KAPL Analyses of Proposed ENDF/B-VII (β2)Nuclear Data

TH Trumbull
CR Lubitz

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Overview

- Testing of the LANL proposed ^{16}O.
- Testing of the ENDF/B-VII(β2) thermal scattering data for H-H_2O.
- Sensitivity study of SG23 Zirconium.

New LANL ^{16}O Data

- PR Page (LANL) reduced the ENDF/B-VI.8 ^{16}O (n,α) cross section by 32% in the range of 2.4 MeV to 8.9 MeV.
- Total cross sections were preserved by increasing the elastic scattering cross section.
- Analyses performed using a suite of 37 HST's:
  - HST01.1-10, HST09.1-4, HST10.1-4, HST11.1-2, HST12, HST13.1-4, HST32, HST42.1-8, HST43.1-3.

HST Ensemble-Averages

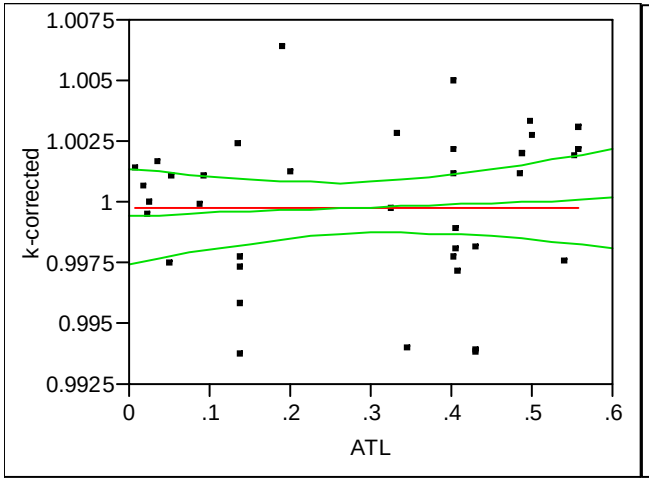
Comparisons of Various Parameters for ENDF68O16 and PAGEO16 RACER Calculations.

(95% CI on eigenvalues are on the order of 0.0002 Δk)

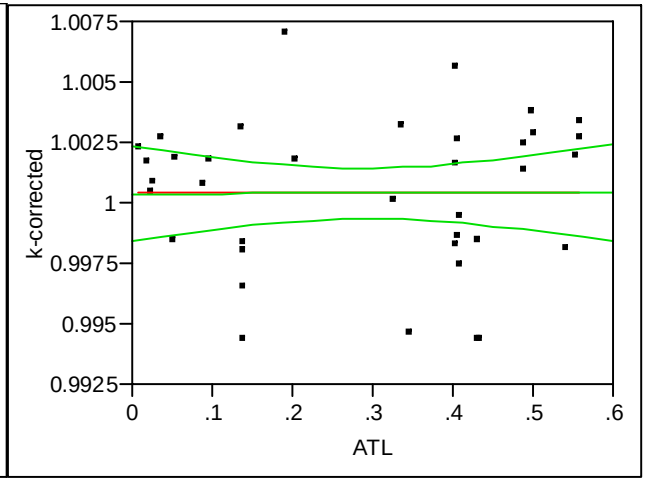
Parameter	ENDF68O16	PAGEO16	PAGEO16 - ENDF68O16
k-corrected	0.99980	1.00043	0.00063
Total Leakage	0.29955	0.29991	0.00036
H Abs.	0.19413	0.19429	0.00016
O Abs.	0.00305	0.00220	-0.00084
U235 Abs.	0.49015	0.49046	0.00031
U235 Fis.	0.41044	0.41070	0.00026
U235 Cap.	0.07971	0.07976	0.00005
U235 Cap. / Fis.	0.19422	0.19421	0.00000
U238 Abs.	0.00170	0.00170	0.00000

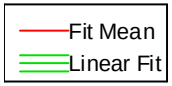
Linear Regression Analysis

ENDF6.8 ^{16}O



Page ^{16}O





k(ATL) = 0.9993(10) + 0.0015(28) * ATL

k(ATL) = 1.0004(10) + 0.0001(28) * ATL

ENDF/B-VII(β2) H-H_2O Thermal Data

- Analyzed using suite of 37 HST's. ENDF6.5 used for everything but H-H_2O.

