OAK RIDGE National Laboratory

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ORNL Validation Testing

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U.S. DEPARTMENT of ENERGY

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Outline

1. Overview of comparison of ENDF/B-VIII.0 and ENDF/B-VIII.1
2. Summary of results from VALID
3. Detailed comparisons
4. Summary

Overview of comparison of ENDF/B-VIII.0 and ENDF/B-VIII.1

- Use VALID suite to test 810 cases with ENDF/B-VIII.0 and ENDF/B-VIII.1 in KENO V.a/KENO-VI
    - SCALE 6.3 used with both libraries
    - Compare k_{eff} C/E values
- Limited number of cases tested with TSUNAMI
    - Compare sensitivities primarily through c_k and E calculations
    - No further details presented here
        - All c_k values 0.98 or higher
        - All E values 0.99 or higher

KENO V.a results summary (CE)

Category	ENDF/B-VIII.1		ENDF/B-VIII.0		Difference		
	Avg. C/E	Avg. C/E unc.	Avg. C/E	Avg. C/E unc.	(E8.1–E8.0)	Unc.	Δ/Unc.
HCT	1.00202	0.00230	1.00190	0.00230	0.00012	0.00326	0.04
HMF	1.00100	0.00032	1.00092	0.00032	0.00009	0.00045	0.19
HMI	1.00117	0.00042	1.00085	0.00042	0.00033	0.00059	0.55
HSI	0.98956	0.00242	0.98726	0.00241	0.00230	0.00341	0.67
HST	0.99933	0.00072	0.99844	0.00072	0.00089	0.00101	0.88
IMF	1.00145	0.00082	1.00104	0.00082	0.00042	0.00117	0.36
IST	0.99985	0.00091	1.00037	0.00091	-0.00052	0.00129	0.40
LCT	0.99973	0.00018	0.99912	0.00018	0.00060	0.00026	2.36
LMT	1.00161	0.00157	1.00155	0.00157	0.00006	0.00222	0.03
LST	0.99860	0.00083	0.99841	0.00083	0.00020	0.00118	0.17
MCF	0.99783	0.00157	0.99770	0.00157	0.00013	0.00222	0.06
MCT	0.99786	0.00087	0.99810	0.00087	-0.00024	0.00123	0.19
MST	0.99498	0.00157	0.99352	0.00157	0.00147	0.00222	0.66
PMF	1.00017	0.00045	1.00010	0.00045	0.00008	0.00063	0.12
PST	1.00162	0.00051	0.99836	0.00051	0.00325	0.00072	4.52
UCT	1.00284	0.00141	0.99818	0.00140	0.00466	0.00199	2.35
UMF	0.99930	0.00051	0.99865	0.00051	0.00064	0.00073	0.89
USI	0.98582	0.00124	0.97945	0.00123	0.00637	0.00175	3.65
USM	0.98269	0.00215	0.97666	0.00214	0.00603	0.00303	1.99
UST	1.00331	0.00053	0.99845	0.00052	0.00486	0.00074	6.56

*1–2σ, 2–5σ, > 5σ

KENO-VI results summary (CE)

Category	ENDF/B-VIII.1		ENDF/B-VIII.0		Difference		
	Avg. C/E	Avg. C/E unc.	Avg. C/E	Avg. C/E unc.	(E8.1–E8.0)	Unc.	Δ/Unc.
HMF	0.99856	0.00044	0.99875	0.00044	-0.00019	0.00062	0.31
IMF	1.00457	0.00275	1.00433	0.00274	0.00024	0.00388	0.06
IST	1.00394	0.00138	1.00416	0.00138	-0.00022	0.00195	0.11
LCT	0.99698	0.00230	0.99722	0.00231	-0.00024	0.00326	0.07
MCT	0.99319	0.00078	0.99386	0.00078	-0.00067	0.00110	0.61
PMM	1.00194	0.00108	1.00435	0.00108	-0.00242	0.00153	1.58

