Description of a Proposed Thermal Titanium Experiment

Thermal/Epithermal eXperiments Feasibility Meeting

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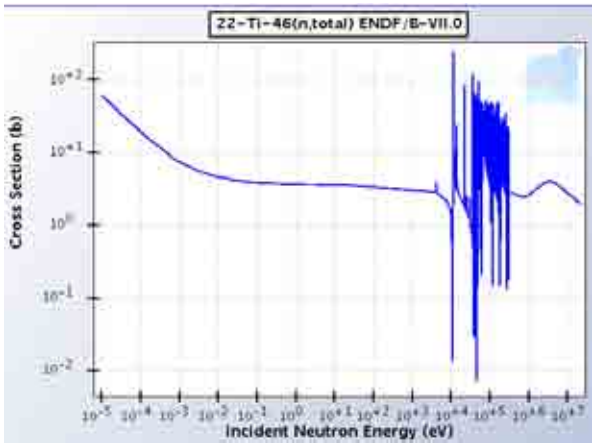
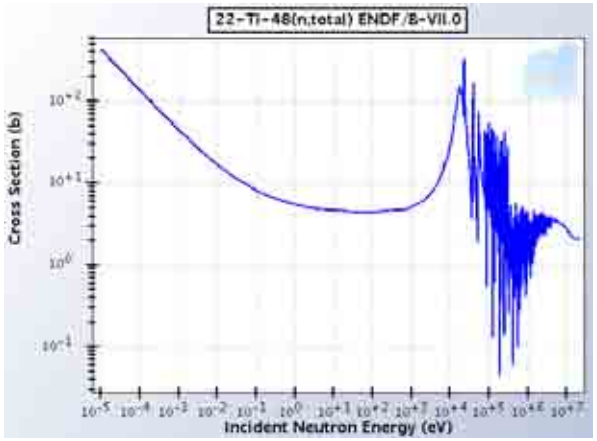
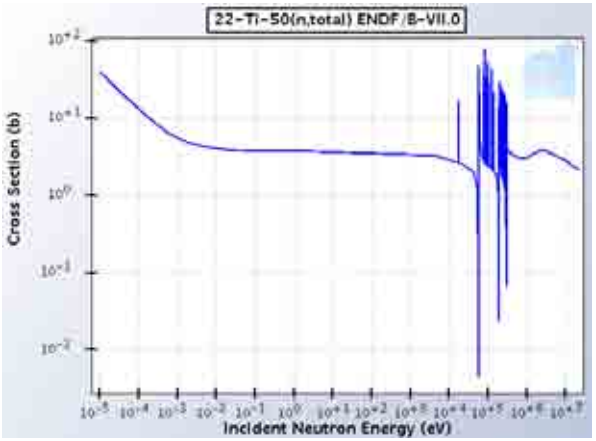
The origin of this experiment study

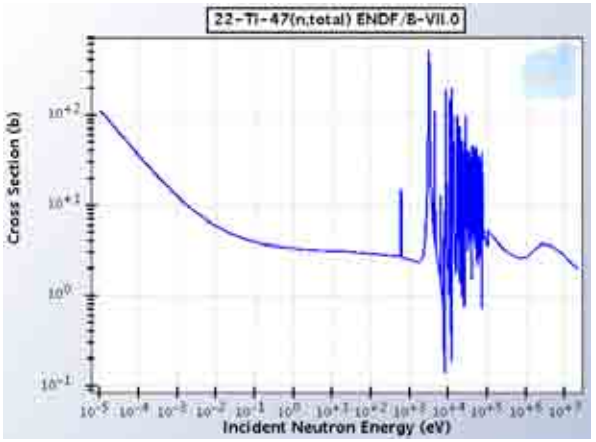
- The thought process covered here originated with a presentation by Brad Kerr at the ANS Annual Meeting in June, 2009
- The desire was for integral benchmark data for titanium in a thermal spectrum
- The data are needed to support criticality safety evaluations for processes using monosodium titanate ($NaTi_2O_5H$ – MST) at the Savanna River National Laboratory
- MST powder is used in adsorption columns for the separation of ^{90}Sr and actinides from fuel reprocessing waste solutions

