SAND2015-7735C

Experiments with Partially-Reflected Square-Pitched Arrays of 6.9 Percent Enriched UO_2 Fuel Rods

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Gary A. Harms, Allison D. Miller, John T. Ford, and Rafe D. Campbell
Sandia National Laboratories

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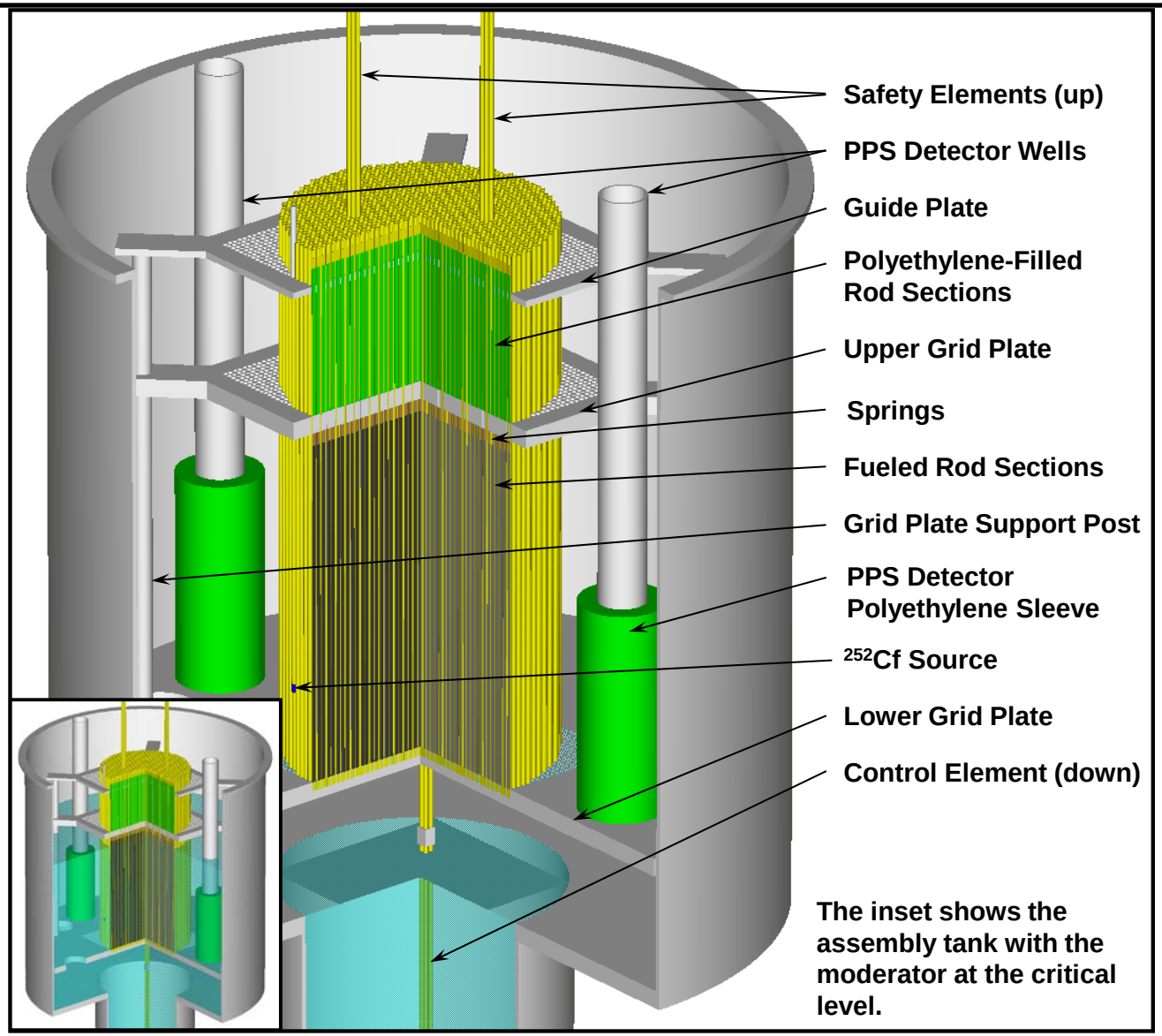
What's ahead

- This is an account of work at the Sandia Critical Experiments (SCX) completed over past couple of years
- The work was supported by the DOE Nuclear Criticality Safety Program (NCSP)
- The critical experiments were part of NCSP Integral Experiment Request (IER) 208
  - Requests for other critical experiments by the NCSP may be submitted at: http://ncsp.llnl.gov/IERMain.html
- The experiments are evaluated in LEU-COMP-THERM-096 in the *International Handbook of Evaluated Criticality Safety Benchmark Experiments*

An overall view of the critical assembly

A cross section of the critical assembly



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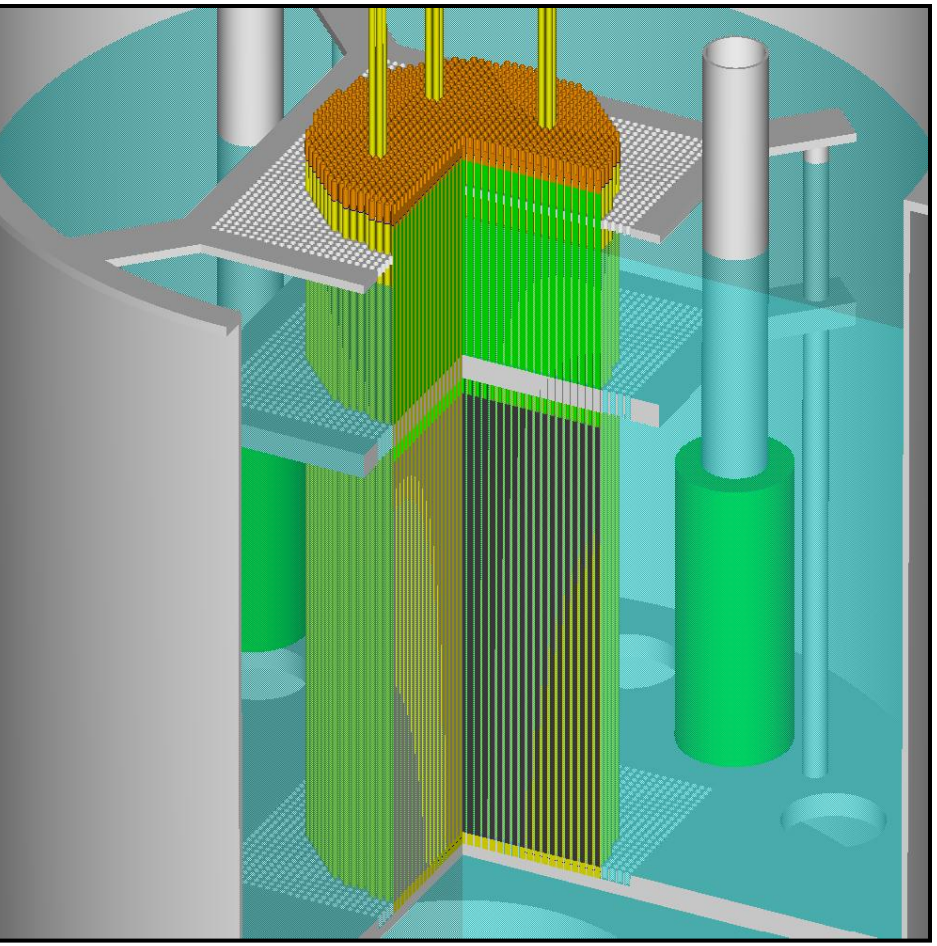
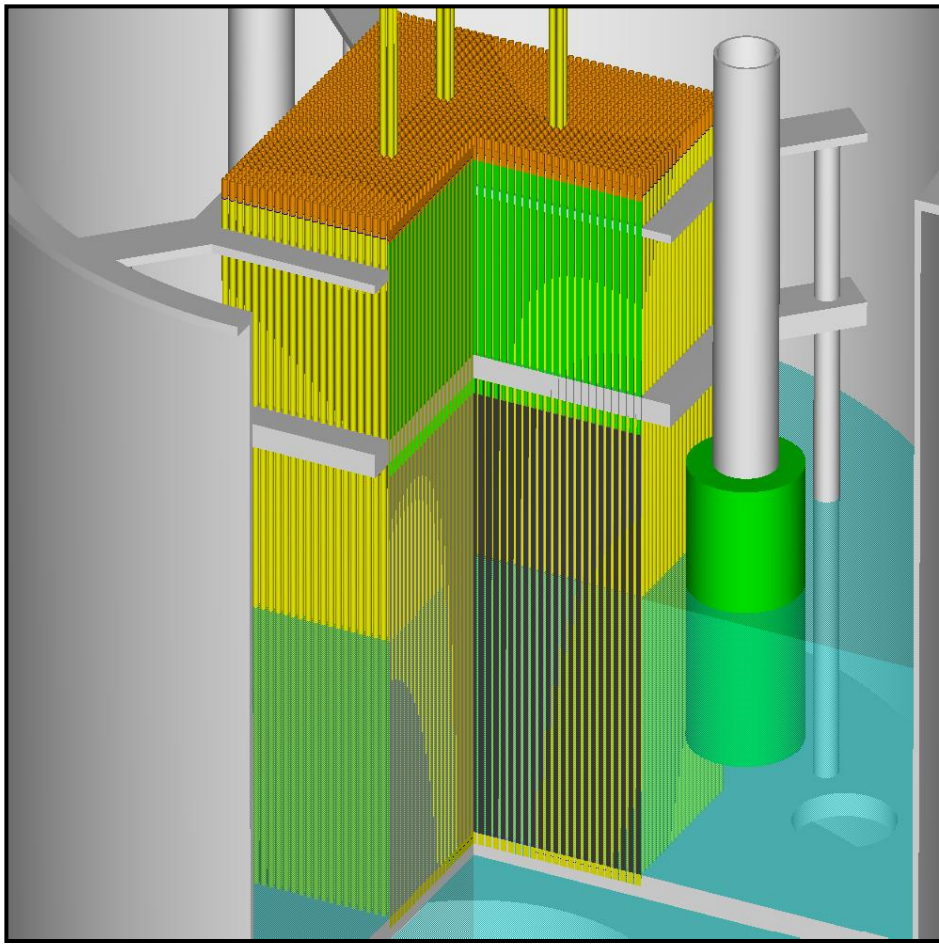
Full vs partial reflection

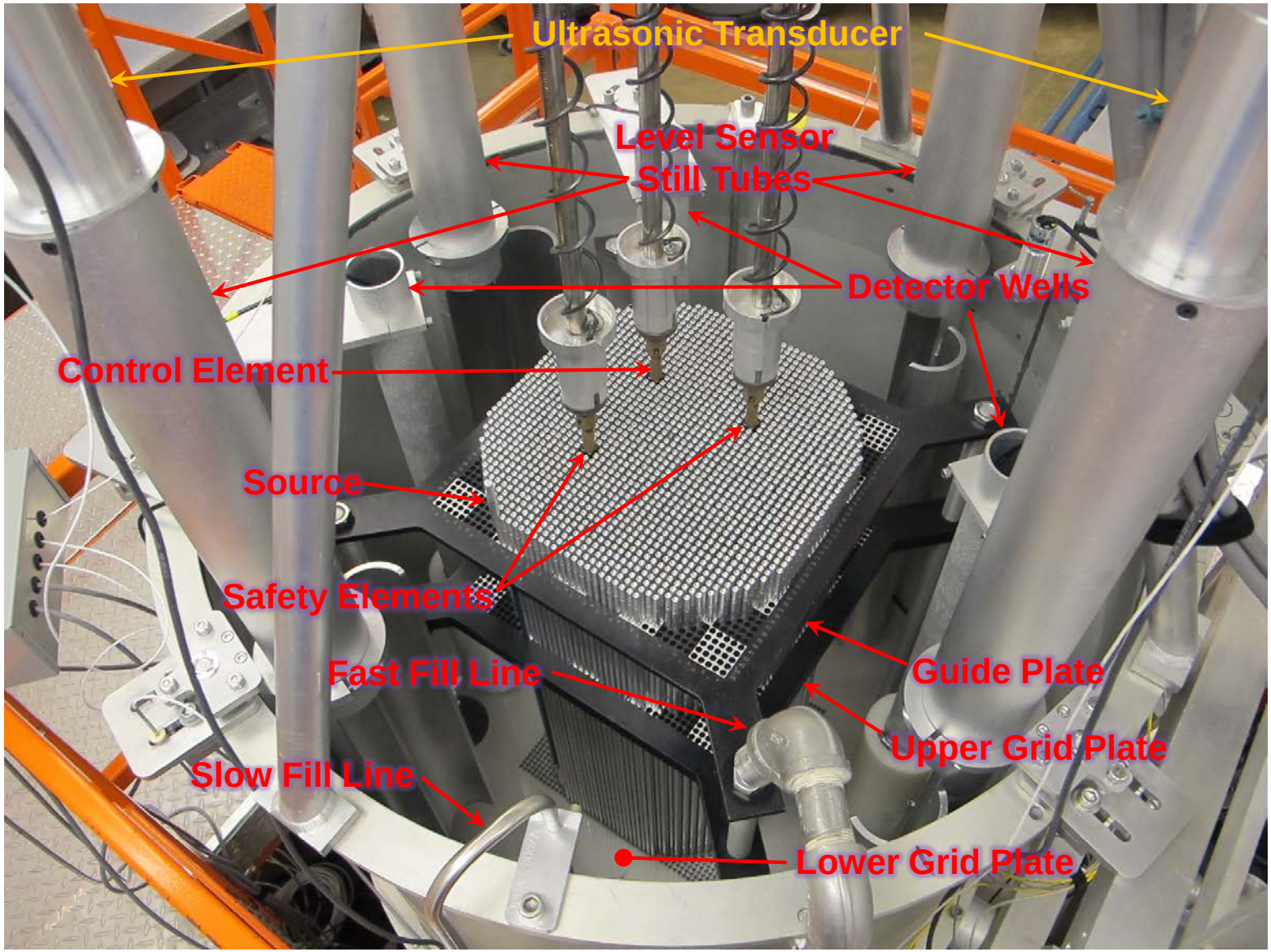




“Fully-Reflected”

“Partially-Reflected”

