

# MCNP input models for ICSBEP and SINBAD

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# ICSBEP Benchmarks

- ▶ The ICSBEP Handbook includes ~5000 cases
  - ▶ Not all benchmarks are clean
    - ▶ Unidentified systematic errors
    - ▶ Unreasonable uncertainty estimates
    - ▶ MCNP models not available for all
- ▶ IAEA/JSI collection includes >3300 cases (ICSBEP & SINBAD) with ready-to-run MCNP models
  - ▶ MCNP input models from ICSBEP Handbook, A.C. Kahler, a few other contributions and some local developments
  - ▶ Results are available for ENDF/B-VII.1, JEFF-3.3, ENDF/B-VIII.0 and INDEN trial evaluations for selected cases.

# Benchmarking strategy

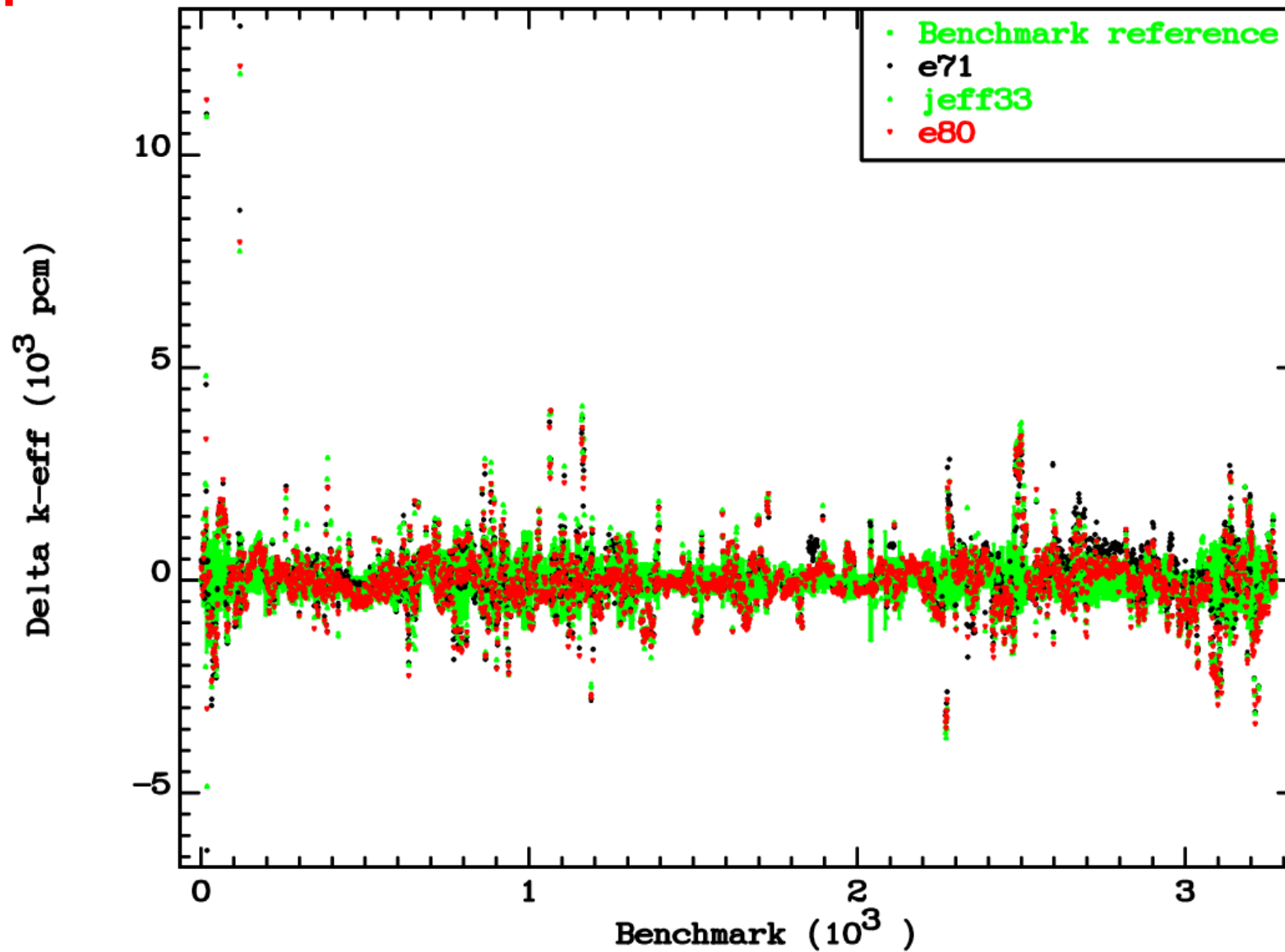
- ▶ Striving for completeness:
  - ▶ Benchmark cases from the same group may show trends, regardless of any systematic errors
  - ▶ Discrepant benchmarks can be checked by cases with similar characteristics
  - ▶ Outliers can be checked for obvious errors or rejected
- ▶ Generating plots of groups of benchmarks as a function of spectral parameters, absorber concentrations, etc.
- ▶ Some examples are presented.

# Benchmark examples

- ▶ Many benchmarks (~800) lie outside 3-sigma uncertainty
  - ▶ In many cases this is due to unrealistically small uncertainties
  - ▶ Such cases should be investigated carefully and corrected or eliminated.

