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Title: Comparison of ENDF71x and ENDF70 Using ICSBEP Criticality Benchmarks in MCNP6

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Comparison of ENDF71x and ENDF70 Using ICSBEP Criticality Benchmarks in MCNP6

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Introduction

ENDF/B-VII.1

Evaluated Nuclear Data File Version 7.1

- Released December 2011
- Neutron sublibrary:
  - 423 evaluations, 32 new in ENDF/B-VII.1
  - Elemental evaluations for V and Zn became isotopic evaulations: ^{50}V, ^{51}V and ^{64}Zn, ^{65}Zn, ^{66}Zn, ^{67}Zn, ^{68}Zn
  - 10 excited-state evaluations, 413 ground-state evaluations

ENDF71x

ENDF71x

423 ENDF/B-VII.1-based ACE data tables

- 423 evaluations, 32 new
- Best neutron XS data available
- Available with MCNP6 from RSICC
- *Extensive* validation and verification

Temperature	ENDF71x	ENDF70
293.6 K	80c	70c
600 K	81c	71c
900 K	82c	72c
1200 K	83c	73c
2500 K	84c	74c
0.1 K	85c	
250 K	86c	

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Validation using ICSBEP Benchmarks

ICSBEP

***I**nternational Handbook of Evaluated **C**riticality **S**afety **B**enchmark **E**xperiments*

- 717 MCNP6 models (Kahler and Mosteller)
  - 18 "classes" of benchmarks
- 500 to 5000 active cycles
- 10,000 histories per cycle
- 6851 CPU hours

ICSBEP Classes of Benchmarks

FUEL Primary fuel in system

- **HEU** Highly-enriched uranium
- **IEU** Intermediate-enriched uranium
- **LEU** Low-enriched uranium
- **MIX** Mix of ^{235}U and ^{239}Pu
- **PU** ^{239}Pu
- **U233** ^{233}U

CHEM Chemical composition

- **MET** Metal
- **COMP** Compound
- **SOL** Solution
- **MISC** Other

SPEC Flux spectrum

- **FAST** 50 % of $\psi > 100$ keV
- **INTER** 50 % of $\psi > 0.625$ eV $< \psi < 100$ keV
- **THERM** 50 % of $\psi > 0.625$ eV
- **MIX** All other spectra