*1–2σ, 2–5σ, > 5σ

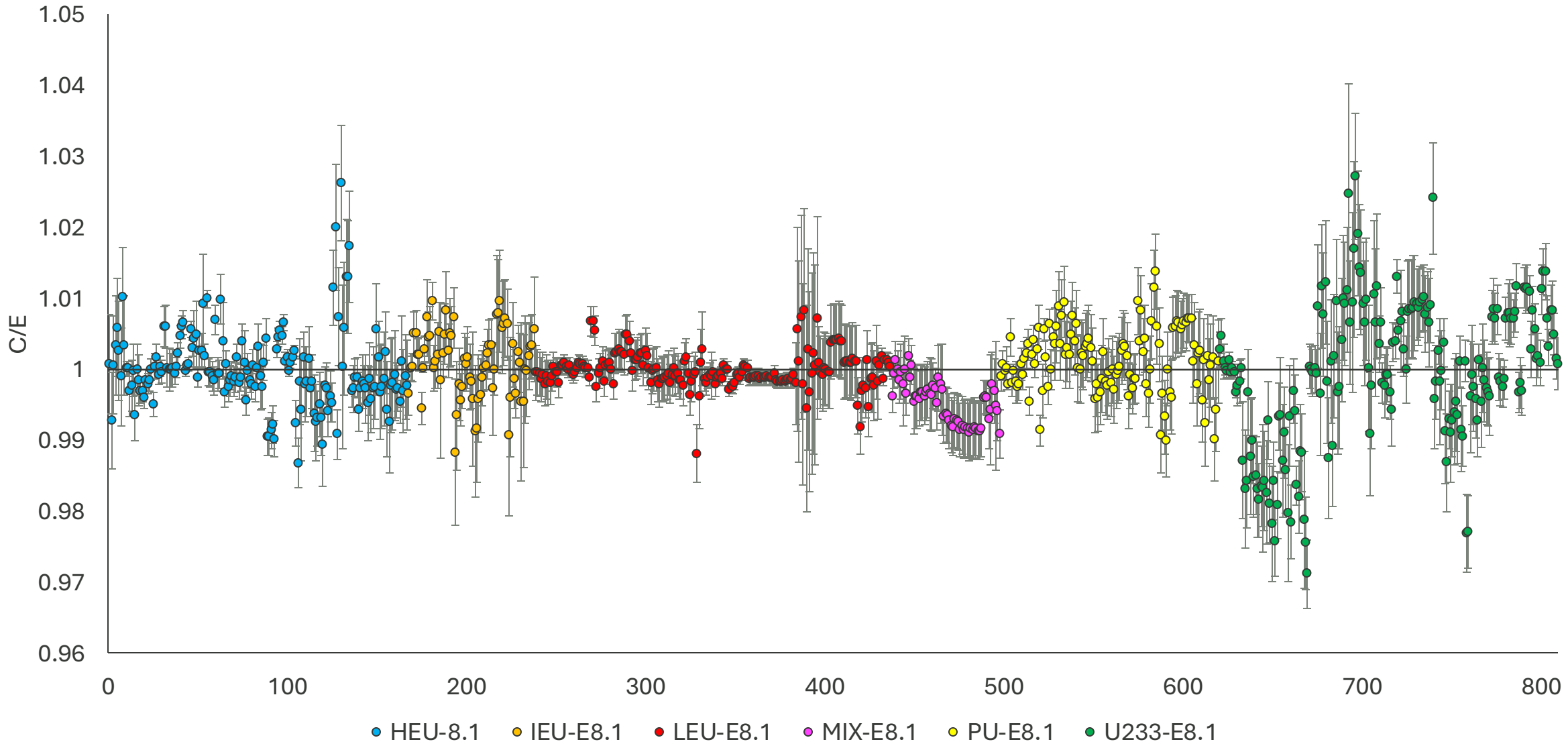
Pooled results summary

Category	ENDF/B-VIII.1		ENDF/B-VIII.0		Difference		
	Avg. C/E	Avg. C/E unc.	Avg. C/E	Avg. C/E unc.	(E8.1–E8.0)	Unc.	Δ/Unc.
HMF	1.00028	0.00026	1.00028	0.00026	0.00000	0.00037	0.01
IMF	1.00193	0.00082	1.00154	0.00081	0.00039	0.00115	0.34
IST	1.00075	0.00075	1.00120	0.00075	-0.00045	0.00106	0.43
LCT	0.99965	0.00019	0.99907	0.00019	0.00058	0.00026	2.19
MCT	0.99519	0.00058	0.99568	0.00058	-0.00049	0.00082	0.59

*1–2σ, 2–5σ, > 5σ

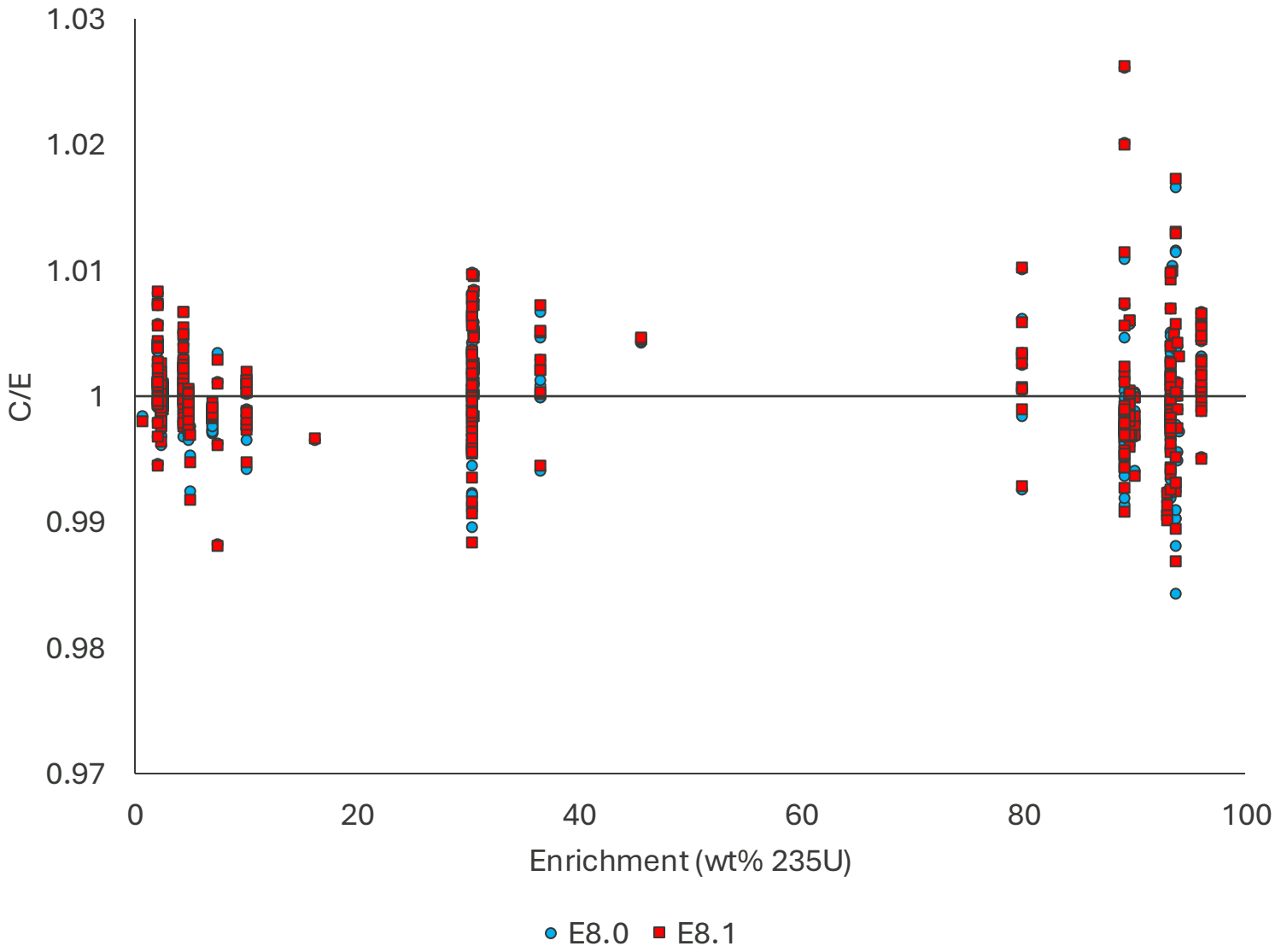
- HMF: 64 KENO V.a and 27 KENO-VI (91 total cases)
- IMF: 11 KENO V.a and 2 KENO-VI (13 total cases)
- IST: 46 KENO V.a and 13 KENO-VI (59 total cases)
- LCT: 140 KENO V.a and 4 KENO-VI (144 total cases)
- MCT: 21 KENO V.a and 28 KENO-VI (49 total cases)
- Pooling not recommended for code validation

