Overview of NCSP Integral Experiments at Sandia

Nuclear Criticality Safety Program Technical Program Review

Oak Ridge, TN

March 28, 2018

Presented by
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Sandia National Laboratories

SAND2018-2995 PE

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Sandia Integral Experiment Requests

IER	Title	Sponsor	CED
206	Re-establish the 4.3% Enriched Critical Experiment Capability at Sandia	SNL	4a
209	7uPCX 0.855 cm Pitch, Variable Depth Pure Water Moderator	SNL	3b
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452	Inversion Point of the Isothermal Reactivity Coefficient	SNL	1

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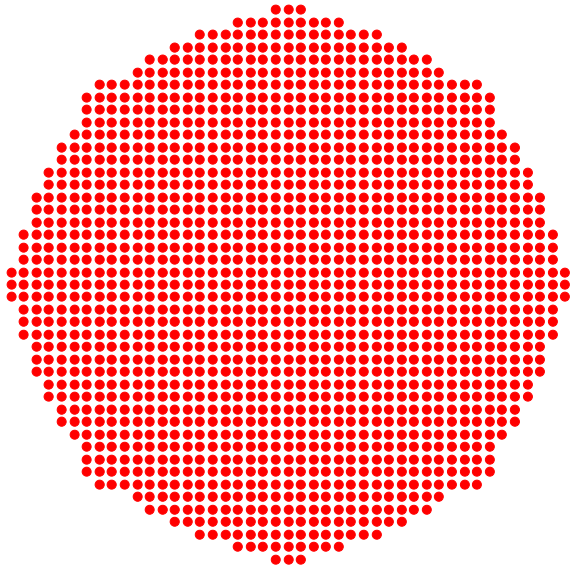
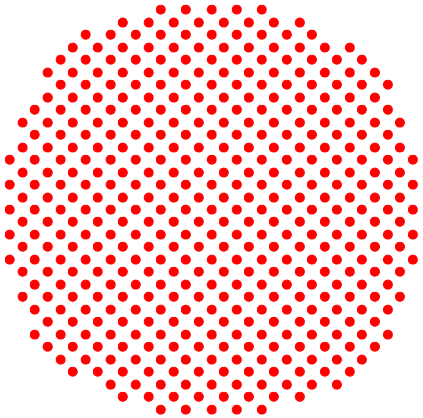
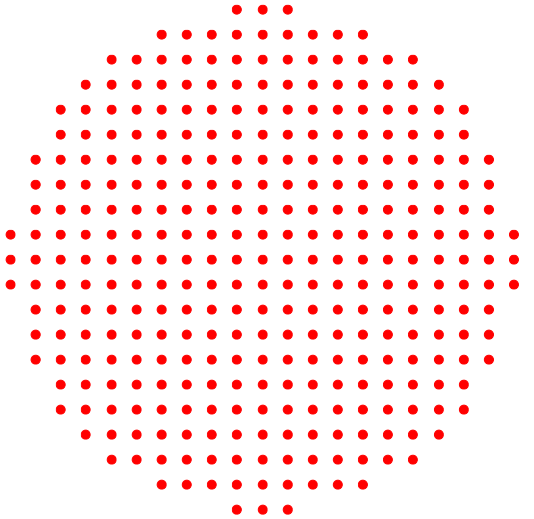
IER-230 – Characterize the Thermal Capabilities of the 7uPCX



0.800 cm Pitch
1461 Rods at DC



1.132 cm Pitch
454 Rods at DC



1.600 cm Pitch
328 Rods at DC

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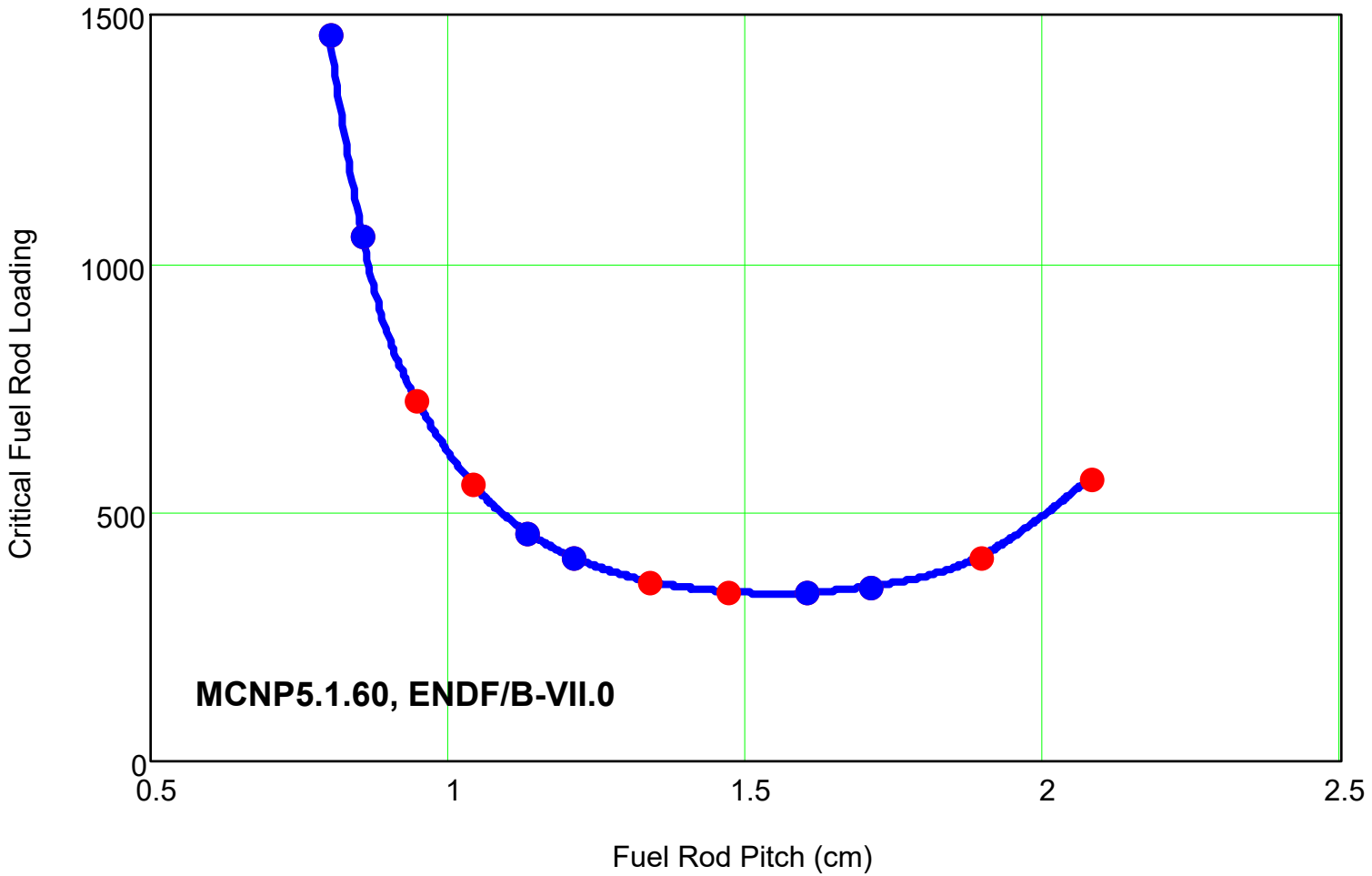
Number of Fuel Rods at DC vs Pitch



