



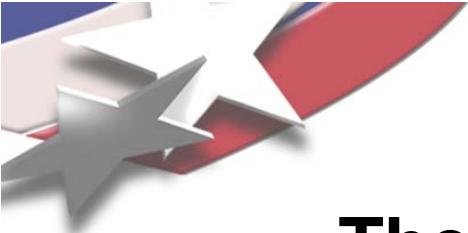
Description of a Proposed Thermal Titanium Experiment

Thermal/Epithermal eXperiments Feasibility Meeting

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Sandia National Laboratories**

SAND2011-XXXXX

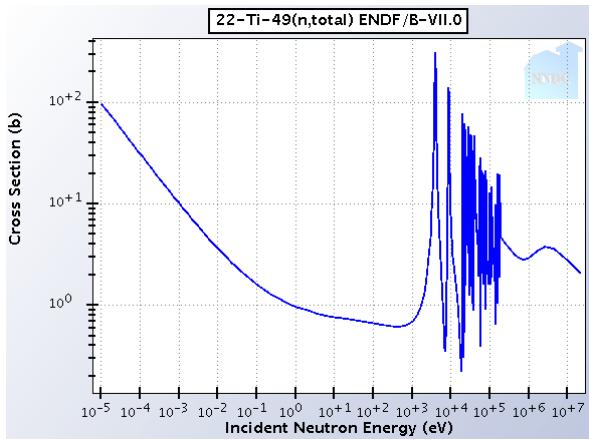
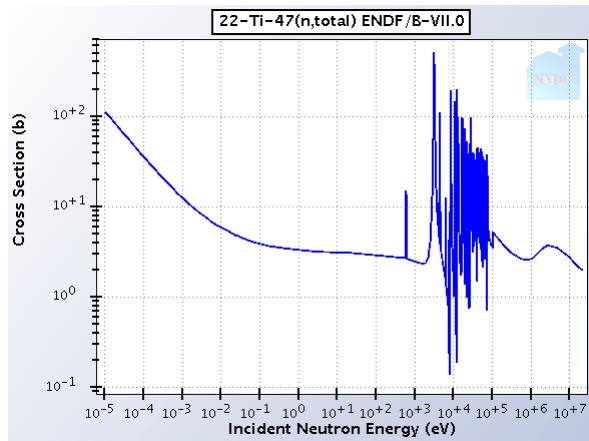
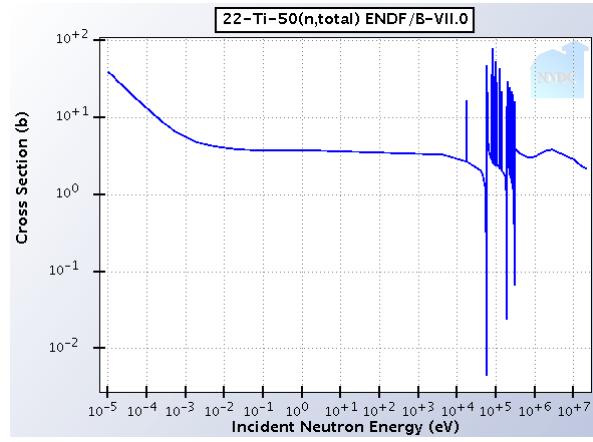
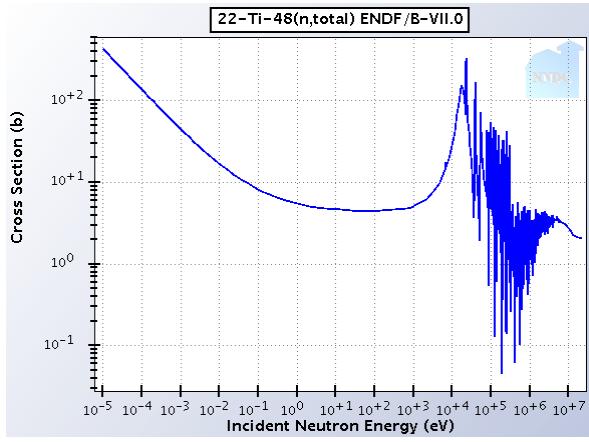
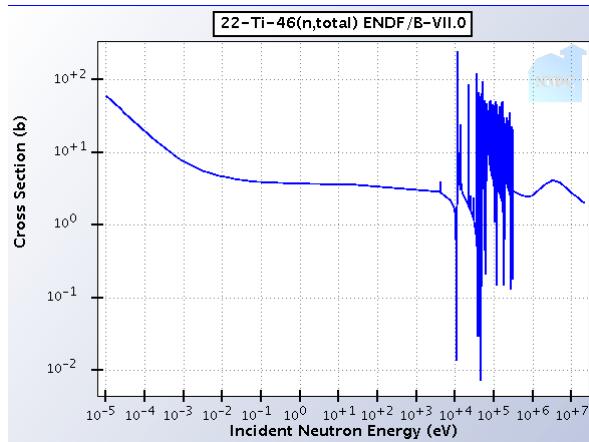