C/E results for ENDF/B-VIII.1

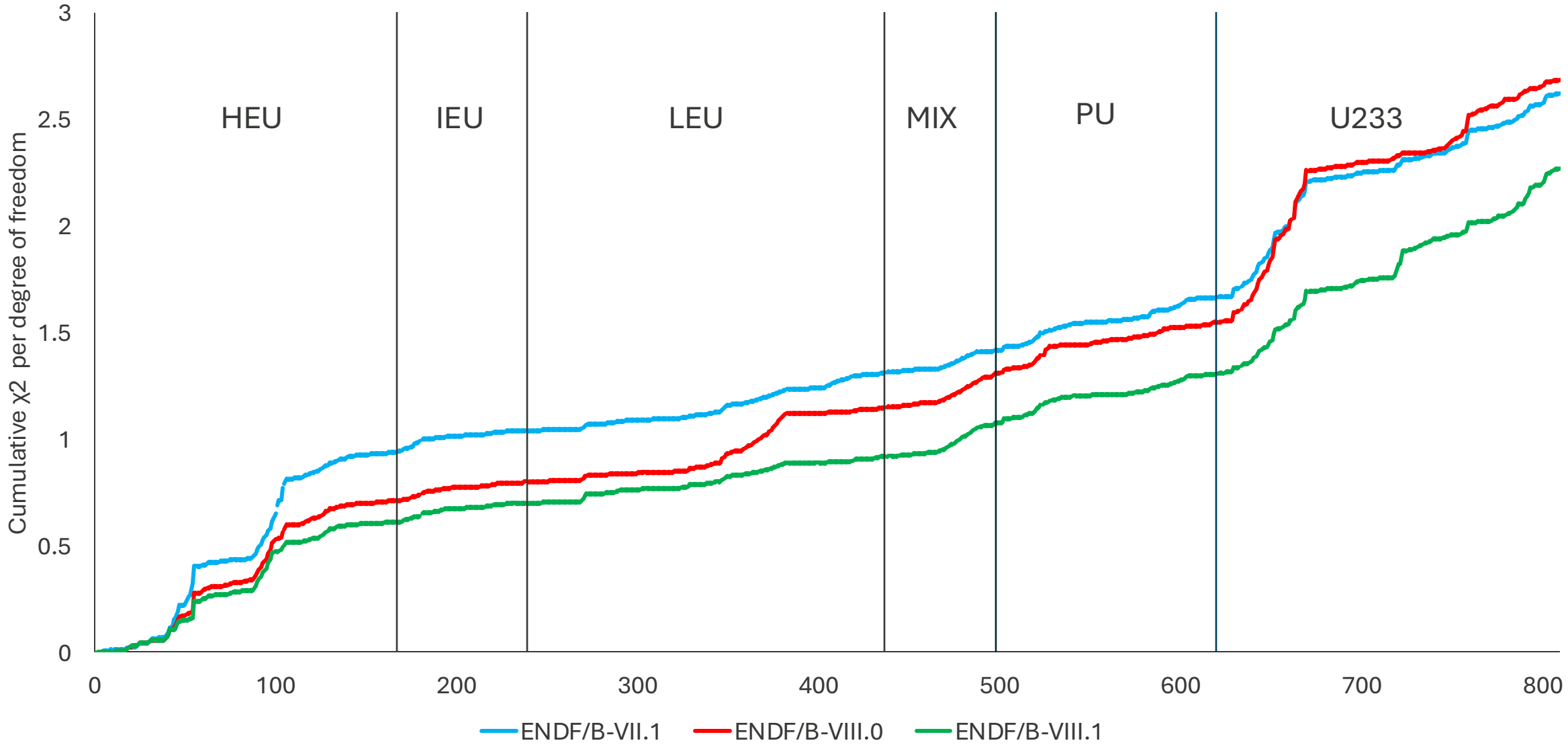


C/E versus enrichment for all uranium systems

- No major changes in C/E values versus enrichment for ENDF/B-VIII.1 compared with ENDF/B-VIII.0



