ENDF/B-VIIβ3 Data Testing

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Presented at the Annual CSEWG Meeting
Brookhaven National Laboratory

November, 2006

Introduction

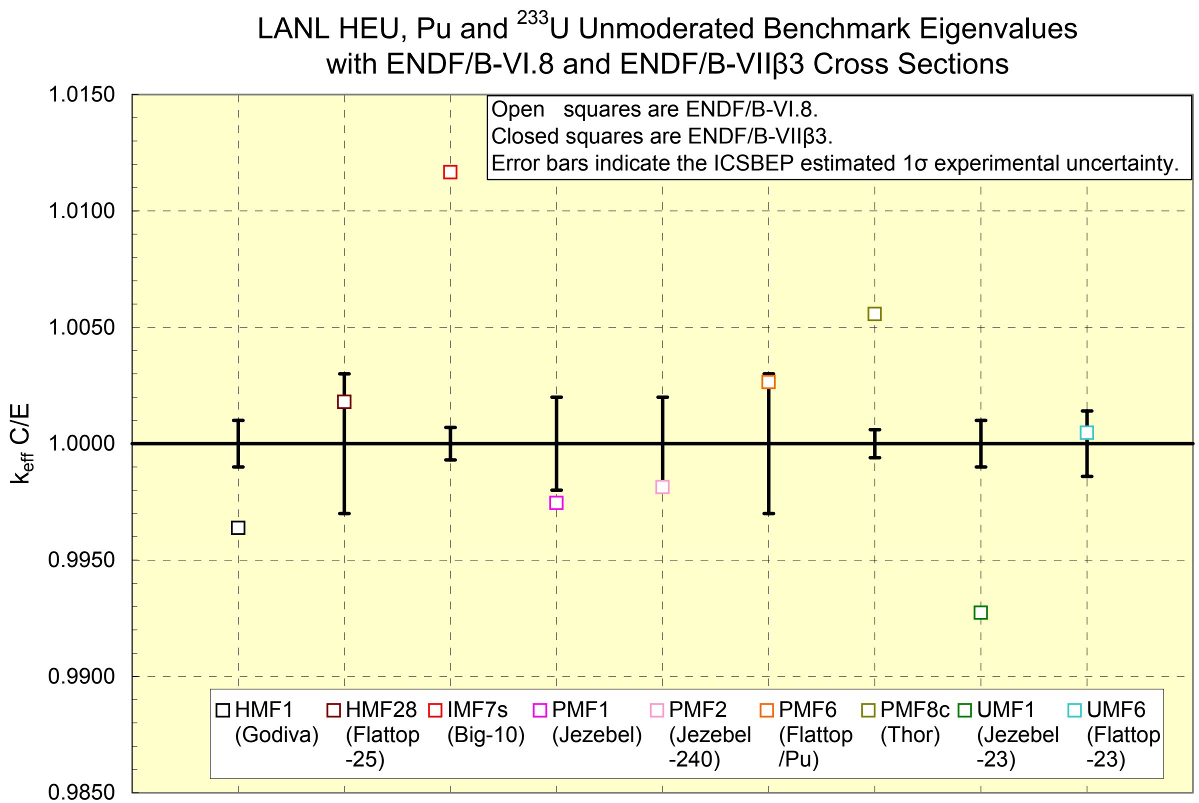
- Data testing at LANL has concentrated on MCNP5 eigenvalue calculations for a variety of critical benchmarks defined in the 2005 Edition of the International Criticality Safety Benchmark Evaluation Project (ICSBEP) Handbook.
  - xxx-MET-FAST (HEU, PU, MIX; bare, water and/or polyethylene reflected, metallic reflectors);
  - xxx-SOL-THERM (HEU, LEU, ^{233}U or Pu; bare and water, polyethylene or beryllium reflected);
  - LEU-COMP-THERM (water moderated, with and without lead reflectors).

- Eigenvalues are determined based upon tracking 25 million to 50 million neutron histories.
  - The uncertainty in the MCNP5 eigenvalue is typically less than 25 pcm.

"LANL"-MET-FAST Benchmarks

- "Traditional" LANL Fast Benchmarks are significantly improved with ENDF/B-VIIβ3 cross sections.
  - HEU-MET-FAST-001 (Godiva)
  - HEU-MET-FAST-028 (Flattop-28)
  - IEU-MET-FAST-007 (Big-10)
  - PU-MET-FAST-001 (Jezebel)
  - PU-MET-FAST-002 (Jezebel-240)
  - PU-MET-FAST-006 (Flattop-Pu)
  - PU-MET-FAST-008c (Thor)
  - U233-MET-FAST-001 (Jezebel-23)
  - U233-MET-FAST-006 (Flattop-23)

"LANL"-MET-FAST Benchmarks



- With ENDF/B-VI.8:
  - Reflector bias is evident.
  - Average k_{eff} C/E is 1.0008.
    - Not bad, but lucky.
  - Population standard deviation is ±0.0056.
    - Large deviations from unity in calculated eigenvalues.

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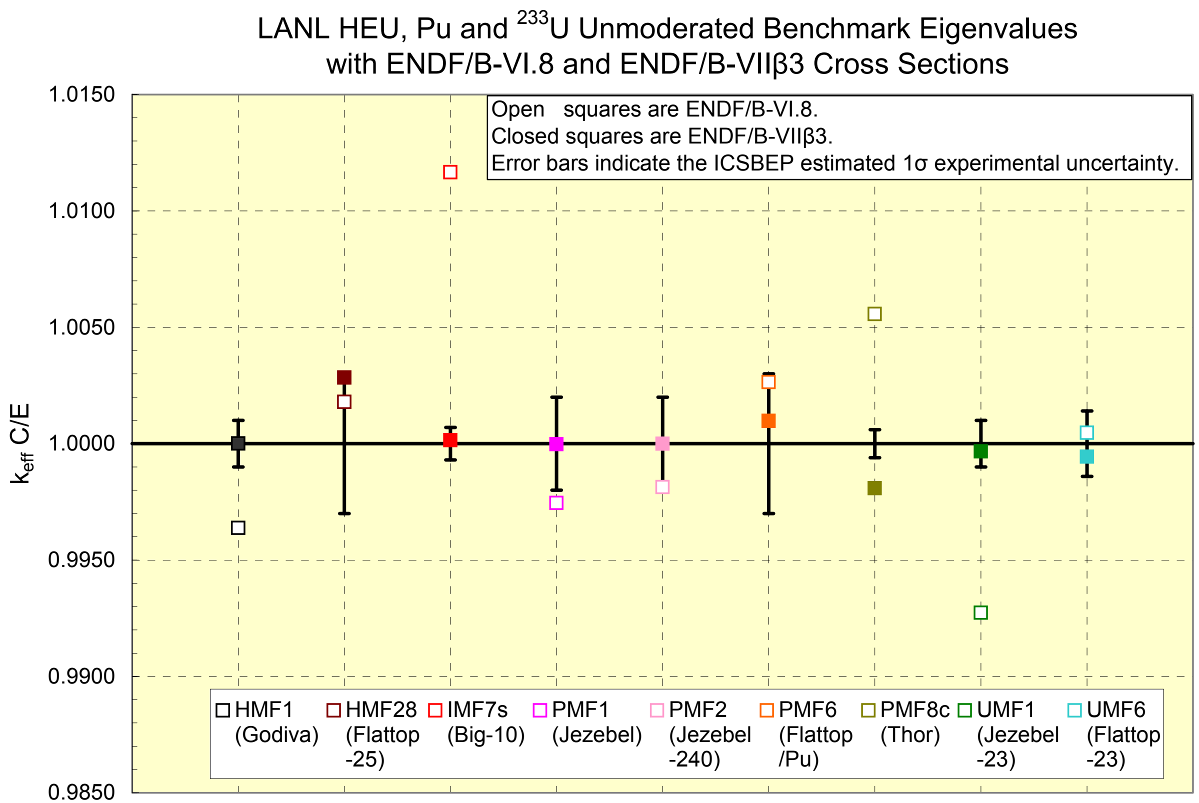
"LANL"-MET-FAST Benchmarks

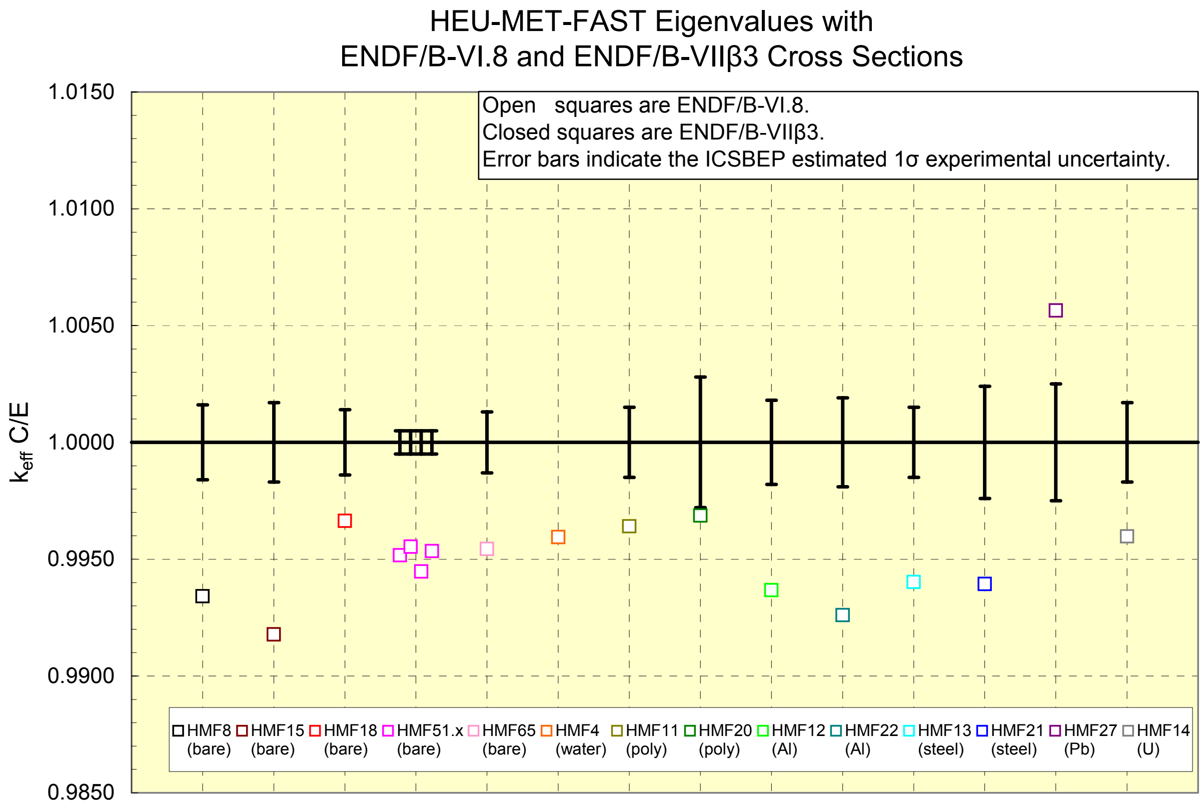


- With ENDF/B-VIIβ3:
  - Reflector bias is virtually eliminated.
  - Average k_{eff} C/E is 1.0001.
  - Population standard deviation is ±0.0014.

Other HEU & PU-MET-FAST Benchmarks

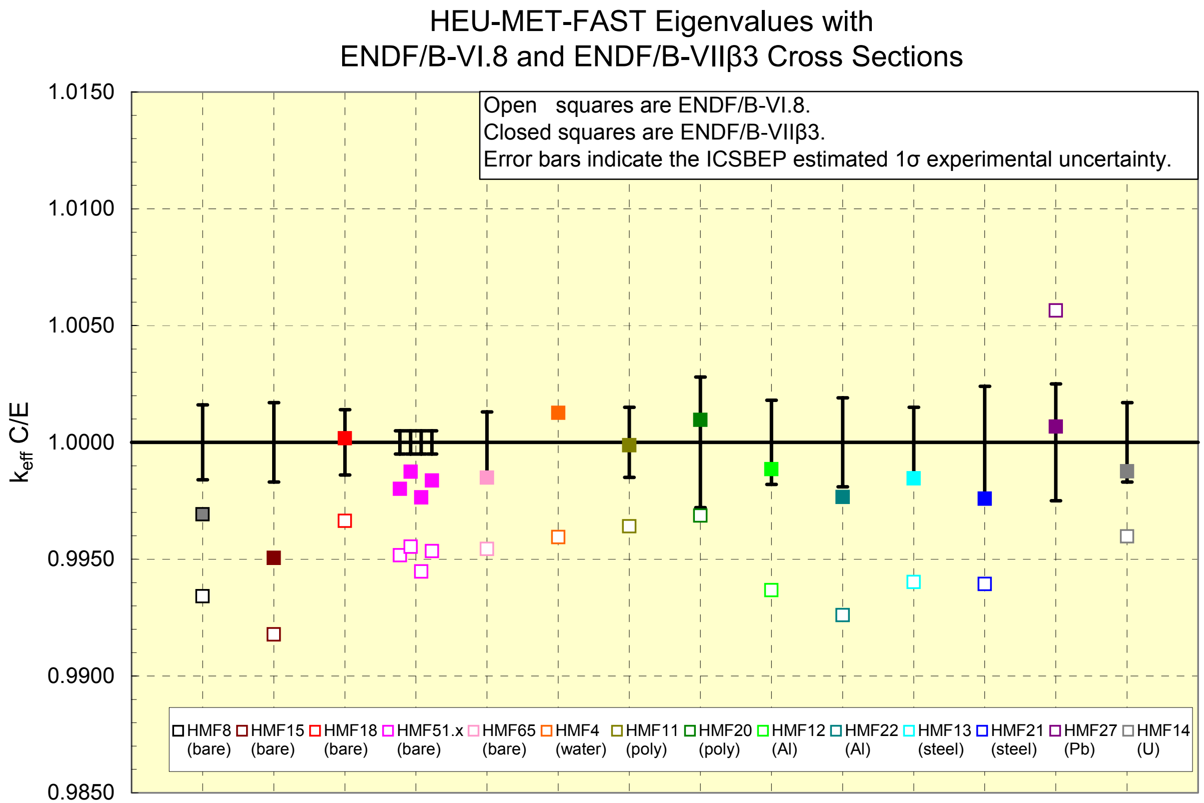
- Other xxx-MET-FAST Benchmarks
  - HEU-MET-FAST bare systems:
    - HEU-MET-FAST-008
    - HEU-MET-FAST-015 & -065
    - HEU-MET-FAST-018
    - HEU-MET-FAST-051
  - HEU-MET-FAST reflected systems
    - HEU-MET-FAST-004 (water)
    - HEU-MET-FAST-007, -011 (polyethylene)
    - HEU-MET-FAST-012, -022 (aluminum)
    - HEU-MET-FAST-013, -021 (steel)
    - HEU-MET-FAST-027, -057, -064 (lead)
    - HEU-MET-FAST-014 (uranium)

Other HEU & PU-MET-FAST Benchmarks



- With ENDF/B-VI.8:
  - Most calculated eigenvalues are biased low.
  - Small reflector bias for low-Z materials.
  - Lead reflector bias is large.
  - Average k_{eff} C/E and the population standard deviation are 0.9955 ± 0.0030.

Other HEU & PU-MET-FAST Benchmarks



- With ENDF/B-VIIβ3:
  - Calculated eigen-values are closer to unity and many are within the experi-mental uncertainty.
  - Small reflector bias for low-Z materials.
  - Lead reflector bias is significantly reduced.
  - Average k_{eff} C/E and the population standard deviation are 0.9984 ± 0.0016.

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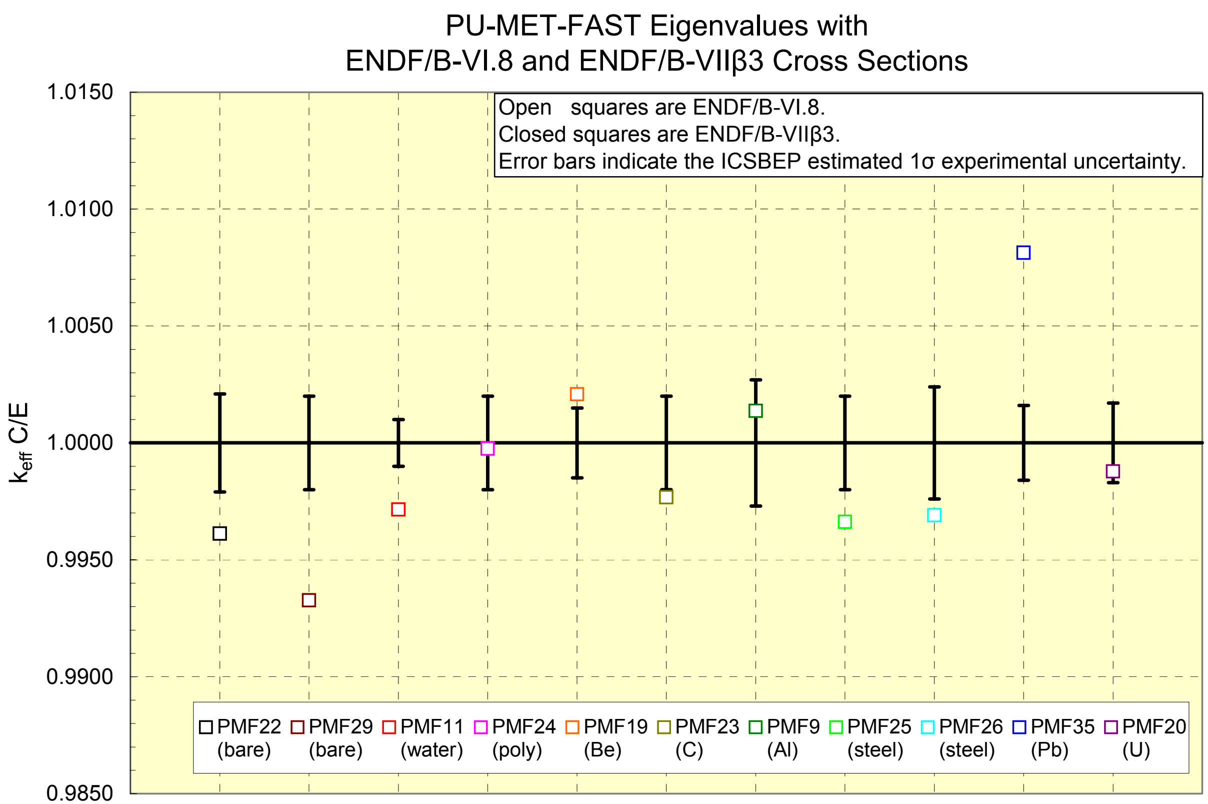
Other HEU & PU-MET-FAST Benchmarks

