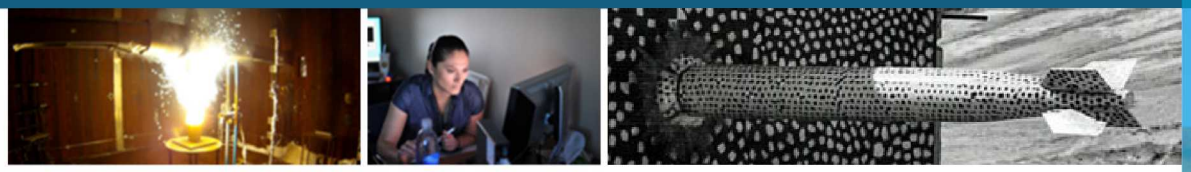
SAND2019-10557C

Sandia National Laboratories

The Sandia Critical Experiments Program
What Are We Doing For You Now?



Gary A. Harms, David E. Ames, John T. Ford, and Rafe D. Campbell

11th International Conference on Nuclear Criticality Safety
Paris
September 15 - 20, 2019

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Sandia Integral Experiment Requests

IER	Title	Sponsor	CED
209	7uPCX 0.855 cm Pitch, Variable Depth Pure Water Moderator	SNL	4a
230	Characterize the Thermal Capabilities of the 7uPCX	SNL	3a
304	Temperature Dependent Critical Benchmarks	ORNL	2
305	Critical Experiments with UO2 Rods and Molybdenum Foils	IRSN	2
306	Critical Experiments with UO2 Rods and Rhodium Foils	IRSN	1
441	Epithermal HEX Lattices with SNL 7uPCX Fuel for Testing Nuclear Data	ORNL	2
451	Titanium Cross Sections in a Thermal Application (BUCCX Hardware)	SRNL	4a
452	Inversion Point of the Isothermal Reactivity Coefficient	SNL	1

CED status on September 5, 2019

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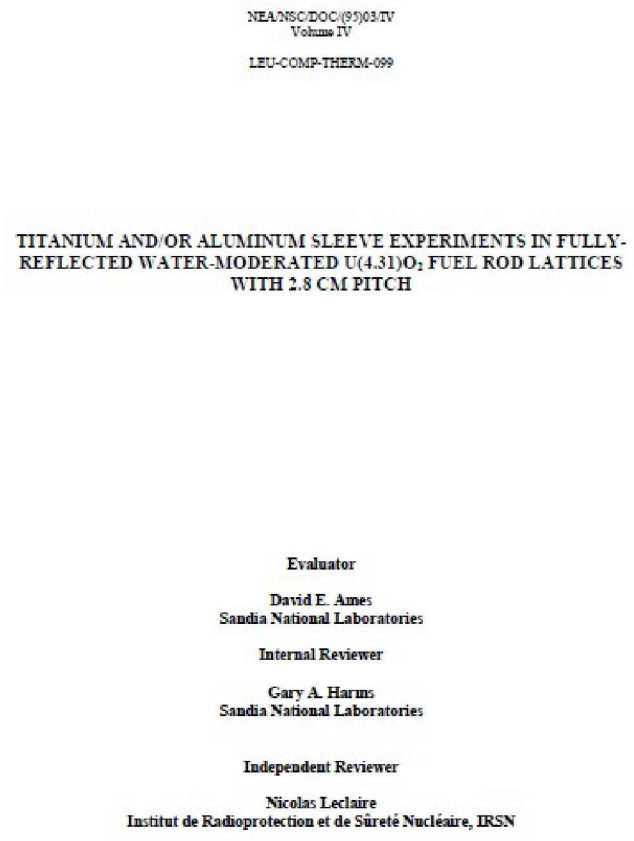
IER-451



NEA/NSC/DOC(95)03/IV
Volume IV

LEU-COMP-THERM-099

TITANIUM AND/OR ALUMINUM SLEEVE EXPERIMENTS IN FULLY-REFLECTED WATER-MODERATED U(4.31)O_2 FUEL ROD LATTICES WITH 2.8 CM PITCH

Evaluator

David E. Ames
Sandia National Laboratories

Internal Reviewer

Gary A. Harms
Sandia National Laboratories

Independent Reviewer

Nicolas Leclaire
Institut de Radioprotection et de Sûreté Nucléaire, IRSN

- David Ames is the Experimenter and Evaluator for this experiment
- His presentation is in the following Track 4 session

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

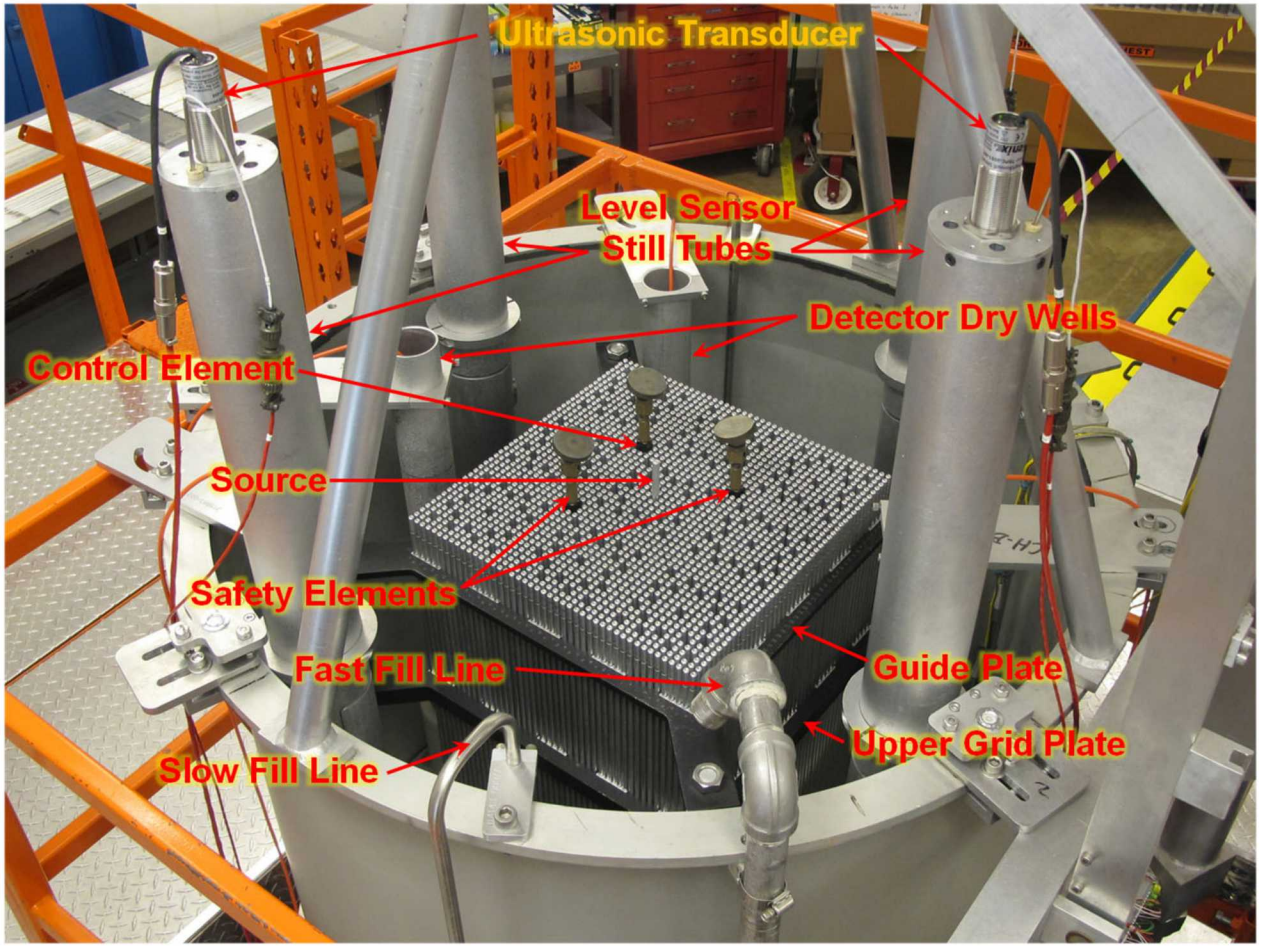
This is similar to the experiments completed in IER-208 that resulted in the benchmark evaluation LEU-COMP-THERM-096 (2015)

The difference is in the fuel rod pitch (0.855 vs 0.800 cm)