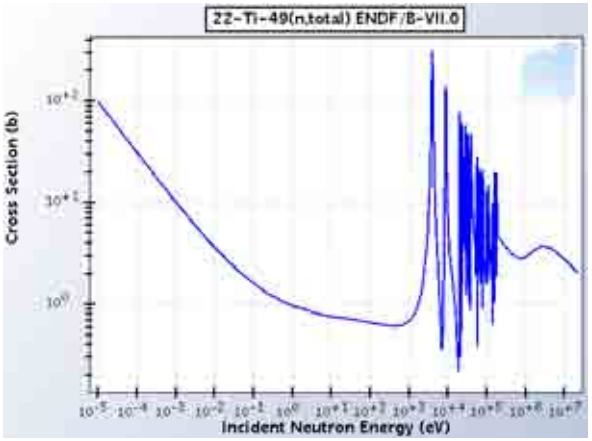
Titanium cross sections











Thermal absorption cross sections:

^{46}Ti (8.25%): 0.6 b

^{47}Ti (7.44%): 1.7 b

^{48}Ti (73.72%): 7.9 b

^{49}Ti (5.41%): 2.2 b

^{50}Ti (5.18%): 0.18 b

Ti (natural): 6.1b

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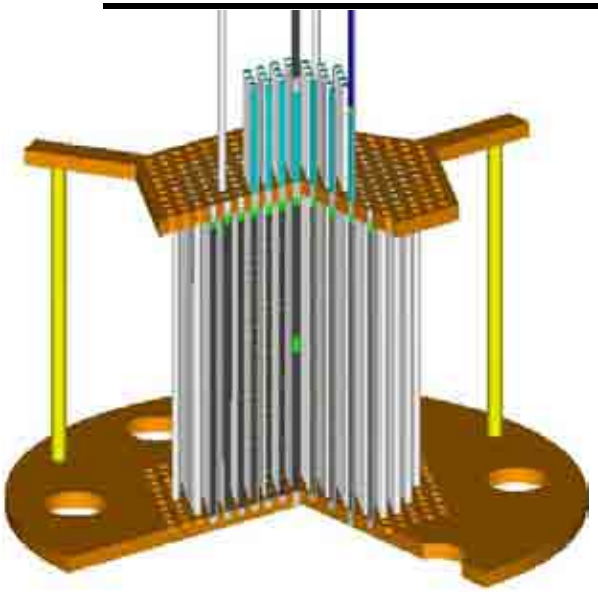
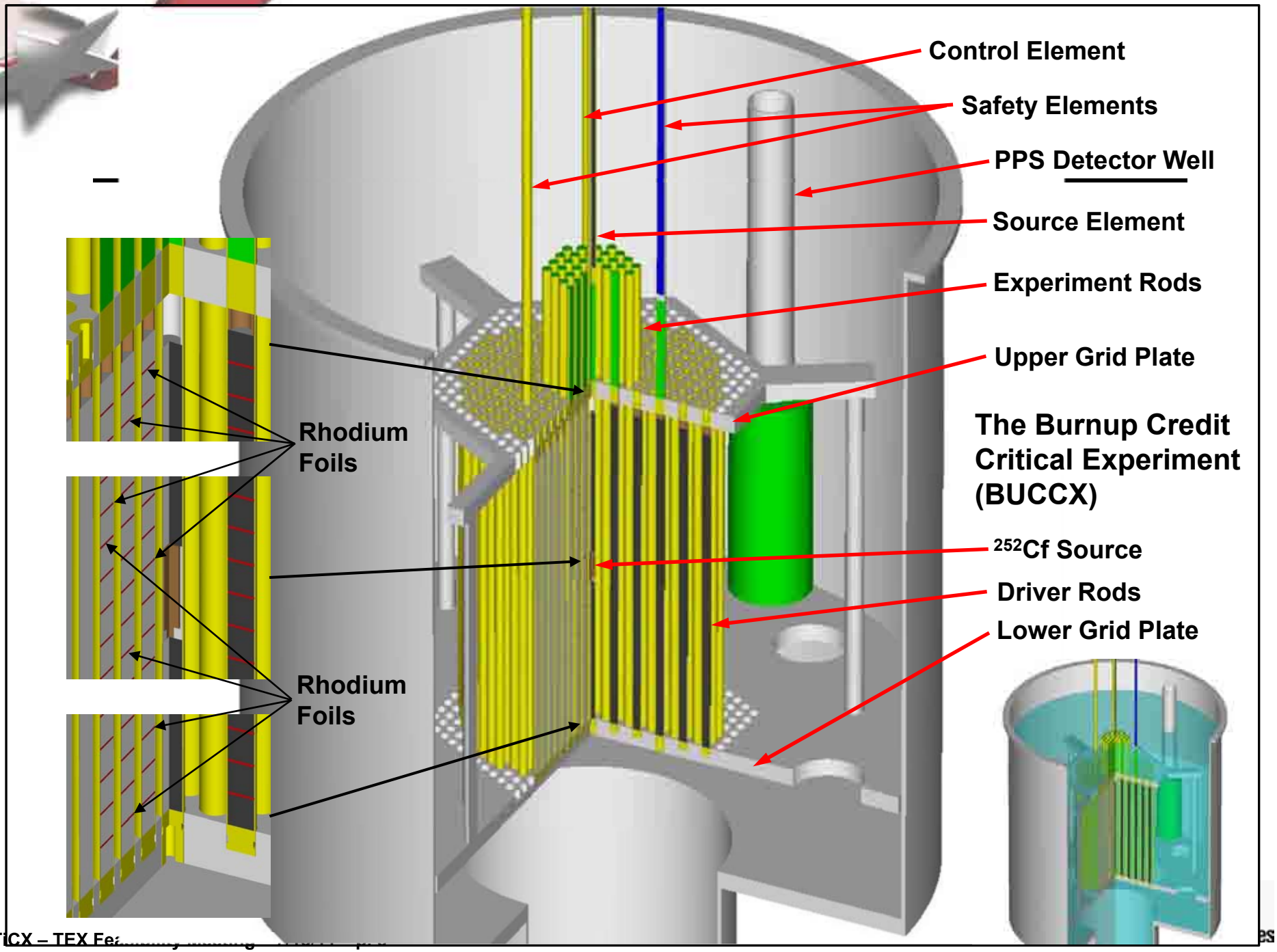
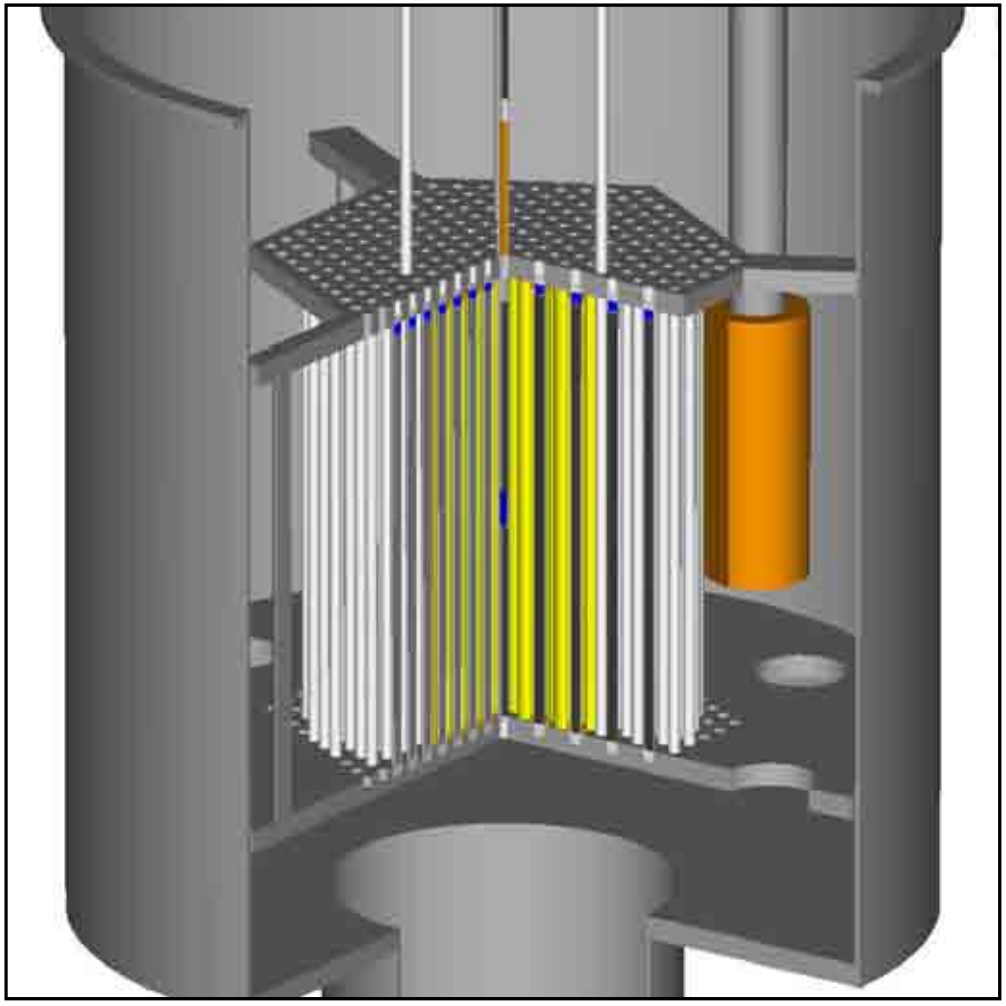
In 2002, we performed some critical experiments with rhodium