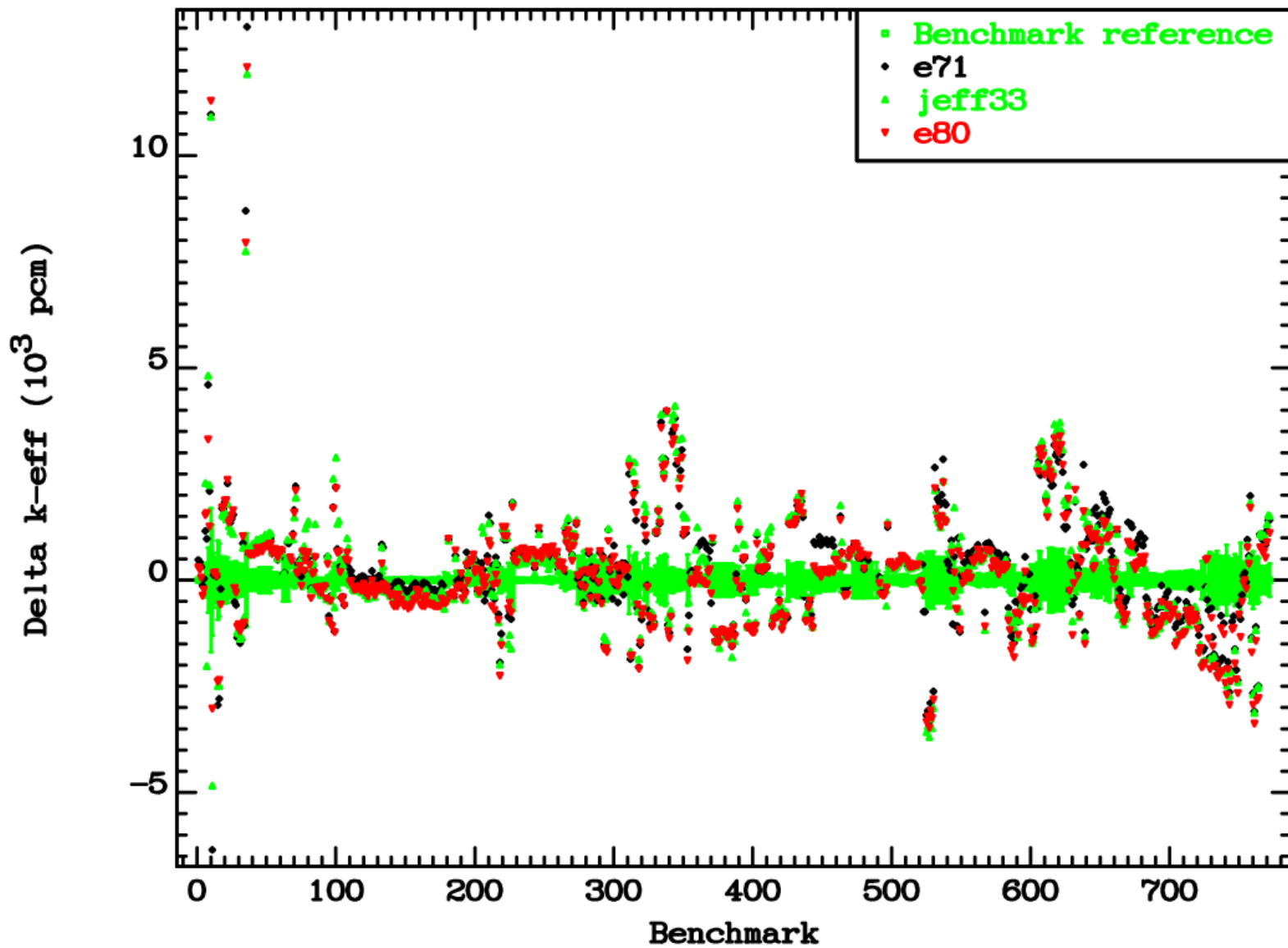
# Global picture

ICSBEP Benchmark Summary Results  
Integral Parameter Intercomparison



# 3-Sigma Outliers

ICSBEP Benchmark Summary Results  
Integral Parameter Intercomparison



# Trends as a function of selected parameters

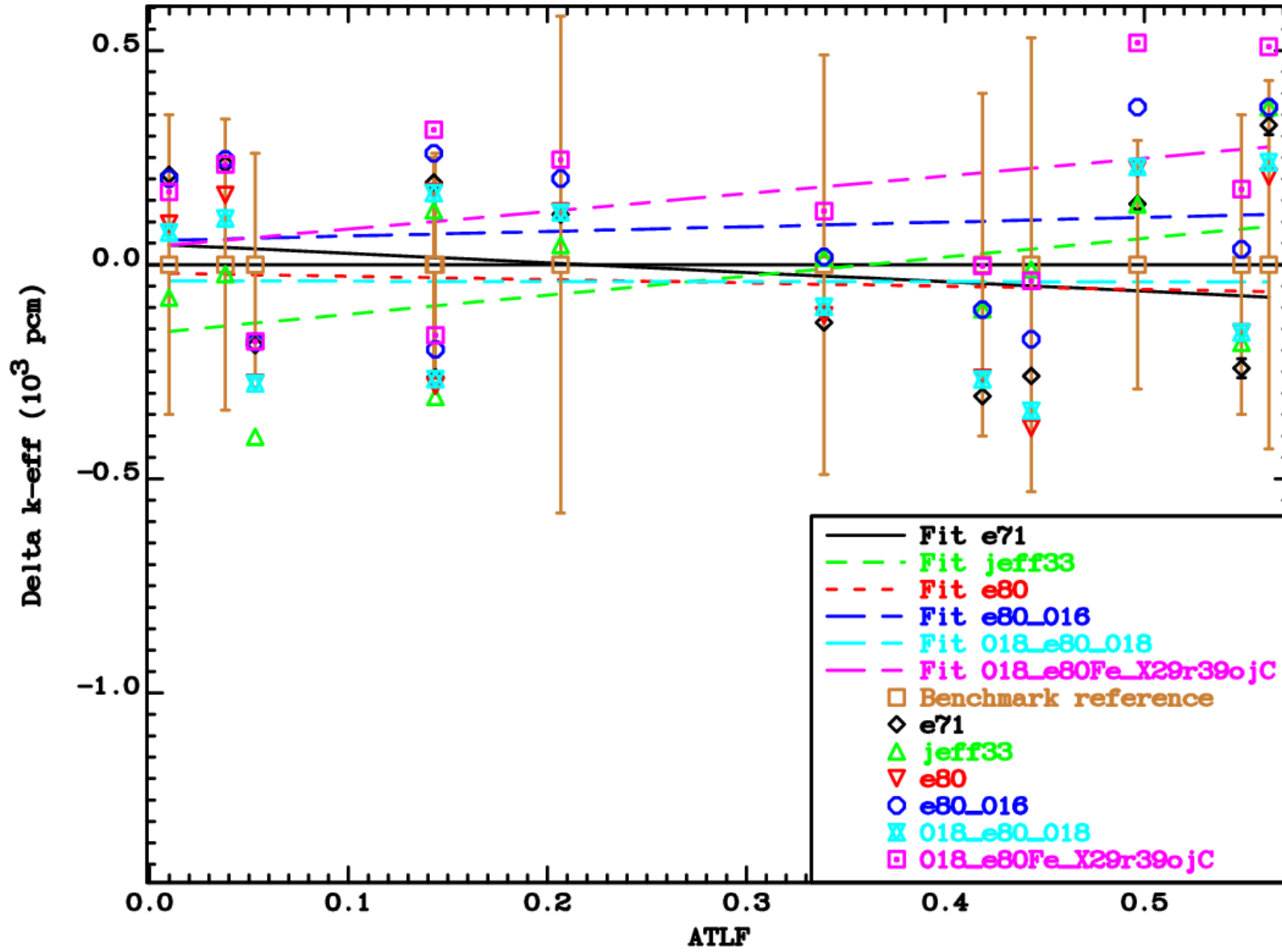
- ▶ Skip Kahler has shown trend diagrams as a function of “above-thermal leakage fraction” (ATLF)
- ▶ A short list of representative cases was selected for quick testing
- ▶ Other groups of benchmarks can be analyzed as a function of spectral parameters (EALF, FEPIT, FFAST), absorber concentration, reflector thickness, etc.