Cumulative χ^2 per degree of freedom



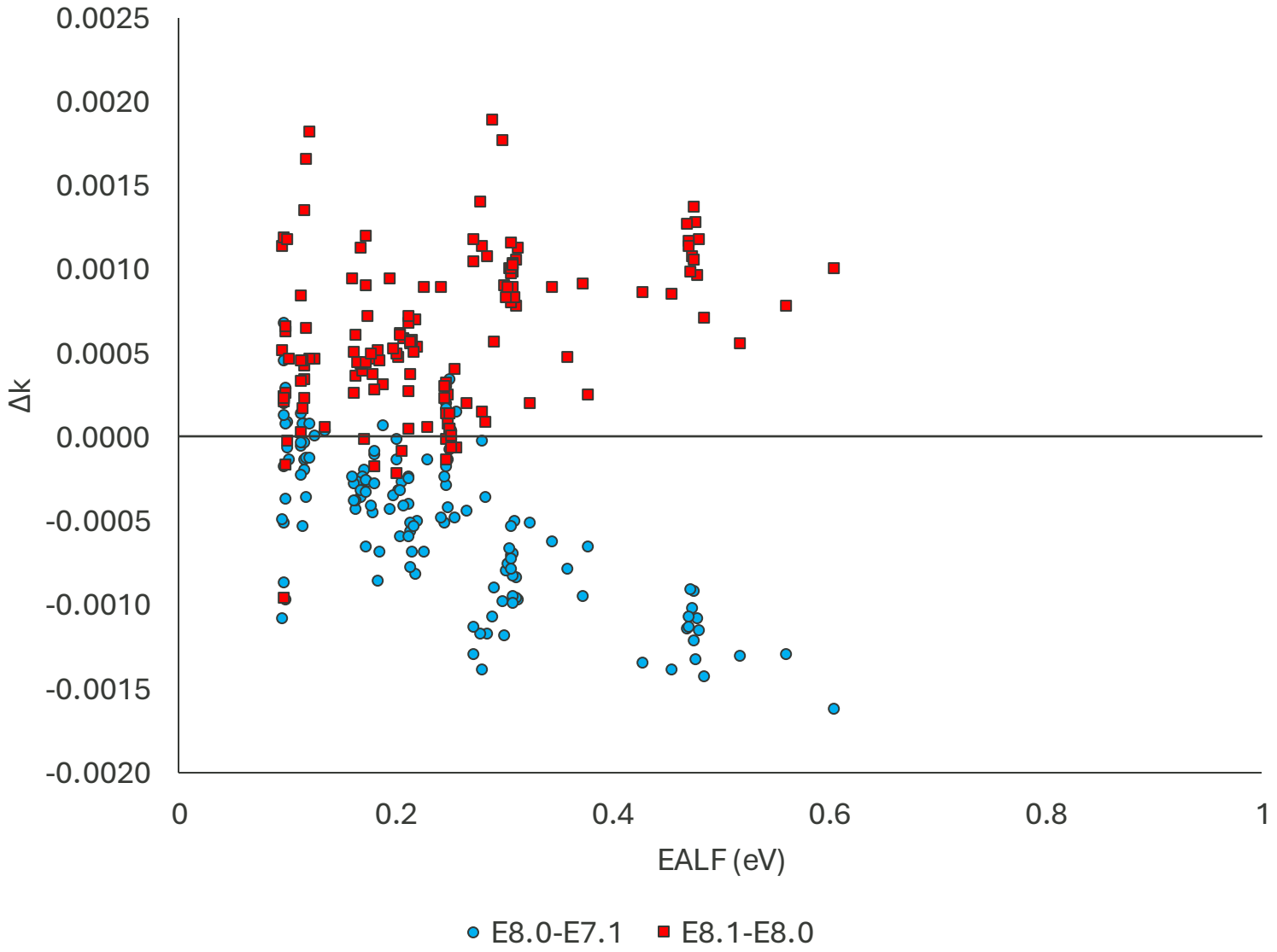
Cumulative χ^2 per degree of freedom per category

- ENDF/B-VIII.1 provides total χ^2 per degree of freedom values lower than ENDF/B-VIII.0
- Improvements in all categories of experiments except IMF, LMT, LST, MCT, PST, UCT, and UST
- Largest differences coming from USM, USI, and HSI

Category	ENDF/B-VII.1	ENDF/B-VIII.0	ENDF/B-VIII.1
HCT	1.15	0.52	0.51
HMF	5.66	4.68	4.18
HMI	25.4	6.49	3.60
HSI	17.0	14.3	9.65
HST	1.67	1.53	1.31
IMF	2.93	1.53	1.66
IST	0.73	0.843	0.839
LCT	1.09	1.82	1.05
LMT	1.33	0.16	0.18
LST	0.85	0.79	0.99
MCF	2.39	1.49	1.34
MCT	1.54	1.95	2.11
MST	0.63	3.26	2.18
PMF	2.69	2.76	2.75
PMM	1.87	6.67	2.99
PST	1.36	1.00	1.11
UCT	0.26	0.91	1.72
UMF	3.41	3.68	2.01
USI	8.91	12.0	6.17
USM	18.8	23.9	13.8
UST	2.34	2.42	3.30
Total	2.62	2.68	2.27