The origin of this experiment study

- 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 ($\text{NaTi}_2\text{O}_5\text{H}$ – MST) at the Savannah 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

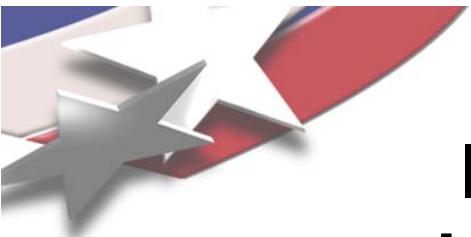
^{47}Ti (7.44%): 1.7 b

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

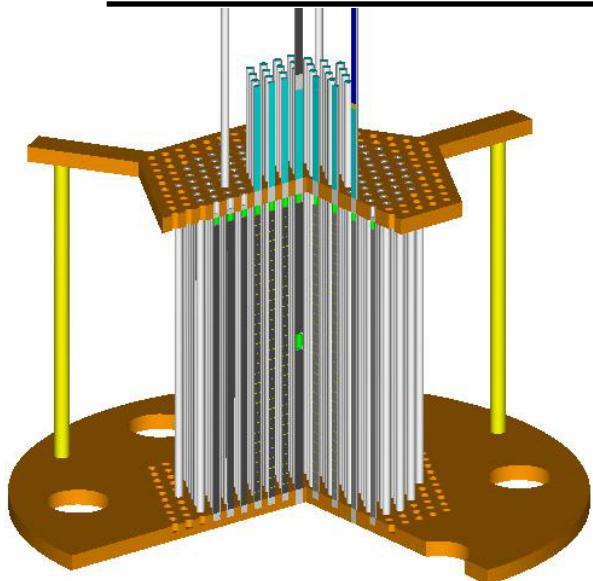