The blue points are for existing grid plates (0.800 and 0.855 cm pitch).
The red points are for new grid plates (0.947 and 1.039 cm pitch)

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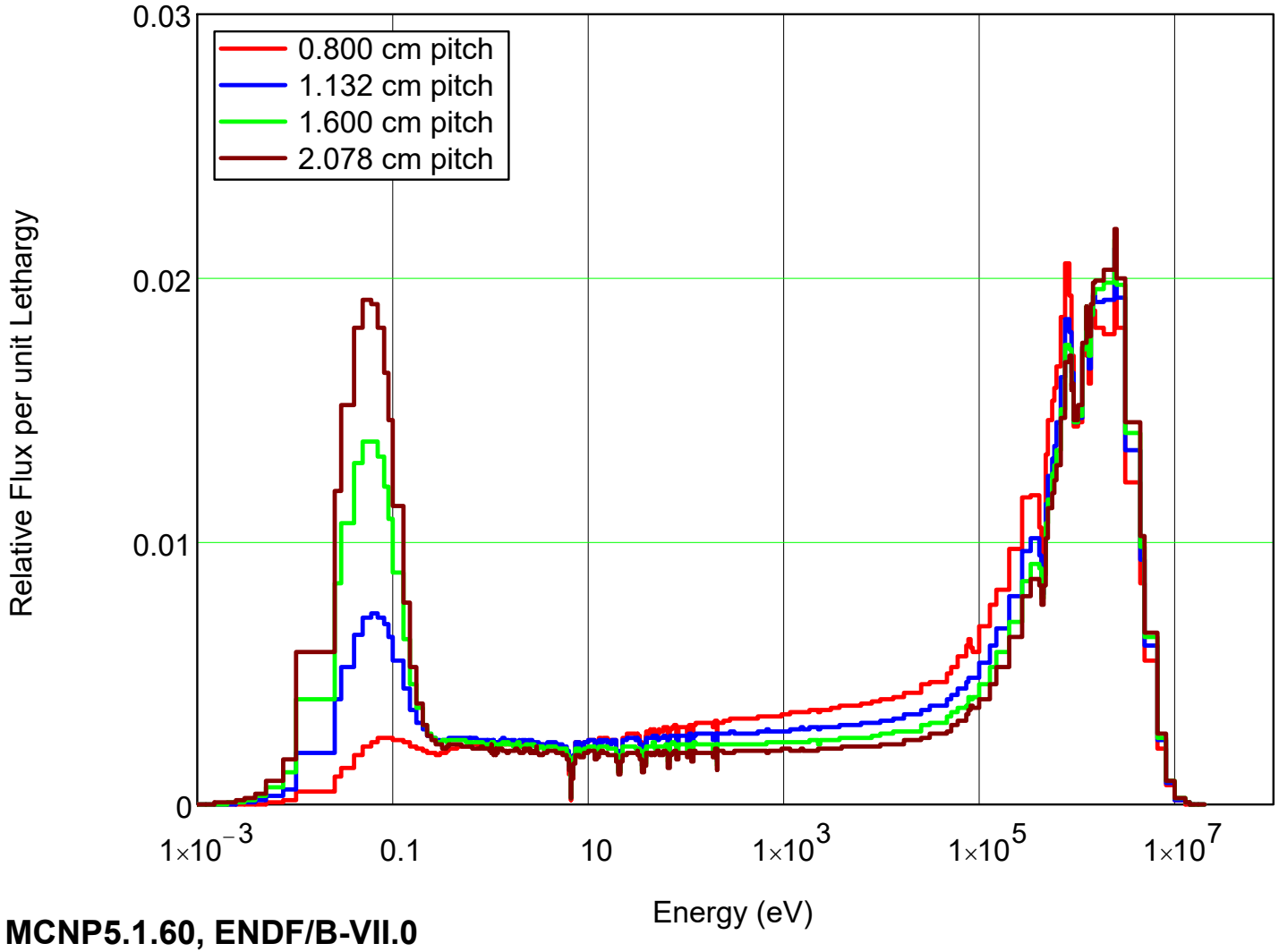
The Neutron Spectrum vs Pitch



