Validation of ENDF/b-VIII.0 in GNDS format

CSEWG

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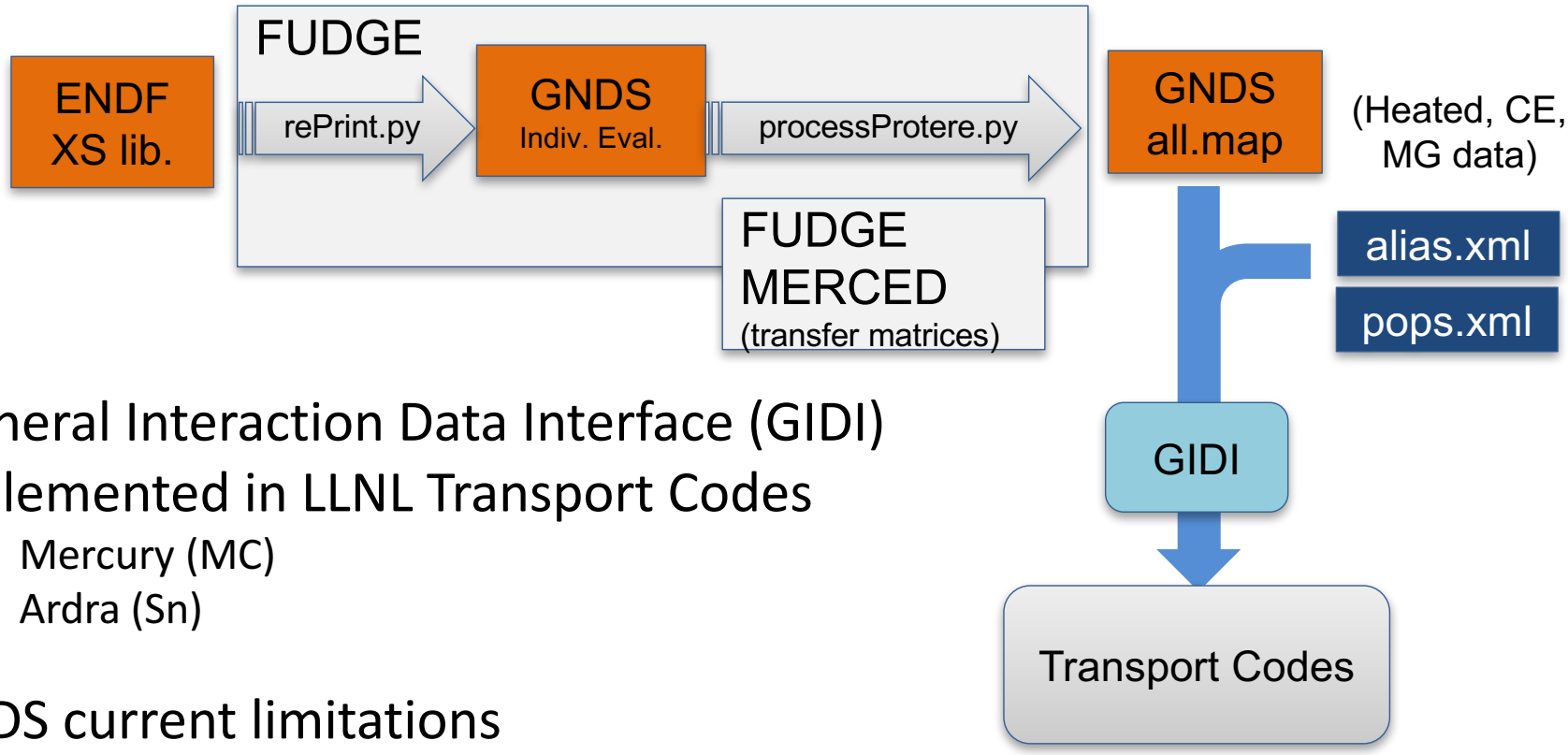
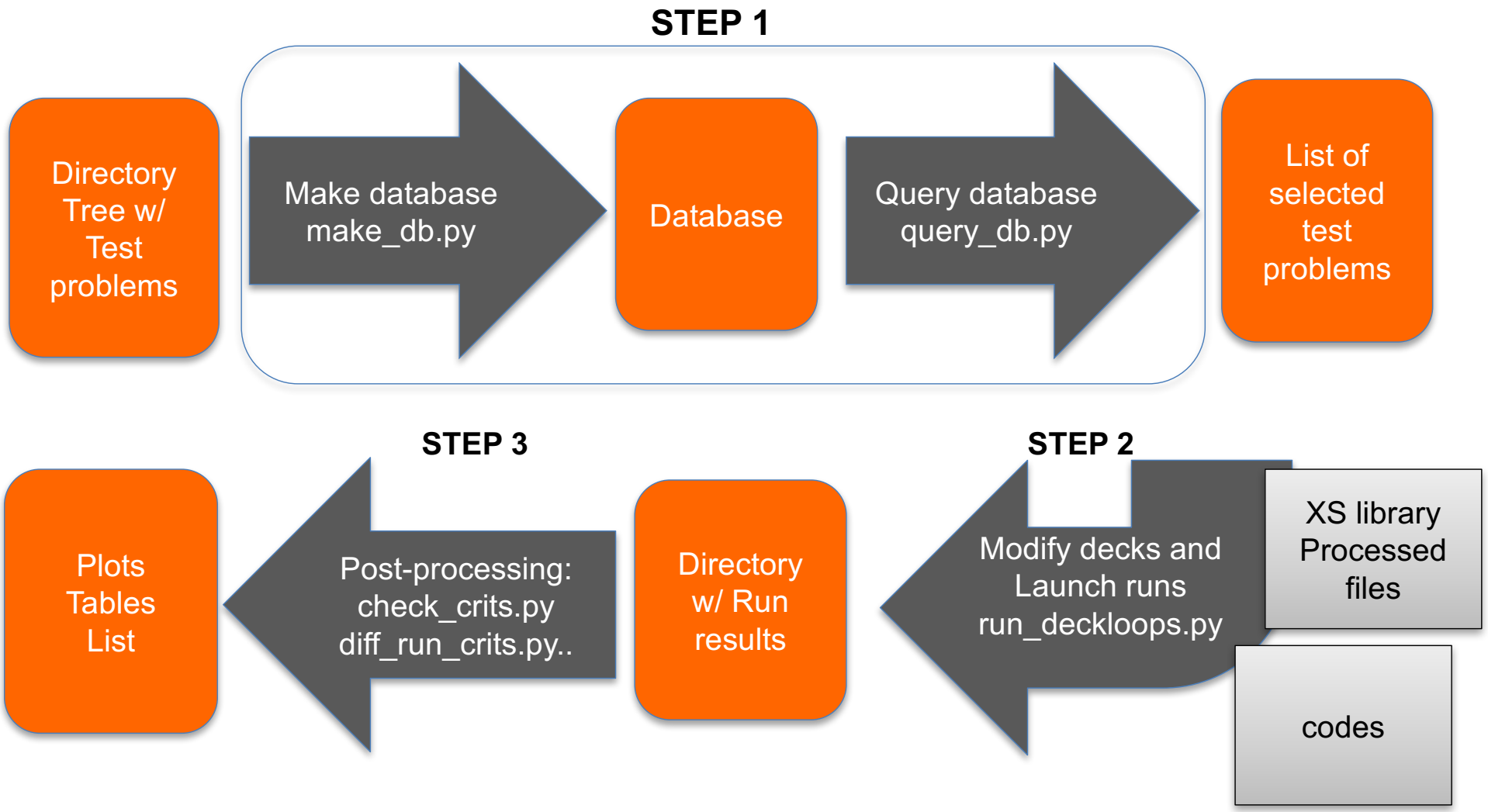
From ENDF to GNDS formatted data



- General Interaction Data Interface (GIDI) implemented in LLNL Transport Codes
  - Mercury (MC)
  - Ardra (Sn)
- GNDS current limitations
  - URR
  - Thermal Scattering Laws ($S_{\alpha\beta}$)
  - Angular biasing (MC)

GND presentations: B. Beck, C. Mattoon
Tuesday Nov 6

LLNL Automated Test Suite



The process from translation to run completion is fast

- Translation and Processing <1 day

  Example:
  - ENDF->GND: 15mn
  - Processing 1 temperature on 8 nodes: 4h
  - Data check: few h
  - Generating all.map file <15 mn

- Testing <12h
  - Database query or Pre-existing list of cases to run
  - Set-up XS library links, flags and codes
  - Launch Ardra and Mercury runs
  - Runs completion (8 nodes, LC Quartz)

- Analysis: variable?