# HEU-SOL-THERM v.s. ATLF

## (Short List)

No.	ICSBEP Label	Short name	Common name
1	HEU-SOL-THERM-009	hst009-001	ORNL_S1
2	HEU-SOL-THERM-009	hst009-004	ORNL_S4
3	HEU-SOL-THERM-013	hst013-001	ORNL_T1
4	HEU-SOL-THERM-032	hst032	ORNL_T5
5	HEU-SOL-THERM-001	hst001-004	R04
6	HEU-SOL-THERM-001	hst001-005	R05
7	HEU-SOL-THERM-001	hst001-007	R07
8	HEU-SOL-THERM-042	hst042-1	ORNL_C1
9	HEU-SOL-THERM-042	hst042-004	ORNL_C4
10	HEU-SOL-THERM-042	hst042-008	ORNL_C8
11	HEU-SOL-THERM-043	hst043-003	ORNL_LS3
12	HEU-SOL-THERM-010	hst010-001	ORNL_S10T0
13	HEU-SOL-THERM-012	hst012	ORNL_S91

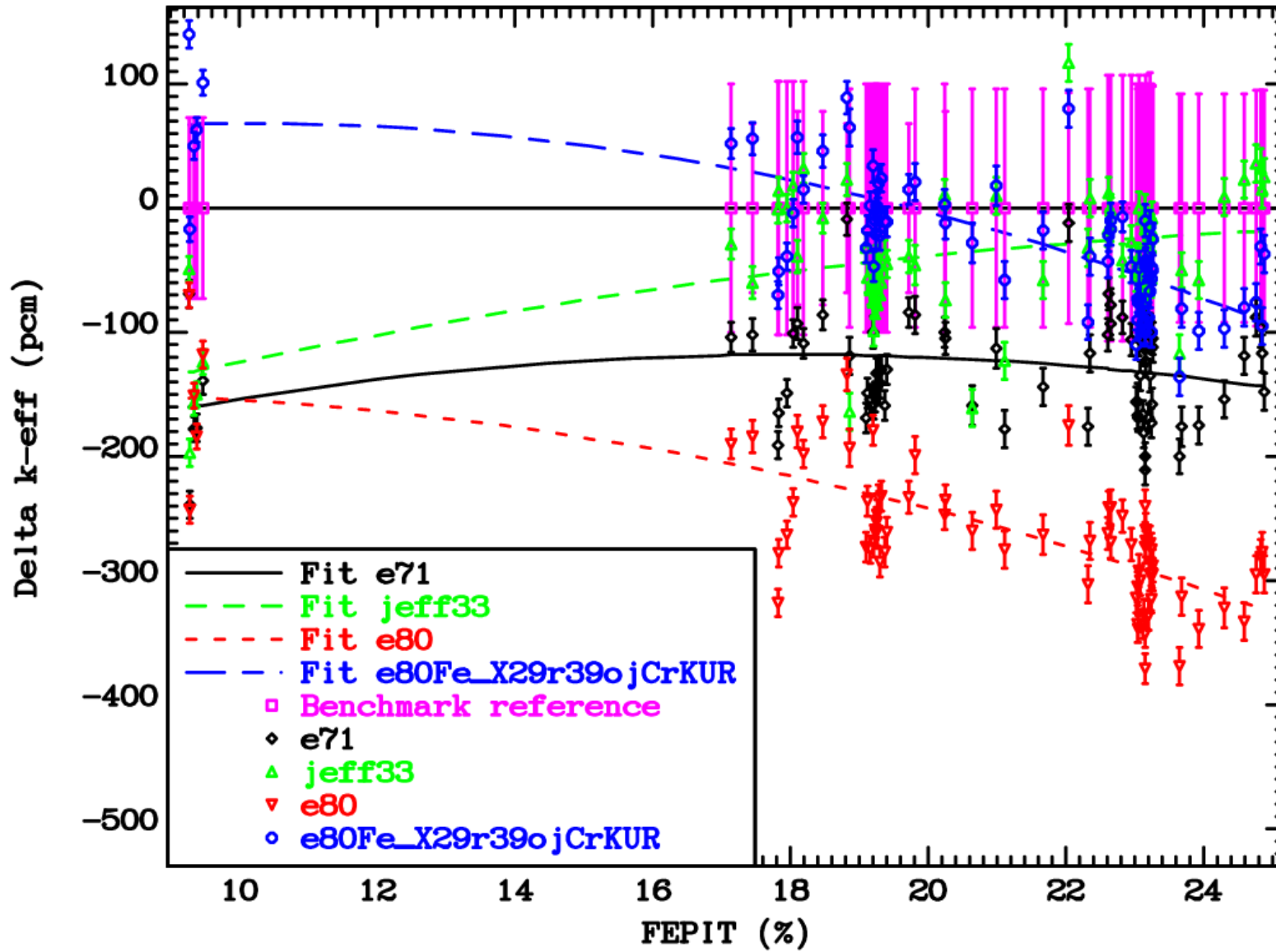
ICSBEP Benchmark Summary Results  
Integral Parameter Intercomparison