HST Ensemble-Averages

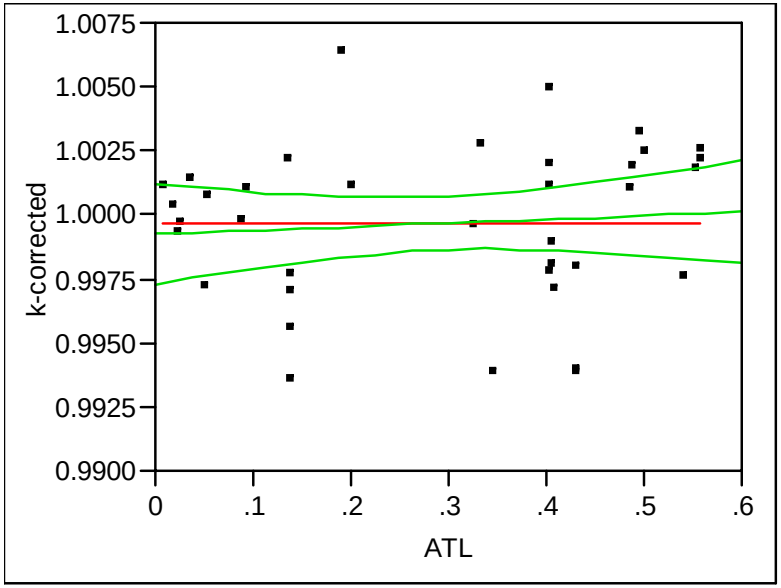
Comparisons of Various Parameters for ENDF65 and ENDF/B-VII(β2) Thermal Data RACER Calculations.

(95% CI on eigenvalues are on the order of 0.0002 Δk)

Parameter	ENDF6.5	β2	β2 - ENDF6.5
k-corrected	0.99971	0.99921	-0.00050
Total Leakage	0.29985	0.29947	0.00038
H Abs.	0.19411	0.19401	-0.00010
O Abs.	0.00319	0.00319	0.00000
U235 Abs.	0.49011	0.48984	-0.00027
U235 Fis.	0.41041	0.41020	-0.00021
U235 Cap.	0.07971	0.07964	-0.00007
U235 Cap. / Fis.	0.19422	0.19415	-0.00006
U238 Abs.	0.00170	0.00170	0.00000

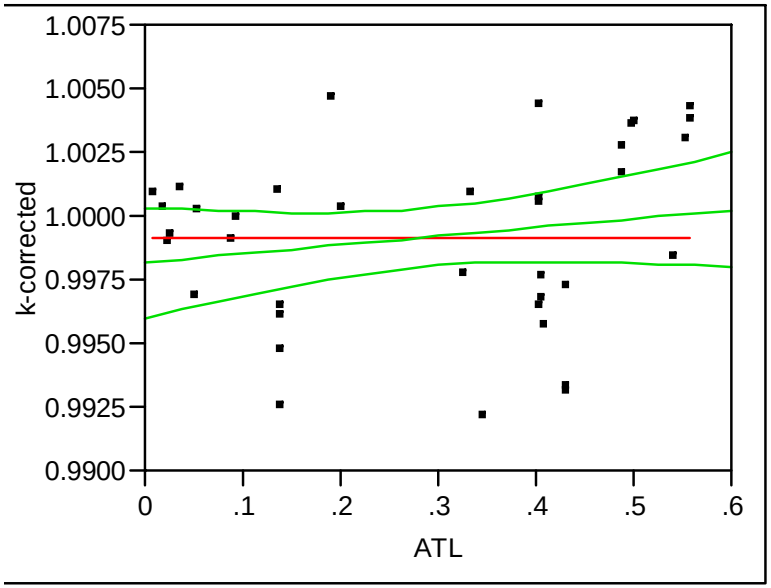
Linear Regression Analysis

ENDF6.5 H-H_2O



k(ATL) = 0.9993(10) + 0.0015(28) * ATL

β2 H-H2O



k(ATL) = 0.9982(11) + 0.0034(31) * ATL

Summary and Conclusions

- Mixed effect on reactivity from the β2 H-H2O thermal data.
  - Low leakage, bare benchmark thermal leakage is increased, reducing eigenvalue.
  - High leakage, reflected benchmarks show greater reflector savings and increased eigenvalue.
- HST testing supports the proposed ^{16}O changes and is neutral on the H-H_2O data.