Several ENDF cross-section libraries were processed to GNDS format

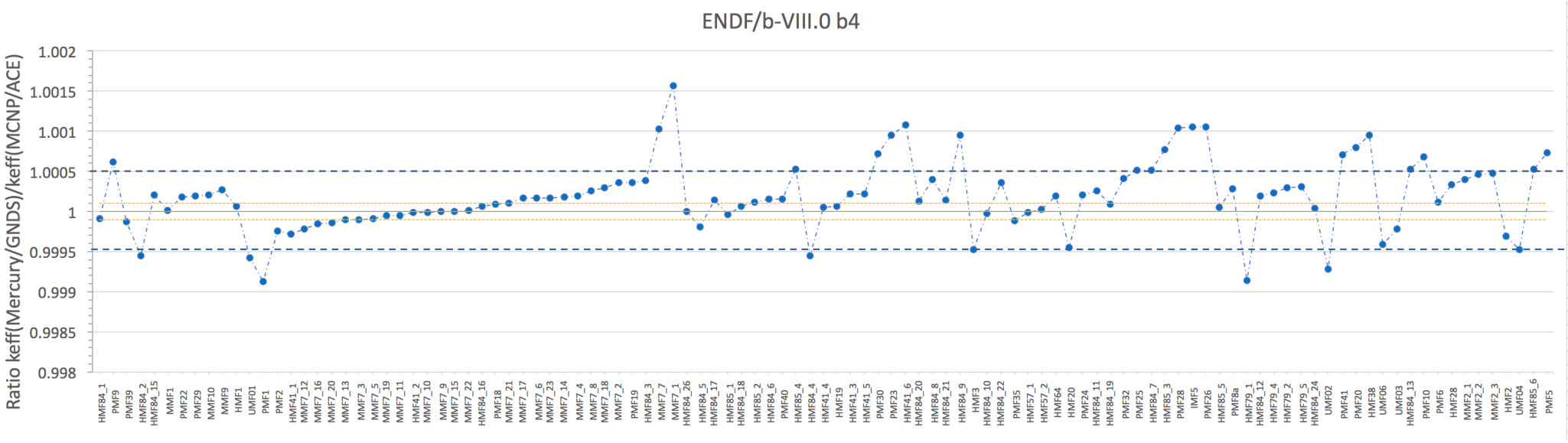
- Three ENDF library release and candidates translated and processed with FUDGE into GNDS formatted data
  - ENDF/b-VII.1
  - ENDF/b-VIII.0 β4
  - ENDF/b-VIII.0 β5

- Summary:

Code	Type	Data Format/API	GNDS/GIDI tests	XS
Mercury	Monte Carlo	Legacy/MCAPM GNDS/GIDI/MCGIDI	Criticality Reaction ratios	CE
Ardra	Deterministic	Legacy/NDF GNDS/GIDI	Criticality	Multigroup 230 groups

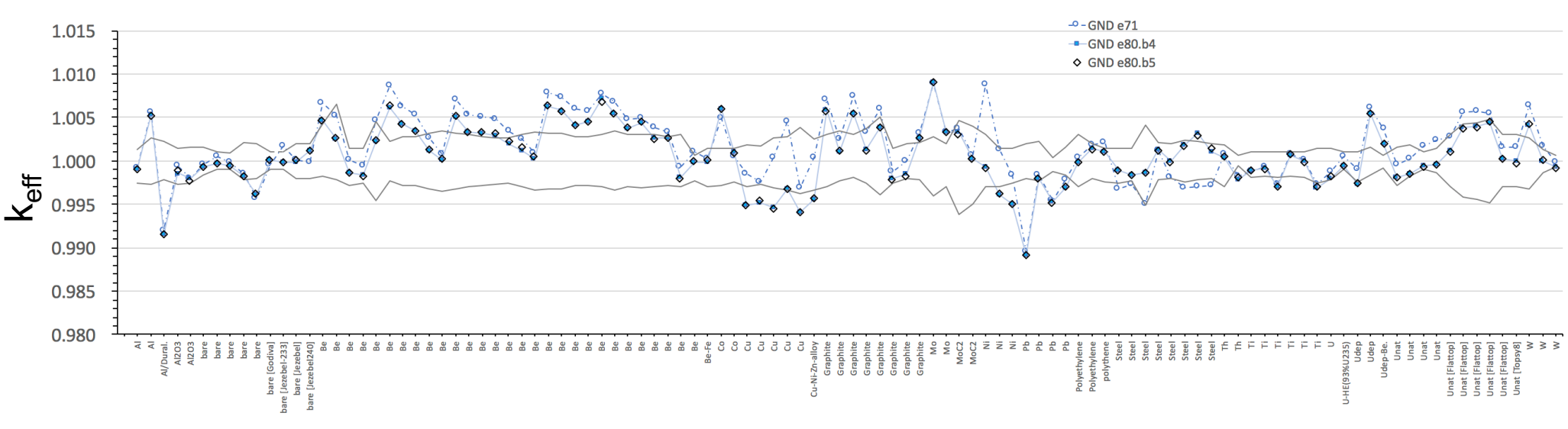
- Comparison to MCNP6 - ENDF/B-VII.1 and VIII.0 β4 results from S. Kahler 2017

ENDF/b-VIII.0 β4
GNDS vs ENDF formatted data



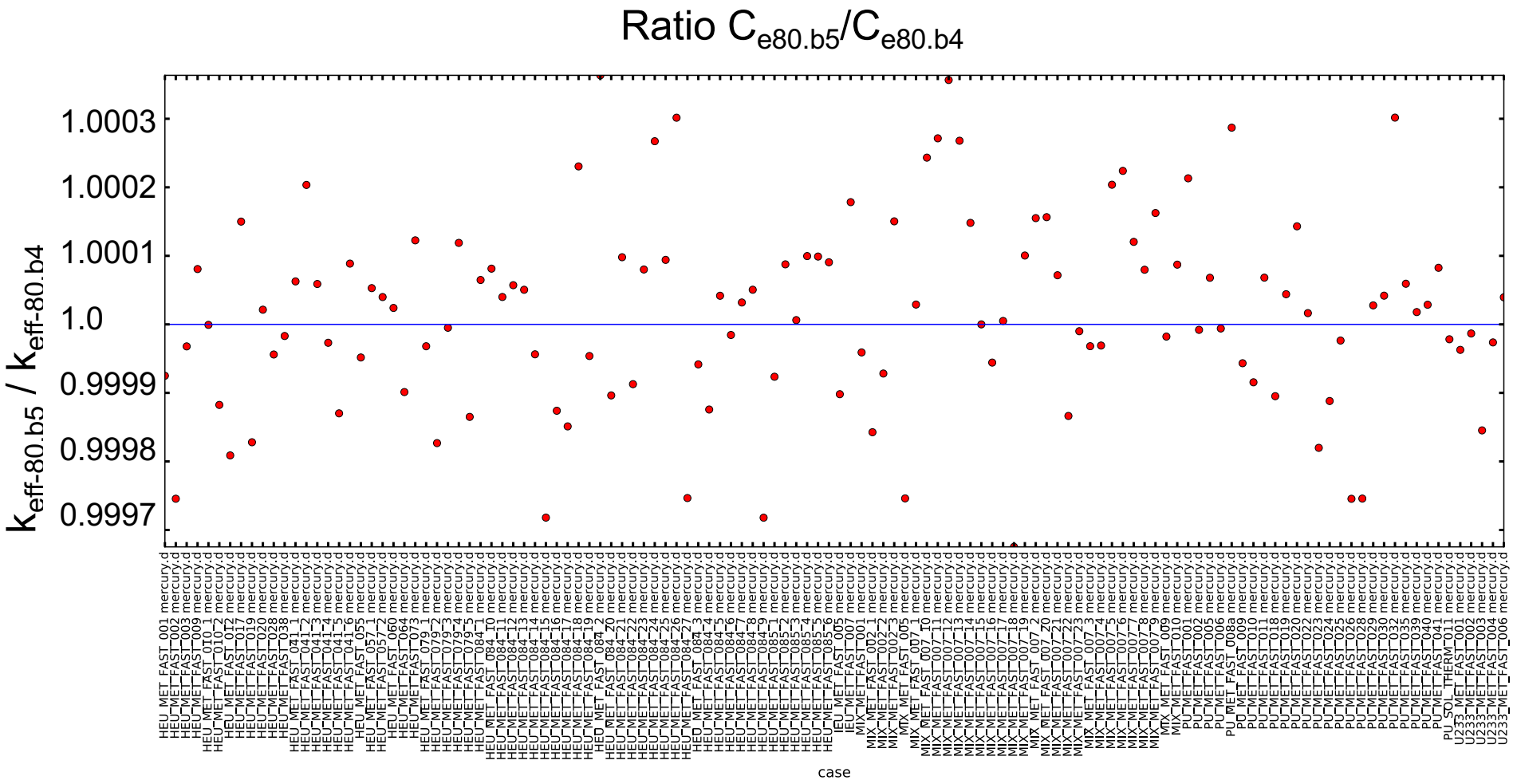
GNDS keff are within 5e-4 of ENDF's for 80/107 fast critical assemblies