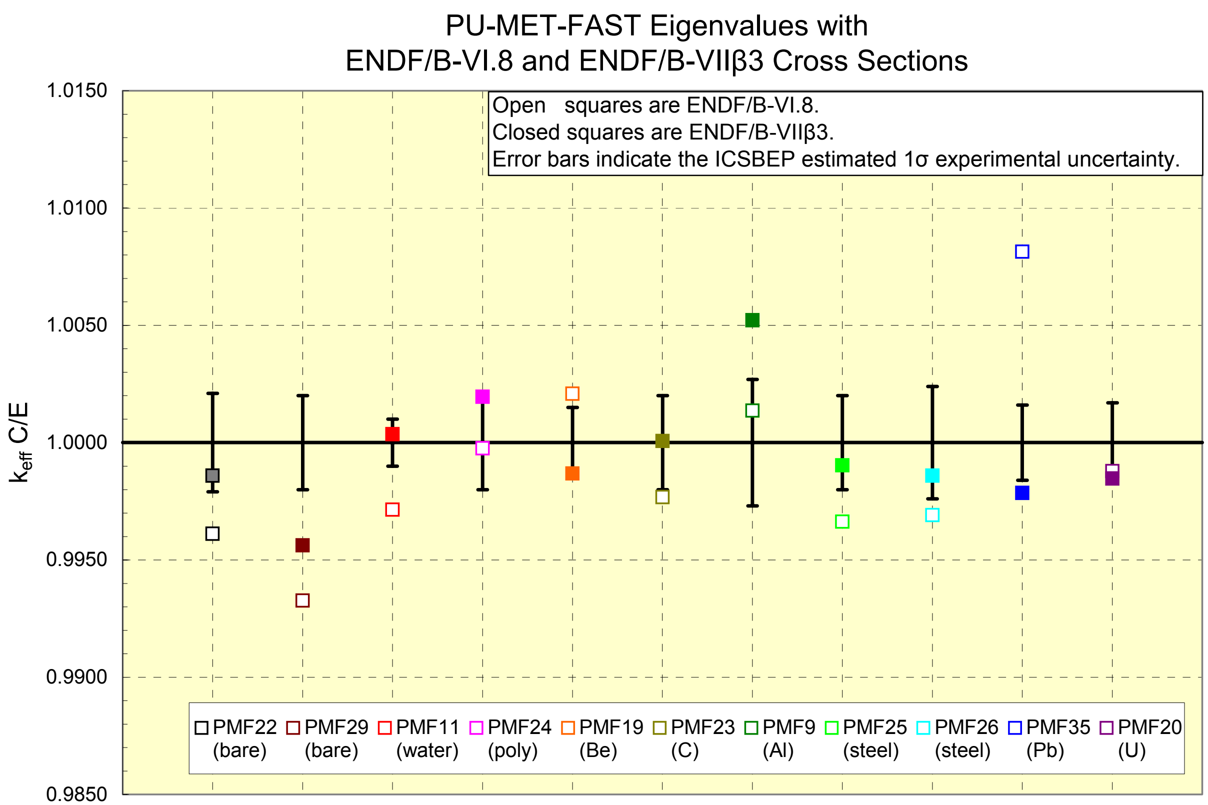
- Other xxx-MET-FAST Benchmarks (con't)
  - PU-MET-FAST bare systems
    - PU-MET-FAST-022, -029
  - PU-MET-FAST Reflected Systems
    - PU-MET-FAST-011 (water)
    - PU-MET-FAST-024 (polyethylene)
    - PU-MET-FAST-018, -019 (beryllium)
    - PU-MET-FAST-023 (graphite)
    - PU-MET-FAST-009 (aluminum)
    - PU-MET-FAST-025, -026 (steel)
    - PU-MET-FAST-035 (lead)
    - PU-MET-FAST-010, -020 (uranium)

Other HEU & PU-MET-FAST Benchmarks



- With ENDF/B-VI.8:
  - Calculated eigen-values are generally biased low.
  - Reflector bias for low-Z materials is observed.
  - Lead reflector bias is large.
  - Average k_{eff} C/E and the population standard deviation are 0.9989 ± 0.0039.

Other HEU & PU-MET-FAST Benchmarks



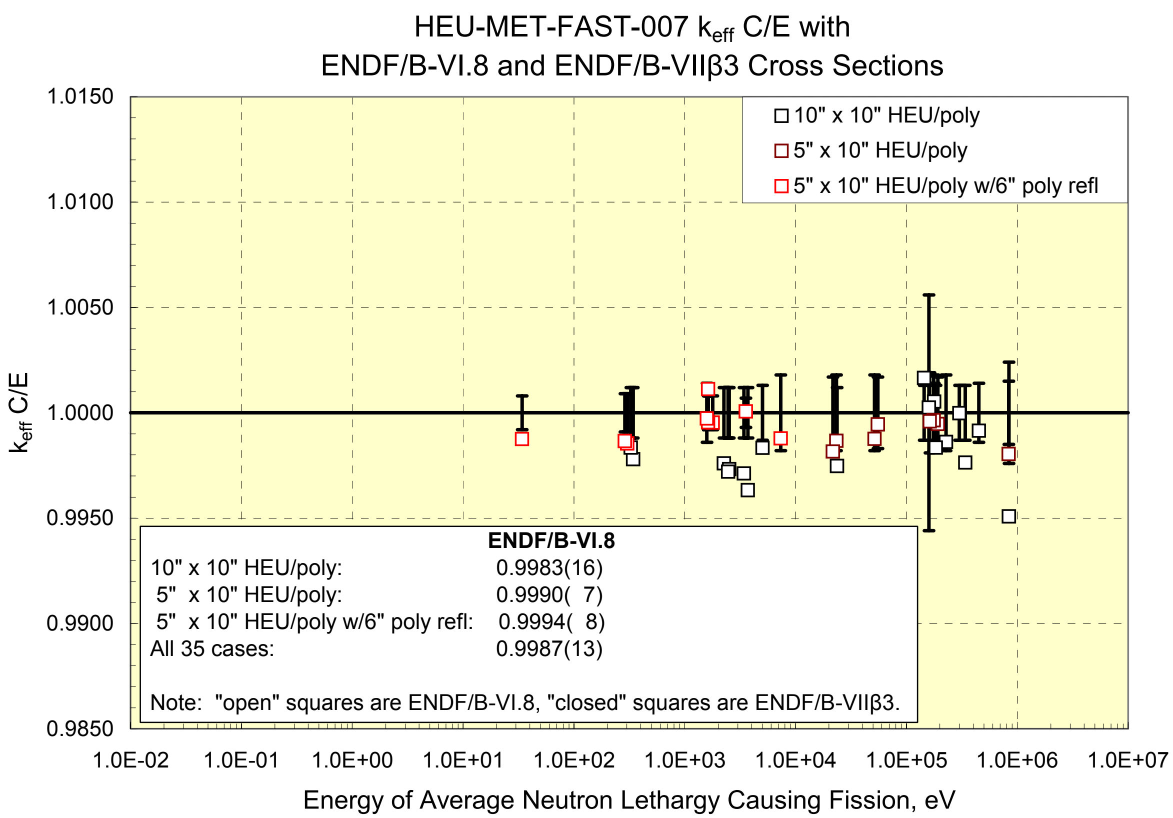
- With ENDF/B-VIIβ3:
  - Calculated eigen-values are closer to unity and most are within the experi-mental uncertainty.
  - Reflector bias for low-Z materials is reduced.
  - Lead reflector bias is eliminated.
  - Average k_{eff} C/E and the population standard deviation are 0.9995 ± 0.0025.

HEU-, Pu- and U233-MET-FAST Benchmarks

- k_{eff} C/E values are significantly more accurate when using ENDF/B-VIIβ3 cross sections, compared to the corresponding values obtained with ENDF/B-VI.8 cross sections.
  - The historical uranium reflector bias has been eliminated.

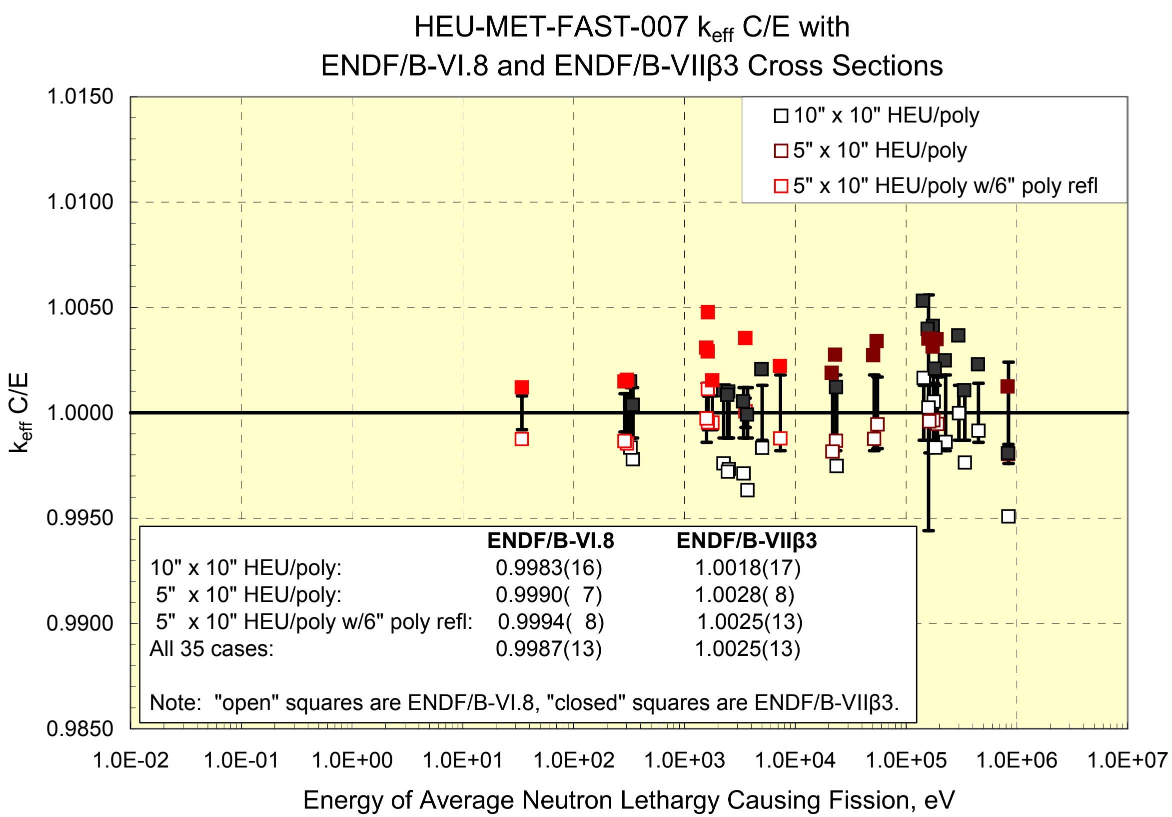
- Subsequent slides expand on this conclusion, examining k_{eff} C/E for FAST systems with polyethylene, beryllium and lead reflectors.

HEU-MET-FAST Benchmarks Polyethylene Reflected & Moderated



- HEU-MET-FAST-007
  - 10” x 10” HEU slabs interleaved with polyethylene (cases 1 – 18).
  - 5” x 10” HEU slabs interleaved with polyethylene (cases 19 – 26).
  - 5” x 10” HEU slabs interleaved with polyethylene and surrounded by 6” of polyethylene (cases 35 – 43).
- Average ENDF/B-VI.8 k_{eff} C/E’s are:
  - 0.9983 ± 0.0016
  - 0.9990 ± 0.0007
  - 0.9994 ± 0.0008

HEU-MET-FAST Benchmarks Polyethylene Reflected & Moderated



- HEU-MET-FAST-007
  - 10” x 10” HEU slabs interleaved with polyethylene (cases 1 – 18).
  - 5” x 10” HEU slabs interleaved with polyethylene (cases 19 – 26).
  - 5” x 10” HEU slabs interleaved with polyethylene and surrounded by 6” of polyethylene (cases 35 – 43).
- Average ENDF/B-VIIβ3 k_{eff} C/E’s are:
  - 1.0018 ± 0.0017
  - 1.0028 ± 0.0008
  - 1.0025 ± 0.0013

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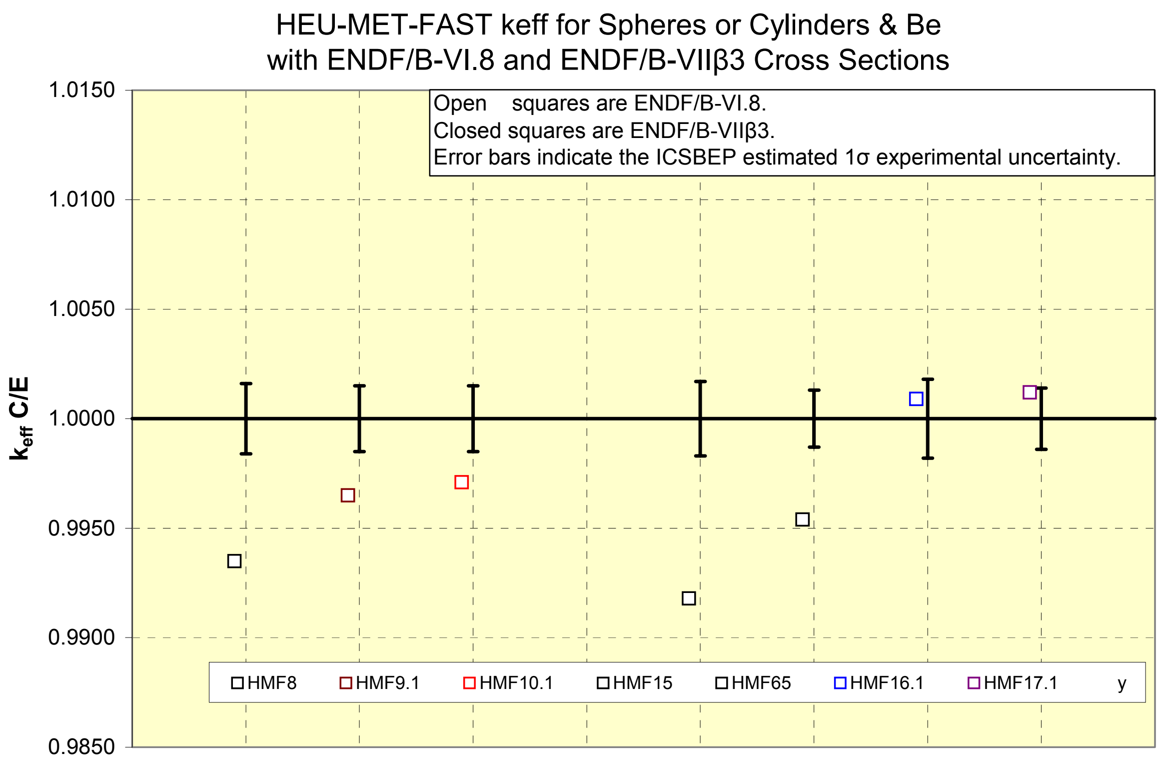
HEU-MET-FAST Benchmarks Polyethylene Reflected & Moderated

- Average calculated eigenvalue increase is ~0.3%.
  - Consistent with the general increase seen for other HEU benchmarks.
- ENDF/B-VI.8 results are 0.1% to 0.2% too low.
- ENDF/B-VIIβ3 results are 0.2% to 0.3% too high.
  - For Crit Safety its better to calculate high, but decease in absolute accuracy is disappointing.

xxx-MET-FAST Benchmarks – Be Reflected

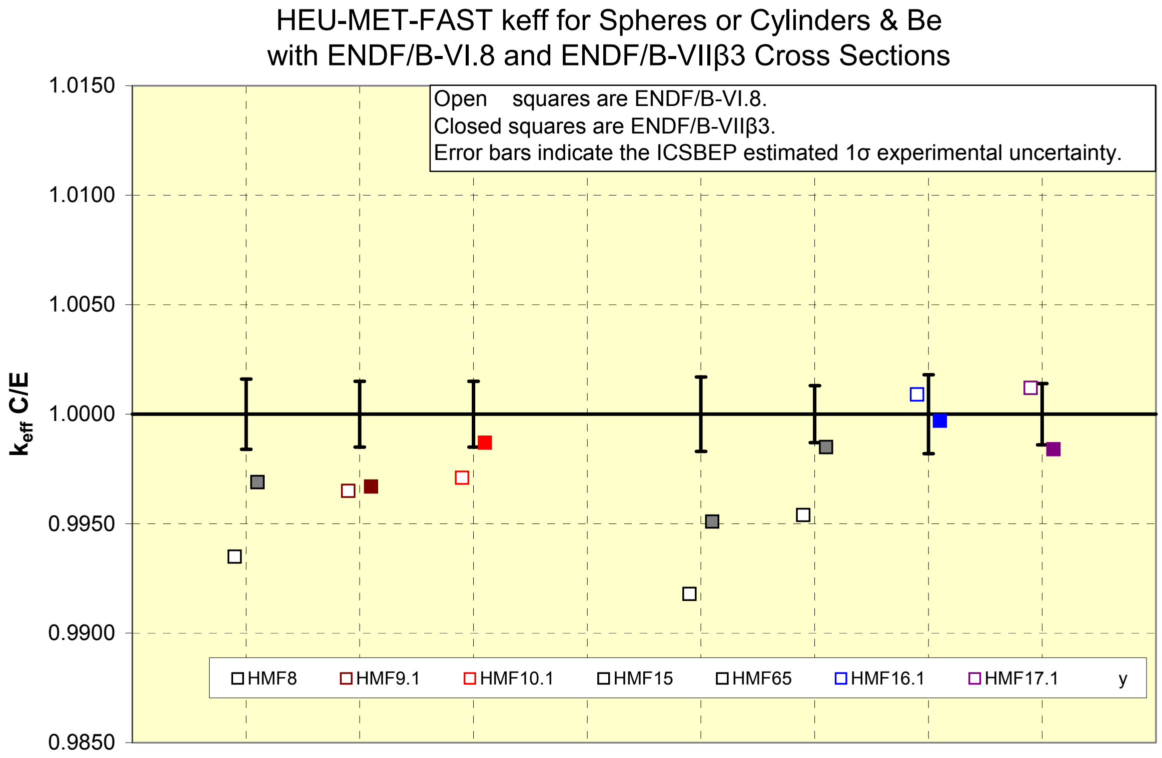
- Fast, beryllium reflected benchmarks
  - HEU-MET-FAST-009
  - HEU-MET-FAST-010
  - HEU-MET-FAST-016
  - HEU-MET-FAST-017
  - HEU-MET-FAST-041
  - HEU-MET-FAST-058
  - HEU-MET-FAST-066
  - HEU-MET-FAST-077 (preliminary model)
    - Approved for publication in the 2006 edition of the ICSBEP Handbook.
  - MIX-MET-FAST-007

HEU-MET-FAST Benchmarks – Be Reflected



- ENDF/B-VI.8.
- HEU-MET-FAST-008 is the base case for HEU-MET-FAST-009 & -010.
  - Be reflector surrounding an HEU sphere.
- HEU-MET-FAST-015 & -065 are the base case for HEU-MET-FAST-016 & -017.
  - Be reflectors and interleaved plates in a cylindrical stack.

HEU-MET-FAST Benchmarks – Be Reflected



- ENDF/B-VIIβ3.
- HEU-MET-FAST-008 is the base case for HEU-MET-FAST-009 & -010.
  - Be reflector surrounding an HEU sphere.
- HEU-MET-FAST-015 & -065 are the base case for HEU-MET-FAST-016 & -017.
  - Be reflectors and interleaved plates in a cylindrical stack.

