Naval Nuclear Laboratory
Thermal Scattering Library Analyses

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Cross Section Evaluation Working Group meeting

Brookhaven National Laboratory

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Neptune Experiment Used for Validation of ENDF/B-VIII.0(β5) H-H_2O TSL as a Function of Temperature

- Rolls-Royce conducted a series of critical experiments at the Neptune facility to validate the ability to predict criticality for water-isolated arrays as function of temperature [see Ref.].

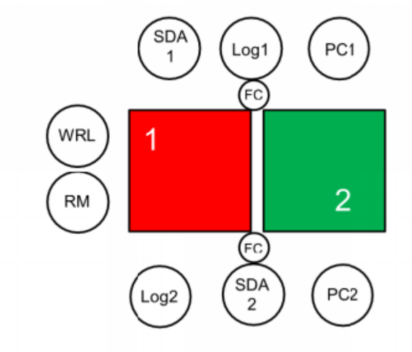
- Configurations were neutronically similar to spent fuel storage racks without poison inserts in flux trap.

- Test was specifically designed to assess criticality safety issues for spent fuel rack configurations with water gaps.

- In this configuration, undermoderated fuel assemblies can have a positive temperature coefficient of reactivity.

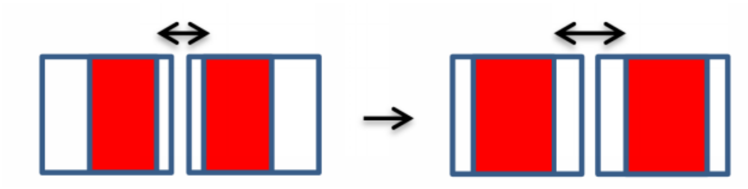
- Water temperature varied from 20-60 °C

Schematic of Core and Detector Arrangement



FC = Fission Chamber
SDA = ShutDown Amplifier
Log = Log Channel
PC = Pulse Channel
WRL = Wide Range Linear
RM = Reactivity Meter

Schematic of Fuel Arrangement Showing Increase in Effective Water Gap



Ref.: S. Walley et al., "Measurement of Positive Temperature Coefficients of Reactivity for Rack-like Arrangements of Reactor Fuel in the Neptune Zero Energy Facility," Proc. RRFM-2016, Berlin, March 13-17, 2016.

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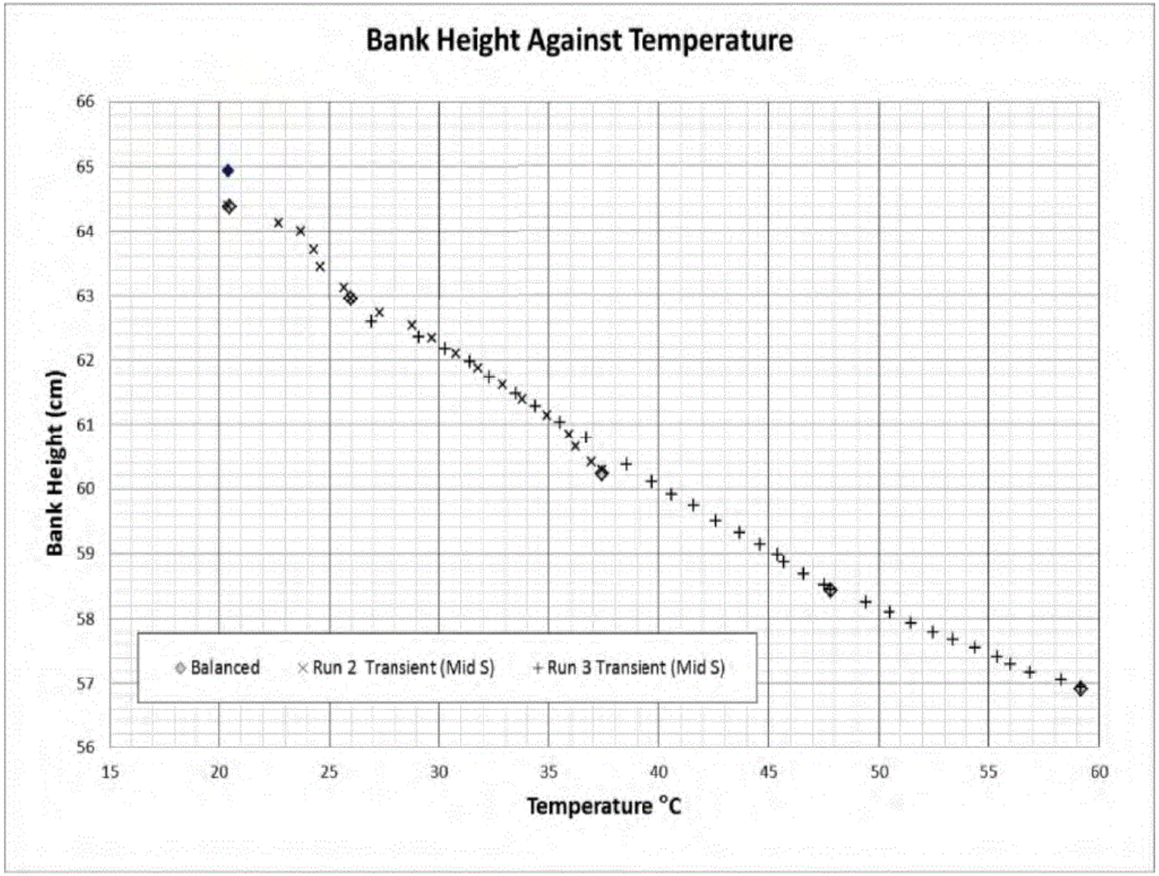
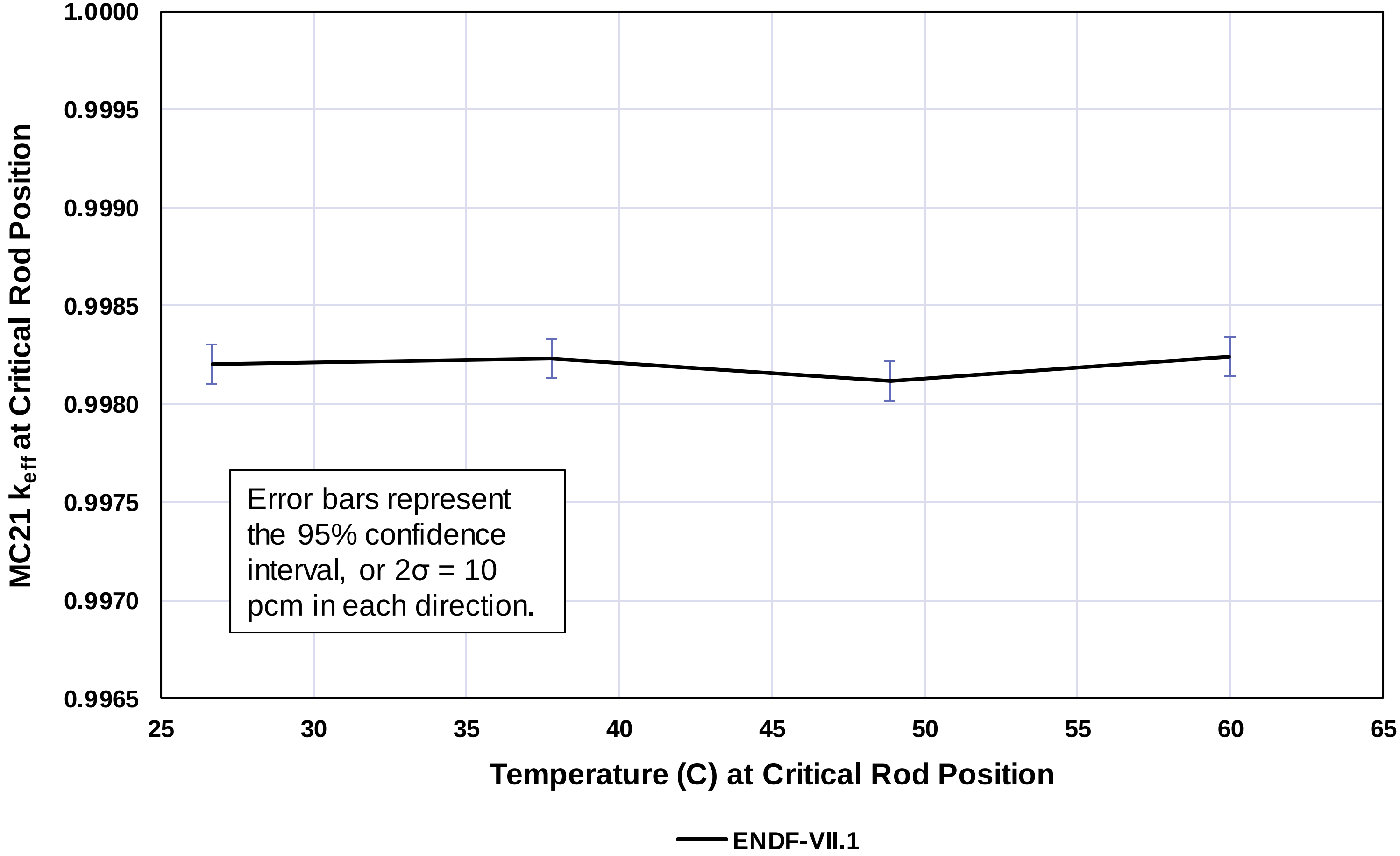
Neptune Configuration C Positive Bank Height vs. Temperature Displaying a Positive Temperature Coefficient of Reactivity



This Neptune experiment is specifically designed to be sensitive to thermal scattering in water as a function of temperature.

Various combinations of ENDF non-moderator libraries and H-H2O TSL libraries were used to determine if the positive temperature coefficient of reactivity was being accurately predicted.

MC21 Calculated k_{eff} for Neptune Configuration C as a Function of Temperature Using ENDF/B-VII.1 Non-Moderator Libraries and Various H-H_2O TSL Libraries



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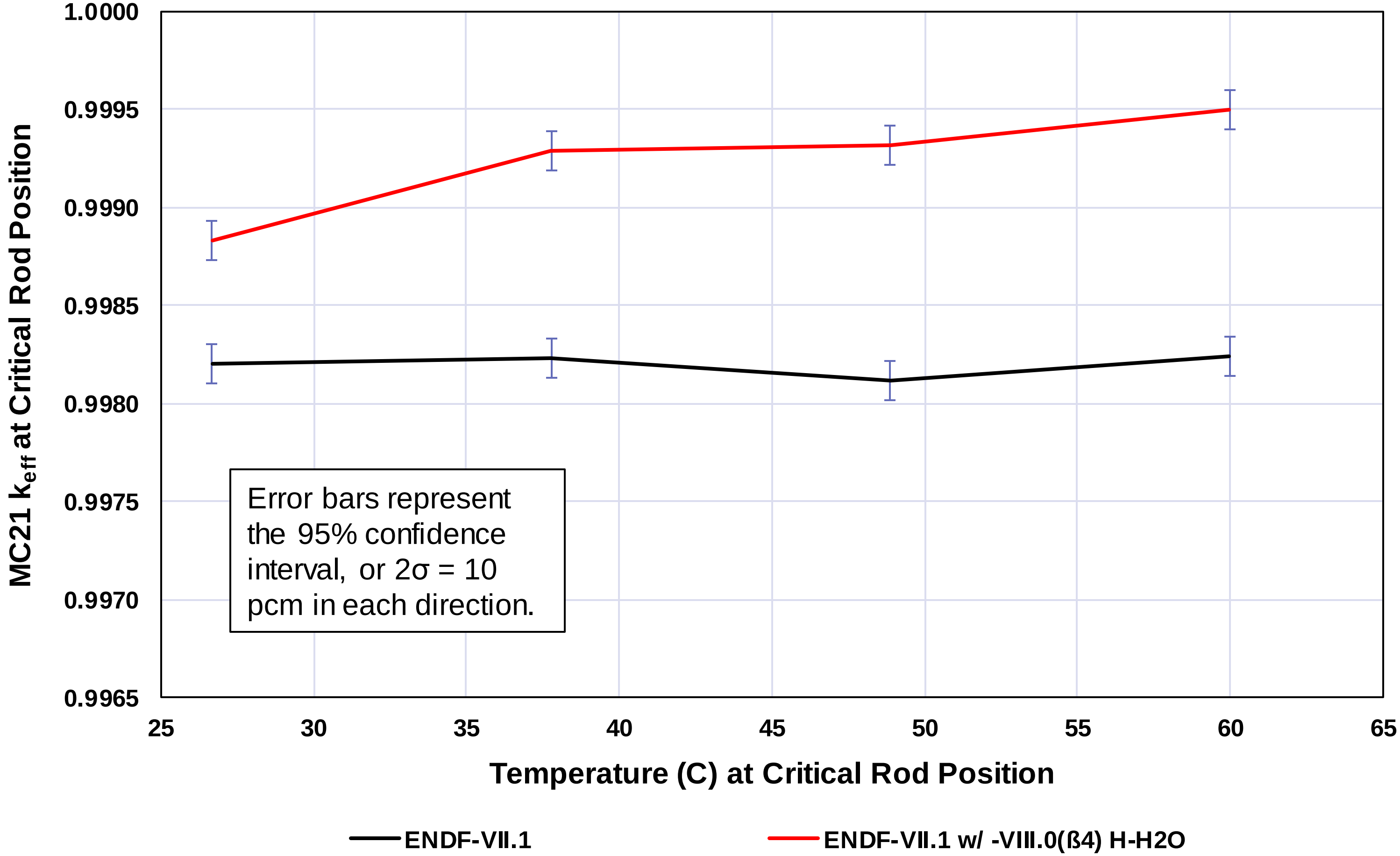