ENDF/b-VII.1, VIII.0 β4 & β5 Criticality *GNDS data*



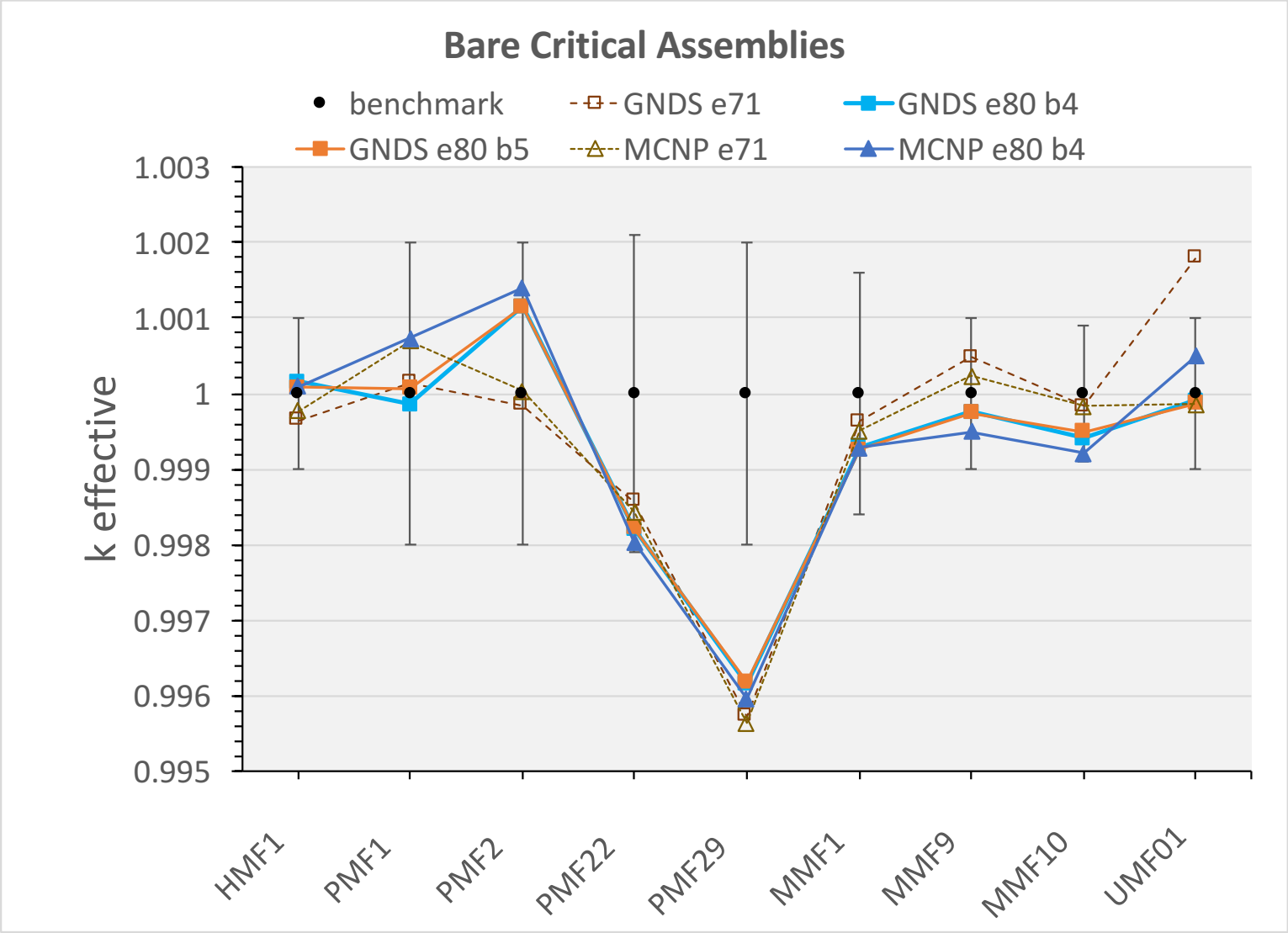
Overall, ENDF/b-VII.1 >> ENDF/b-VIII.0 b β4 and β5 except for Fe.
Very few changes between e80 β4 and β5: some small variations for Be, C, Fe, and Unat.