# LEU-COMP-THERM (SNL) Benchmarks

- ▶ Plot as a function of the epithermal fission fraction (FEPIT) shows distinct trend, different in different libraries
- ▶ ENDF/B-VIII.0 results are significantly worse than ENDF/B-VII.1
  - ▶ Substitution of U-235 had no big effect
  - ▶ The culprit was (surprisingly) found to be O-16
  - ▶ O-16 from JENDL-4/HE gives best agreement, but some trend remains - possibly due to U-235
  - ▶ However, compensating effects cannot be excluded.

LEU-COMP-THERM (SNL) Benchmarks  
v.s. Epithermal fission fraction

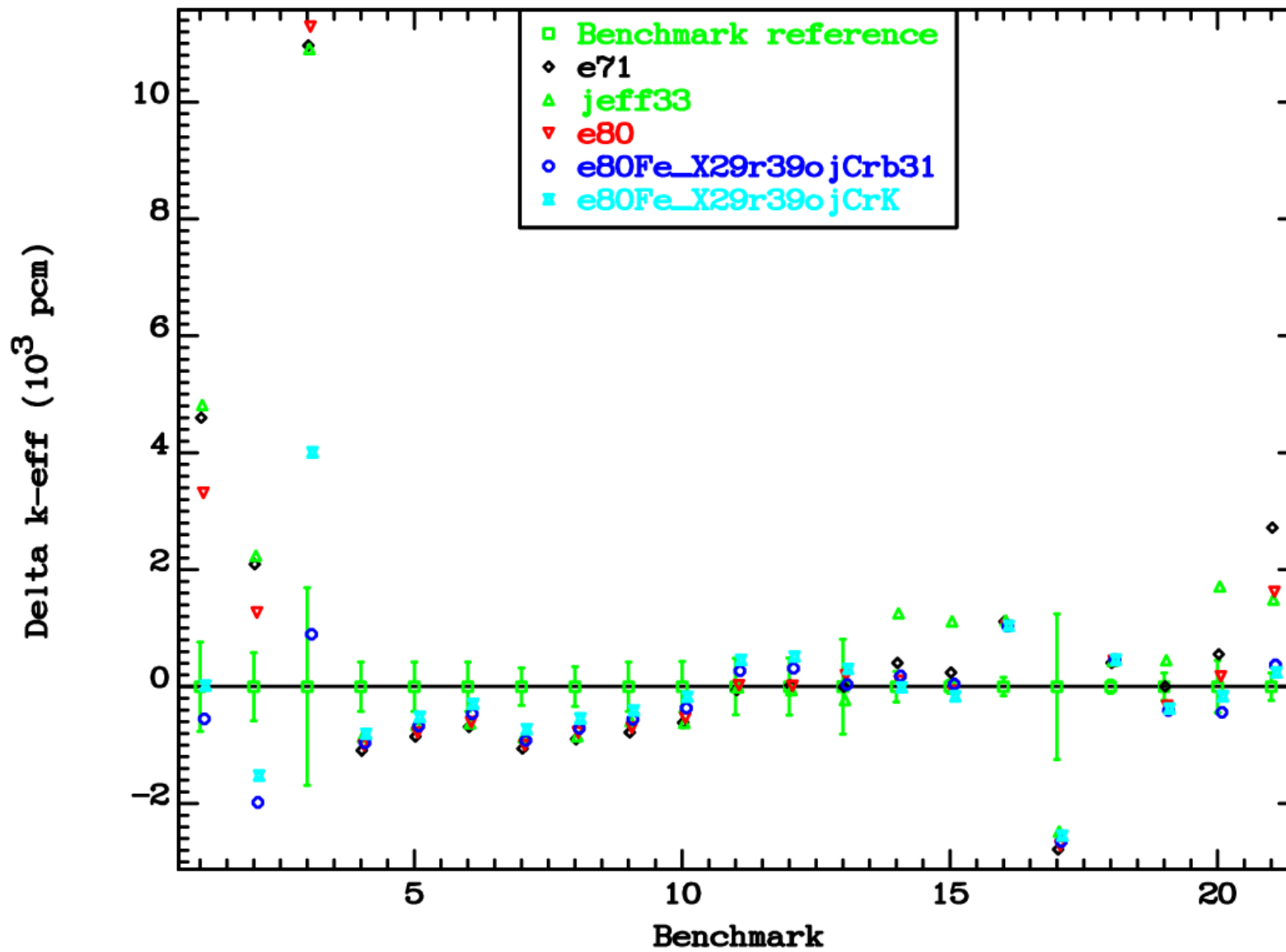


# Example: Benchmarking of Cr for criticality

- ▶ Very few benchmarks are sensitive to Cr (very expensive as bulk material)
- ▶ KBR-15 (HEU-COMP-INTER-005) is off by >10 000 pcm
- ▶ ZPR-6/10 (Pu-MET-INTER-002) is also a notorious outlier
  - ▶ Highly sensitive to the cluster of resonances near 5 keV
- ▶ Trial INDEN evaluation fixes ZPR-6/10 and greatly reduces the discrepancy in KBR-15
- ▶ Other benchmarks are hardly affected