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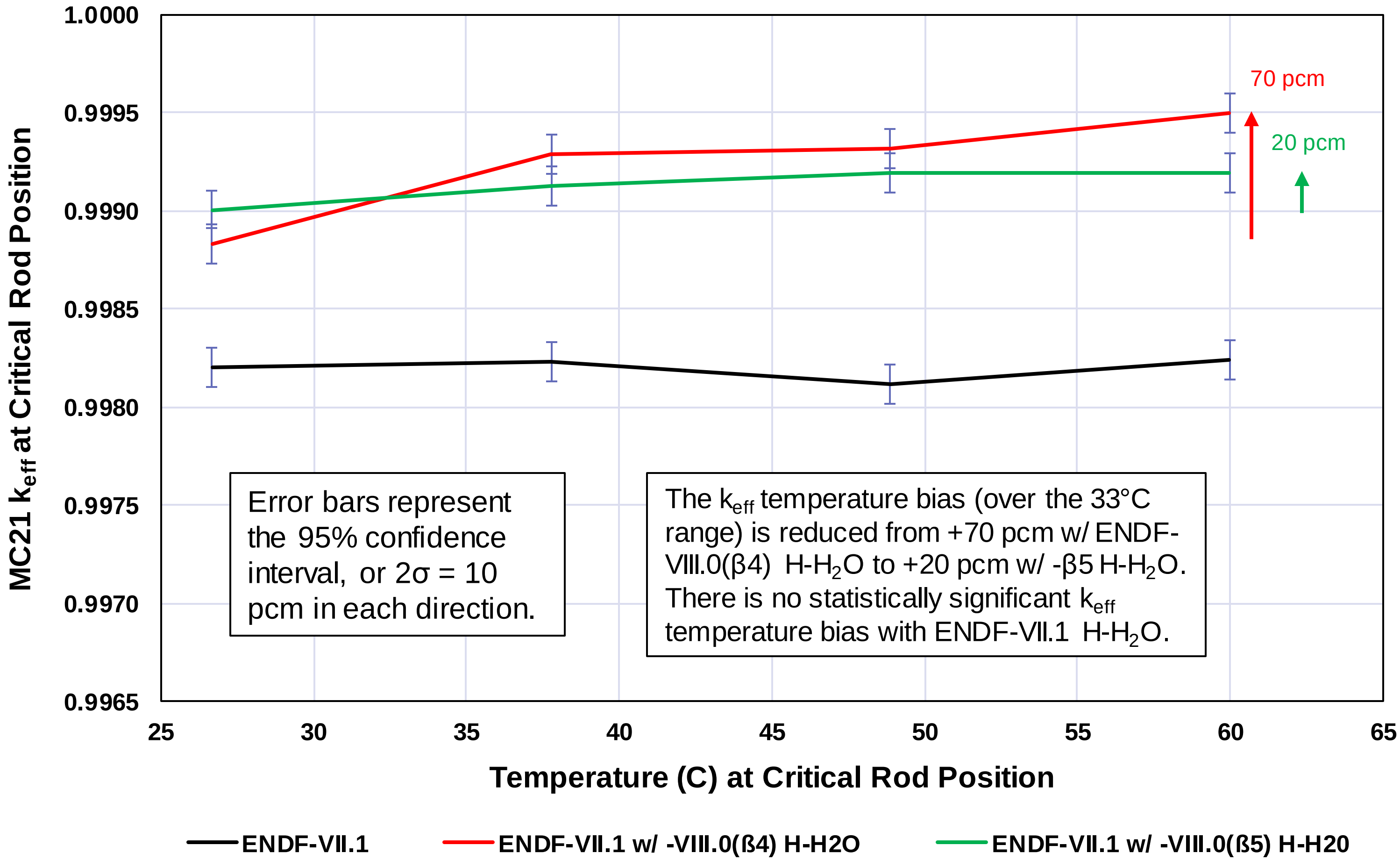

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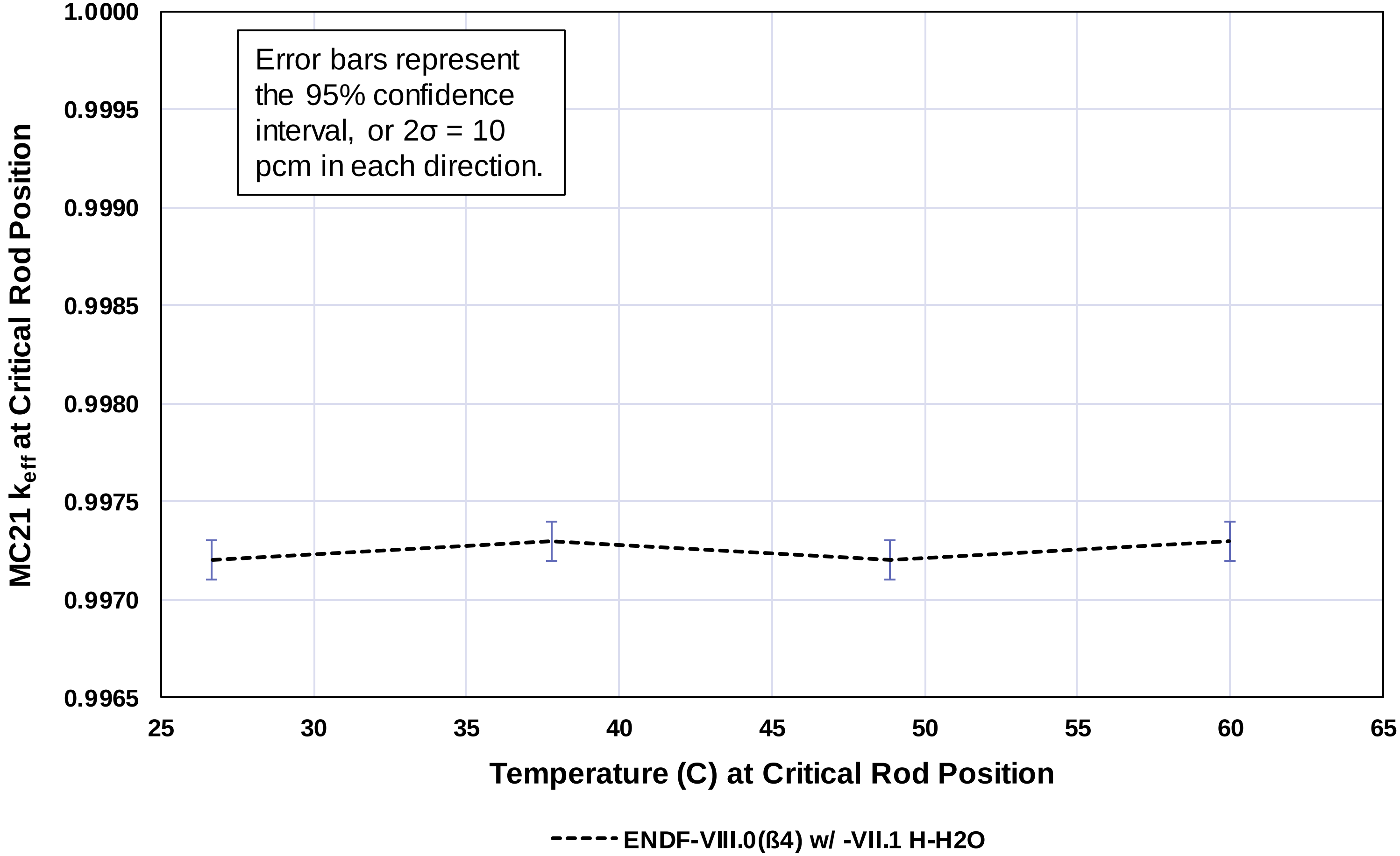
MC21 Calculated k_{eff} for Neptune Configuration C as a Function of Temperature Using ENDF/B-VIII.0(β4) Non-Moderator Libraries and Various H-H_2O TSL Libraries



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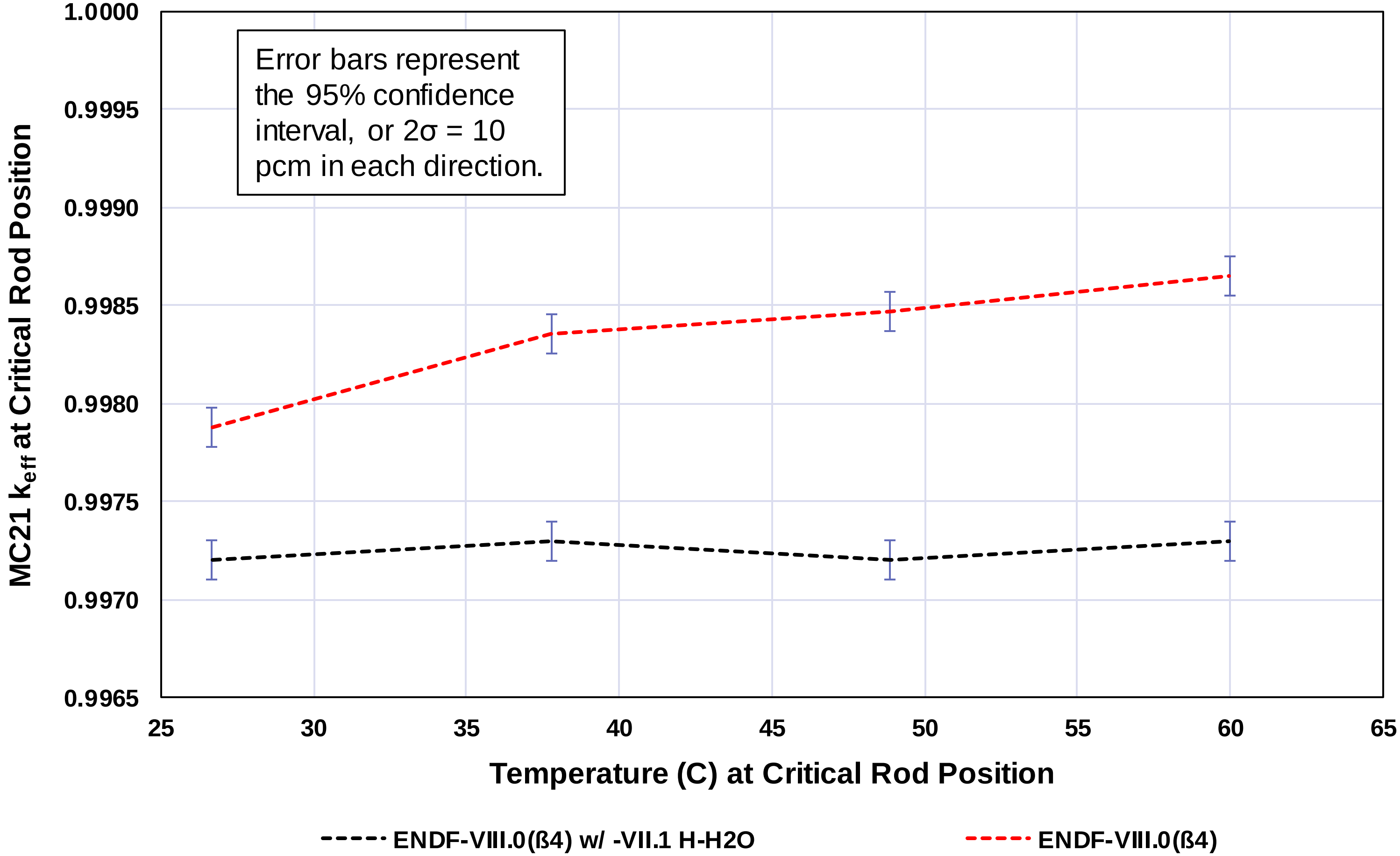

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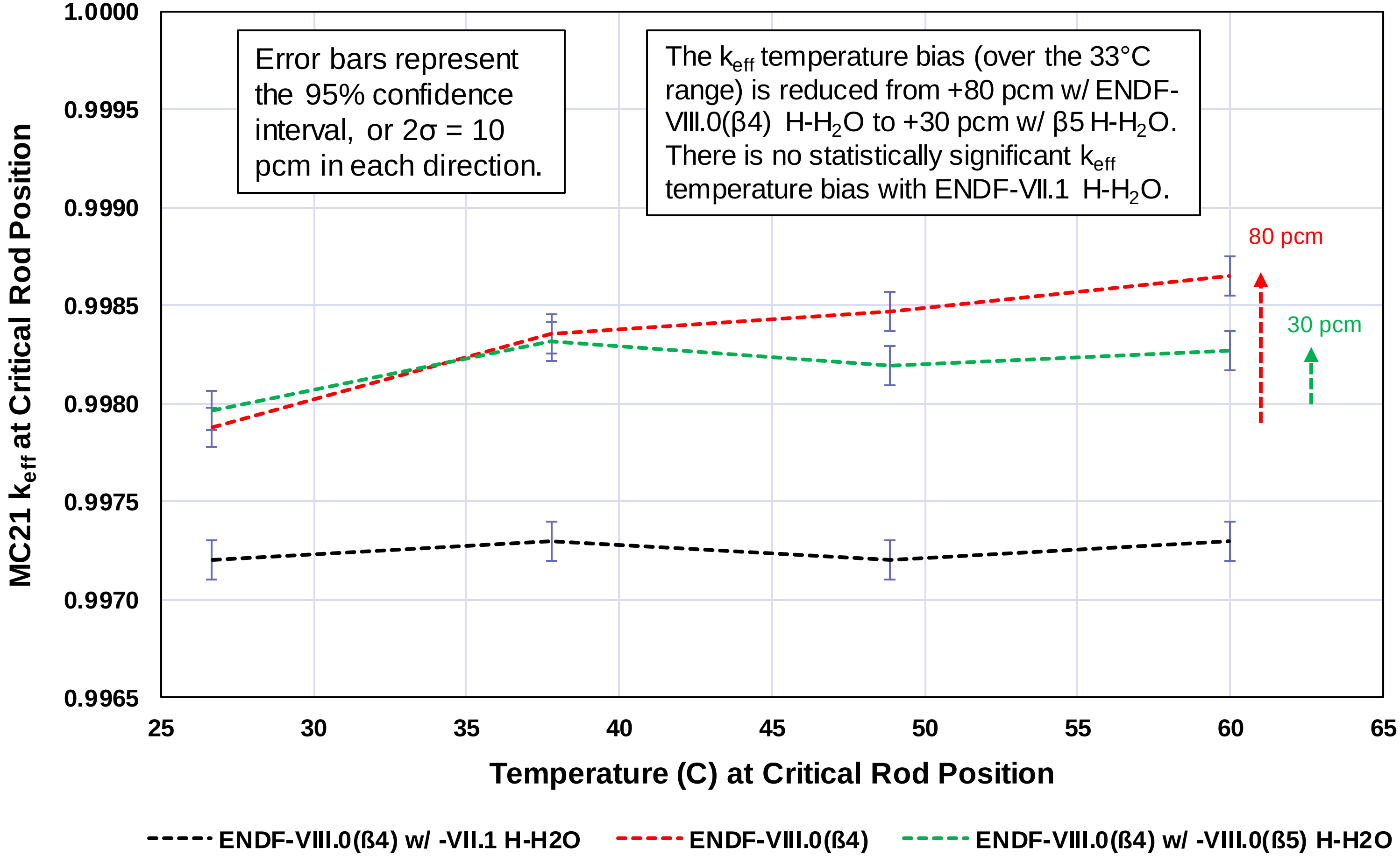

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KRITZ Reactor Experiment Benchmark Description

- The KRITZ reactor was operated in Studsvik, Sweden, in the 1970s.
- IRPhEP experiment benchmarks KRITZ-LWR-RESR-002 (2:1) and -003 (2:13) are designed to attain criticality in a rectangular 40x40 array of 3.65m LEU UO_2 fuel rods in pressurized light water by regulating water level and boration.
- KRITZ-002 has 14.85mm lattice pitch.
  KRITZ-003 has 16.35mm lattice pitch.
- KRITZ-002 was performed at 292.9K (67.5°F) and 521.7K (479.3°F).
  KRITZ-003 was performed at 295.3K (71.8°F) and 516.2K (469.4°F).
- KRITZ is one of very few public (unclassified and non-proprietary) benchmarks available for nuclear data library validation at elevated temperatures.