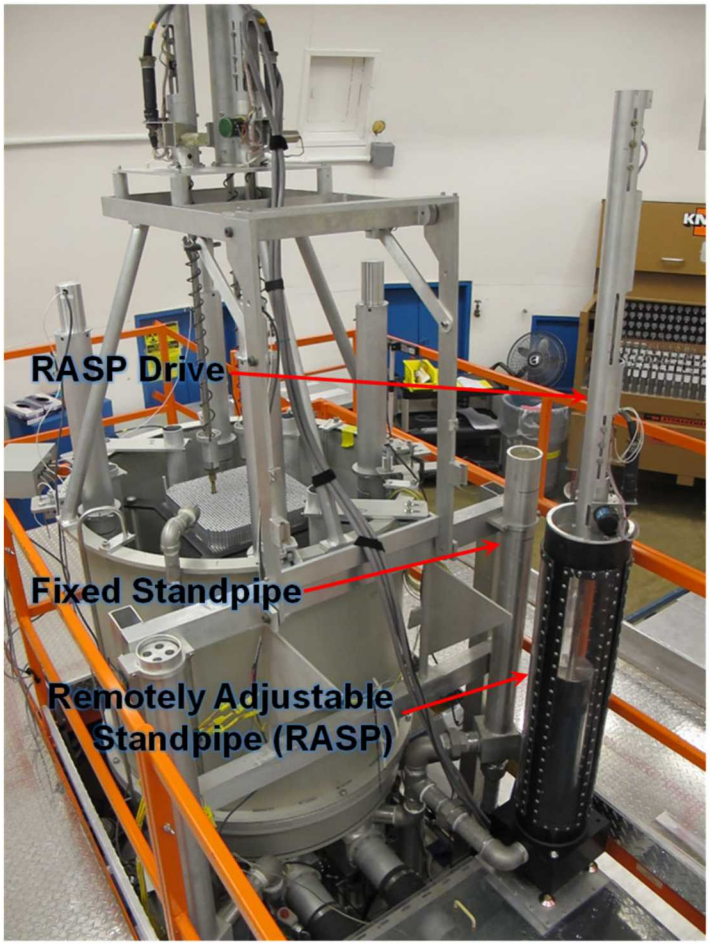
The 0.855 cm pitch array is more reactive than the 0.800 cm pitch array (~1060 rods fully reflected vs ~1460)

This experiment is currently being documented as LEU-COMP-THERM-101 (LCT101)

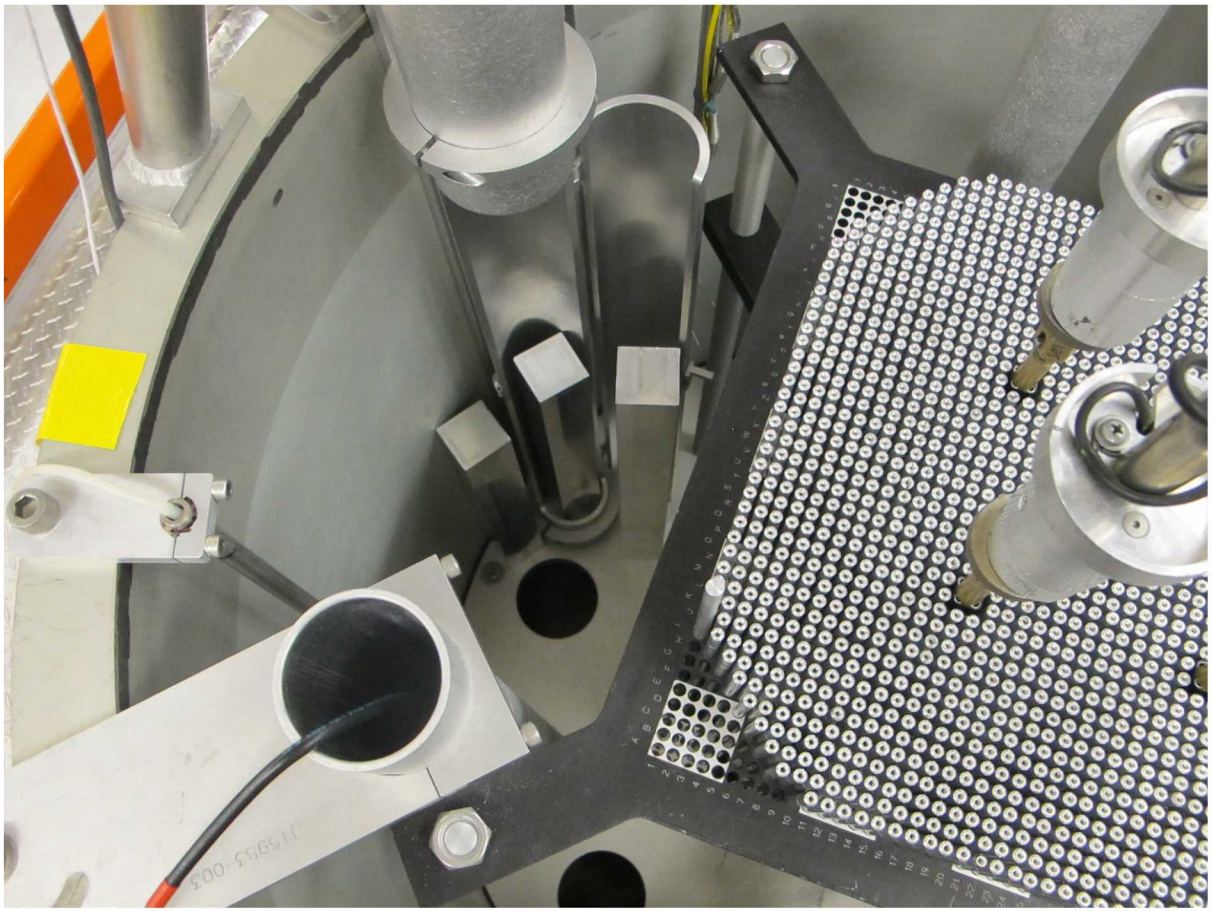
A look into the core tank of the assembly



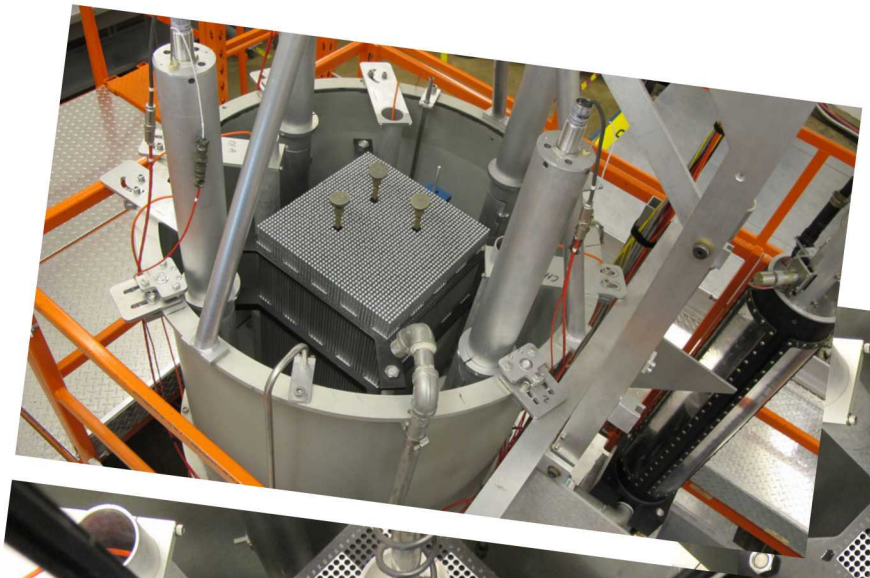
The moderator/reflector level in the assembly is controlled by two overflow standpipes



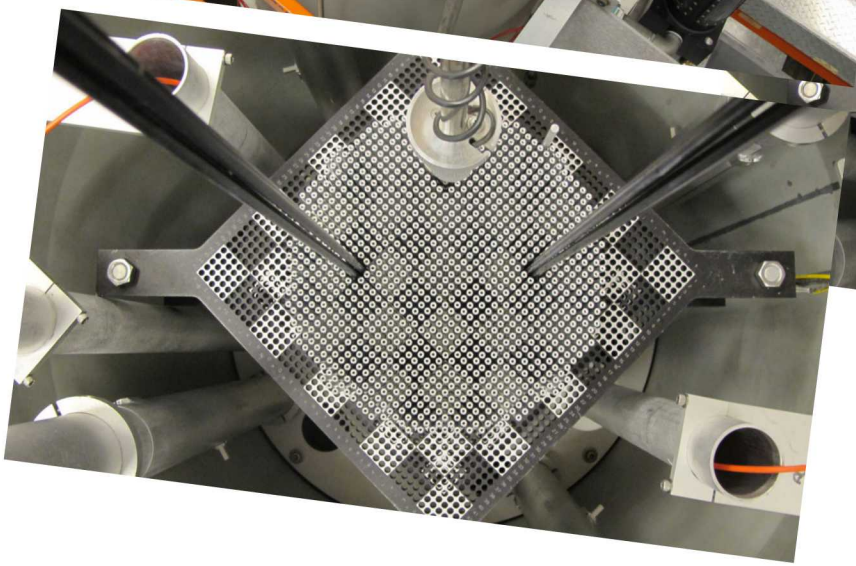
The level of the moderator is measured by a set of four ultrasonic transducers

