Validation of the Fe-CIELO Evaluations

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What do we test?

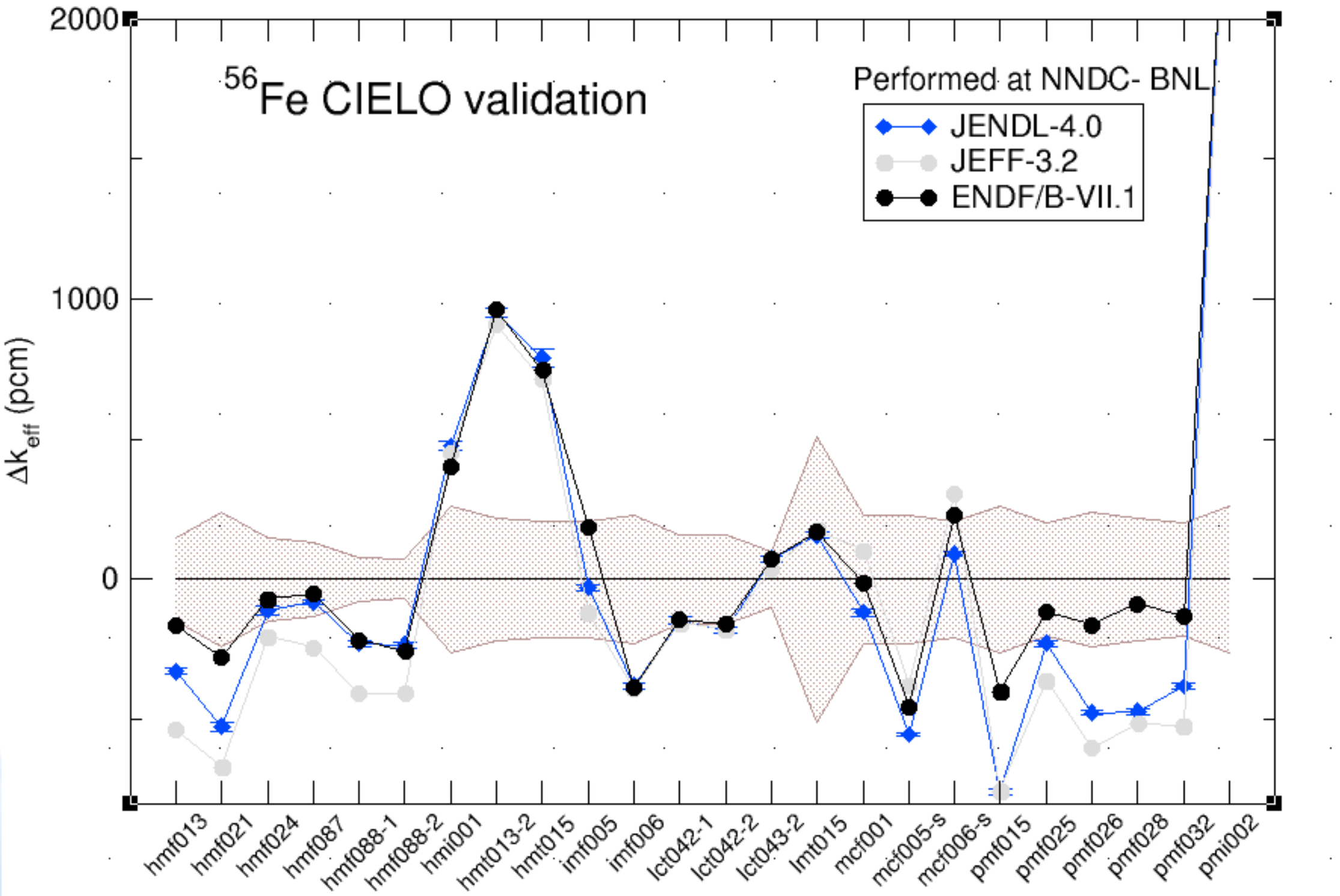
- NNDC
  - CIELO 54Fe rev.222
  - CIELO 56Fe rev.219
  - CIELO 57Fe rev.234
  - CIELO 58Fe rev.224
  - ENDF/B-VII.1
    (official LANL ACE lib.)

- IAEA
  - CIELO 54Fe rev.222
  - CIELO 56Fe rev.219 (fe56ib15k)
  - CIELO 57Fe rev.234
  - CIELO 58Fe rev.224
  - CIELO 239Pu 239Pu_ENDF_LANL_23c
  - CIELO 235U u238ib46rjFs
  - CIELO 238U u235ib06ao17g6cnu5cf2
  - CIELO 16O O16_haleadx
  - CIELO 1H h1tslcab2
  - ENDF/B-VII.1