No.	ICSBEP Label	Short name	Common name
1	HEU-COMP-INTER-005	hci005-009	KBR-09 (SS)
2	HEU-COMP-INTER-005	hci005-010	KBR-10 (Mo)
3	HEU-COMP-INTER-005	hci005-015	KBR-15 (Cr)
4	HEU-COMP-THERM-011	hct011-001	RRC-KI-21x21-001
5	HEU-COMP-THERM-011	hct011-002	RRC-KI-21x21-002
6	HEU-COMP-THERM-011	hct011-003	RRC-KI-21x21-003
7	HEU-COMP-THERM-012	hct012-001	RRC-KI-18x18-001
8	HEU-COMP-THERM-012	hct012-002	RRC-KI-18x18-002
9	HEU-COMP-THERM-013	hct013-001	RRC-KI-14x14-001
10	HEU-COMP-THERM-013	hct013-002	RRC-KI-14x14-002
11	HEU-COMP-THERM-014	hct014-001	RRC-KI-10x10-001
12	HEU-COMP-THERM-014	hct014-002	RRC-KI-10x10-002
13	HEU-COMP-THERM-022	hct022-001	SPERT-III
14	HEU-MET-INTER-001	hmi001	ZPR-9/34
15	HEU-MET-INTER-001	hmi001d	ZPR-9/34
16	HEU-MET-THERM-016	hmt016	LACEF/Ni-Cr-Mo-Gd
17	HEU-SOL-THERM-026	hst026-001	RF_Concrete
18	IEU-COMP-THERM-005	ict005	KBR-21
19	LEU-SOL-THERM-012	lst012-001	TRACY-203c
20	MIX-COMP-FAST-001	mcf001	ZPR-6/7
21	MIX-MET-FAST-008	mmf008-003	ZEBRA-8C/2
22	PU-MET-INTER-002	pmi002	ZPR-6/10

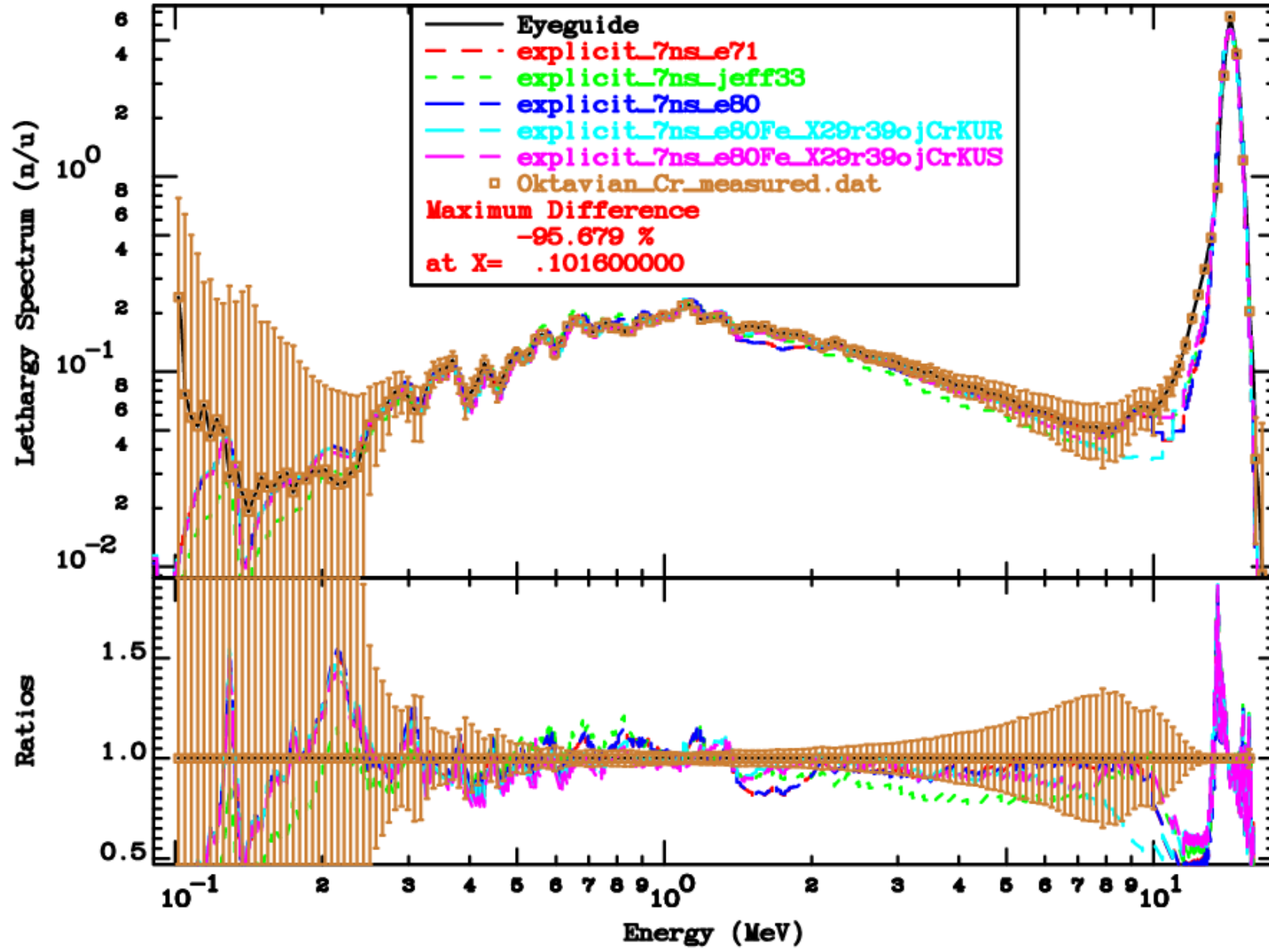
### ICSBEP Benchmarks sensitive to Cr Integral Parameter Intercomparison