ENDF/b-VIII.0 β4 & β5 Mercury

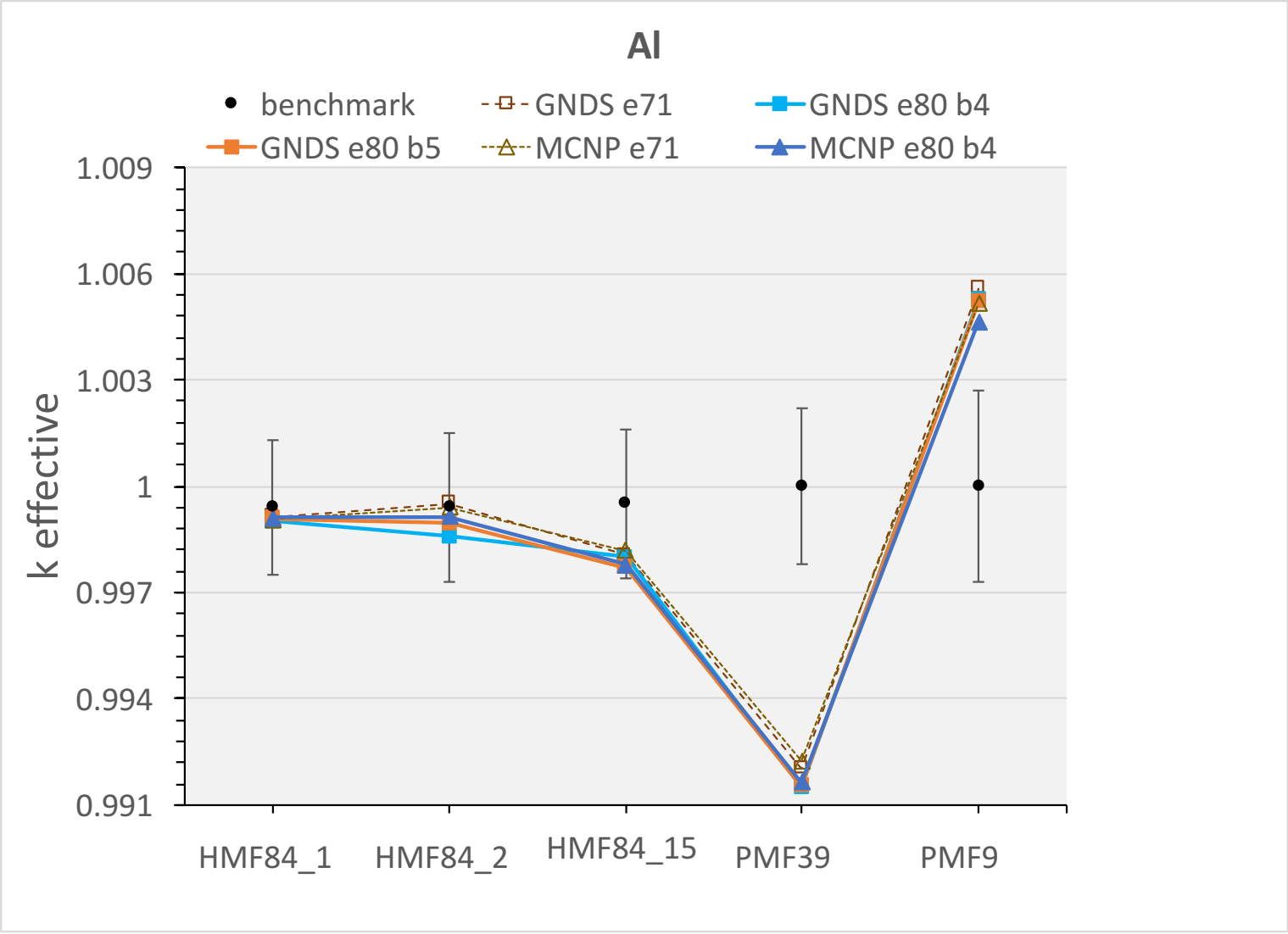


Differences are < 4.0e-4 or 4x the statistical uncertainty of the simulations.
Changes for Be, C, Fe and Unat

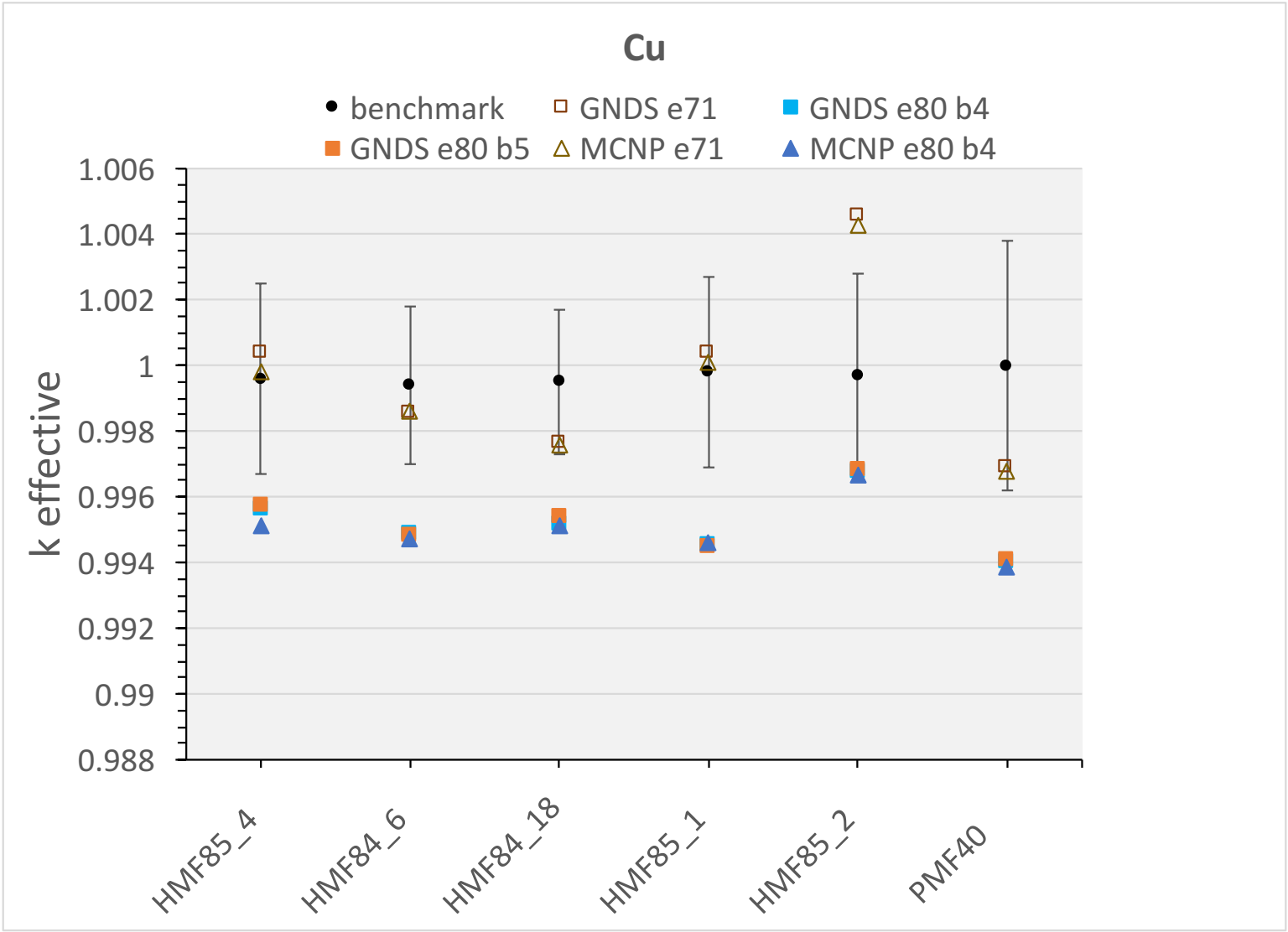
Bare assemblies
Godiva, Jezebel, Jezebel240,…