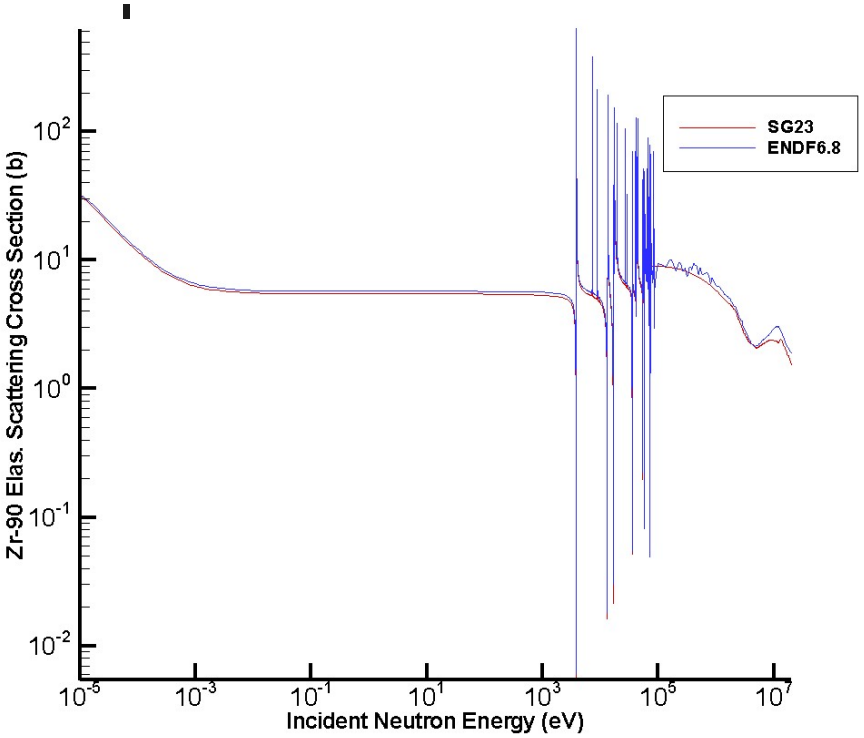
SG23 Zirconium

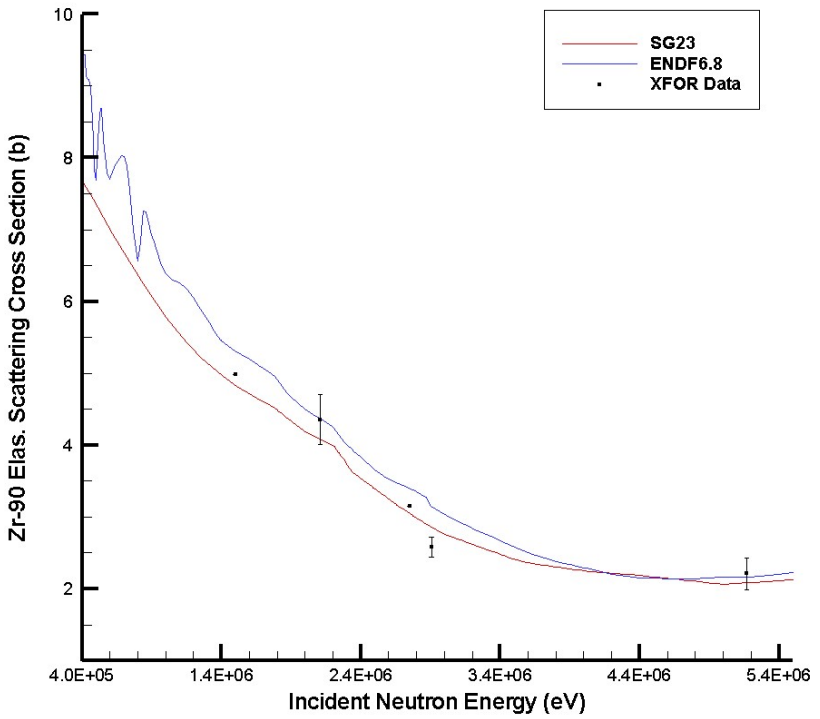
- The proposed WPEC SG23 zirconium cross sections were tested on some ICSBEP benchmarks and other assemblies.
- A loss of reactivity in thermal reactors, relative to earlier data sets, was mainly due to a lower elastic scattering cross section.
- It appears that some adjustment to the SG23 zirconium cross sections would be desirable.
- Additional zirconium-sensitive benchmarks are needed.

Cross Section Sensitivity Study, I

- First round of perturbations:
  - 27 versions of elemental zirconium created
    - -5%, 0, +5% changes to σ_D, σ_s, and P1 scattering moment over the entire energy range.
  - Thermal benchmark calculations showed reactivity most sensitive to σ_s changes.
    - Increase in σ_s provides increase in reactivity.
- Second round of perturbations:
  - Change the elastic scattering cross section by +5% and +10% for various isotopes and energy ranges.

