PAUL SCHERRER INSTITUT

PSI

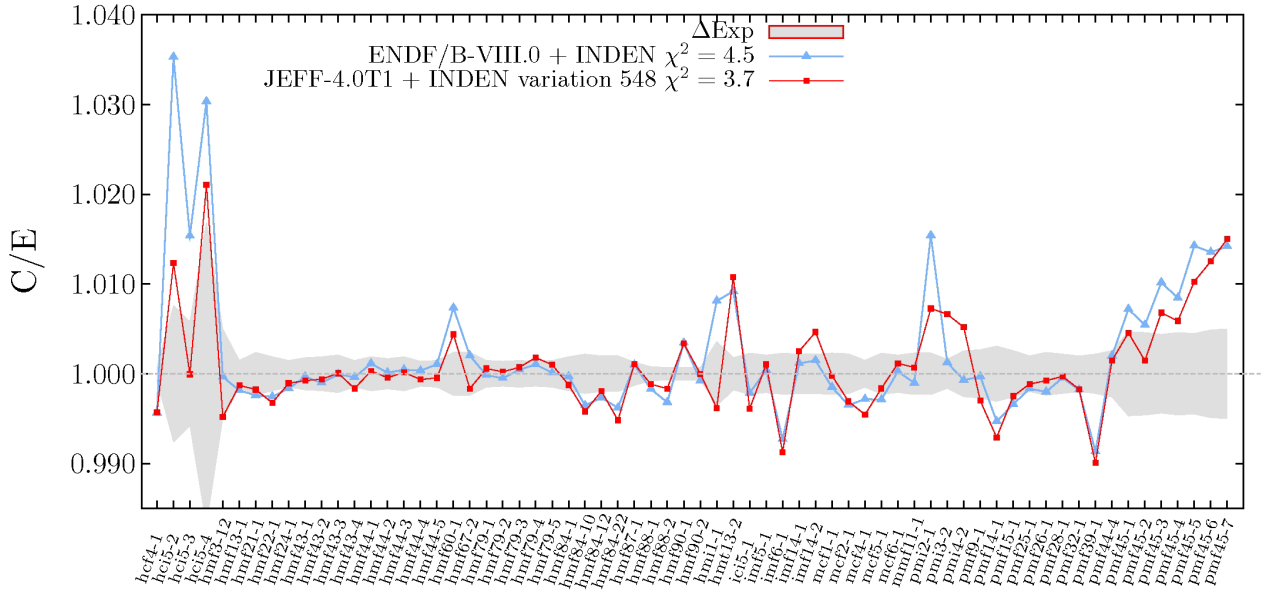
D. Rochman, A. Koning, S. van der Marck, R. Capote and A. Trkov

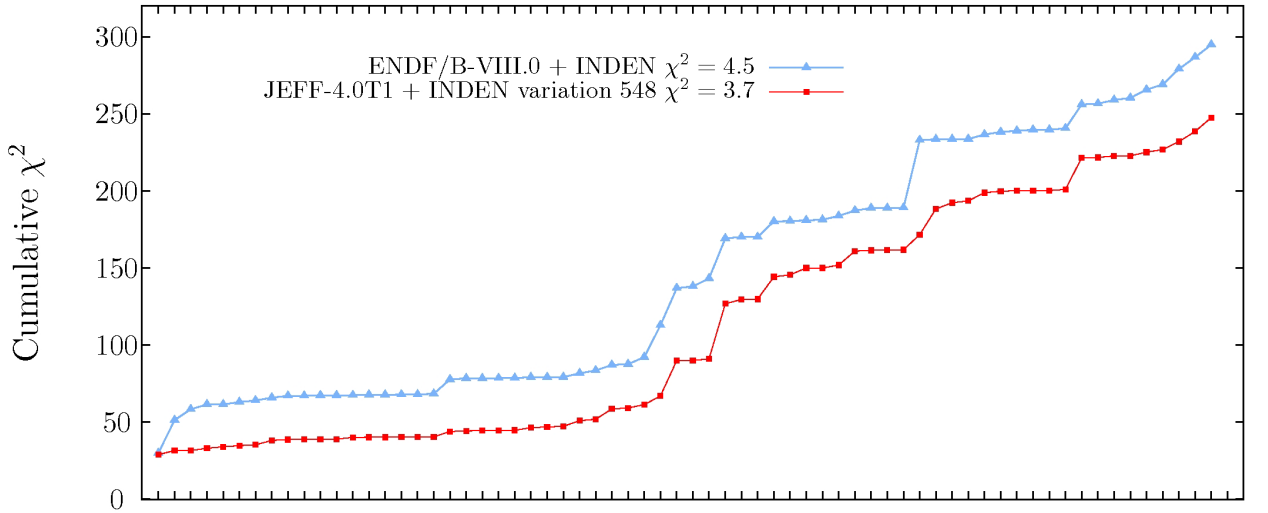
Example of simultaneous adjustment for JEFF-4 based on INDEN

INDEN Meeting, IAEA, Vienna, 29-31 August 2022

Summary

- Goal and Method
- Elements & benchmarks
- Sampling
- Results
  - Benchmark
  - Some cross sections
- Future & conclusion





Goal and Method

- Goal:
  - perform a demonstration of adjustment for the JEFF-4 library, including the maximum number of isotopes and benchmarks
  - Make use of the INDEN effort and “tune” it towards JEFF needs

- Method:
  - TMC + χ^2 selection (Petten method: produce a statistical ensemble of 1000 random ENDF files with OMP, LD and γ-str modified)
  - Applied in the past to ^{239}Pu, Cu, H in H_2O

  - Present application of TMC:
    - need to have T3 (Talys, Tefal, Tasman)
    - RRR fixed