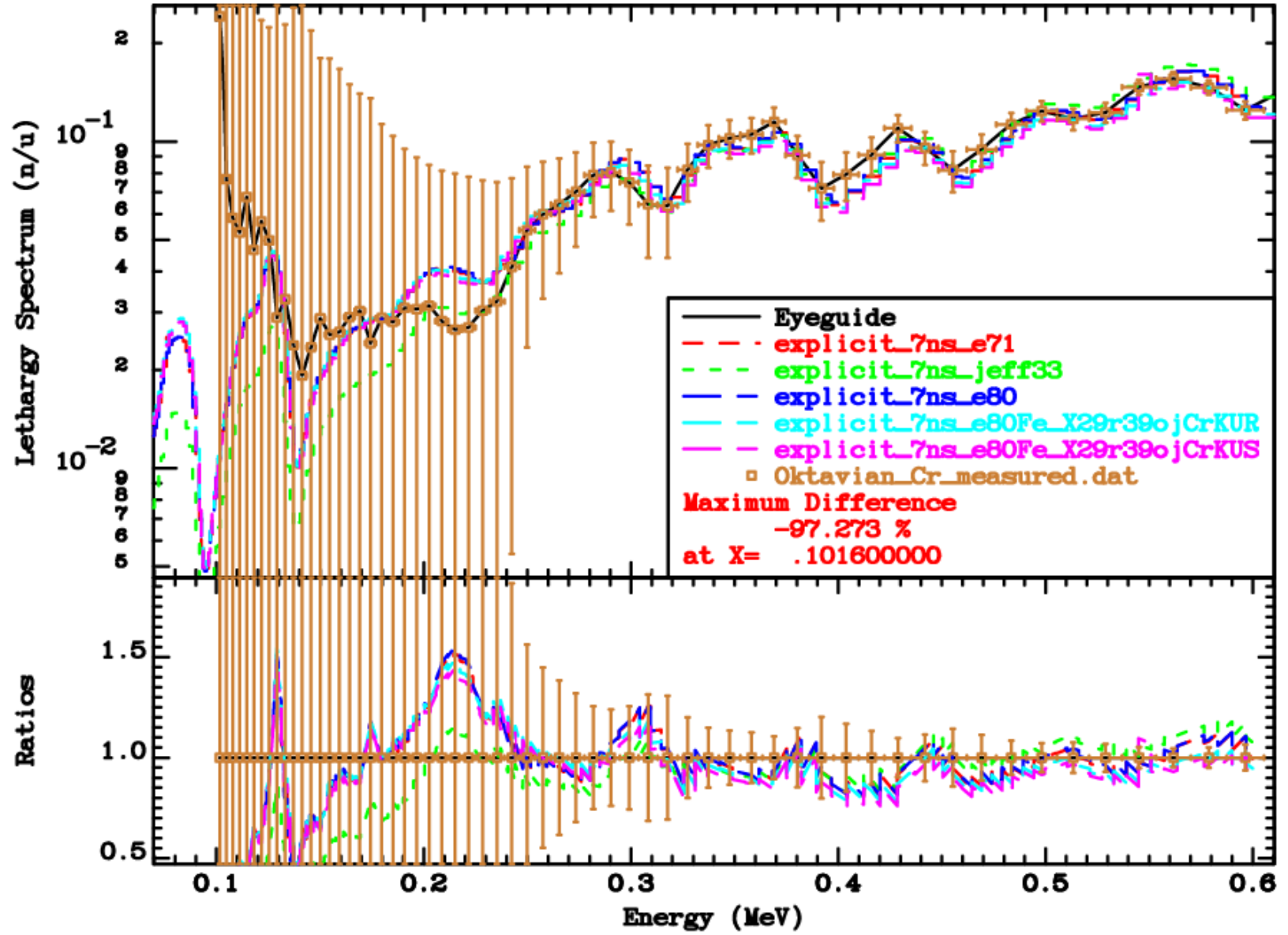
# SINBAD Case: Oktavian\_Cr

- ▶ Currently not in SINBAD - candidate for inclusion
- ▶ Documented in JAERI-M-j94-014 and JAERI-M-j98-024
- ▶ Source specification in Table 4.6 of j94-014 is in error
  - ▶ Source is “per unit energy” (not lethargy)
  - ▶ Verified by comparison with Figure 4.11 in JAERI-M-j94-014
- ▶ Oktavian benchmarks were analyzed previously by Alberto Milocco and Ivo Kodeli (but not Cr)
  - ▶ Source model developed from first principles
  - ▶ Analysis in time-domain is **very important**
- ▶ Analysis of the Cr case done by Bor Kos and A. Trkov, following the methodology of Alberto Milocco