EVAL Number identifying experiment

CASE Number identifying experiment configuration

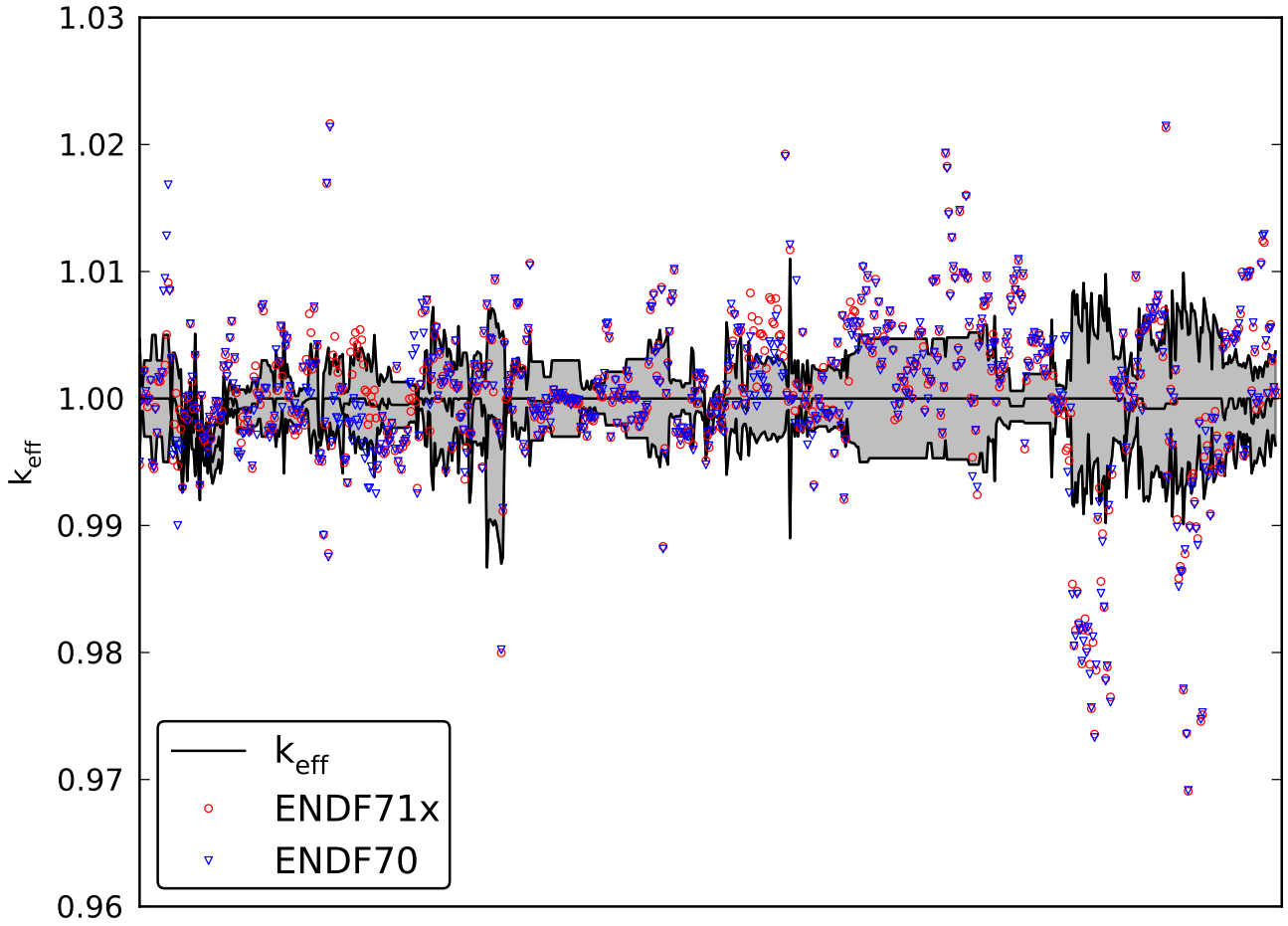
Example

HEU-MET-FAST-001-001

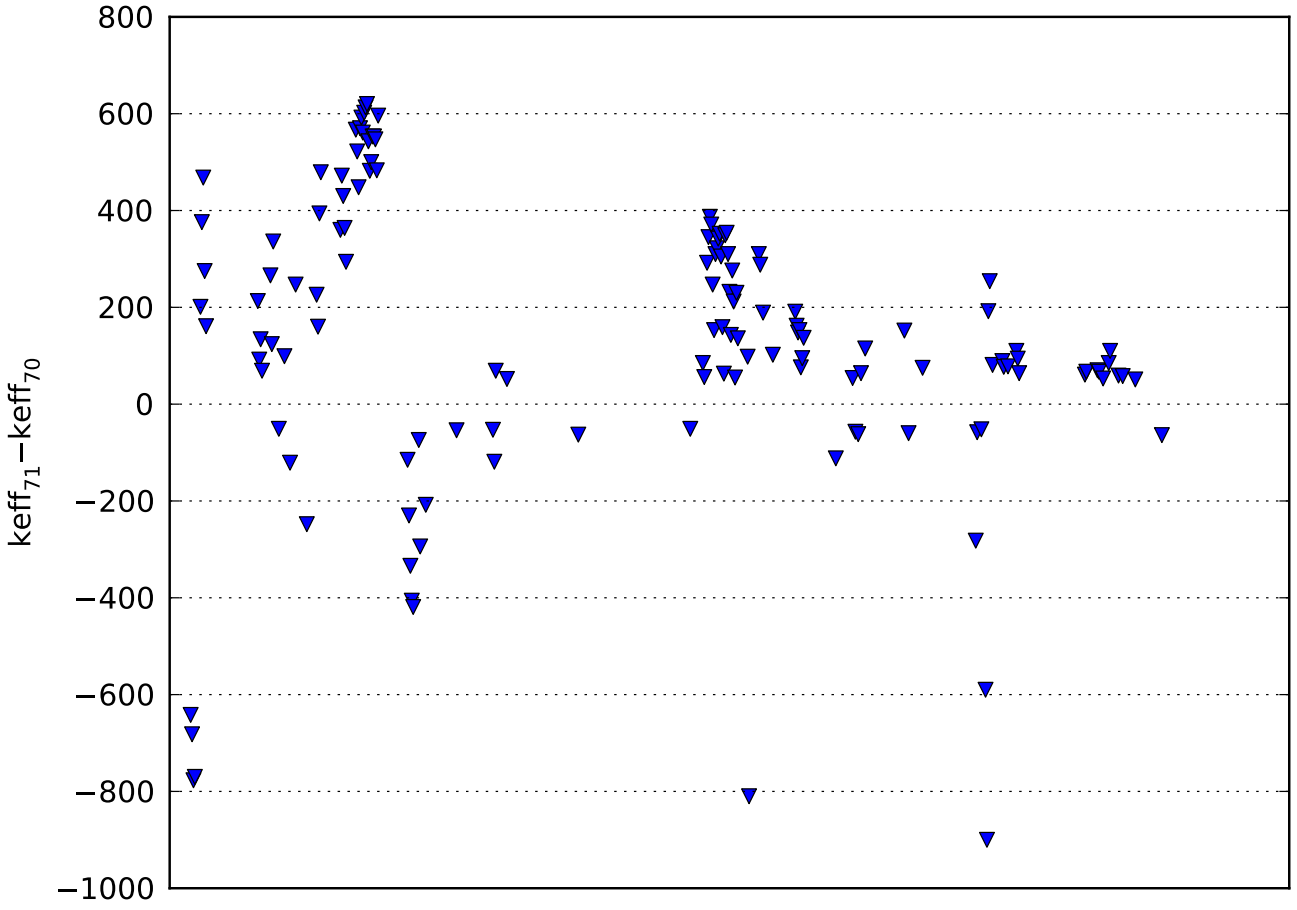
ICSBEP Classes of Benchmarks

Benchmark Group	#	Benchmark Group	#
HEU-COMP-INTER	1	MIX-COMP-THERM	6
HEU-MET-FAST	174	MIX-MET-FAST	34
HEU-MET-INTER	4	PU-COMP-INTER	1
HEU-MET-MIXED	5	PU-MET-FAST	43
HEU-SOL-THERM	46	PU-SOL-THERM	122
IEU-COMP-THERM	1	U233-COMP-THERM	2
IEU-MET-FAST	16	U233-MET-FAST	10
LEU-COMP-THERM	101	U233-SOL-INTER	26
LEU-SOL-THERM	22	U233-SOL-THERM	103