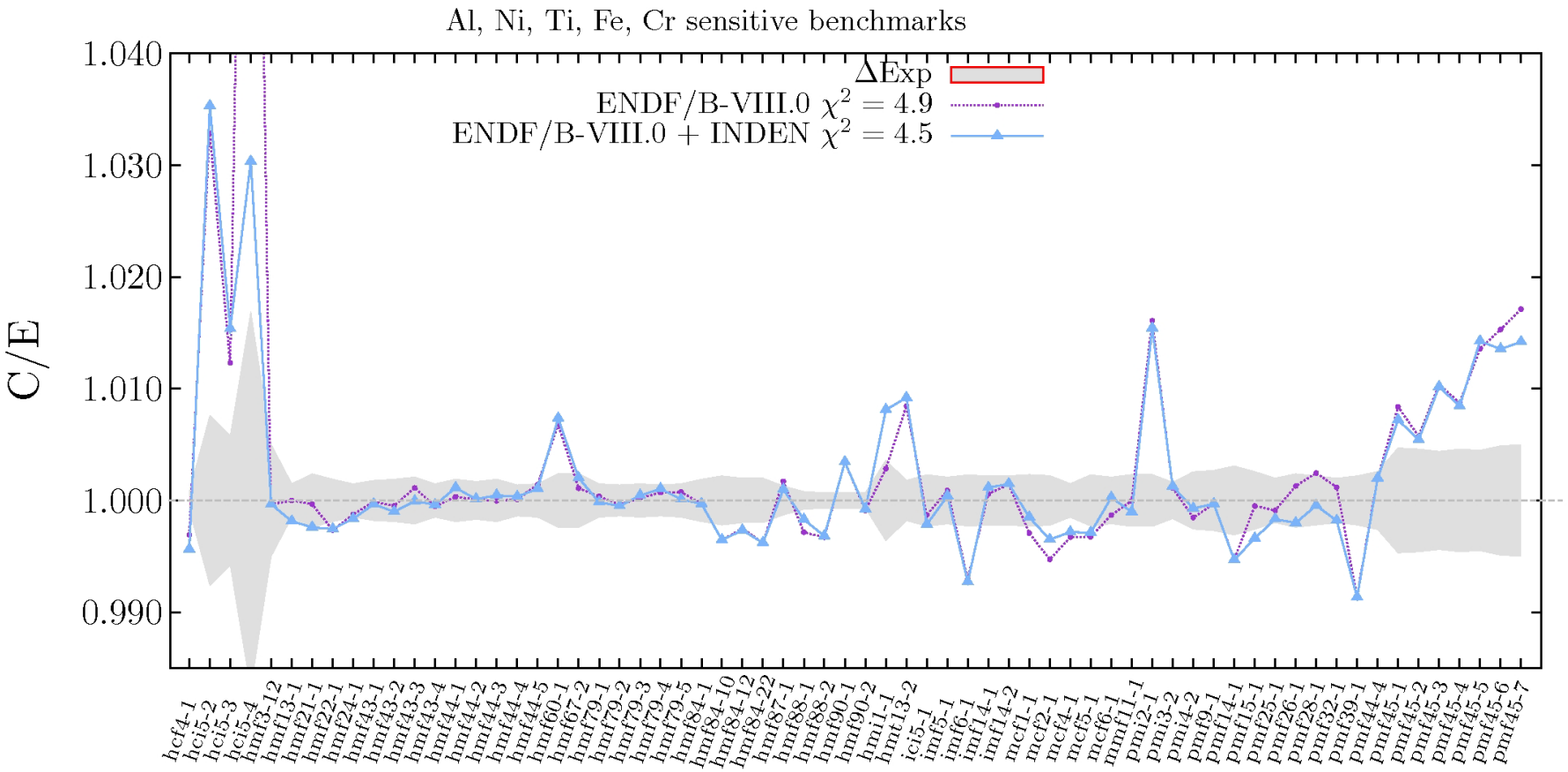
  - χ2 calculated on criticality benchmarks
  - MCNP calculations
  - ACE files starting point: JEFF-4.0 Test 1 (released in March 2022) and INDEN

Elements and benchmarks considered

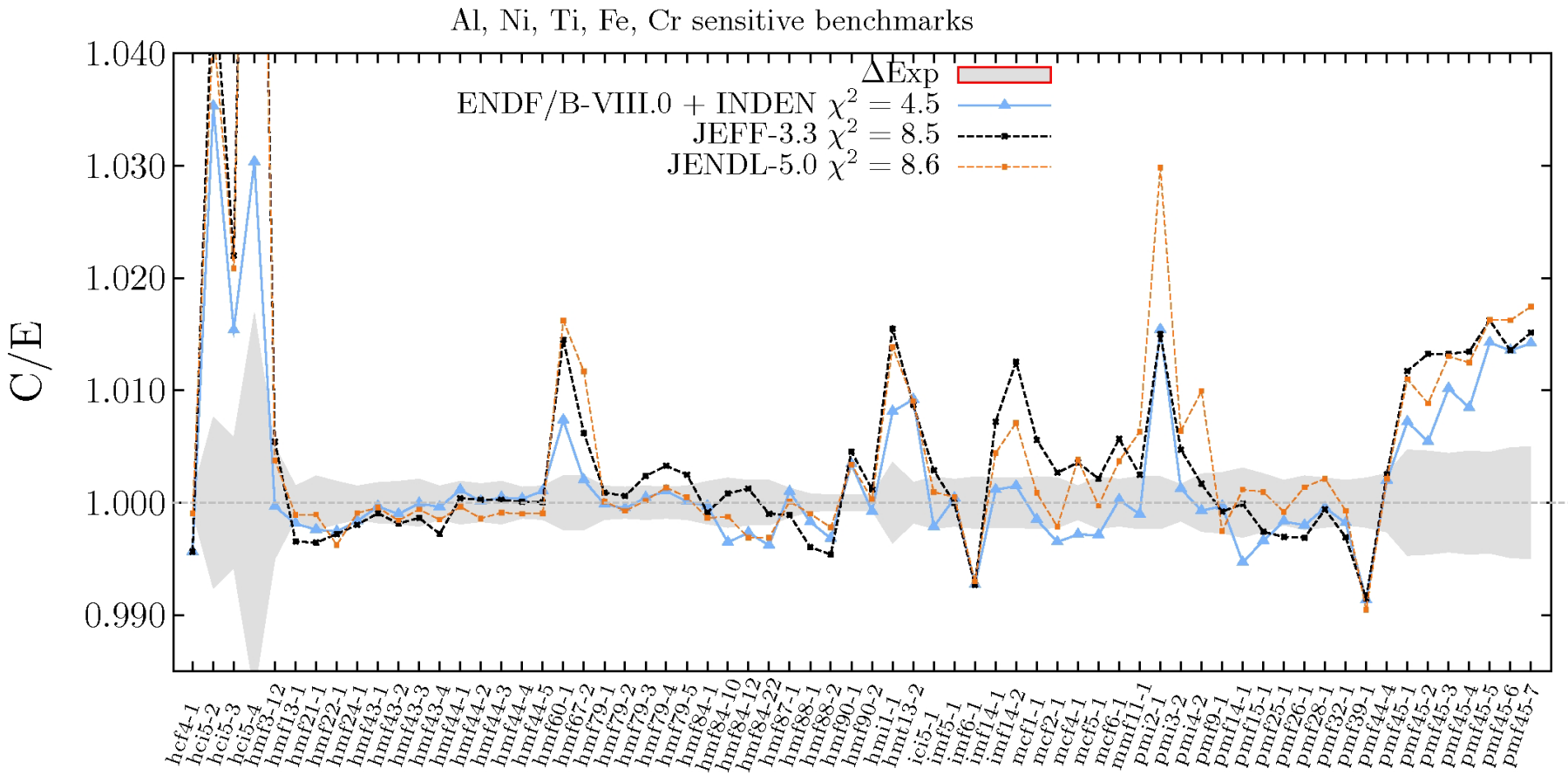
- All ACE files are from JEFF-4.0T1, except:
  - Al27, Ti48,50, Ni58,60,61,64 (nominal JEFF-4.0T1 & ENDF/B-VIII.0)
  - Fe54,56,57,58, Cr50,52,53,54 (nominal INDEN)