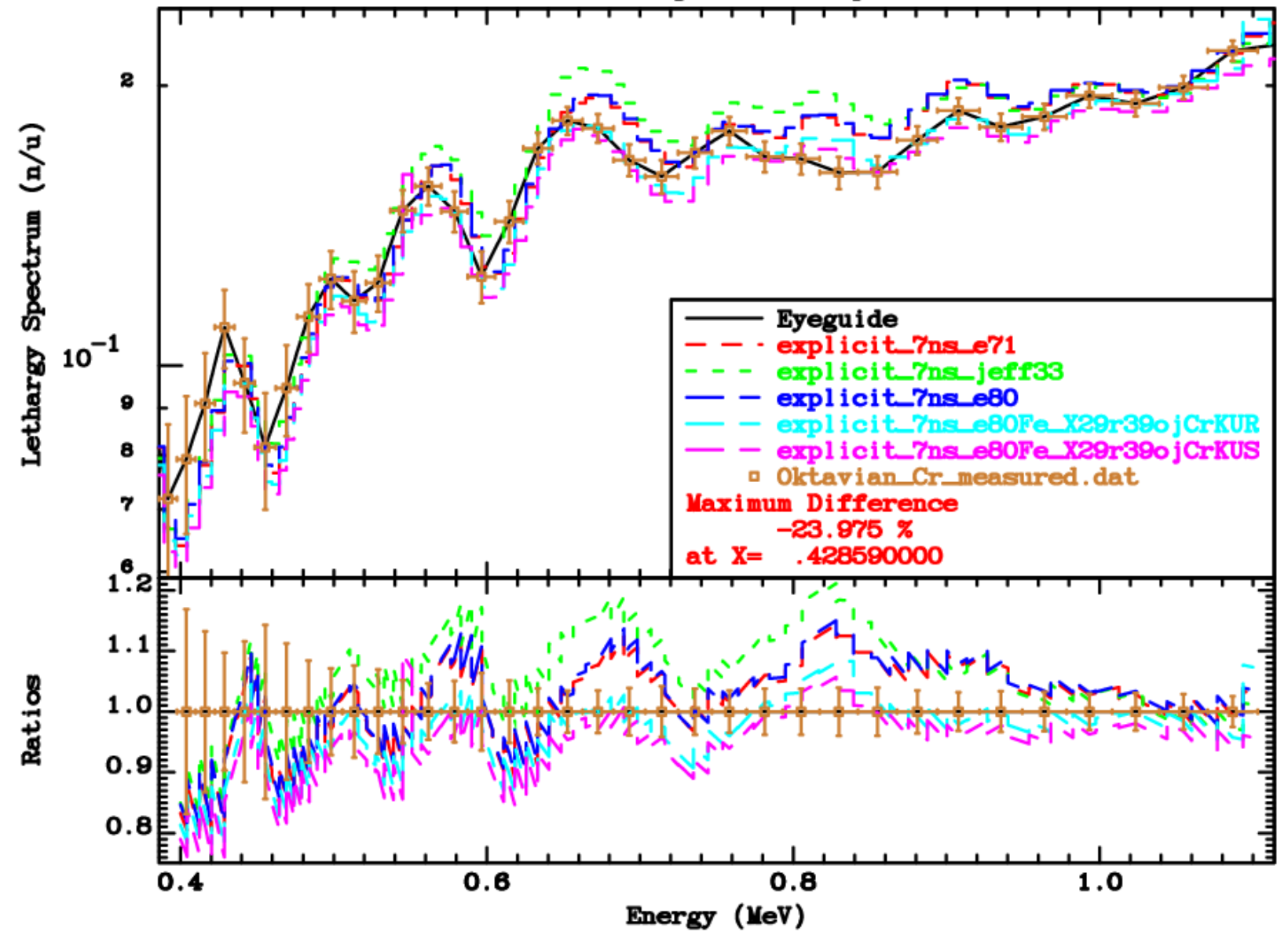
Oktavian Manganese Sphere Benchmark  
Neutron Leakage Current Spectrum