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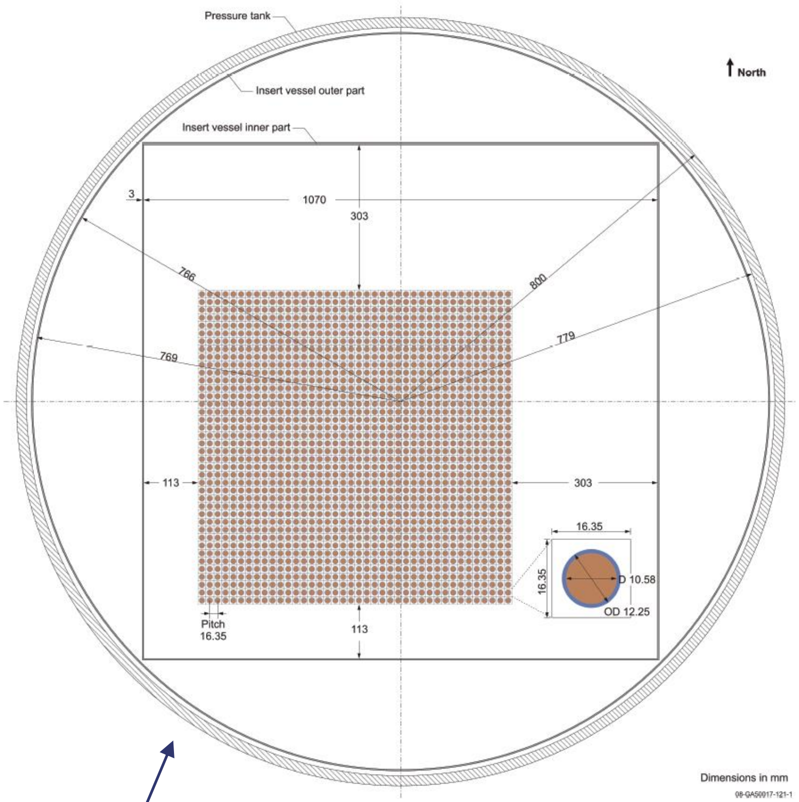
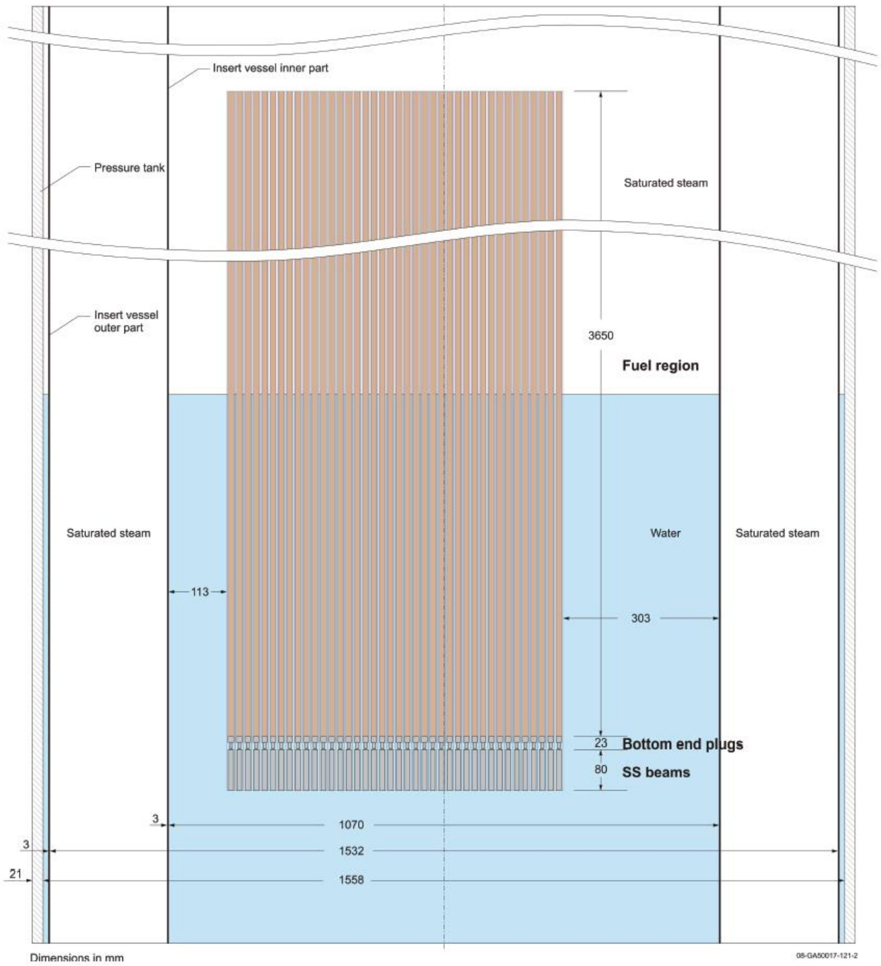
KRITZ-002 Reactor Experiment Configuration (KRITZ-003 Differs by Pitch, Water Level, and Boration)



TOP VIEW

SIDE VIEW



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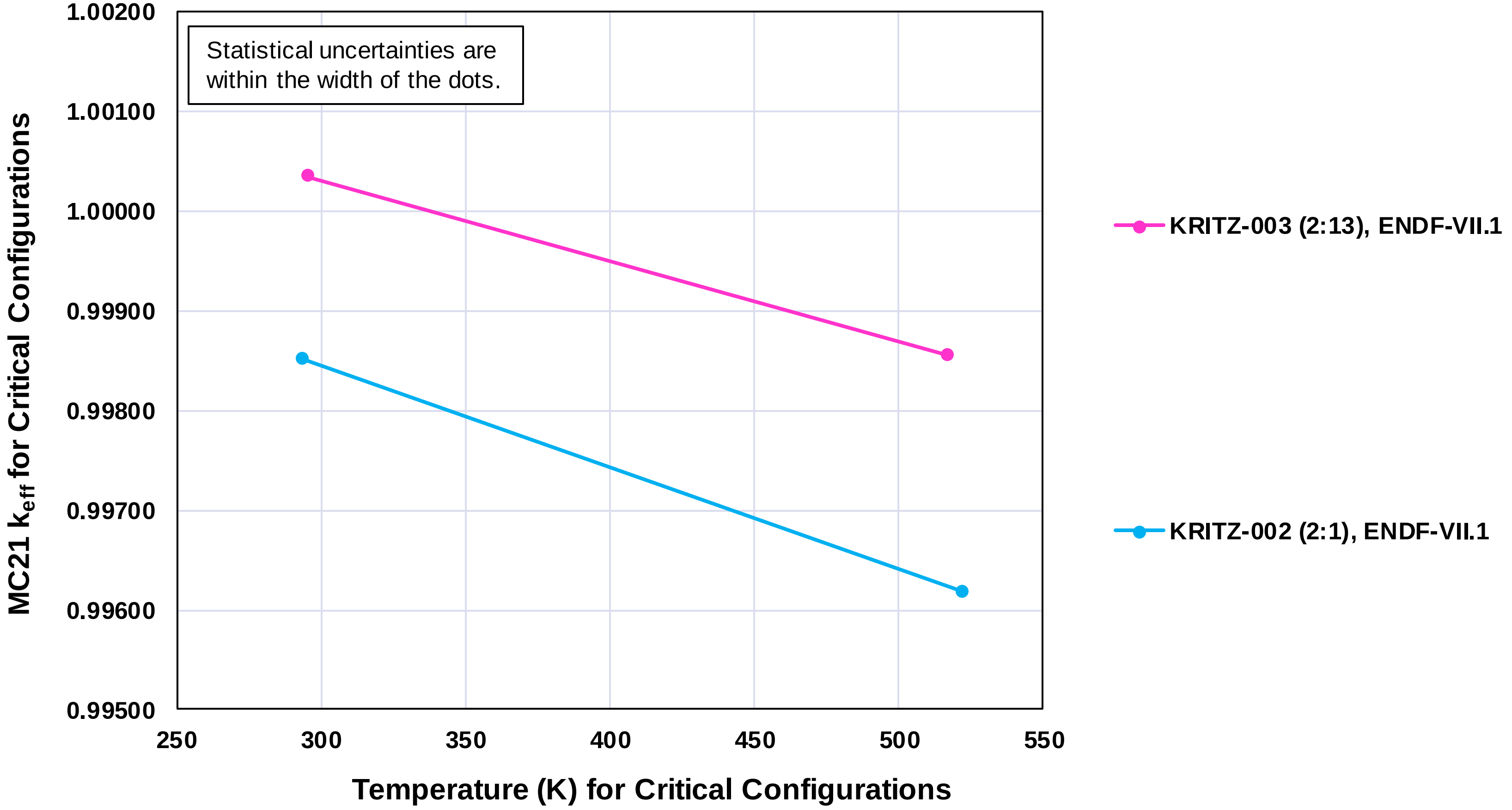

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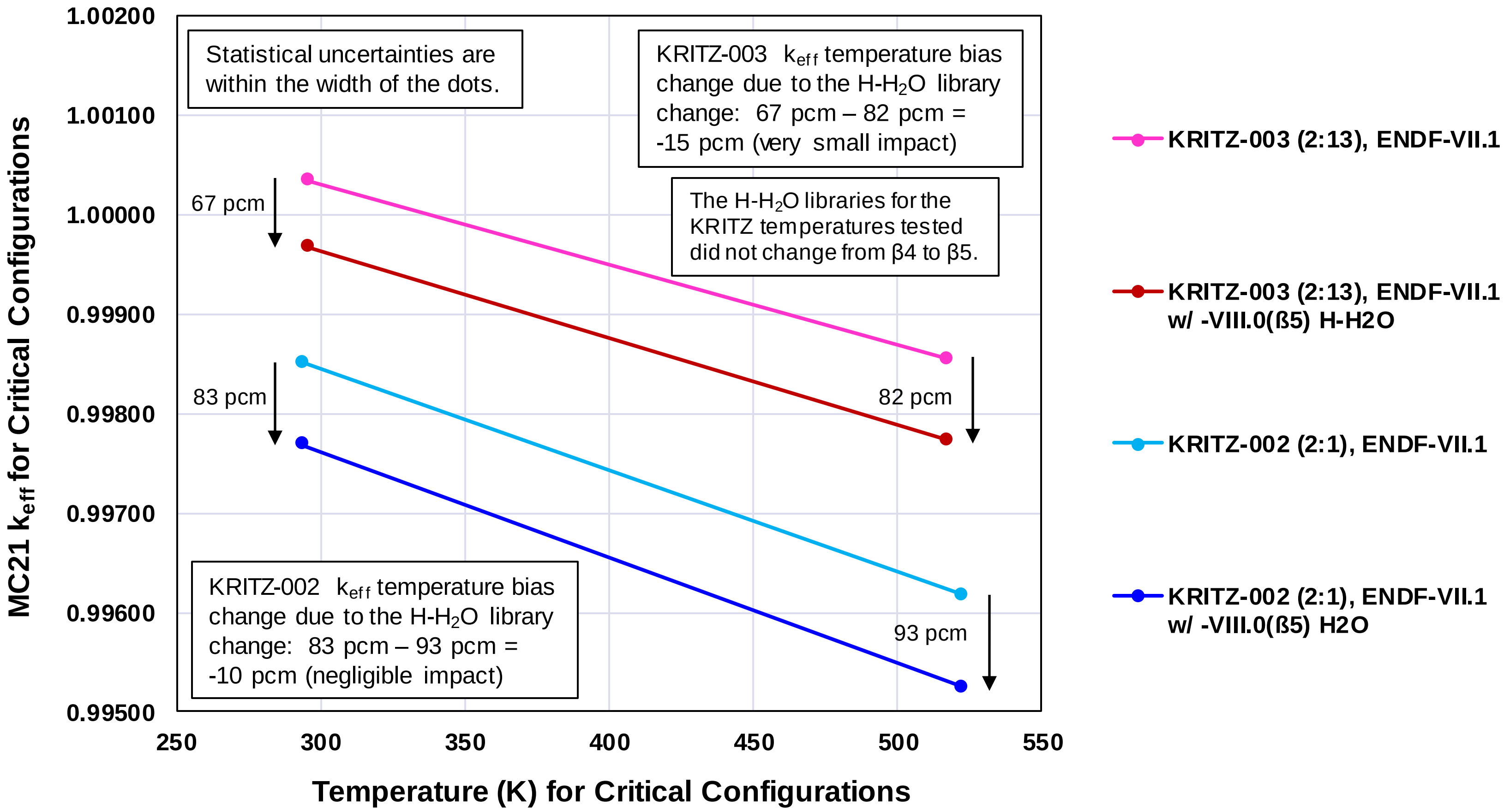