- 66 criticality benchmarks
  - hcf4,
  - hci5-(2,3,4)
  - hmf3-12, hmf13, hmf21, hmf22, hmf24, hmf43-(1,2,3,4), hmf44-(1,2,3,4,5), hmf60, hmf67-2, hmf79-(1,2,3,4,5), hmf84-(1,10,12,22), hmf87, hmf88-(1,2), hmf90-(1,2),
  - hmi1
  - hmt12-2
  - ici5,
  - imf5, imf6, imf14-(1,2),
  - mcf1, mcf2, mcf4, mcf5, mcf6,
  - mmf11
  - pmi2, pmi3, pmi4-2, pmf9, pmf14, pmf15, pmf25, pmf26, pmf28, pmf32, pmf29, pmf44-4, pmf45-(1,2,3,4,5,6,7)

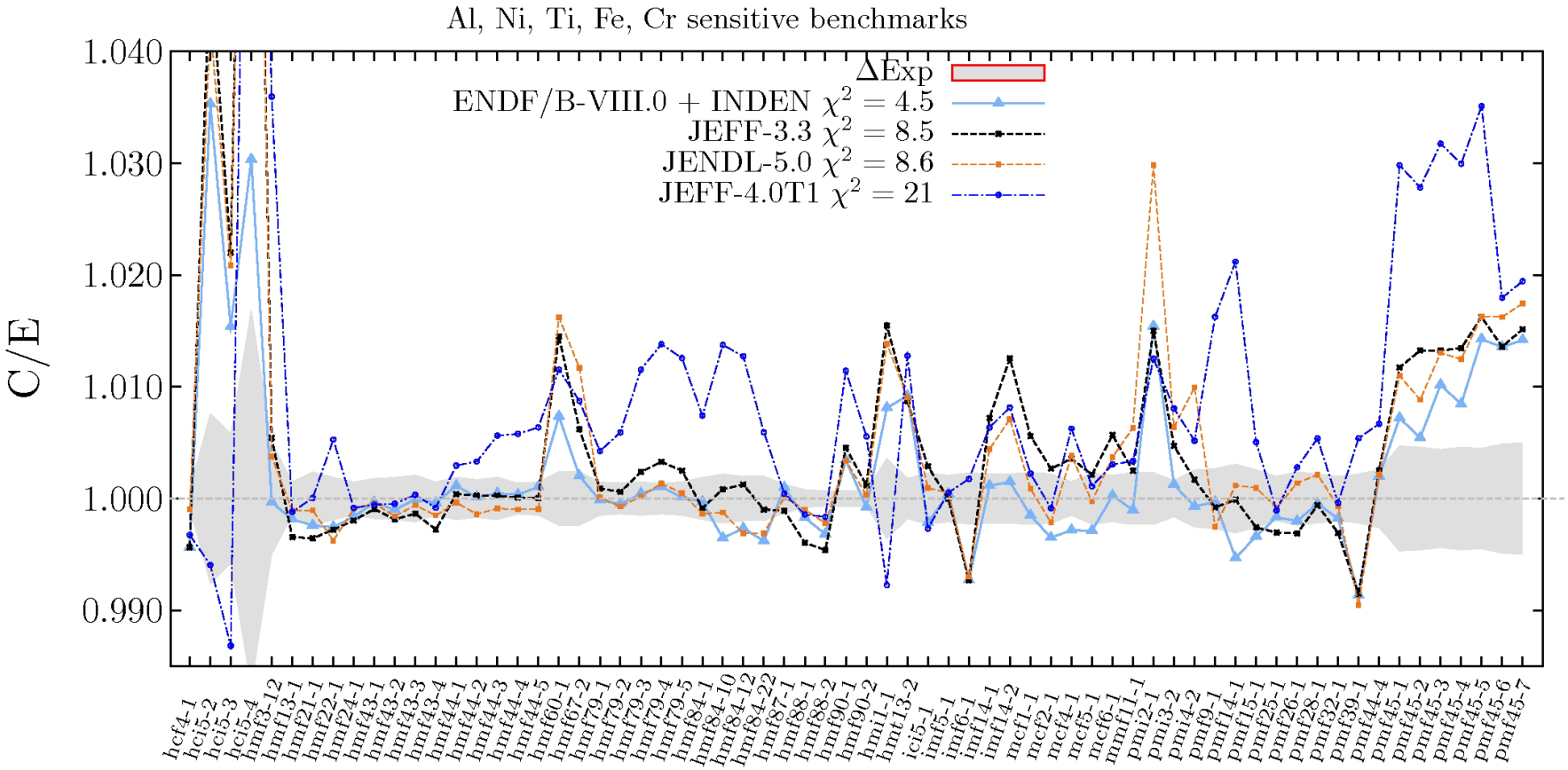
Benchmarks (INDEN improvement)