MCNP5.1.60, ENDF/B-VII.0

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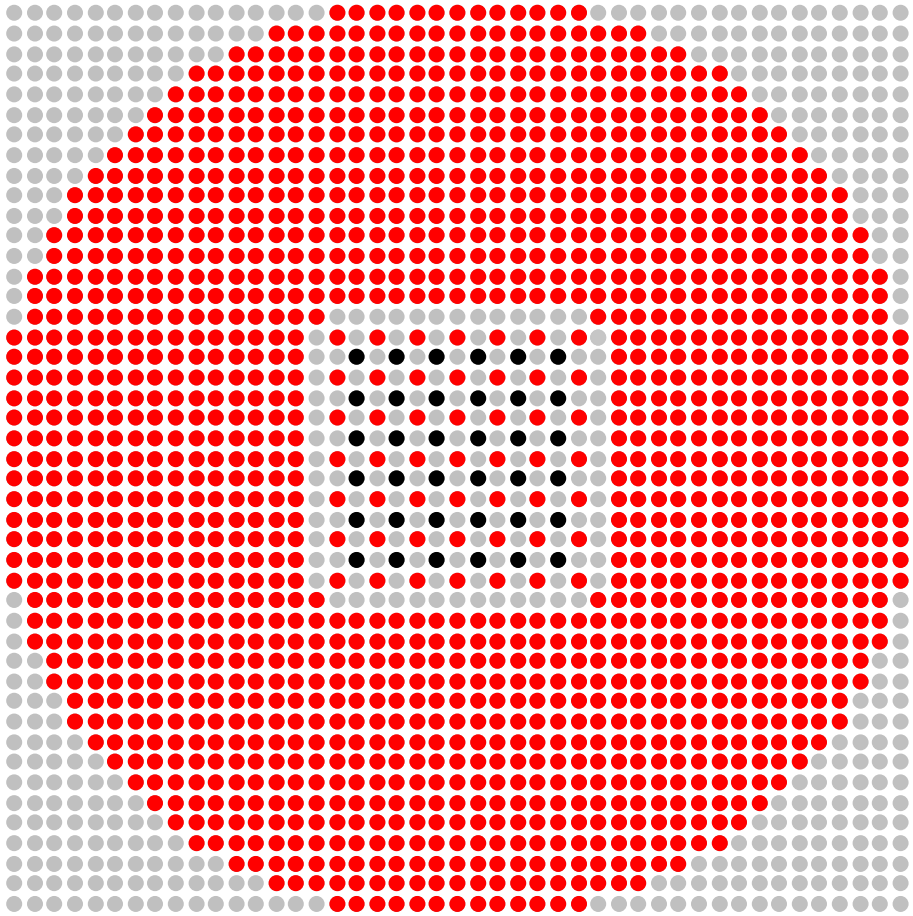
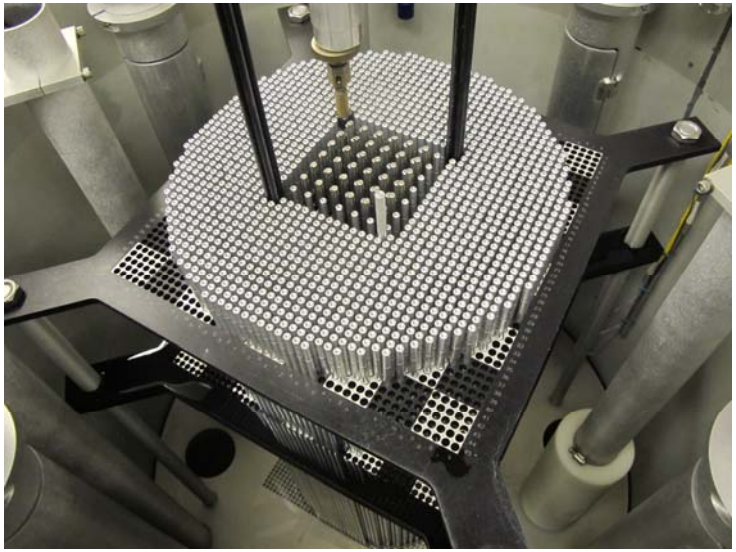
IER-285
LEU-COMP-THERM-097 Case 24



- Fuel Rod
- Empty Grid Location
- Titanium Experiment Rod

We stole the IER-230 concept from ourselves and used it in some of the IER-285 experiments



Fuel	1485
Expt.	36 Ti
Empty	136
Total	1657

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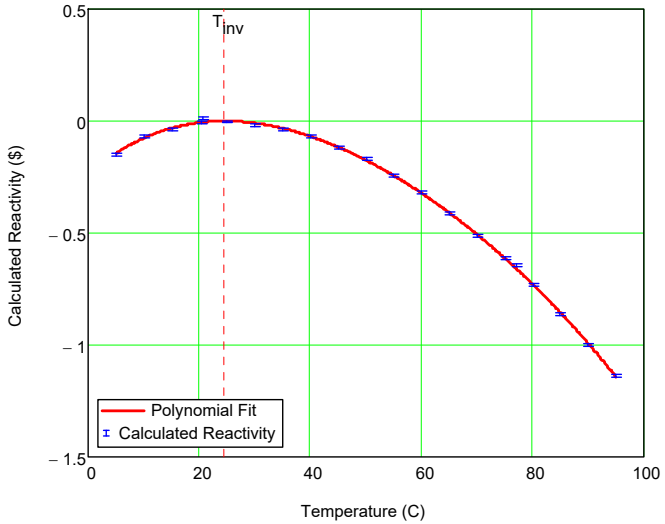
IER-452 – Inversion Point of the Isothermal Reactivity Coefficient



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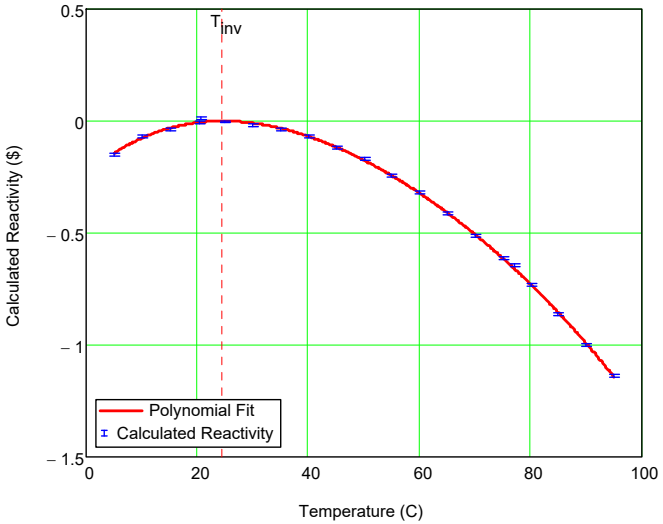
IER-452 – Inversion Point of the Isothermal Reactivity Coefficient



International Reactor Physics Experiment Evaluation Project: International Handbook of Evaluated Reactor Physics Benchmark Experiments

IPEN(MB01)-LWR-RESR-017
THE INVERSION POINT OF THE ISOTHERMAL REACTIVITY COEFFICIENT OF THE IPEN/MB-01 REACTOR
Adimir dos Santos et al.