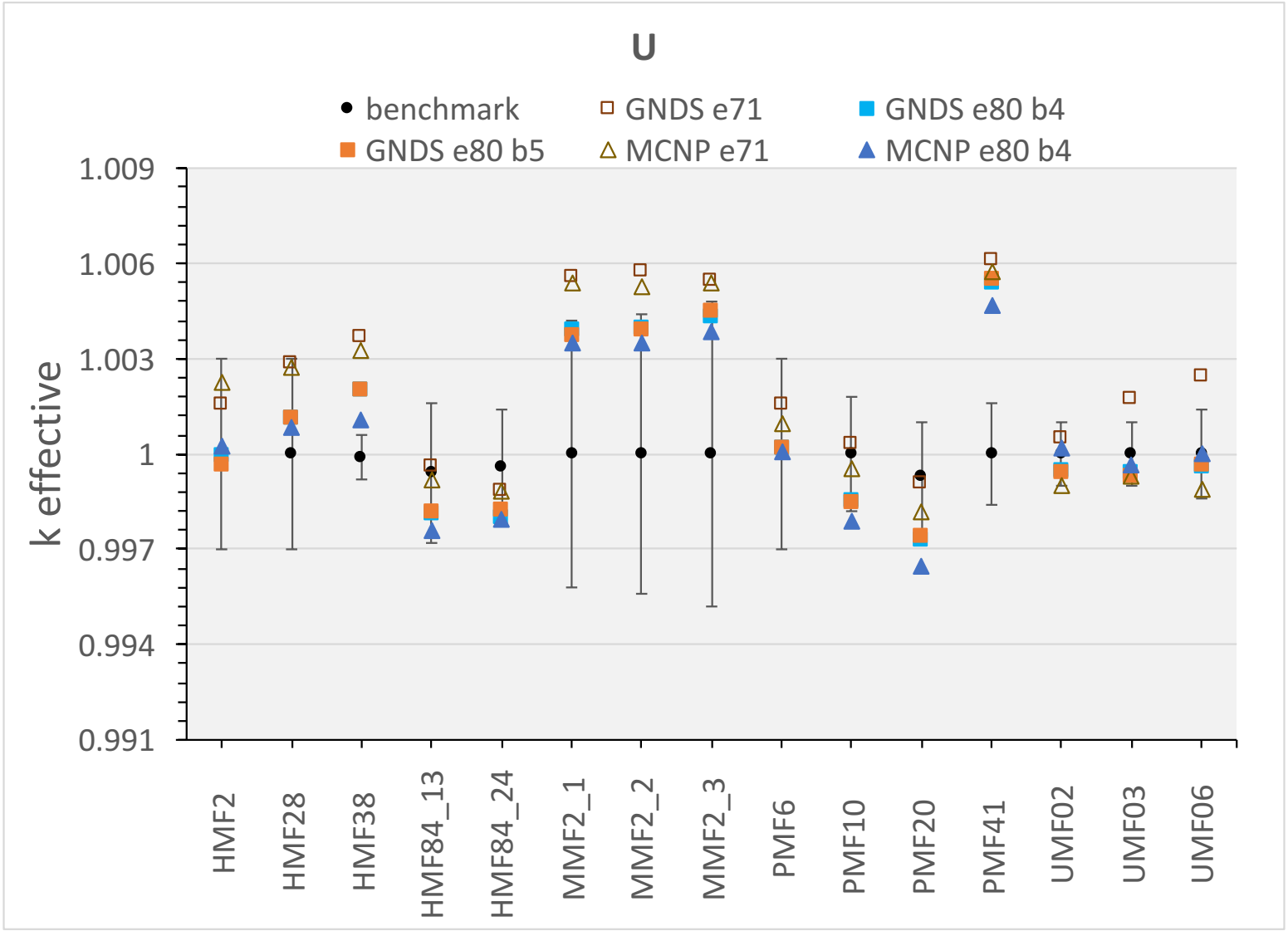
Al reflector



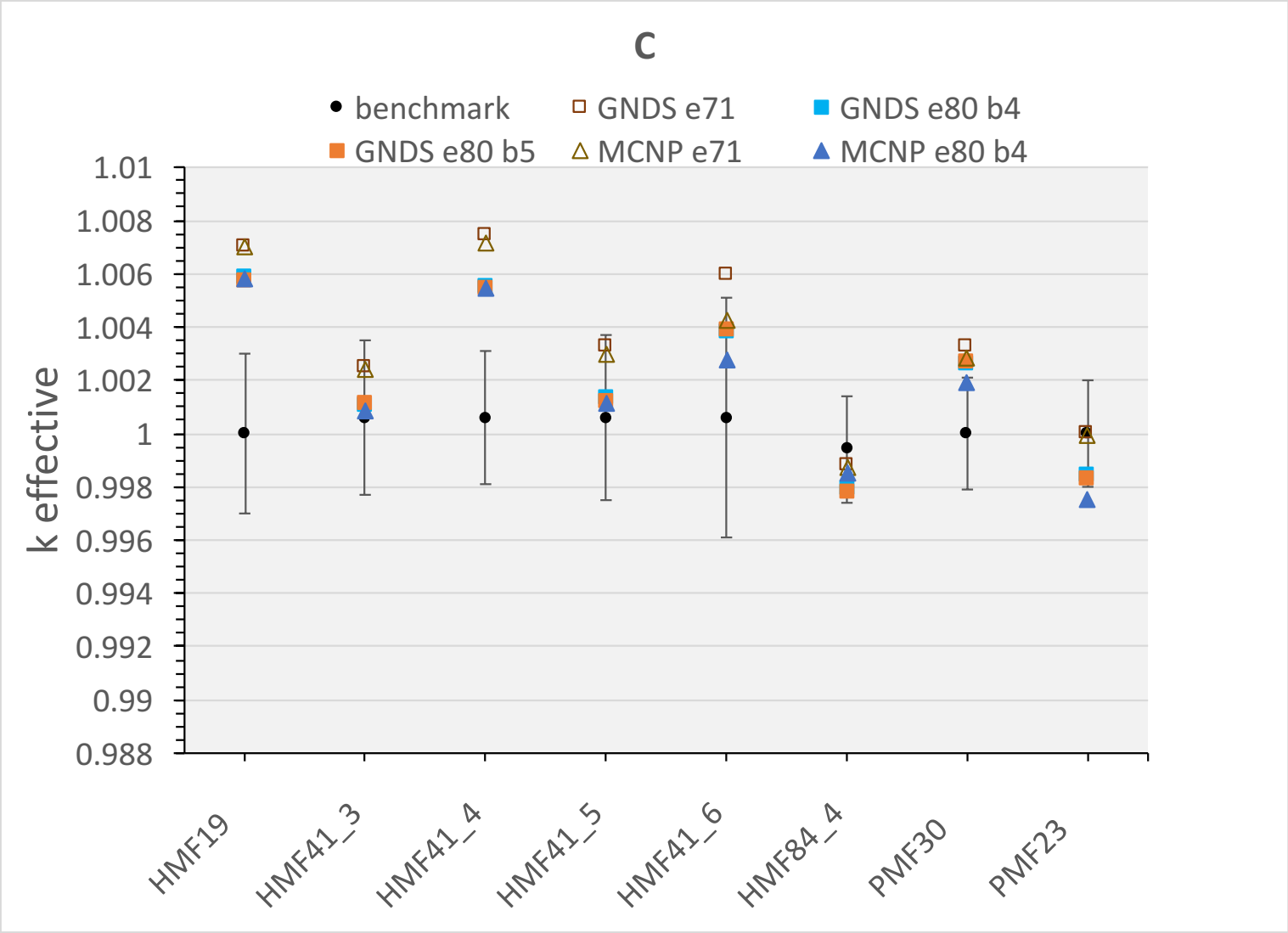
Cu reflector



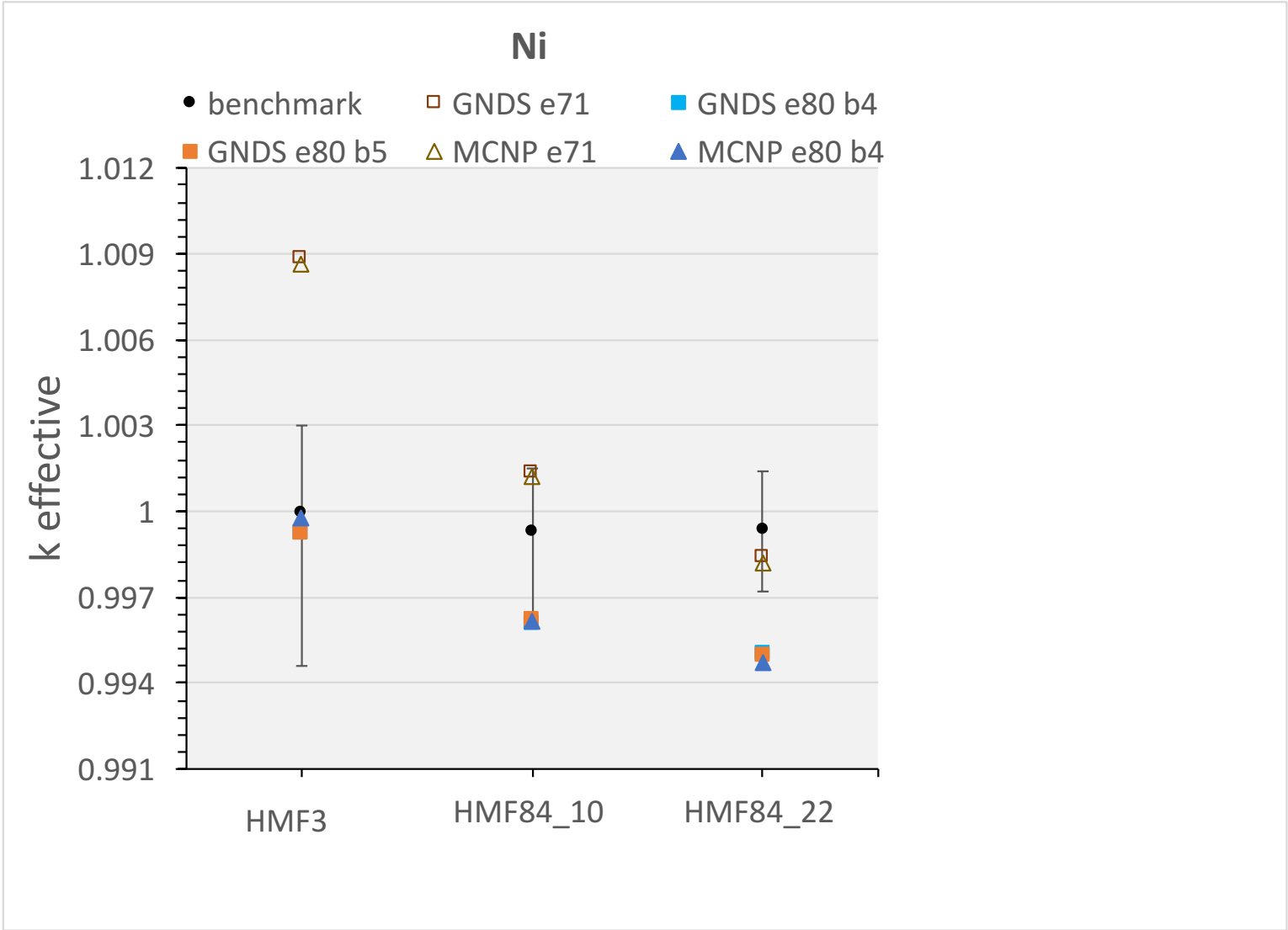
U reflector


U
benchmark
GNDS e71
GNDS e80 b4
GNDS e80 b5
MCNP e71
MCNP e80 b4
k effective
1.009
1.006
1.003
1
0.997
0.994
0.991
HMF2
HMF28
HMF38
HMF84_13
HMF84_24