A look into the core tank of the assembly



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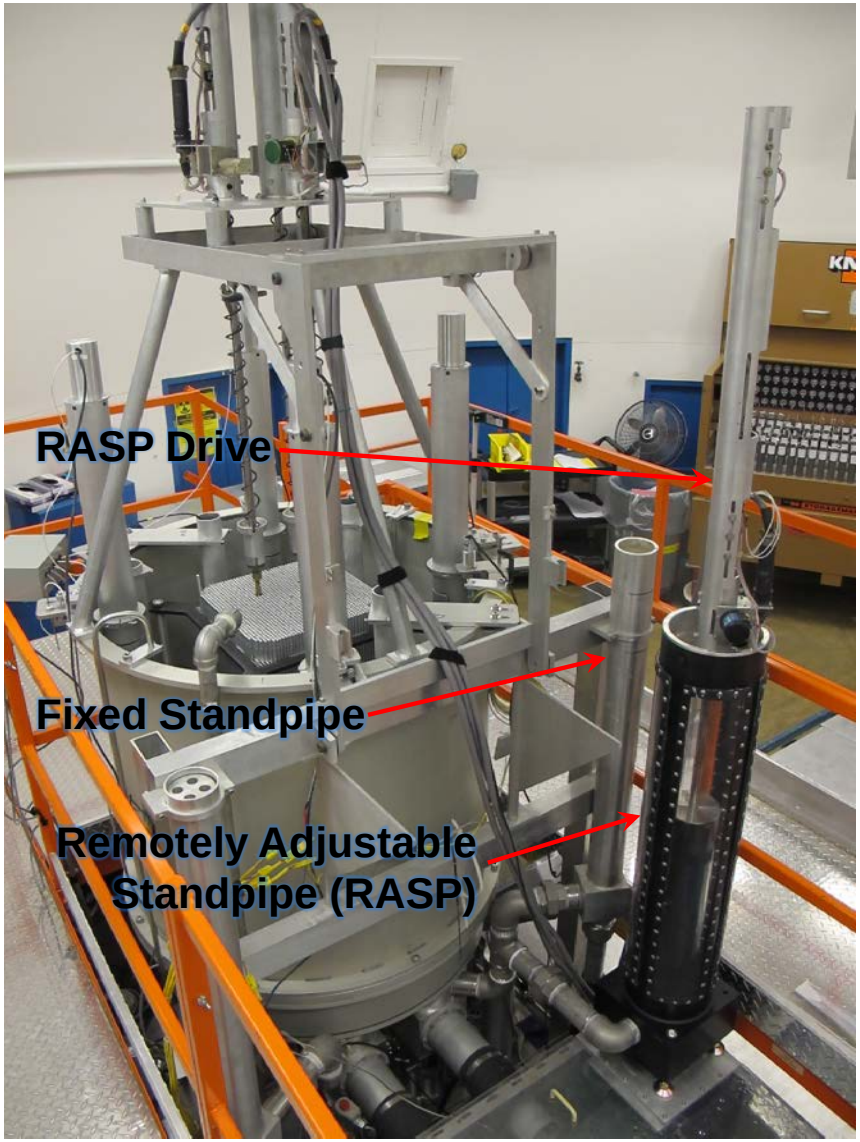
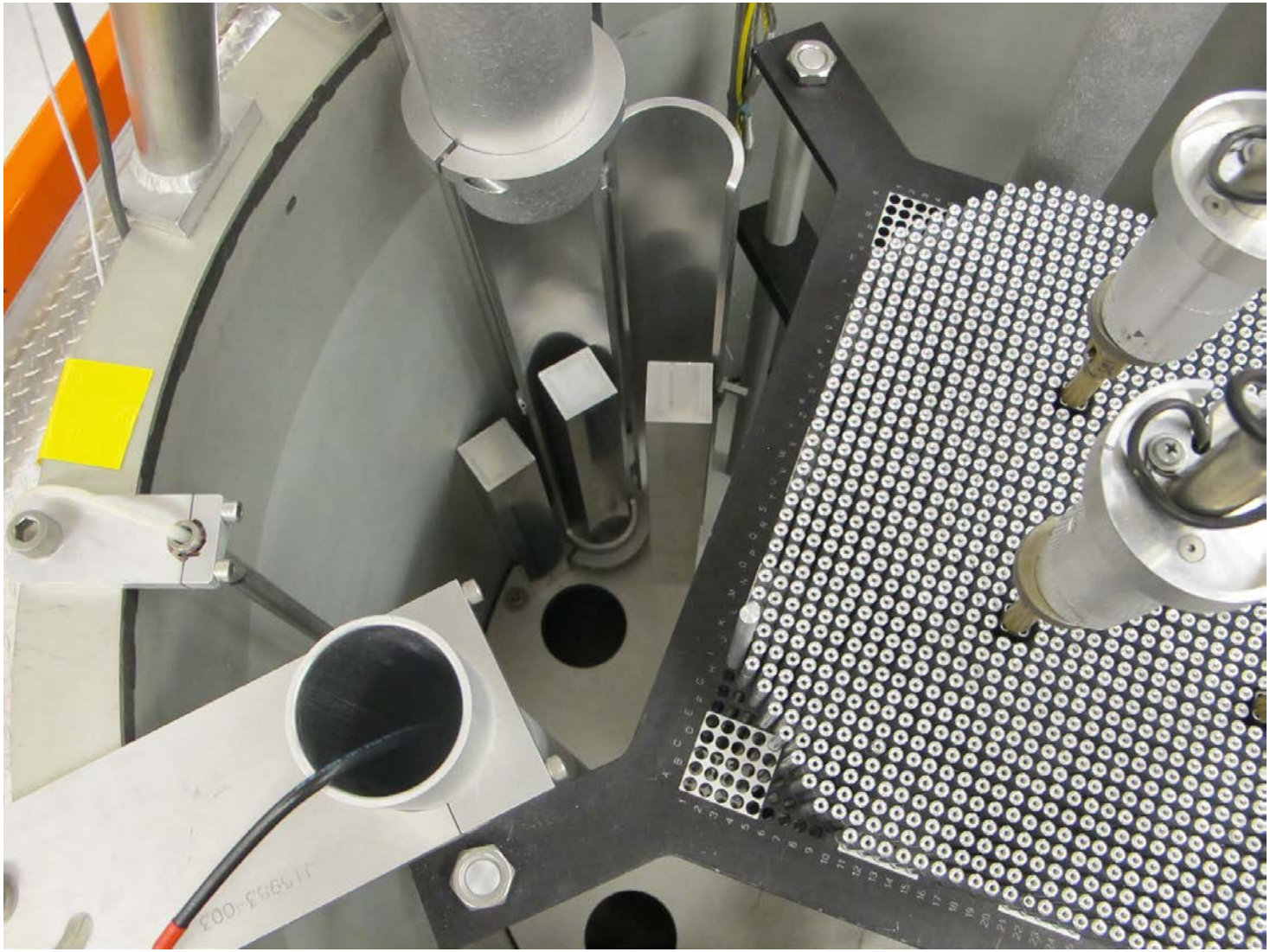
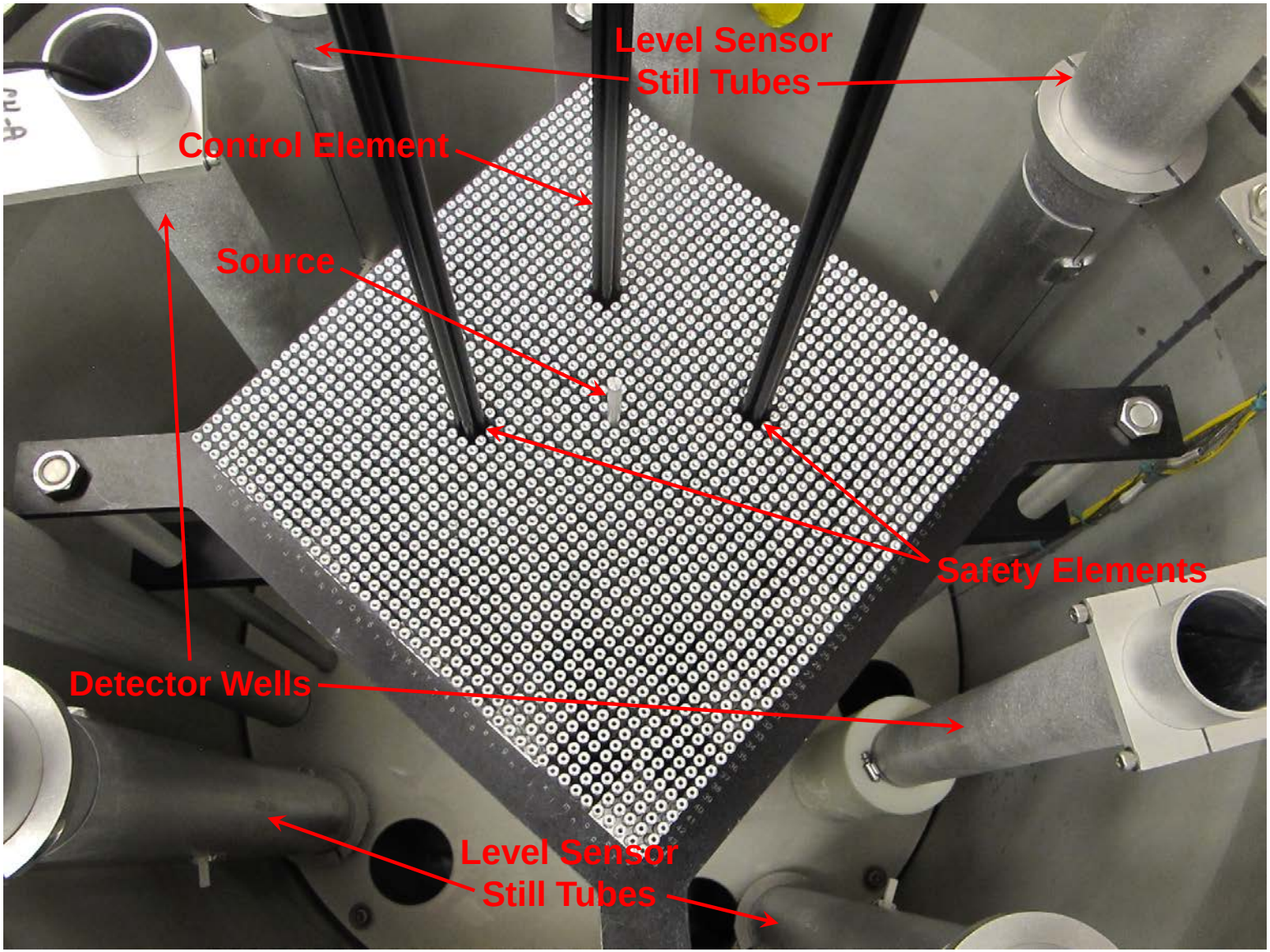
The moderator/reflector level in the assembly is controlled by two overflow standpipes



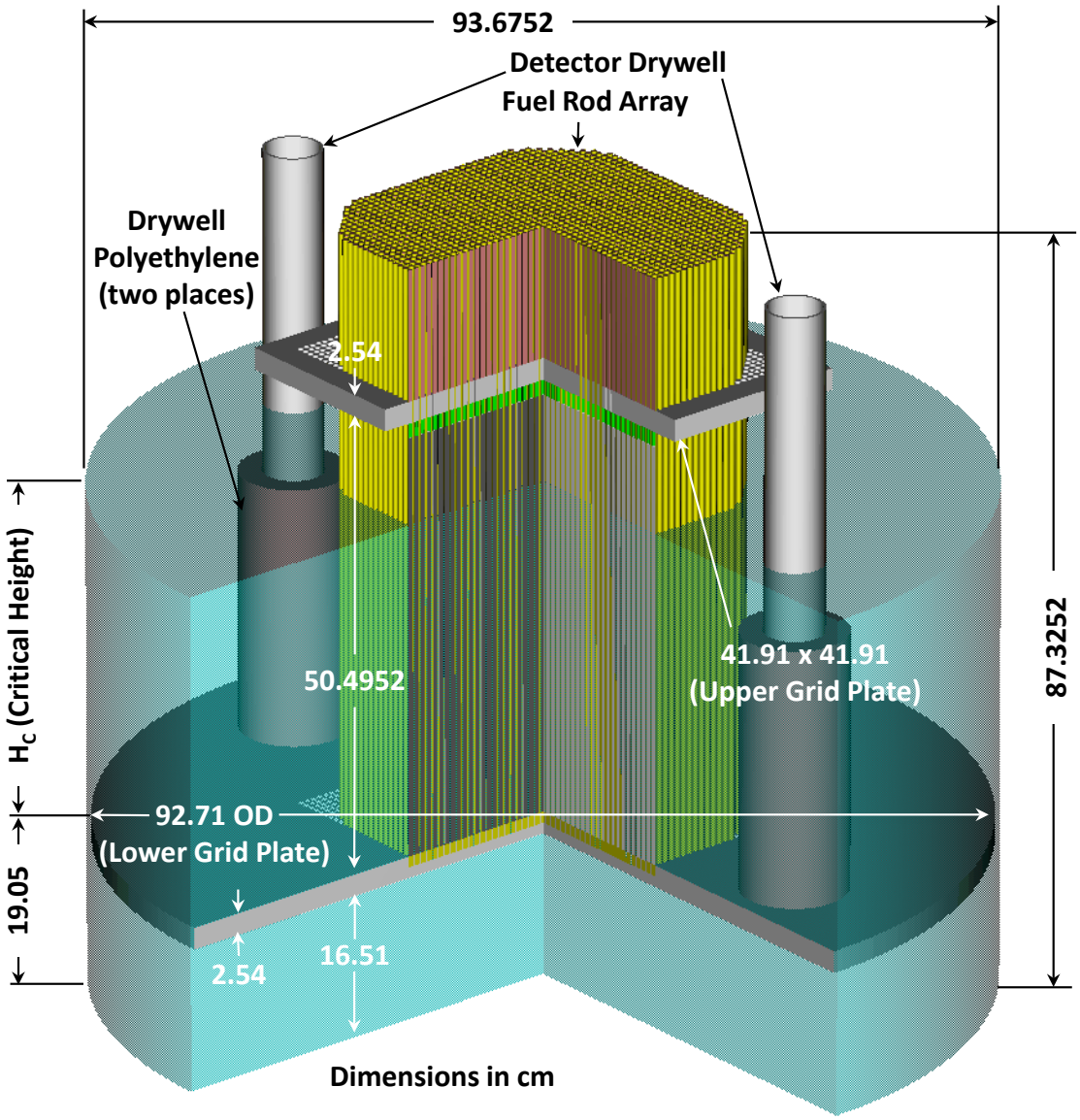
The level of the moderator is measured by a set of four ultrasonic transducers



A look at a different configuration



The core of the critical assembly was simplified for the benchmark model



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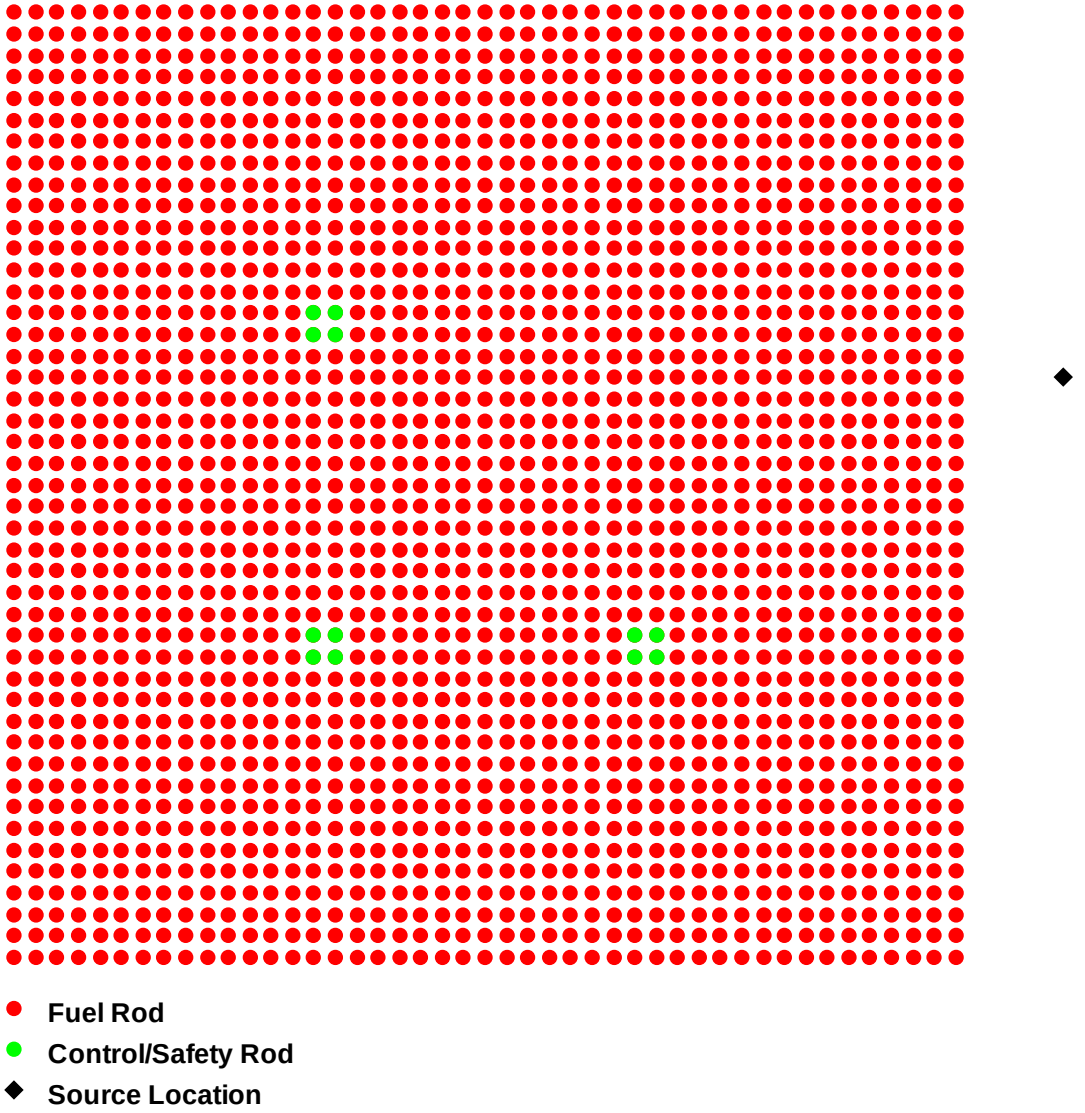
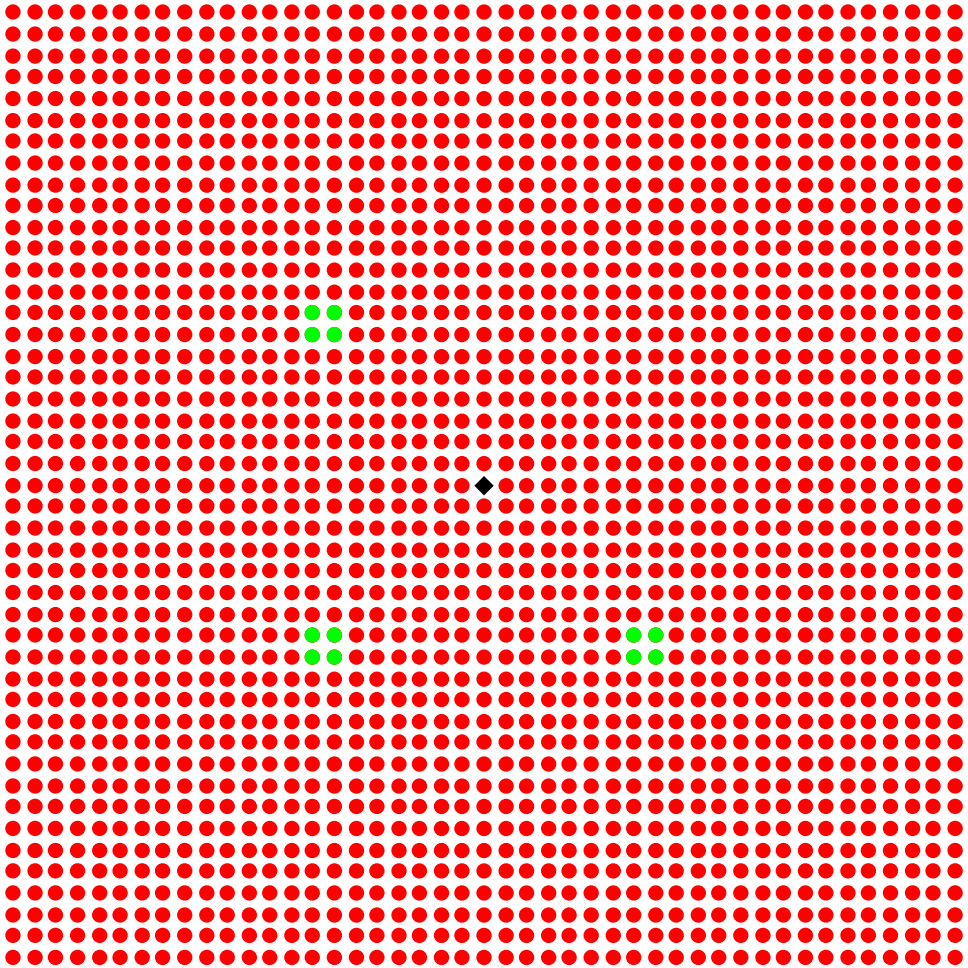
Case 1 – 2025 Fuel Rods
36.54 cm critical water height