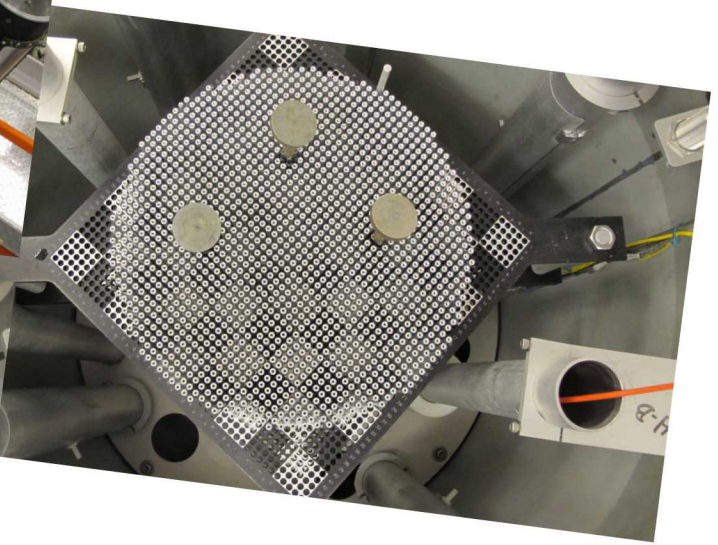


LCT101 Cases 1, 4, and 7

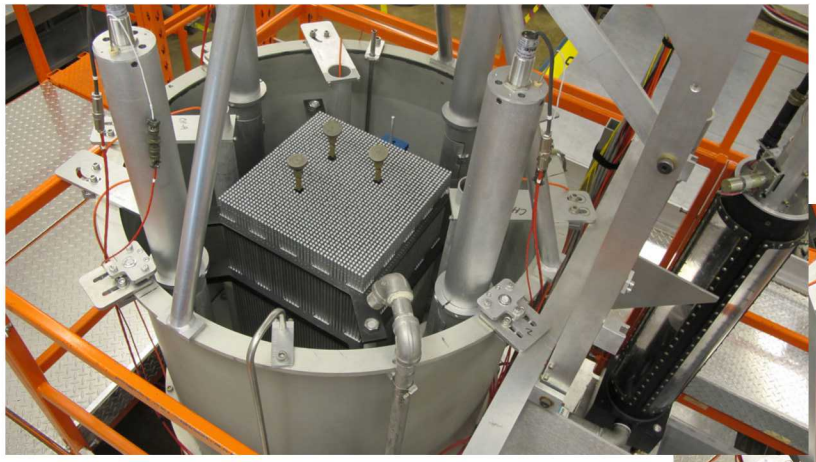


Compact Cores

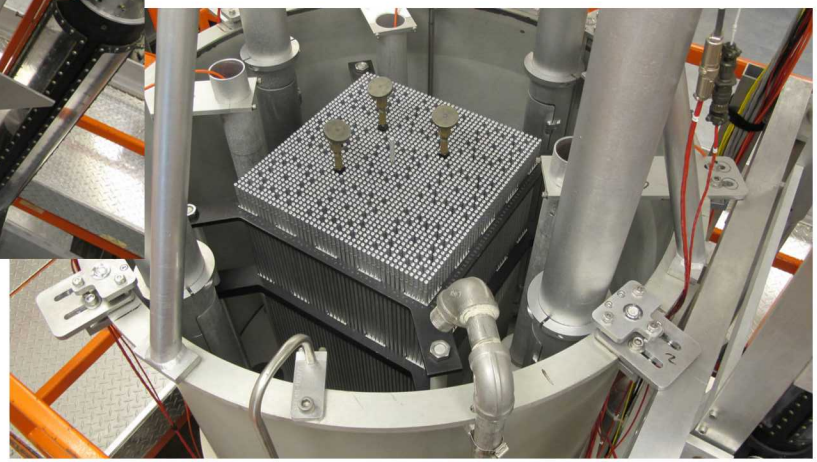




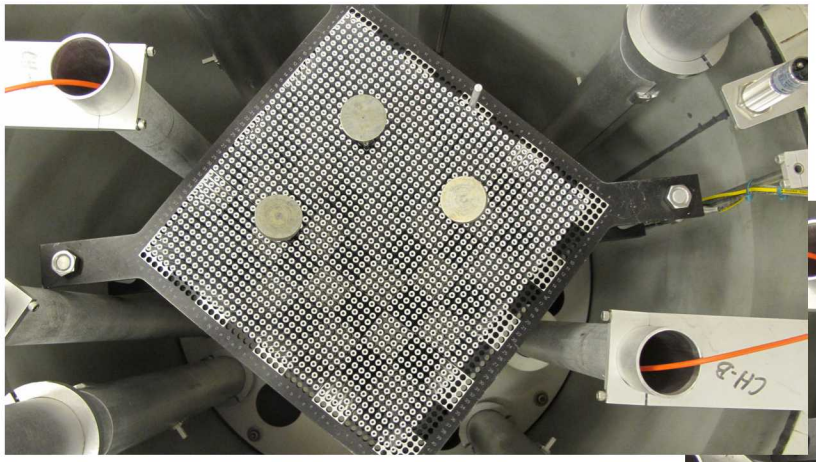
LCT101 Cases 1 and 2

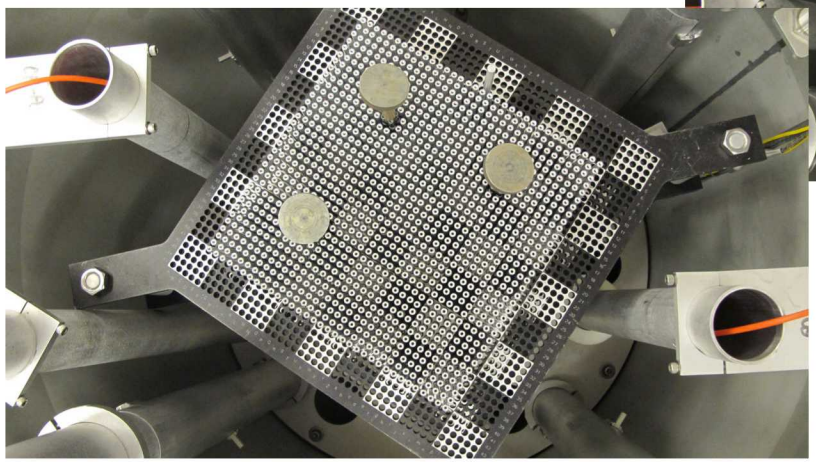


Full Grid

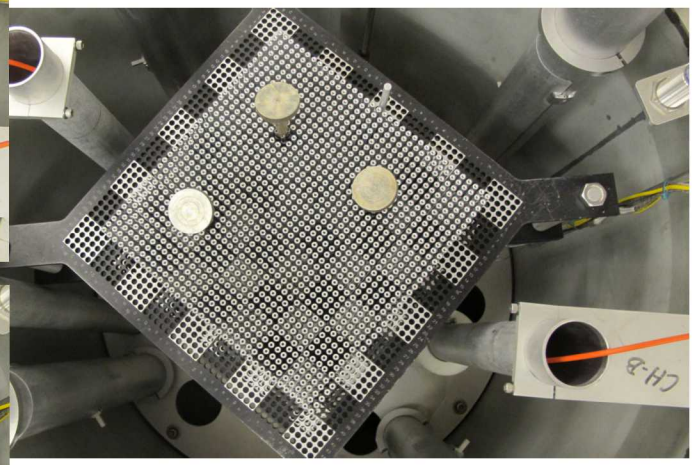


LCT101 Cases 9, 10, and 11

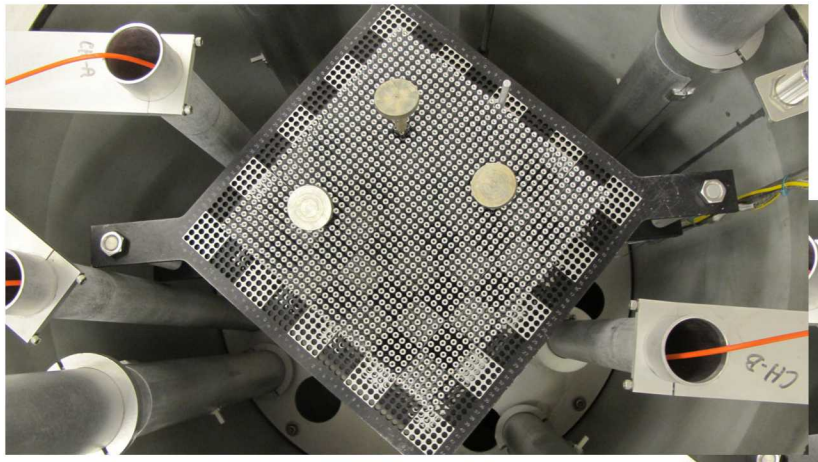