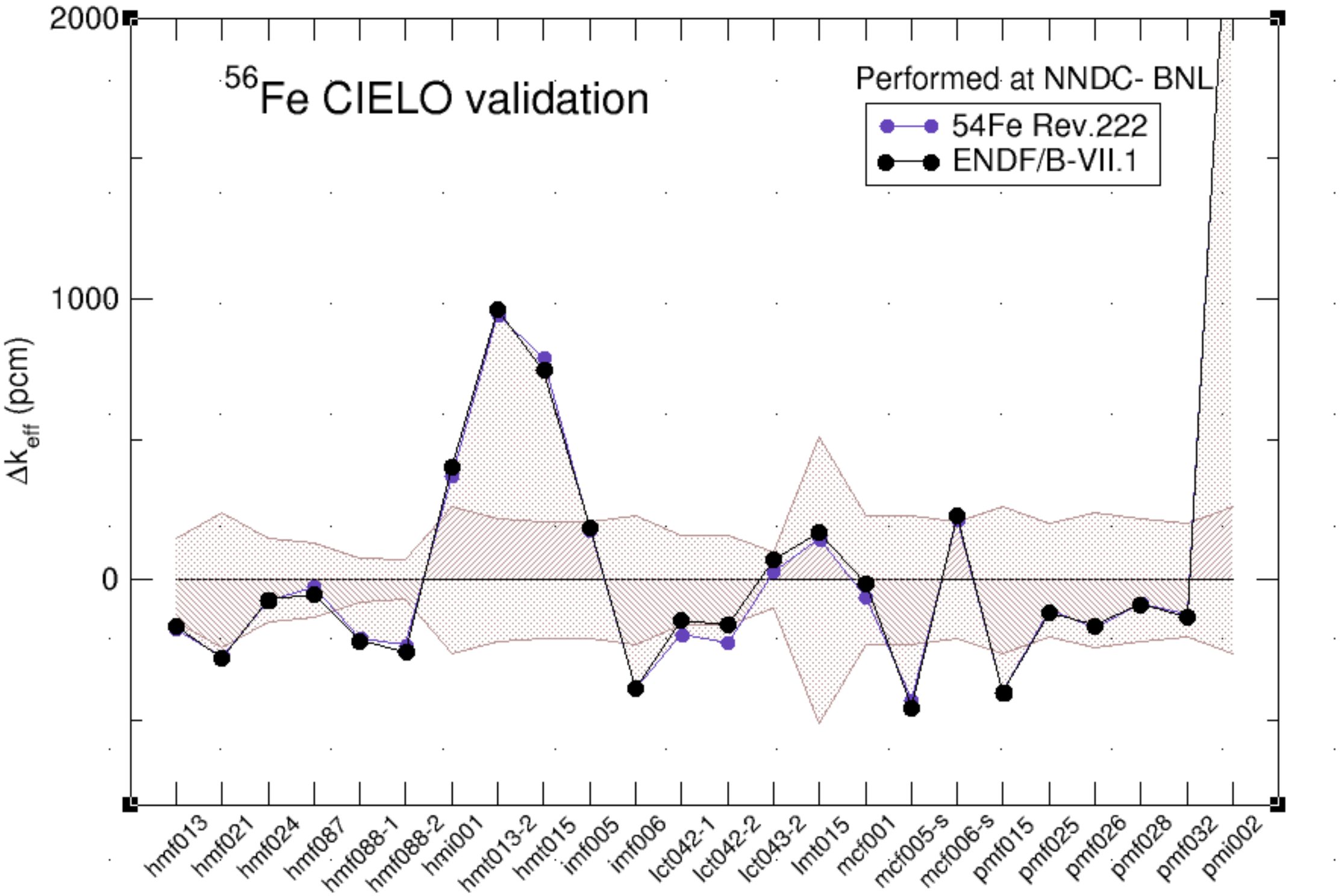
On what do we test?

	ICSBEP name	Common name
1	PU-MET-FAST-015	BR-1-3
2	PU-MET-FAST-025	pmf025
3	PU-MET-FAST-026	pmf026
4	PU-MET-FAST-028	pmf028
5	PU-MET-FAST-032	pmf032
6	HEU-MET-FAST-013	VNIITF-CTF-SS-13
7	HEU-MET-FAST-021	VNIITF-CTF-SS-21
8	HEU-MET-FAST-024	VNIITF-CTF-SS-24
9	IEU-MET-FAST-005	VNIITF-CTF-SS-5
10	IEU-MET-FAST-006	VNIITF-CTF-SS-6
11	HEU-MET-FAST-087	VNIITF-CTF-Fe
12	HEU-MET-FAST-088	hmf088-1
13	HEU-MET-FAST-088	hmf088-2
14	LEU-COMP-THERM-042	lct042-1
15	LEU-COMP-THERM-042	lct042-2
16	LEU-COMP-THERM-043	IPEN/MB-01
17	LEU-MET-THERM-015	lmt015
18	HEU-MET-THERM-013	hmt013-2
19	HEU-MET-THERM-015	hmt015
20	HEU-MET-INTER-001	ZPR-9/34
21	PU-MET-INTER-002	ZPR-6/10
22	MIX-COMP-FAST-001	ZPR-6/7
23	MIX-COMP-FAST-005	ZPR-9/31
24	MIX-COMP-FAST-006	ZPPR-2