MMF2_1
MMF2_2
MMF2_3
PMF6
PMF10
PMF20
PMF41
UMF02
UMF03
UMF06

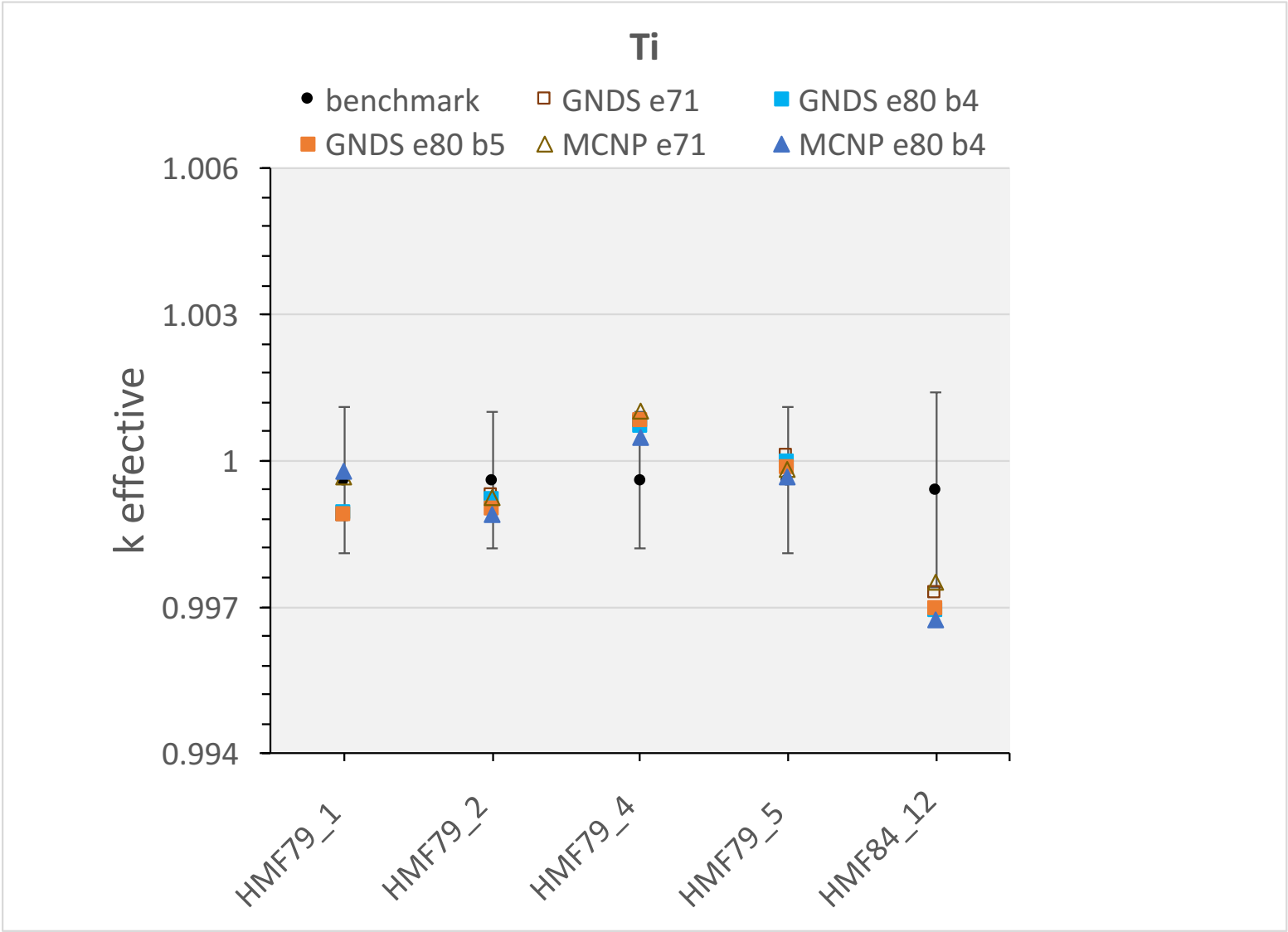
C reflector


C
benchmark
GNDS e71
GNDS e80 b4
GNDS e80 b5
MCNP e71
MCNP e80 b4
k effective
1.01
1.008
1.006
1.004
1.002
1
0.998
0.996
0.994
0.992
0.99
0.988
HMF19
HMF41_3
HMF41_4
HMF41_5
HMF41_6
HMF84_4
PMF30
PMF23