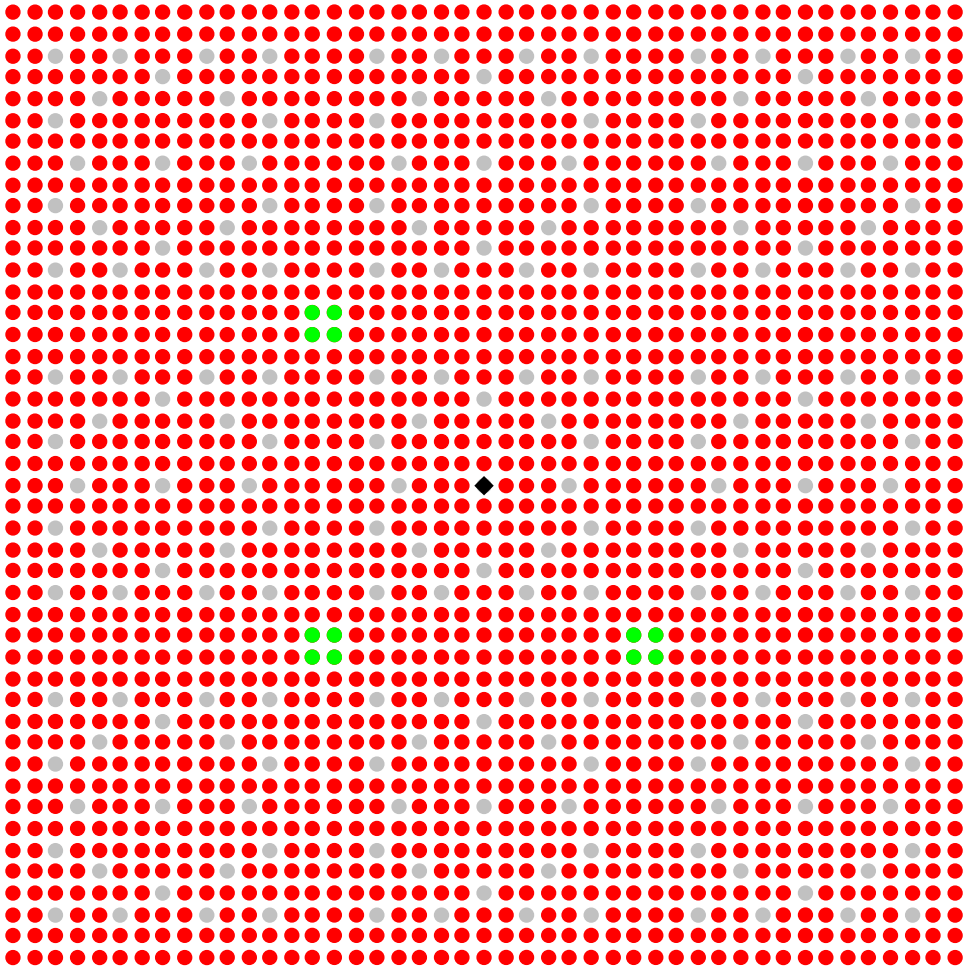
- Fuel Rod
- Control/Safety Rod
- Source Location

Case 2 – 2024 Fuel Rods
36.49 cm critical water height



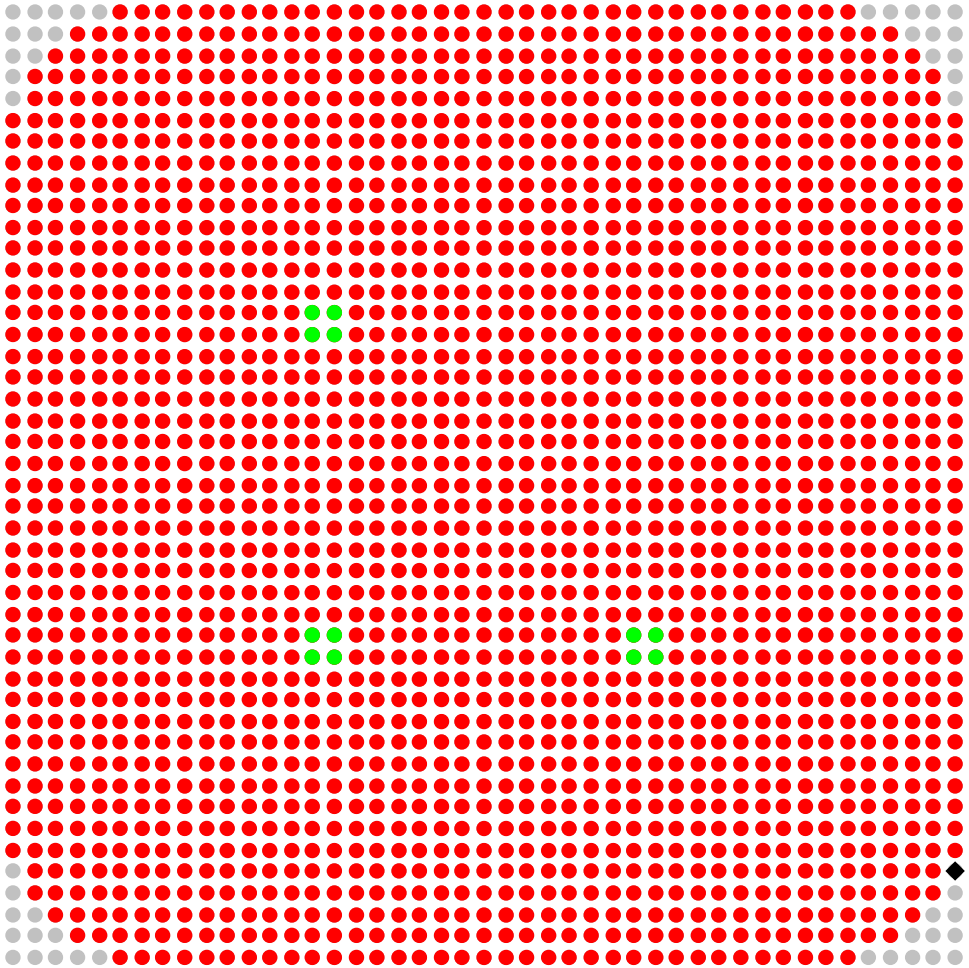
- Fuel Rod
- Control/Safety Rod
- Source Location

Case 3 – 1836 Fuel Rods
31.55 cm critical water height



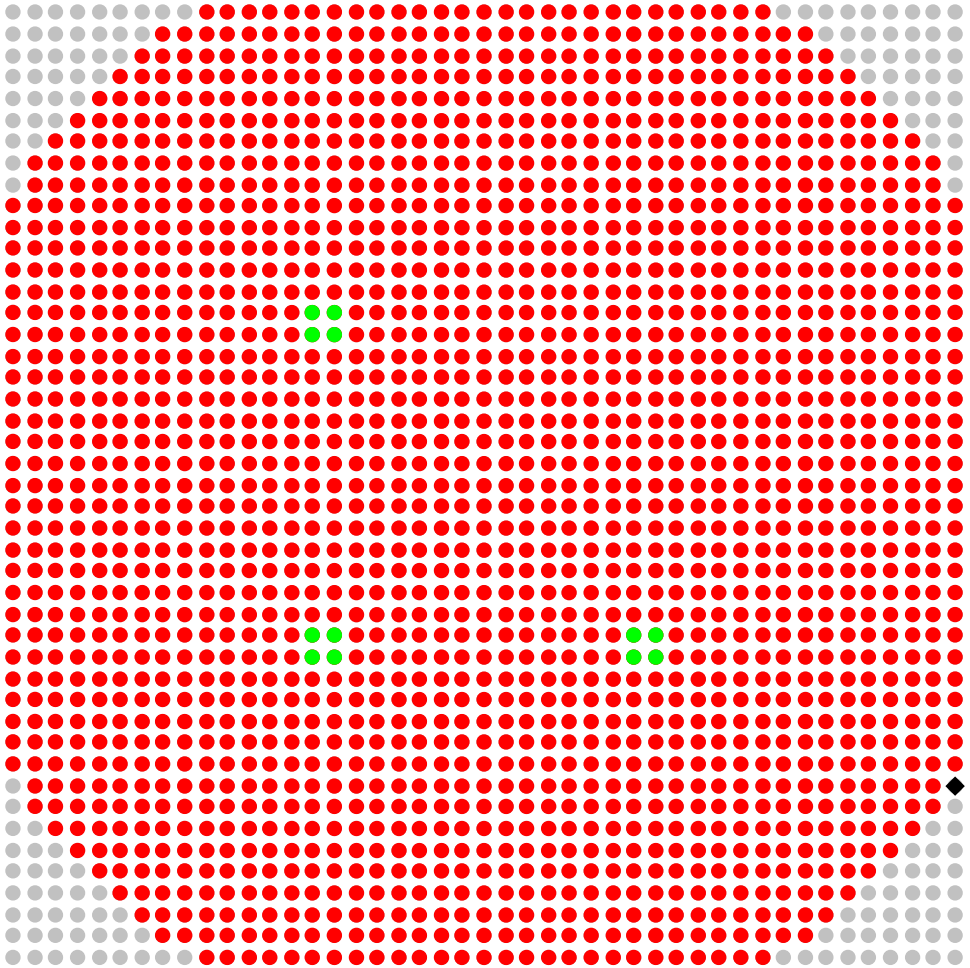
- Fuel Rod
- Control/Safety Rod
- Empty Grid Location
- Source Location

Case 4 – 1977 Fuel Rods
37.12 cm critical water height



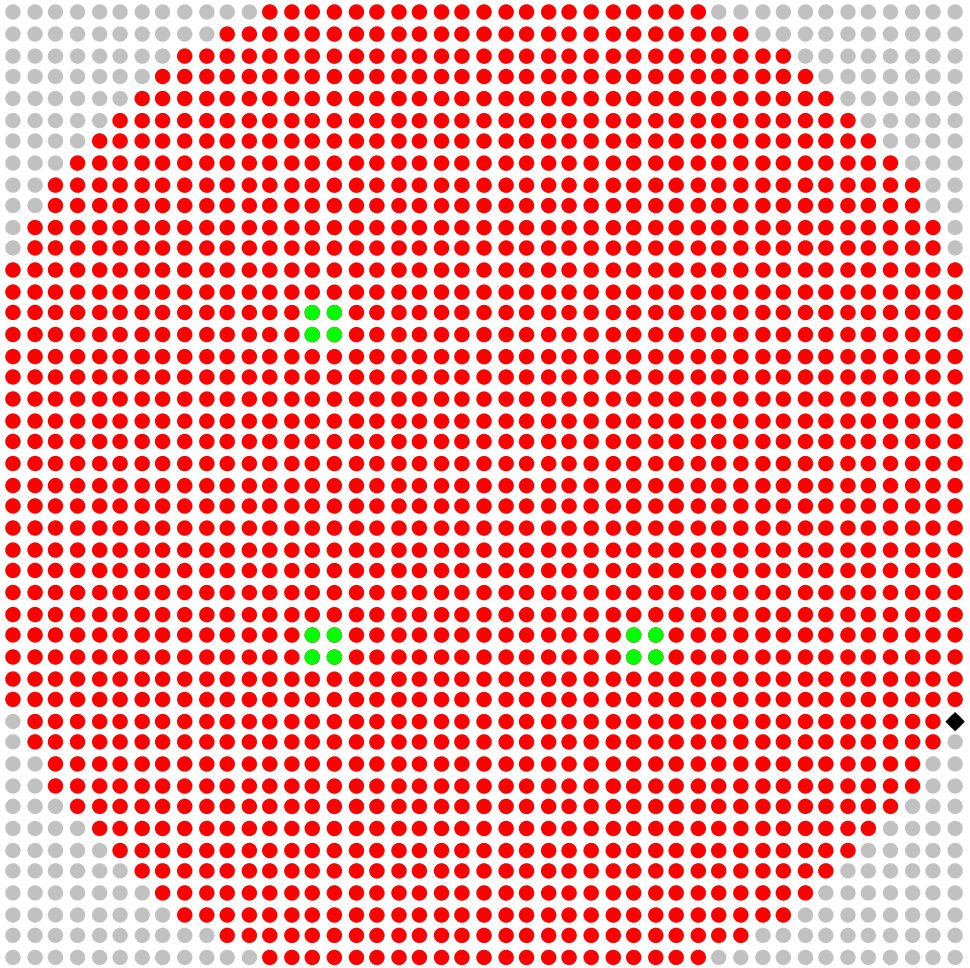
- Fuel Rod
- Control/Safety Rod
- Empty Grid Location
- Source Location