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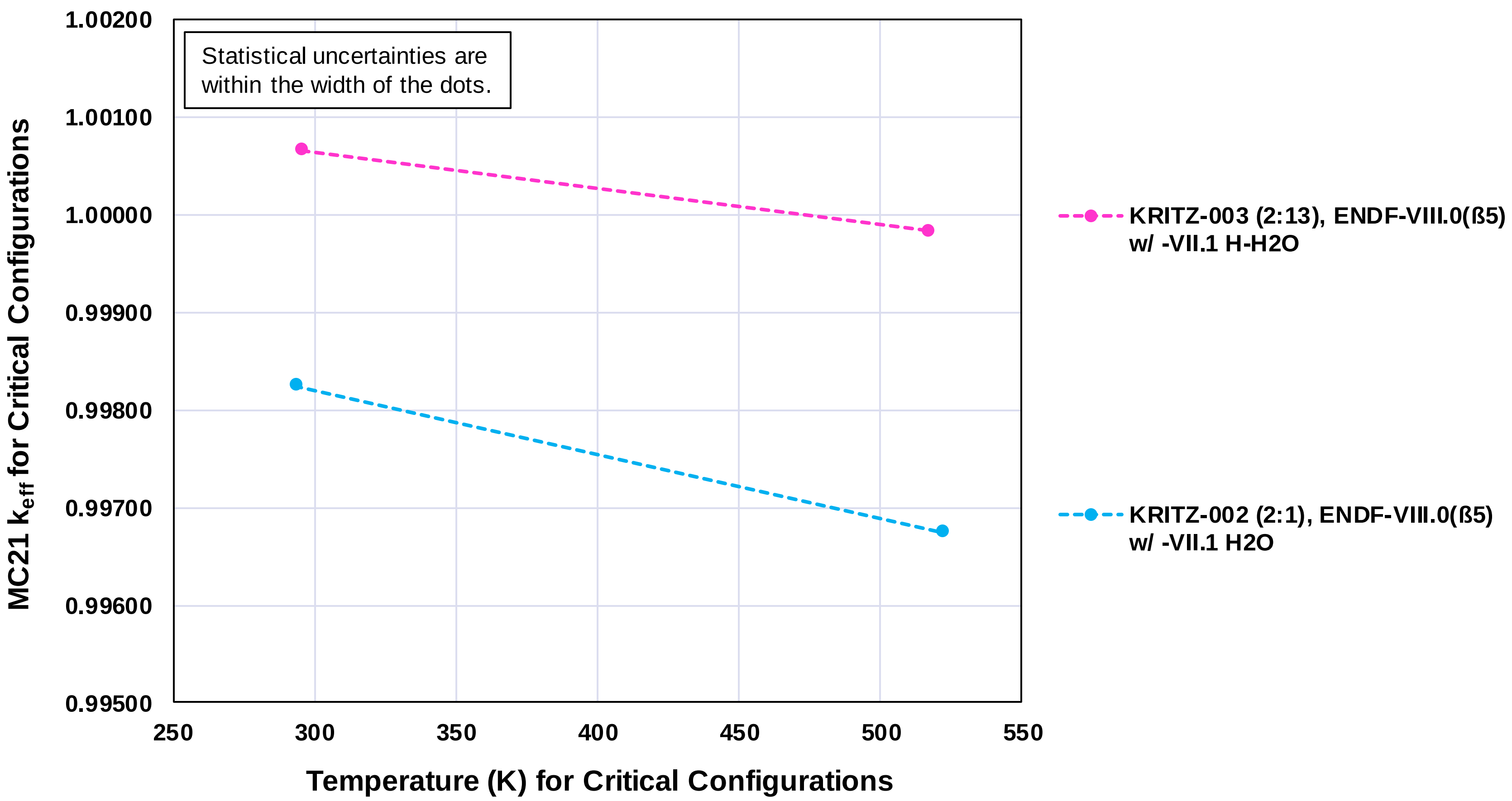

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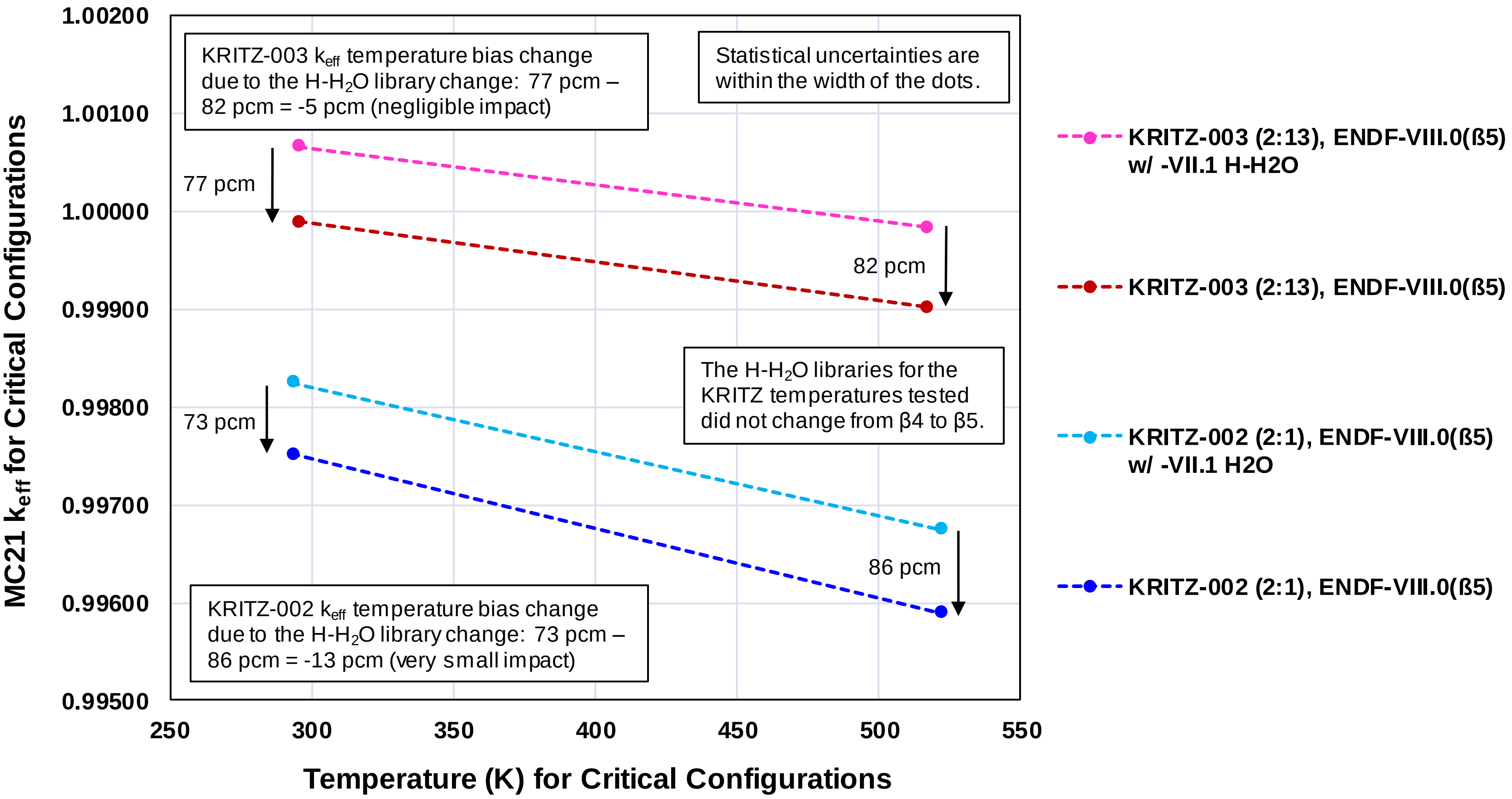

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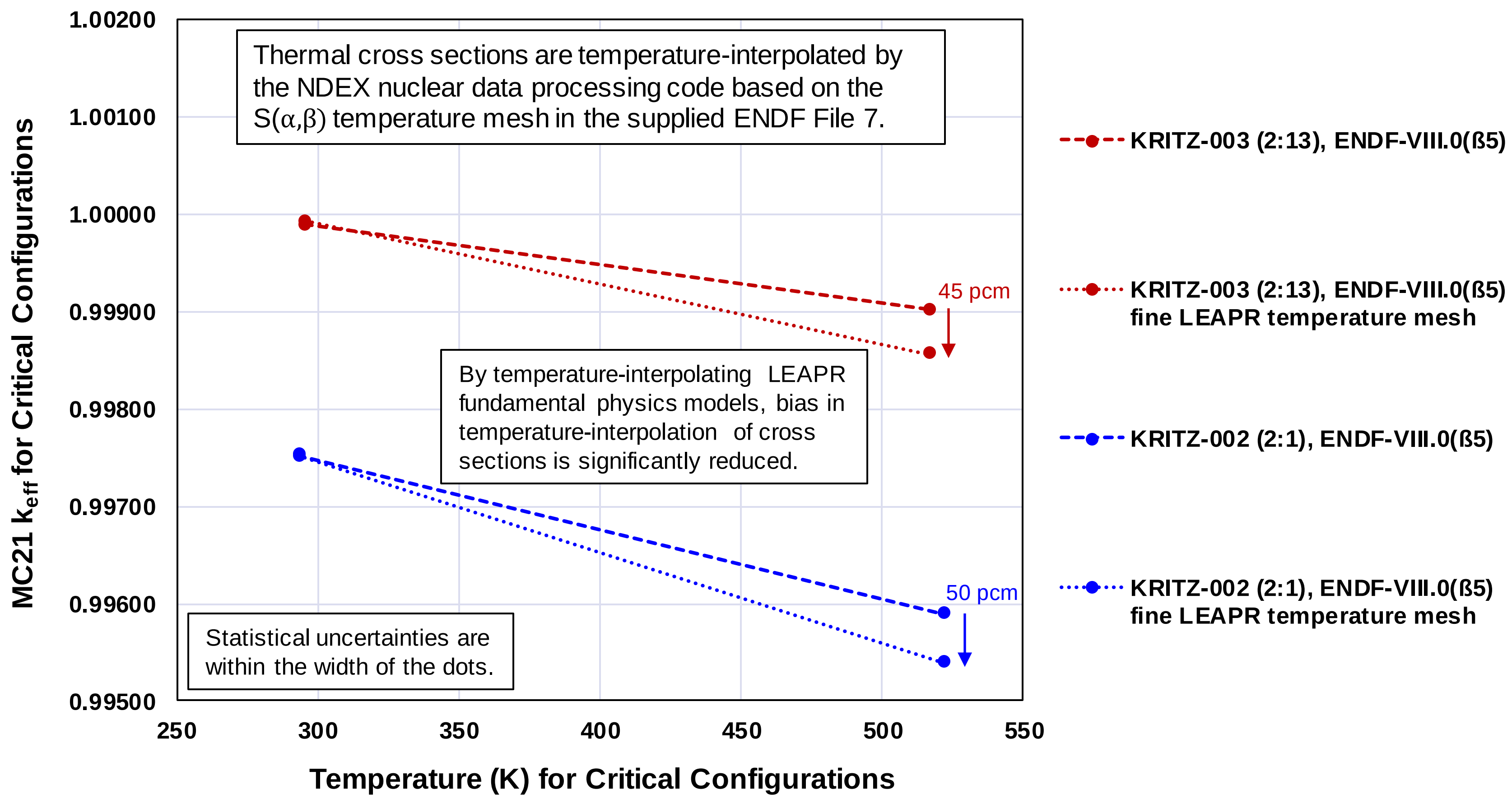

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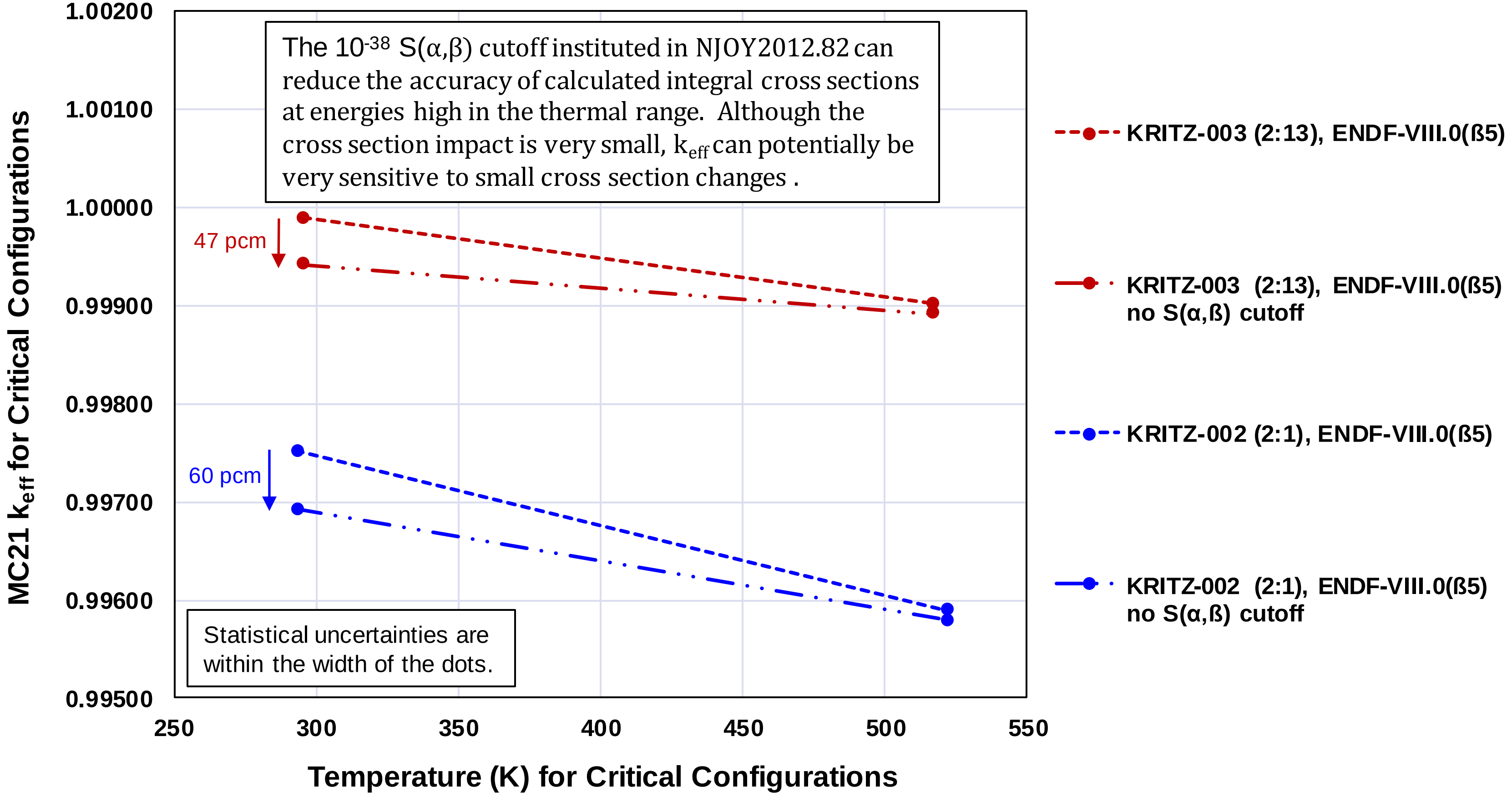

