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Critical Benchmark Results for a Modified ^{16}O Evaluation

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Background

- Compelling evidence suggests ^{16}O elastic scattering cross section in current evaluations is 3% too high

- *What would the effect of reducing scattering by 3% be on eigenvalues of critical benchmarks?*

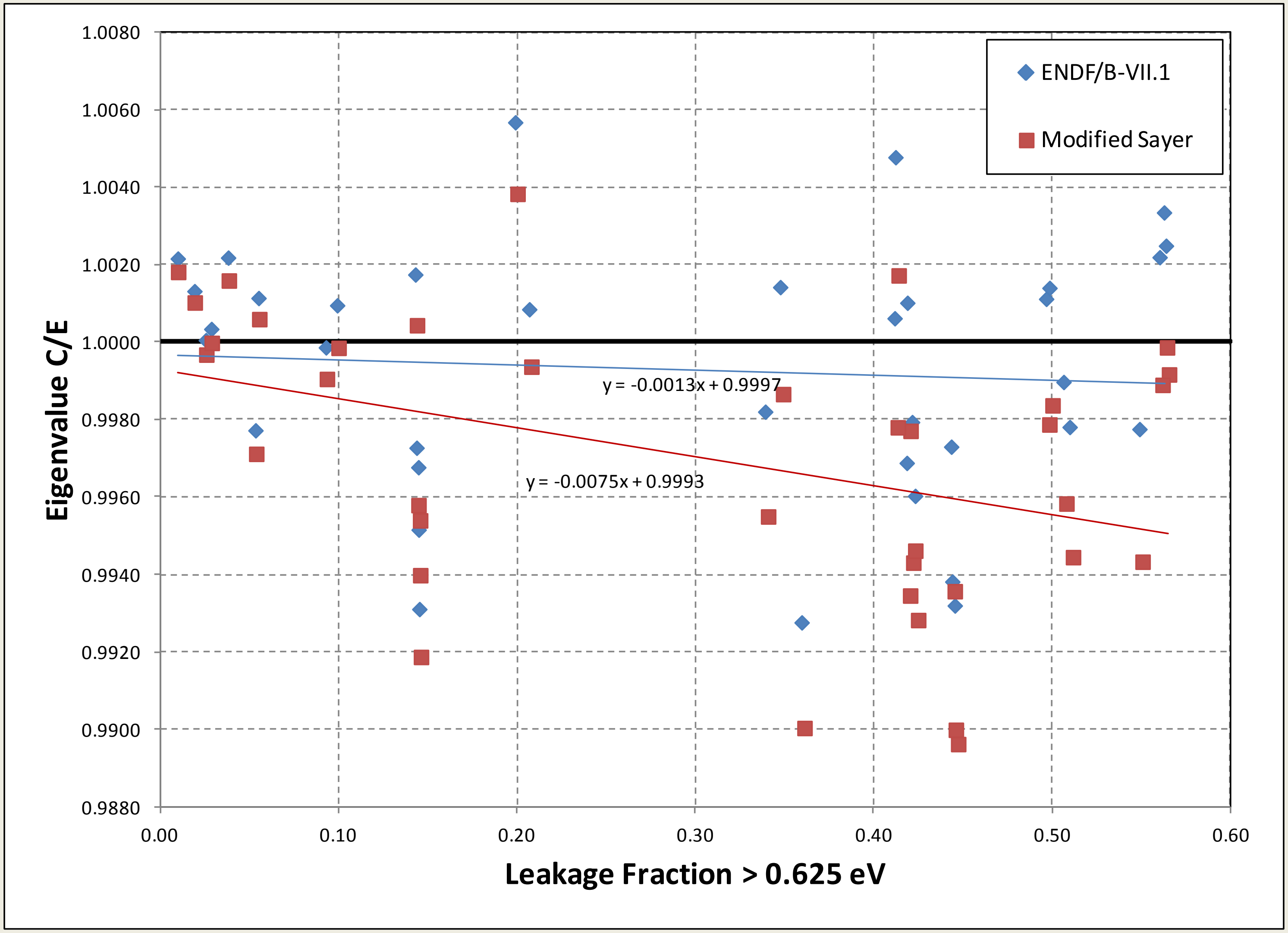
Benchmarks

- HEU-SOL-THERM-001 – Rocky Flats, unreflected $UO_2(NO_3)_2$
- HEU-SOL-THERM-009 – ORNL, water-reflected UO_2F_2
- HEU-SOL-THERM-010 – ORNL, water-reflected UO_2F_2
- HEU-SOL-THERM-011 – ORNL, water-reflected UO_2F_2
- HEU-SOL-THERM-012 – ORNL, water-reflected UO_2F_2
- HEU-SOL-THERM-013 – ORNL, unreflected $UO_2(NO_3)_2$