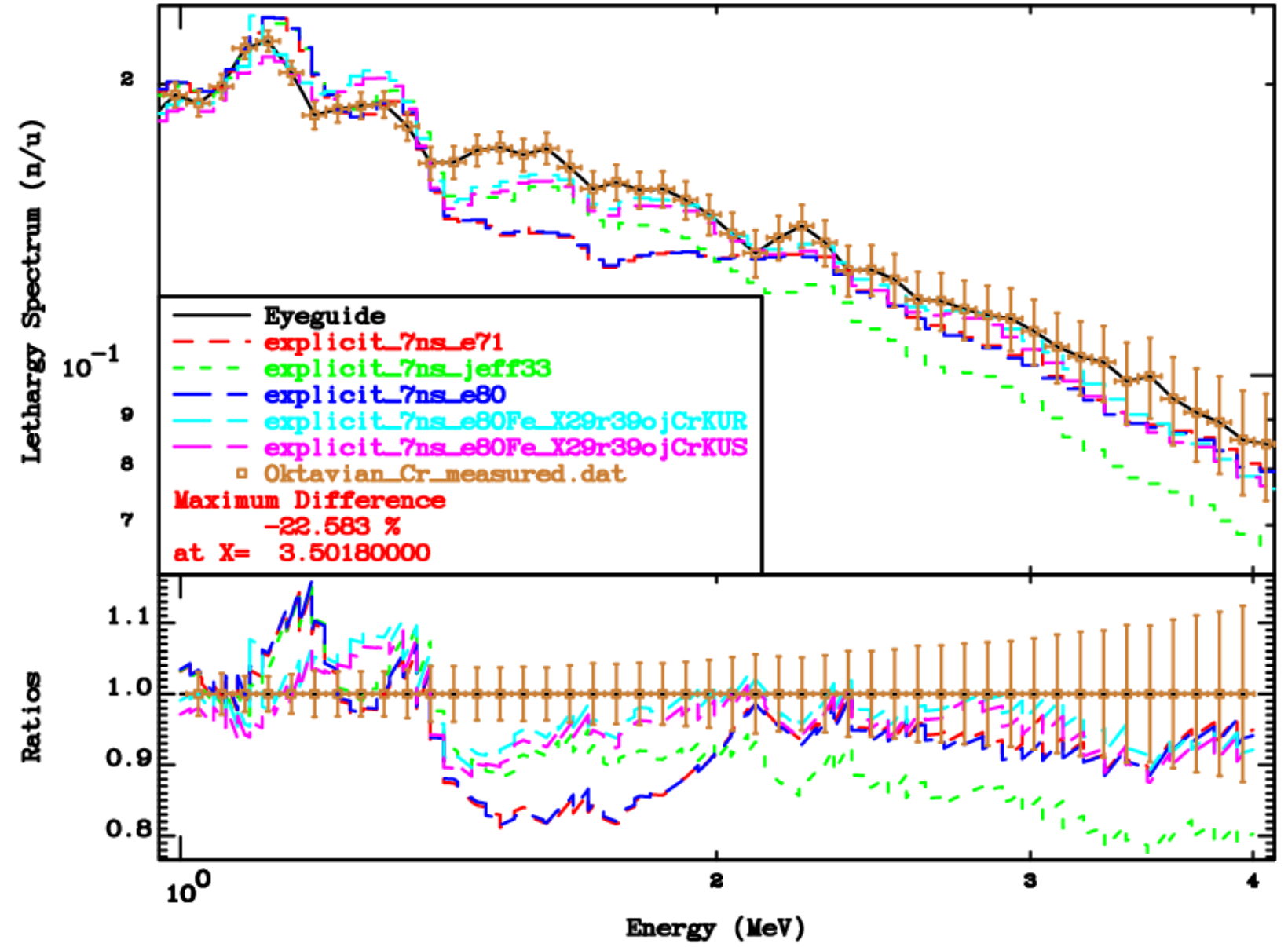
Oktavian Manganese Sphere Benchmark  
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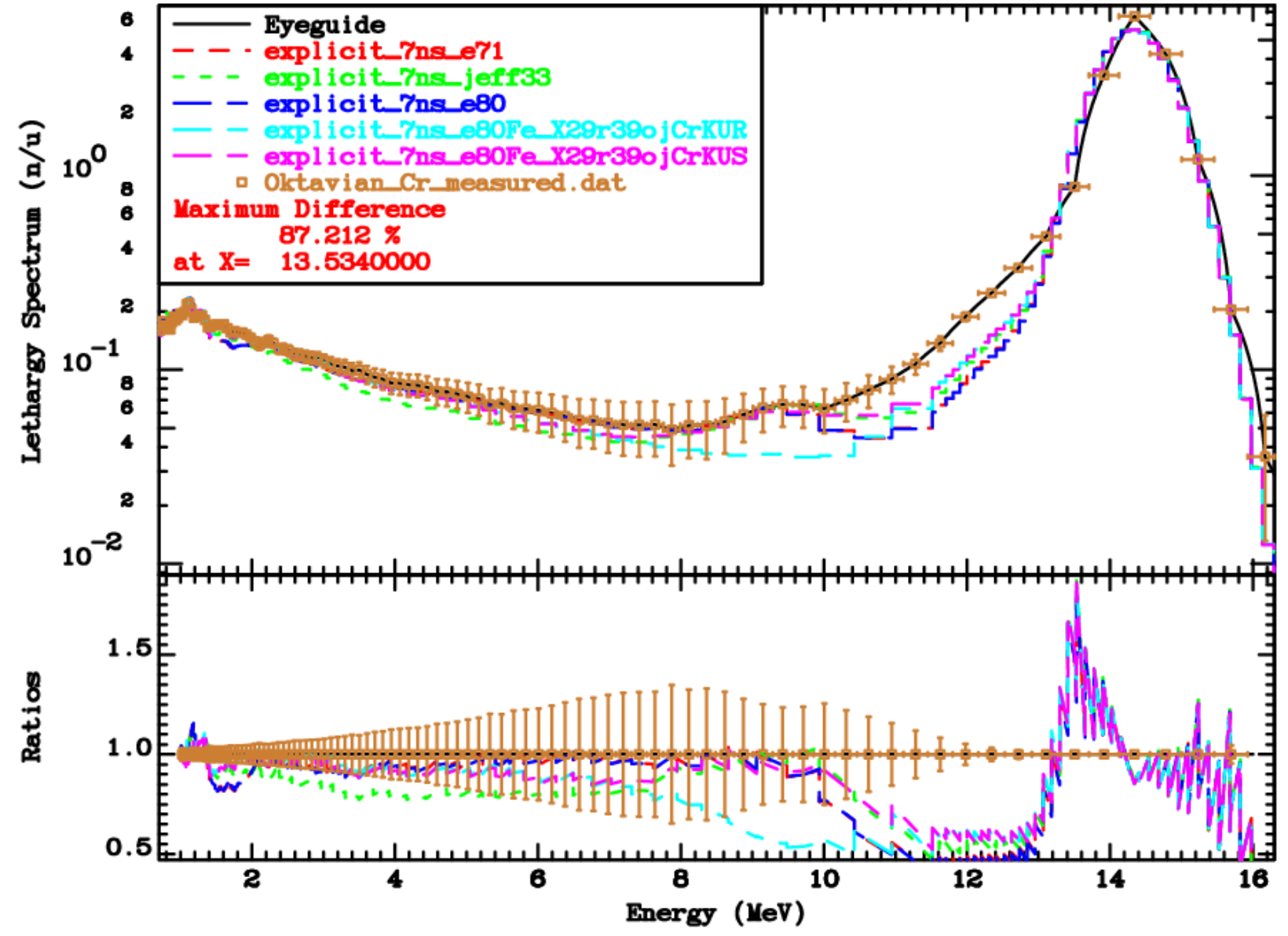
Oktavian Manganese Sphere Benchmark  
Neutron Leakage Current Spectrum



### Oktavian Manganese Sphere Benchmark Neutron Leakage Current Spectrum



Oktavian Manganese Sphere Benchmark  
Neutron Leakage Current Spectrum



# Conclusions on Oktavian-Cr

- ▶ Library comparison includes
  - ▶ ENDF/B-VII.1
  - ▶ JEFF-3.3
  - ▶ ENDF/B-VIII
  - ▶ Trial INDEN evaluations “KUR” and “KUS”
- ▶ Marked improvement with INDEN “KUS” evaluation
- ▶ May be important for high-energy shielding (constituent of stainless steels)