU-MET-FAST did not show major changes using ENDF/B-VIII.1 beta2
- C/E of IEU-MET-FAST benchmarks are lower and worse than those simulated with VIII.0 and VIII.1beta1
- Changes seen were driven by reflector, mostly Pb, Cu and Be
  - Be ENDF/B-VIII.1 beta2 results are improved compared to ENDF/B-VIII.1 beta1
  - Cu ENDF/B-VIII.1 beta2 results are improved for HEU-MET-FAST cases, not for IEU-MET-FAST but unlikely to be related to the Cu evaluations
  - Pb ENDF/B-VIII.1 beta2 results are improved for 4 cases, the Pulsed sphere spectrum shows odd features.

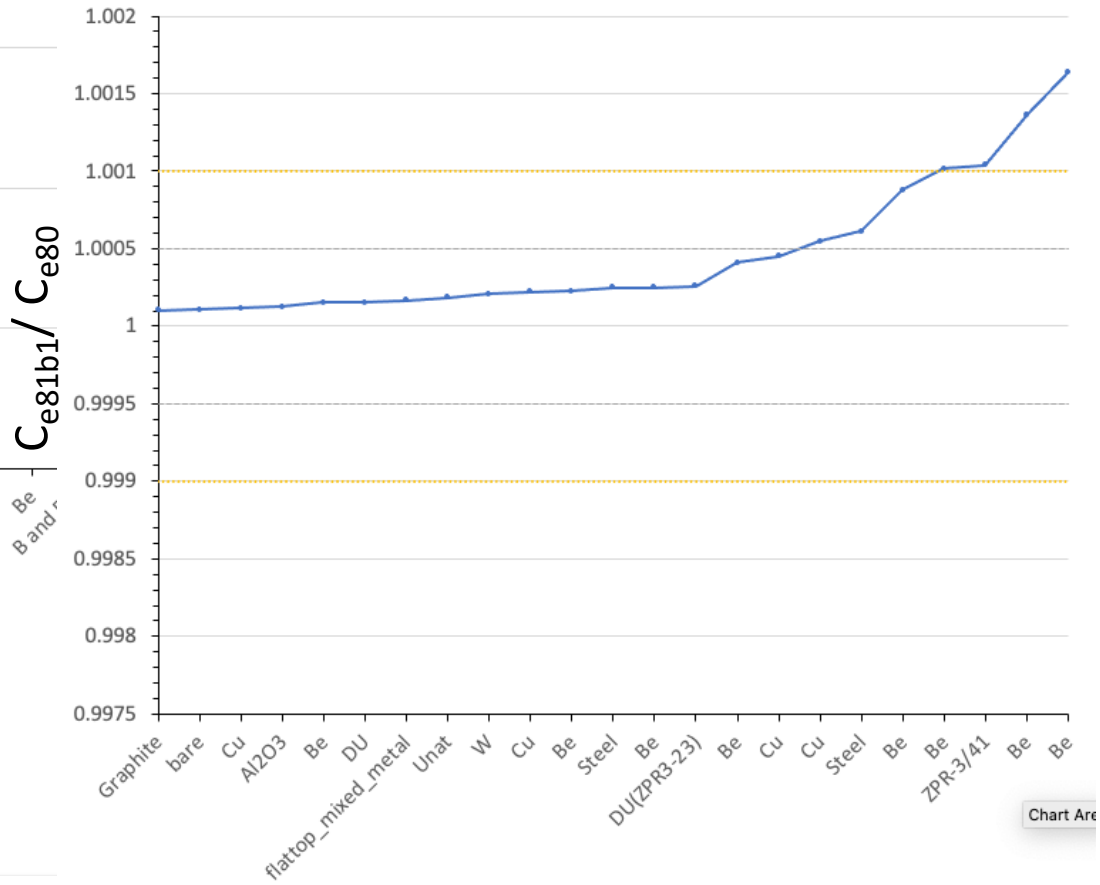
Backup

Thermal assemblies



Then, Criticality: C_{e81b1}/C_{e80}





Cases with MMF7(Be) & IMF22(Cu) reflectors show largest differences; 2 steel reflected & 3 bare Pu assemblies (PMF2, 22, 29)

Then: Beta 1 Fission Ratios

- Mercury/GNDS – MCNP6.2/ACE

* Brown et al. NDS 148 (2018)

- Reaction rates are normalized by ^{235}U(n,f)

Benchmark	Reaction Ratio	238U(n,f)	237Np(n,f)	233U(n,f)	239Pu(n,f)
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	Mercury e80	0.2107	0.9768	1.5661	1.4271
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	Mercury e81b1/e80	1.0013	0.9949	1.0001	0.9982
Flattop25	Mercury e81b1	0.1447	0.7728	1.5779	1.3608
	Mercury e80	0.1451	0.7732	1.5779	1.3621
	MCNP e80 *	0.1451	0.7735	*1.5664*	1.3622
	Mercury e81b1/e80	0.9972	0.9995	1.0000	0.9990

TNSL files available to Mercury

- <alias id="1401" pid="HinC5O2H8"/>
- <alias id="1501" pid="HinYH2"/>
- <alias id="1701" pid="HinZrH"/>
- <alias id="1801" pid="HinH2O"/> 6 std 32tnsl ///cog 231/190
- <alias id="1901" pid="HinCH2"/> 5 tnsl 80/190
- <alias id="1902" pid="DinD2O"/> 5 tnsl
- <alias id="4809" pid="Be-metal"/> 56
- <alias id="4909" pid="BeinBeO"/> 2
- <alias id="6512" pid="benzene"/>
- <alias id="6712" pid="CinSiC"/>
- <alias id="6612" pid="reactor-graphite-30P"/>
- <alias id="6812" pid="reactor-graphite-10P"/>
- <alias id="6912" pid="crystalline-graphite"/>
- <alias id="7914" pid="NinUN"/>
- <alias id="8716" pid="OinD2O"/>
- <alias id="8816" pid="OinUO2"/>
- <alias id="8916" pid="OinBeO"/>
- <alias id="13927" pid="tnsl-Al27"/>
- <alias id="26956" pid="tnsl-Fe56"/>
- <alias id="14728" pid="SiinSiC"/>
- <alias id="14928" pid="SiO2-alpha"/>
- <alias id="39989" pid="YinYH2"/>
- <alias id="40900" pid="ZrinZrH"/>
- <alias id="92838" pid="UinUN"/>
- <alias id="92938" pid="UinUO2"/>

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