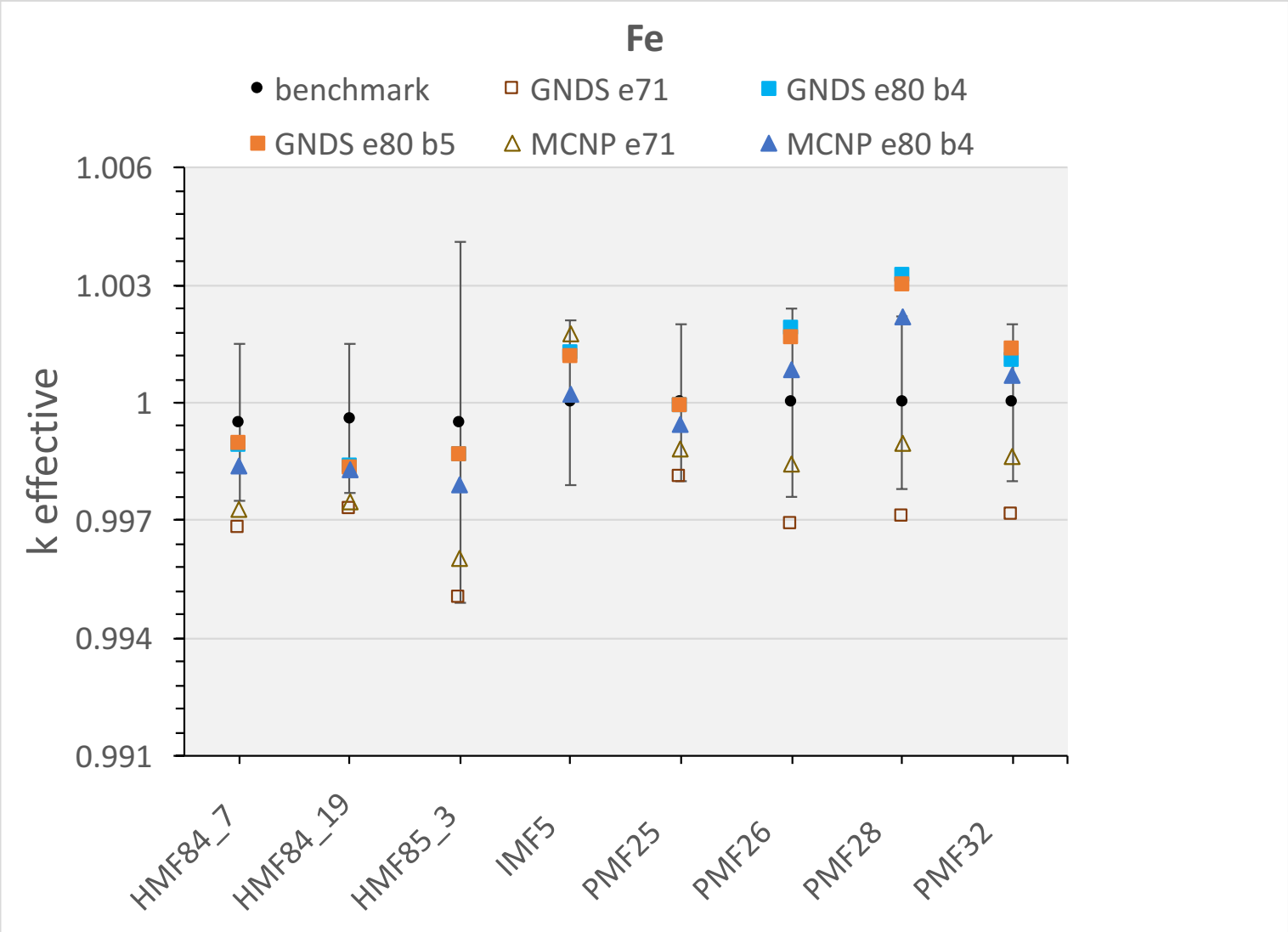
Ni reflector



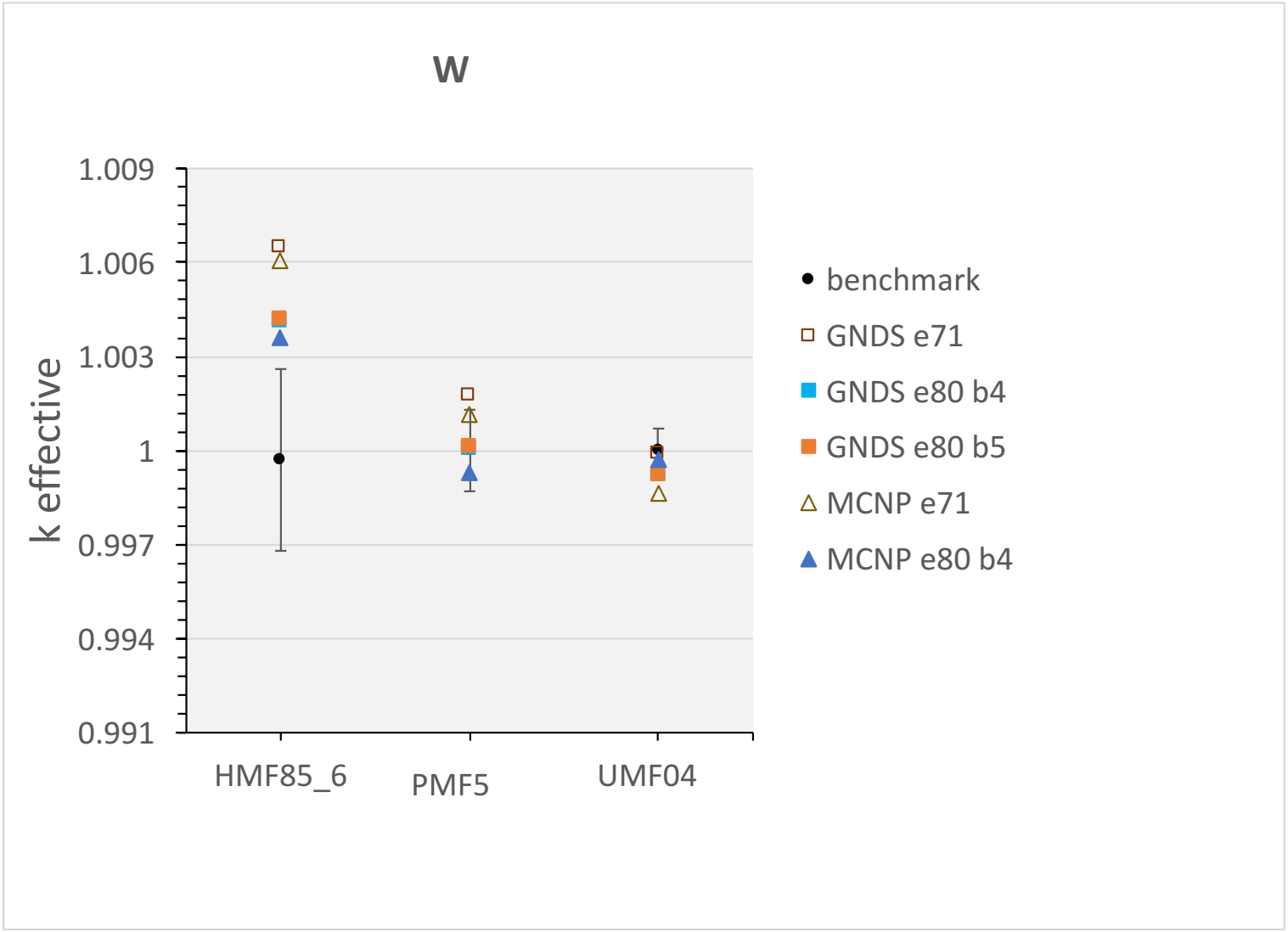
Ti reflector



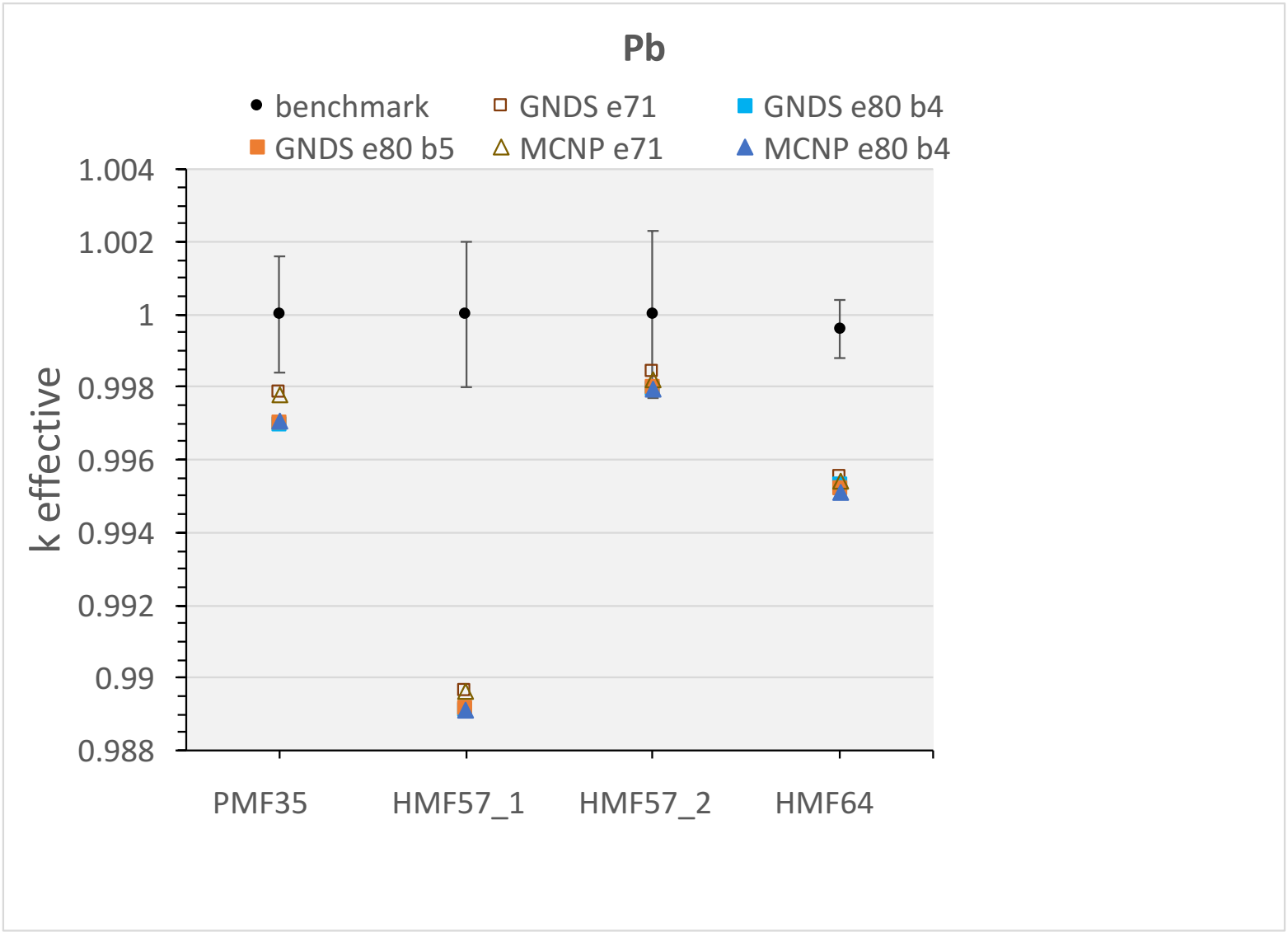
Fe reflector



W reflector


W
1.009
1.006
1.003
1
0.997
0.994
0.991
k effective
HMF85_6
PMF5
UMF04
benchmark
GNDS e71
GNDS e80 b4
GNDS e80 b5
MCNP e71
MCNP e80 b4

Pb reflector



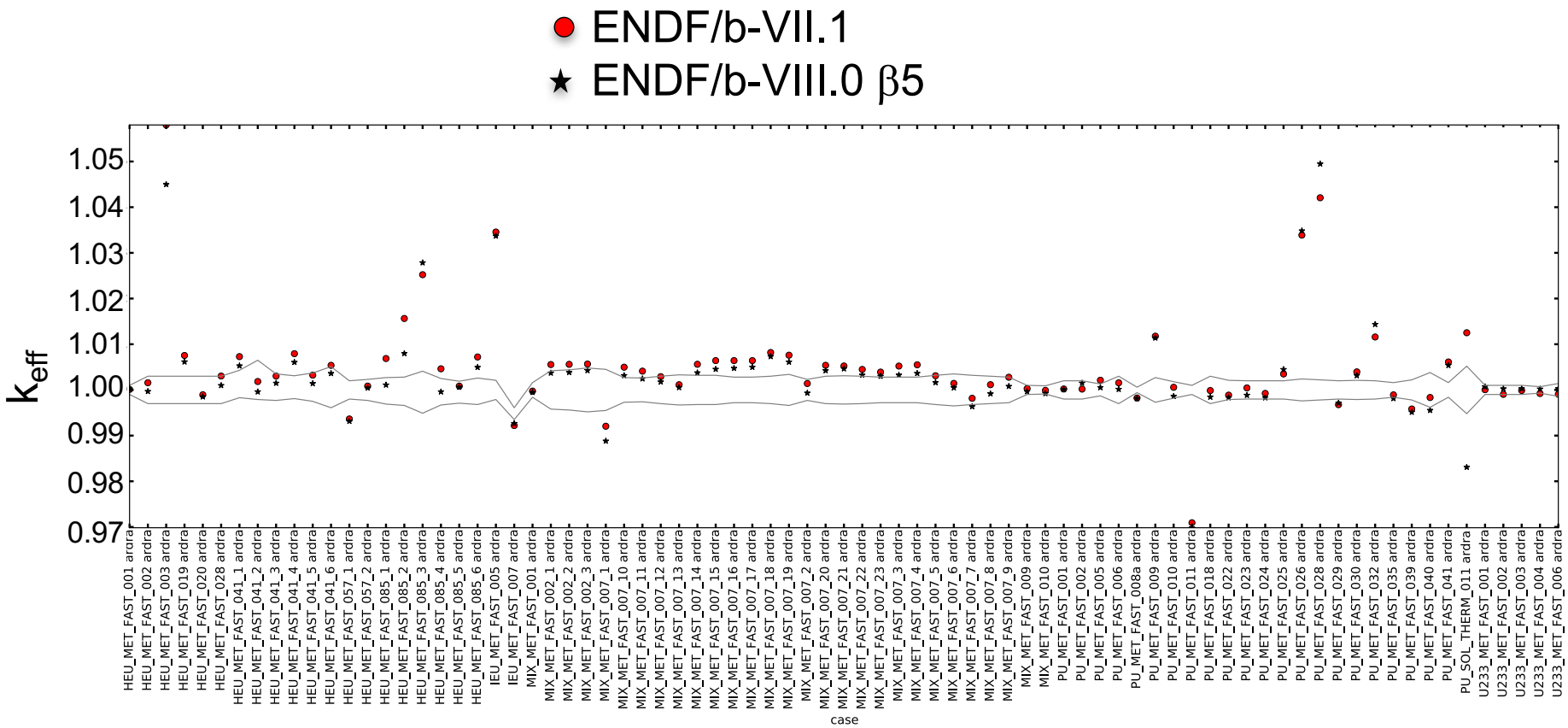
New: reaction ratios tests on GNDS data with Mercury/GIDI/MCGIDI

ENDF/b-8 β4

Benchmark	Reaction Ratio	^{233}U(n,f)fp	^{238}U(n,f)fp	^{237}Np(n,f)fp	^{239}Pu(n,f)fp	Simulated k_{eff}
Godiva	C1= Mercury	1.5793	0.1583	0.8314	1.3844	1.00016+/-0.00010
	C2=MCNP	1.5793	0.1583	0.8318	1.3846	1.00009+/-0.00008
	C1/C2	1.0000	1.0001	0.9995	0.9998	
Jezebel	C1= Mercury	1.5660	0.2120	0.9772	1.4275	0.99986+/-0.00010
	C2=MCNP	1.5560	0.2121	0.9770	1.4273	1.00073+/-0.00008
	C1/C2	1.0064	0.9997	1.0002	1.0001	
Flattop25	C1= Mercury	1.5776	0.1450	0.7737	1.3621	1.00115+/-0.00010
	C2=MCNP	1.5664	0.1451	0.7735	1.3622	1.00082 +/-0.00009
	C1/C2	1.0072	0.9990	1.0003	0.9999	

We are investigating possible sources of discrepancies for U233(n,f).

We can run criticality benchmarks using GNDS multigroup data and Ardra/GIDI



Conclusion

- ENDF/b-VII.1, VIII.0 β4 and β5 XS libraries in GNDS format
- GNDS data are tested with Fast critical assemblies (MC, Sn) and fission reaction ratios (MC)
- Results:
  - ENDF/b-VII.1 consistently higher than ENDF/b-VIII.0 except for Fe
  - GNDS keff are within 5e-4 of ENDF's for 80/107 fast critical assemblies and within 1e-3 for all assemblies but one.
  - k_{eff} variations <4.e-4 from ENDF/b-VIII.0 β4 to β5
  - Fission reaction ratios for Godiva and Jezebel are in good agreement with MCNP6 results.
- Process is in place
- Fast turn around, from data translation to tests completion: 24 to 48h depending on computer availability