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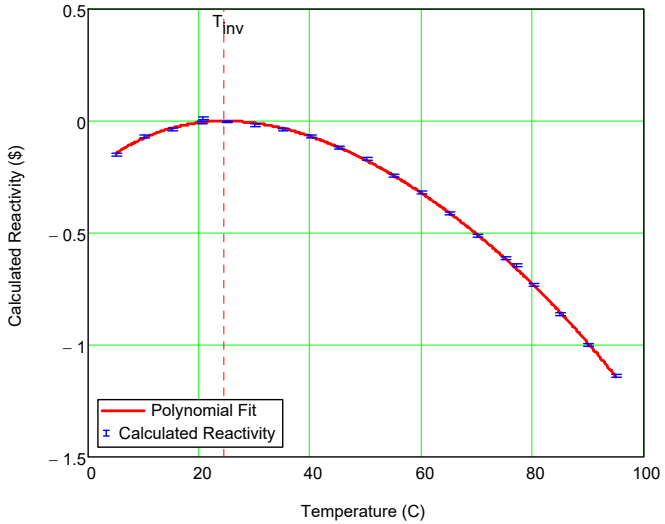
IER-452 – Inversion Point of the Isothermal Reactivity Coefficient



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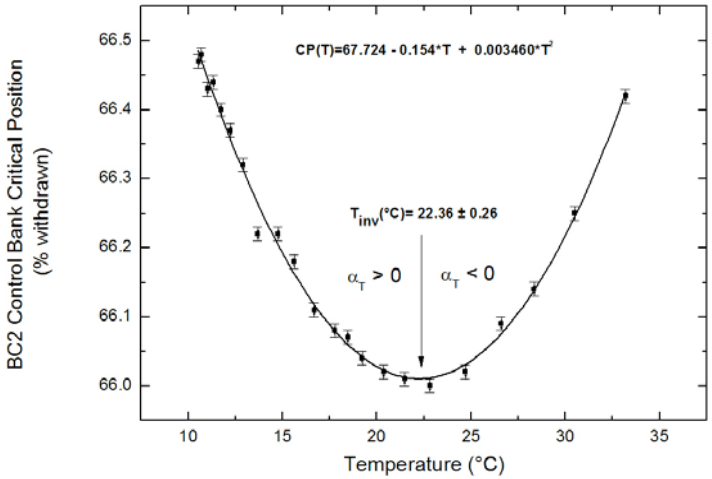

Adimir and his colleagues measured three systems with T_{inv} between 14.99 and 22.36 C

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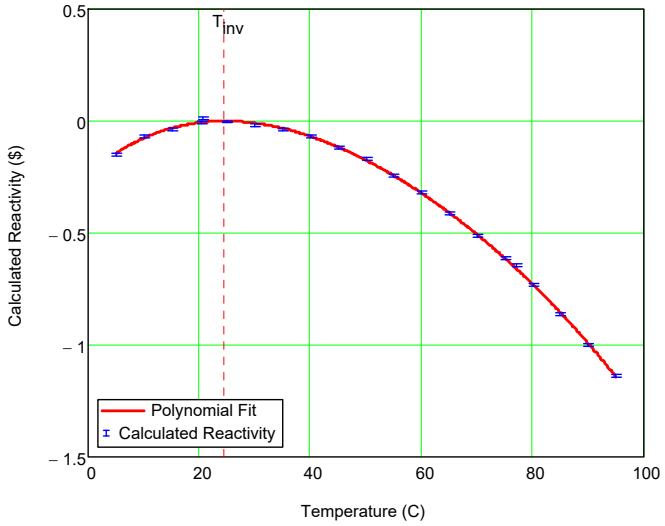
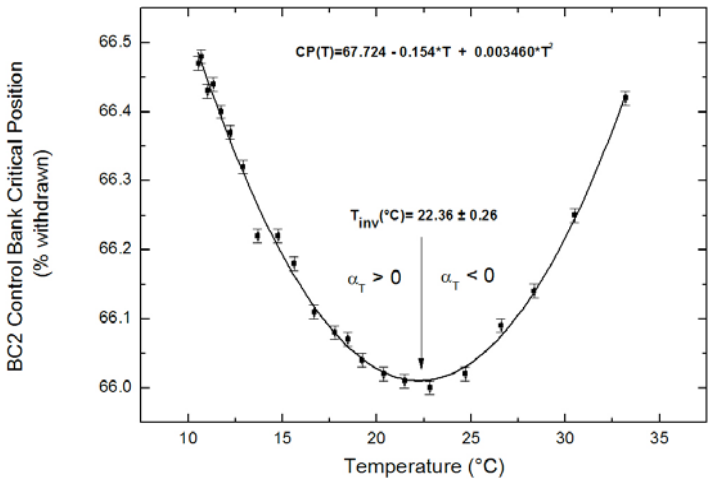
IER-452 – Inversion Point of the Isothermal Reactivity Coefficient





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What IS required:

1. Control element with high-precision position indication (worth need not be calibrated)
2. Ability to measure power changes
3. Accurate knowledge of the temperature in the core (uniformity – space and time – is important)

What IS NOT required:

Knowledge (measurement/calculation/guess) of the kinetics parameters of the system

Adimir and his colleagues measured three systems with T_{inv} between 14.99 and 22.36 C

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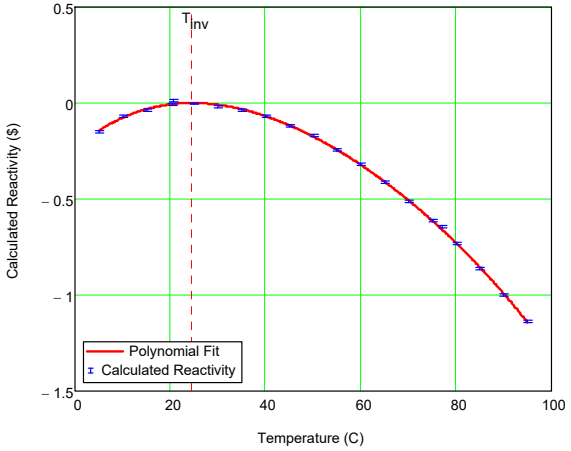
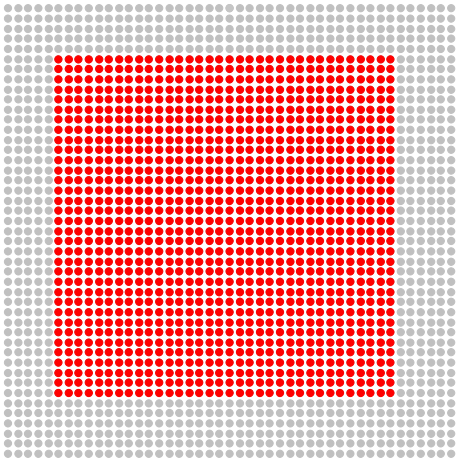
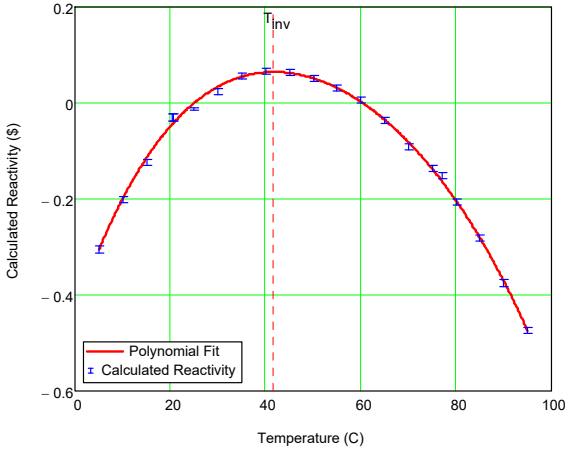
IER-452 – What can we do?