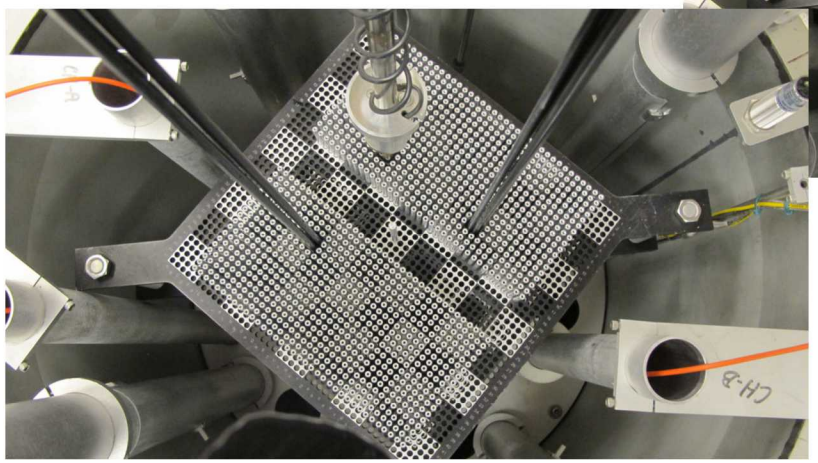


Square Cores

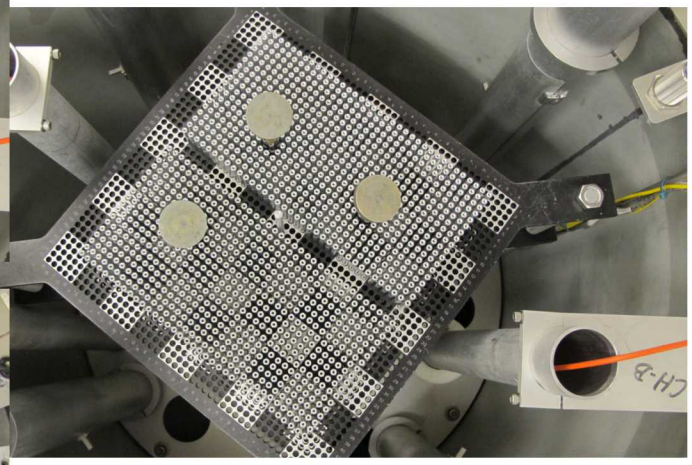


LCT101 Cases 10, 13, and 17

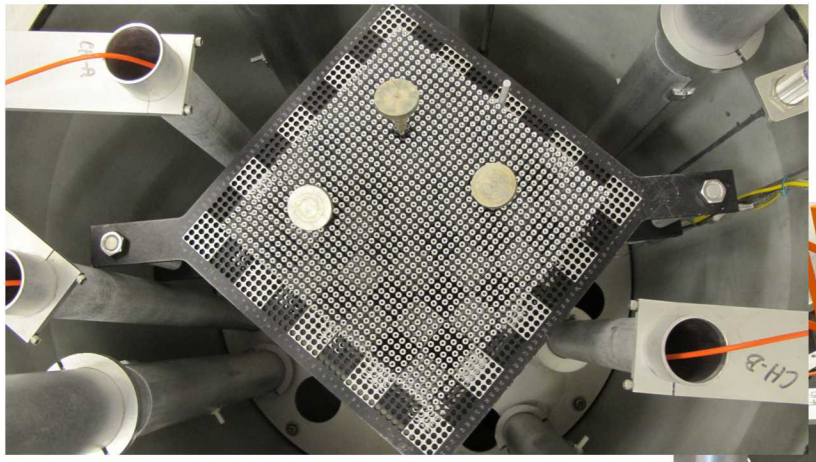


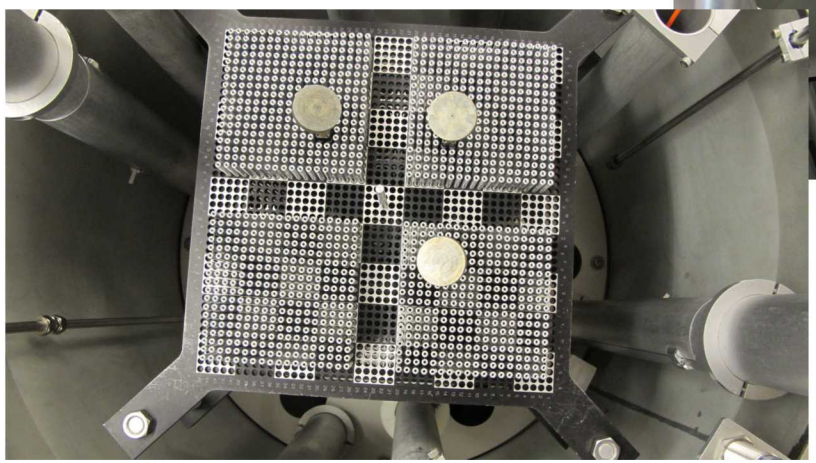


Linear Water Channels

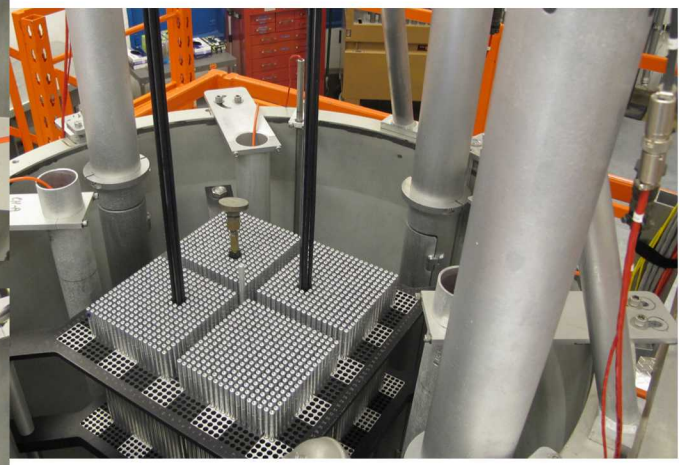


LCT101 Cases 10, 19, and 22

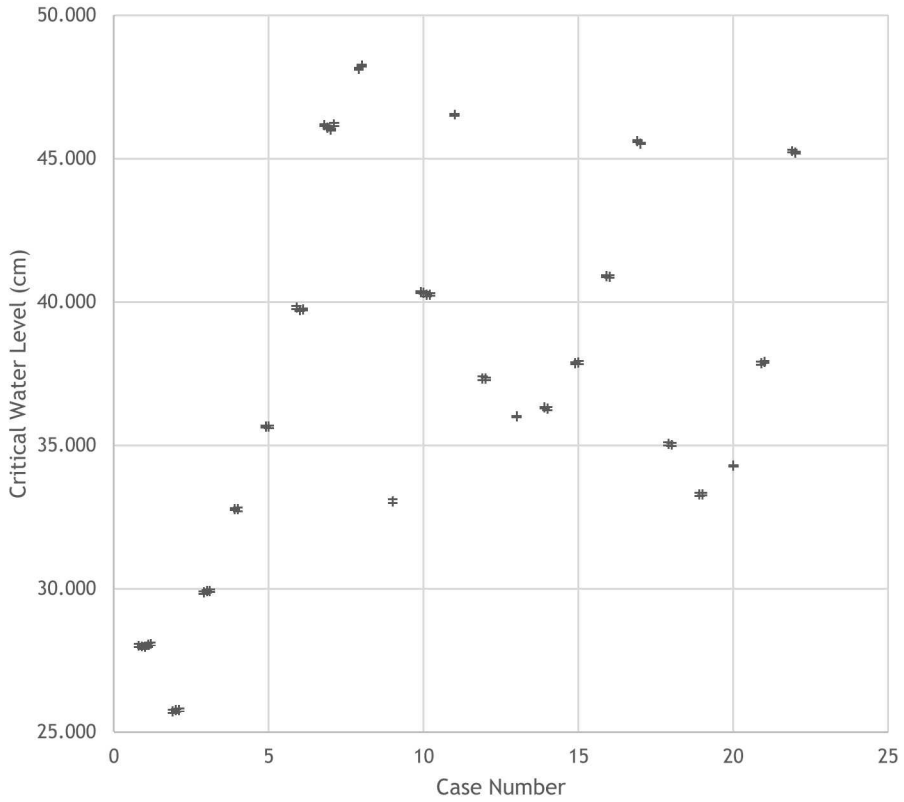




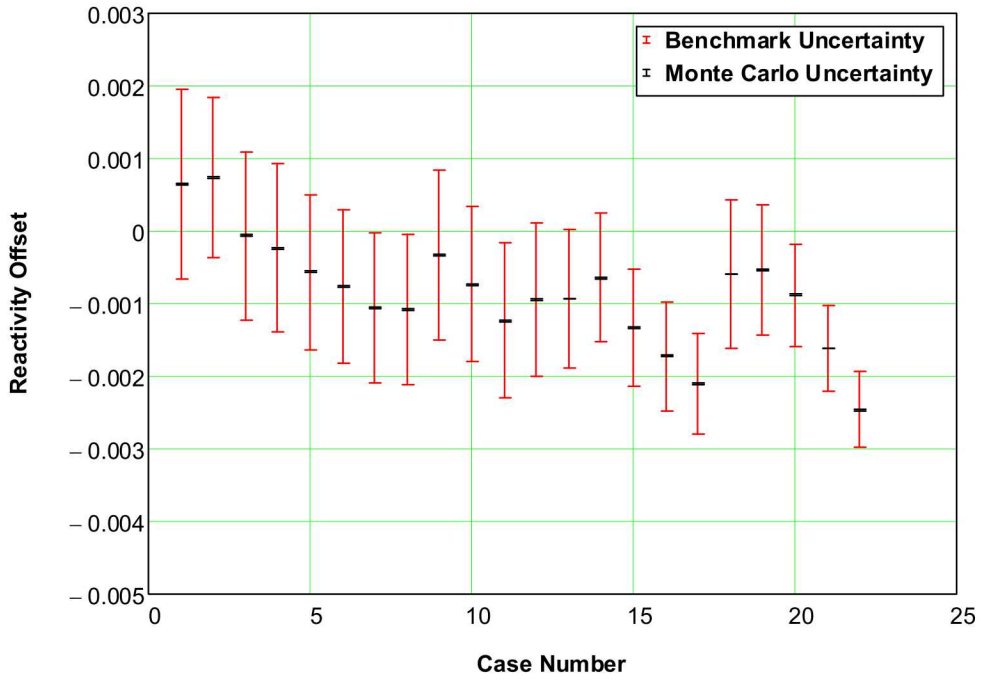