Case 5 – 1873 Fuel Rods
38.65 cm critical water height



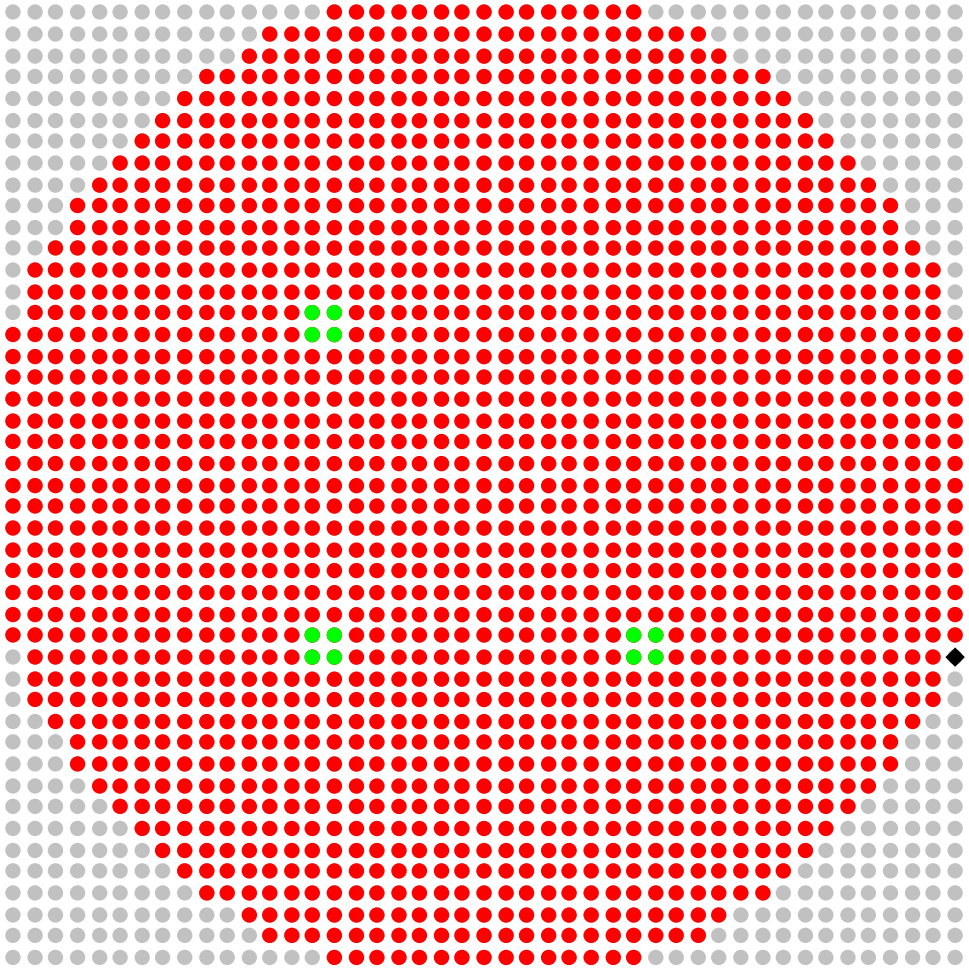
- Fuel Rod
- Control/Safety Rod
- Empty Grid Location
- Source Location

Case 6 – 1781 Fuel Rods
40.39 cm critical water height



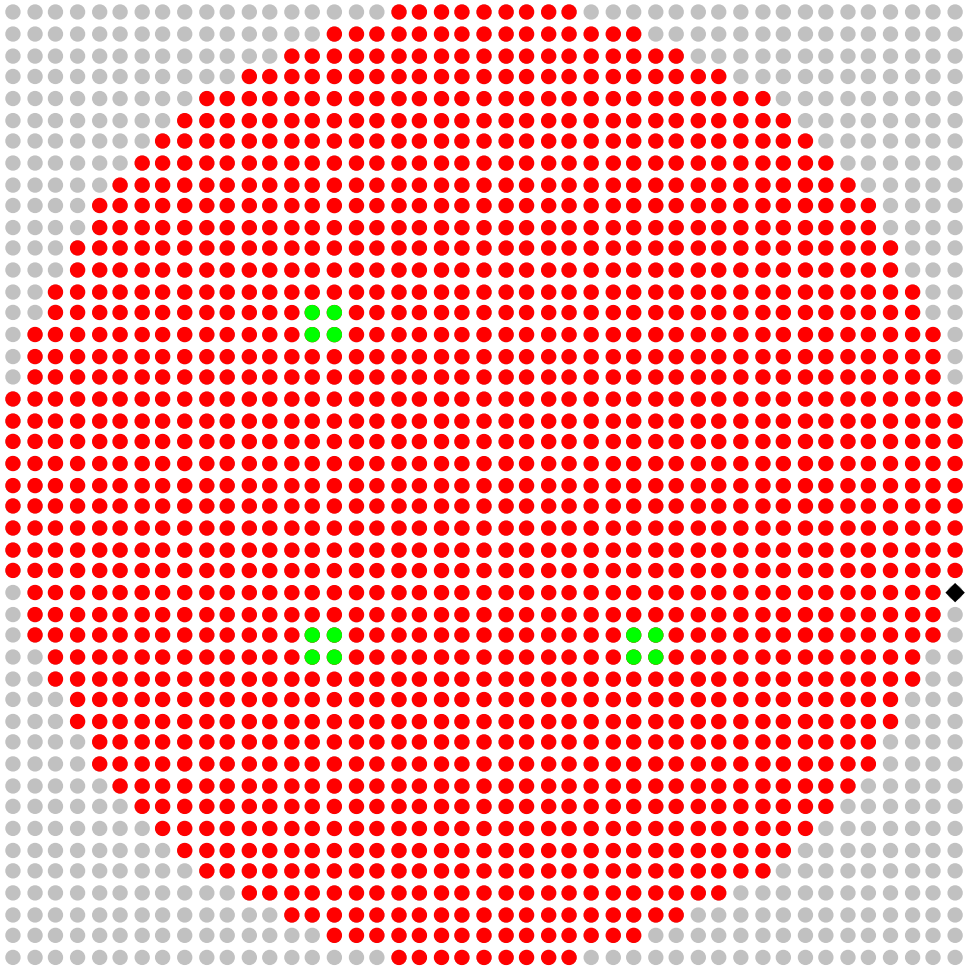
- Fuel Rod
- Control/Safety Rod
- Empty Grid Location
- Source Location

Case 7 – 1673 Fuel Rods
43.10 cm critical water height



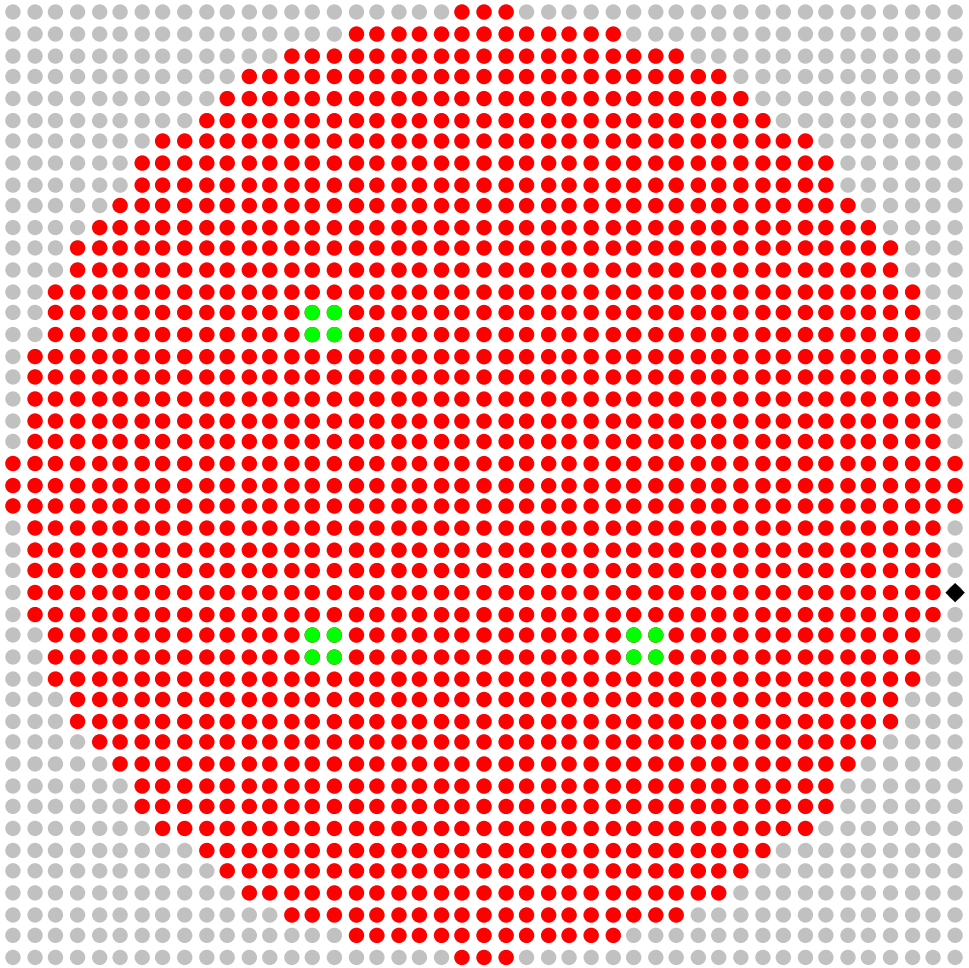
- Fuel Rod
- Control/Safety Rod
- Empty Grid Location
- Source Location

Case 8 – 1573 Fuel Rods
46.57 cm critical water height



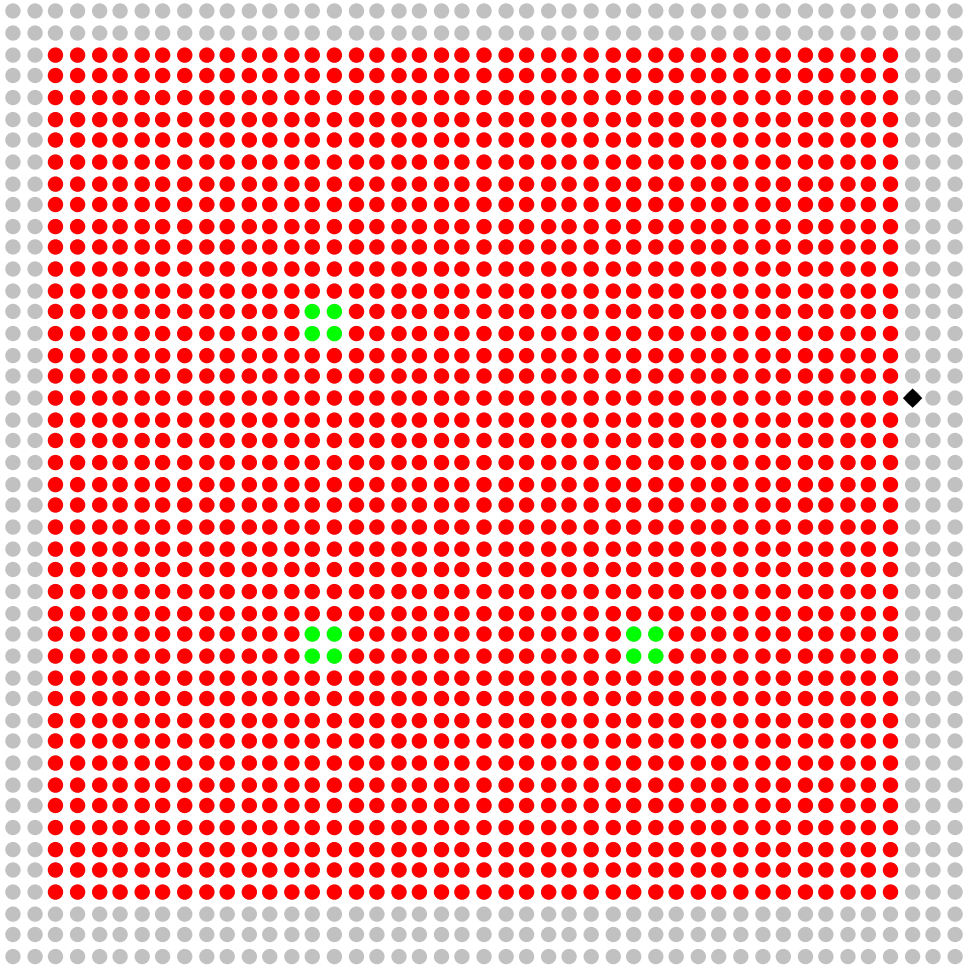
- Fuel Rod
- Control/Safety Rod
- Empty Grid Location
- Source Location

Case 9 – 1525 Fuel Rods
48.70 cm critical water height



- Fuel Rod
- Control/Safety Rod
- Empty Grid Location
- Source Location

Case 10 – 1600 Fuel Rods
46.79 cm critical water height



- Fuel Rod
- Control/Safety Rod
- Empty Grid Location
- Source Location

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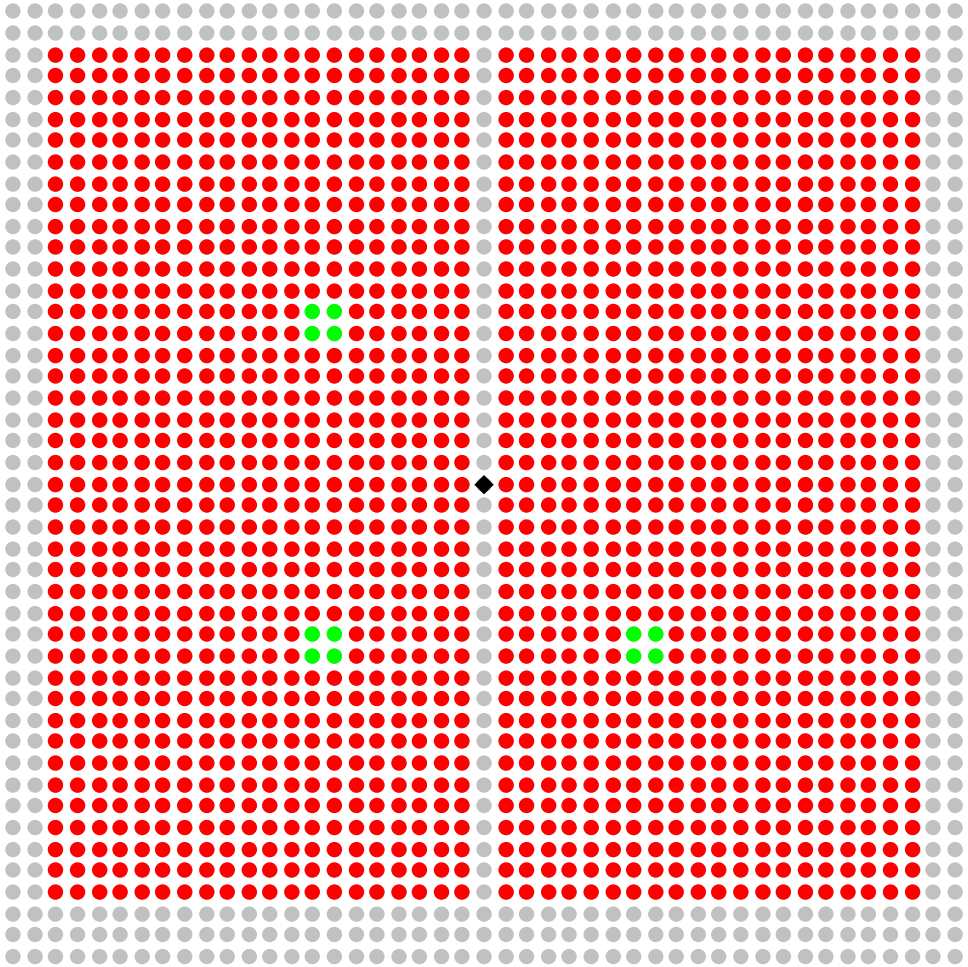
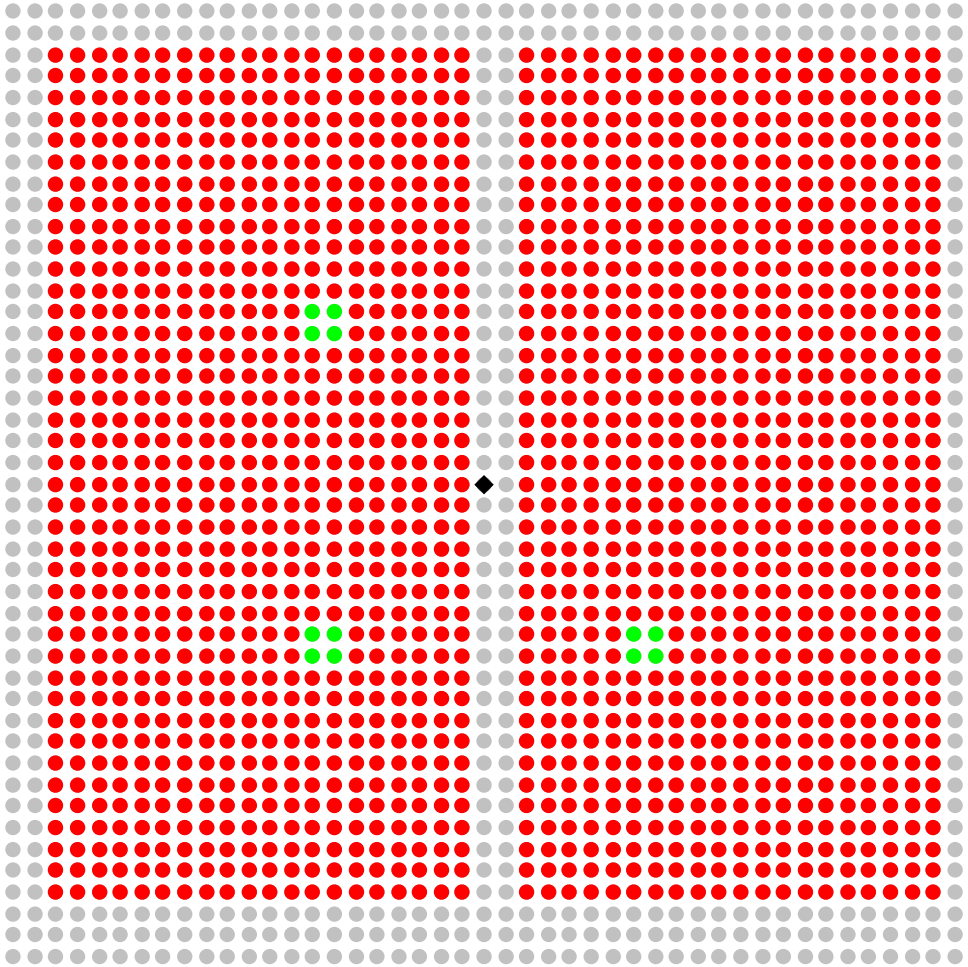
Case 11 – 1600 Fuel Rods
42.19 cm critical water height