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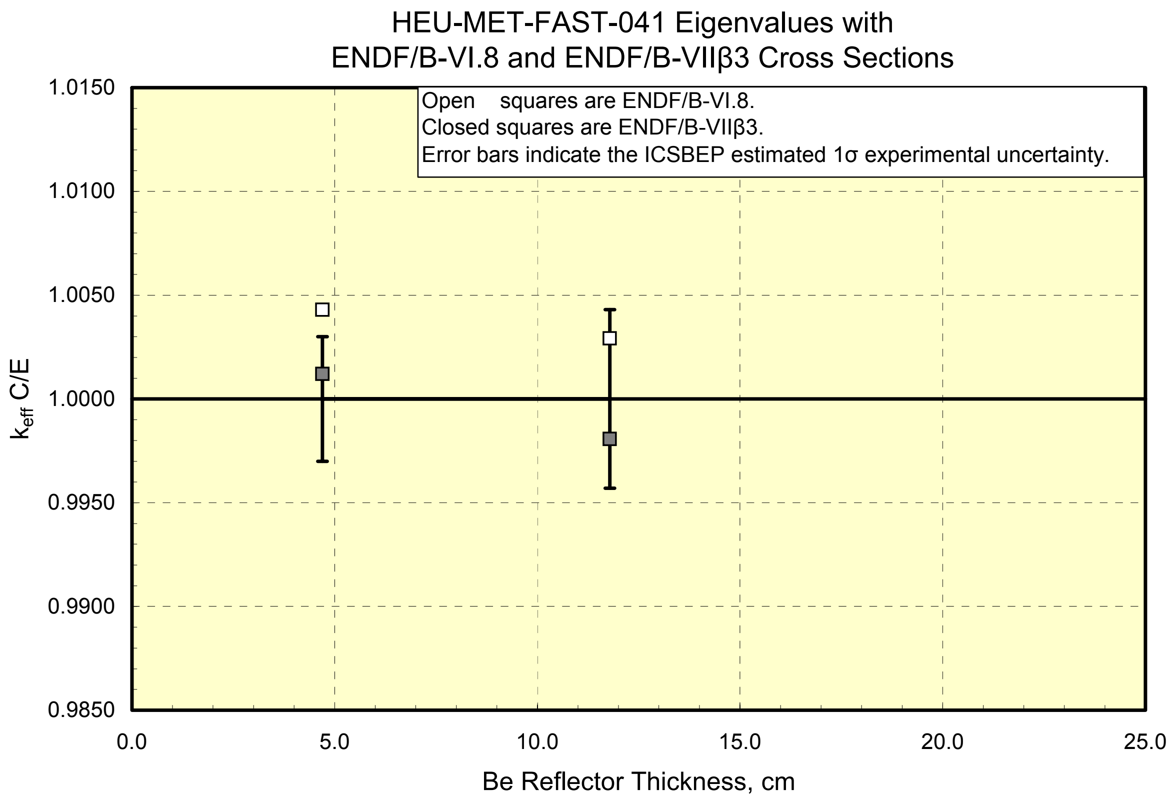
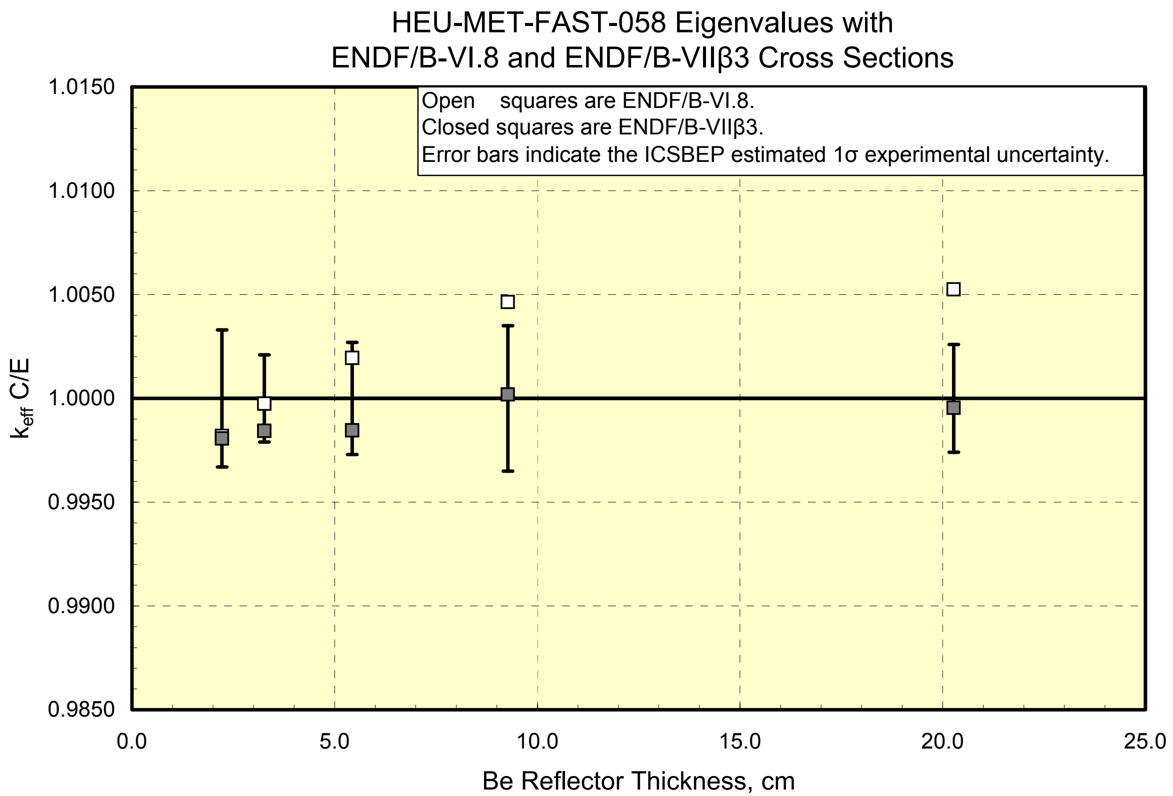
HEU-MET-FAST Benchmarks – Be Reflected



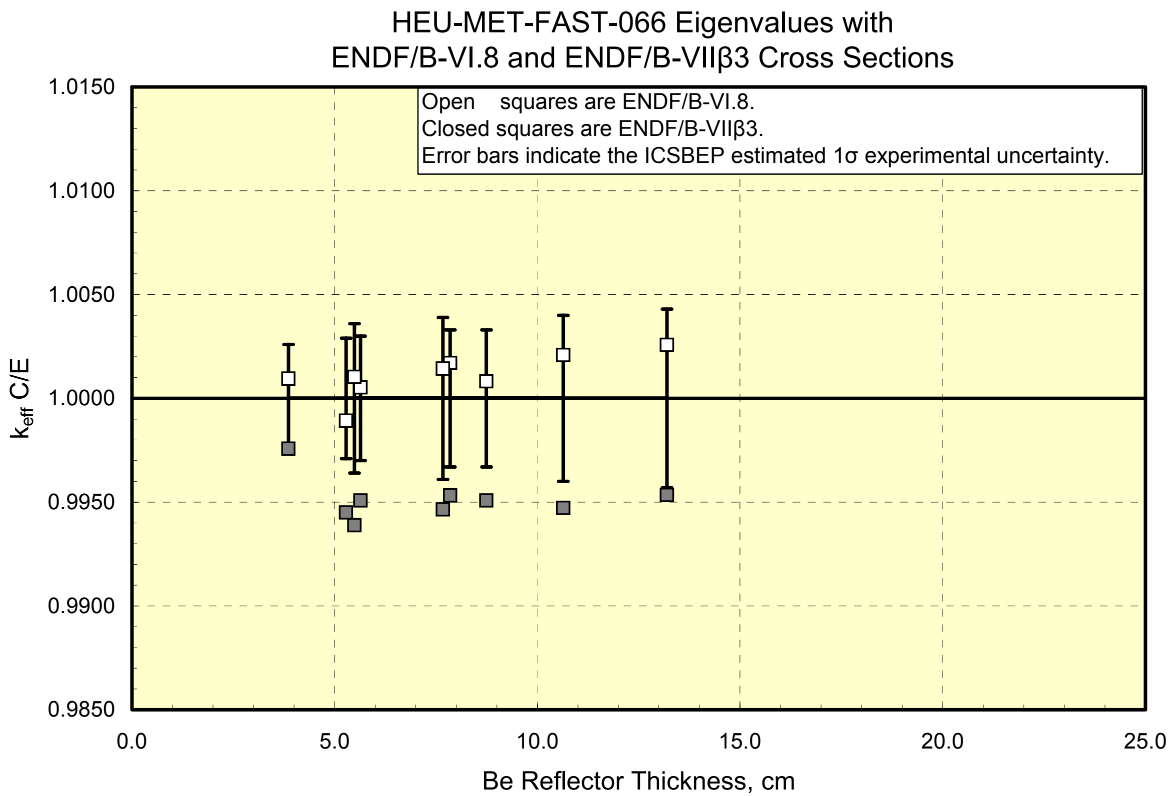
- HMF41 (2 cases)
  - LANL experiment.
  - HEU spherical core.
    - HEU radii are 6.73 cm and 5.64 cm.
  - Be reflector.
    - Be reflector thicknesses are 4.70 cm and 11.79 cm.

HEU-MET-FAST Benchmarks – Be Reflected



- HMF58 (5 cases)
  - LLNL experiment (Nimbus).
  - HEU spherical core.
    - HEU Core radii varied from 5.2 cm to 7.48 cm.
  - Be reflector.
    - Be reflector thickness varied from 20.26 cm to 2.22 cm.

HEU-MET-FAST Benchmarks – Be Reflected



- HMF66 (9 cases)
  - LLNL experiment (Nimbus).
  - HEU spherical core.
    - HEU Core inner cavity radii varied from 3.15 cm to 6.54 cm.
    - HEU Core outer radii varied from 6.54 cm to 9.13 cm.
  - Be moderator and reflector.
    - Be moderator placed within inner HEU cavity.
    - Be reflector thick-ness varied from 13.20 cm to 3.86 cm.
  - Different biases and impurities.

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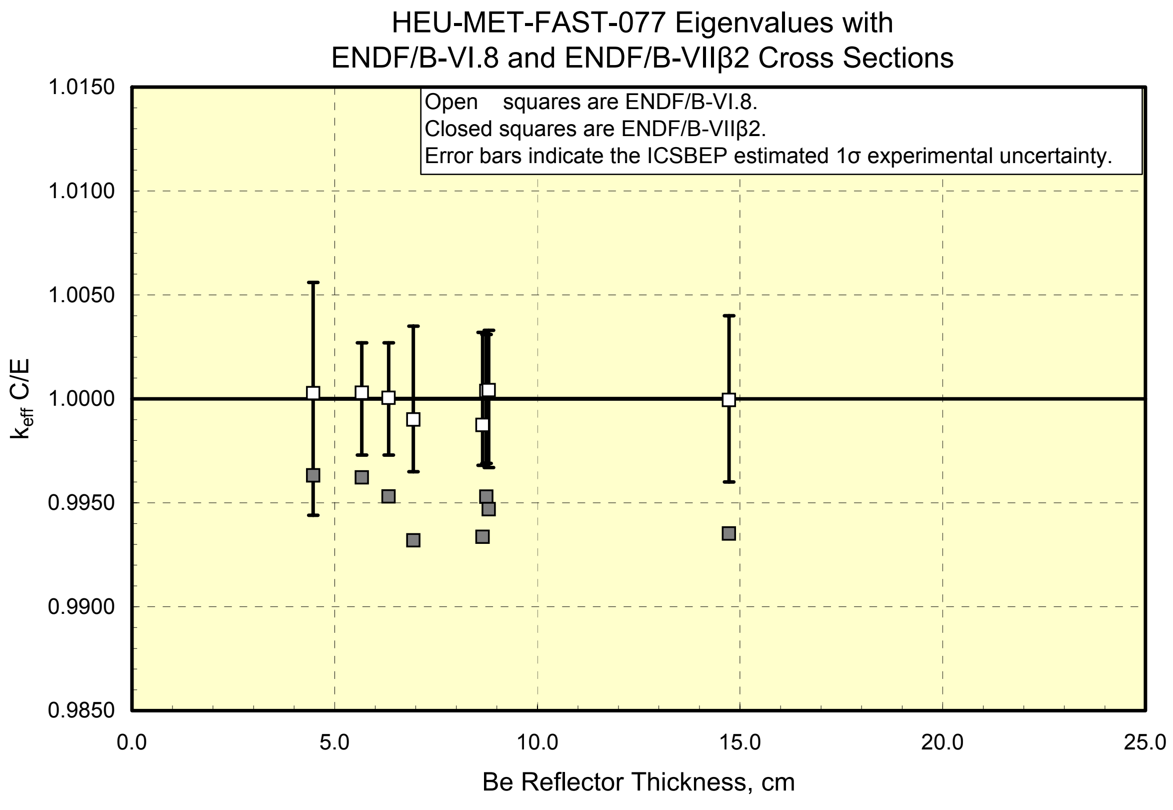
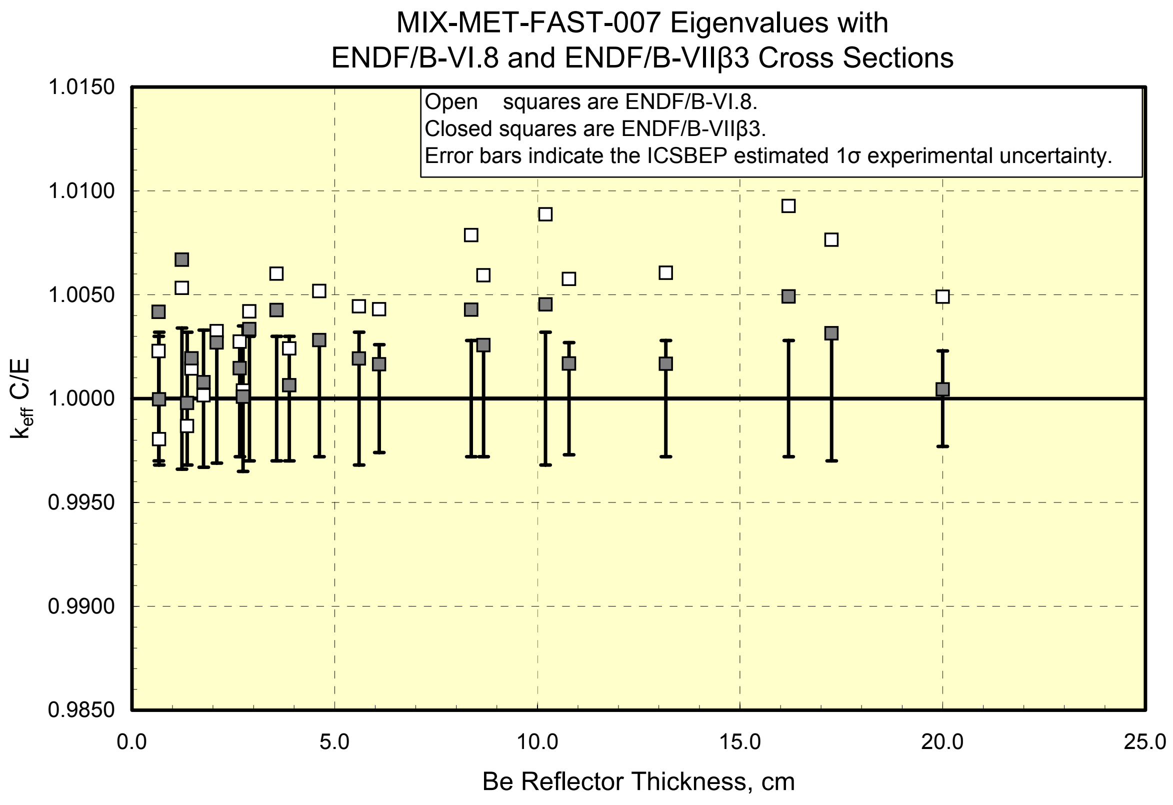
HEU-MET-FAST Benchmarks – Be Reflected



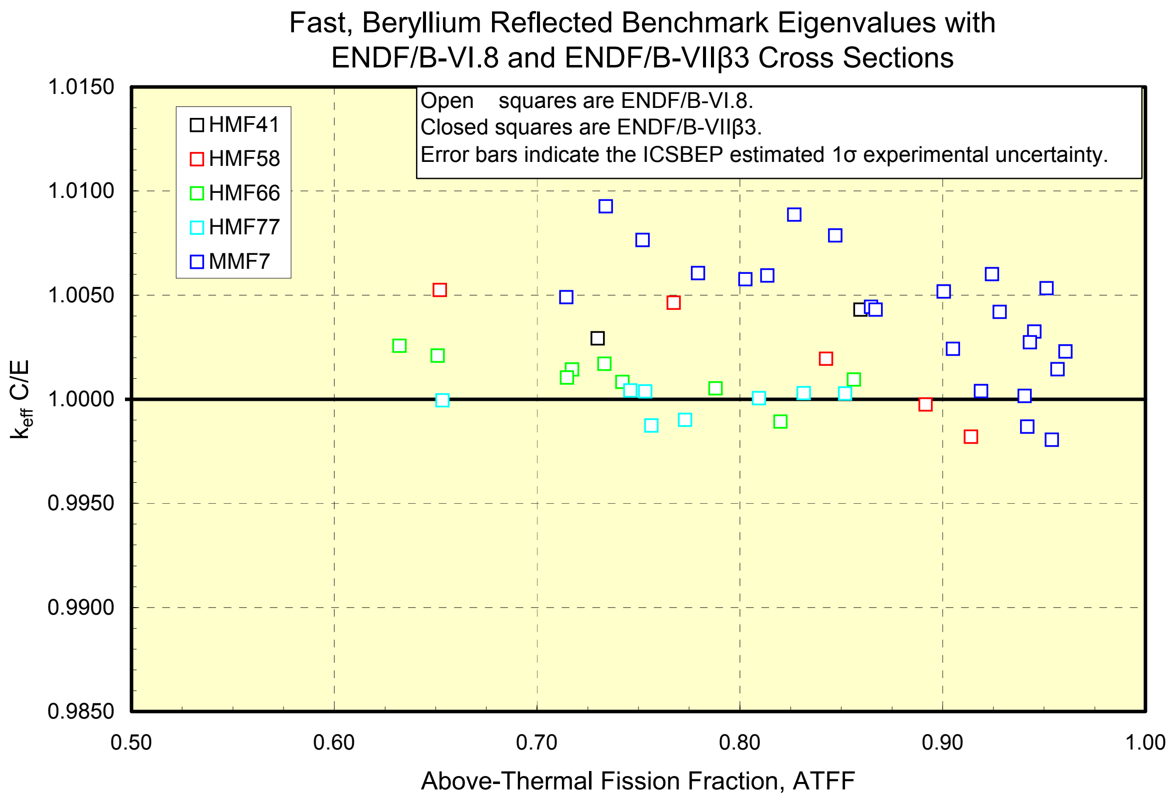
- HMF77 (8 cases)
  - Preliminary model.
  - LLNL experiment (Nimbus).
  - HEU spherical core.
    - HEU Core inner cavity radii varied from 3.15 cm to 6.54 cm.
    - HEU Core outer radii varied from 6.54 cm to 9.13 cm.
  - Be reflector.
    - Inner HEU cavity is void.
    - Be reflector thickness varied from 14.73 cm to 4.47 cm.
- **ENDF/B-VIIβ2 results**

HEU-MET-FAST Benchmarks – Be Reflected



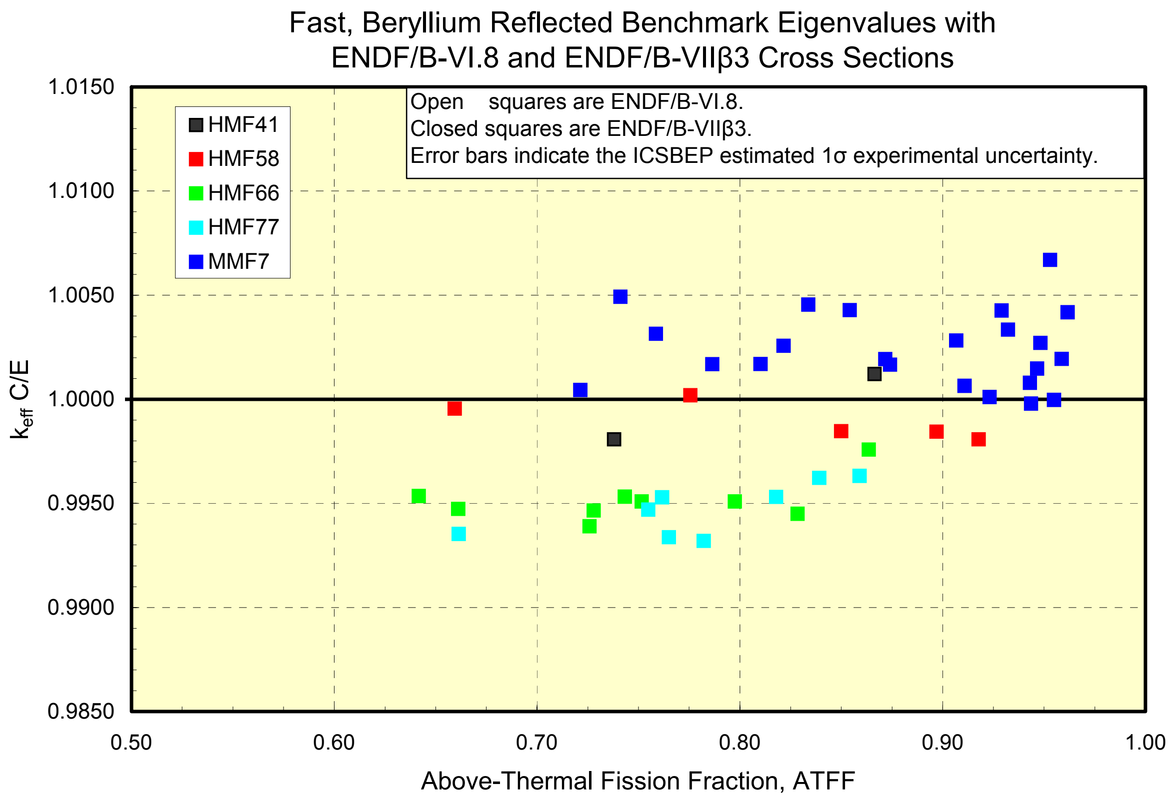
- MMF7 (23 cases)
  - LLNL experiment.
  - Pu core (one of five radii from 3.13 cm to 4.07 cm).
  - HEU inner reflector (various thickness, from ~0.6 cm to ~3.4 cm).
  - Be outer reflector (various thickness, from ~20.0 cm to ~0.7 cm).