Cruciform Water Channels



LCT101 Measured Critical Water Levels



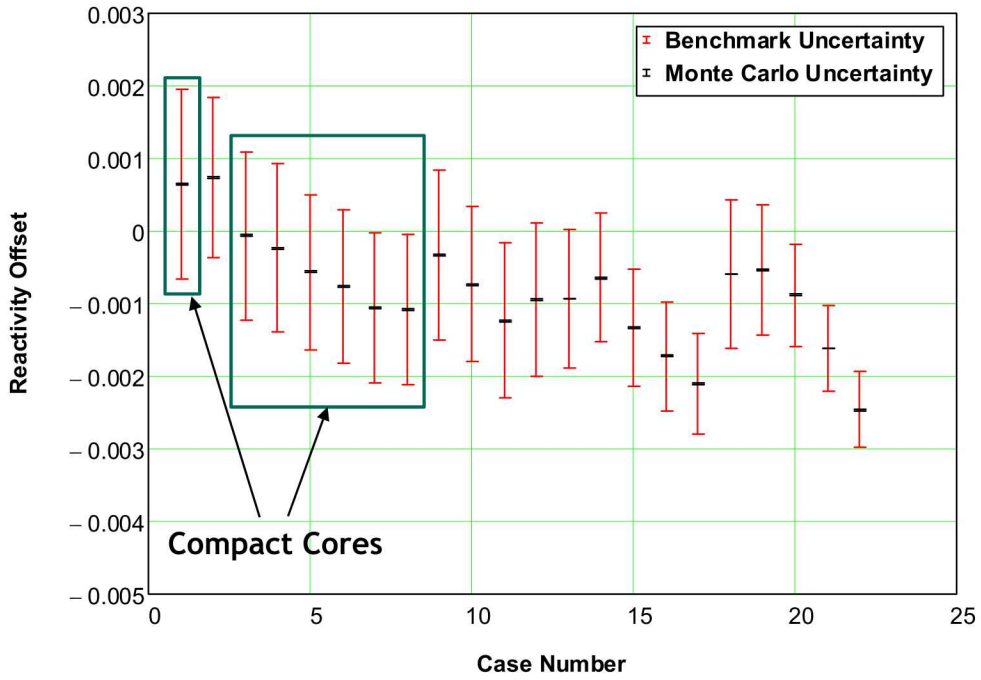
LCT101 Reactivity Offsets – MCNP6.1.1



Code: MCNP6.1.1
Cross Sections: Continuous-energy ENDF/B-VII.1

$$\Delta\rho = \frac{k_c - k_e}{k_c k_e}$$

LCT101 Reactivity Offsets – MCNP6.1.1



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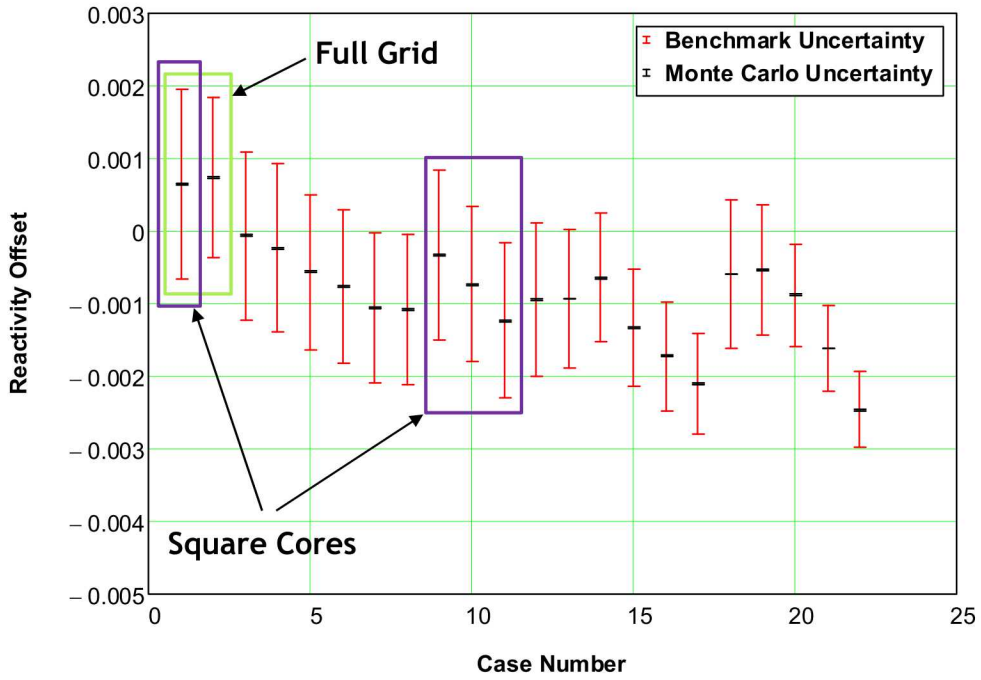