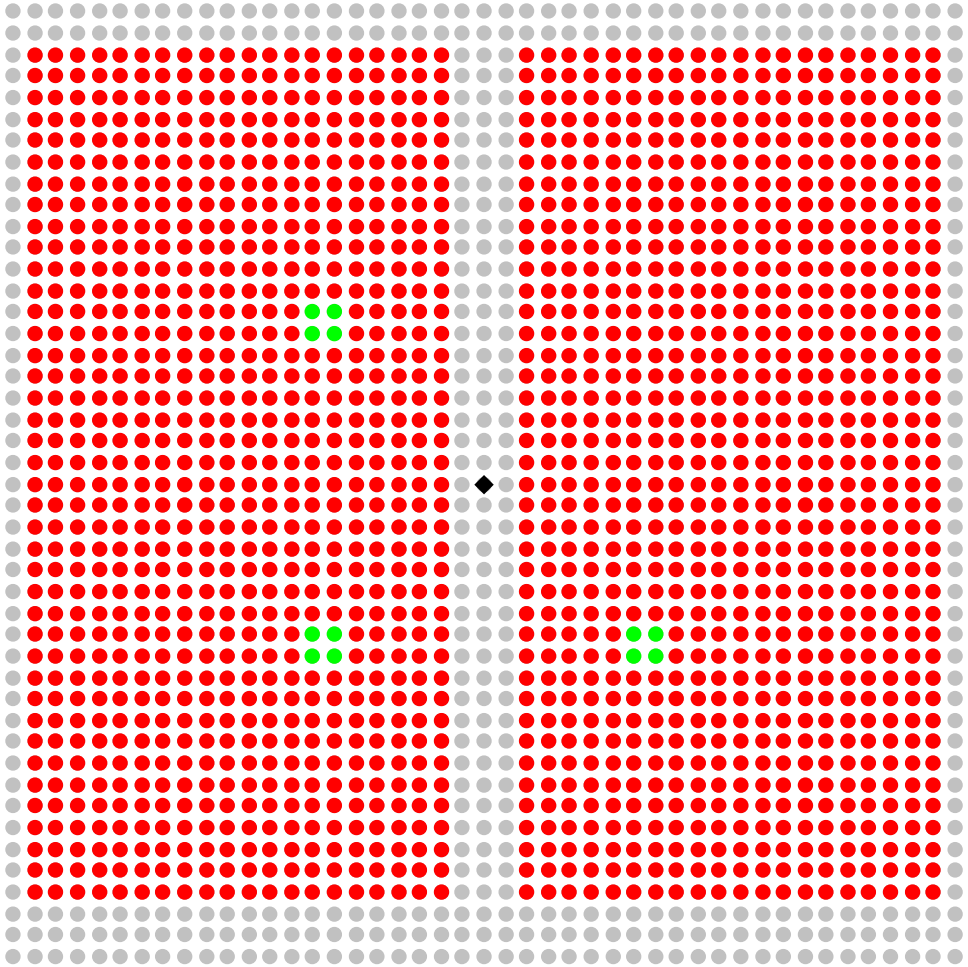
- Fuel Rod
- Control/Safety Rod
- Empty Grid Location
- Source Location

Case 12 – 1600 Fuel Rods
39.60 cm critical water height



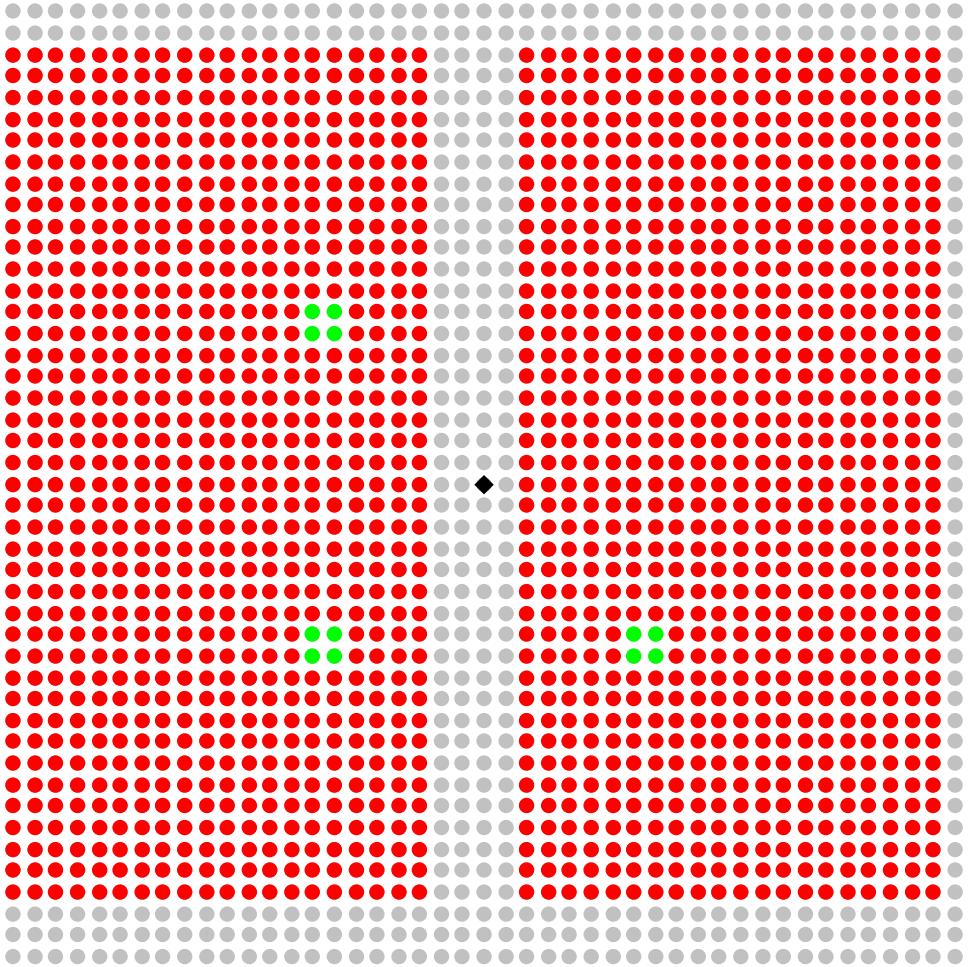
- Fuel Rod
- Control/Safety Rod
- Empty Grid Location
- Source Location

Case 13 – 1600 Fuel Rods
39.03 cm critical water height



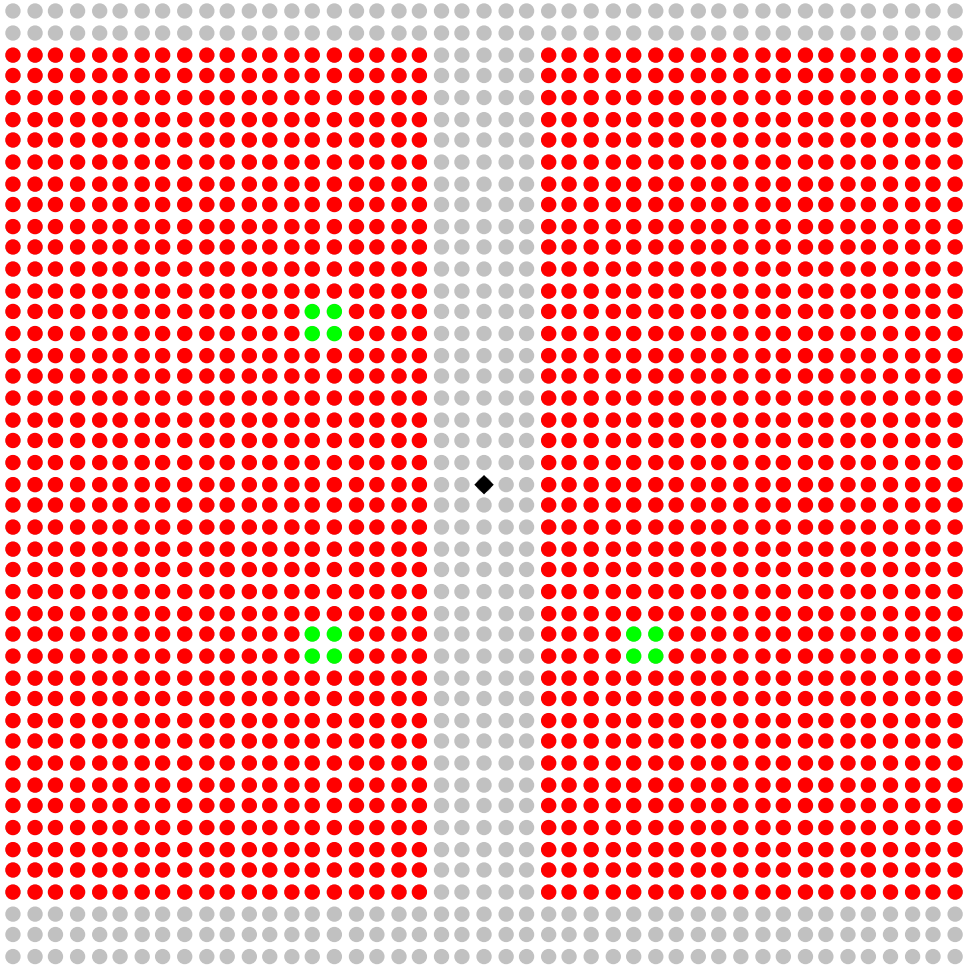
- Fuel Rod
- Control/Safety Rod
- Empty Grid Location
- Source Location

Case 14 – 1600 Fuel Rods
39.98 cm critical water height



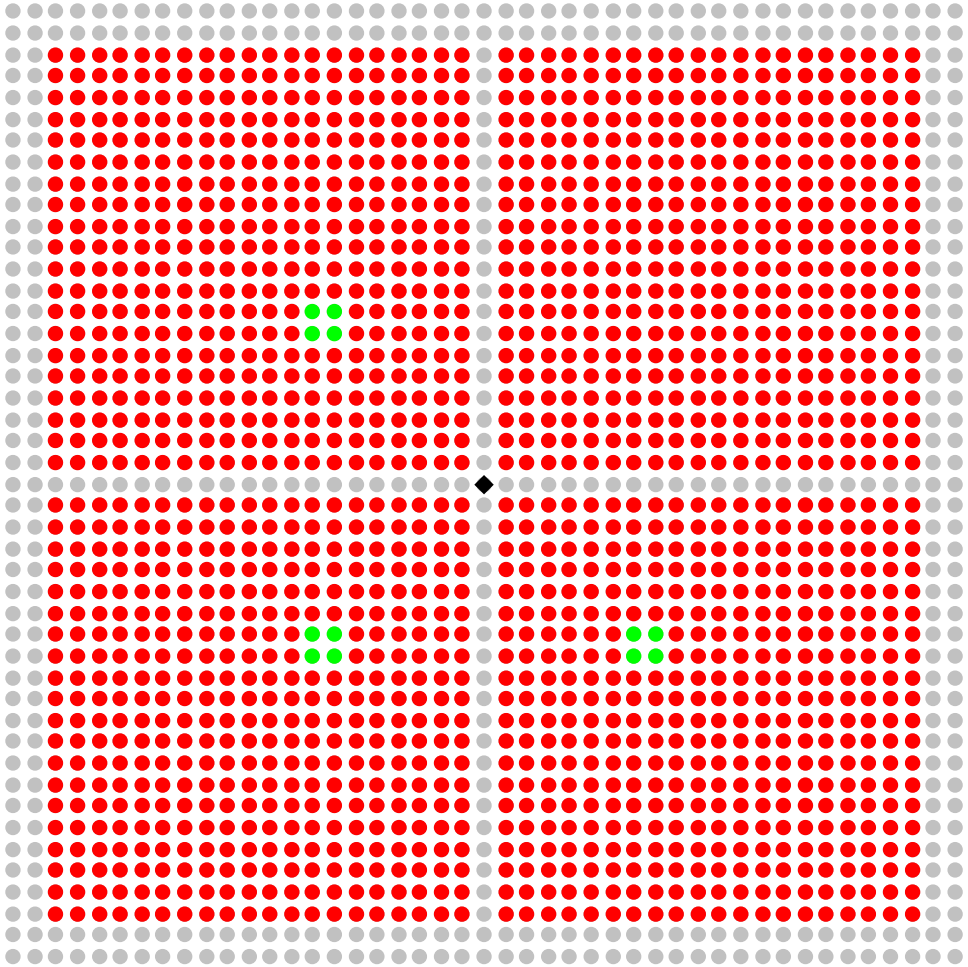
- Fuel Rod
- Control/Safety Rod
- Empty Grid Location
- Source Location

Case 15 – 1600 Fuel Rods
42.57 cm critical water height



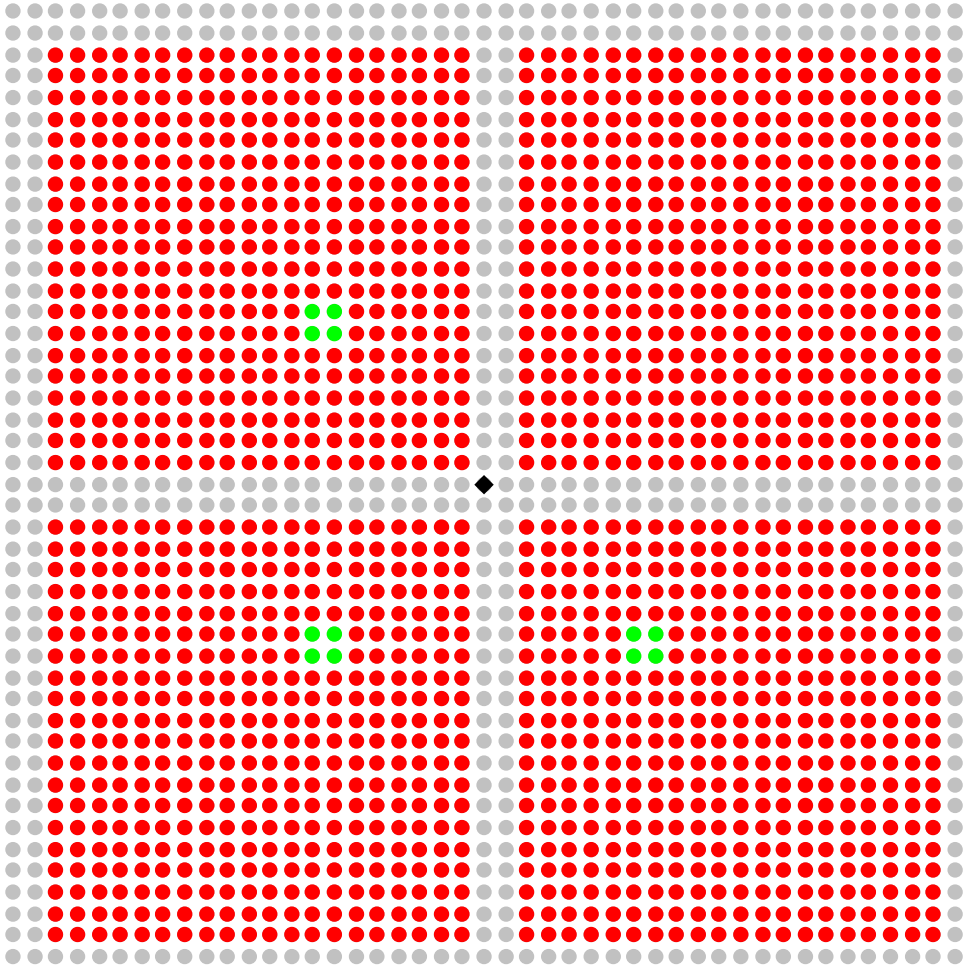
- Fuel Rod
- Control/Safety Rod
- Empty Grid Location
- Source Location