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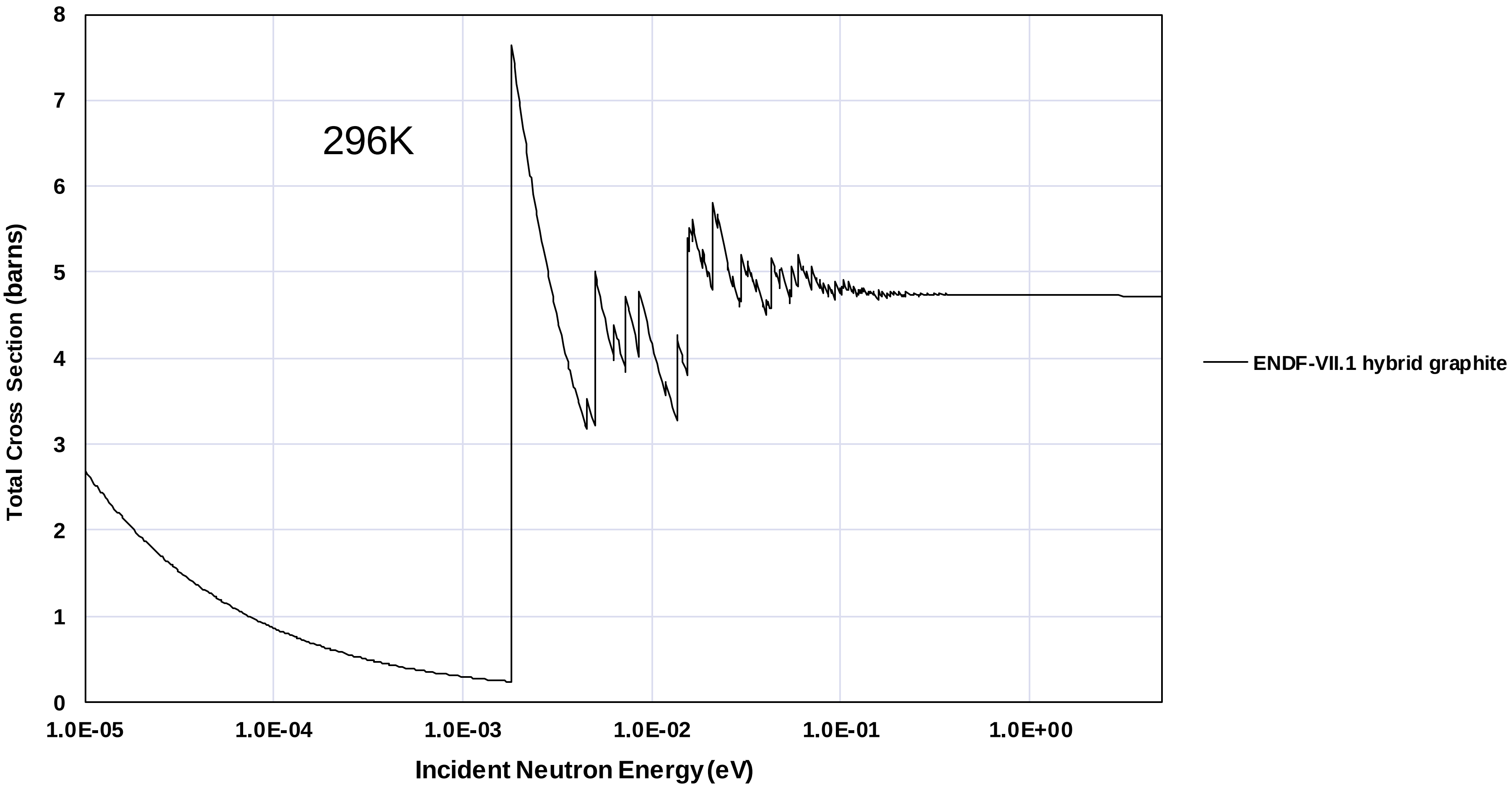
Graphite Total Thermal Cross Sections Calculated from File 7s with NDEX 8 for Different Graphite Structures and Different Physics Models at 296K



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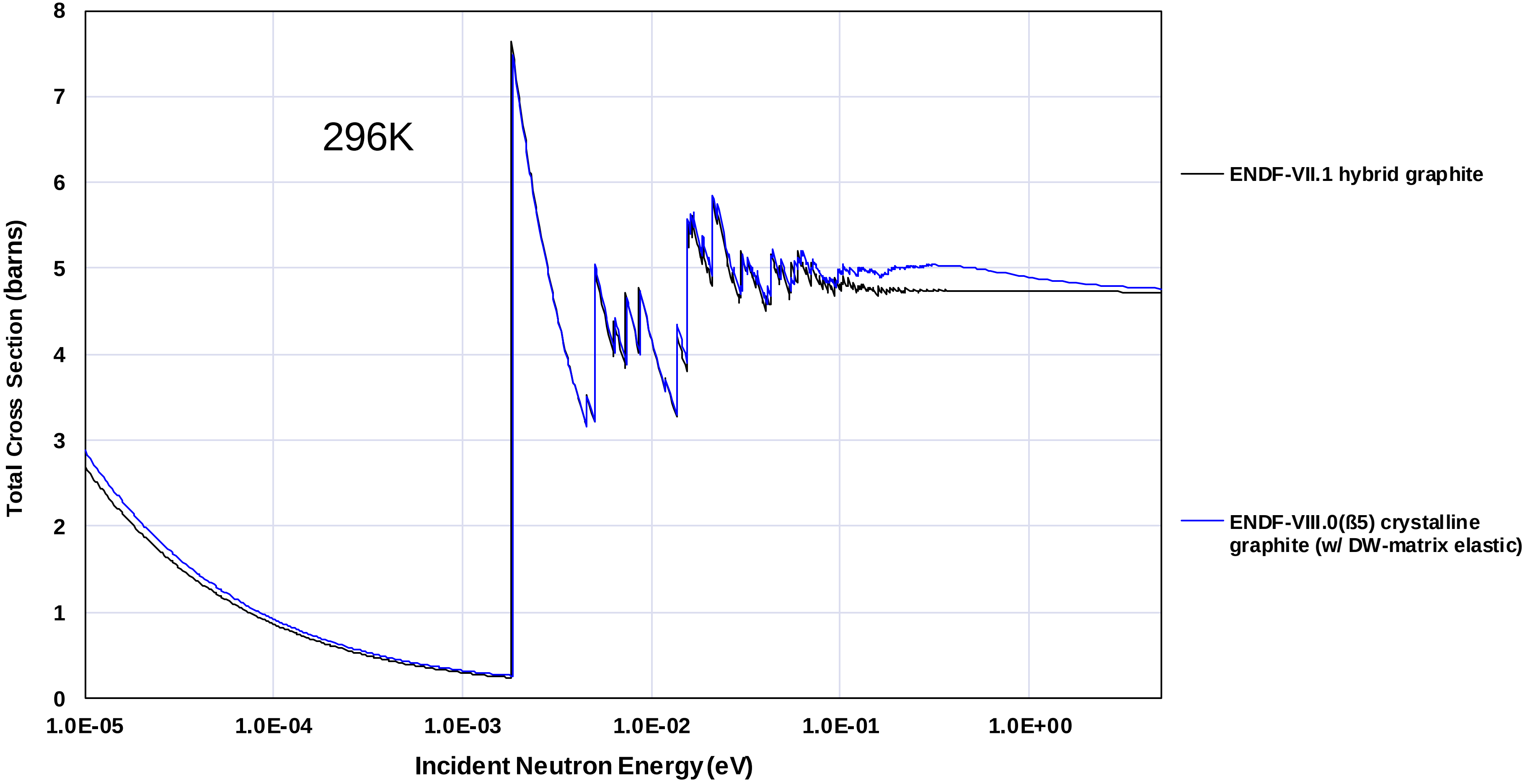

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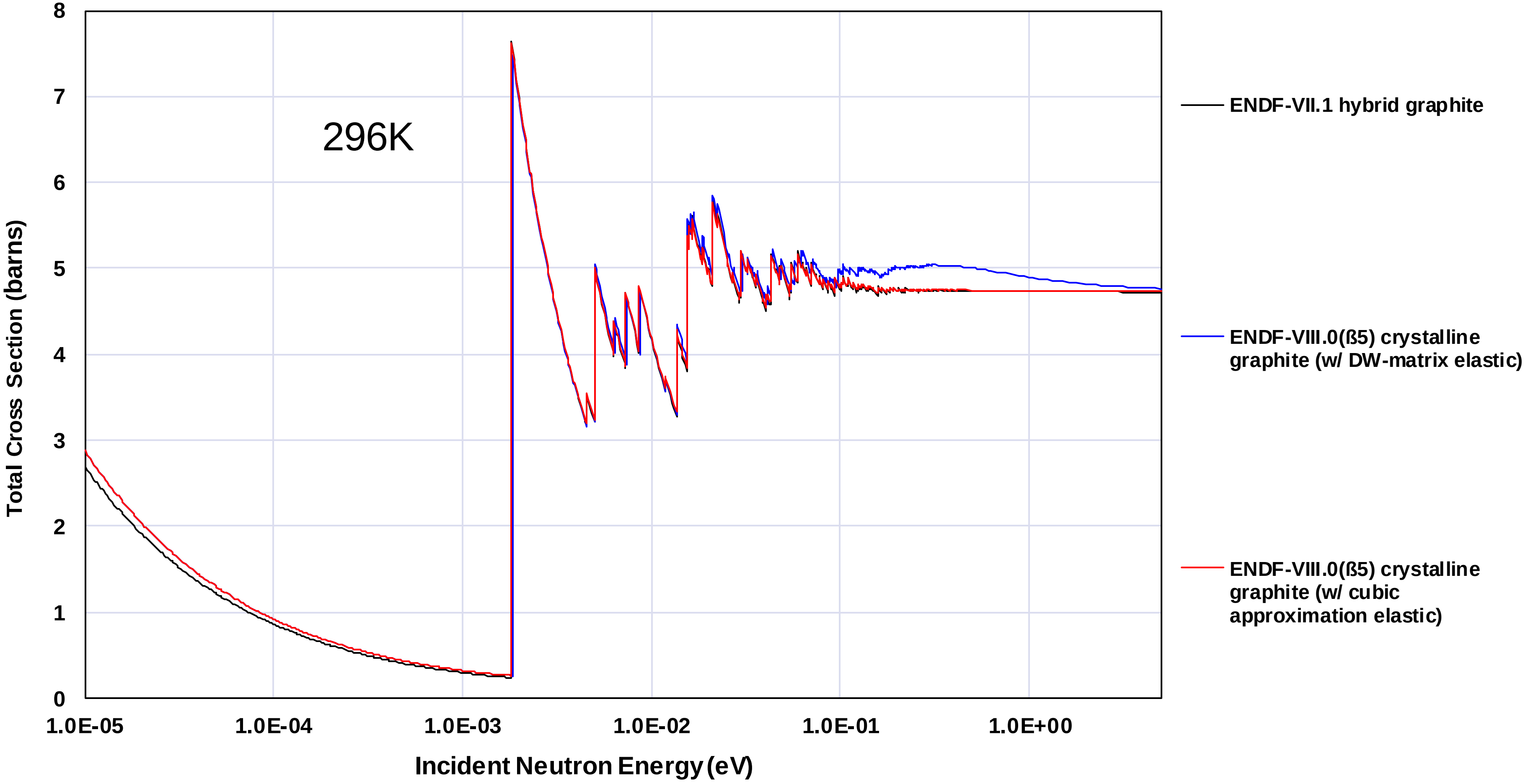