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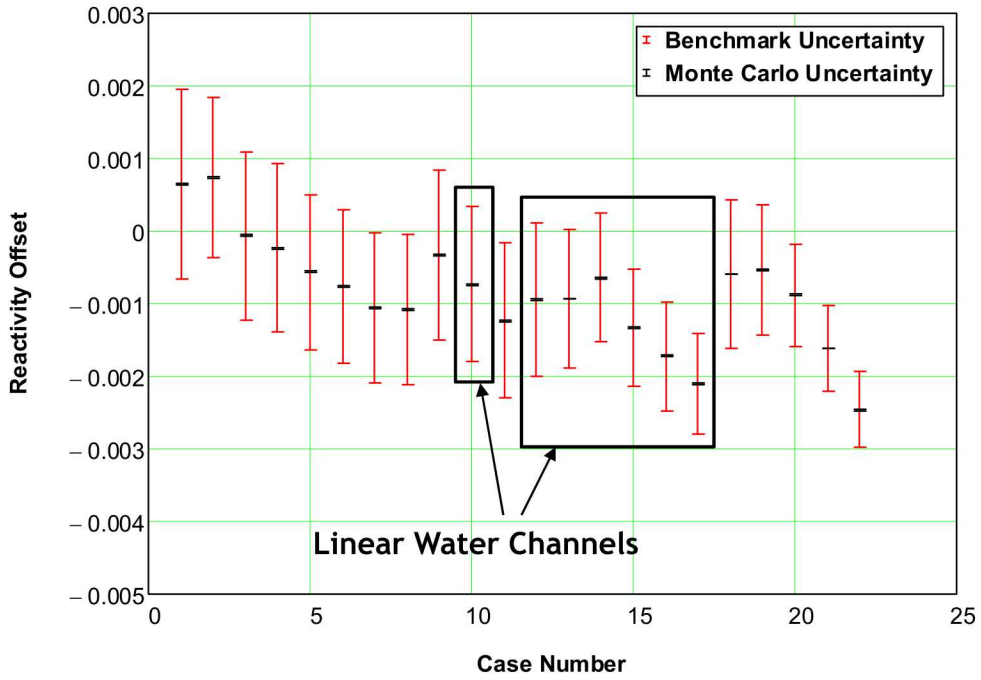
LCT101 Reactivity Offsets – MCNP6.1.1



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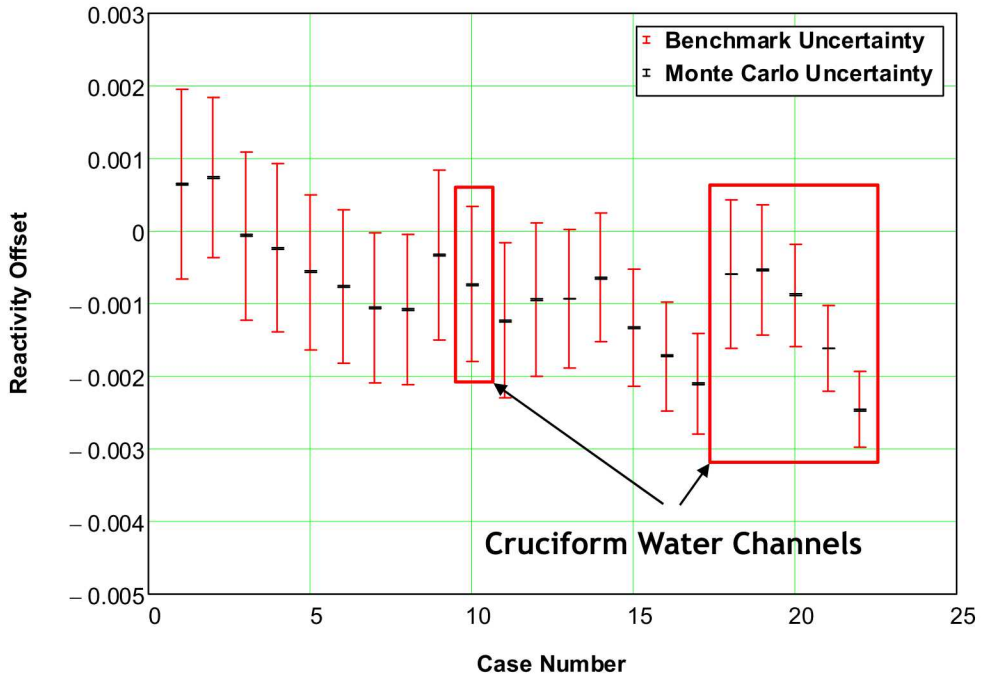

Code: MCNP6.1.1
Cross Sections: Continuous-energy ENDF/B-VII.1

$$\Delta\rho = \frac{k_c - k_e}{k_c k_e}$$

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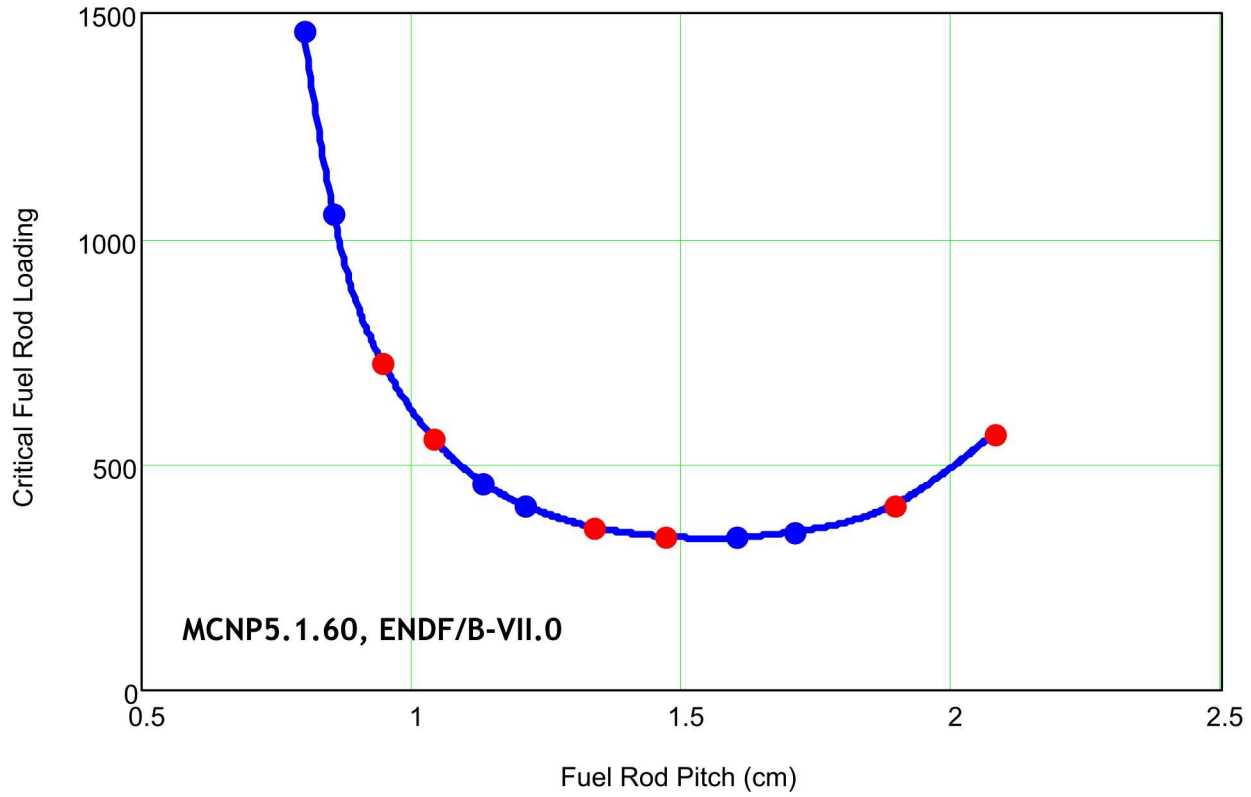
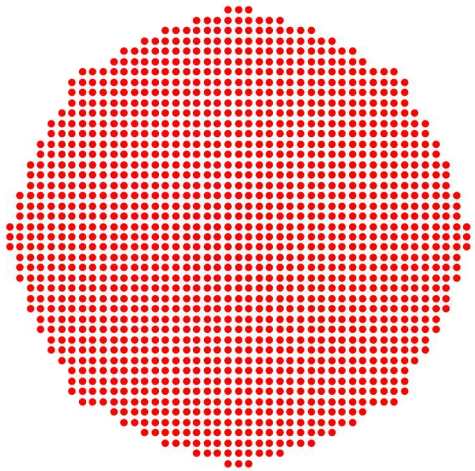
Number of Fuel Rods at DC vs Pitch

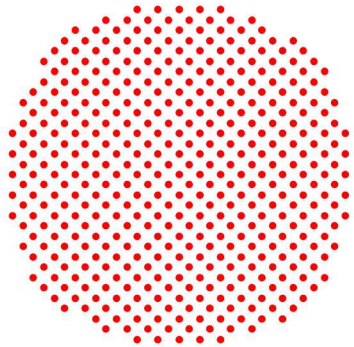


The blue points are for existing grid plates (0.800 and 0.855 cm pitch).
The red points are for new grid plates (0.947 and 1.039 cm pitch)