^{49}Ti (5.41%): 2.2 b

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

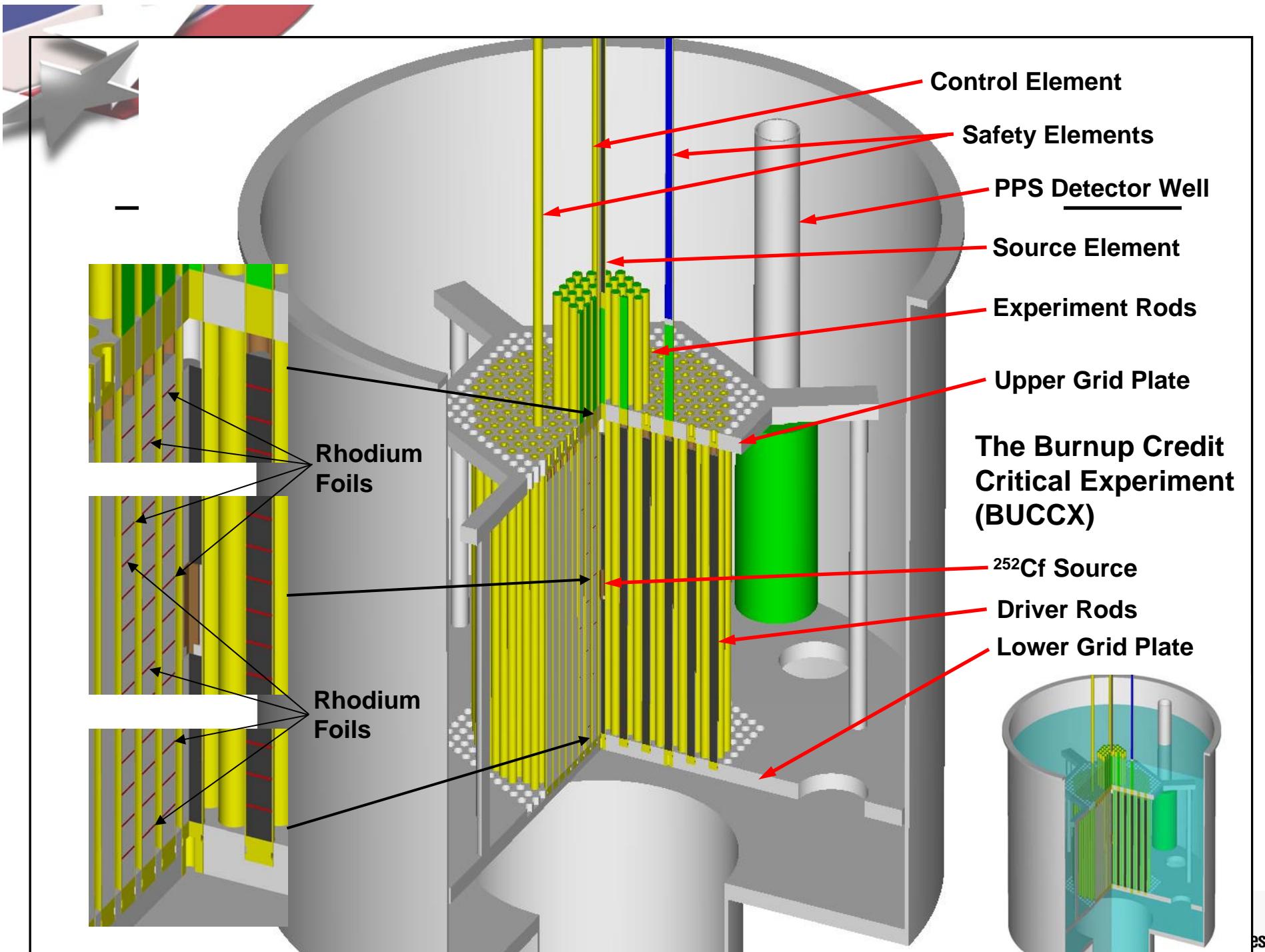
Ti (natural): 6.1b



In 2002, we performed some critical experiments with rhodium

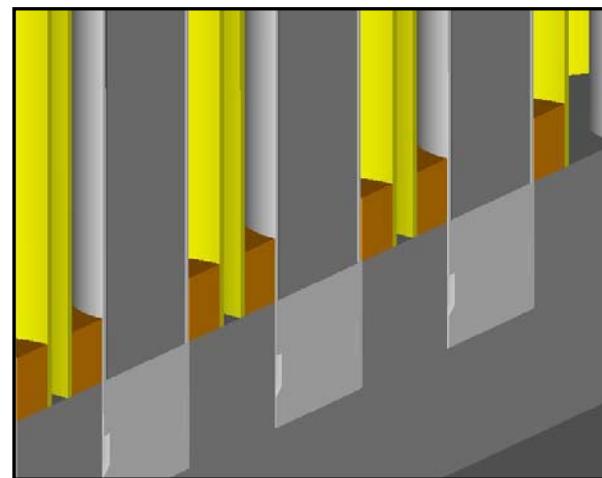
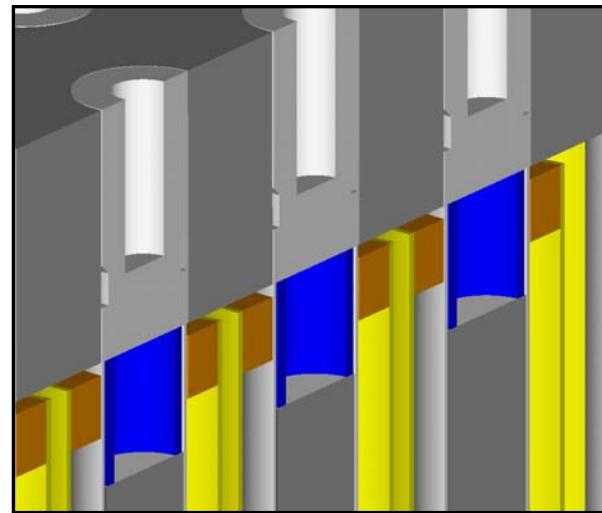
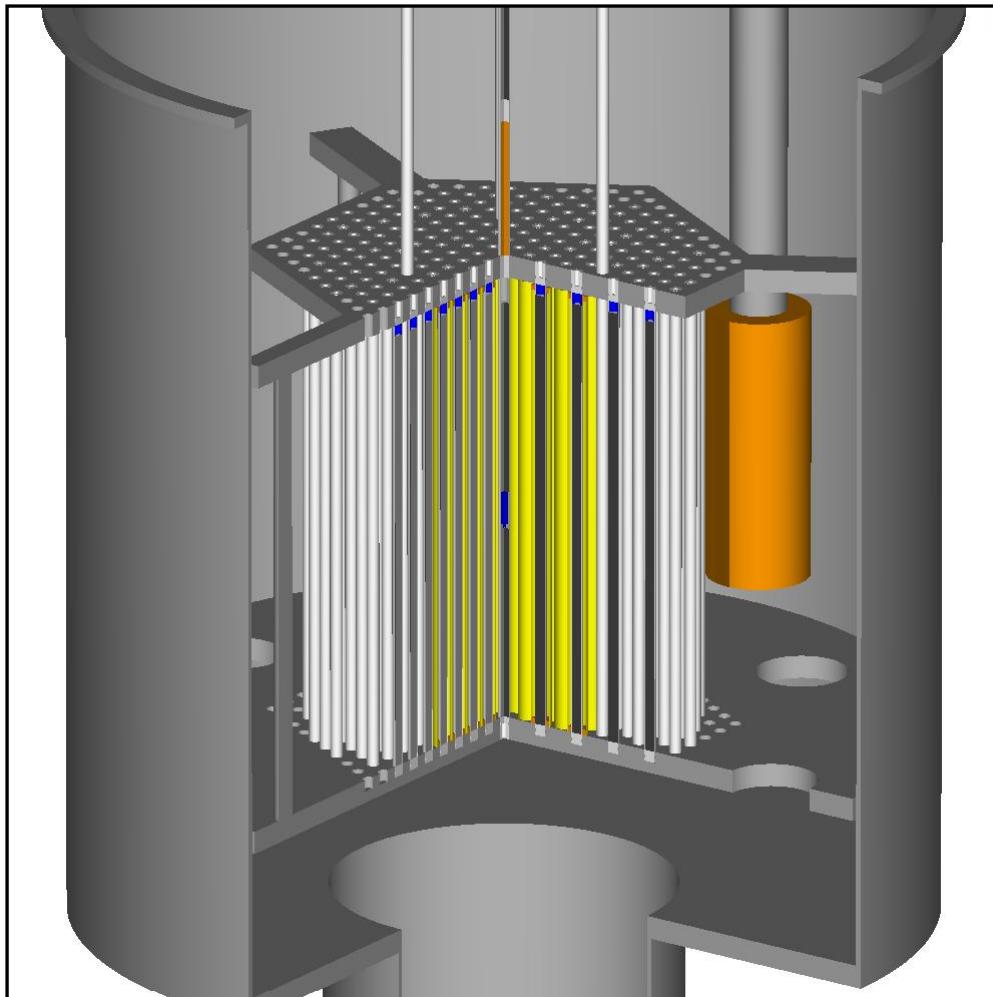


- The Burnup Credit Critical Experiment (BUCCX) was funded by the Nuclear Energy Research Initiative (NERI)
- We built a critical assembly in which we could insert fission product materials to measure reactivity effects
- The NERI funding was used to bring the experiment capability up and perform the 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