HEU-MET-FAST Benchmarks – Be Reflected



- ENDF/B-VI.8
- Previous figures showed k_{eff} C/E versus Be reflector thickness.
- What about another parameter, such as spectrum (Above-Thermal Fission Fraction).

HEU-MET-FAST Benchmarks – Be Reflected



- ENDF/B-VIIβ3
- Previous figures showed k_{eff} C/E versus Be reflector thickness.
- What about another parameter, such as spectrum (Above-Thermal Fission Fraction).

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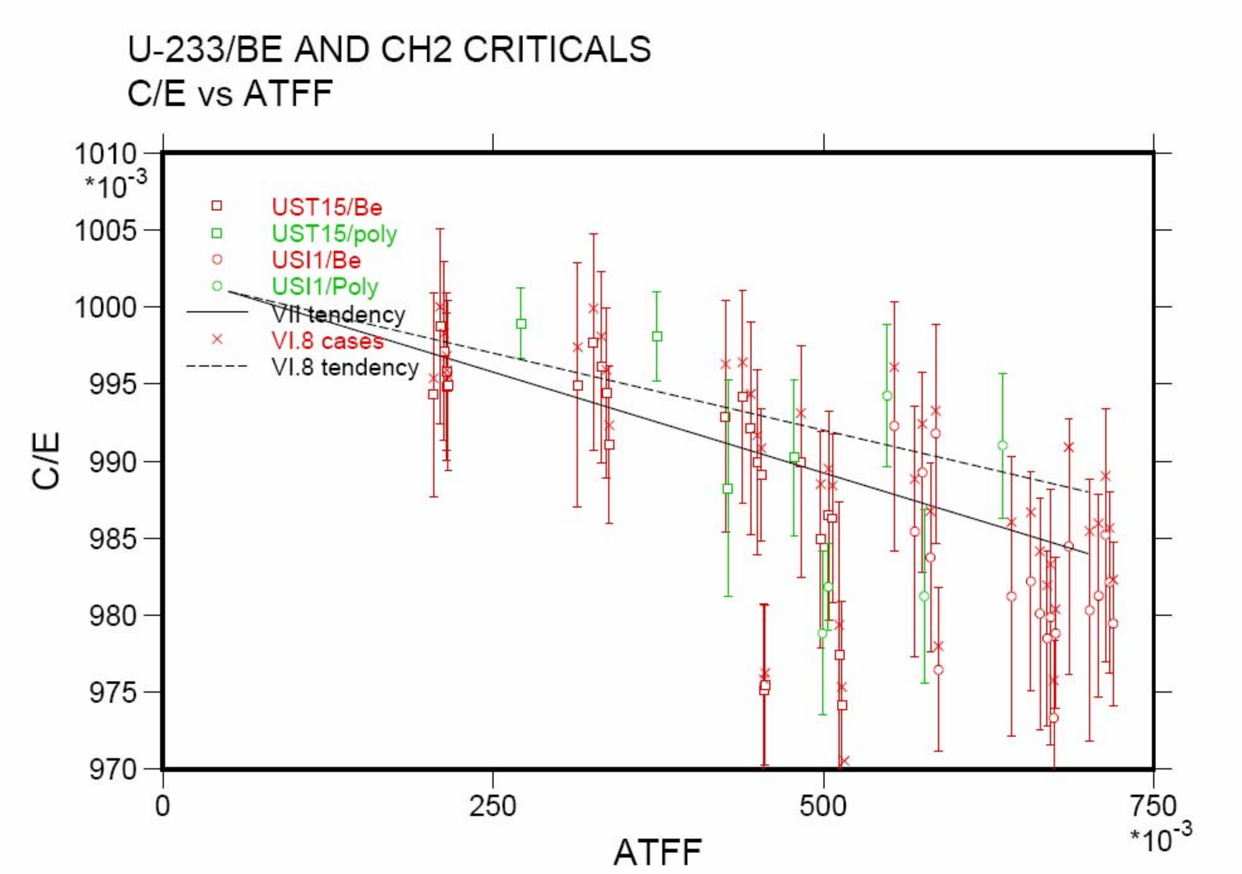
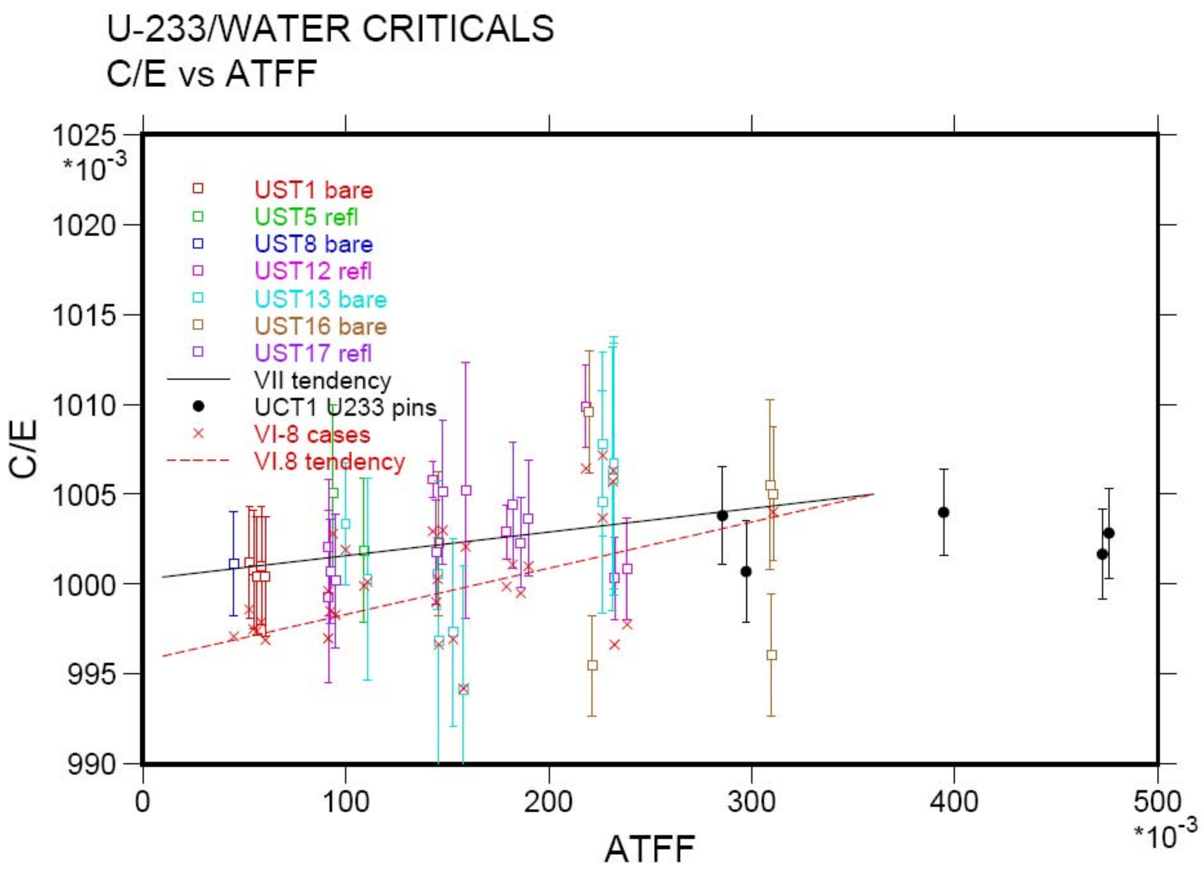
Thermal ^{233}U Benchmarks with Beryllium



- Thermal ^{233}U solution benchmarks with beryllium or polyethylene reflectors.
- Decreasing k_{eff} C/E trend with increasing spectrum hardness.
- This is opposite the k_{eff} C/E trend observed with ^{233}U water only assemblies.

Thermal ^{233}U Benchmarks - Bare or Water Reflected



- Thermal ^{233}U solution benchmarks, bare or water reflected.
- Increasing k_{eff} C/E trend with increasing spectrum hardness.
- This is opposite the k_{eff} C/E trend observed with ^{233}U polyethylene or beryllium reflected assemblies.

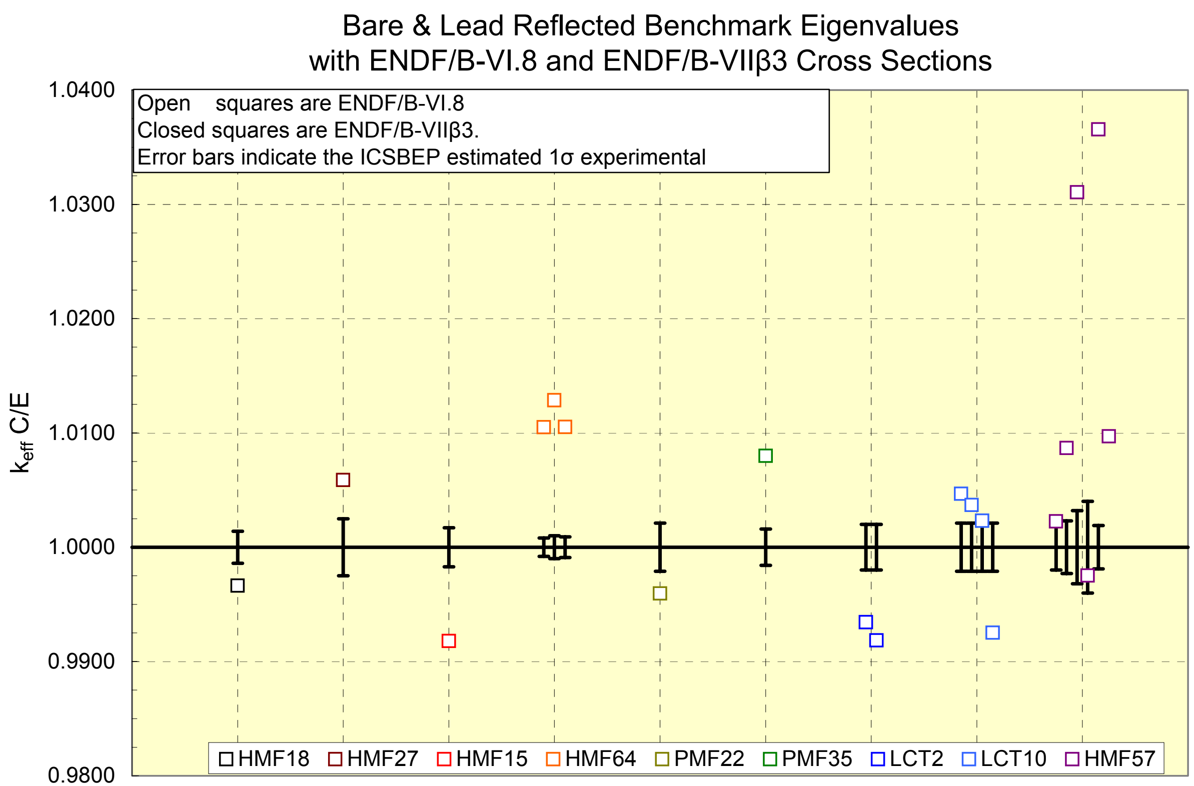
Benchmarks with Beryllium

- Overall accuracy of k_{eff} C/E calculations with the revised beryllium cross sections is inconsistent, as the
  - revised beryllium cross sections have lead to more accurate calculated eigenvalues for the HEU-MET-FAST-009, -010, -016, -041, -058 and MIX-MET-FAST-007 benchmarks.
  - but the revised beryllium cross sections have lead to less accurate calculated eigenvalues for the HEU-MET-FAST-066 and HEU-MET-FAST-077 benchmarks.
- Results for ^{233}U critical systems are also contradictory.
  - Positive k_{eff} C/E trend in water reflected assemblies; negative k_{eff} C/E trend in polyethylene or beryllium reflected assemblies.
- We look forward to including new RPI data in future analyses.

FAST & Thermal Benchmarks – Pb Reflected

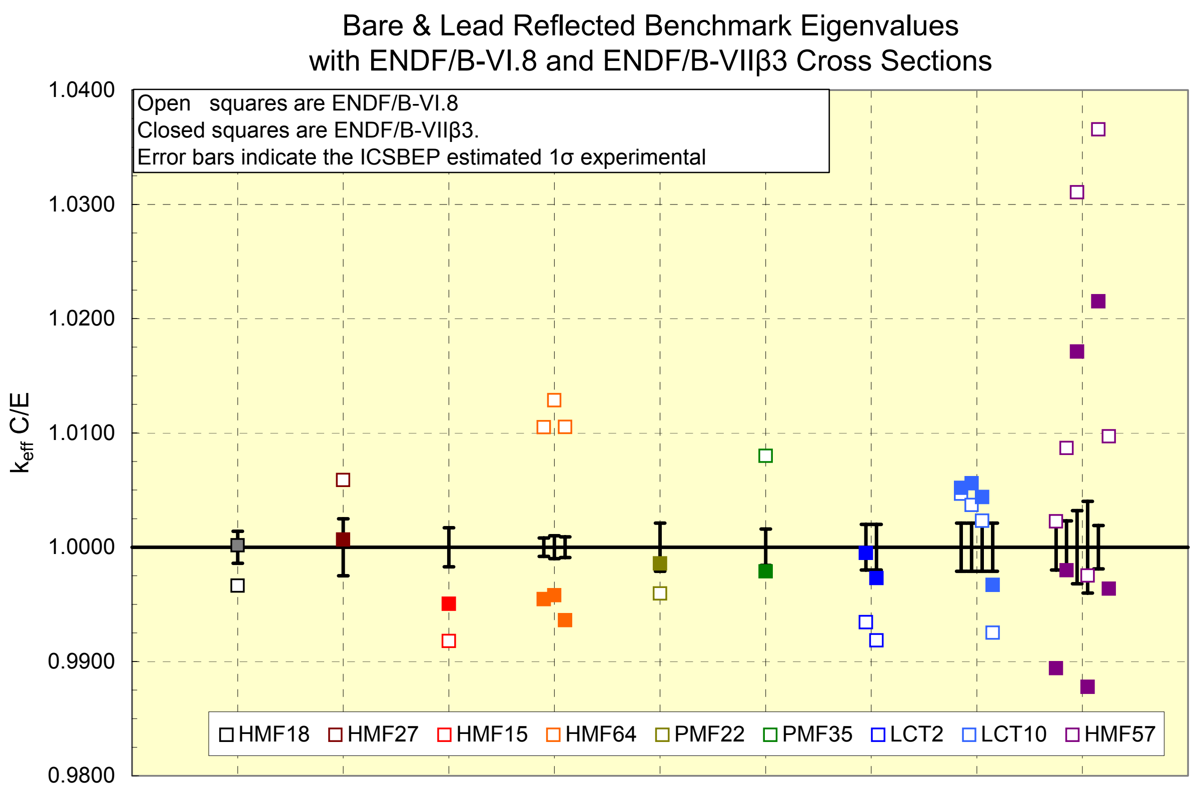
- HEU, lead reflected benchmarks
  - HEU-MET-FAST-027
    - HEU-MET-FAST-018 is the “base case”.
  - HEU-MET-FAST-064
    - HEU-MET-FAST-015 is the “base case”.
  - HEU-MET-FAST-057
- Pu, lead reflected benchmarks
  - HEU-MET-FAST-035
    - Pu-MET-FAST-022 is the “base case”.
- LEU, lead reflected benchmarks
  - LEU-COMP-THERM-010
    - LEU-COMP-THERM-002 is the “base case”.

FAST & Thermal Benchmarks – Pb Reflected



- ENDF/B-VI.8
- There is an obvious lead reflector bias in k_{eff} C/E values.
- HMF18 is a base case for HMF27.
- HMF15 is a base case for HMF64.
- PMF22 is a base case for PMF35.
- LCT2 is a base case for LCT10.

FAST & Thermal Benchmarks – Pb Reflected



- ENDF/B-VIIβ3
- The lead reflector bias is virtually eliminated for fast systems; there is little improvement for thermal systems.
- HMF18 is a base case for HMF27.
- HMF15 is a base case for HMF64.
- PMF22 is a base case for PMF35.
- LCT2 is a base case for LCT10.