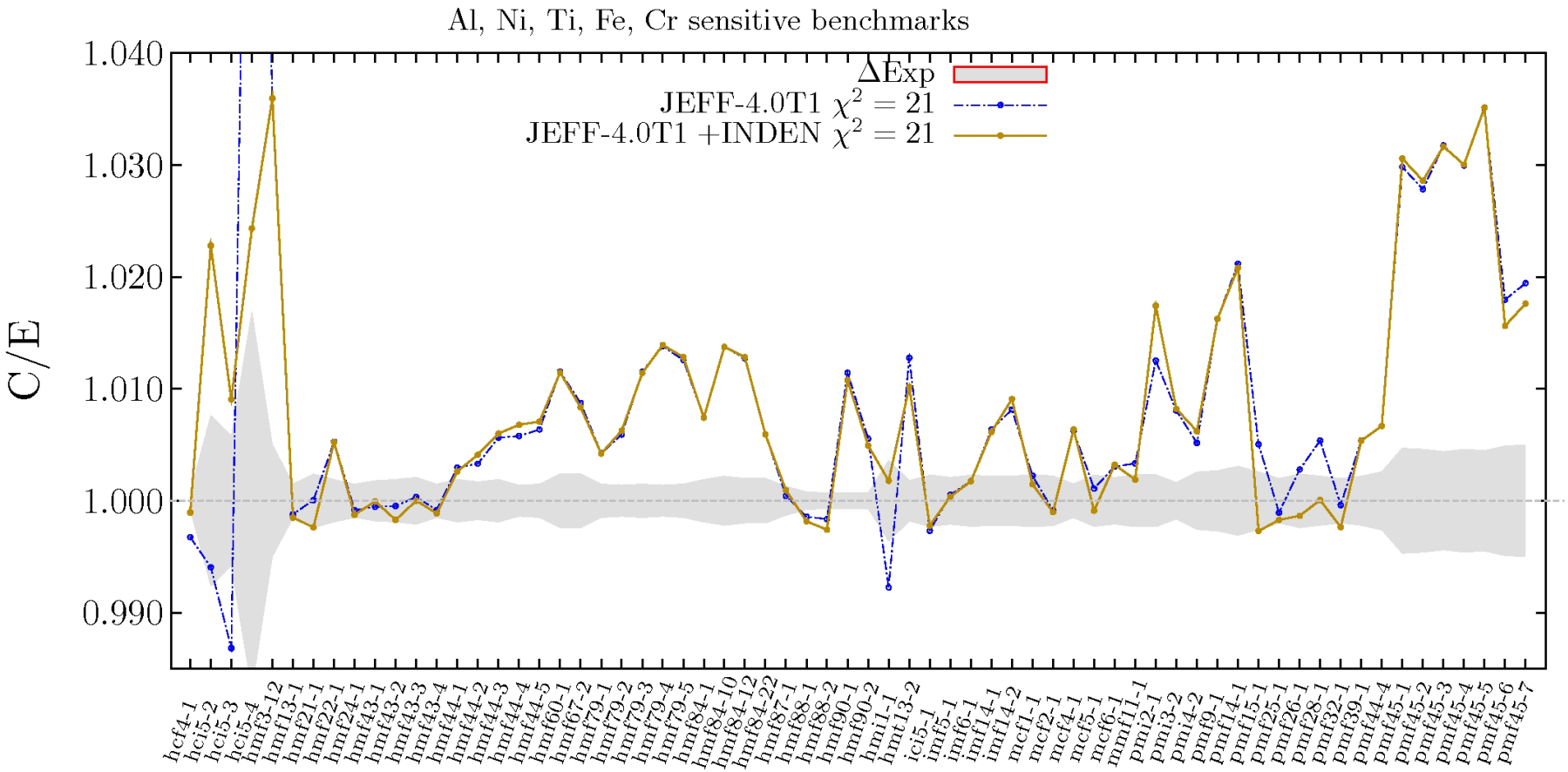
Benchmarks (main libraries)



Benchmarks (latest JEFF Test release)



Benchmarks (JEFF Test + INDEN)



Sampling

- 1000 random files for Al, Ti, Ni, Fe and Cr as follows:
- Run 0: nominal ; runs 1 to 1000: sampled around run 0
- RRR are fixed and from JEFF-4.0T1 or INDEN
- Fast range: TALYS for the full files (mainly MF3, MF4) with
  - Al27: autonorm to ENDF/B-VIII.0 for MF3MT2, 51 to 54
  - Al27: adopt MF4MT2 from ENDF/B-VIII.0
  - Ti48: autonorm to ENDF/B-VIII.0 for MF3MT2
  - Ti48: adopt MF4MT2 from ENDF/B-VIII.0
  - Ti50: autonorm to JEFF-3.3 for MF3MT2
  - Ni58,60: autonorm to ENDF/B-VIII.0 for MF3MT2, 51 to 54
  - Ni61: autonorm to JEFF-3.3 for MF3MT2
  - Ni64: autonorm to ENDF/B-VIII.0 for MF3MT2

Sampling

- Fe54: autonorm to ENDF/B-VIII.0 for MF3MT2, 51 to 54
- Fe54: autonorm to INDEN for MF3MT102 (+background)
- Fe54: adopt MF4MT2 from ENDF/B-VIII.0

- Fe56: autonorm to INDEN for MF3MT2, 51, 52, 102
- Fe56: adopt MF4MT2 from JENDL-4.0

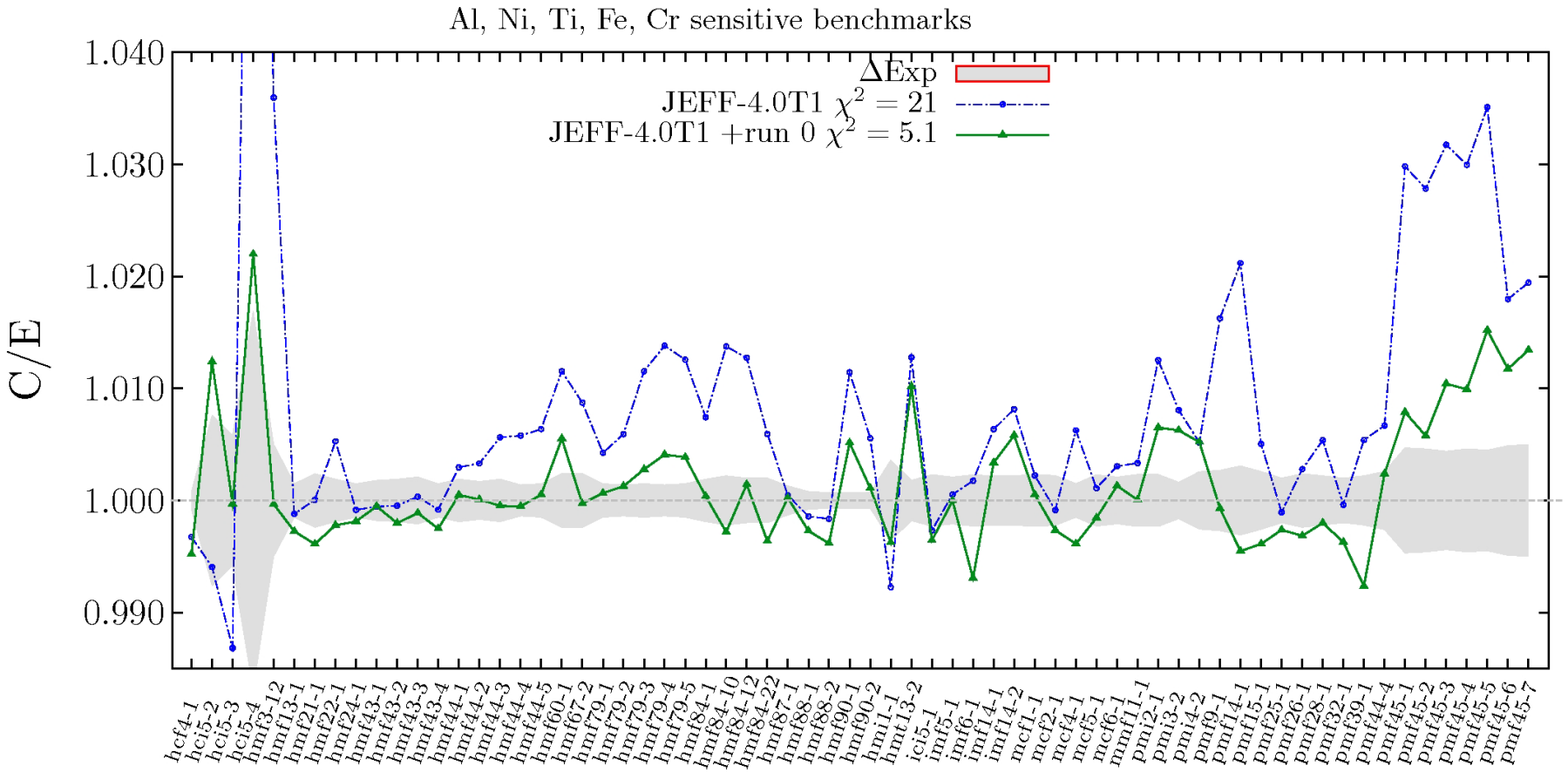
- Fe57: autonorm to INDEN for MF3MT2, 102 (+background)
- Fe57: autonorm to ENDF/B-VIII.0 for MF3MT51 to 54