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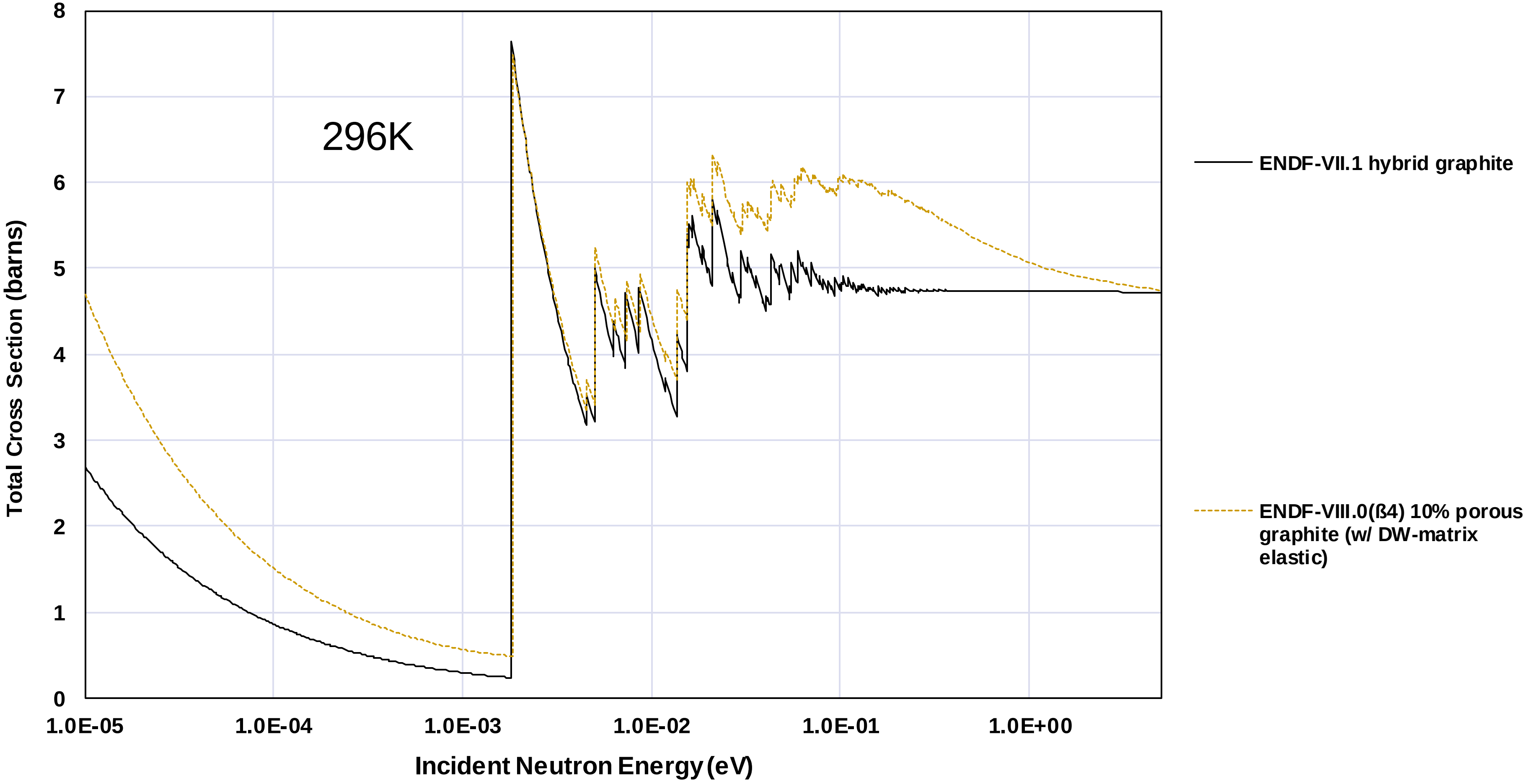

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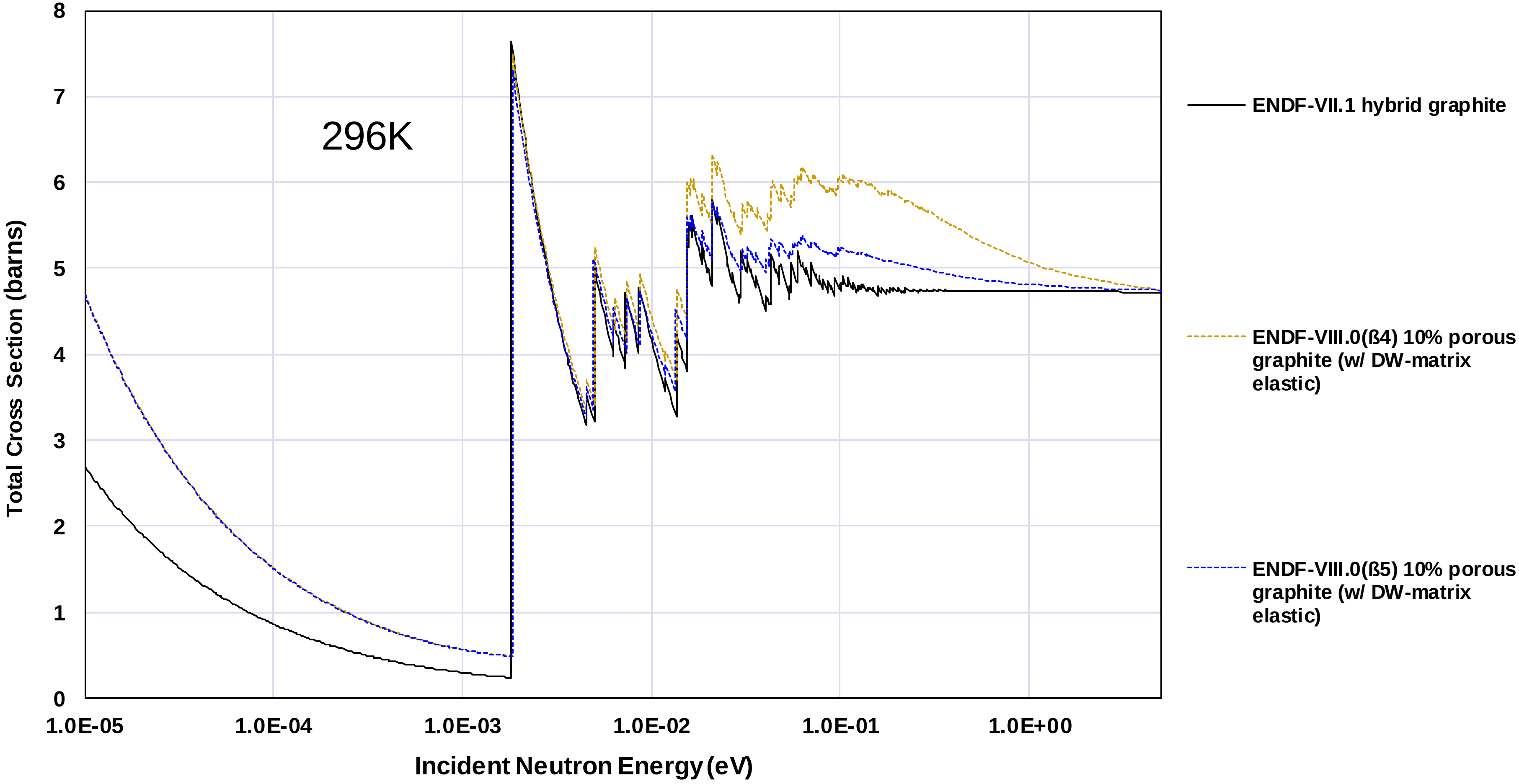

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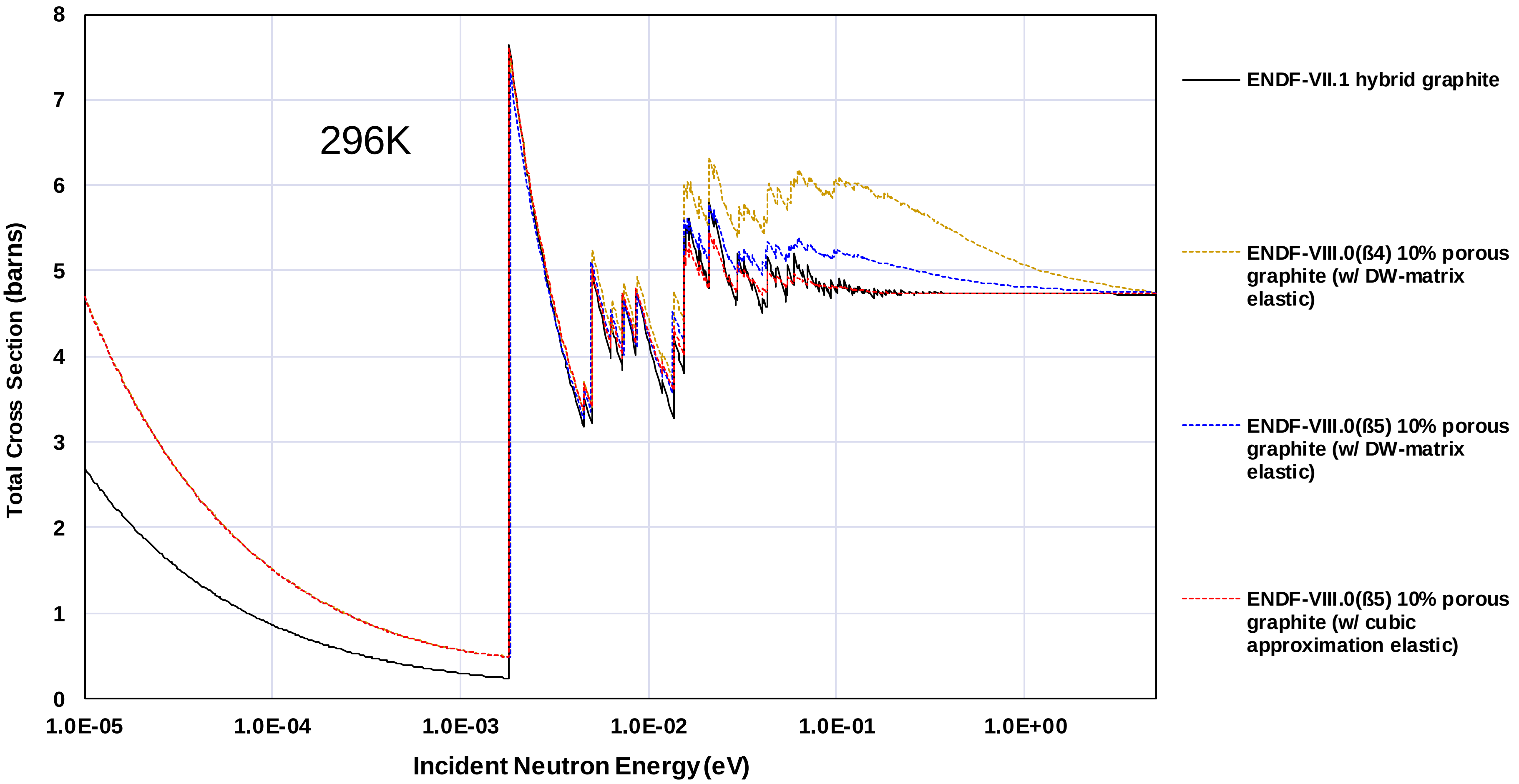

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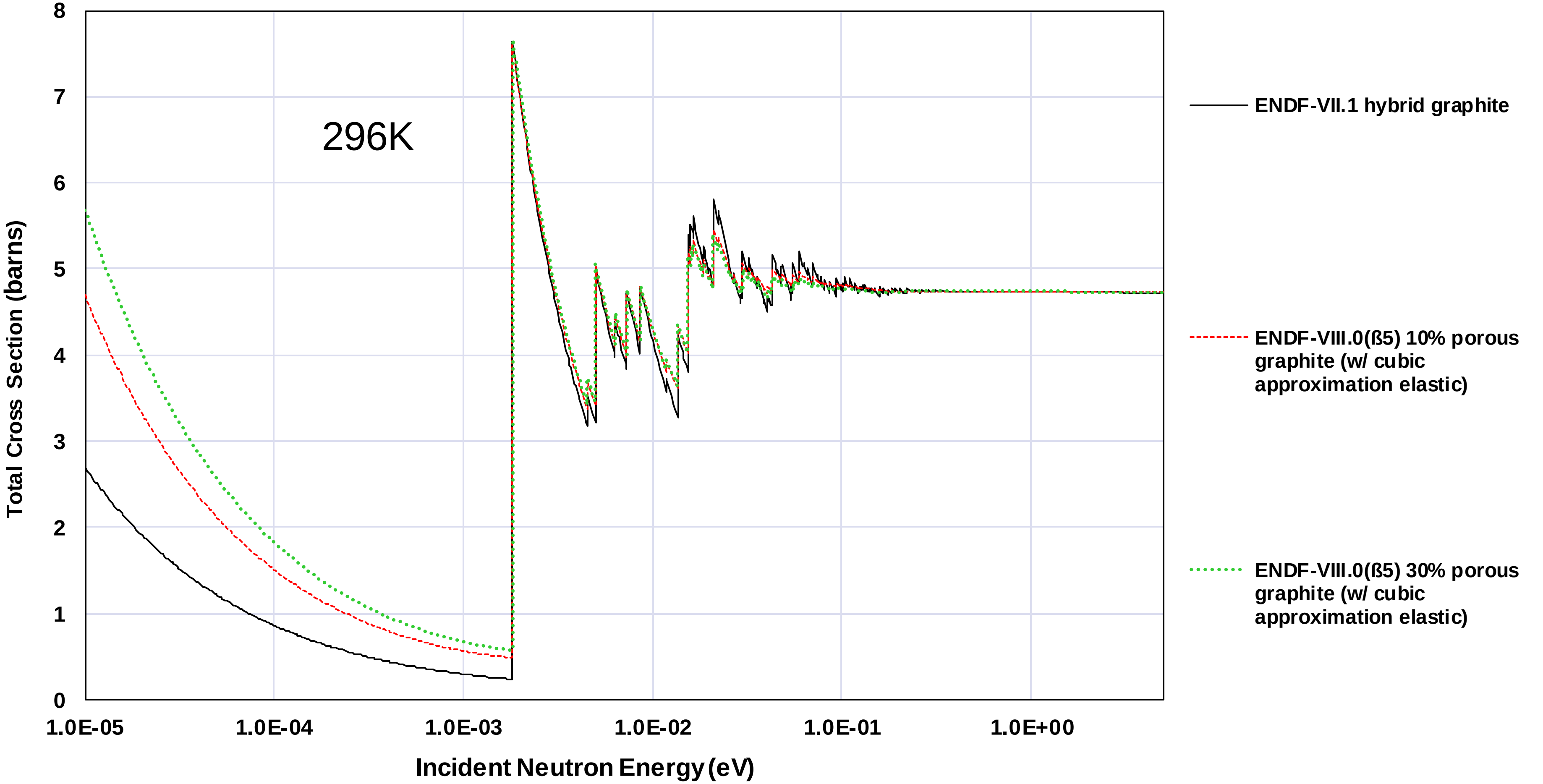