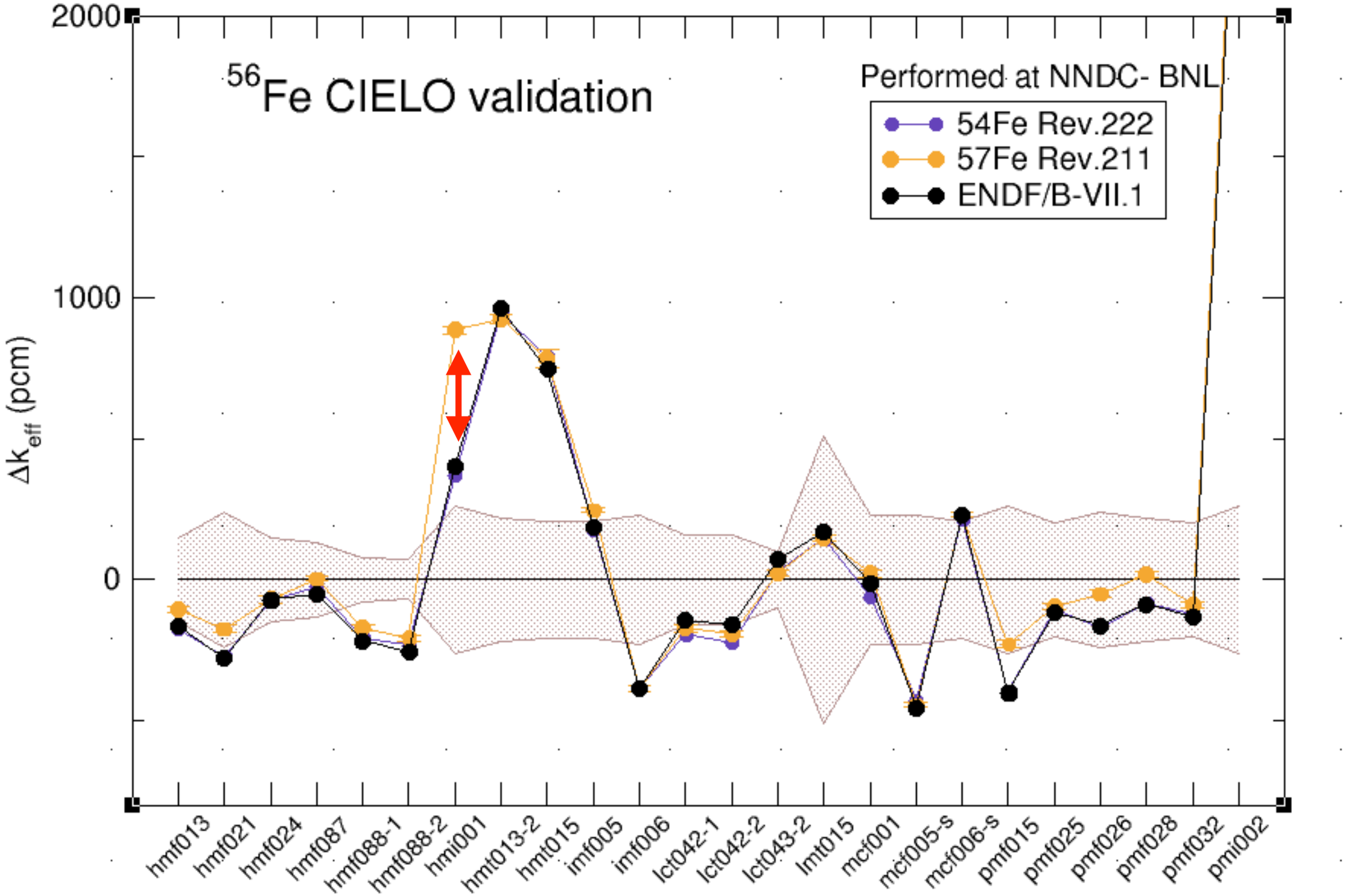
Starting point VII.1 v. FENDL-4.0 v. JEFF-3.2