- Fe58: autonorm to ENDF/B-VIII.0 for MF3MT2, 51 to 54, 91 and 102

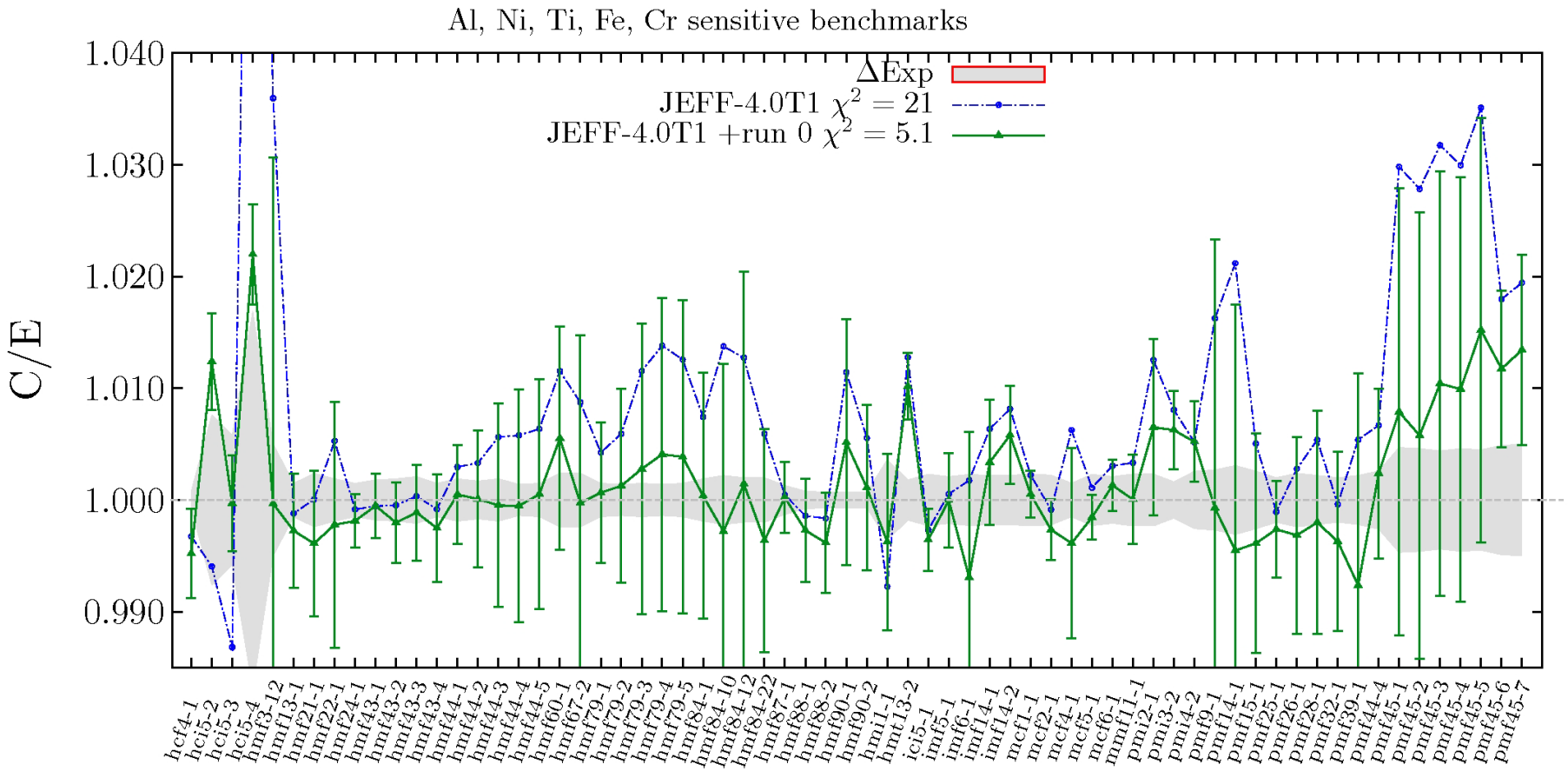
- Cr50, 53, 54: autonorm to ENDF/B-VIII.0 for MF3MT2
- Cr50, 53: adopt MF4MT2 from ENDF/B-VIII.0

- Cr52: autonorm to ENDF/B-VIII.0 for MF3MT2, 51 to 55
- Cr52: adopt MF4MT2 from ENDF/B-VIII.0