Case 16 – 1600 Fuel Rods
38.69 cm critical water height



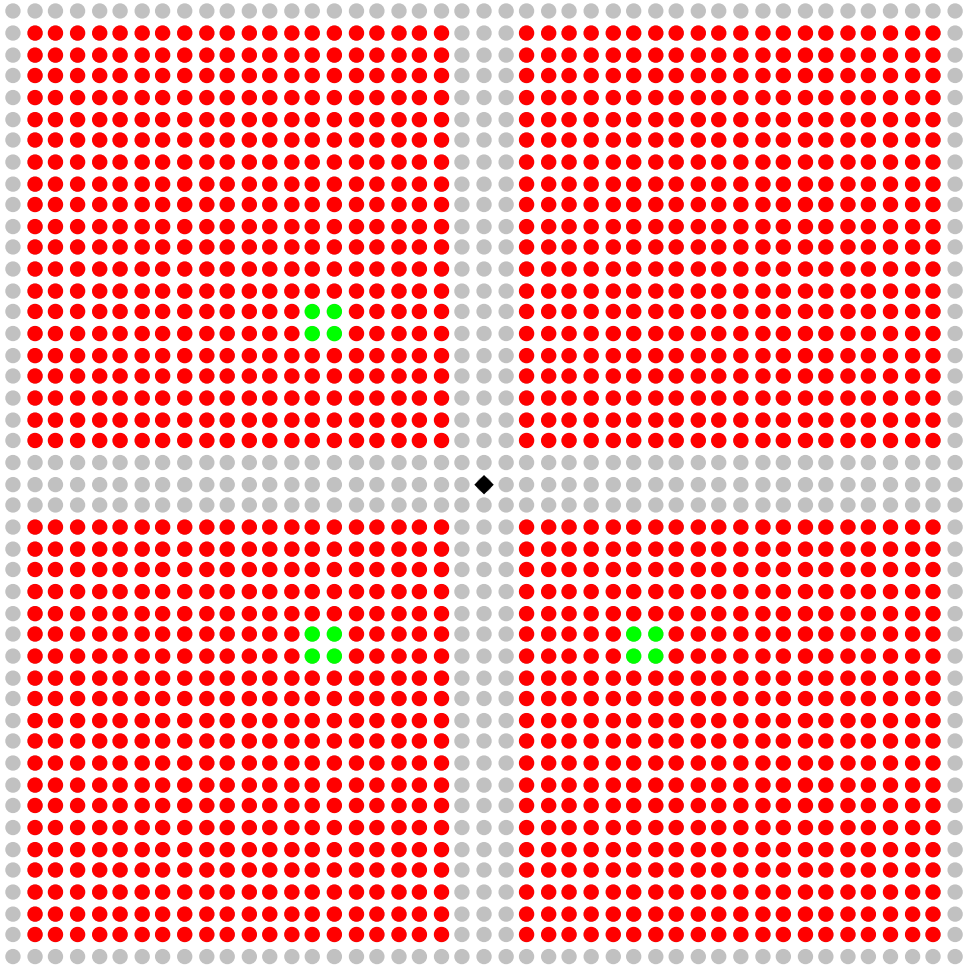
- Fuel Rod
- Control/Safety Rod
- Empty Grid Location
- Source Location

Case 17 – 1600 Fuel Rods
35.31 cm critical water height



- Fuel Rod
- Control/Safety Rod
- Empty Grid Location
- Source Location

Case 18 – 1600 Fuel Rods
35.10 cm critical water height



- Fuel Rod
- Control/Safety Rod
- Empty Grid Location
- Source Location

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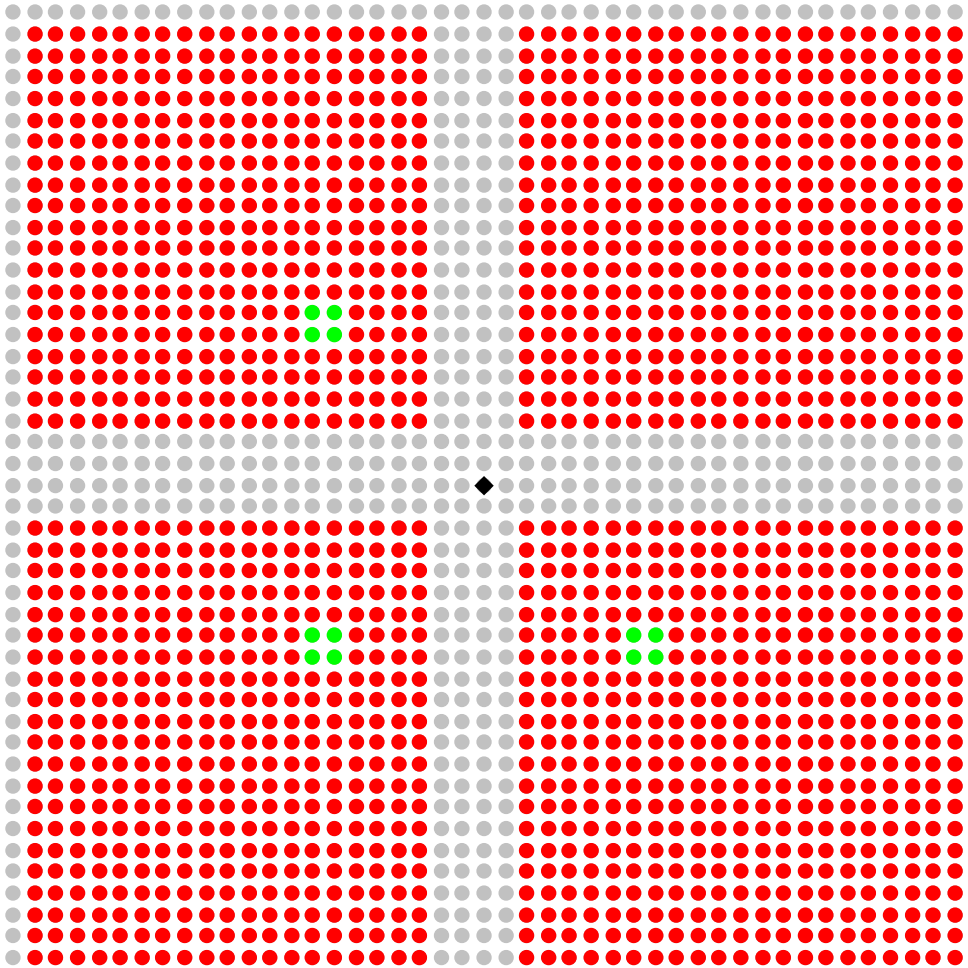
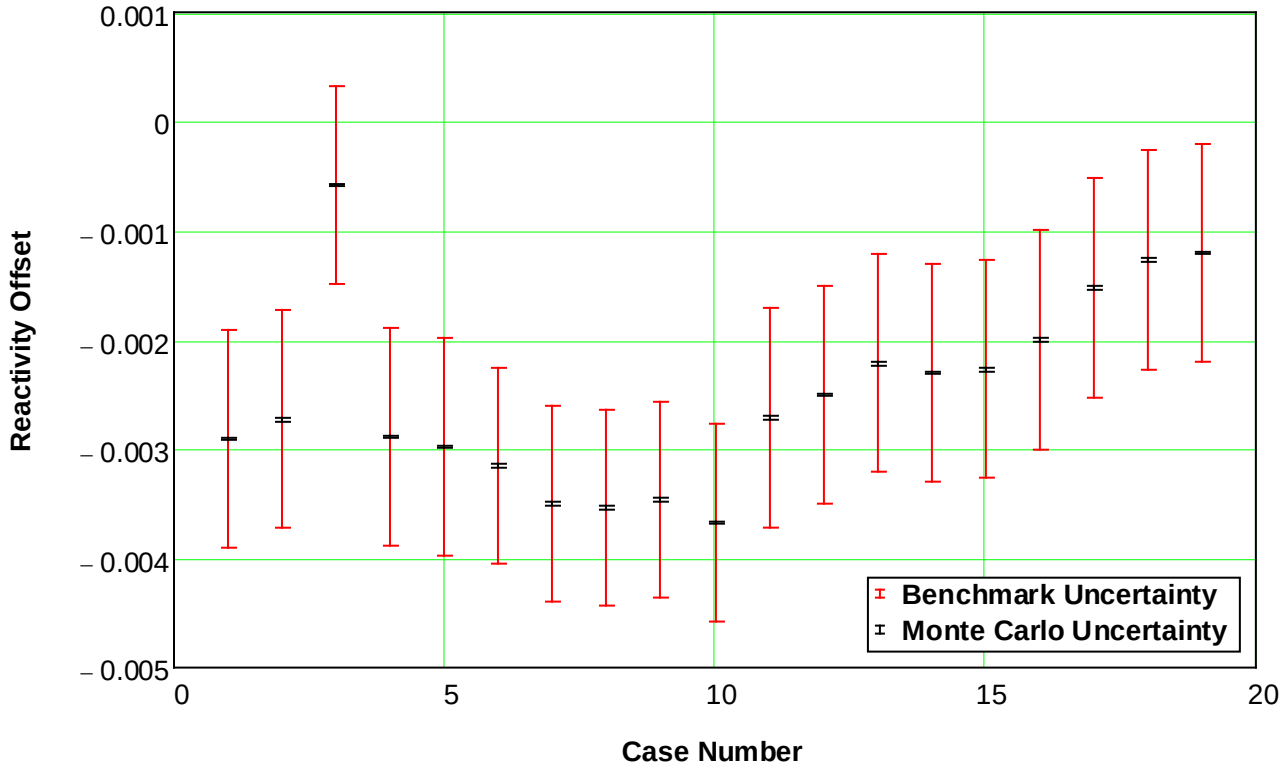
Case 19 – 1600 Fuel Rods
37.50 cm critical water height



- Fuel Rod
- Control/Safety Rod
- Empty Grid Location
- Source Location

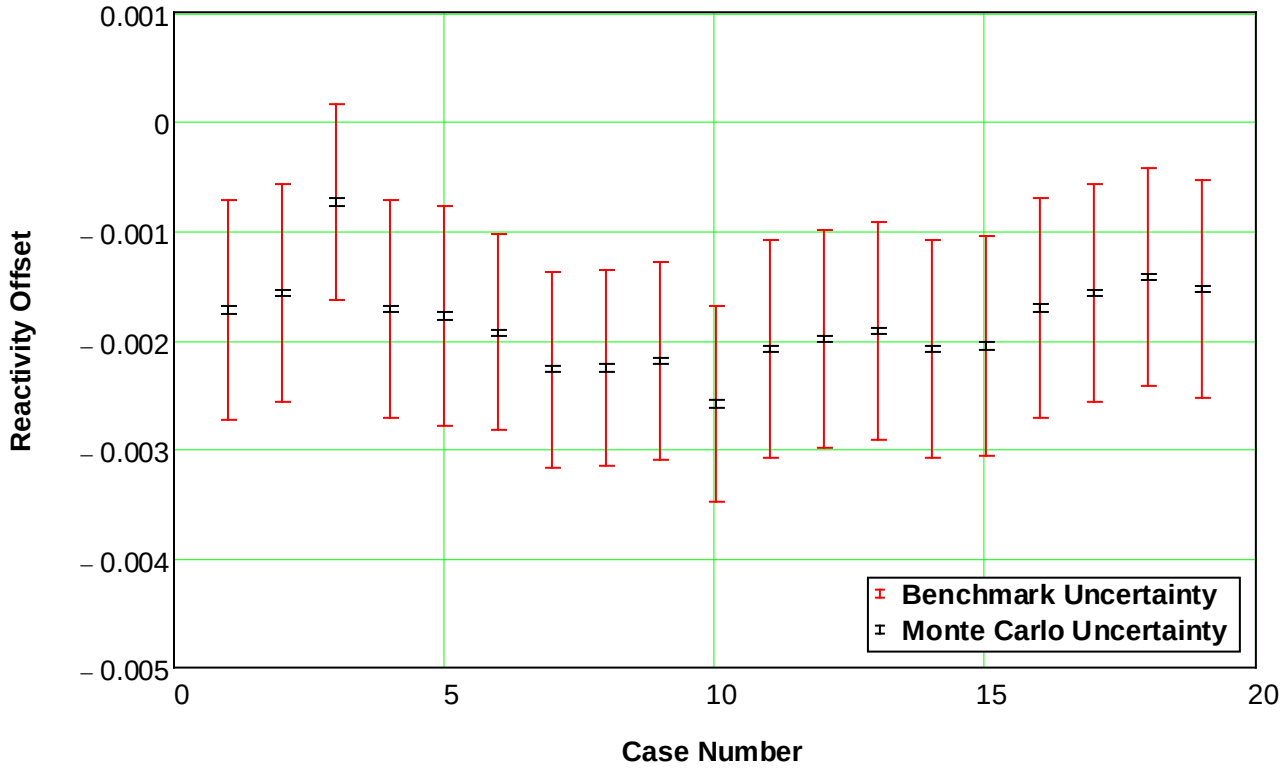
Reactivity Offset – Multi-group KENOV.a



Code: KENOV.a (SCALE6.1.3)
Cross Sections: 238-group ENDF/B-VII.0

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

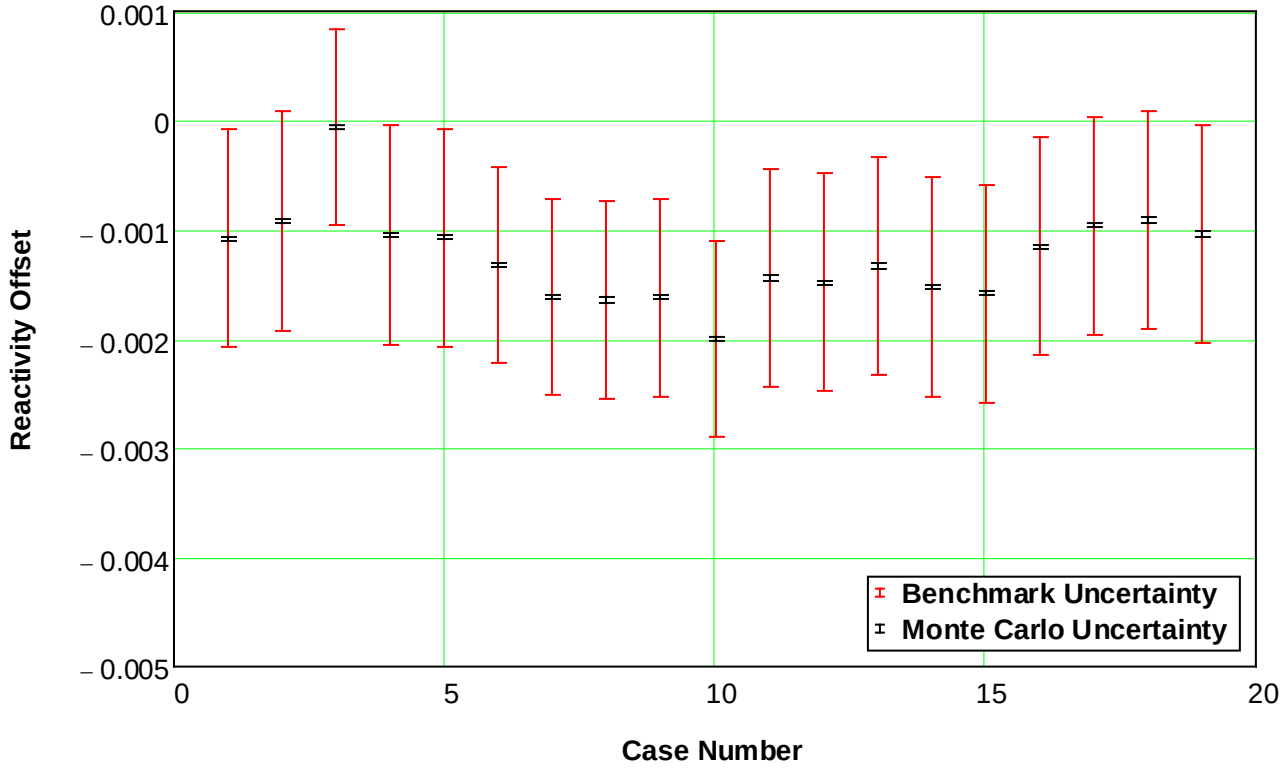
Reactivity Offset – Continuous-Energy KENOV.a