ENDF/B-VII.1 + CIELO 54Fe



…adding CIELO 57Fe



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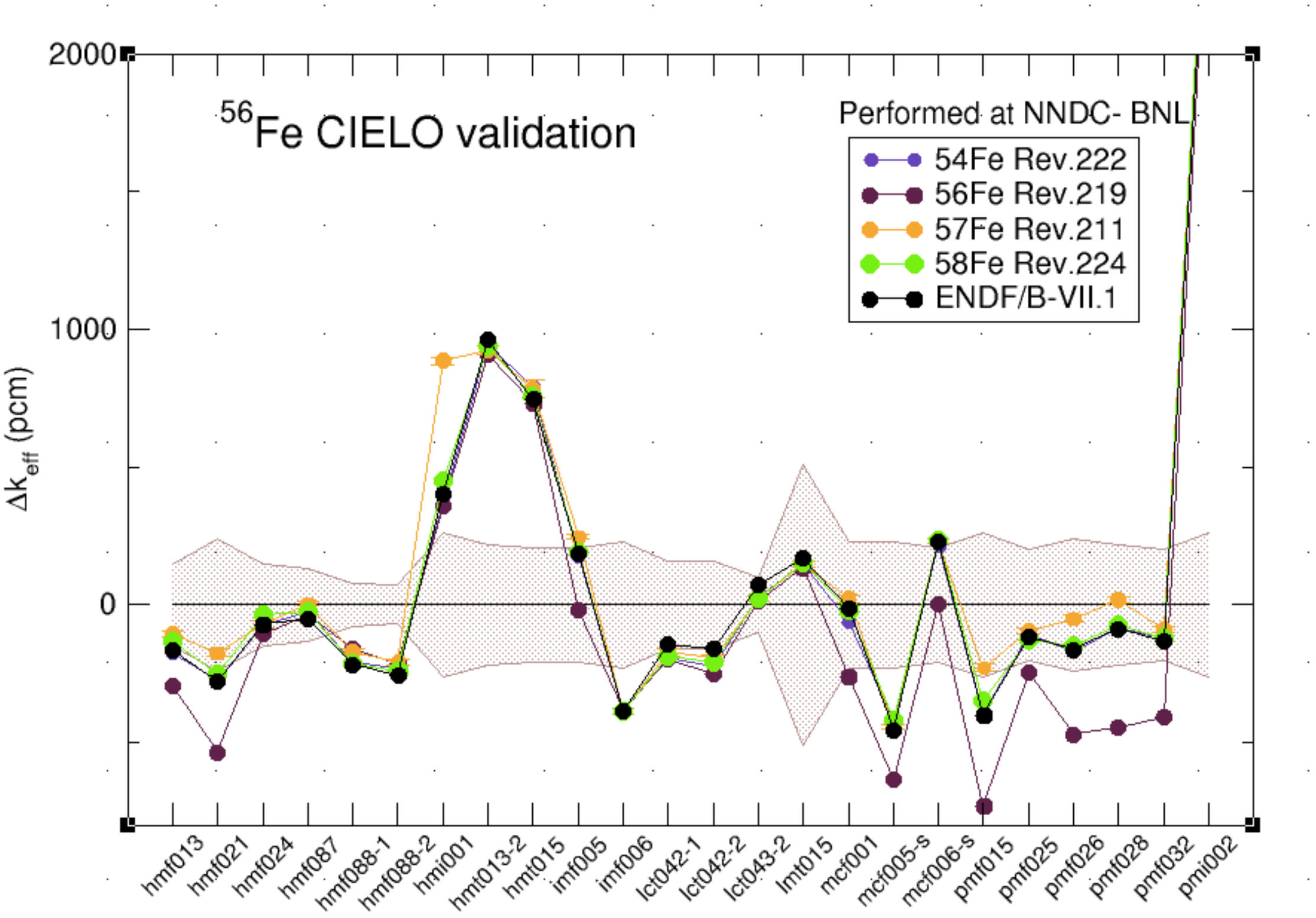
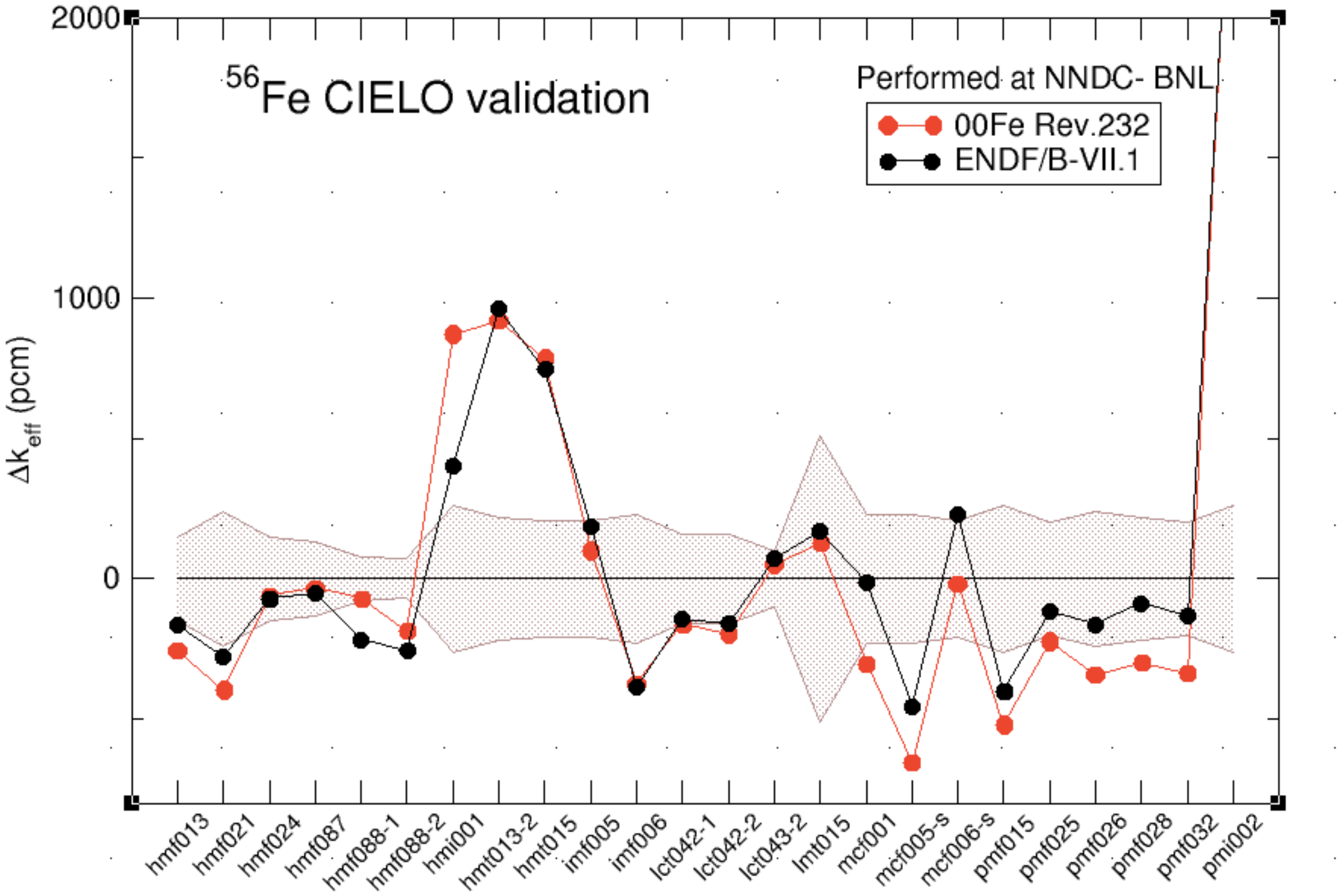
…adding CIELO 56Fe and 58Fe