- HEU-SOL-THERM-032 – ORNL, unreflected $UO_2(NO_3)_2$
- HEU-SOL-THERM-042 – ORNL, unreflected $UO_2(NO_3)_2$
- HEU-SOL-THERM-043 – ORNL, unreflected $UO_2(NO_3)_2$

Procedure

1. Start with ^{16}O from Sayer et al. (2000) R-matrix evaluation
   - Scattering is nearly 3.15% above high precision measurements
   - Has resonance parameters unlike ENDF/B-VII
   - Constant cross section at low energy
2. Reconstruct with NJOY 2012 or PREPRO
3. Process with NDEX to create ND_LIBRARY used in MC21
4. Reduce elastic scattering in ND_LIBRARY by 3.15% and adjust total accordingly

Benchmark Results



Angular Distributions

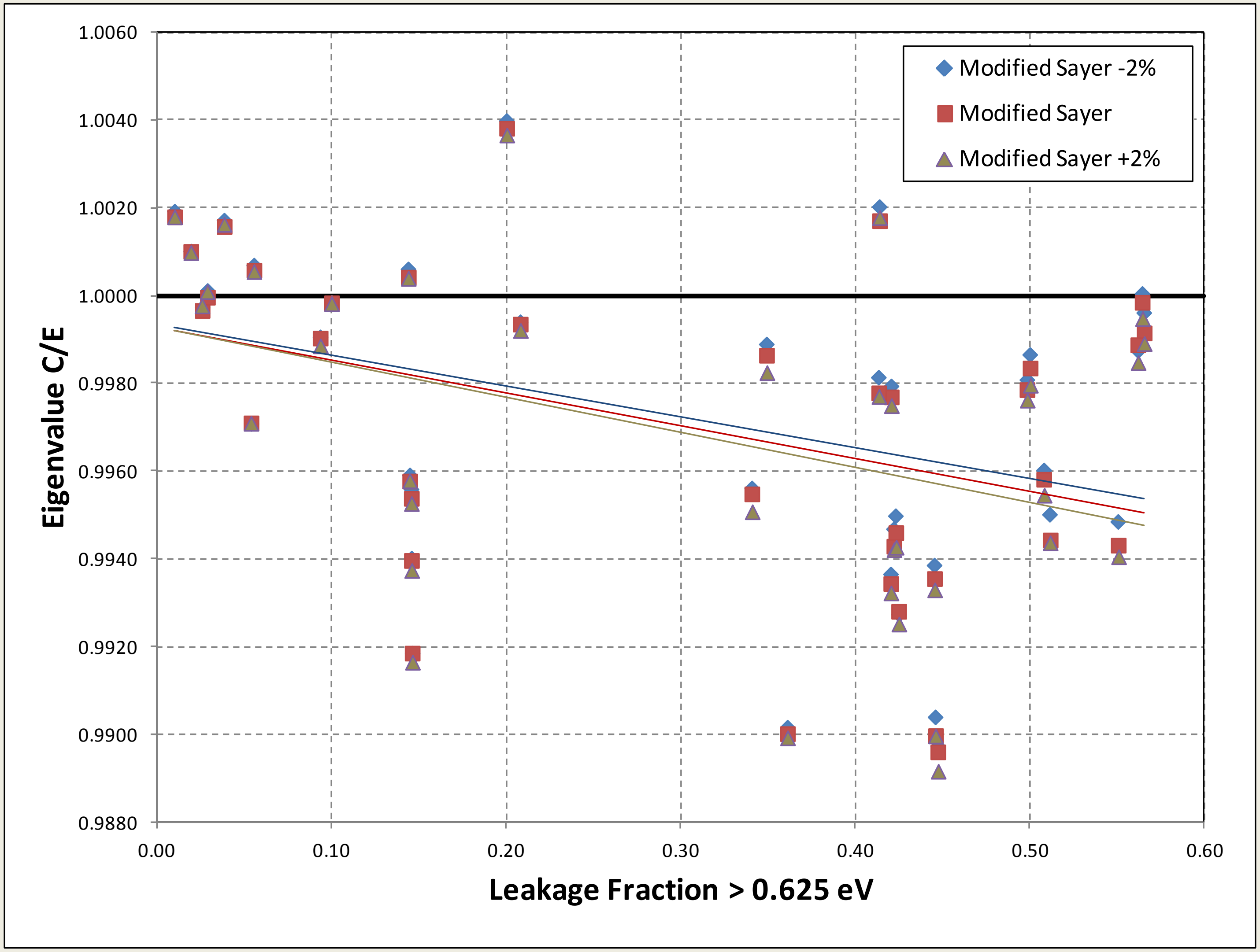
- Increase in leakage due to lower elastic scattering could be offset by changes to angular distributions