Code: KENOV.a (SCALE6.1.3)
Cross Sections: Continuous-energy ENDF/B-VII.0

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

Reactivity Offset – Continuous-Energy MCNP6.1



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

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

What's behind

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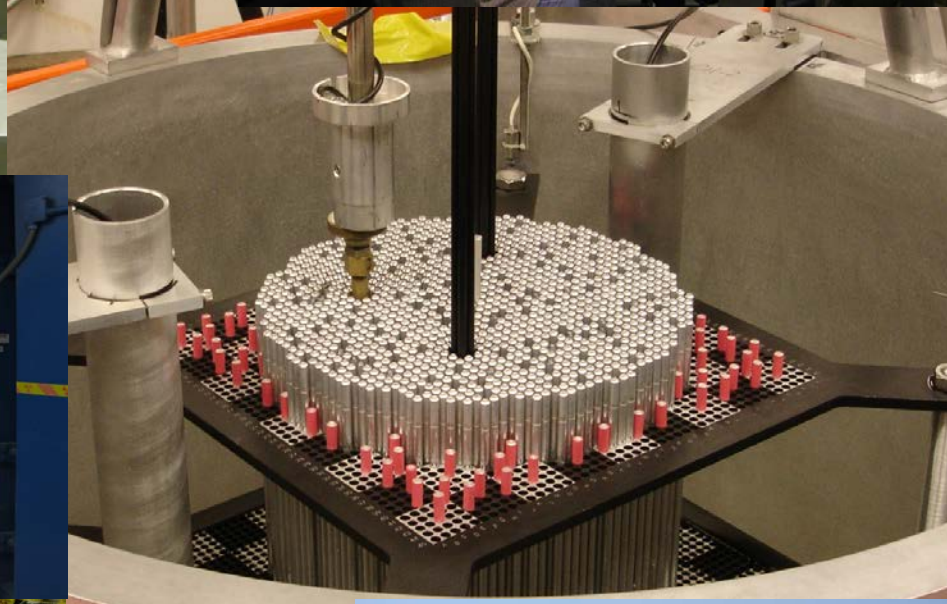
Critical Experiments at Sandia









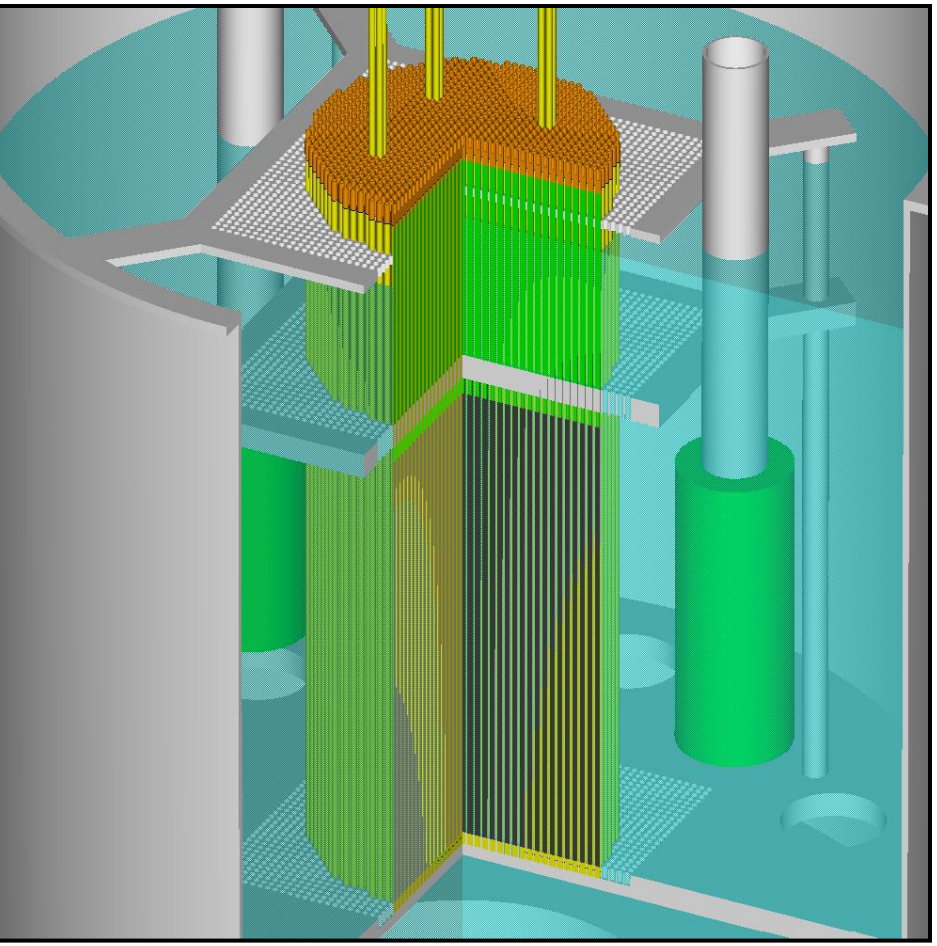
Backup/Previously-Used Material

IER-208

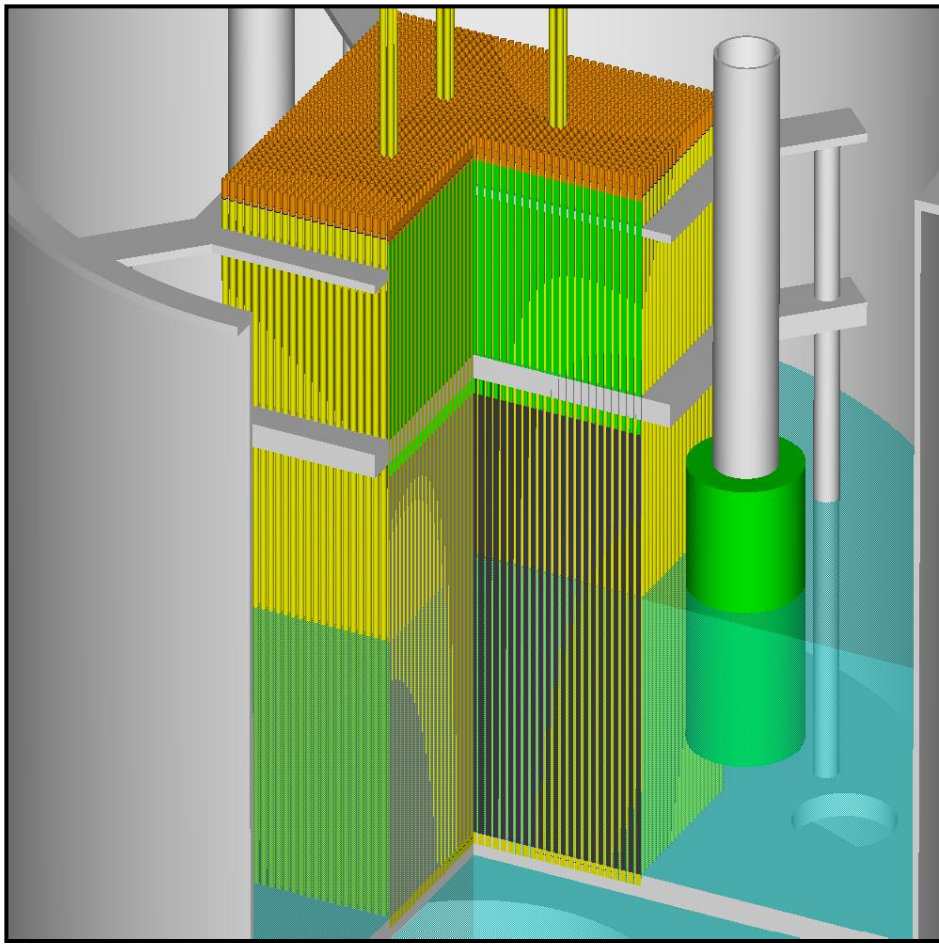
- This is our first set of benchmark-quality experiments using the height of the water moderator/reflector in the assembly tank as the approach variable
- Two new hardware systems were installed on the critical assembly
  - The Remotely Adjustable Standpipe (RASP) limits the excess reactivity available during an experiment.
  - Four ultrasonic level sensors to measure the height of the water in the tank

An overall view of the critical assembly

We are now measuring "partially reflected" configurations

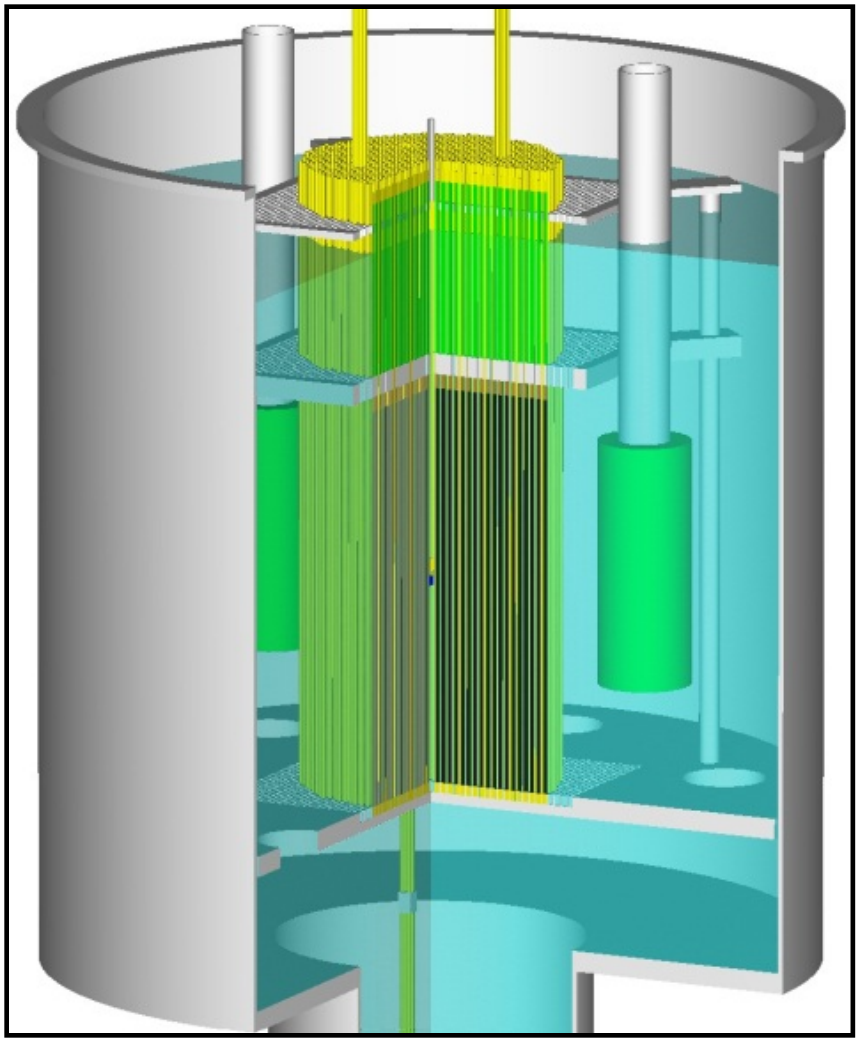


"Fully-Reflected"

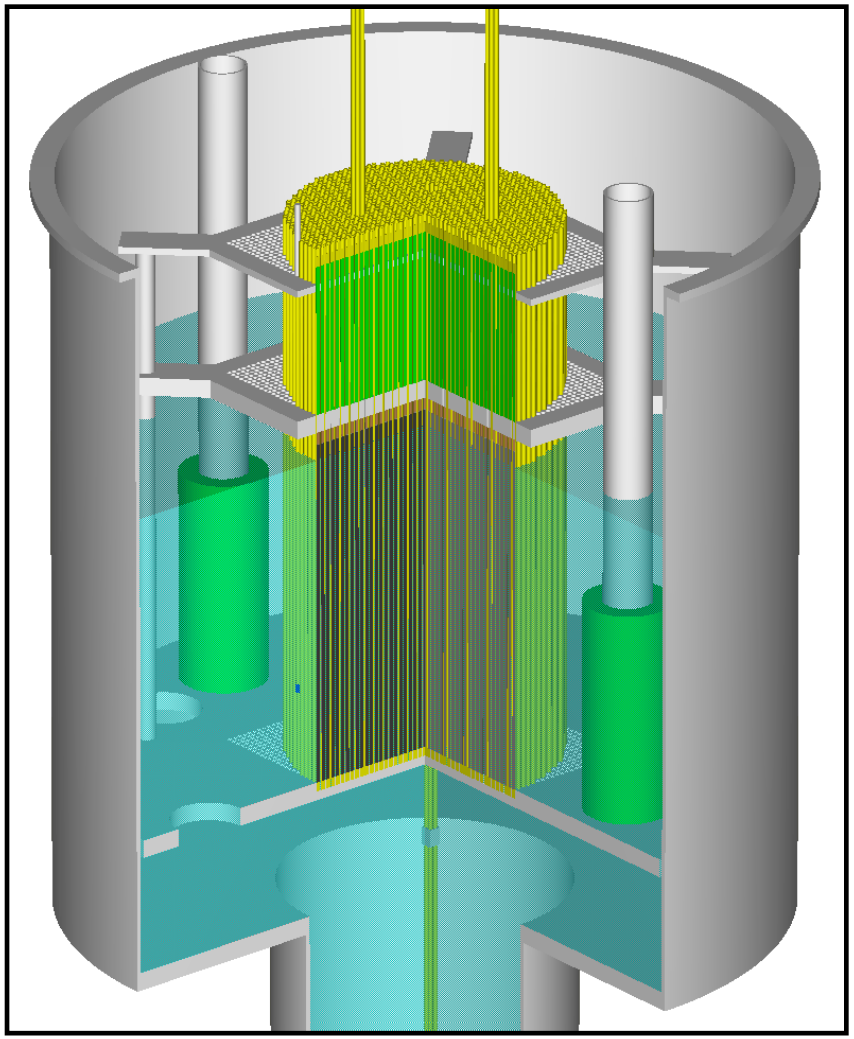


"Partially-Reflected"