FAST & Thermal Benchmarks – Pb Reflected

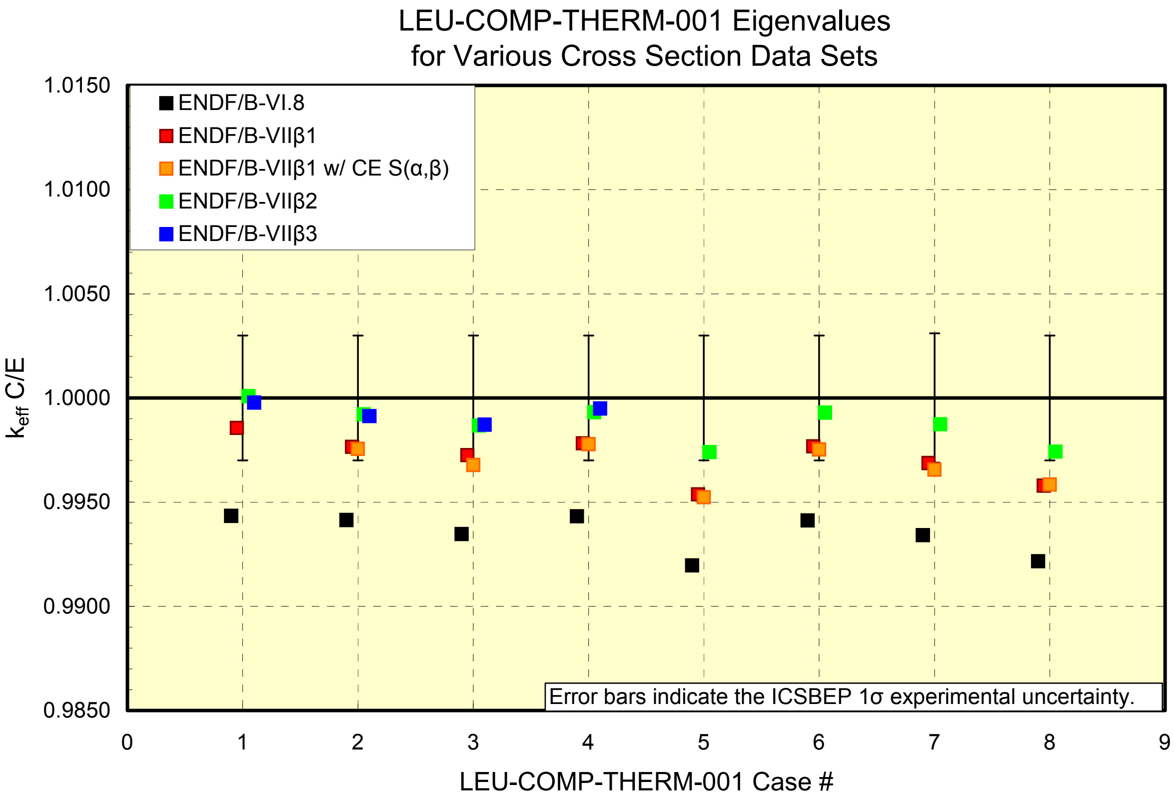
- Fast, lead reflected critical assembly k_{eff} C/E values are significantly more accurate when ENDF/B-VIIb3 cross sections are used.

- These same k_{eff} C/E improvements are not seen for thermal, low-enriched uranium critical systems.

LEU-COMP-THERM Benchmarks

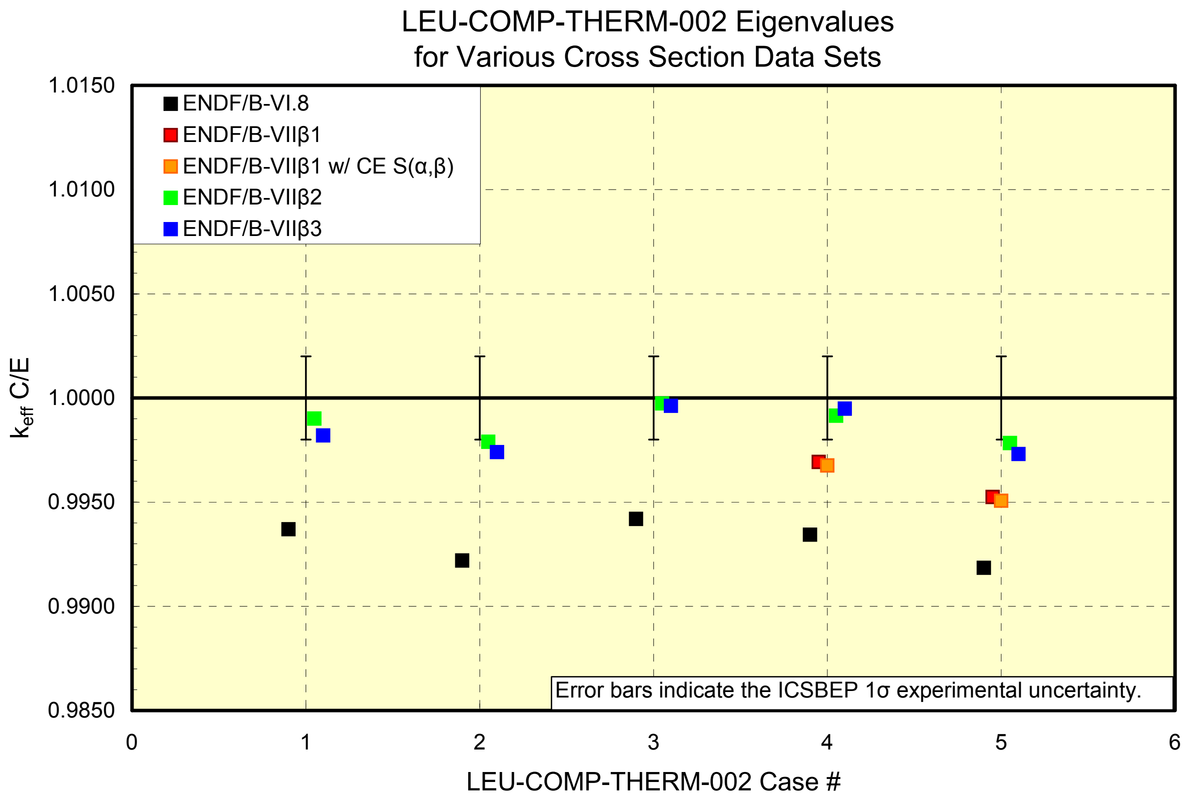
- We have calculated k_{eff} for a suite of seven LEU-COMP-THERM evaluations representing experimental programs from five countries:
  - LEU-COMP-THERM-001 (2.35 w/o ^{235}U, United States – PNL)
  - LEU-COMP-THERM-002 (4.31 w/o ^{235}U, United States – PNL)
  - LEU-COMP-THERM-006 (2.6 w/o ^{235}U, Japan)
  - LEU-COMP-THERM-007 (4.74 w/o ^{235}U, France, Valduc)
  - LEU-COMP-THERM-022 (9.8 w/o ^{235}U, Russia - Kurchatov)
  - LEU-COMP-THERM-024 (9.8 w/o ^{235}U, Russia - Kurchatov)
  - LEU-COMP-THERM-039 (4.74 w/o ^{235}U, France, Valduc)

LEU-COMP-THERM Benchmarks



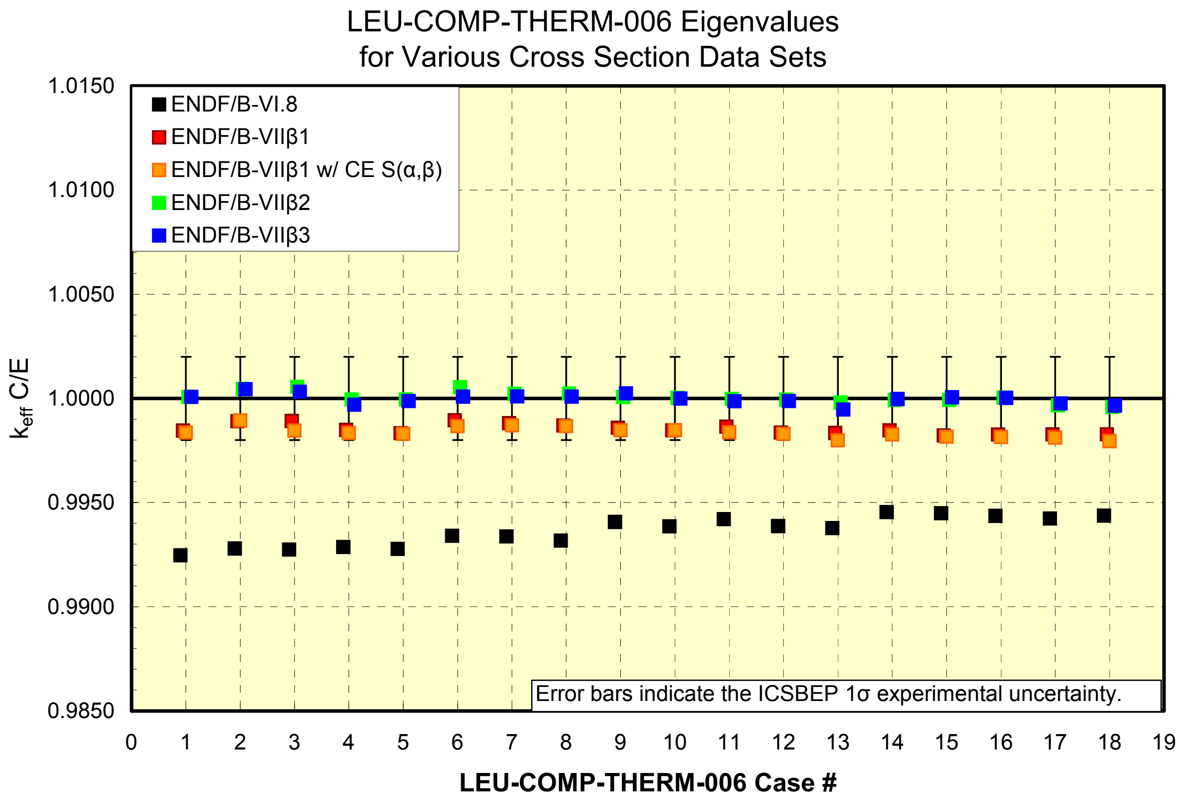
- LEU-COMP-THERM-001 (8 cases)
- 2.35 w/o $^{235}UO_2$
- 1.27 cm rod OD
- 1.118 cm fuel OD
- Rectangular, 2.03 cm rod pitch.
- Nearly square array of rods, or three nearly square clusters.

LEU-COMP-THERM Benchmarks



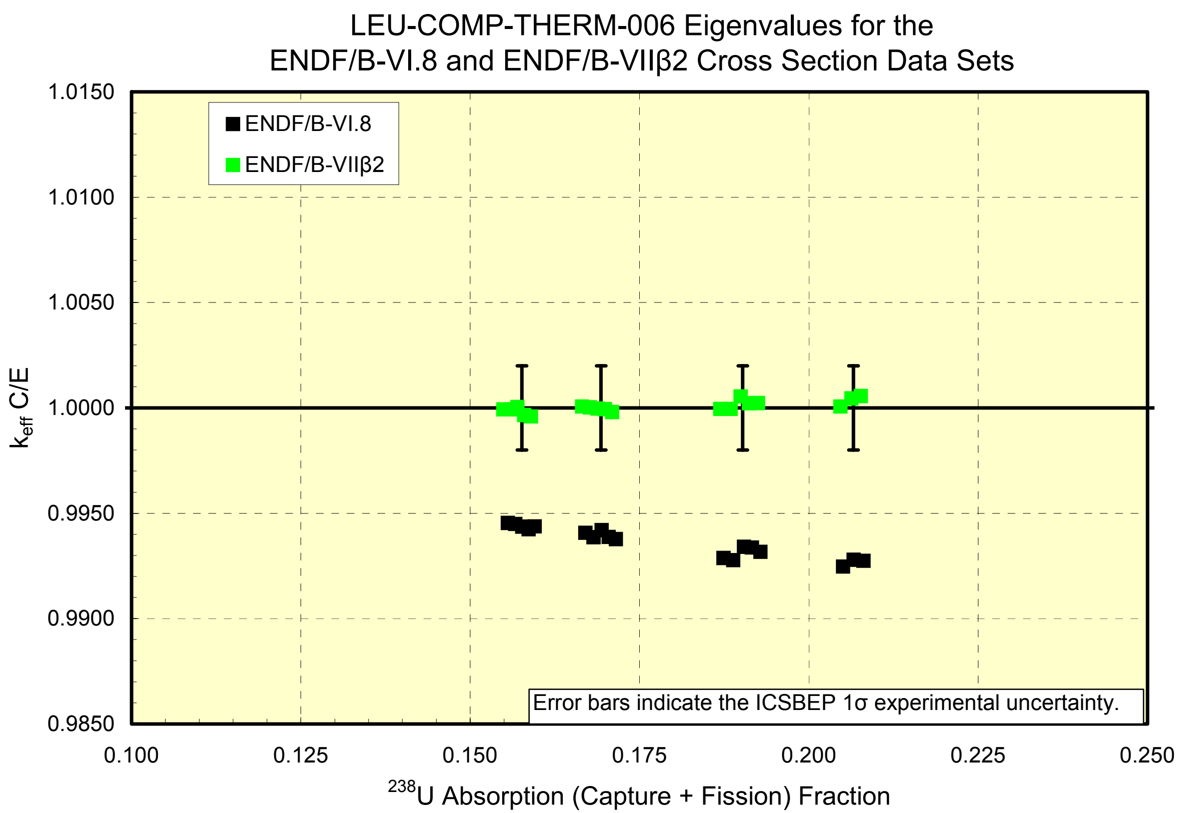
- LEU-COMP-THERM-002 (5 cases)
- 4.31 w/o $^{235}UO_2$
- 1.415 cm rod OD
- 1.265 cm fuel OD
- Rectangular, 2.54 cm rod pitch.
- Nearly square arrays, or three groups of either 15 x 8 (case 4) or 13 x 8 (case 5) clusters.
- Cases 4 & 5 are “base case” for LEU-COMP-THERM-010.

LEU-COMP-THERM Benchmarks



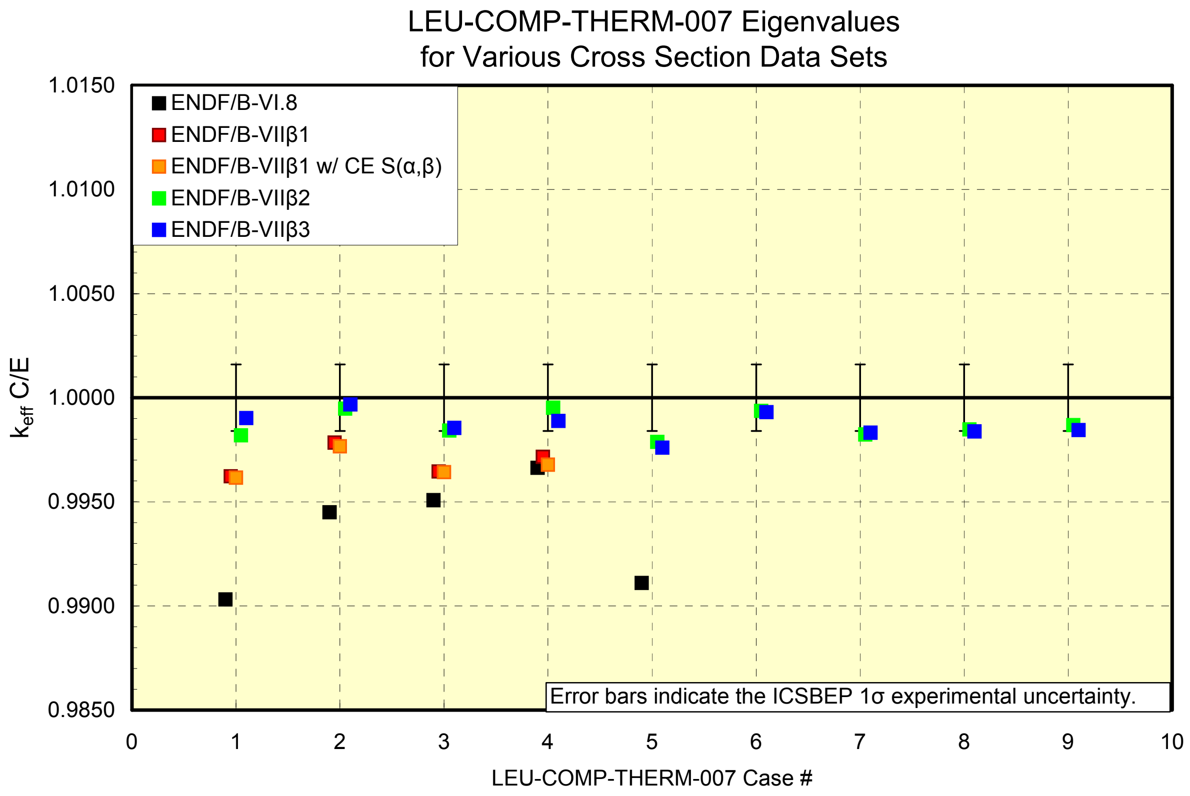
- LEU-COMP-THERM-006 (18 cases)
- 2.6 w/o $^{235}UO_2$
- 1.417 cm rod OD
- 1.25 cm fuel OD
- Square array, set on one of 1.849 cm, 1.956 cm, 2.150 cm or 2.293 cm pitch
- Array size is one of 15 x 15 up to 21 x 21.

LEU-COMP-THERM Benchmarks



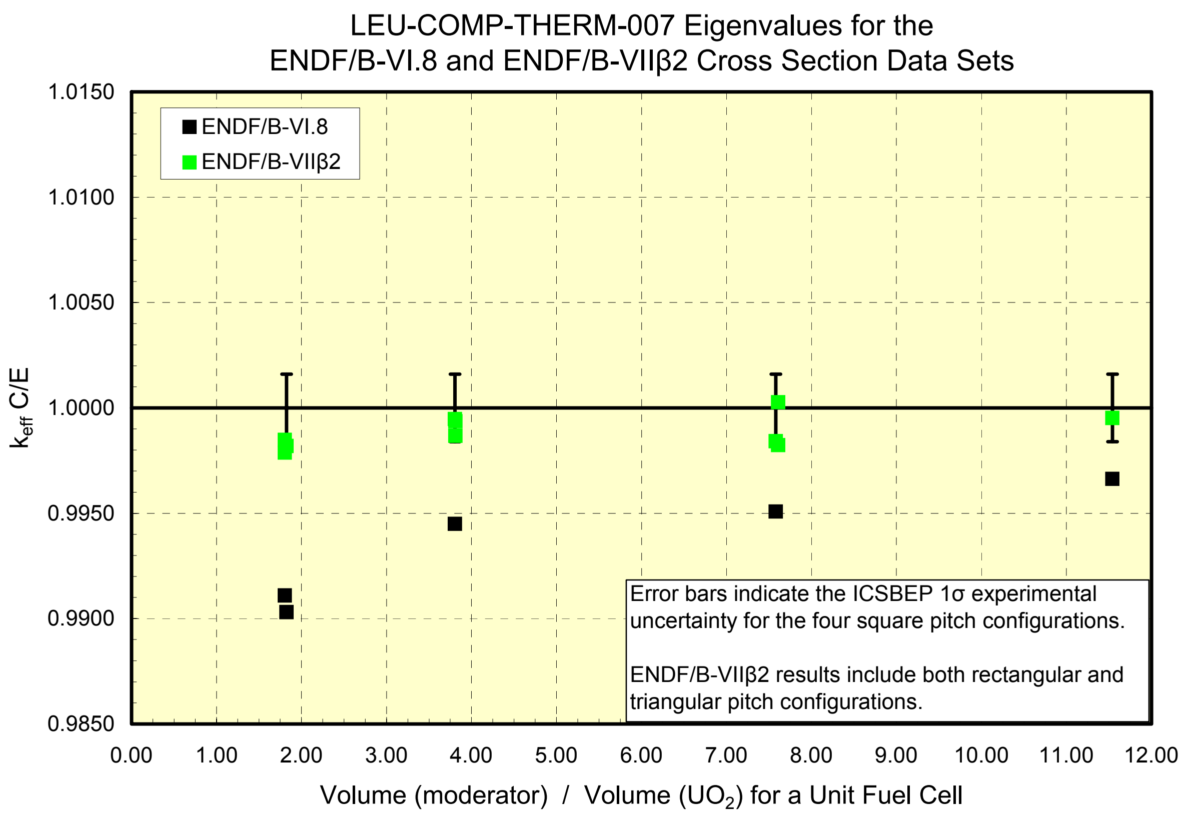
- LEU-COMP-THERM-006 (18 cases)
- 2.6 w/o $^{235}UO_2$
- 1.417 cm rod OD
- 1.25 cm fuel OD
- Square array, set on one of 1.849 cm, 1.956 cm, 2.150 cm or 2.293 cm pitch
- Array size is one of 15 x 15 up to 21 x 21.