^{90}Zr Elastic Cross Section Comparisons



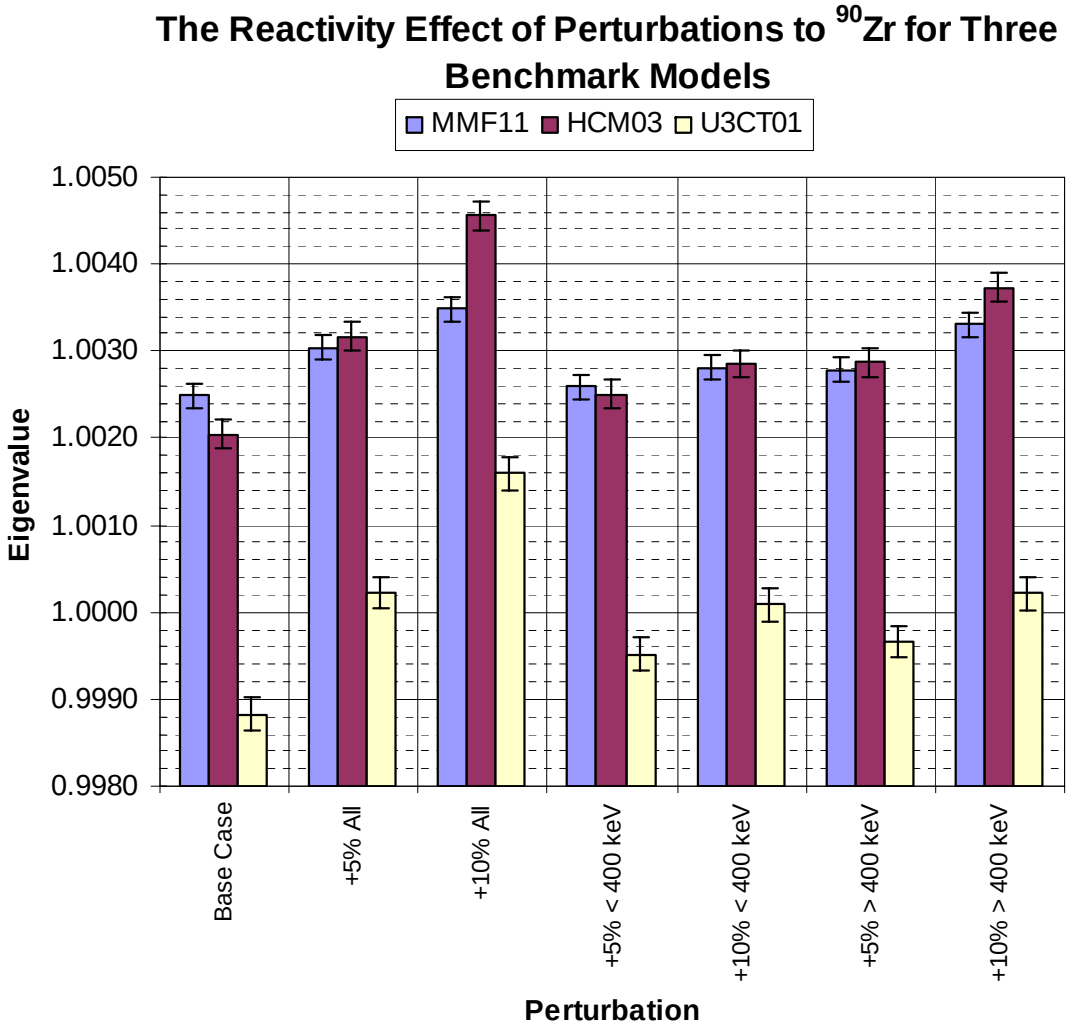


XFOR Data: BET1976, VIR1973, KTY1977, KTY1974

Cross Section Sensitivity Study, II

- Sensitivity study of SG23 zirconium isotopes determined that the main effect was from ^{90}Zr.
- Six modified versions of SG23 ^{90}Zr were made:
  - +5% and +10% changes to σ_n over the entire energy range,
  - +5% and +10% changes to σ_n from 1.0×10^{-5} eV to top of URR,
  - +5% and +10% changes to σ_n from top of URR to 20.0 MeV.
- Perturbed cross sections were tested on the following ICSBEP benchmarks: HCI05, MMF11, HCM03, U3CT01, LCT09.
  - HCI05 (KBR-16 k-inf. experiment) and LCT09 (thin zr absorber plates) were insensitive to the perturbations.
  - MMF11 (ZPPR21B), HCM03 (Config. 1), and U3CT01 (SB-1) demonstrate an effect.

Cross Section Sensitivity Study, II (continued)



	Increase in Reactivity for Model		
Perturbation	MMF11	HCM03	U3CT01
+5% All	0.00055	0.00112	0.00140
+10% All	0.00100	0.00252	0.00278
+5% < 400 keV	0.00010	0.00046	0.00070
+10% < 400 keV	0.00033	0.00081	0.00127
+5% > 400 keV	0.00030	0.00083	0.00084
+10% > 400 keV	0.00082	0.00168	0.00139

Summary and Conclusions

- Increased elastic scattering increases benchmark reactivity:
  - "Good" for thermal benchmarks (U3CT01)
  - "Bad" for fast (MMF11 and HCM03).
- Additional work is required to identify and analyze additional benchmarks that are sensitive to the perturbations.
- Currently, no specific recommendation for SG23 zirconium adjustments.