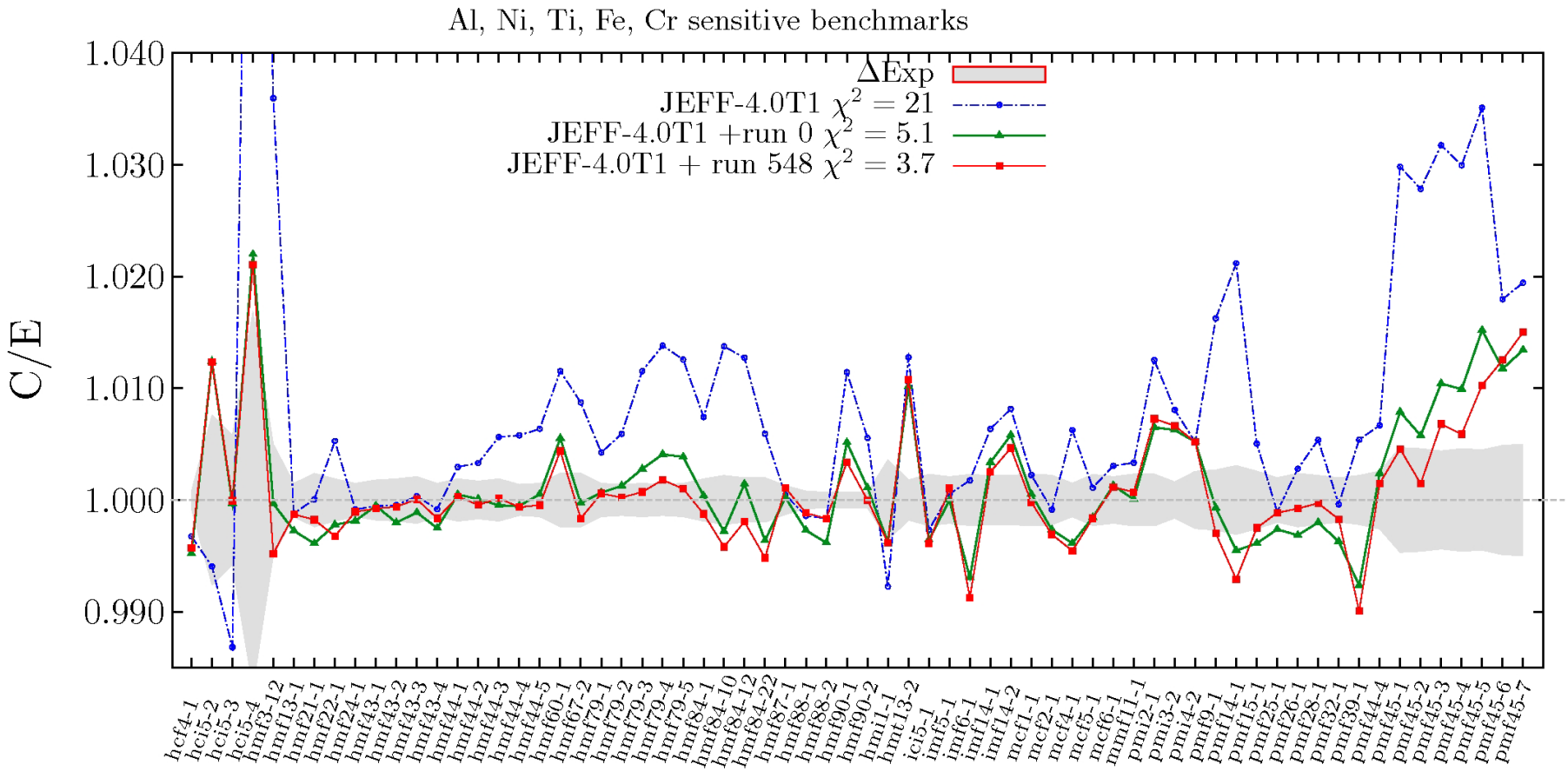
Benchmarks (JEFF Test + run 0)



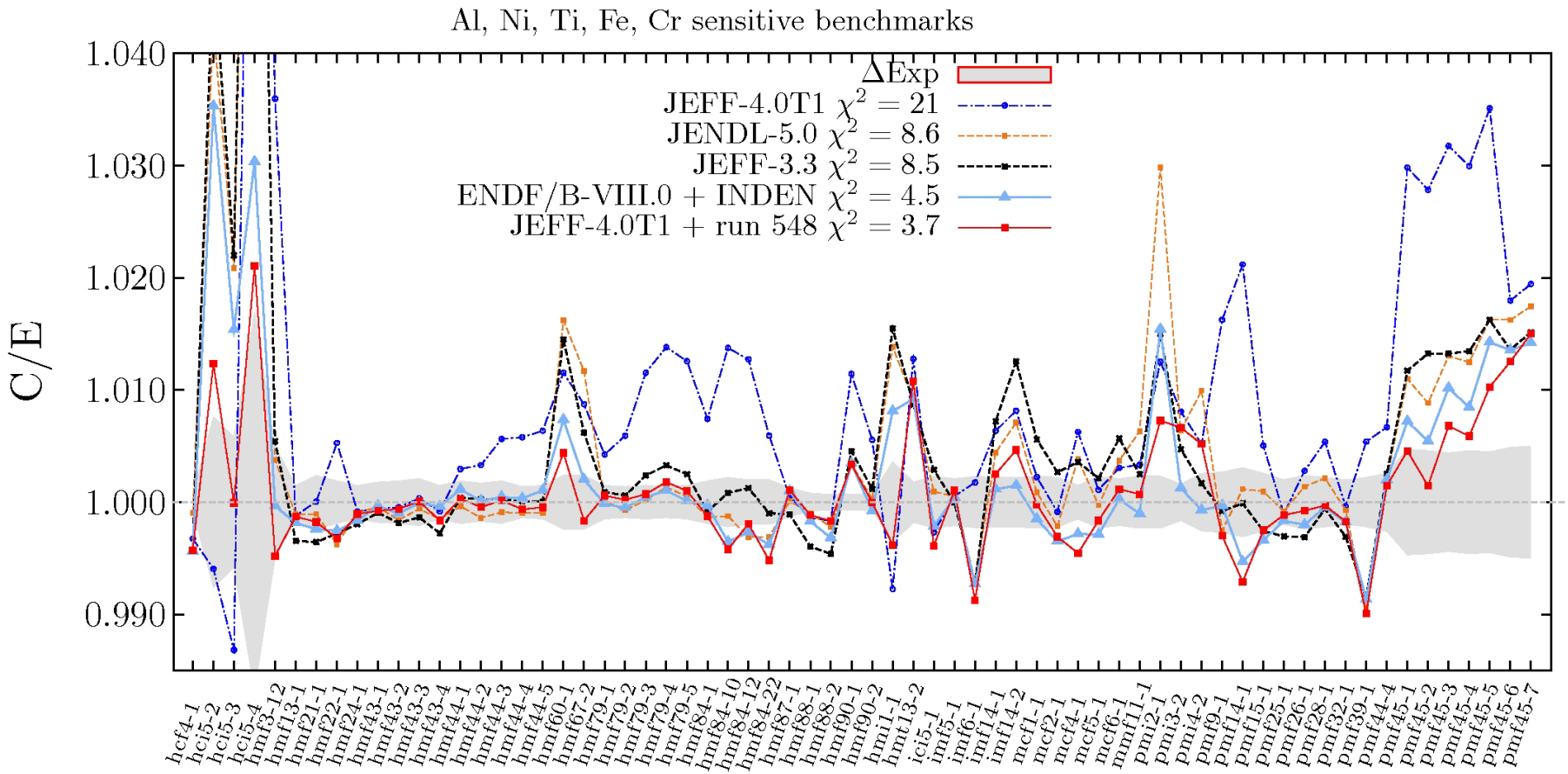
Benchmarks (JEFF Test + run 0 and spread)