LEU-COMP-THERM Benchmarks



- LEU-COMP-THERM-007 (10 cases)
- 4.738 w/o $^{235}UO_2$
- 0.94 cm rod OD
- 0.79 cm fuel OD
- Rectangular or hexagonal rod pitch, from ~1.26 cm to ~2.52 cm pitch.
- Square, Hexagonal and Cylindrical array patterns.

LEU-COMP-THERM Benchmarks



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- 4.738 w/o $^{235}UO_2$
- 0.94 cm rod OD
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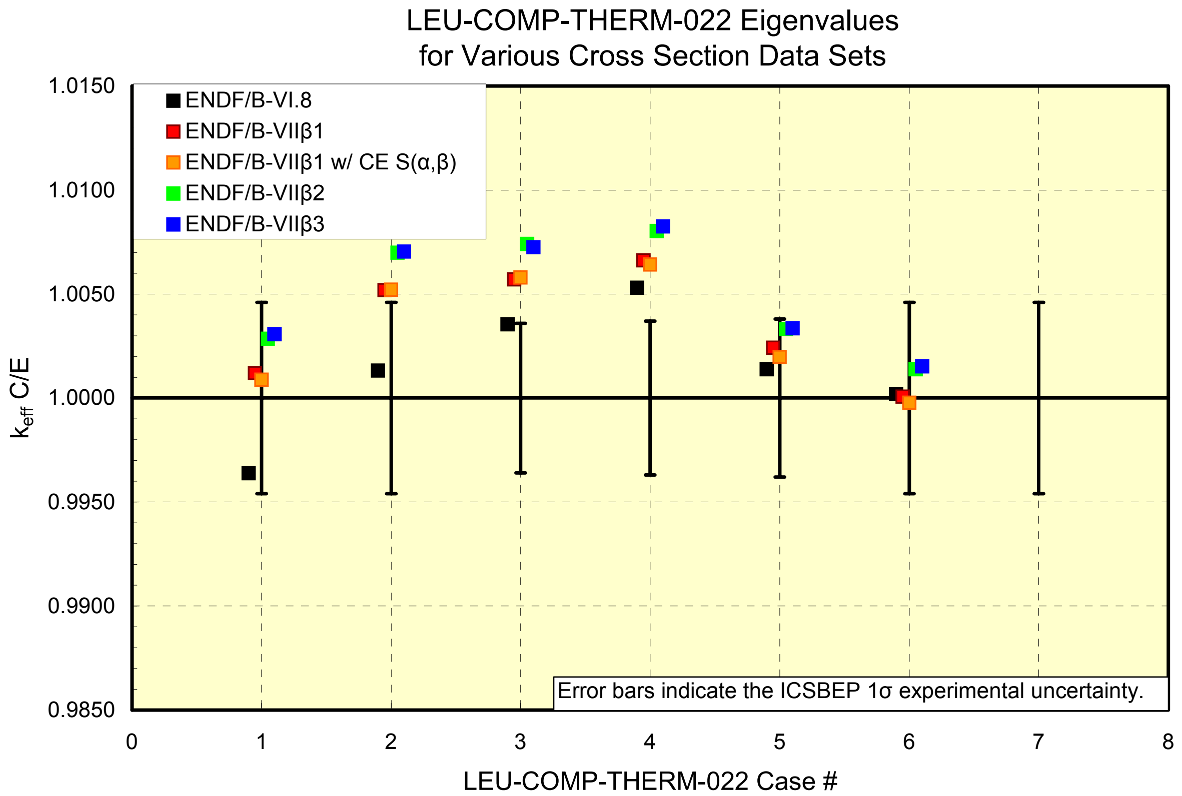
LEU-COMP-THERM Benchmarks



- LEU-COMP-THERM-022 (7 cases)
- 10 w/o $^{235}UO_2$
- 0.51 cm rod OD
- 0.416 cm fuel OD
- Hexagonal pitch, to produce a cylindrical shape.
- Rod pitch is 0.7cm, 0.8cm, 1.0cm, 1.22cm, 1.4cm, 1.83cm and 1.85 cm.

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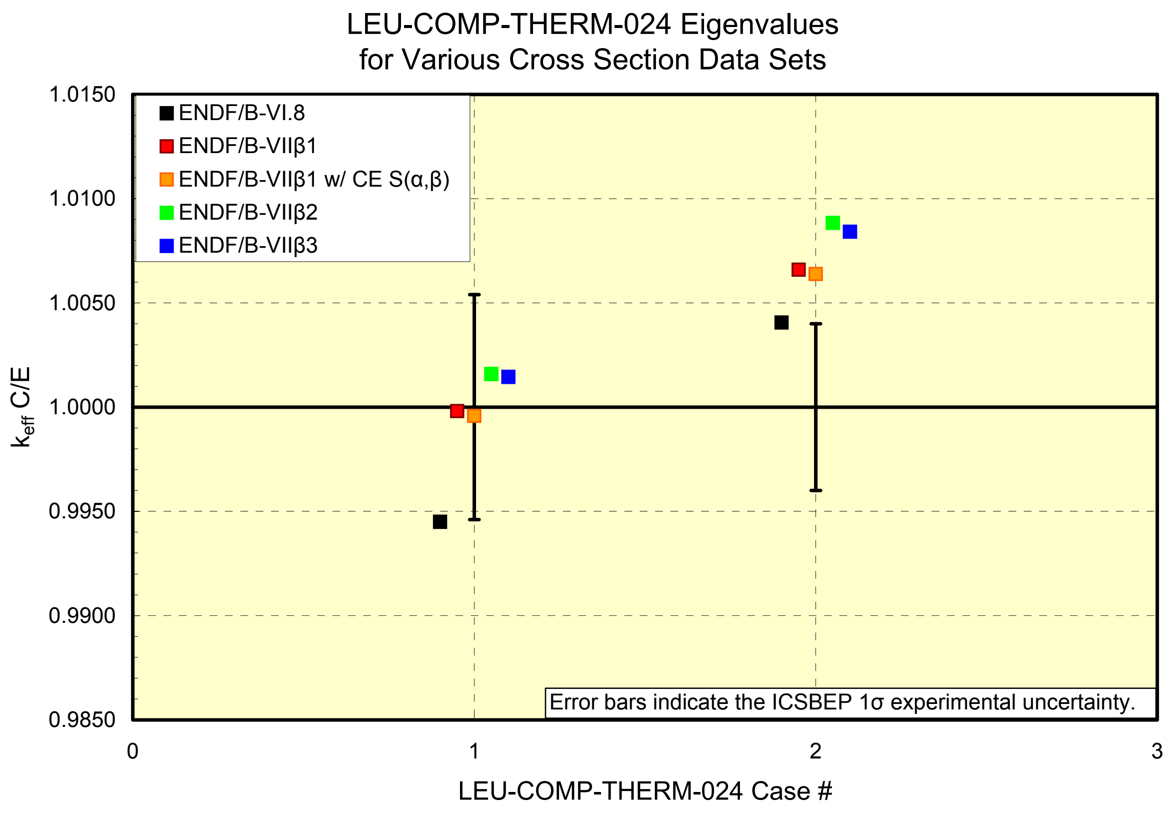
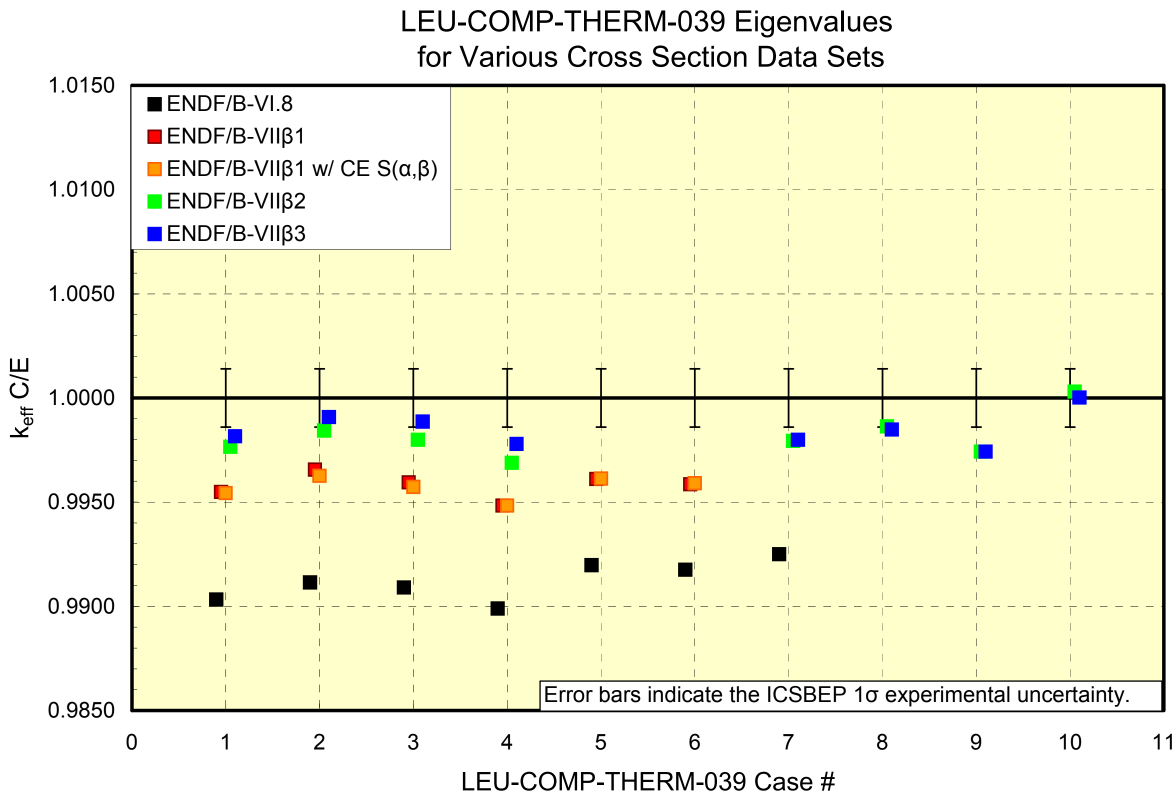
LEU-COMP-THERM Benchmarks



- LEU-COMP-THERM-024 (2 cases)
- 10 w/o $^{235}UO_2$
- 0.51 cm rod OD
- 0.416 cm fuel OD

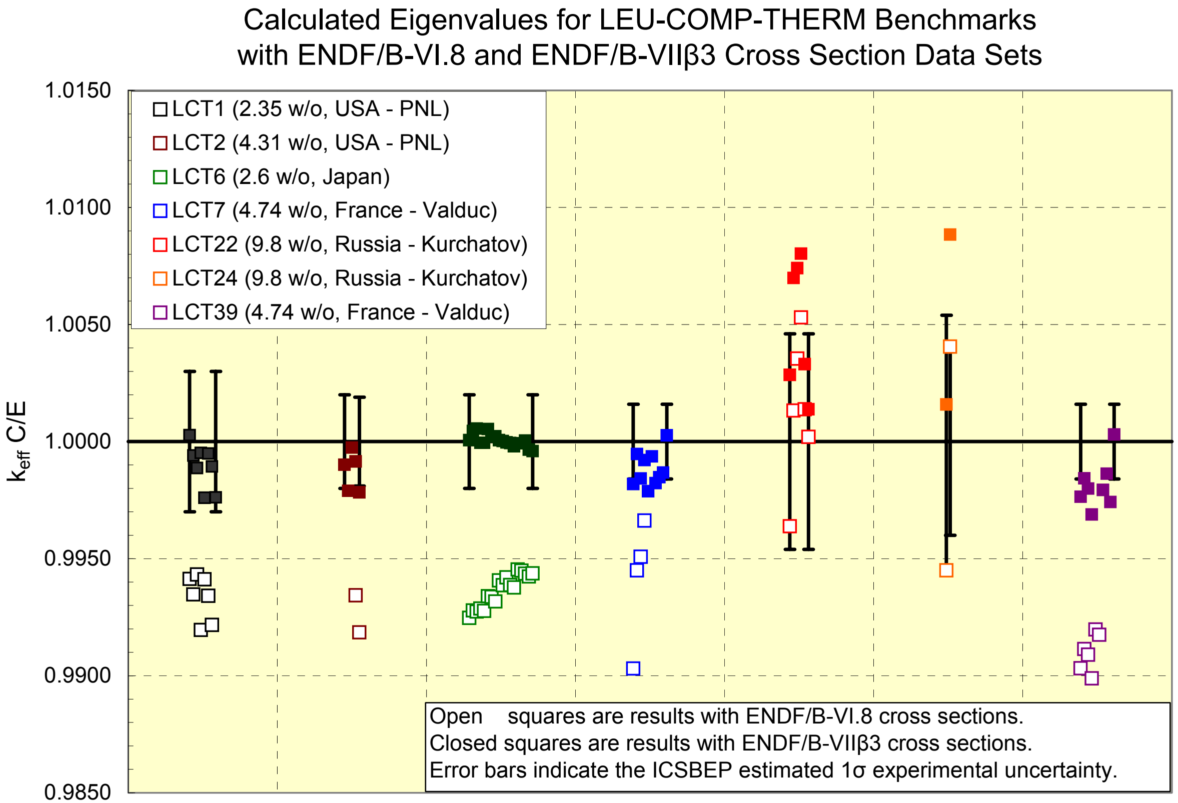
- Case 1 is nearly square rectangular array of 2625 rods set on a 0.62 cm pitch.
- Case 2 is long, narrow hexagonal array of 1297 rods set on a 0.62/√2 cm pitch.

LEU-COMP-THERM Benchmarks



- LEU-COMP-THERM-039 (10 cases)
- 4.738 w/o $^{235}UO_2$
- 0.94 cm rod OD
- 0.79 cm fuel OD
- Rectangular, 1.26 cm pitch.
- Square arrays (22 x 22 rods or 21 x 21 rods) with “water holes”.

LEU-COMP-THERM Benchmarks



- Summary of all LEU-COMP-THERM results.

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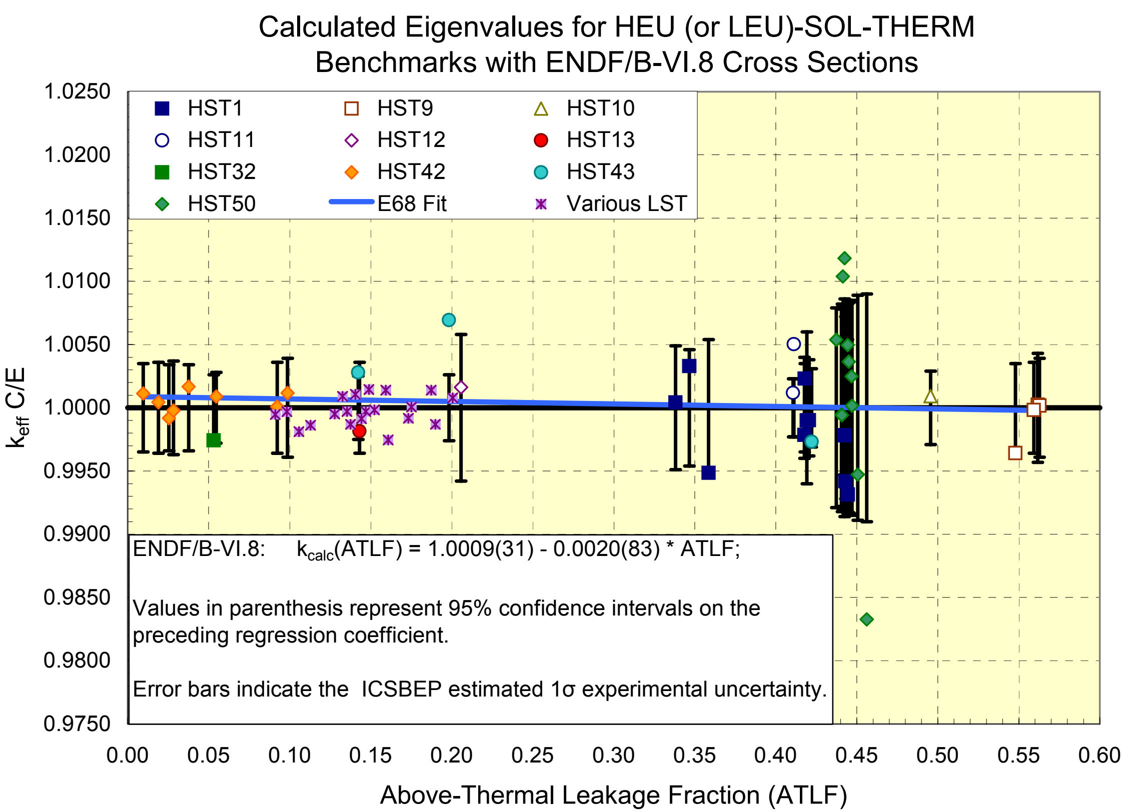
LEU-COMP-THERM Benchmarks

- LEU-COMP-THERM eigenvalues are generally low, by 500 pcm to 1000 pcm, with ENDF/B-VI.8 cross sections.
  - Average eigenvalue for 45 critical configurations from seven LEU-COMP-THERM evaluations is 0.9945 ± 0.0005 (mean) ± 0.0036 (population).
- LEU-COMP-THERM eigenvalues have increased to near unity with ENDF/B-VIIβ3 cross sections.
  - Average eigenvalue for 53 critical configurations from seven LEU-COMP-THERM evaluations is 1.0001 ± 0.0003 (mean) ± 0.0025 (population).