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

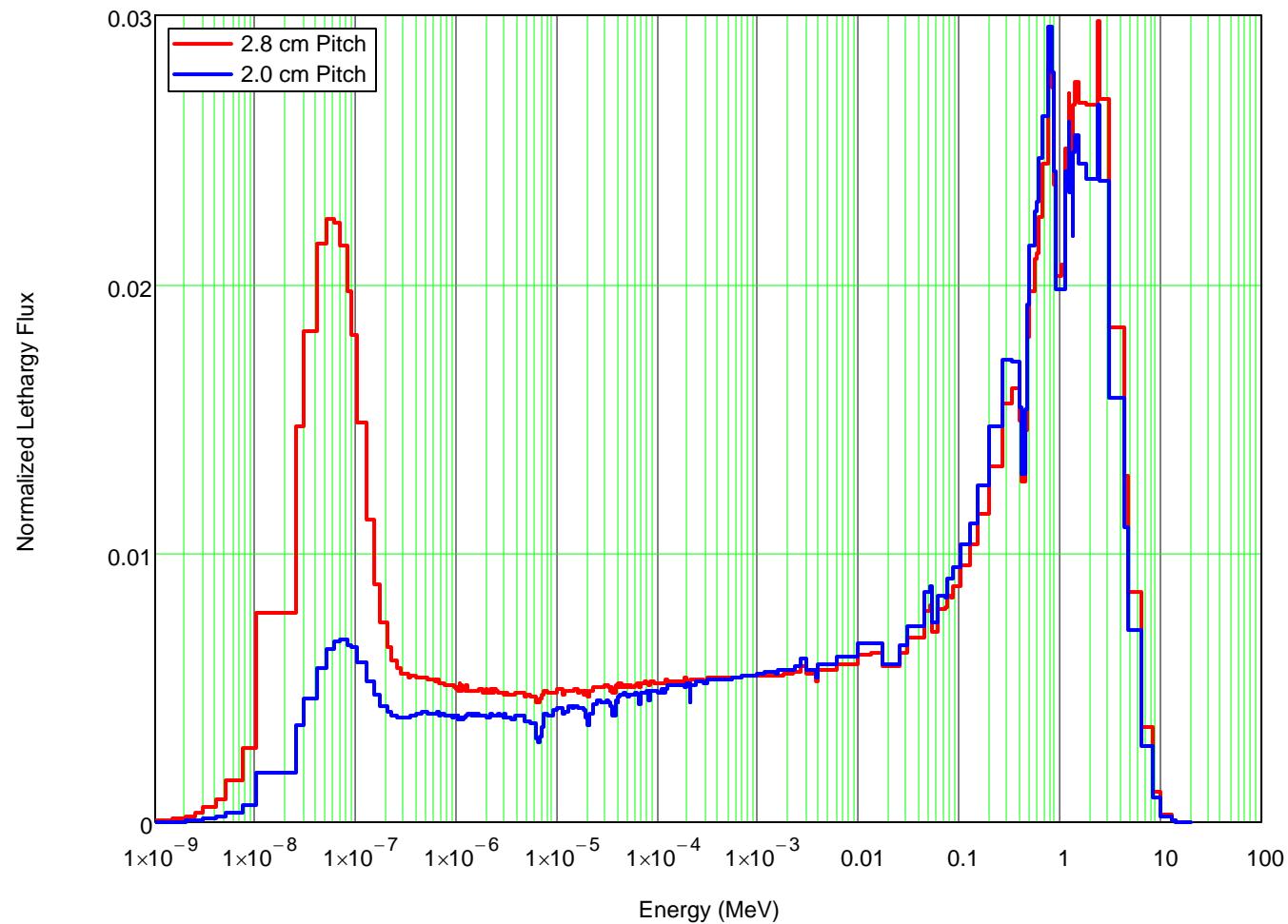


Titanium tube availability