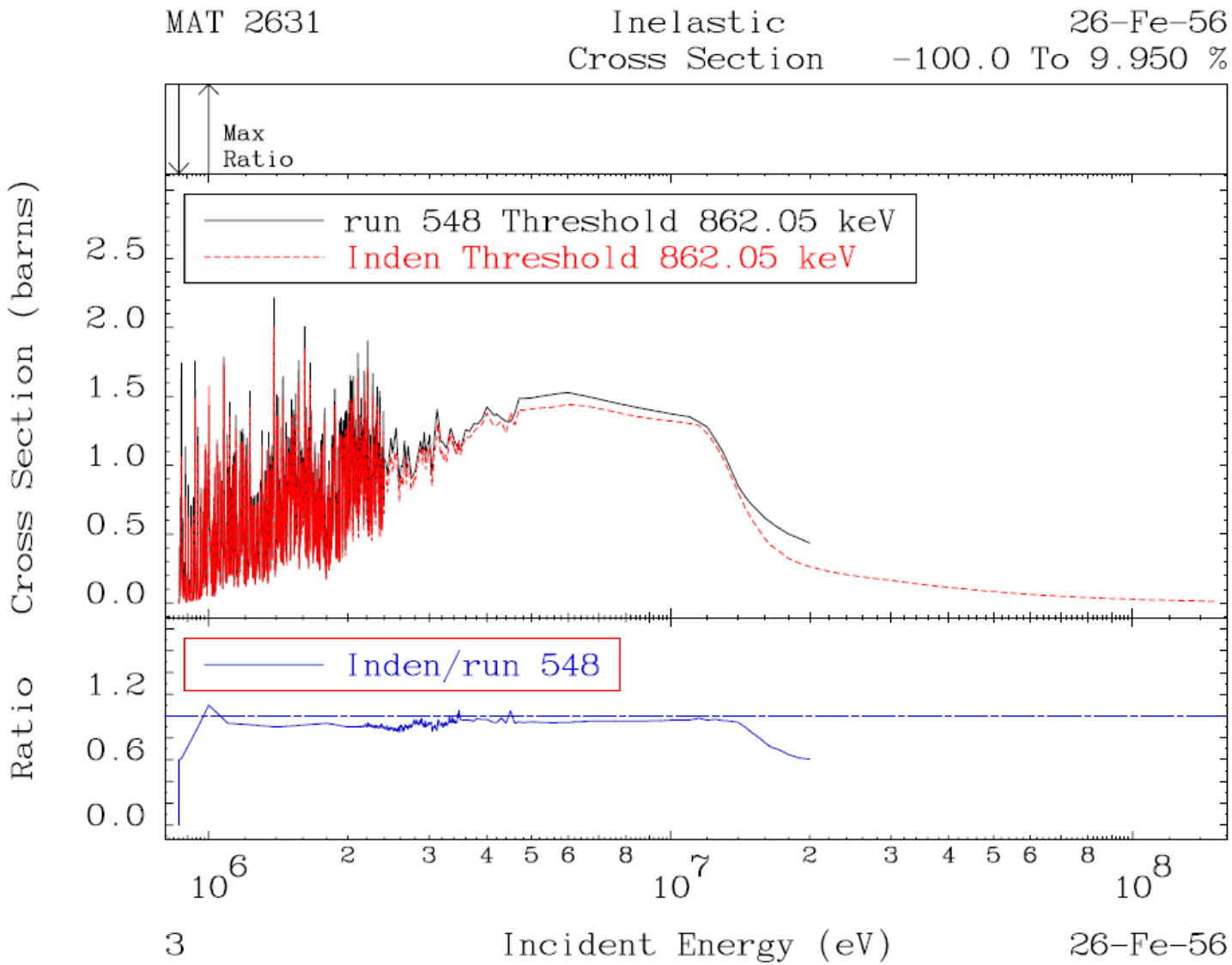
Benchmarks (JEFF Test + best run)