- *What change in the first-order Legendre moments would eliminate trend with leakage?*

Procedure

1. Three versions of Sayer et al. (2000) ENDF file
   – Original
   – First-order Legendre coefficient on MF=4, MT=2 increased by 2%
   – First-order Legendre coefficient on MF=4, MT=2 decreased by 2%
2. Process with NJOY and NDEX to produce ND_LIBRARY file used in MC21
3. Reduce elastic scattering by 3.15%

Sensitivity Results



Implications of Sensitivity

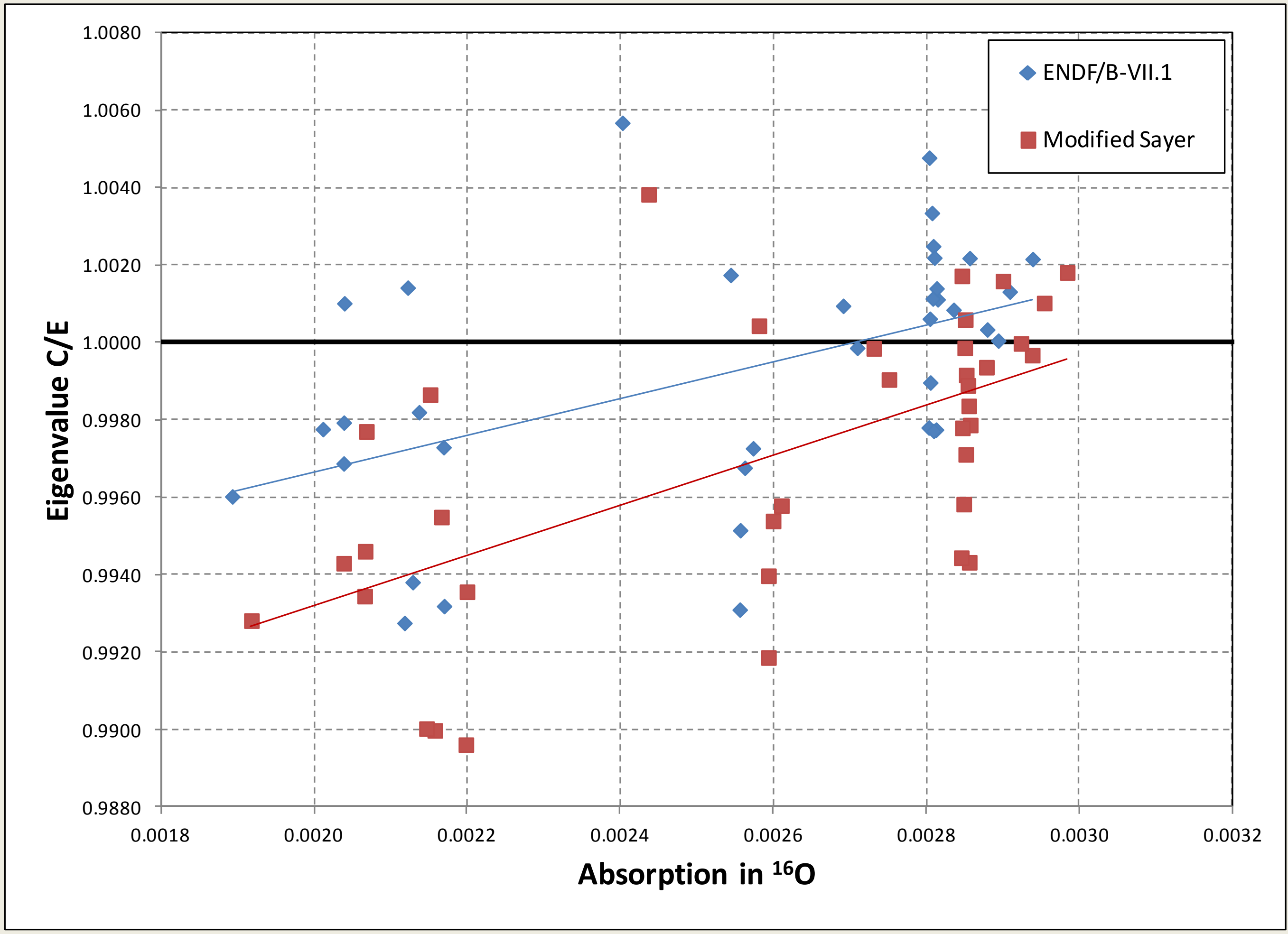
- Can determine change in first-order coefficient necessary to eliminate trend:

$$k(L_1,a_1) + \frac{k(L_1,a_1') - k(L_1,a_1)}{a_1' - a_1}\Delta a_1 = k(L_2,a_1) + \frac{k(L_2,a_1') - k(L_2,a_1)}{a_1' - a_1}\Delta a_1$$

- Solving for Δa_1, we obtain **-30%**
- Change of this magnitude would push angular distributions outside range of uncertainty on measured distributions

Trend with ^{16}O absorption

- Appears to be increasing trend with ^{16}O absorption
- Cannot be eliminated by modifying (n,α) cross section
- Do not yet understand significance



Heavy water benchmarks

- Also looked briefly at HEU-SOL-THERM-004
  - Los Alamos, D_2O-reflected UO_2F_2 solution
- Observed 400-500 pcm change in reactivity from ENDF/B-VII.1 to modified Sayer

Conclusions

- For HST benchmarks, dominant effect of reducing scattering is increased leakage and therefore lower eigenvalue C/E ratios
- Results in trend with fast leakage
  - Trend cannot be eliminated just by simple changes to Legendre polynomial coefficients
- Increasing trend in eigenvalue C/E with ^{16}O absorption not yet understood

Ongoing Work

- Would -30% change in a_1 actually eliminate trend?
- Look at other benchmarks
  - Pin-cell problems (LEU-COMP-THERM)
  - More heavy water benchmarks
    - HEU-SOL-THERM-020
    - LEU-MET-THERM-015

Questions and Discussion