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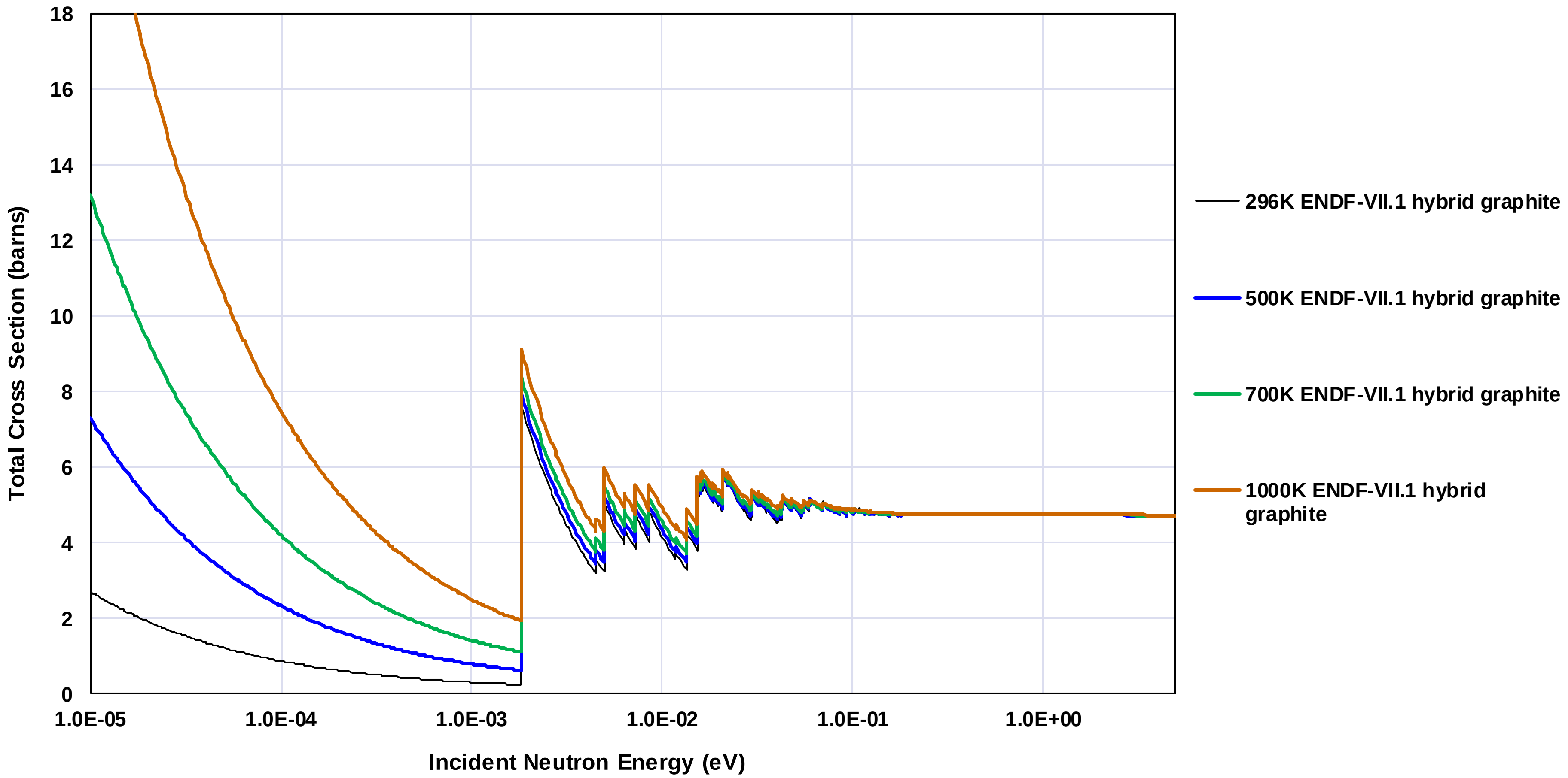
ENDF-VII.1 Graphite Total Thermal Cross Sections Calculated from File 7 with NDEX 8 at 296K, 500K, 700K, and 1000K



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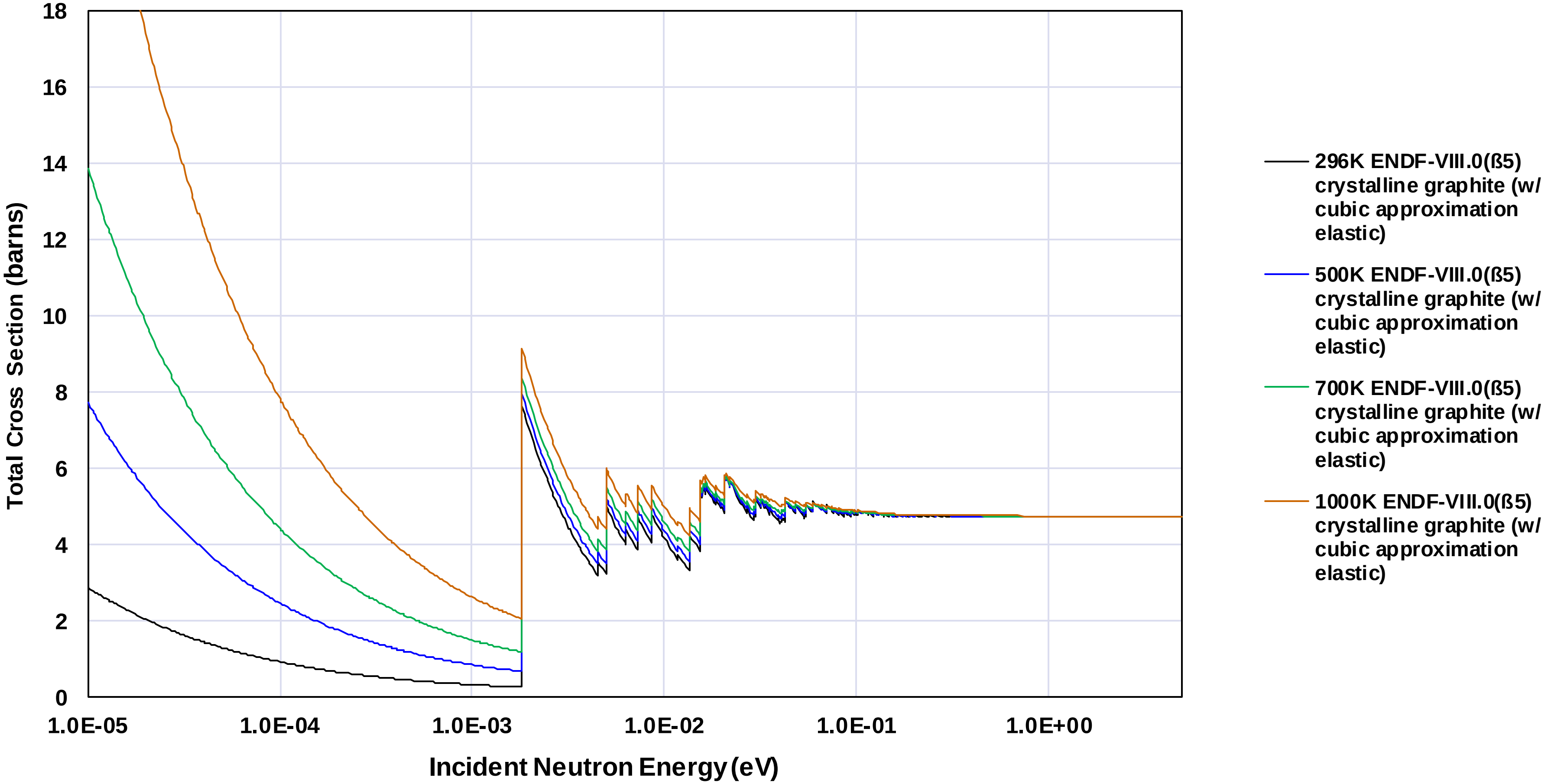
ENDF-VIII.0(β5) Crystalline Graphite (w/ Cubic Approximation Elastic) Total Thermal Cross Sections Calculated from File 7 with NDEX 8 at 296K, 500K, 700K, and 1000K



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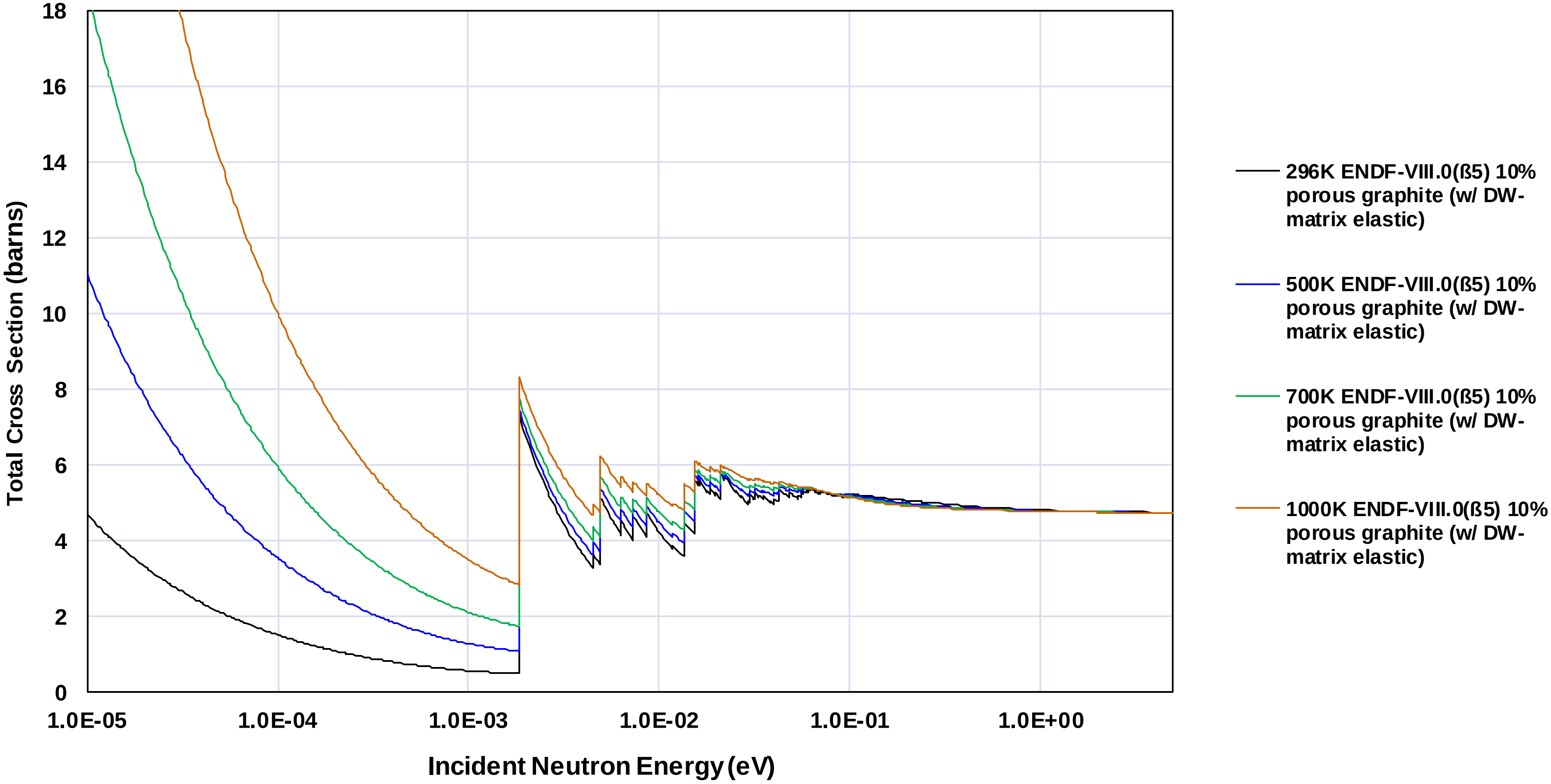
ENDF-VIII.0(β5) 10% Porous Graphite (w/ DW-Matrix Elastic) Total Thermal Cross Sections Calculated from File 7 with NDEX 8 at 296K, 500K, 700K, and 1000K