ENDF/B-VII.1 + CIELO natFe



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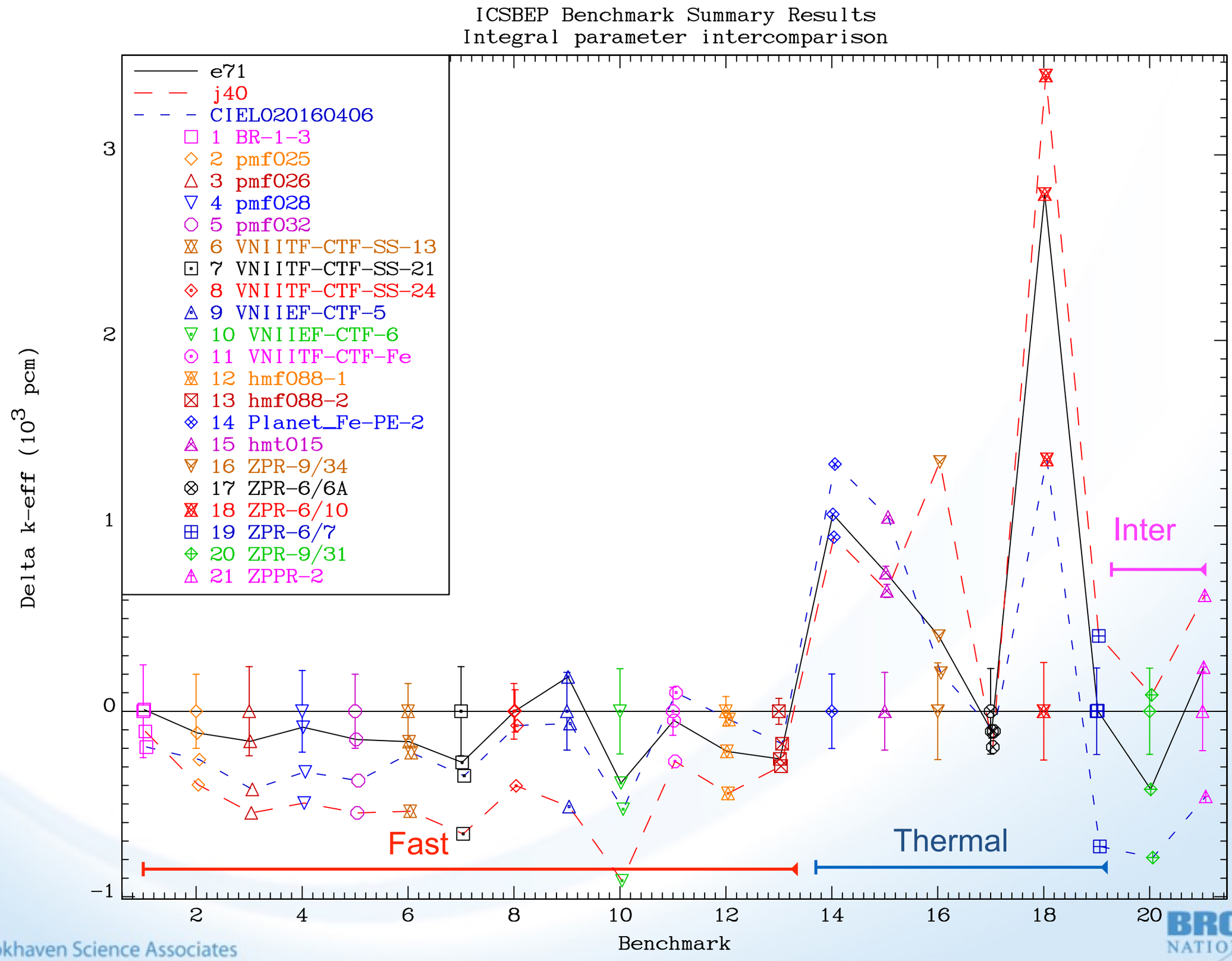
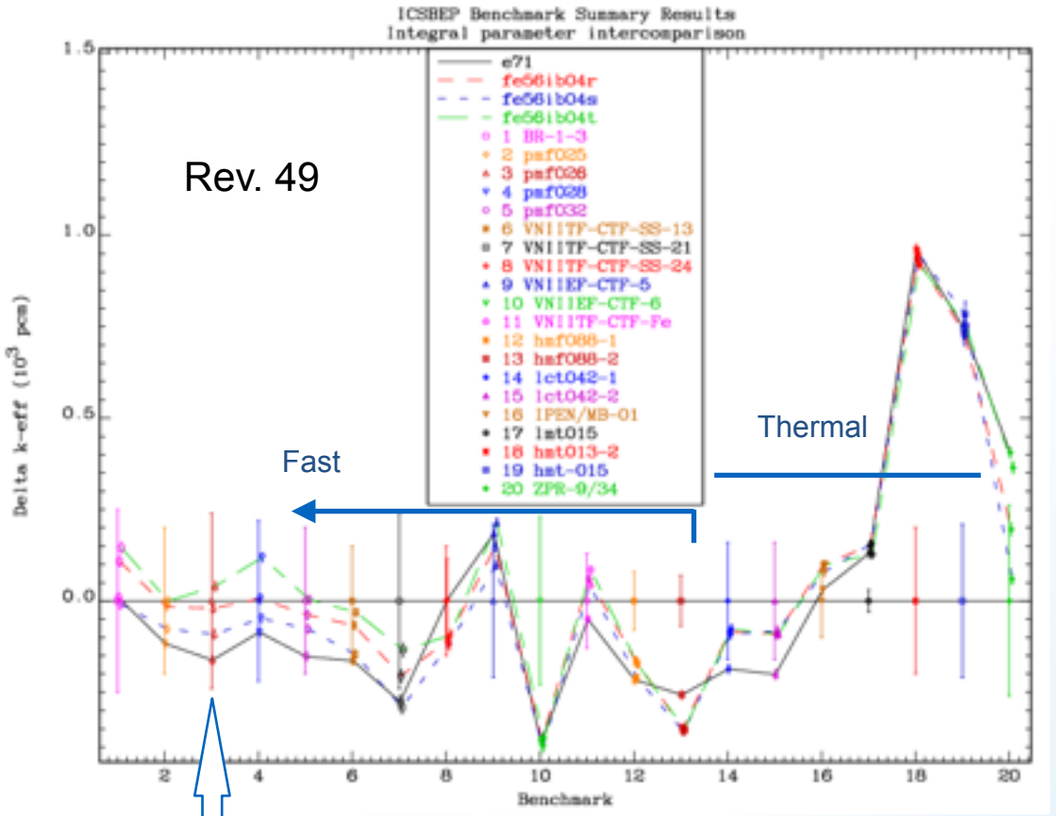
Iron validation with full CIELO library at IAEA