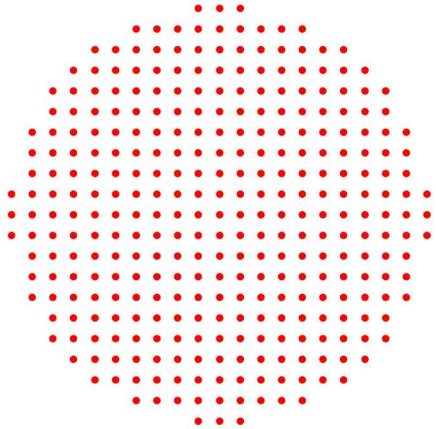
IER-230 – Characterize the Thermal Capabilities of the 7uPCX



0.800 cm Pitch
1461 Rods at DC

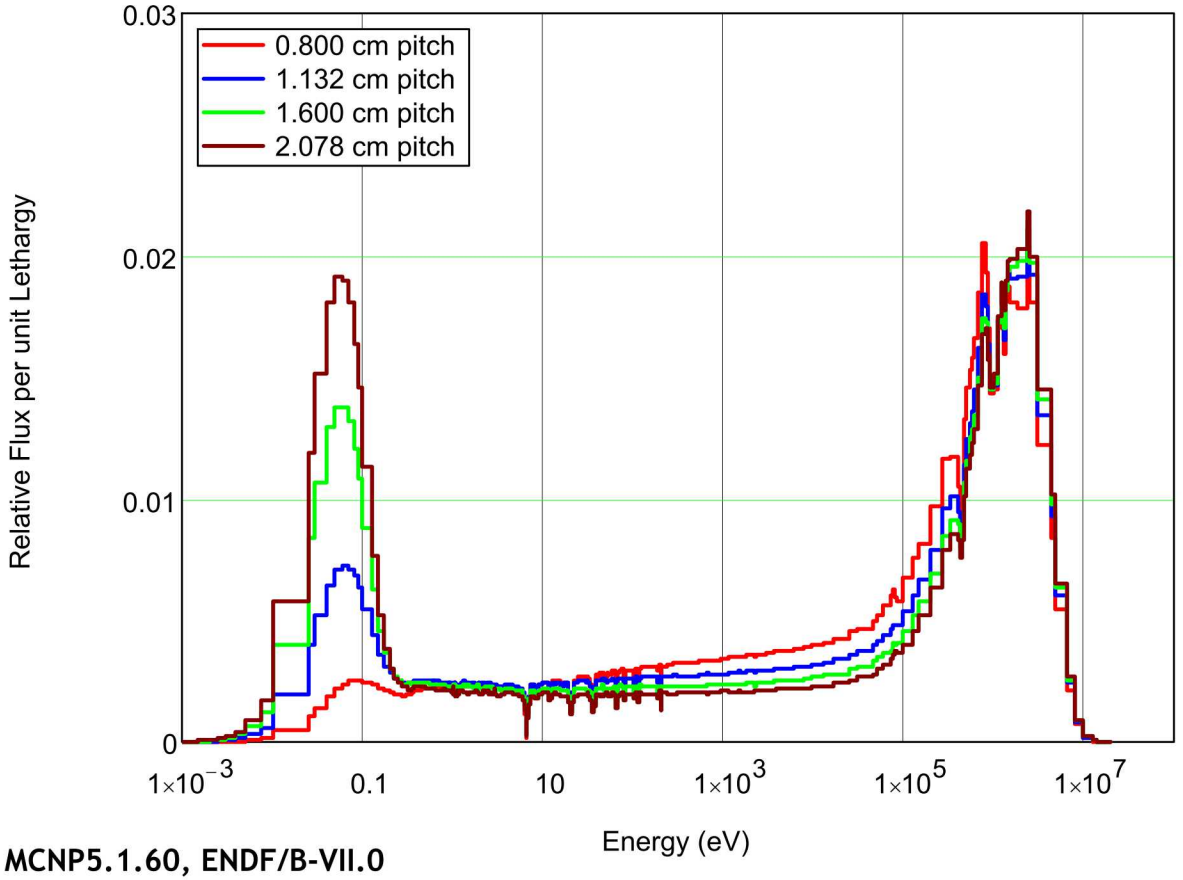


1.132 cm Pitch
454 Rods at DC



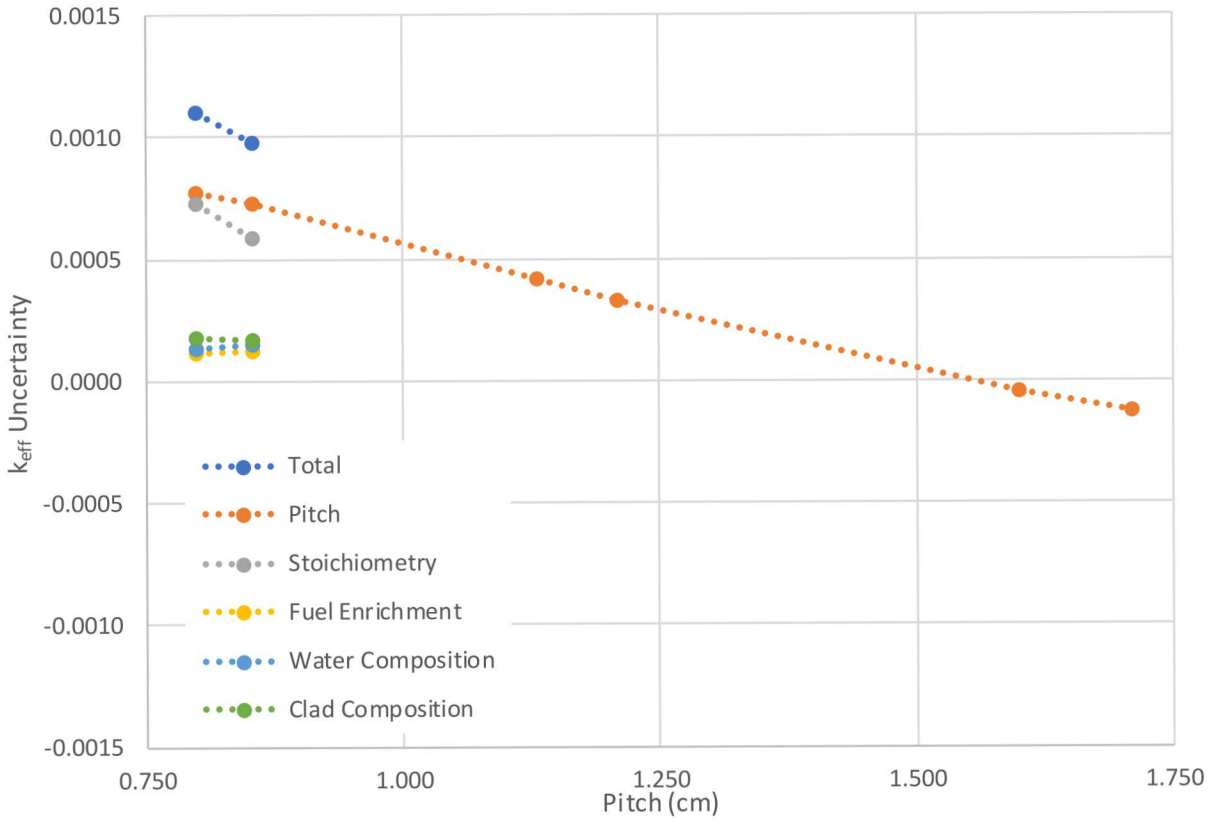
1.600 cm Pitch
328 Rods at DC

The Neutron Spectrum vs Pitch

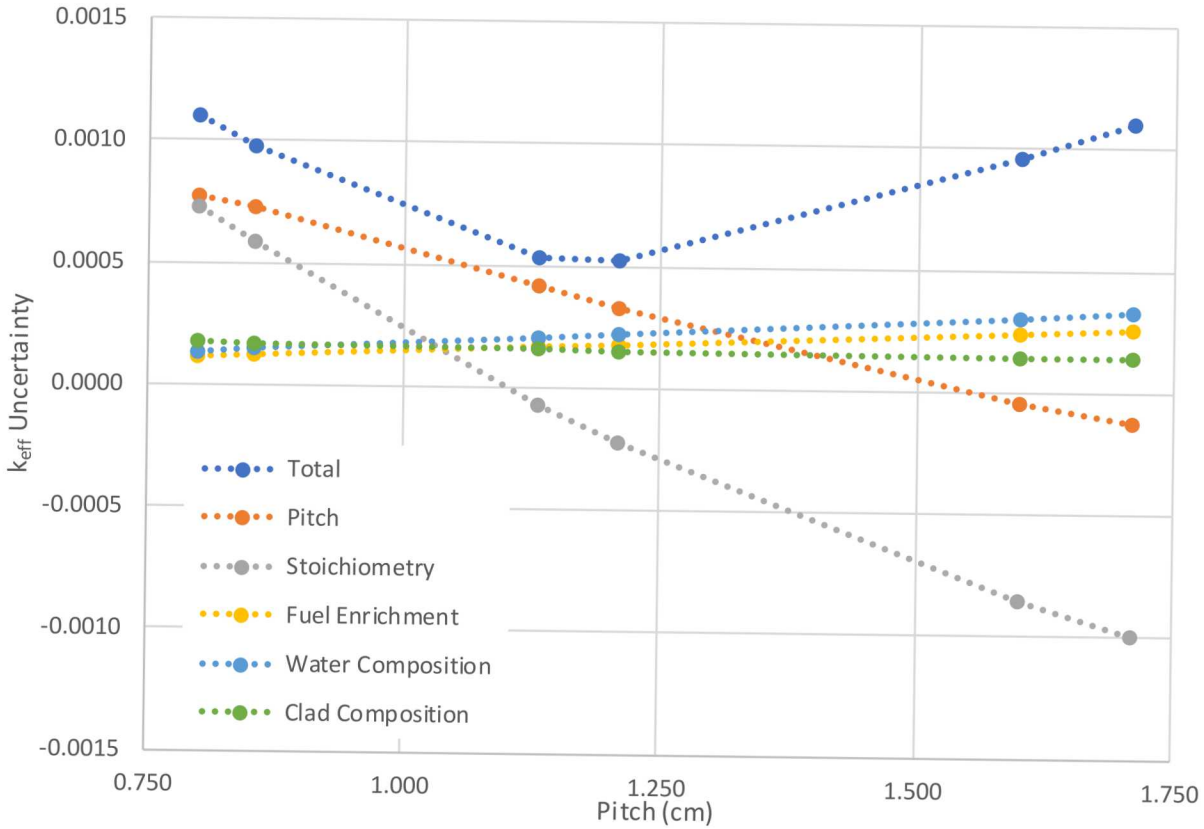


MCNP5.1.60, ENDF/B-VII.0

LCT080 (0.800 cm) and LCT078 (0.855 cm) Uncertainties



IER-230 Uncertainties



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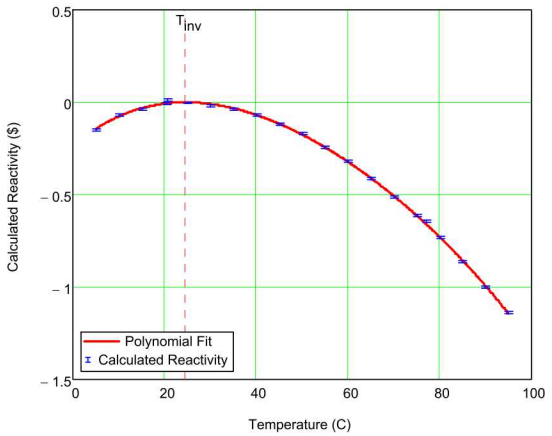
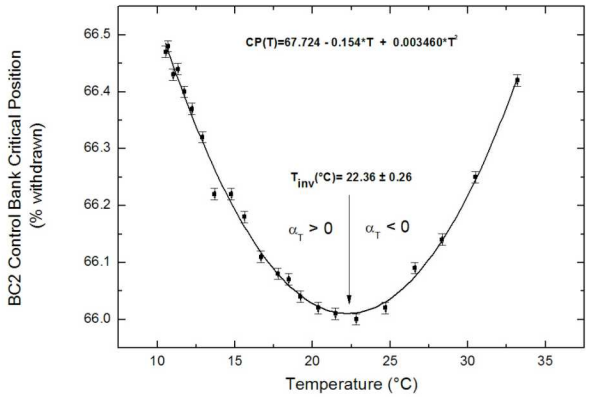
IER-452 – Inversion Point of the Isothermal Reactivity Coefficient





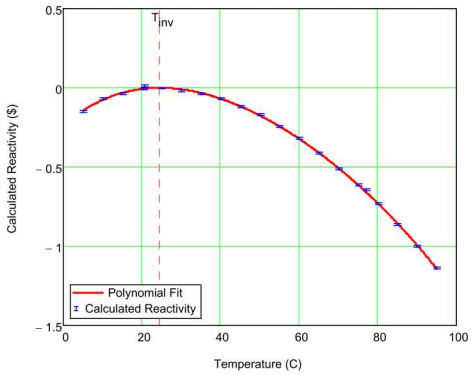
International Reactor Physics Experiment Evaluation Project: International Handbook of Evaluated Reactor Physics Benchmark Experiments

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

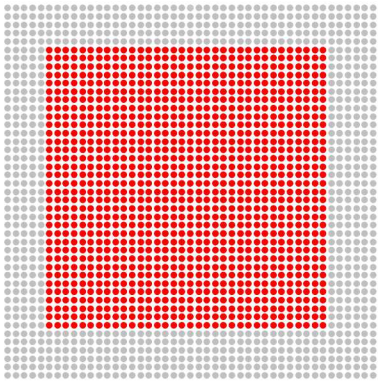
What IS NOT required:
Knowledge (measurement/calculation/guess) of the kinetics parameters of the system

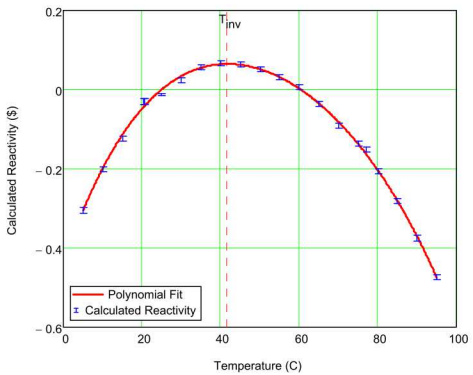
Adimir and his colleagues measured three systems with T_{inv} between 14.99 and 22.36 C