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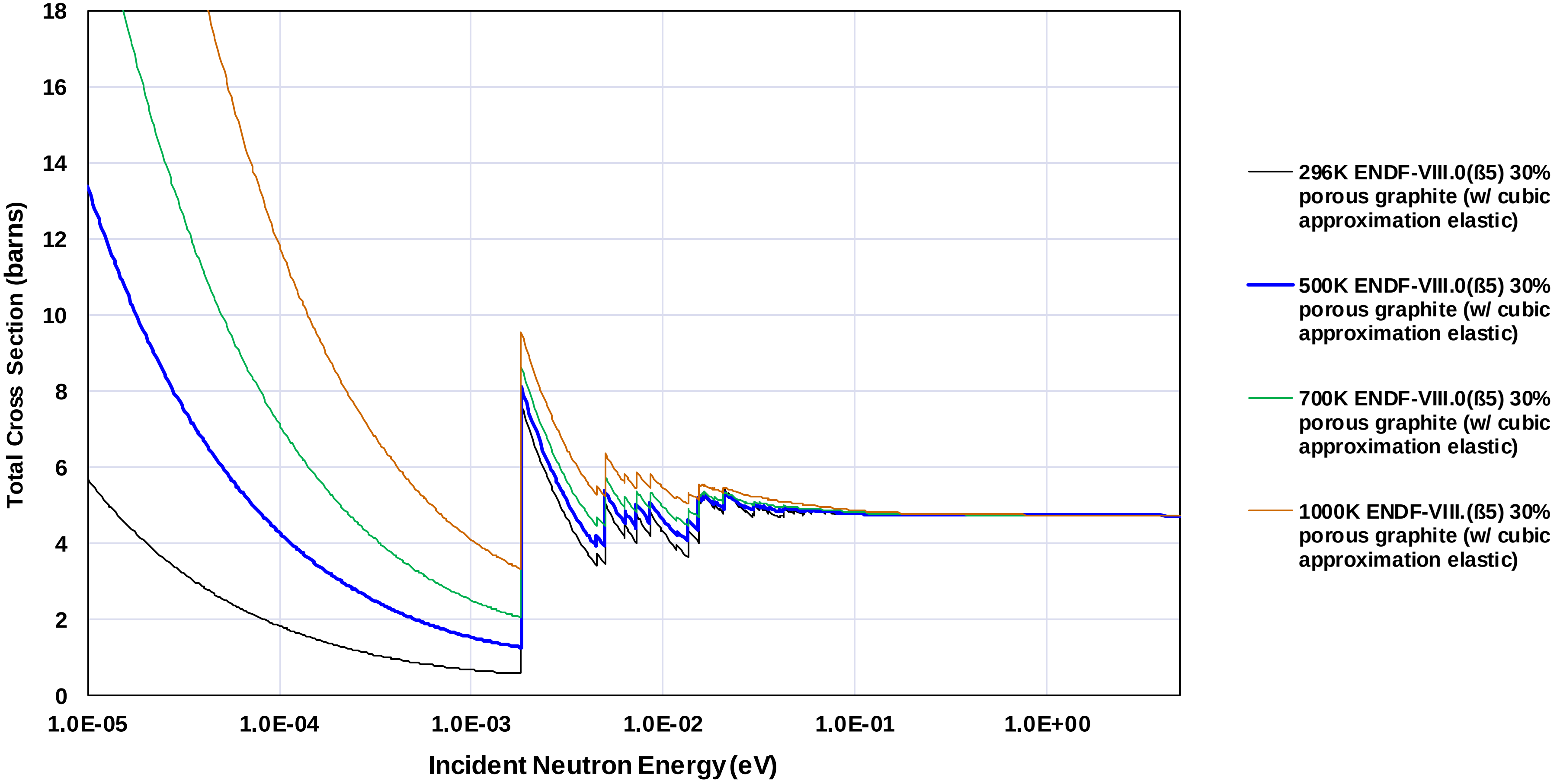
ENDF-VIII.0(β5) 30% Porous Graphite (w/ Cubic Approximation Elastic) Total Thermal Cross Sections Calculated from File 7 with NDEX 8 at 296K, 500K, 700K, and 1000K



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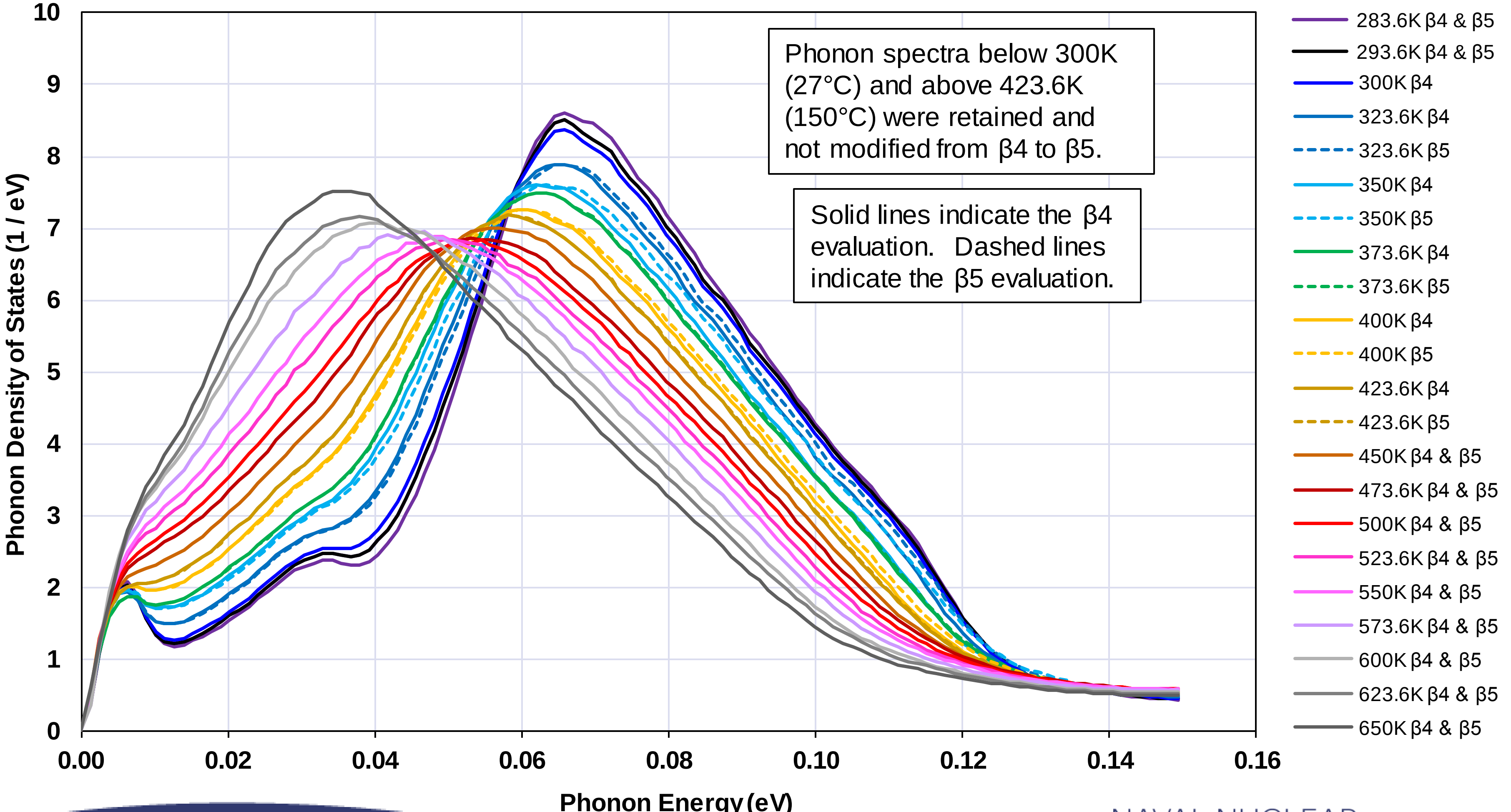
ENDF-VIII.0(β5) vs. -(β4) H-H_2O Phonon Spectrum Adjustments in LEAPR Input Deck



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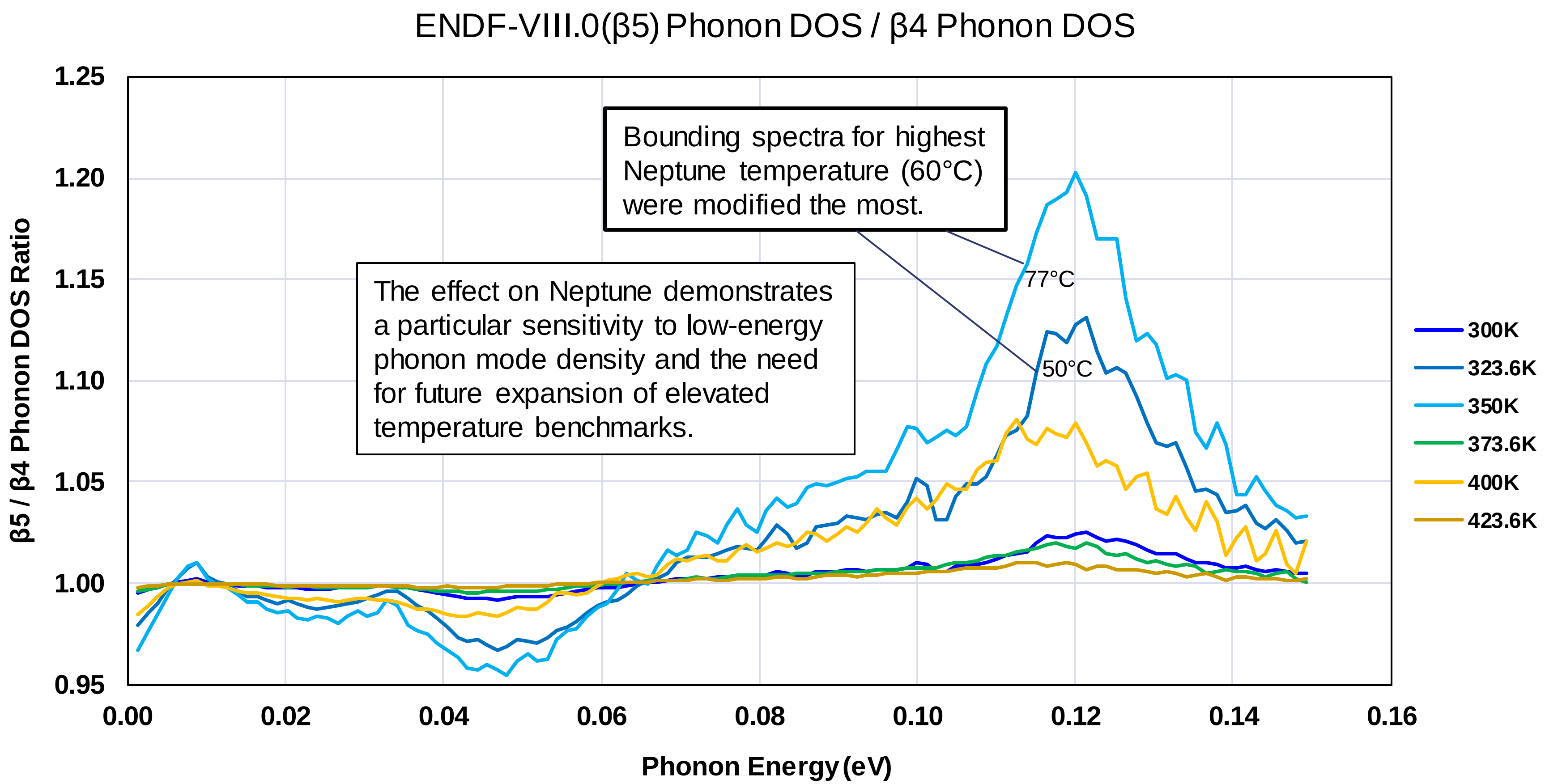

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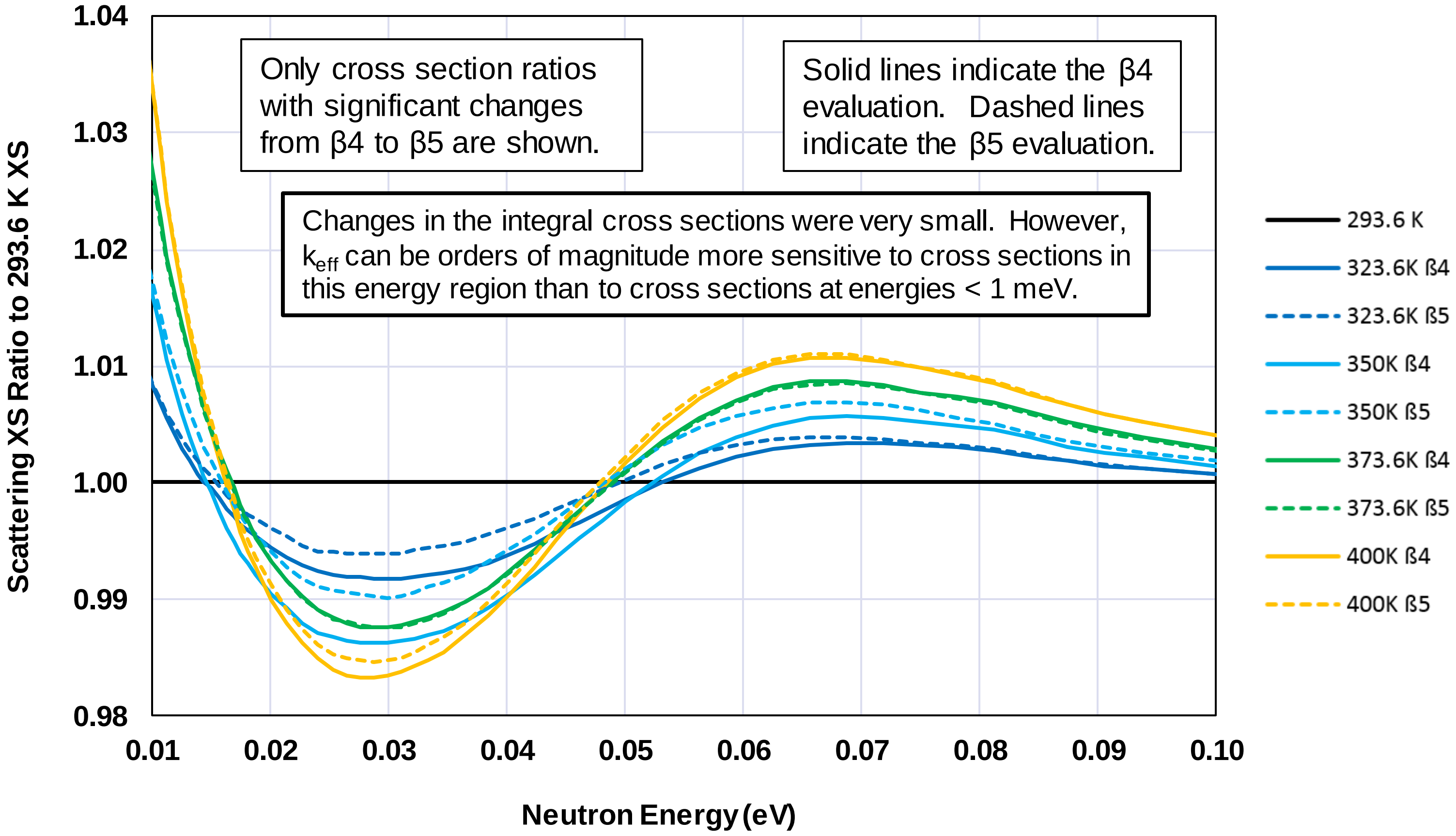
H-H_2O ENDF-VIII.0(β5) vs. -(β4) Temperature-Dependence of Intermediate-Energy Thermal Scattering Cross Section Ratios to 293.6 K Cross Sections



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