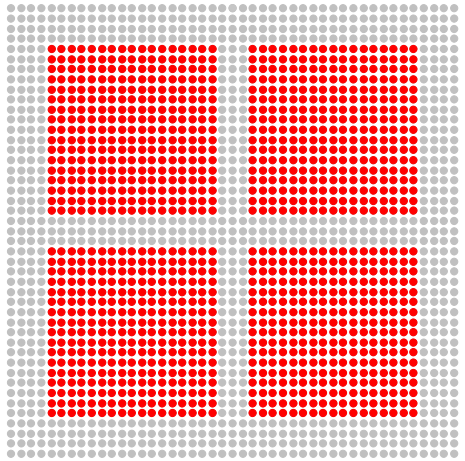


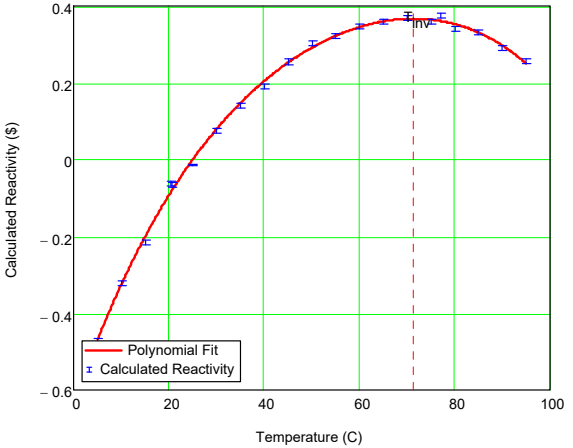
T_{inv} ~ 25ºC



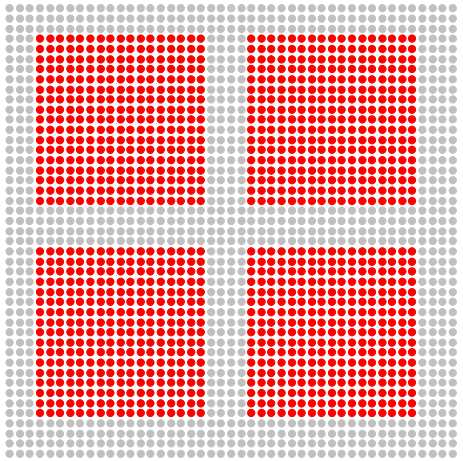


T_{inv} ~ 42ºC





T_{inv} ~ 71ºC



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Thomas Miller (ORNL)

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Justin Clarity (ORNL)

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Nicolas Leclair (IRSN) is the chief analyst

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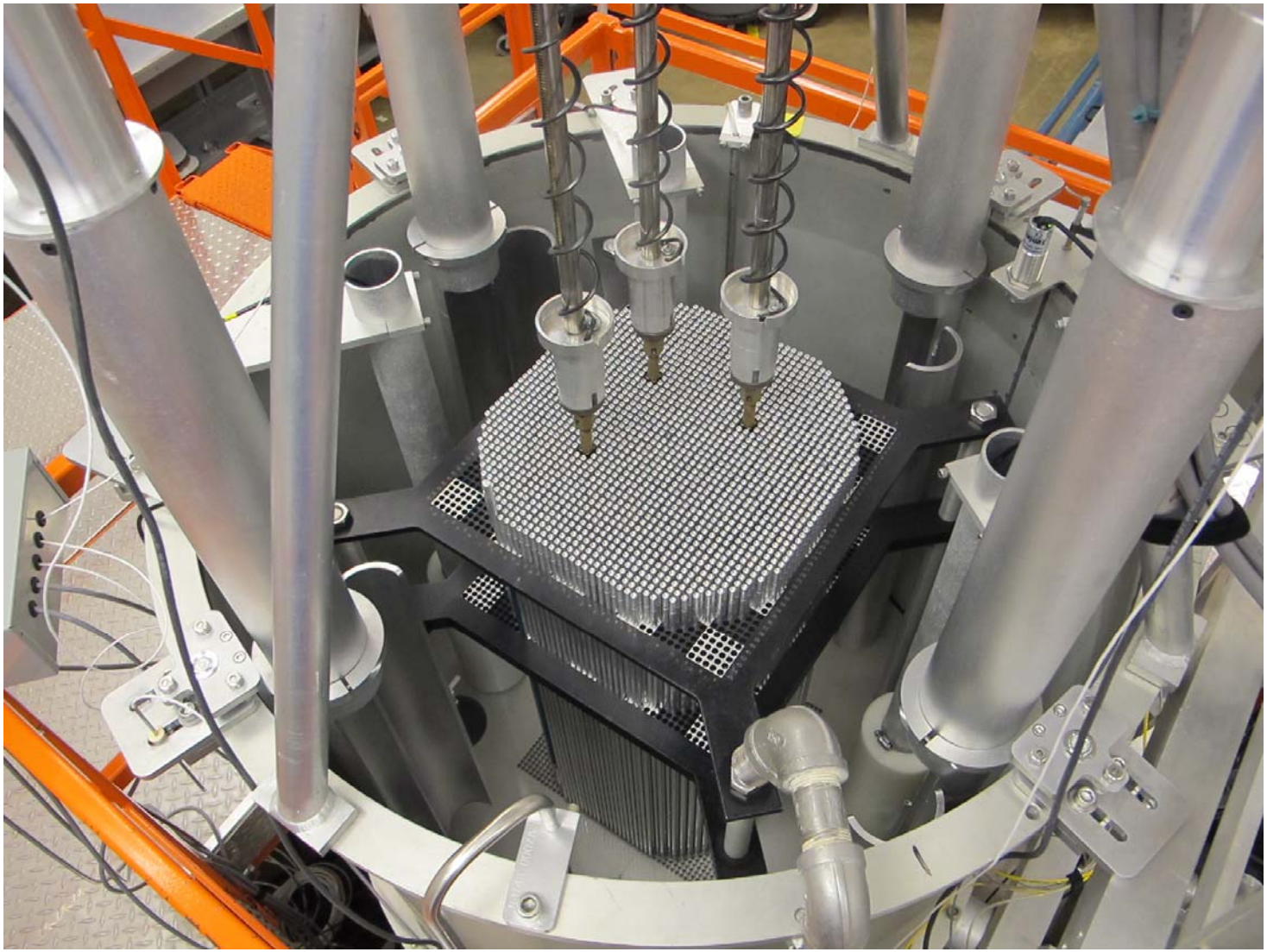
IER-209 – 7uPCX 0.855 cm Pitch, Variable Depth Pure Water Moderator