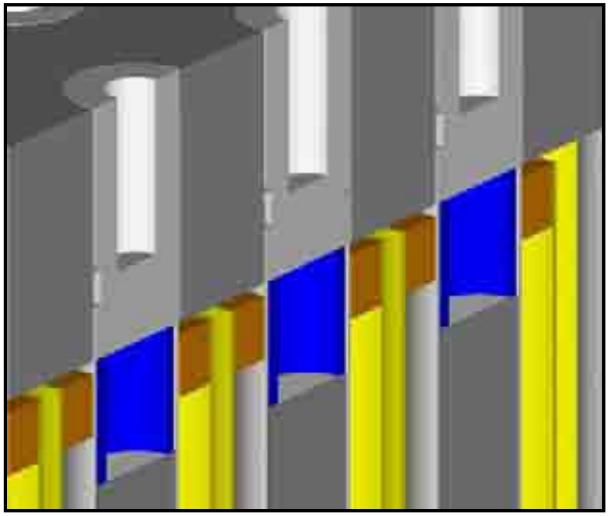


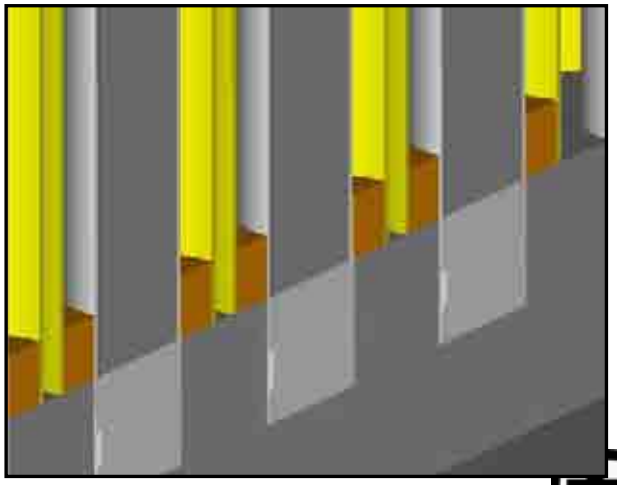
- The Burnup Credit Critical Experiment (BUCCX) was funded by the Nuclear Energy Research Initiative (NERI)
- We built a critical assembly in which we could insert fission product materials to measure reactivity effects
- The NERI funding was used to bring the experiment capability up and perform the first set of experiments
- We completed a set of experiments with rhodium
- The experiment is documented as LEU-COMP-THERM-079 in the International Handbook of Evaluated Criticality Safety Benchmark Experiments