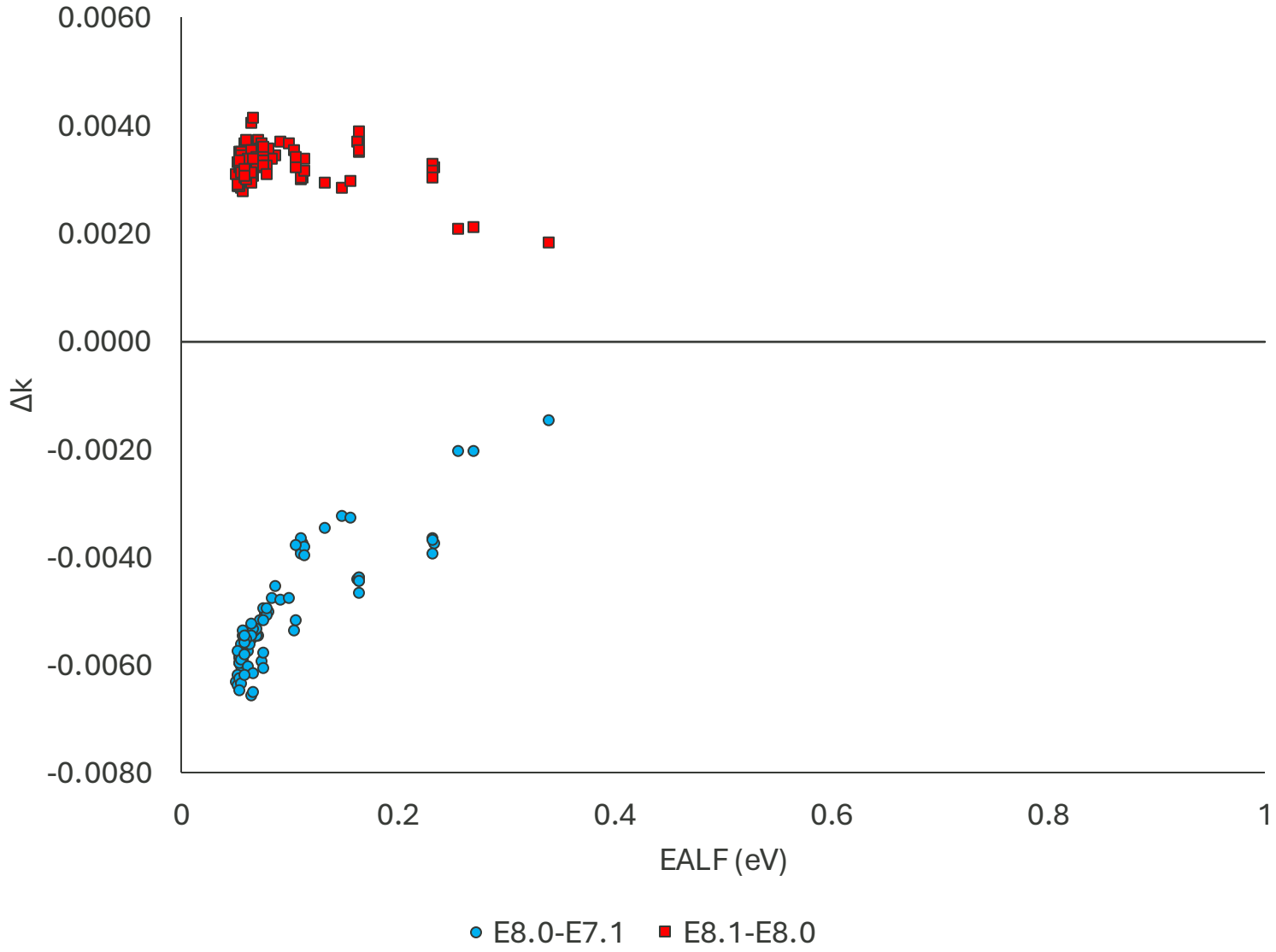
Changes for LCT experiments

- Previous work indicated lower calculated k_{eff} values and an increased negative magnitude bias for ENDF/B-VIII.0 compared with ENDF/B-VII.1
- Current work reveals higher calculated k_{eff} values and an increase in positive magnitude bias for ENDF/B-VIII.1 compared with ENDF/B-VIII.0
- Average C/E values
  - ENDF/B-VII.1: 0.99952 ± 0.00019
  - ENDF/B-VIII.0: 0.99907 ± 0.00019
  - ENDF/B-VIII.1: 0.99965 ± 0.00019