IER-452 – What can we do?

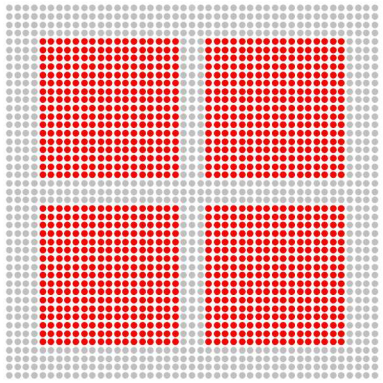


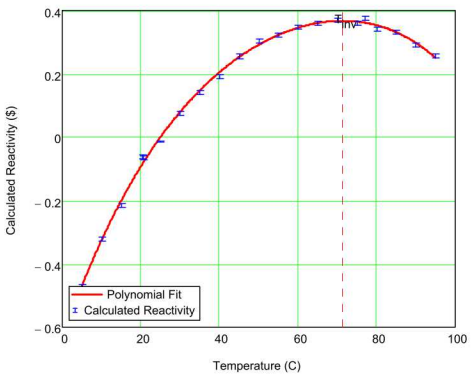
T_{inv} ~ 25°C



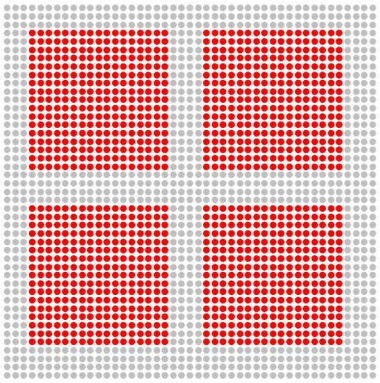


T_{inv} ~ 42°C





T_{inv} ~ 71°C



New features needed for IER-452

Temperature control of the assembly

- Heater/chiller with significant capacity
- Bigger heat sink (dump tank)
- Insulation of tanks
- Homogenization of core moderator/reflector
- Ability to make detailed temperature measurements across core

Fine control of the assembly reactivity

- Low-worth but agile shim rod
- High-resolution measurement of shim position
- Automatic shim rod controller?

Linear count-rate system

Removable source

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- **Justin Clarity at ORNL is leading the design of these experiments**

IER-305 and IER-306 are IRSN experiments

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- **Nicolas Leclaire at IRSN is leading the design of these experiments**
  - **IER-305 is projected to complete final design in December**
  - **IER-306 is projected to complete conceptual design in December**

Critical Experiments at Sandia