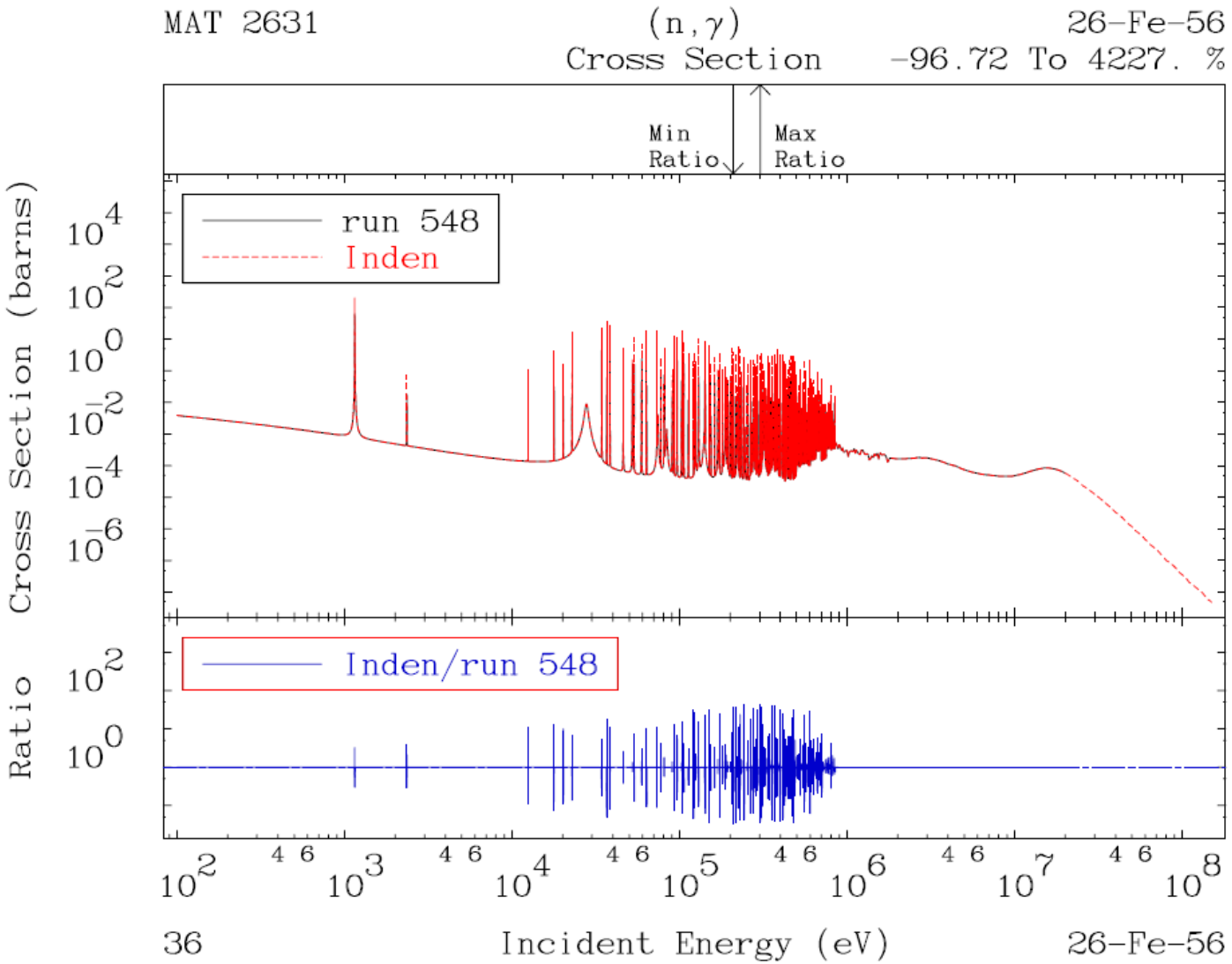
Benchmarks (JEFF Test + best run)



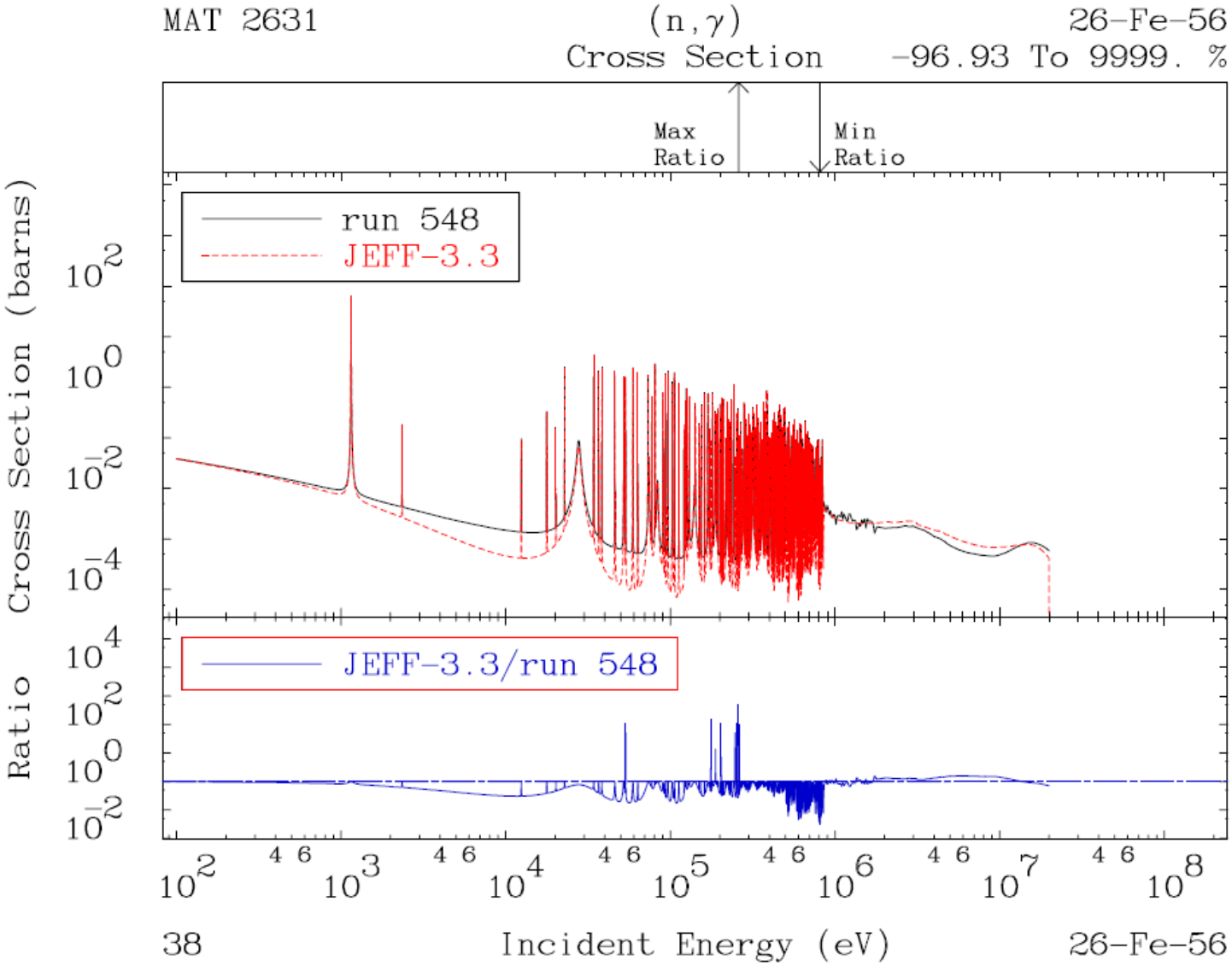
Cross section comparison: Fe56



Cross section comparison: Fe56



Cross section comparison: Fe56



Future and conclusions

- An example of adjustment was presented
- Great improvement for JEFF-4.0T1
- Use of INDEN for JEFF

- Needs to be redone:
  - More isotopes (actinides), more benchmarks
  - Comparison with EXFOR
  - Shielding benchmark
  - For the new JEFF4.0T2 release

- Can extract:
  - Sensitivity
  - Correlation between benchmarks
  - Correlation nuclear data – benchmarks
  - Combine sampled runs to get χ^2=1 (66 benchmarks, 66 runs, 66 coefficients)

PAUL SCHERRER INSTITUT

PSI

Wir schaffen Wissen – heute für morgen