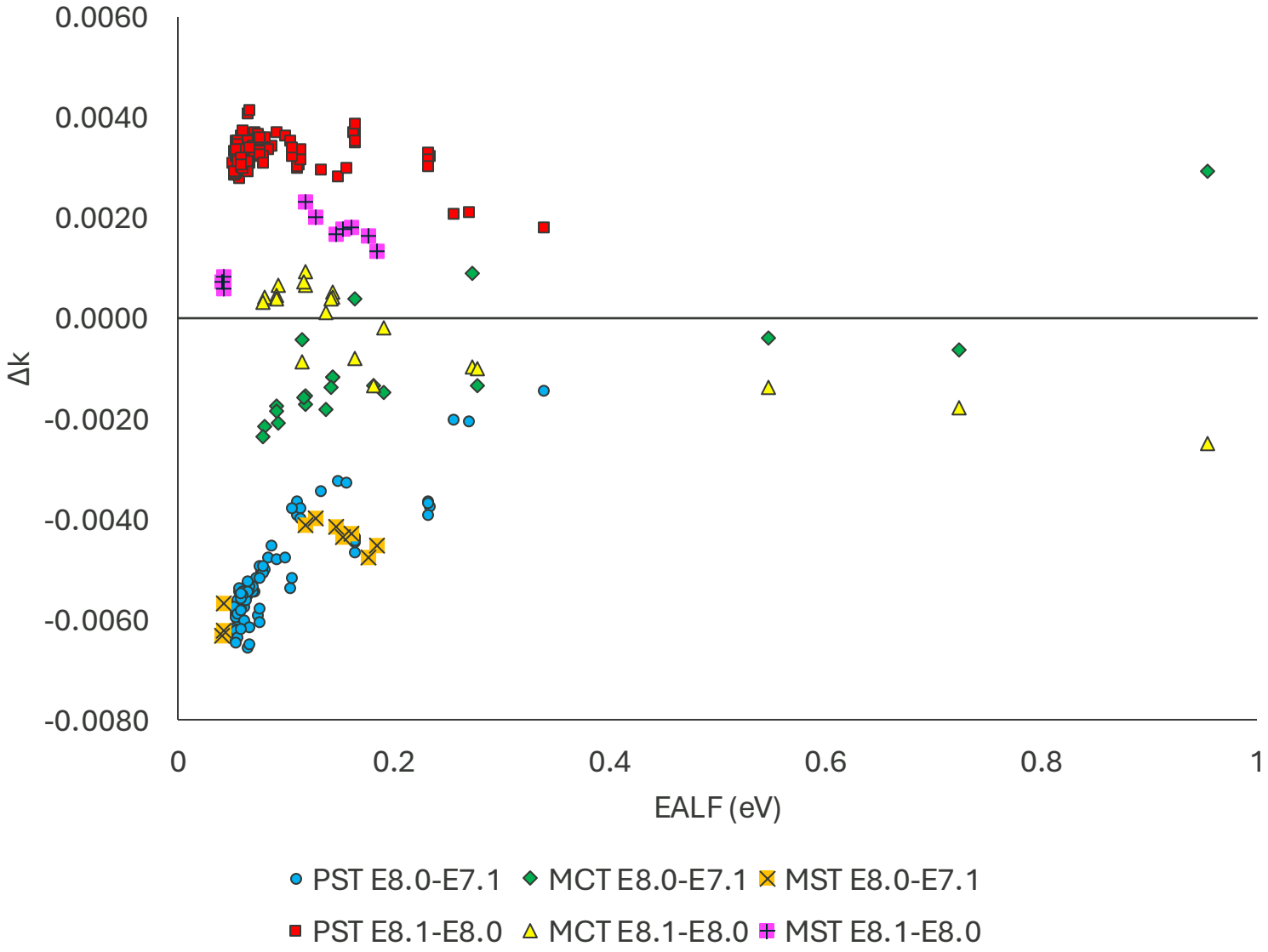
Changes for PST experiments

- Overprediction for PST experiments for ENDF/B-VIII.1 compared with ENDF/B-VIII.0
- Average C/E increased from 0.99836 ± 0.00051 to 1.00162 ± 0.00051
- Average C/E values
  - ENDF/B-VII.1: 1.00349 ± 0.00051
  - ENDF/B-VIII.0: 0.99836 ± 0.00051
  - ENDF/B-VIII.1: 1.00162 ± 0.00051