- This is similar to the experiments completed in IER-208 that resulted in the benchmark evaluation LEU-COMP-THERM-096 (2015)
- The difference is in the fuel rod pitch (0.855 vs 0.800 cm)
- The 0.855 cm pitch array is more reactive than the 0.800 cm pitch array (~1060 rods fully reflected vs ~1450)

IER-208 Configuration



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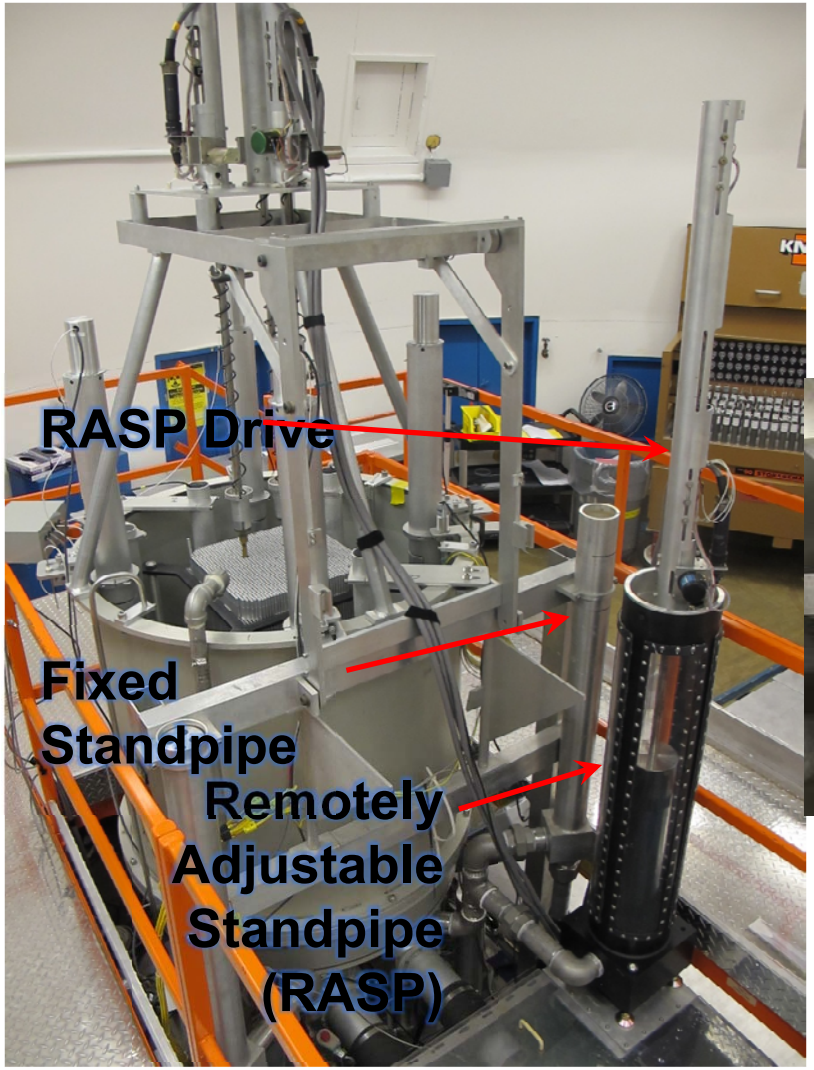
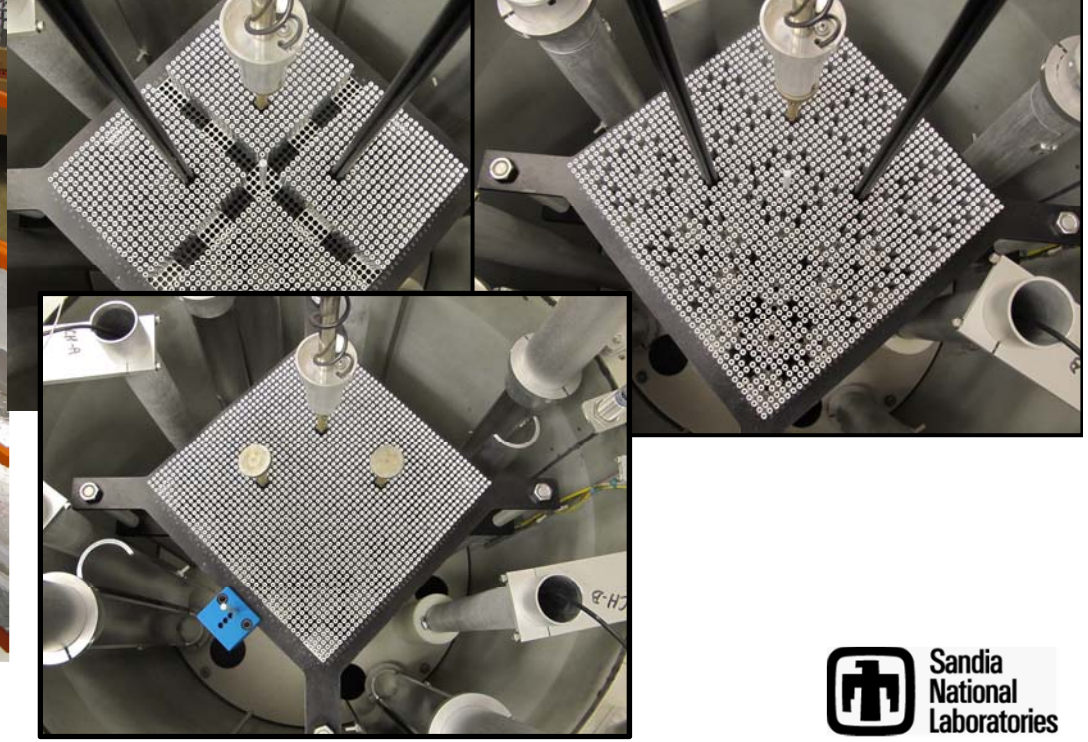
IER-208 Experiments