- 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

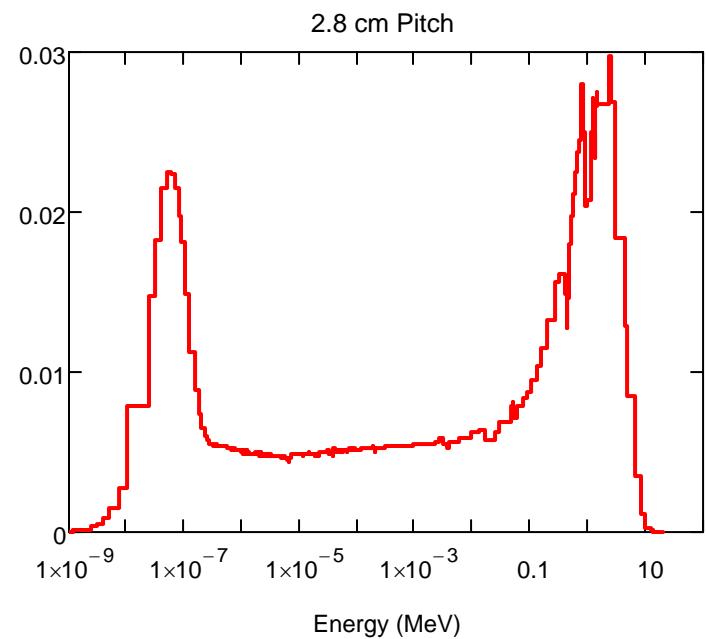
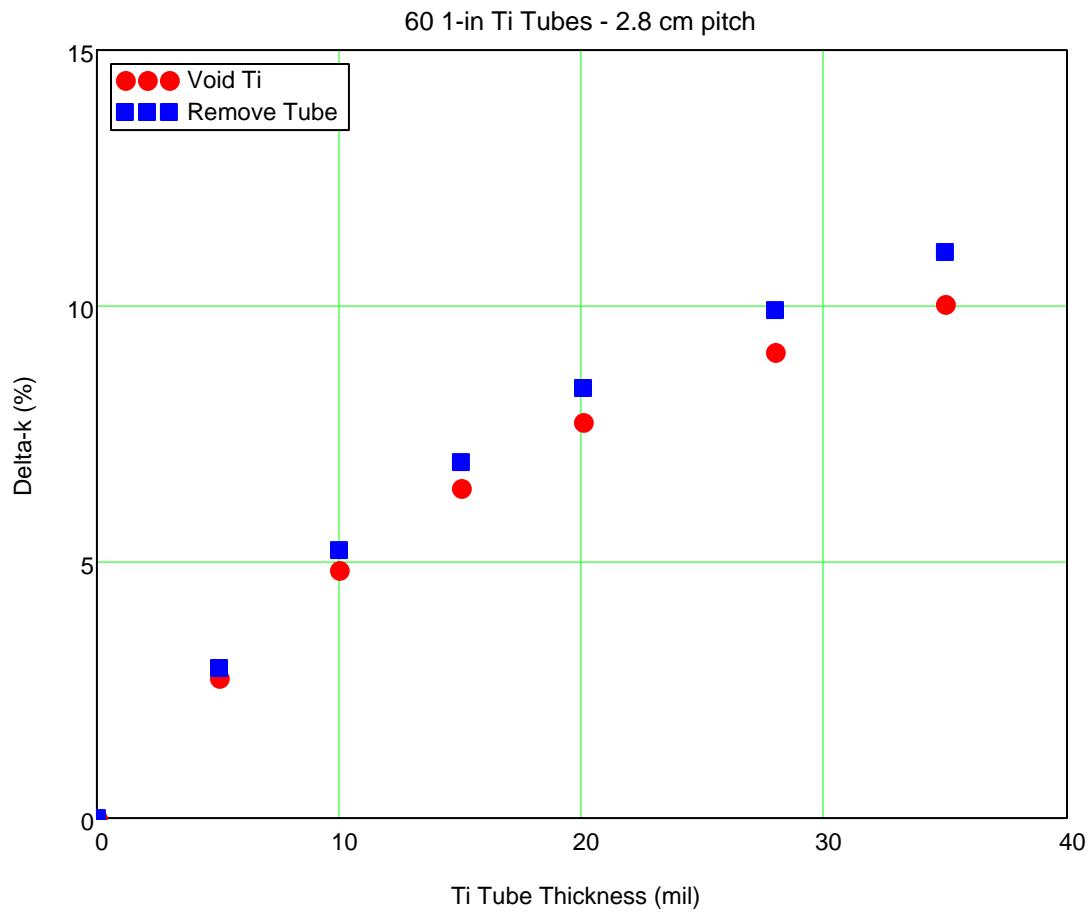