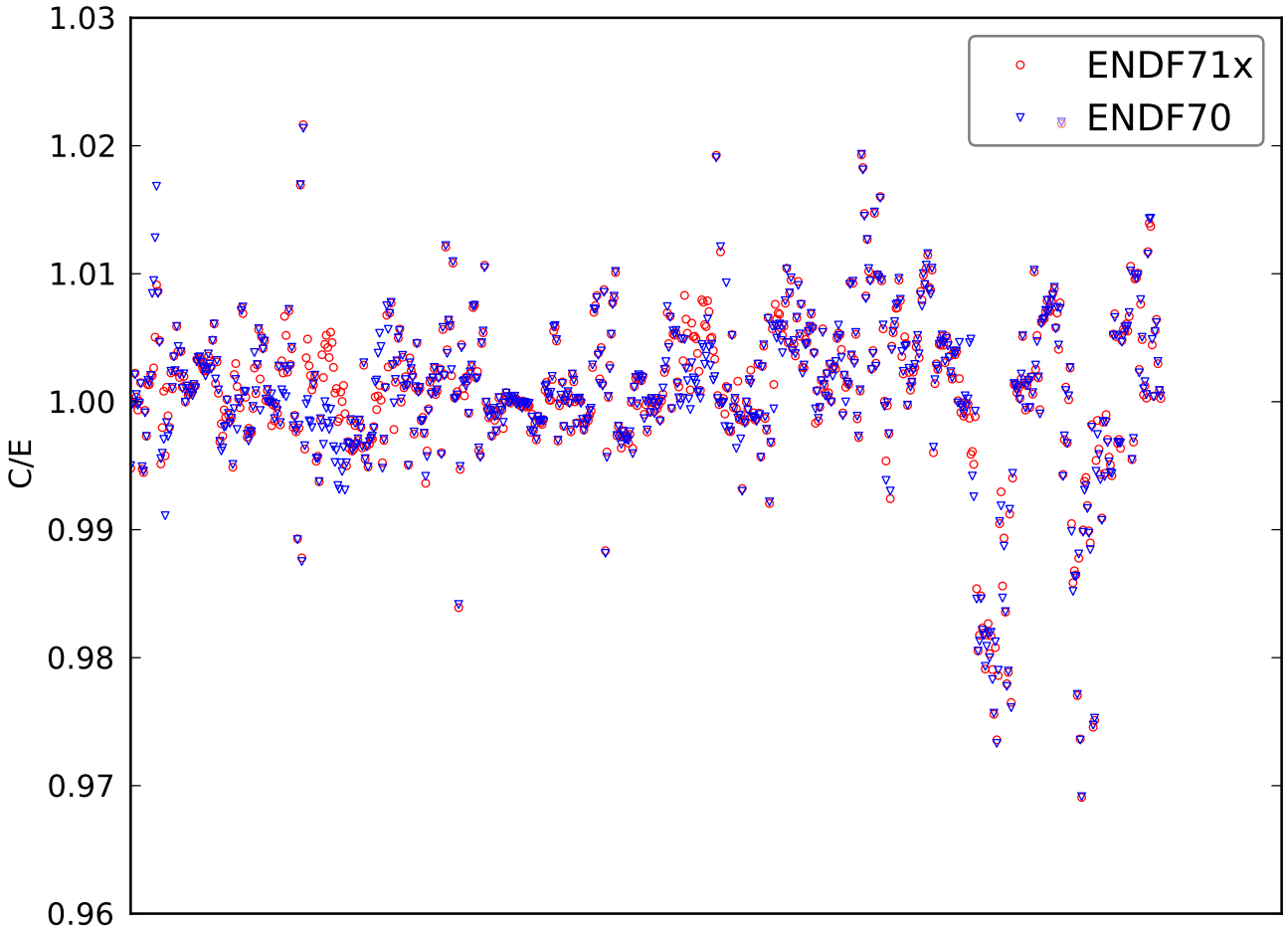
MCNP6 k_{eff} Results



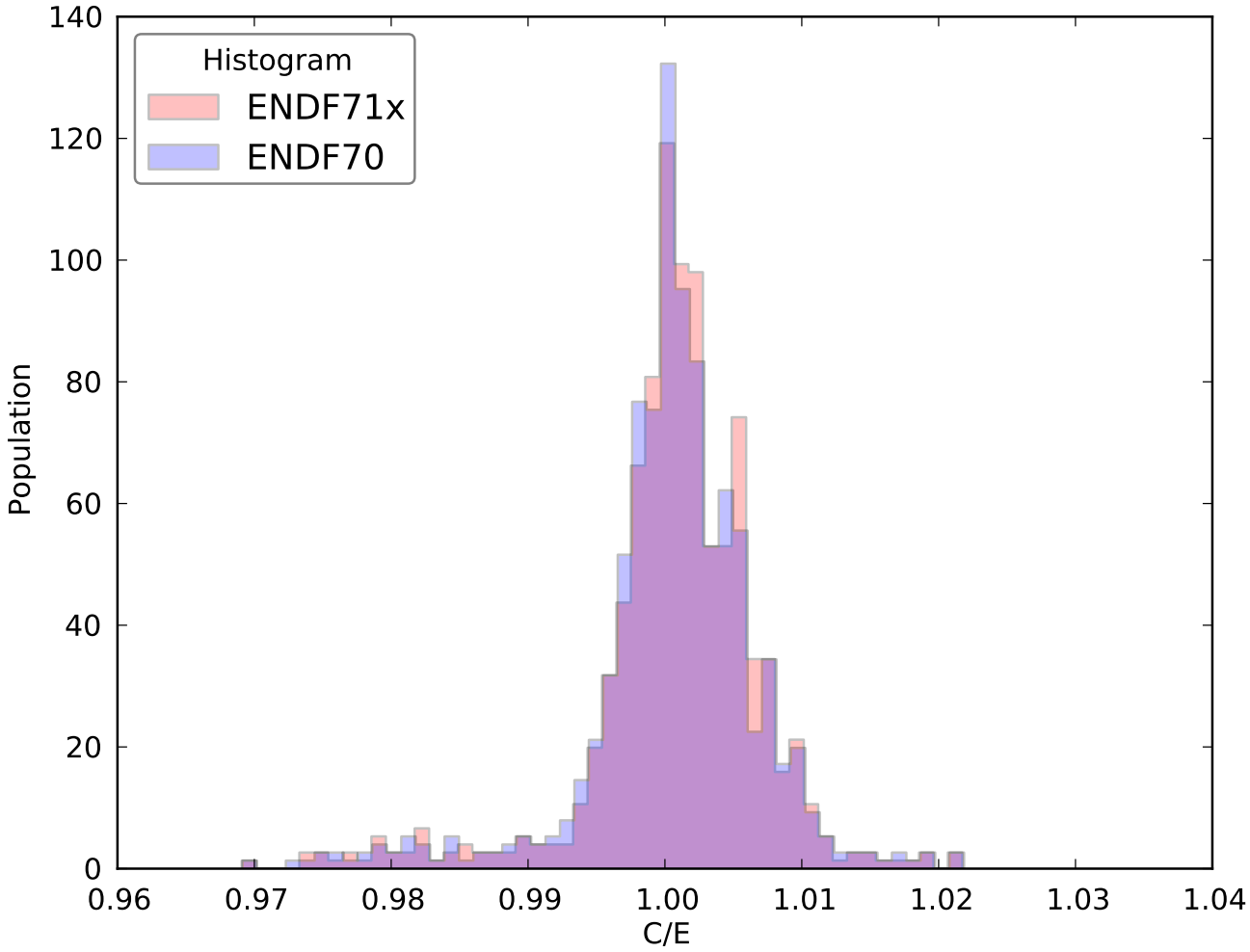
MCNP6 k_{eff} Results



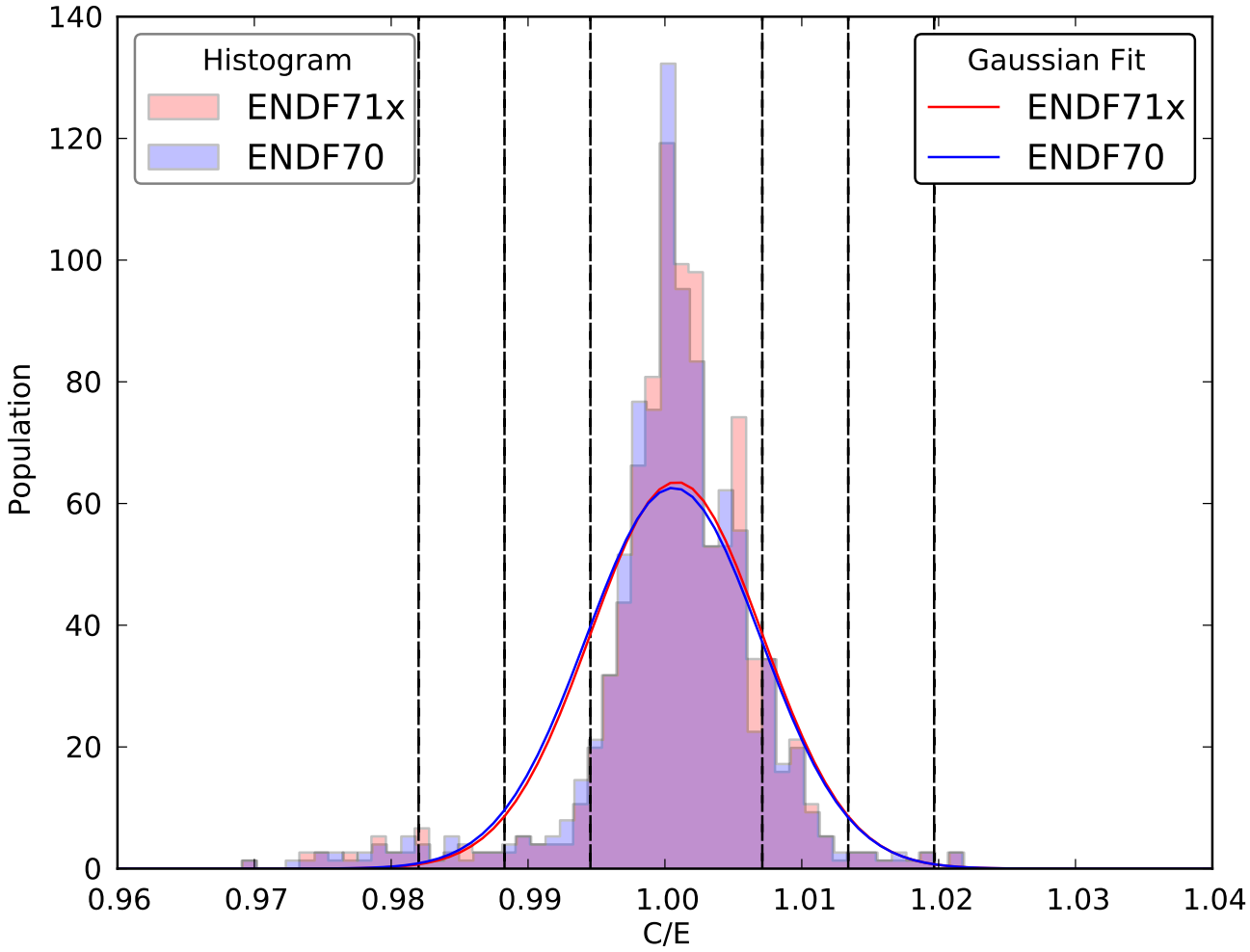
MCNP6 k_{eff} Results



Statistical Deviations

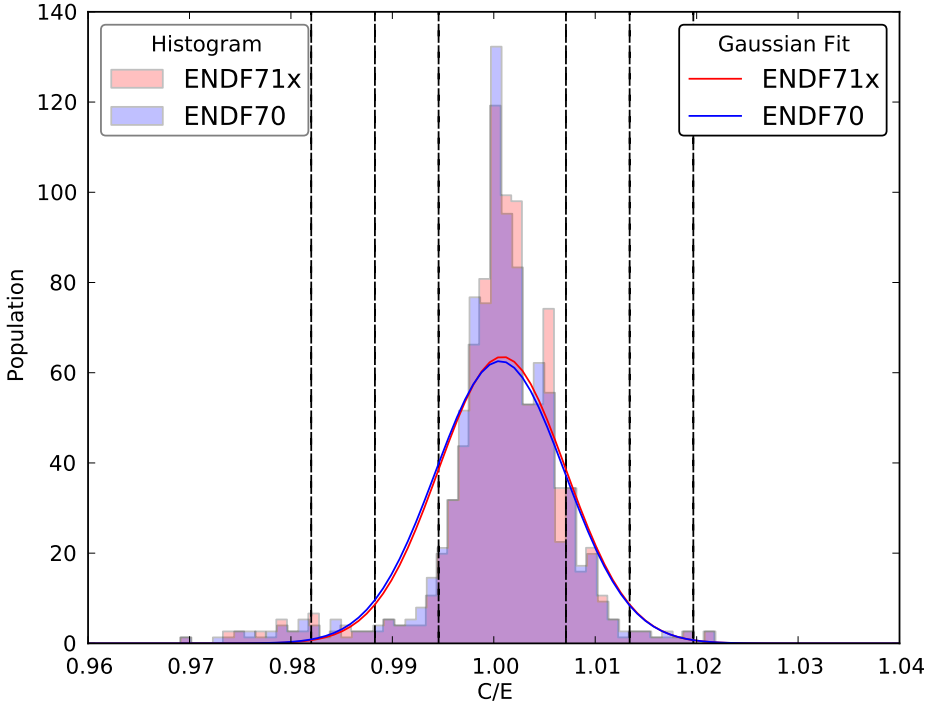


Statistical Deviations



Statistical Deviations

Attempting a Gaussian Distribution



How many models fall within x standard deviations σ:

	%	Exp.	71x	70
1σ	68.3	488	335	338
2σ	95.4	682	548	550
3σ	99.7	713	642	636
4σ	99.9	714	676	674

Biggest Players

Largest Δk_{eff}

1. u233-met-fast-004-002
2. pu-met-fast-005-001
3. heu-met-fast-003-010
4. heu-met-fast-003-011
5. heu-met-fast-003-009
6. heu-met-fast-003-008
7. heu-met-fast-066-009
8. heu-met-fast-066-008
9. heu-met-fast-066-007
10. heu-met-fast-077-008

Partial reasons for change

1. Beryllium
2. Tungsten
3. Titanium

Biggest Players

Furthest from experiment

1. heu-met-fast-033-002
2. heu-met-fast-033-001
3. heu-met-fast-004-001
4. heu-met-fast-057-005
5. pu-sol-therm-028-006
6. pu-sol-therm-028-005
7. pu-sol-therm-028-009
8. pu-sol-therm-028-003
9. heu-met-inter-006-004
10. mix-met-fast-008-007

Conclusion

- ENDF71x library released with MCNP6
- Best neutron cross section data available
- Extensive validation:
  - 717 ICSBEP MCNP6 benchmark models
  - 548 fall within 2σ, expected 682
- Majority of changes may be attributed to:
  - Beryllium
  - Titanium
  - Tungsten
- More work to find cause for large discrepancies