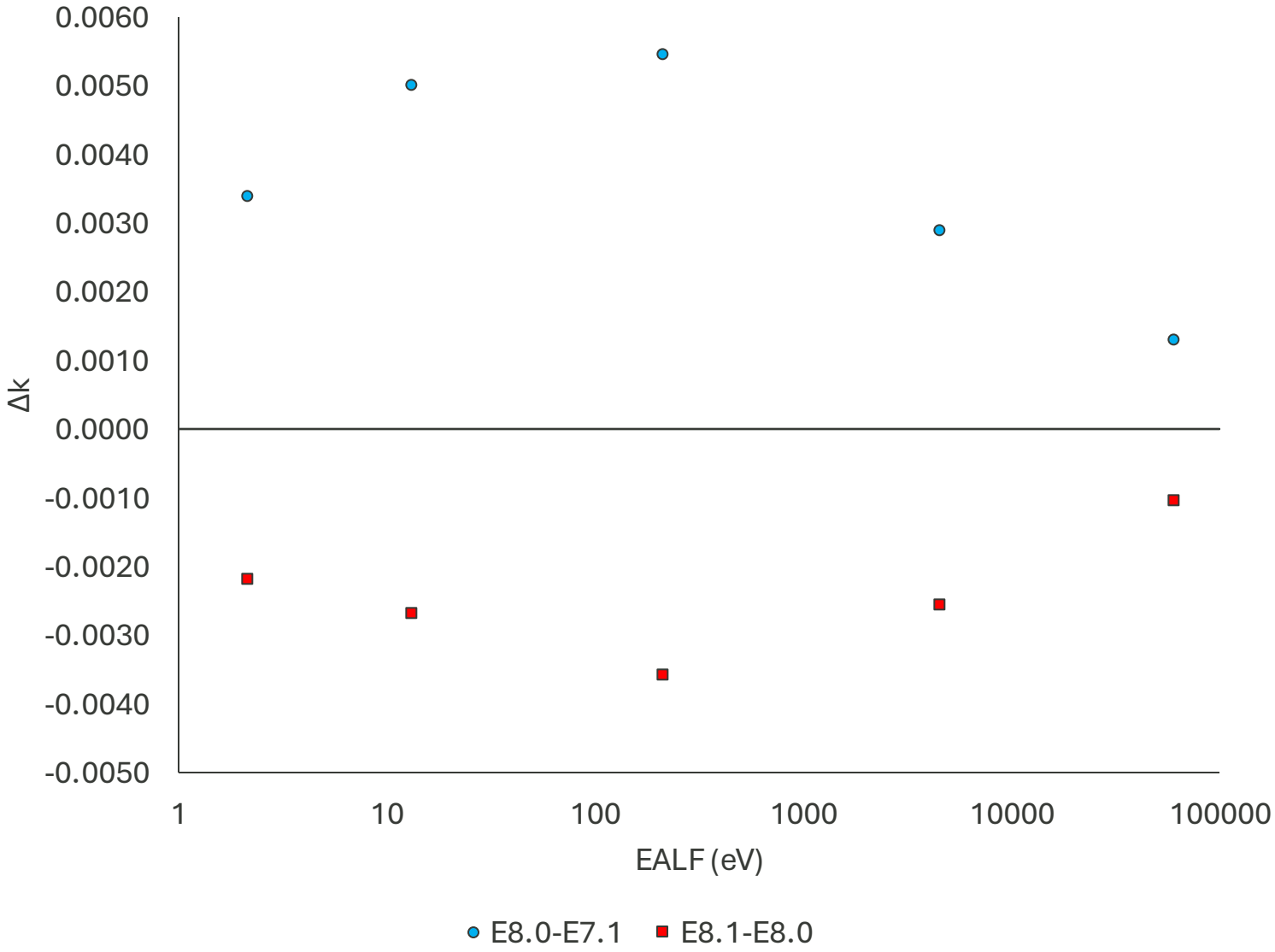


MCT, MST, and PST experiments

- MCT and MST results driven by Pu
- Predictions of oxide-fueled array and mixed solution experiments closer to measurements than highly thermalized Pu systems
- As with PST cases, there is an increase in most C/E values for ENDF/B-VIII.1 (for most cases)