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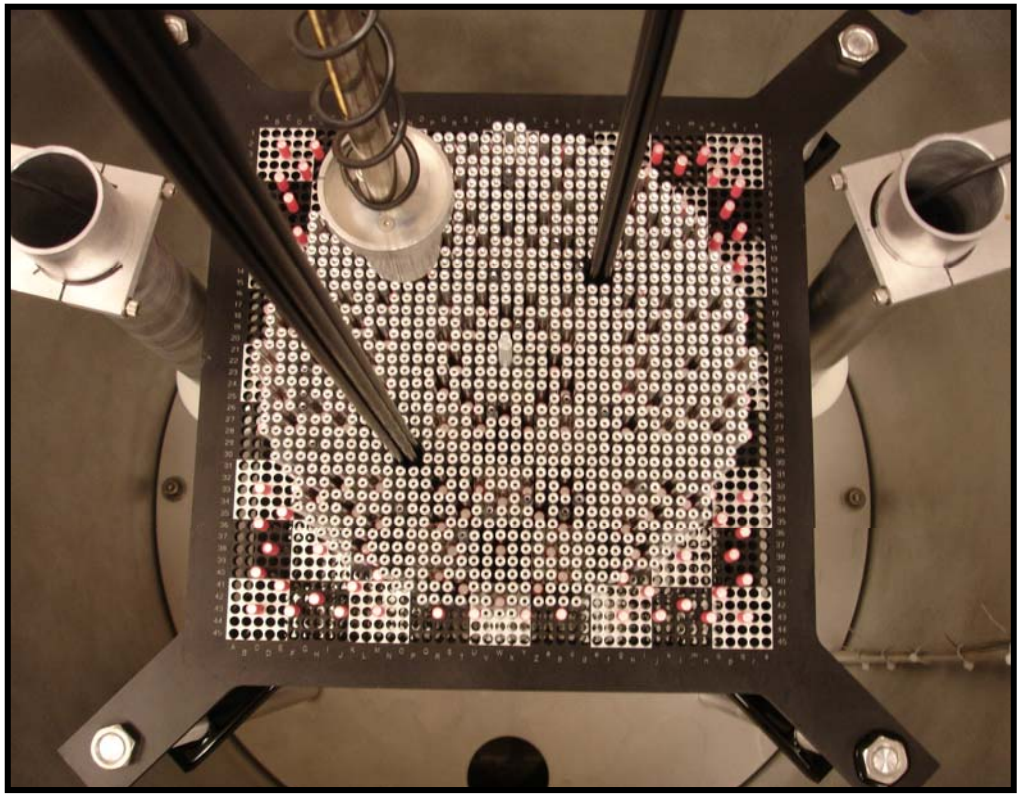
IER-206 – Re-establish the 4.3% Enriched Critical Experiment Capability at Sandia



The cores (fuel, grid plates, etc.) are different. The balance of the assembly hardware is the same.

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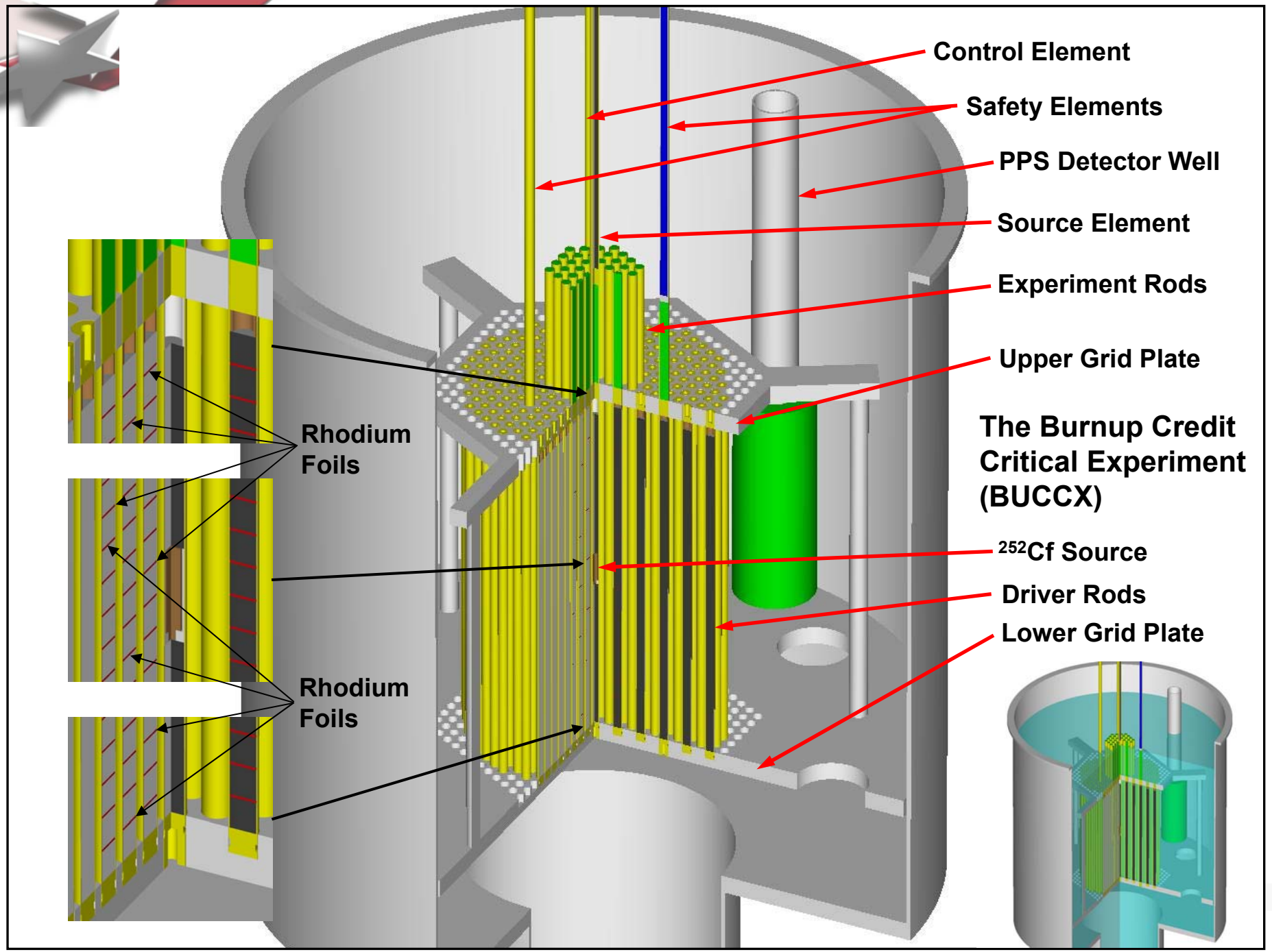
Control Element
Safety Elements
PPS Detector Well
Source Element
Experiment Rods
Upper Grid Plate
Rhodium Foils
Rhodium Foils
The Burnup Credit Critical Experiment (BUCCX)
252Cf Source
Driver Rods
Lower Grid Plate