A couple of thoughts

- 24 benchmarks are mostly sensitive to the RR region
- Resonance parameters for 56Fe are very much fixed (Said) - there is not much room for improvement except:
  - external resonances
  - artificial background added to improve benchmarks
  - missing resonances at the end of RR
  - angular distributions in RR



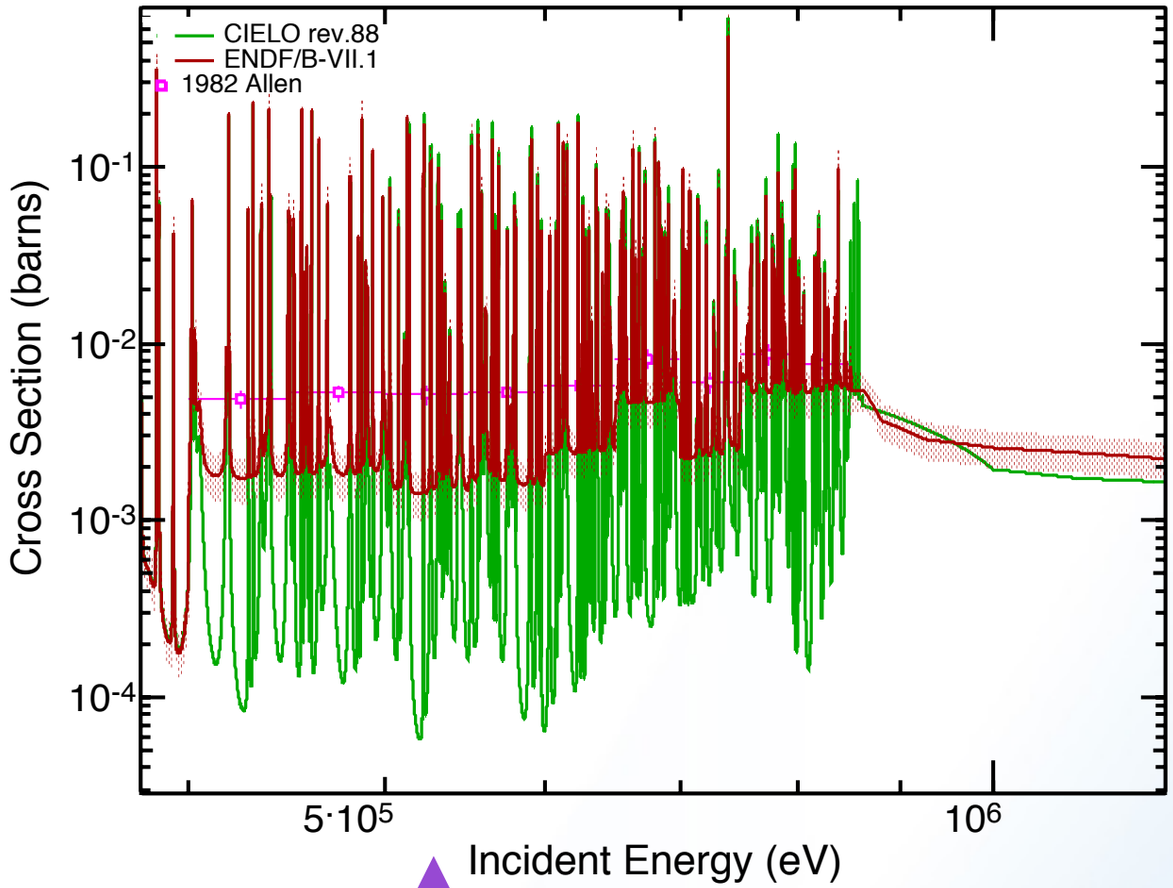
Sensitive to degree of smoothing of elastic angular distributions

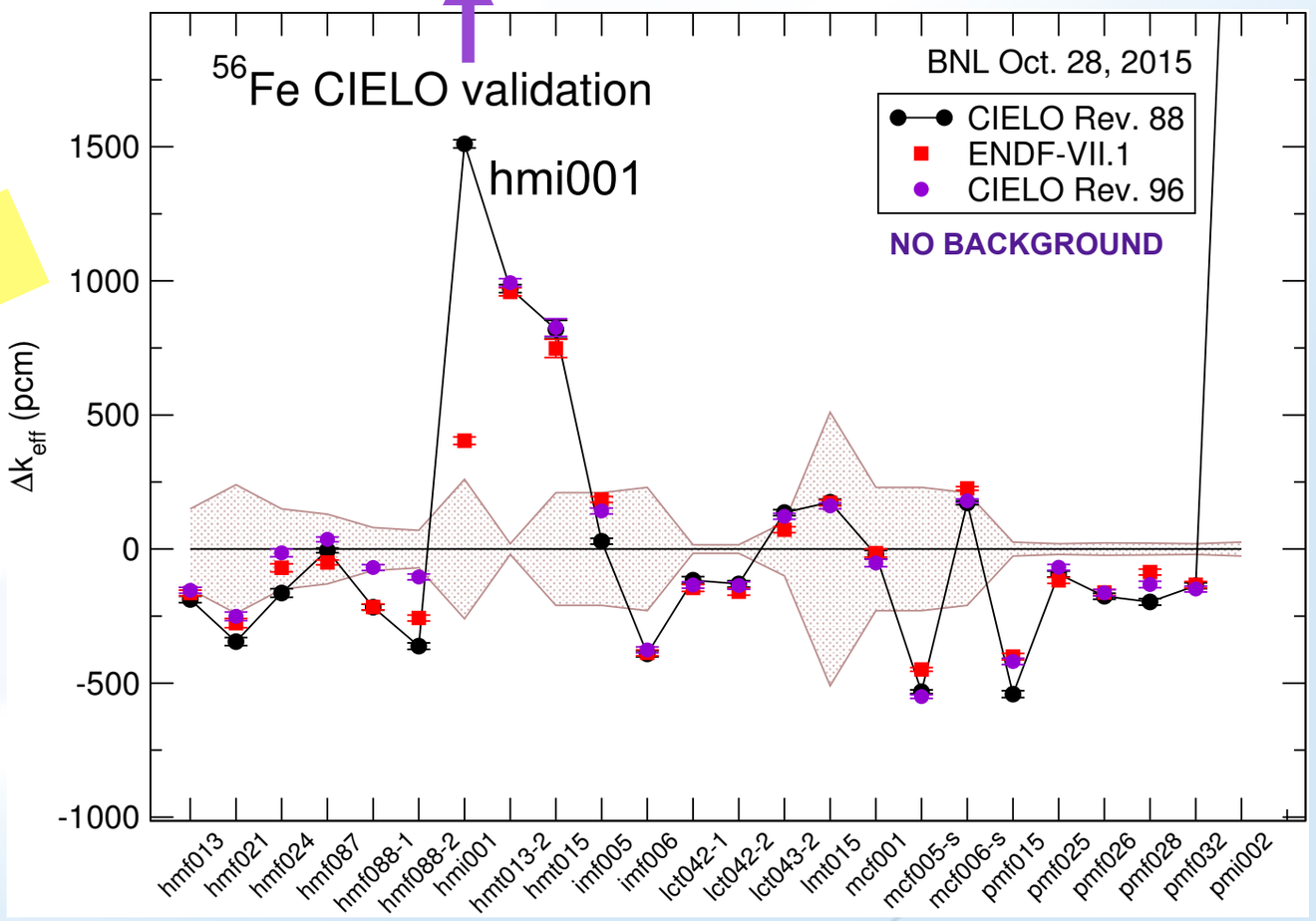
In the recent files, we haven't used angular distributions calculated from resonance parameters.
Exercise on the early file shows that there is a potential for improvement.