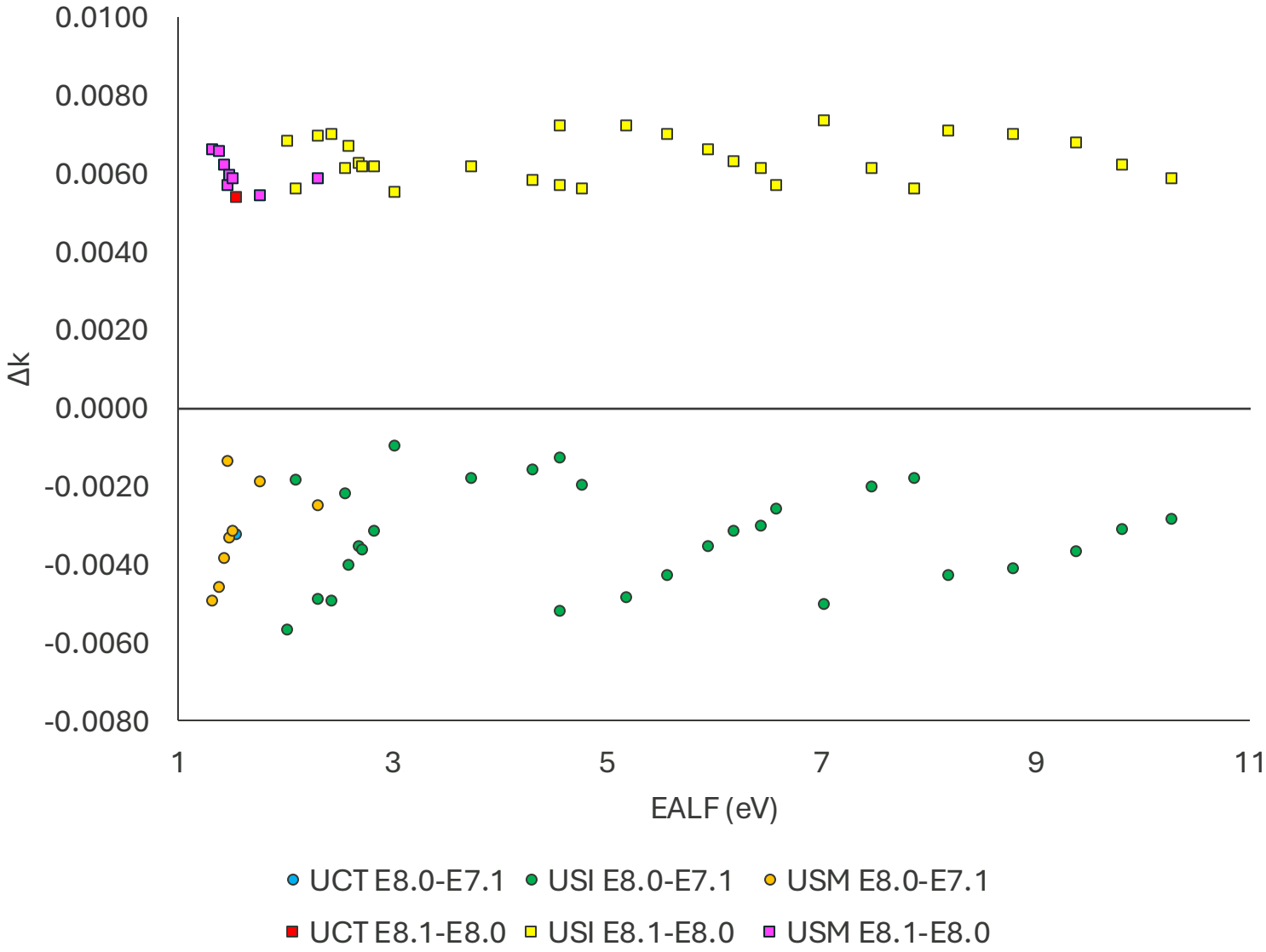


PMM experiments

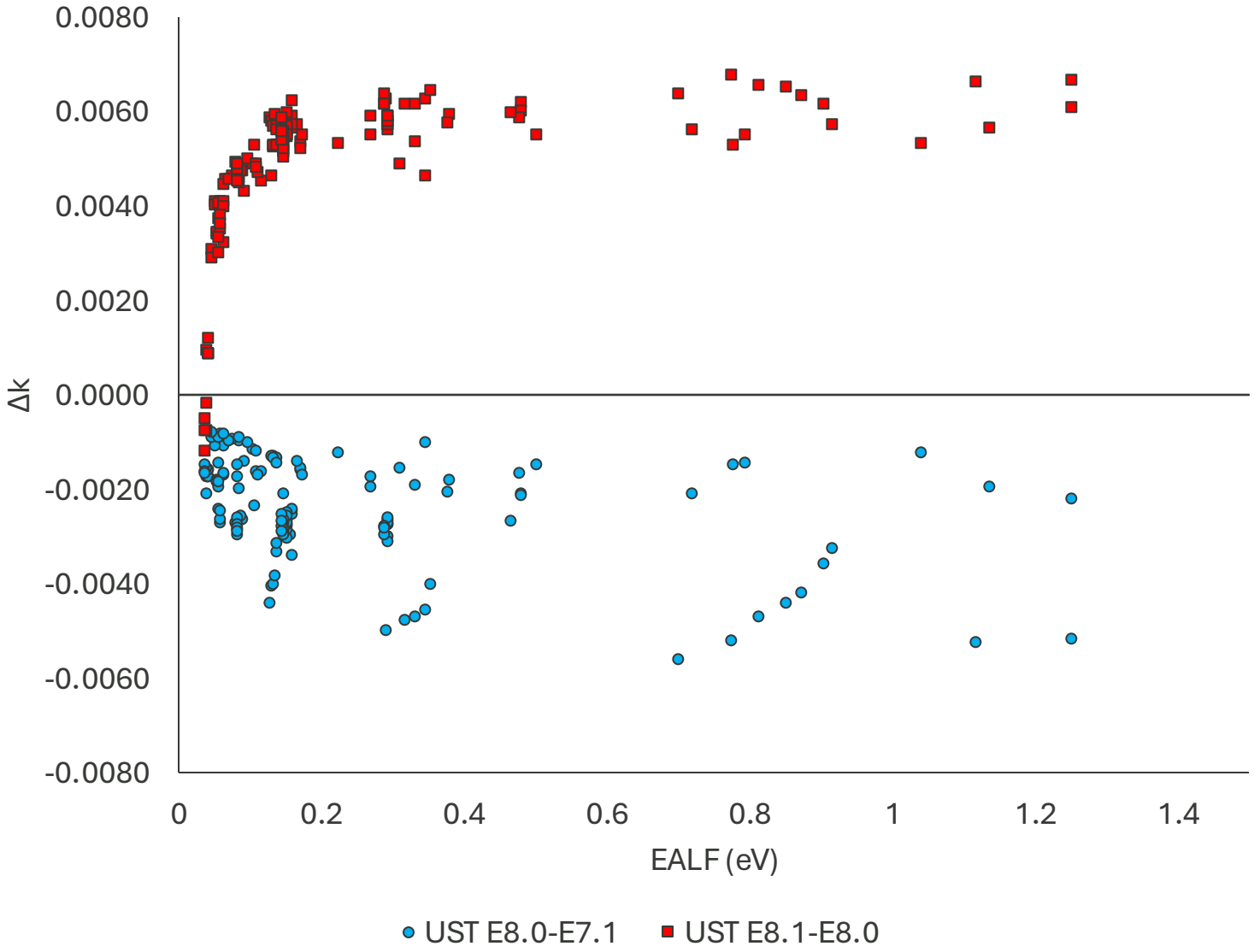


Changes for U233 experiments

- With a few exceptions, there are higher calculated k_{eff} values representing a positive magnitude change for ENDF/B-VIII.1 compared with ENDF/B-VIII.0
- All U233 categories of experiments experienced an increase in C/E values for ENDF/B-VIII.1
- Generally consistent trend across multiple evaluations and categories of experiments



Changes for U233 experiments



Summary

- ENDF/B-VIII.1 is an improvement over ENDF/B-VIII.0 based on C/E and χ^2 results
- Work is also being performed for advanced reactor applications and nuclide inventories
- Other efforts are ongoing
    - Covariance data evaluations
    - Expanding VALID for greater applicability to advanced reactors and HALEU applications
        - DNCSH targeted experiments
        - Intermediate enrichment
        - Graphite and molten salts
        - Intermediate spectrum systems

Questions?

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