Control Element
Safety Elements
PPS Detector Well
Source Element
Experiment Rods
Upper Grid Plate
Rhodium Foils
Rhodium Foils
The Burnup Credit Critical Experiment (BUCCX)
252Cf Source
Driver Rods
Lower Grid Plate

The experiment concept







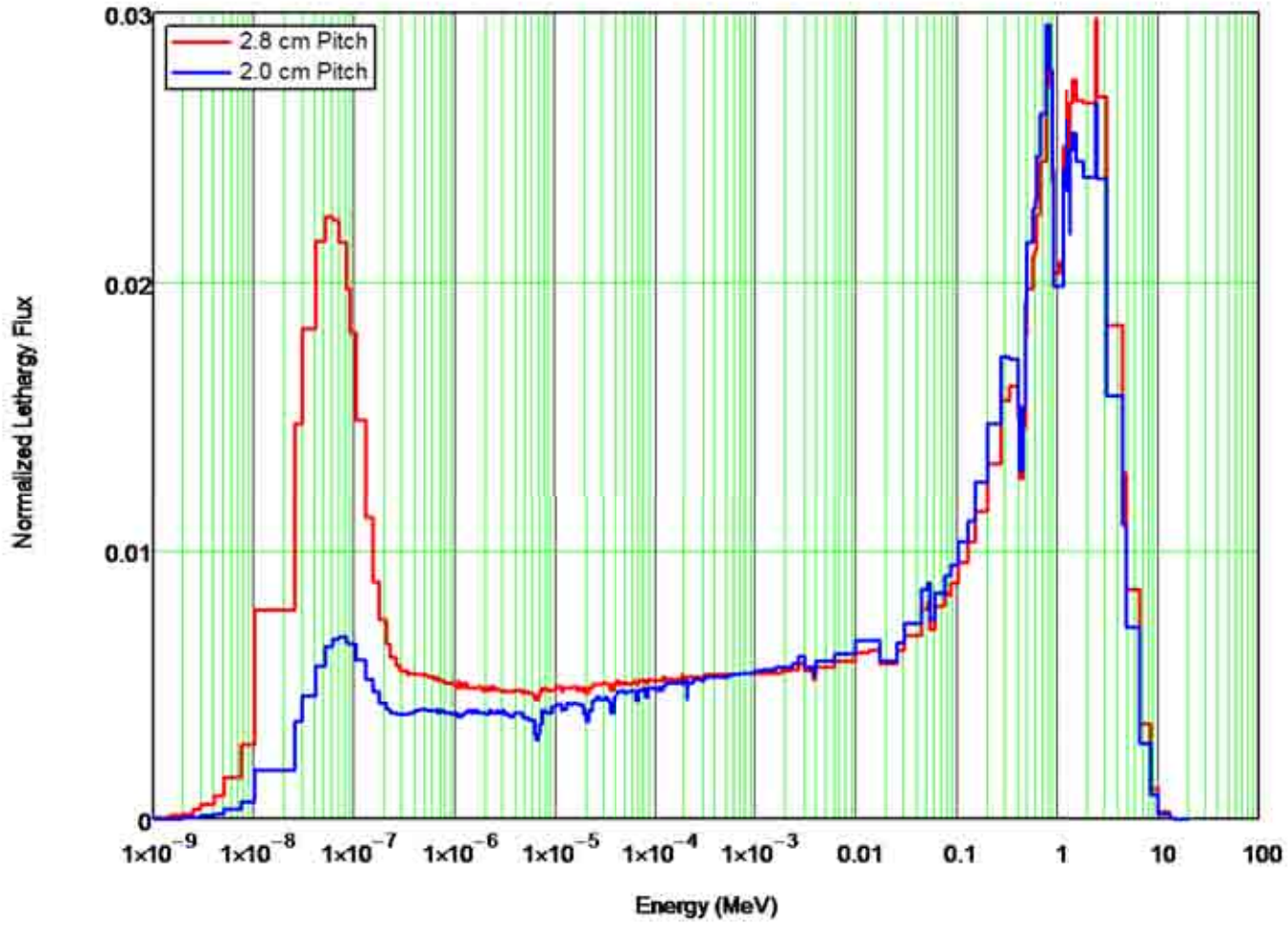
Available experiment hardware

- Two grid plate sets are available
  - 2.0 cm pitch (significantly undermoderated)
  - 2.8 cm pitch (near optimum moderation)
- 350 BUCCX fuel rods are available

Titanium tube availability

- Stock commercially-pure Grade 2 titanium tubes
  - ODs of 0.75 and 1.0 inch
  - Wall thicknesses of 0.028, 0.035, 0.049, and 0.065 inch
  - Reasonable cost
- Non-stock wall thickness can be fabricated at a higher cost