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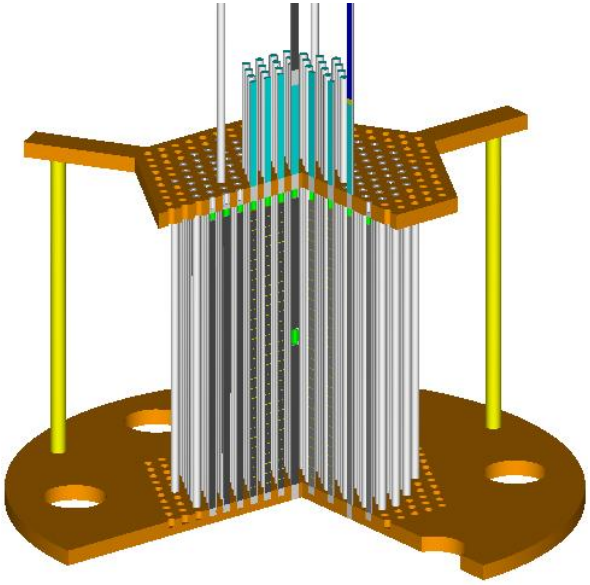

- In 2002, we built a critical assembly in which we could insert fission product materials to measure reactivity effects
- We completed a set of experiments with rhodium between the fuel pellets in "experiment" elements
- The experiment is documented as LEU-COMP-THERM-079
- In 2017, we completed approach-to-critical experiments on all the original configurations
- Improvements for new experiments:
  - We precisely measured the diameter of each fuel/experiment element (decrease in the uncertainty)
  - We performed the experiments with the original source away from the assembly
- At the conclusion of the experiments we rolled into the IER-451 Titanium Sleeve experiments

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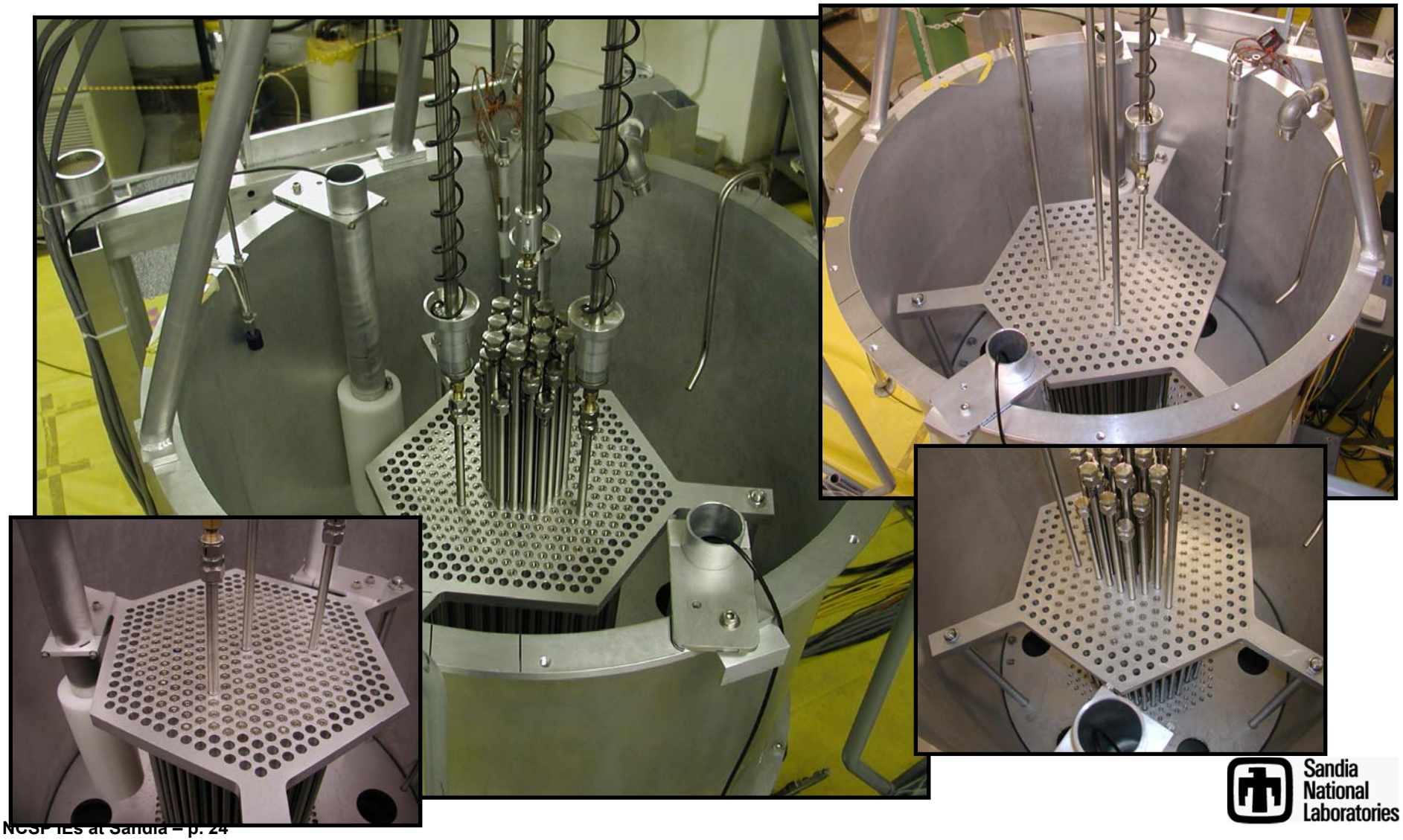
The BUCCX core shown at the end of approach-to-critical experiments



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