HEU-SOL-THERM Benchmarks

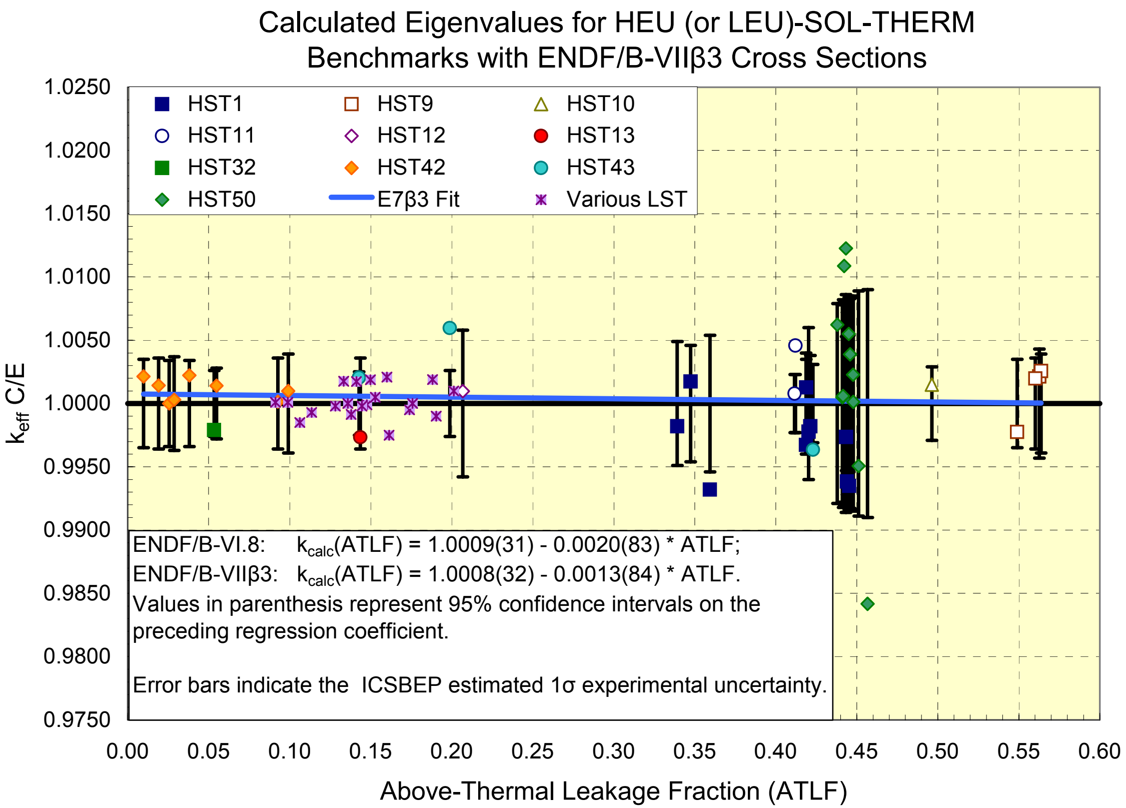
- Homogenous solution benchmark k_{eff} C/Es have been correlated against Above-Thermal Leakage Fraction (ATLF).
- The benchmark suite consists of 42 critical configurations defined in ten HEU-SOL-THERM evaluations.
  - All Rocky Flats and ORNL benchmarks used on past data testing efforts are now incorporated in the ICSBEP Handbook.
- HEU-SOL-THERM results are supplemented with calculations of Japanese LEU-SOL-THERM benchmarks.
  - LEU-SOL-THERM-004, -007, -020 & -021.
  - Bare and water reflected (cylindrical) assemblies are represented.

HEU-SOL-THERM Benchmarks



- HEU(&LEU)-SOL-THERM-xxx
- Experiments from ORNL, Rocky Flats and Japan.
- With ENDF/B-VI.8 Cross Sections:
  - ATLF Correlation shows no bias nor trend in k_{eff} C/E.
  - No bias nor trend versus other parameters:
    - ATFF,
    - Hydrogen abs,
    - Bare versus Reflected,
    - N versus F.

HEU-SOL-THERM Benchmarks

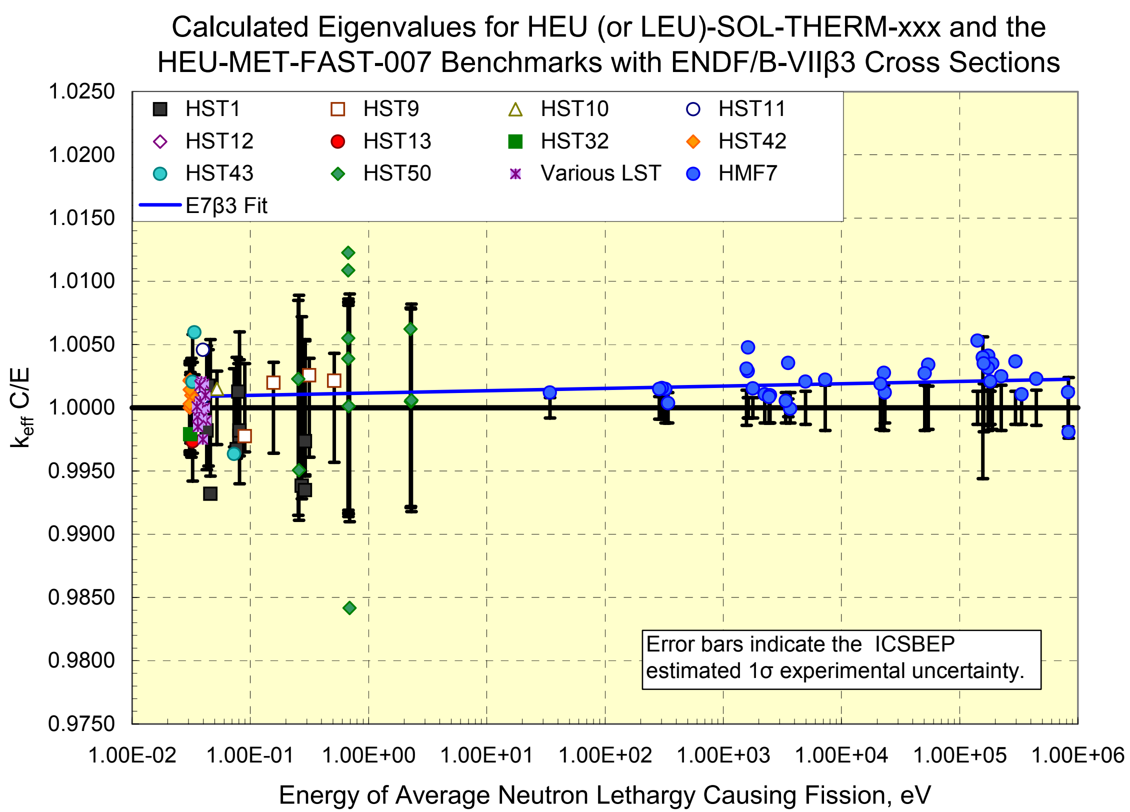


- HEU(&LEU)-SOL-THERM-xxx
- Experiments from ORNL, Rocky Flats and Japan.
- With ENDF/B-VIIβ3 Cross Sections:
  - ATLF Correlation shows no bias nor trend in k_{eff} C/E.
  - No bias nor trend versus other parameters
    - ATFF,
    - Hydrogen abs,
    - Bare versus Reflected,
    - N versus F.

HEU-SOL-THERM Benchmarks

- ENDF/B-VI.8 HST & LST k_{eff} C/E values are very accurate.
  - There is no trend with ATLF or other parameters (such as Above-Thermal Fission Fraction, ATFF; Hydrogen absorption fraction, …).
  - The average eigenvalue for 42 HST critical configurations from ten HST evaluations is 1.0002 ± 0.0007 (mean) ± 0.0046 (population); and from 62 HST & LST critical configurations is 1.0001 ± 0.0005 (mean) ± 0.0039 (population).
- ENDF/B-VIIβ3 HST & LST k_{eff} C/E values are also very accurate.
  - There is no trend with ATLF or other parameters.
  - The Above-Thermal Leakage Fraction (ATLF) correlation is insensitive to weighting of the individual HST eigenvalues.
  - The average eigenvalue for 42 HST critical configurations from ten HST evaluations is 1.0003 ± 0.0007 (mean) ± 0.0047 (population); and from 62 HST & LST critical configurations is 1.0003 ± 0.0005 (mean) ± 0.0039 (population).

HEU Benchmarks – Fast to Thermal

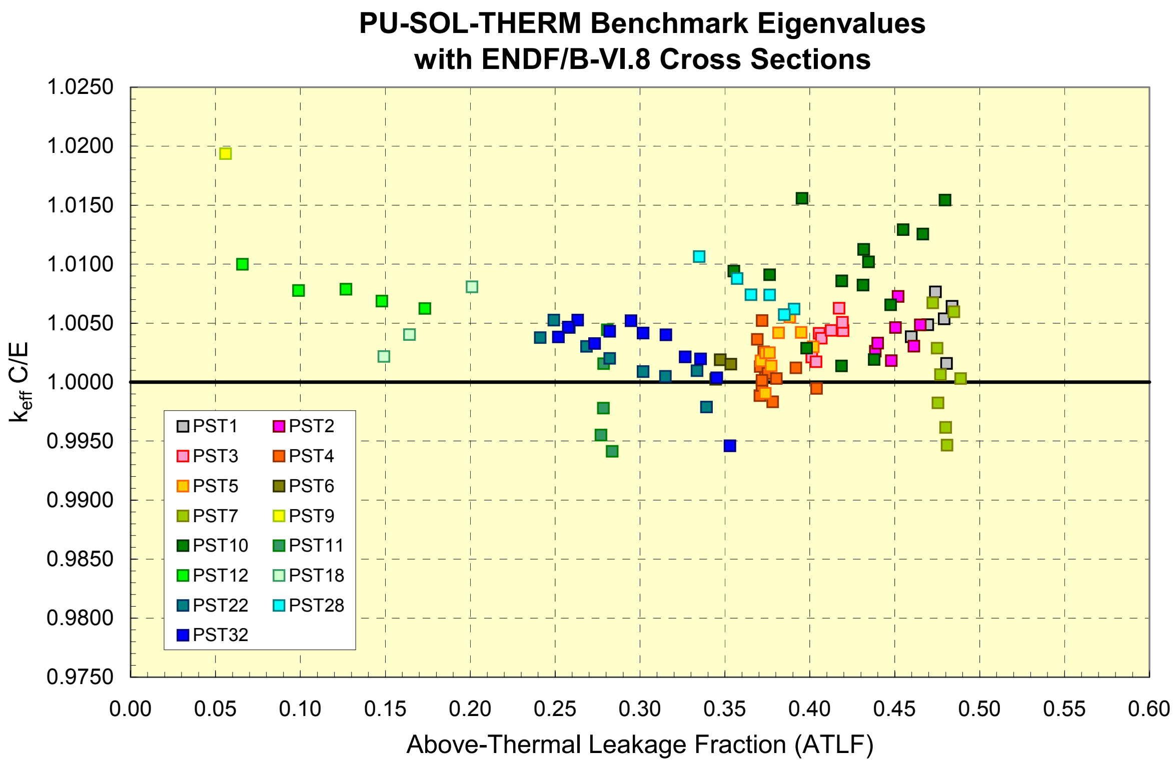


- The combination of HEU-MET-FAST-007 & the HEU-SOL-THERM-xxx benchmarks span the complete fission energy space.
- k_{eff} trend is close to but slightly greater than unity.
  - k_{eff}(EAL) = 1.0008(7) + 1.66(4.98) * 10^{-9} * EAL

PU-SOL-THERM Benchmarks

- We have calculated k_{eff} for a suite of nine PU-SOL-THERM evaluations (109 cases) with ENDF/B-VIIβ2 cross sections.
  - Replicate calculations have been performed for 26 configurations with ENDF/B-VIIβ3 cross sections.
    - The average difference in k_{eff} is 2 pcm.
  - PU-SOL-THERM-001 (11.5” diameter water reflected sphere)
  - PU-SOL-THERM-002 (12” diameter water reflected sphere)
  - PU-SOL-THERM-003 (13” diameter water reflected sphere)
  - PU-SOL-THERM-004 (14” diameter water reflected sphere)
  - PU-SOL-THERM-005 (more 14” diameter …)
  - PU-SOL-THERM-006 (15” diameter water reflected sphere)
  - PU-SOL-THERM-009 (48” diameter sphere, bare)
  - PU-SOL-THERM-011 (16”, 18” diameter spheres, bare)
  - PU-SOL-THERM-018 (24” diameter water reflected cylinder)
    - Published in the 2006 edition of the ICSBEP Handbook)

PU-SOL-THERM Benchmarks – ENDF/B-VI.8



- PU-SOL-THERM-xxx
  - USA & French experiments.
  - 15 evaluations, 109 configurations.
  - Benchmark uncertainties range from 0.0012 to 0.0058.
- Highly thermal
  - 82% to 99% thermal fission.
- k_{eff} C/E ranges from 0.9941 to 1.0194.
- Average k_{eff} C/E is 1.0039.
- Population standard deviation is 0.0043.

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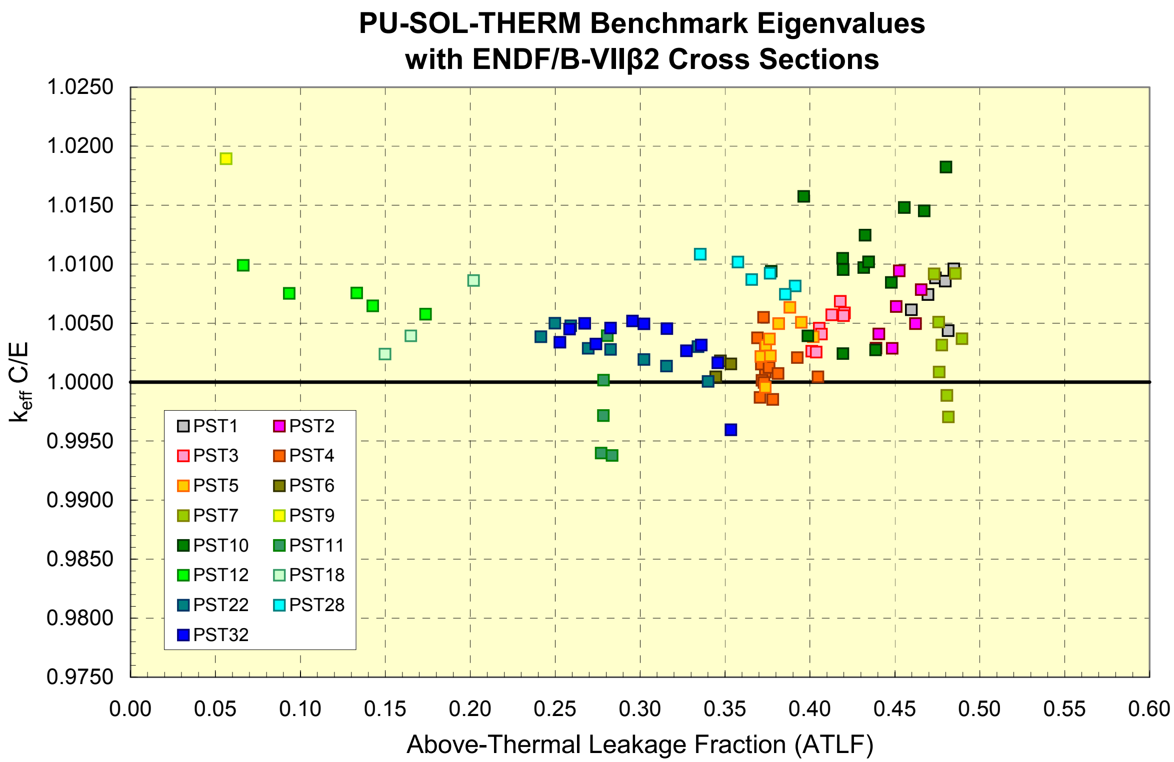
PU-SOL-THERM Benchmarks – ENDF/B-VIIβ2



- PU-SOL-THERM-xxx
  - USA & French experiments.
  - 15 evaluations, 109 configurations.
  - Benchmark uncer-tainties range from 0.0012 to 0.0058.
- Highly thermal
  - 82% to 99% thermal fission.
- k_{eff} C/E ranges from 0.9938 to 1.0189.
- Average k_{eff} C/E is 1.0048.
- Population standard deviation is 0.0044.

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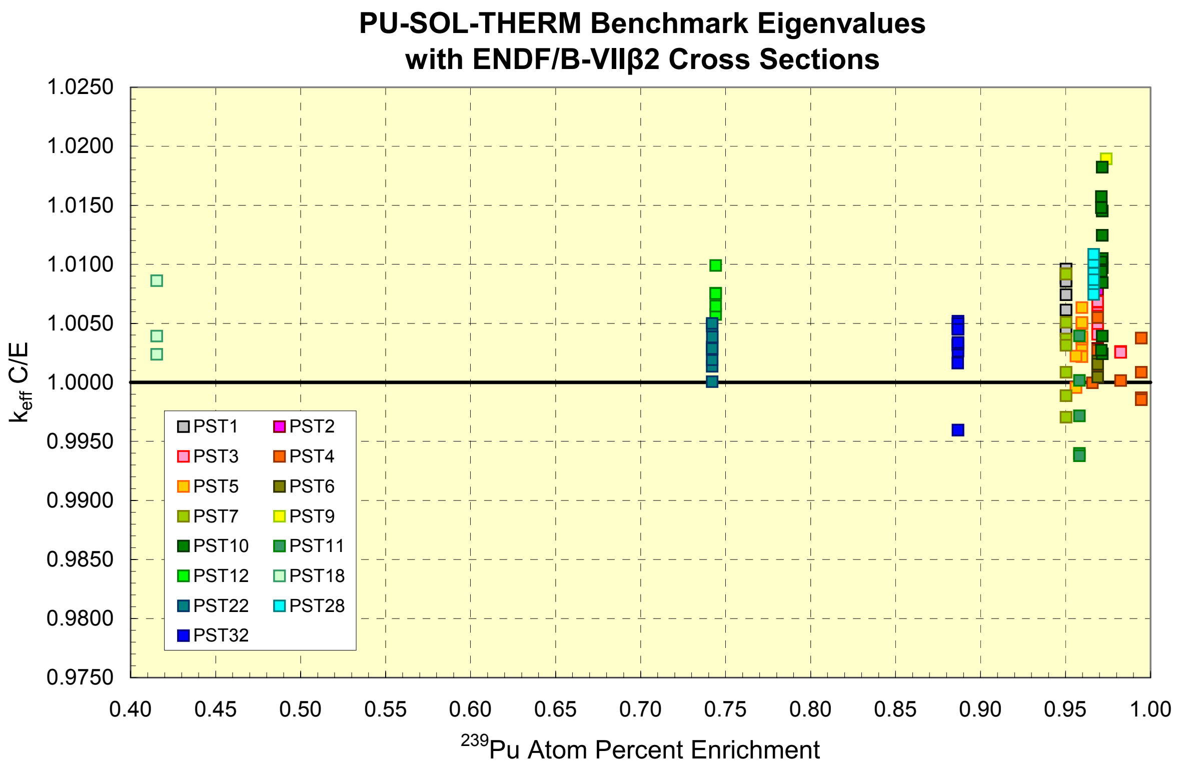
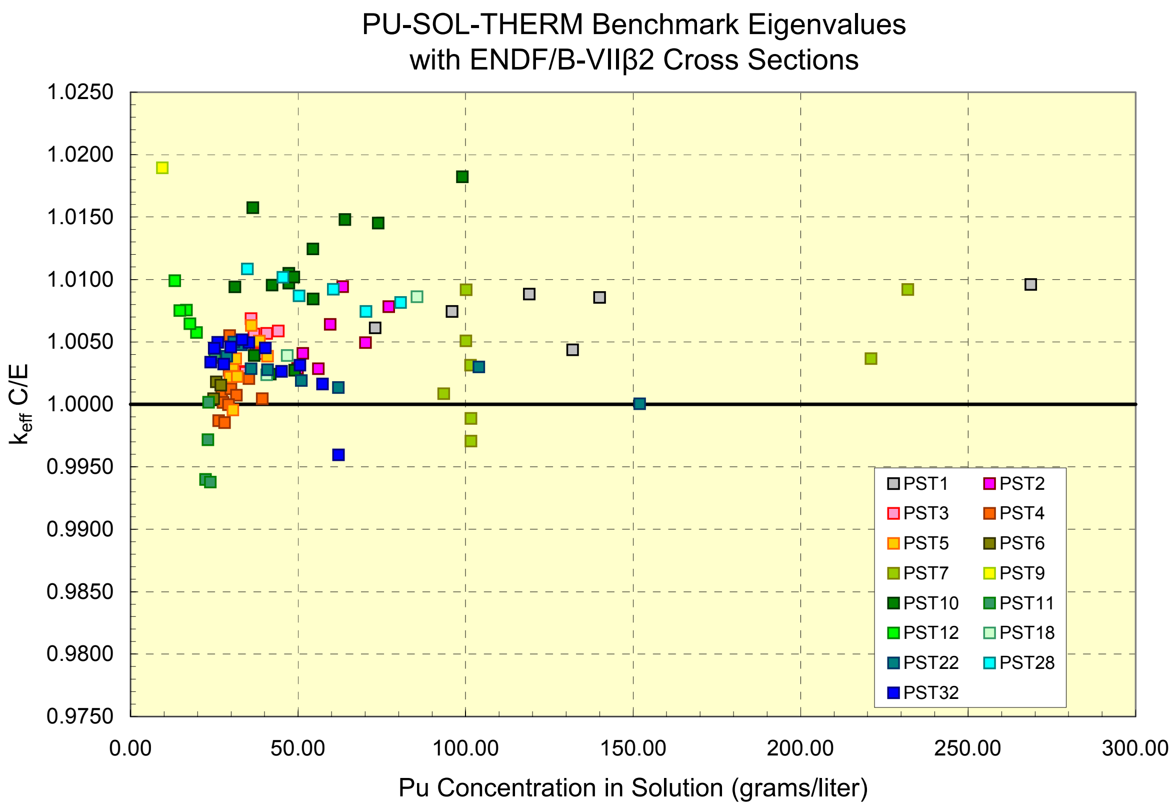
PU-SOL-THERM Benchmarks – ENDF/B-VIIβ2



- PU-SOL-THERM-xxx
- PST18 is new in 2006.
- k_{eff} C/E for PST18 are in line with those obtained with higher ^{239}Pu enrichments.
- Therefore, no k_{eff} C/E trend with ^{239}Pu enrichment.