The neutron spectra in the titanium tubes



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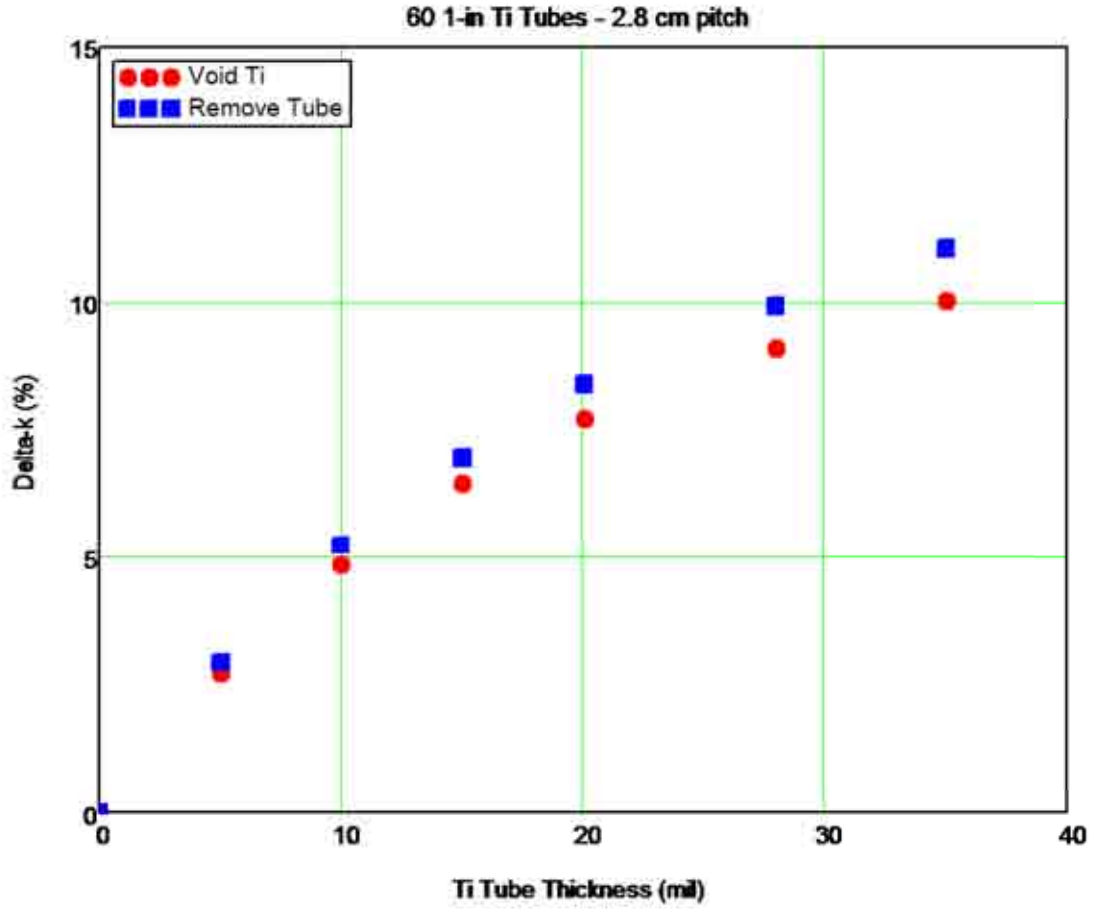
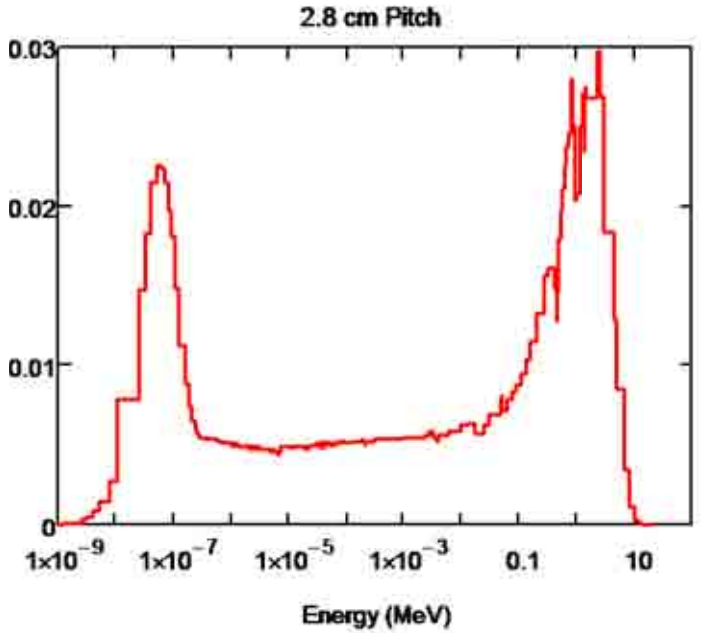
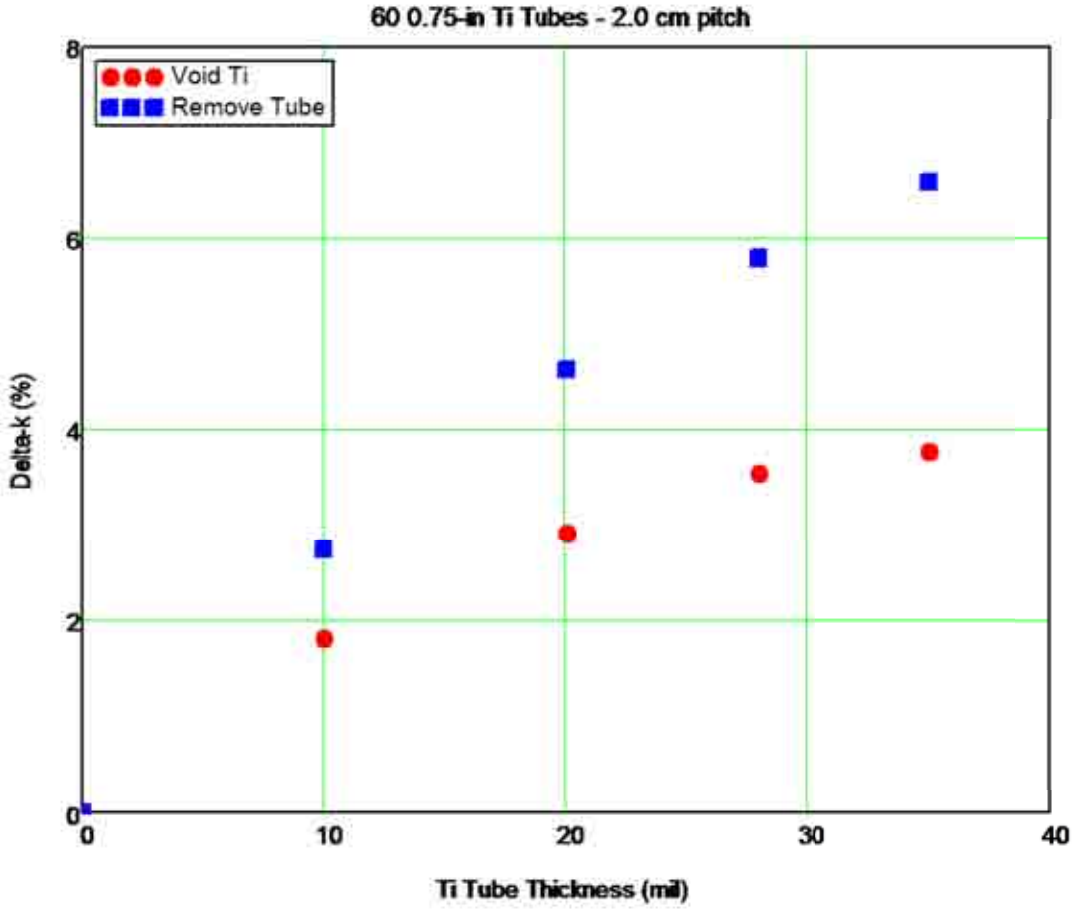
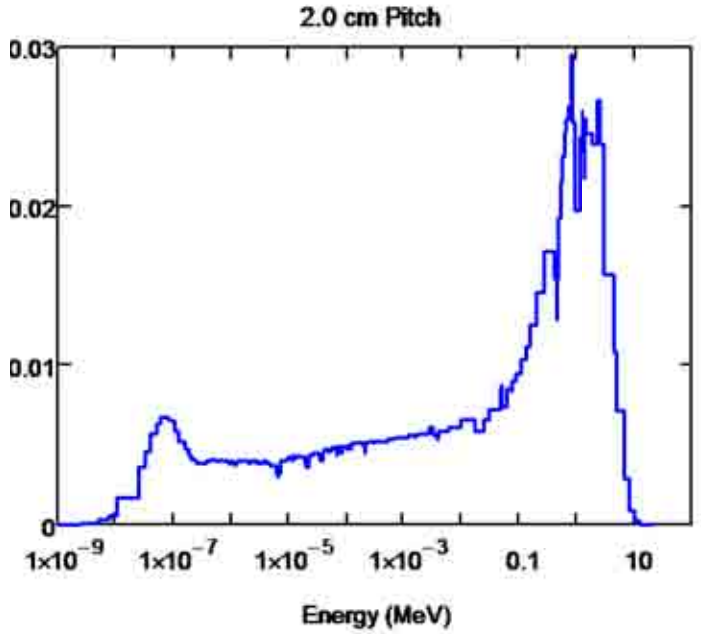
Results – 2.8 cm pitch, 1 inch tubes





Results – 2.0 cm pitch, 0.75 inch tubes





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Conclusions

- Critical experiments with titanium in the thermal spectra available in the BUCCX are feasible with the existing critical experiment hardware.
- The available quantity of BUCCX fuel is adequate to perform these experiments.
- Commercially-available titanium tubing (a.k.a. relatively low-cost) may be usable as experiment samples.
- The titanium worth in the experiments is well above the anticipated uncertainties in the experiments.
- The reaction-rate profiles across the thickness of the tubes are relatively flat indicating minimal self-shielding occurs in the tubes.

What's next?

- $C_E dT$