Background?

- ENDF/B-VII.1 has background in RR above 400 keV
- Rev.88: Luiz RR (no background)
- Rev.96: VII.1 RR without background
- background keeps hmi001 in ENDF/B-VII.1 below 500 ppm
- for other benchmarks background doesn't do anything or makes them worse!

hmi001 (ZPR-9/34) needs background!

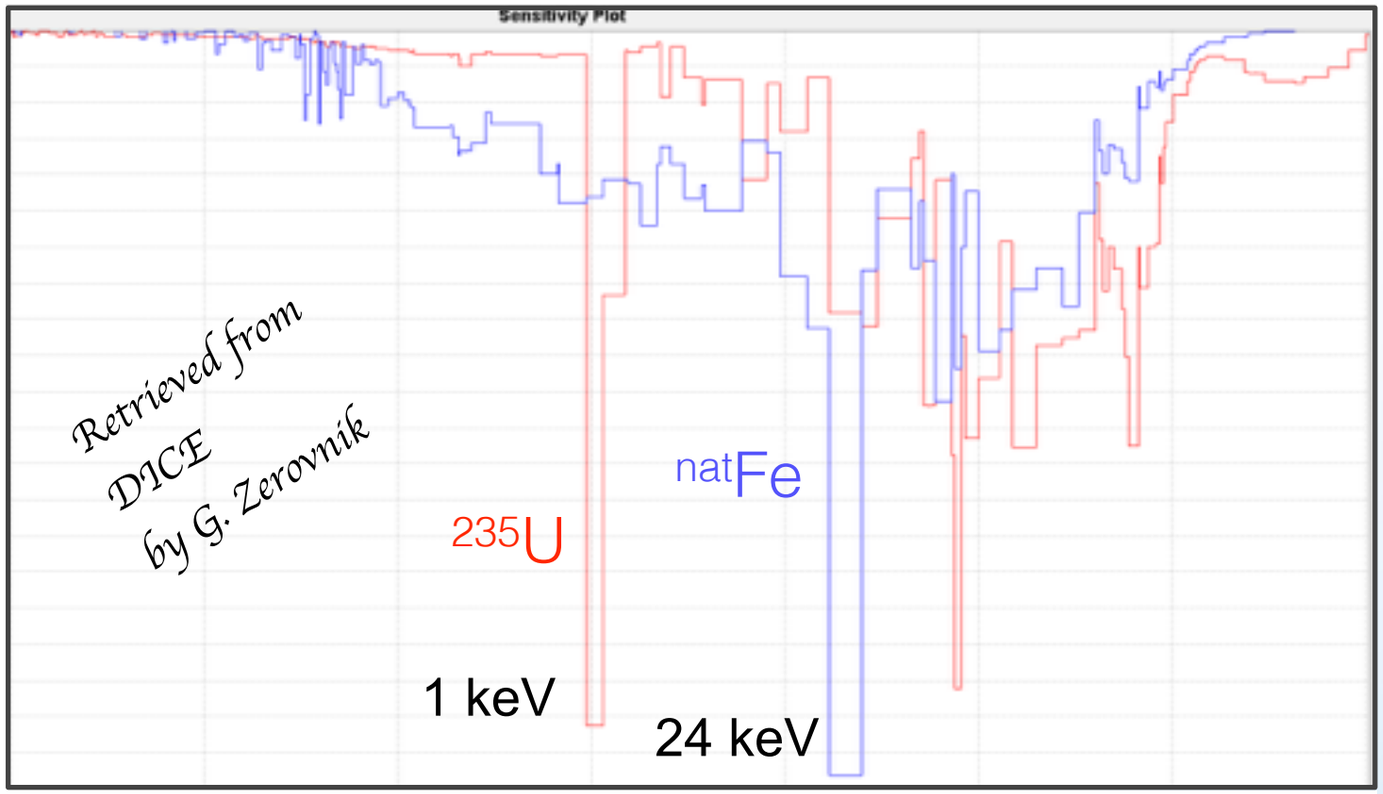




Could we fix ZPR-9/34 other way?