The neutron spectra in the titanium tubes



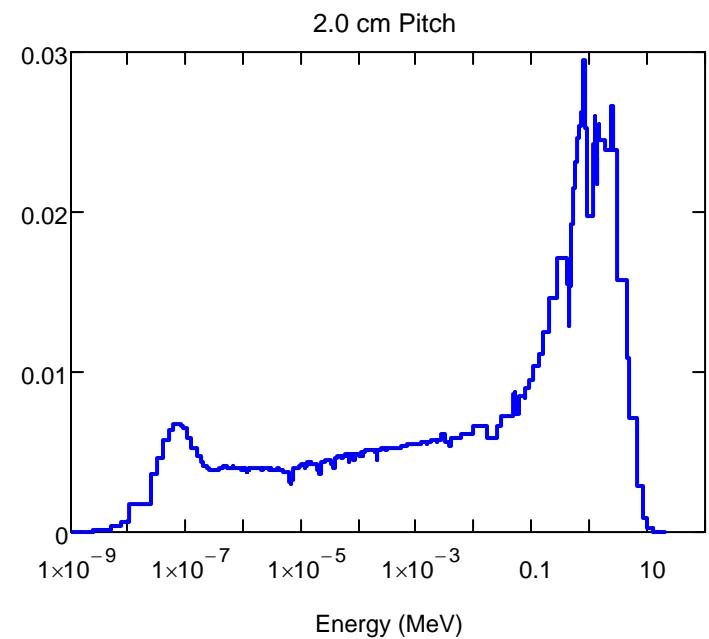
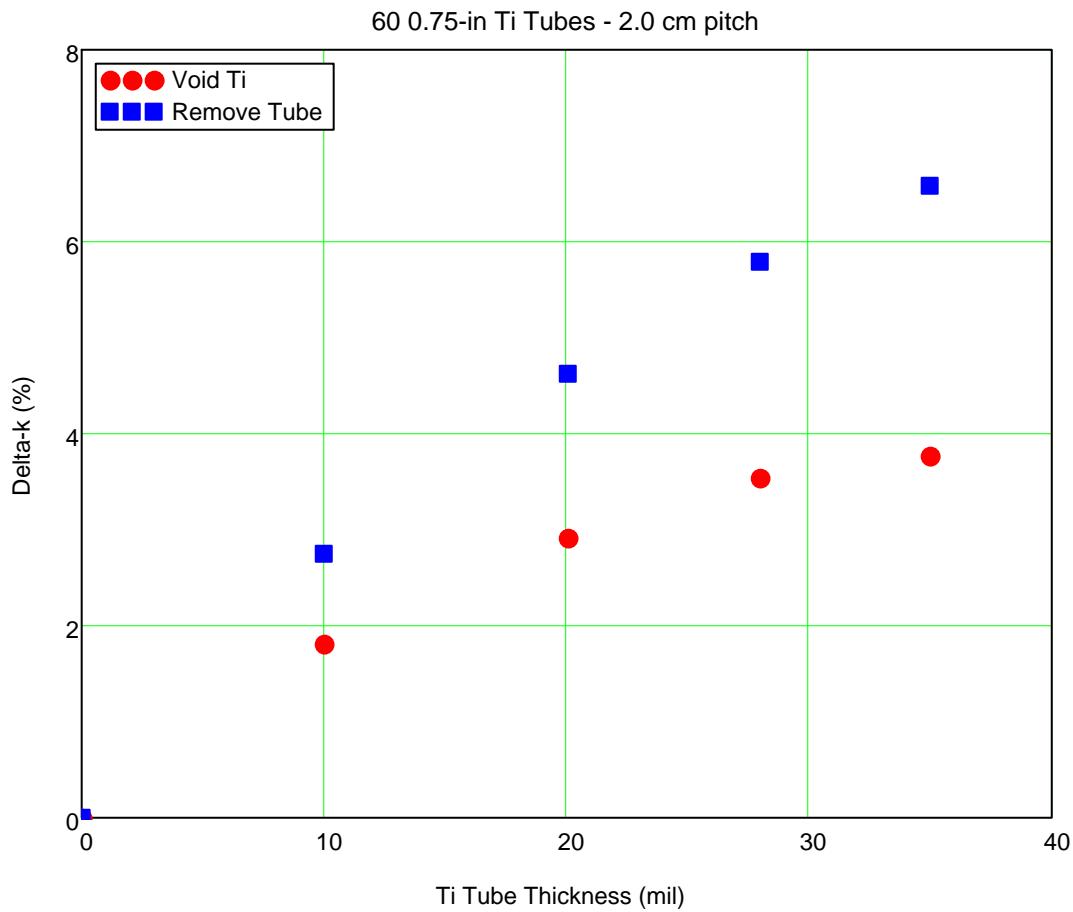


Results – 2.8 cm pitch, 1 inch tubes





Results – 2.0 cm pitch, 0.75 inch tubes





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?

- $C_E dT$