PU-SOL-THERM Benchmarks – ENDF/B-VIIβ2



- PU-SOL-THERM-xxx
- No k_{eff} C/E trend with Pu concentration.
- Not shown, but no k_{eff} C/E trend with Above-Thermal Fission Fraction (ATFF).
- Not shown, but no k_{eff} C/E trend with ^{239}Pu absorption fraction.
- Not shown, but no k_{eff} C/E trend with Neutron Lethargy.

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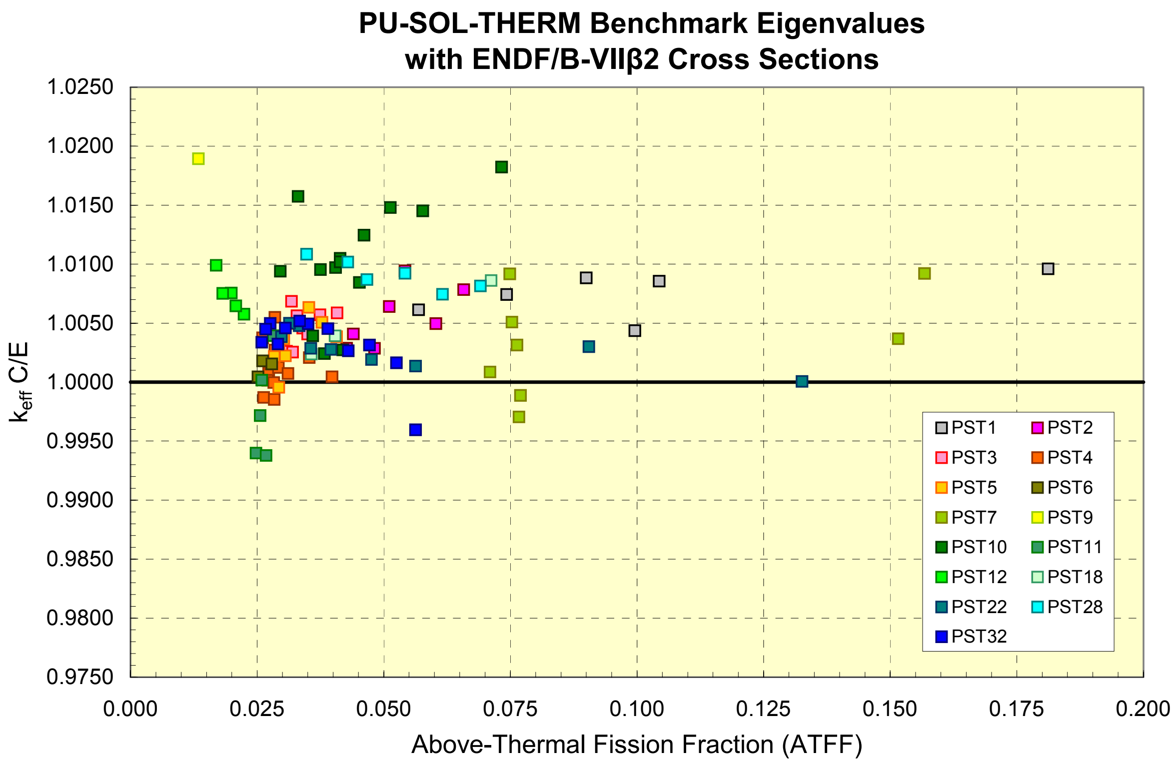
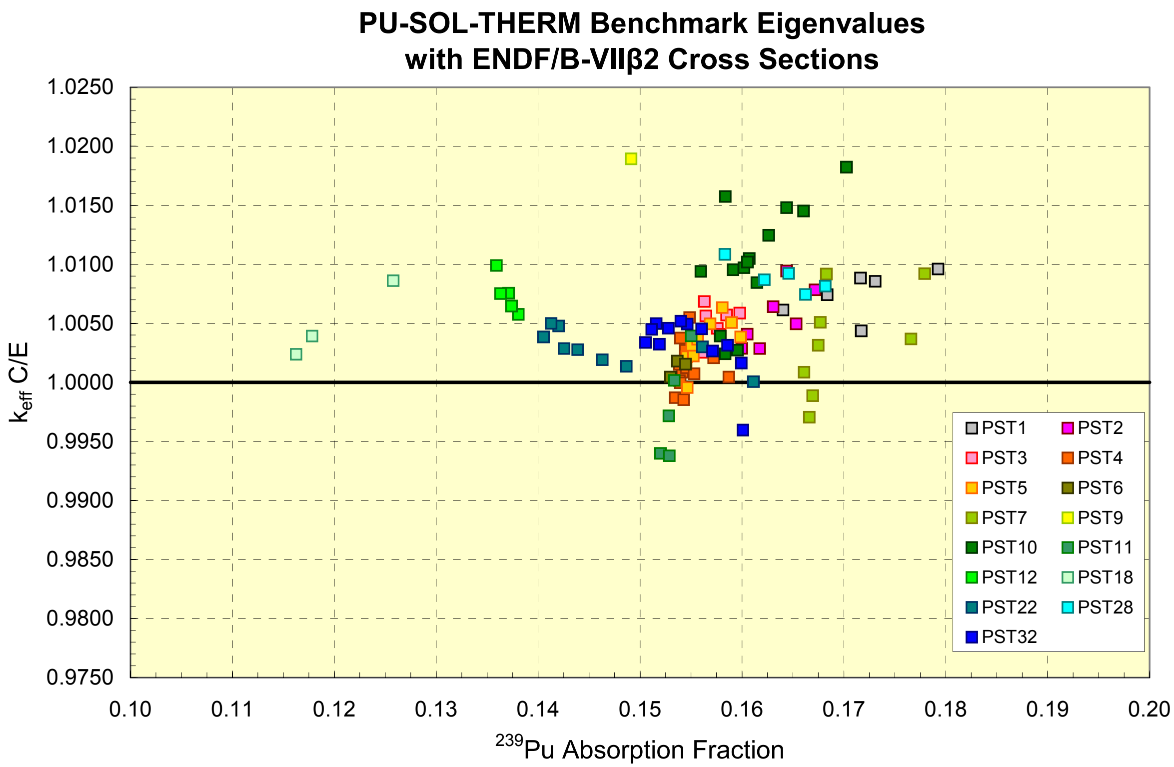
PU-SOL-THERM Benchmarks – ENDF/B-VIIβ2

- PU-SOL-THERM-xxx
- No k_{eff} C/E trend with Above-Thermal Fission Fraction (ATFF).

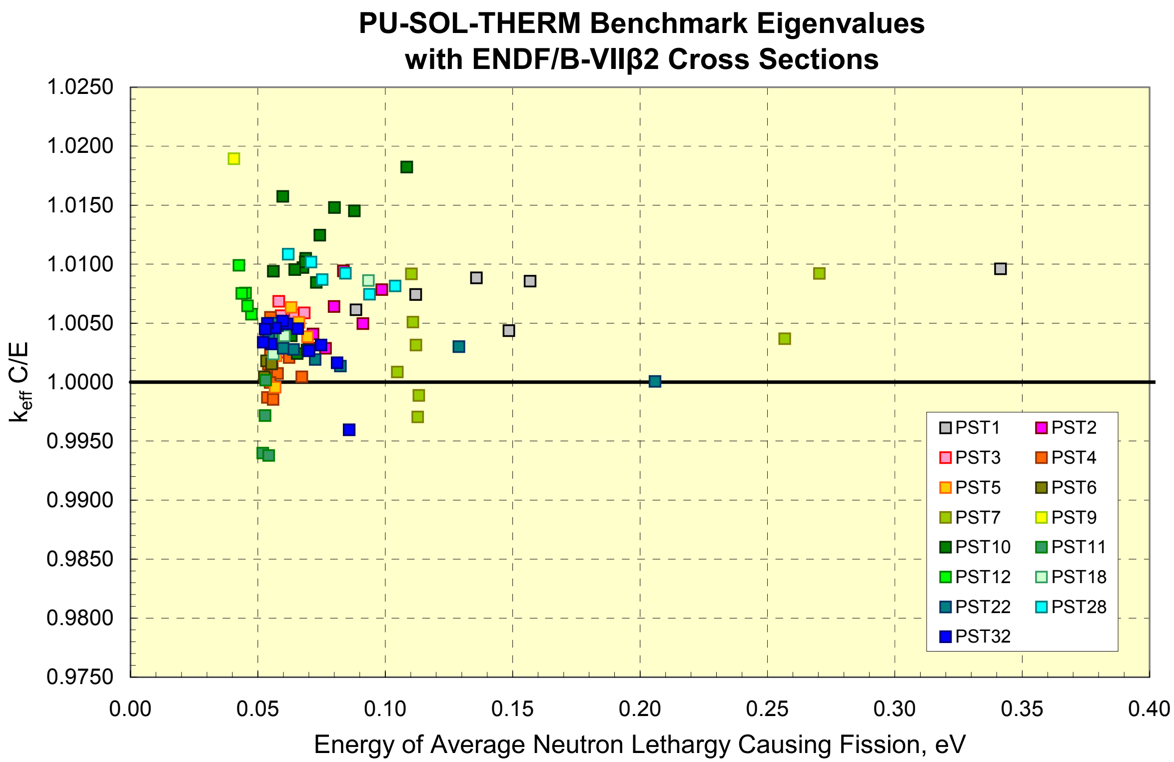


PU-SOL-THERM Benchmarks – ENDF/B-VIIβ2



- PU-SOL-THERM-xxx
- No k_{eff} C/E trend with ^{239}Pu absorption fraction.

PU-SOL-THERM Benchmarks – ENDF/B-VIIβ2



- PU-SOL-THERM-xxx
- No k_{eff} C/E trend with Neutron Lethargy.

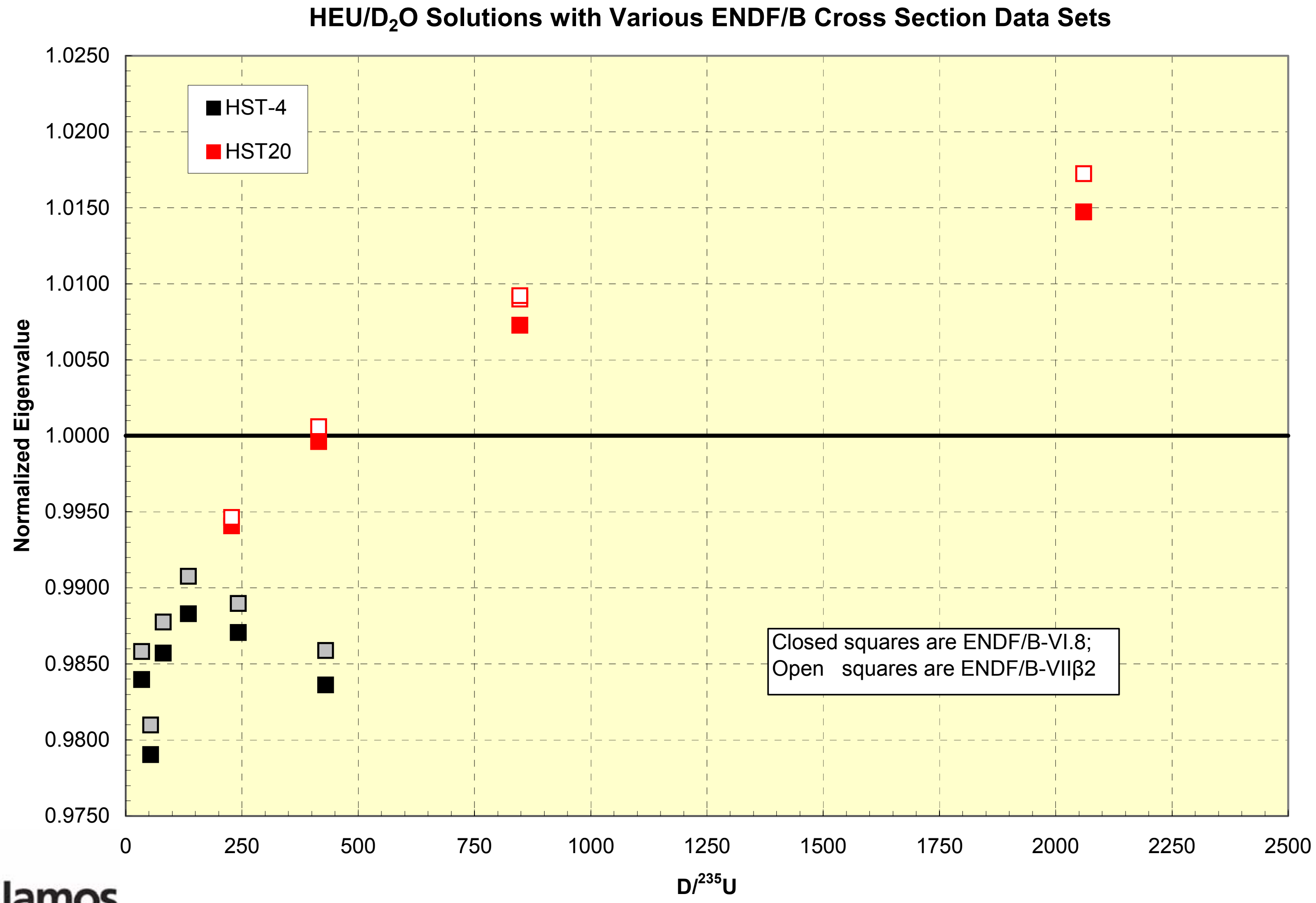
PU-SOL-THERM Benchmarks

- Little to no changes have been made to low energy ^{239}Pu cross sections for ENDF/B-VII.
- Modest changes in hydrogen and oxygen cross sections result in a small (~0.1%) increase in k_{eff} C/E.
- Additional work seemed to be needed to improve calculations of thermal Pu system eigenvalues.

HEU/D_2O Benchmarks

- HEU-SOL-THERM-004
  - Heavy water reflected benchmarks
- HEU-SOL-THERM-020
  - Heavy water unreflected benchmarks
- Significant biases are observed in calculated eigenvalues for both ENDF/B-VI.8 and ENDF/B-VIIβ2 cross section data sets.
  - Unreflected benchmark eigenvalues exhibit an increasing trend with increasing $D/^{235}U$.

HEU/D_2O Benchmarks



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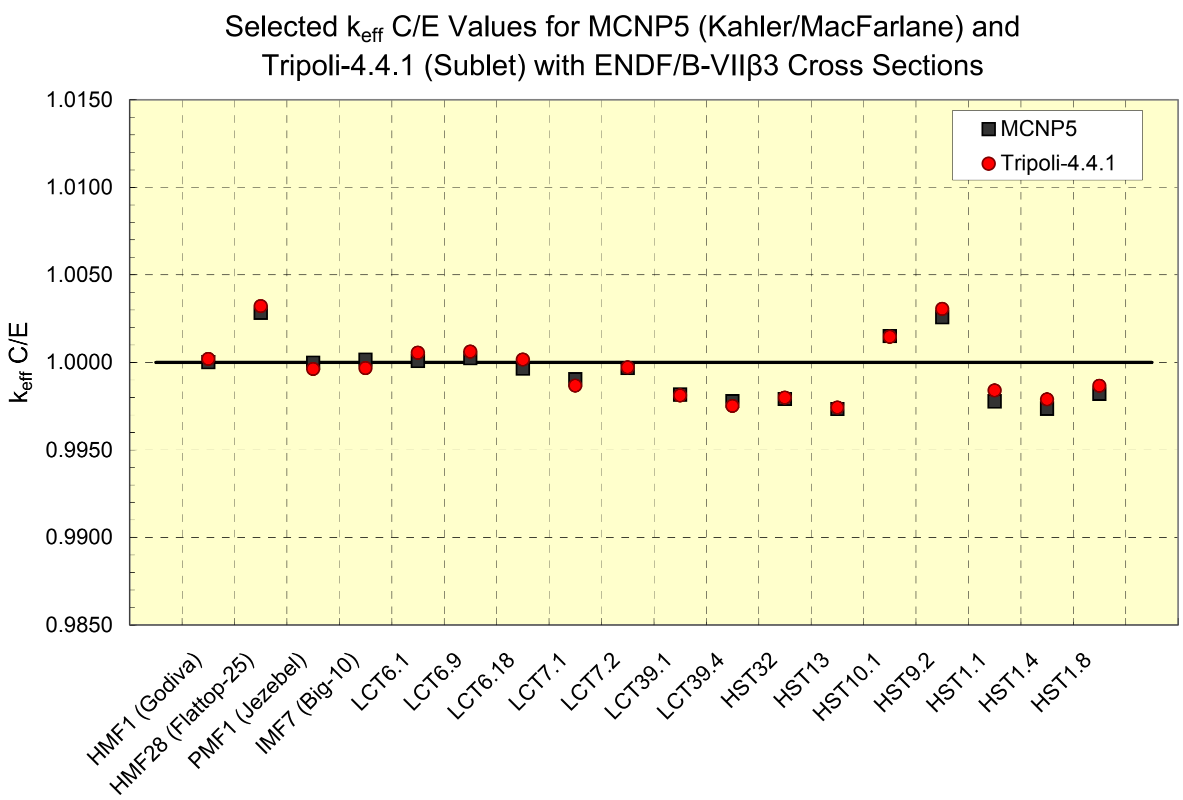
Comparison Between MCNP5 (LANL) and Tripoli 4.4.1 (Sublet)

- Excellent agreement in calculated eigenvalues is observed for MCNP5 and Tripoli-4.4.1 for a variety of benchmarks.
  - Previous differences in LEU-COMP-THERM-006 have been attributed to slightly different fuel compositions.
  - Previous differences in selected HEU-SOL-THERM-001 eigenvalues are attributed to different normalizations.

Comparison Between MCNP5 (LANL) and Tripoli 4.4.1 (Sublet)



- Excellent agreement observed in calculated eigenvalues for all benchmark types.
- MCNP/Tripoli k_{eff} for unmoderated systems is 0.9999.
- MCNP/Tripoli k_{eff} for LEU-COMP-THERM systems is 1.0001.
- MCNP/Tripoli k_{eff} for LEU-COMP-THERM systems is 1.0003.