May be…

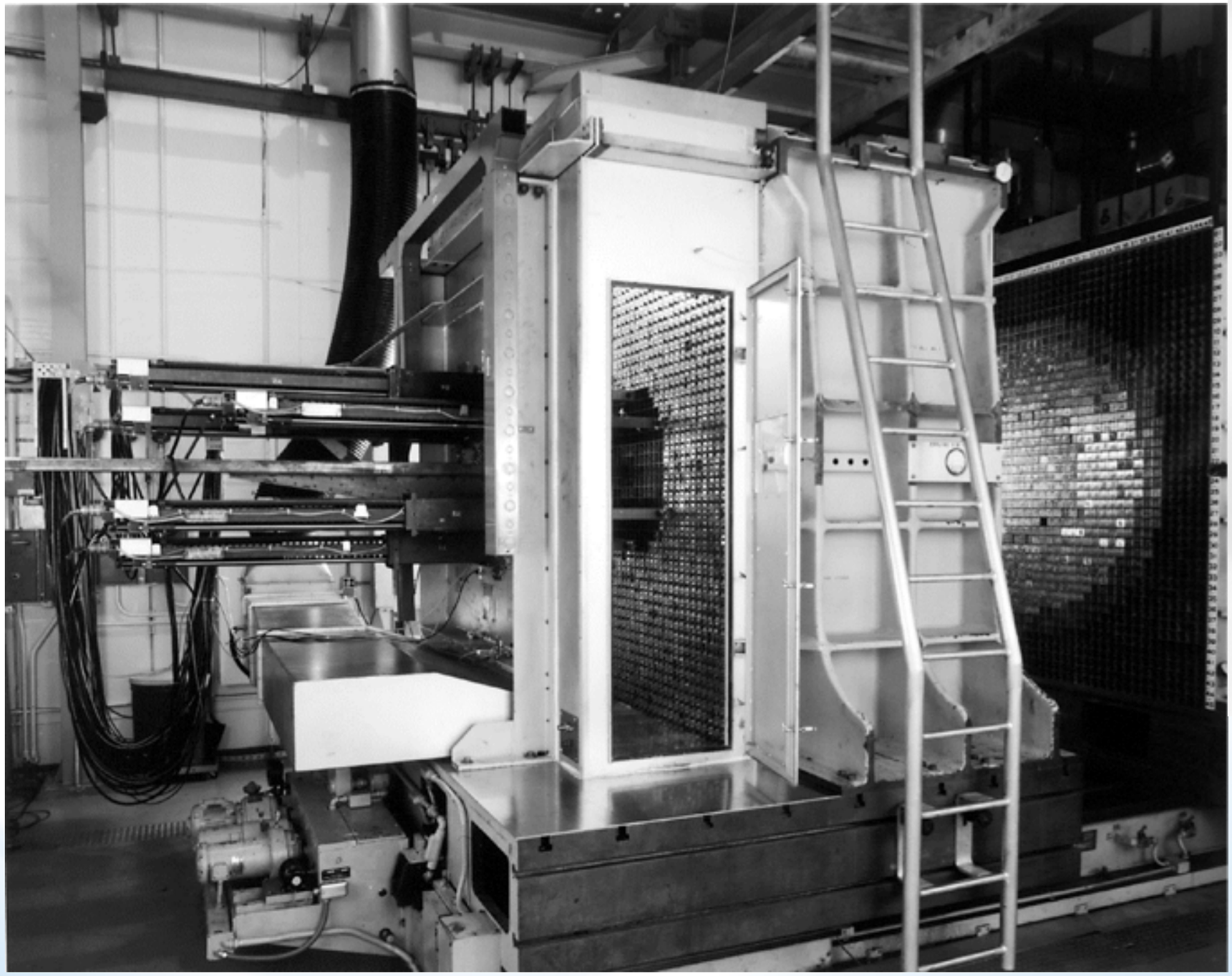
- sensitivity to capture on 235U at 1 keV
- sensitivity to capture on 56Fe around 24 keV (reason for a tweak in 56Fe rev.219)
- sensitivity to both captures between 50 keV and 1 MeV
- 57Fe alone makes ~400 pcm (in the wrong direction!)
- could be another material, e.g., 53Cr,…
- can we trust MCNP simplified (homogenized) model for ZPR-9/34?



Sensitivity of ZPR-9/34 (hmi001) to capture in U-235 and Fe-nat

We should try a holistic approach: consider CIELO 235U, look at other materials & factors, check MCNP model…

View of the ZPR-9 Facility (HEU-MET-INTER-001)



Conclusions

- There are indications that ENDF/B-VII.1 56Fe would not work with the new CIELO 235U (there is no way back!).
- Criticality validation for thermal and intermediate assemblies: effect of capture on 235U (going down around 1 keV as indicated by RPI and Jandel data) quite important for iron benchmarks due to high sensitivity.
- There is an under-prediction for Pu fueled assemblies which need further investigation.
- Role of the minor isotopes is minor but not negligible, especially of 57Fe.
- Resonance range in 56Fe needs some work to eliminate backgrounds and improve performance.
- Angular distributions calculated from resonance parameters - it's not a model, it's the theory! **as long as we know spins and parities** 😉
- We've got some 'knobs to turn' but have to do it wisely with a picture bigger than 56Fe in mind.

Idea for CIELO expansion

We started with five (six) most important and best measured materials

By the end, we'll know which other materials are correlated with these five via benchmarks

Let's take on those in the next round of CIELO to expand the island of coherence

We might need to go back and readjust the previous ones but will have an ovule of a consistent library.