Full vs partial reflection



Full Reflection



Partial Reflection

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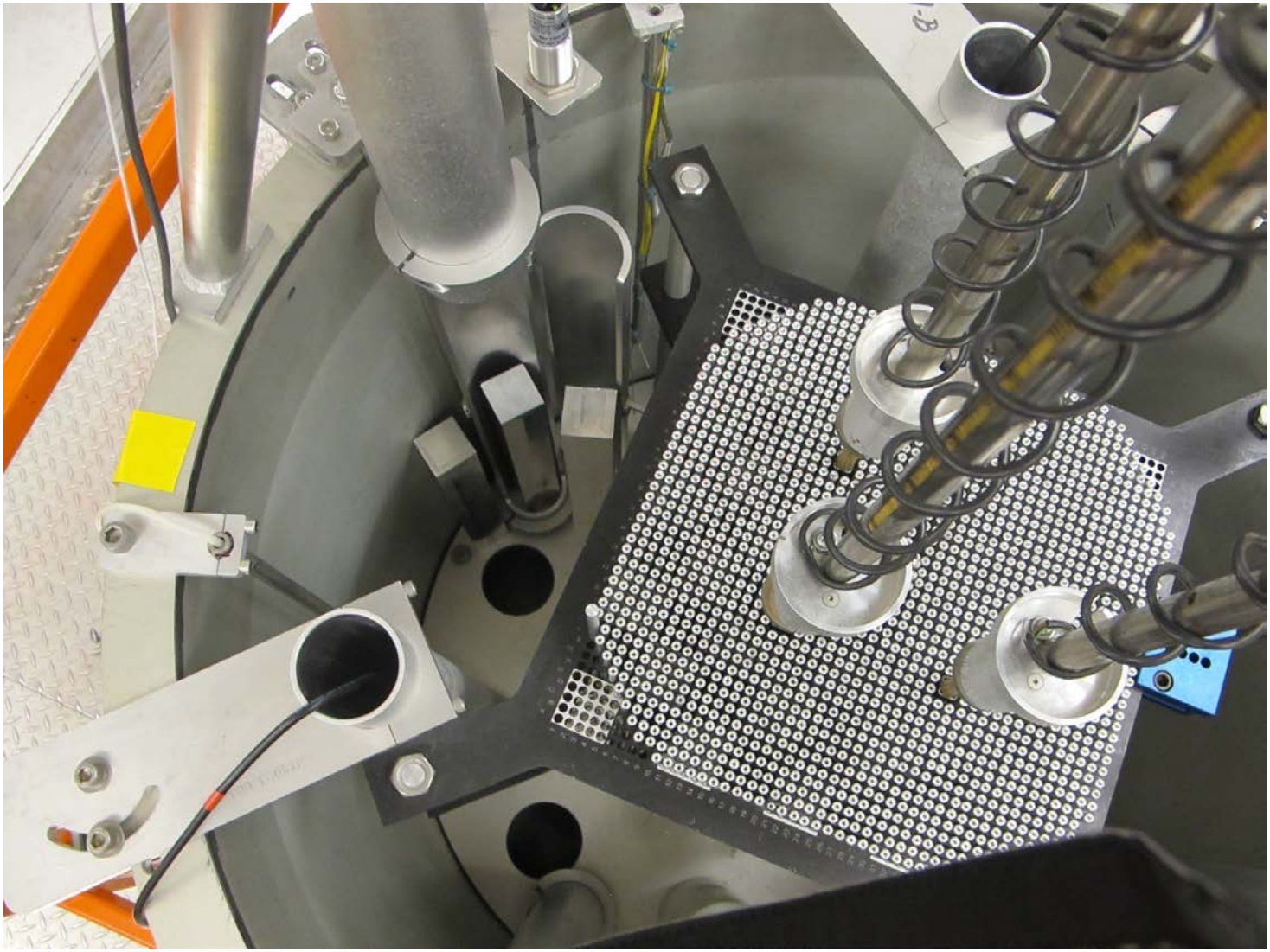

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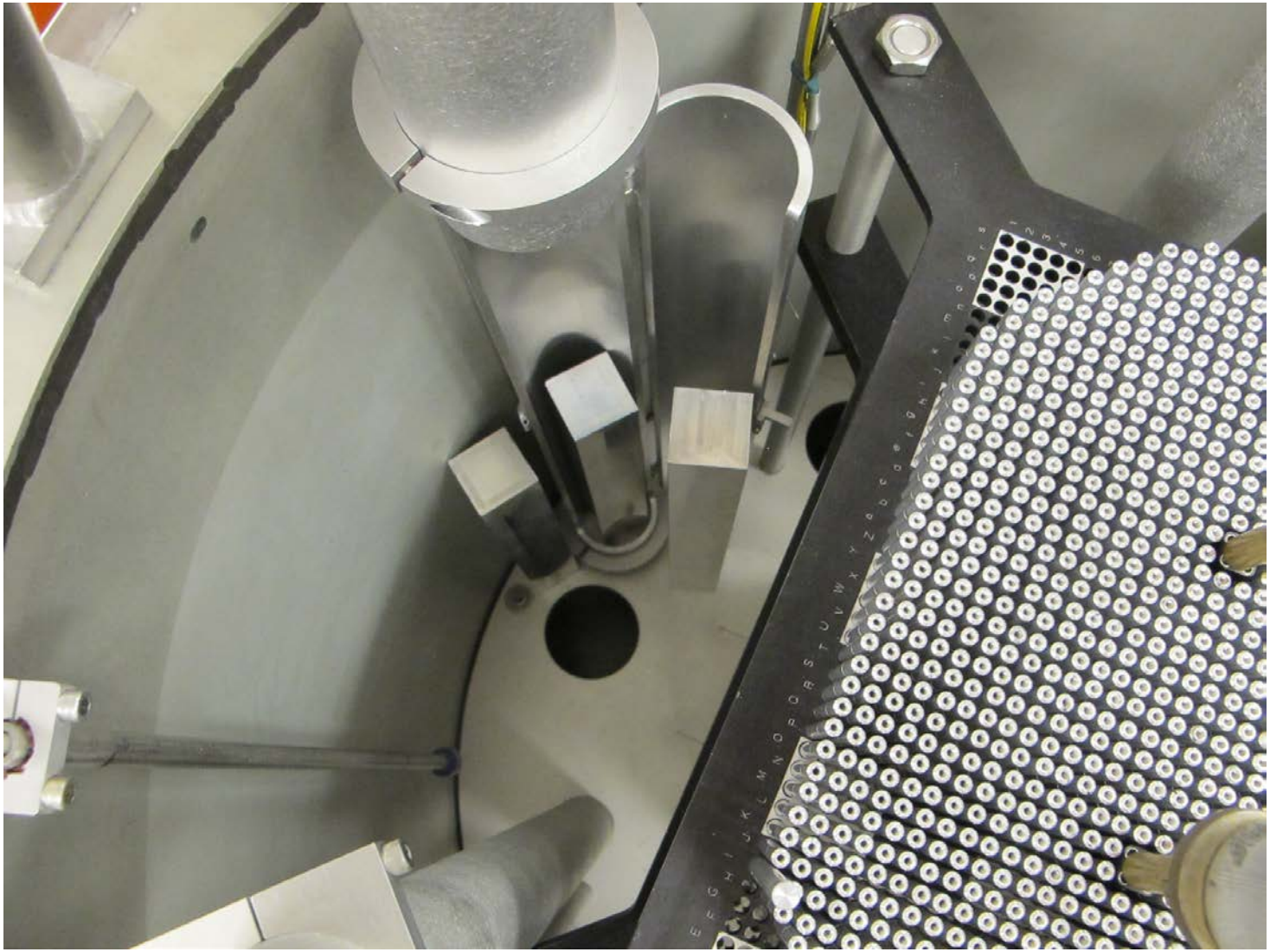
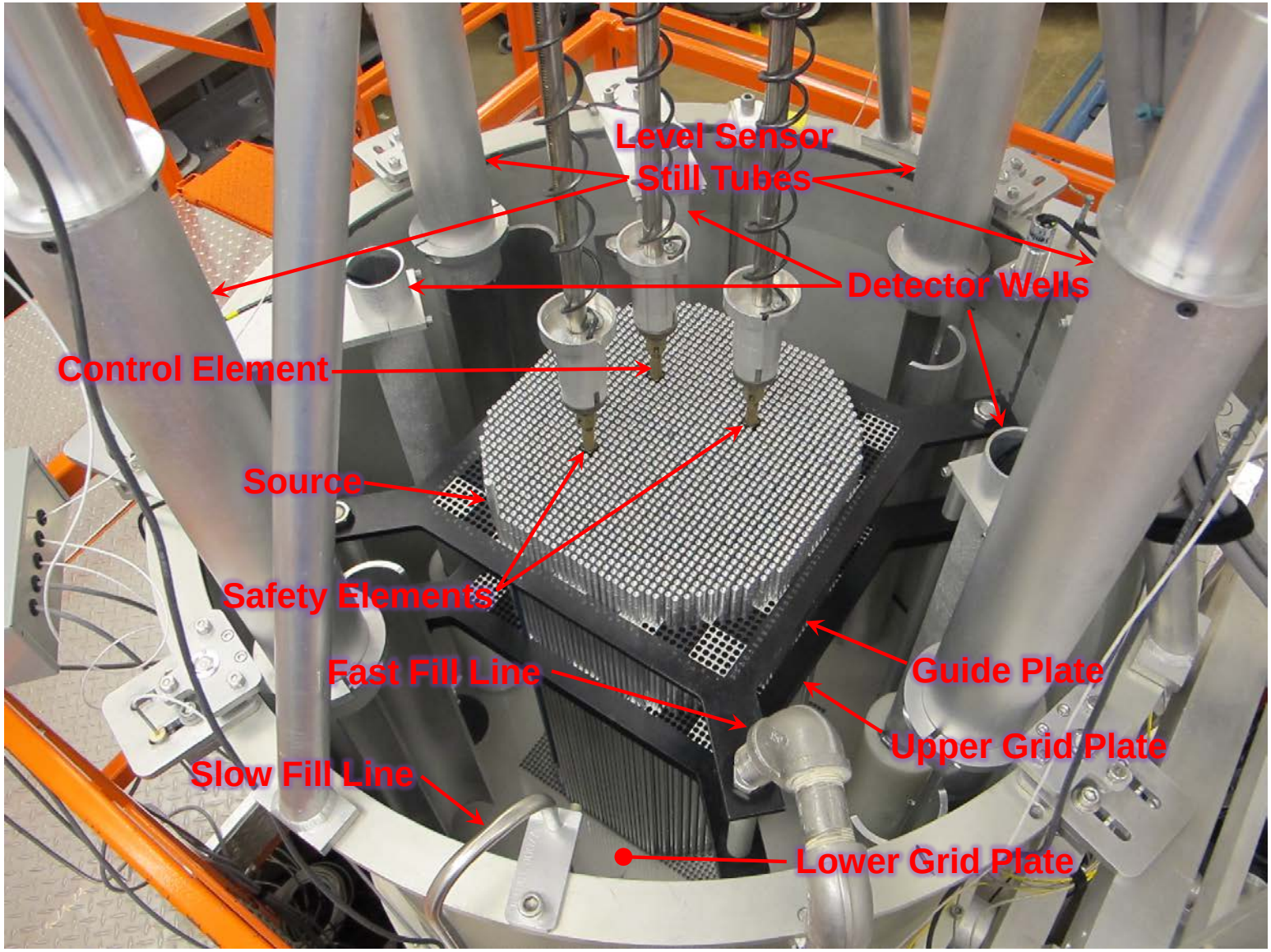


A look into the core tank of the assembly



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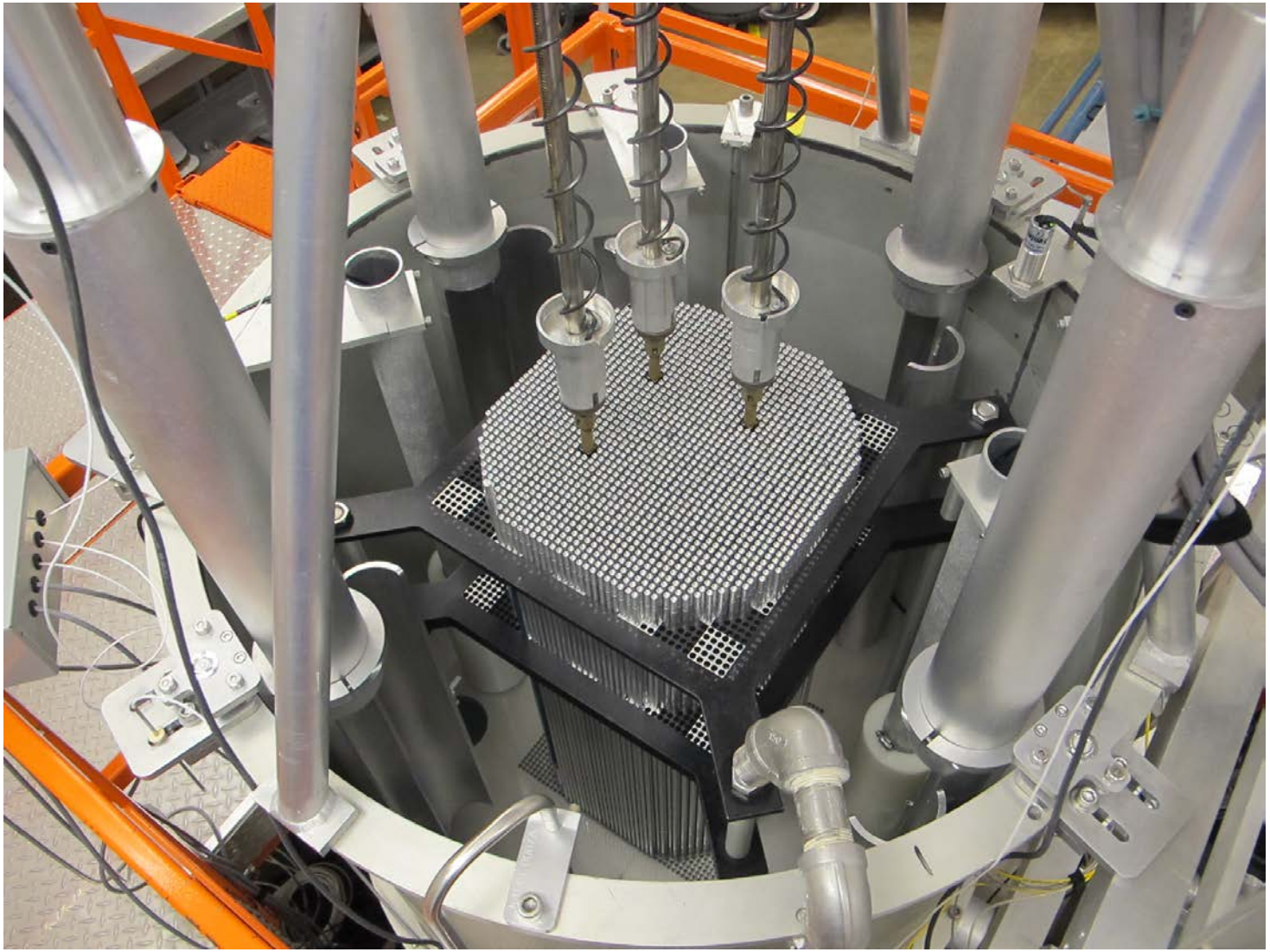
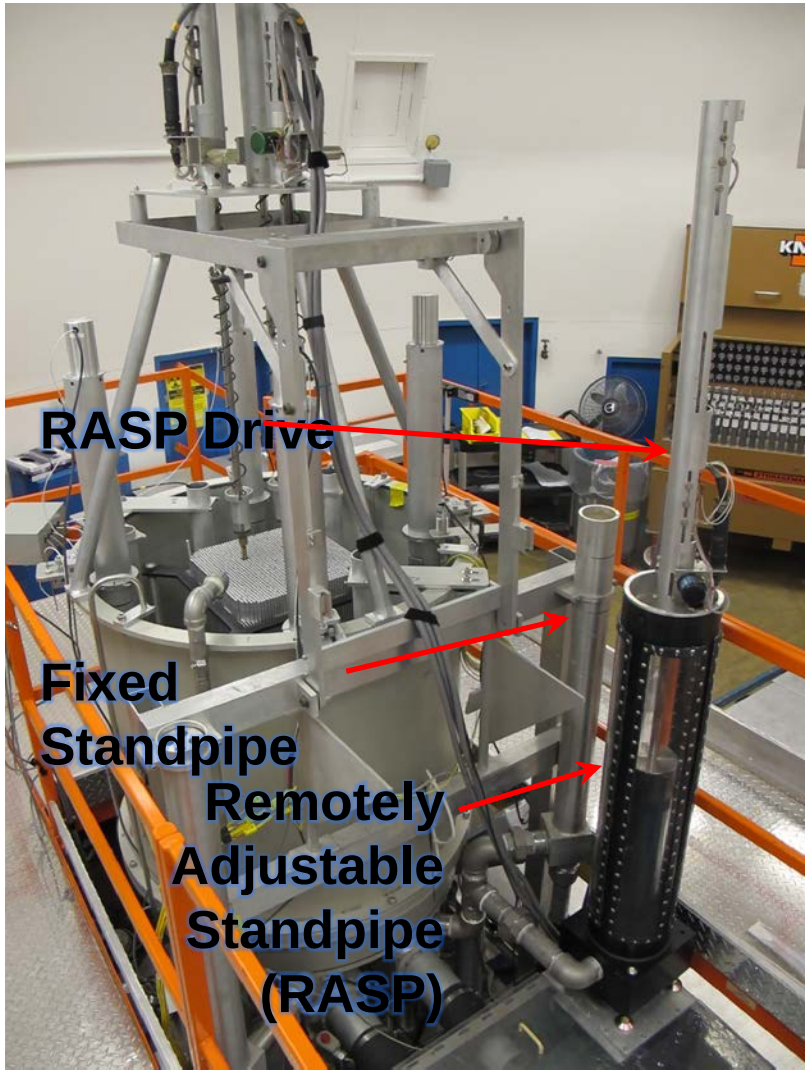
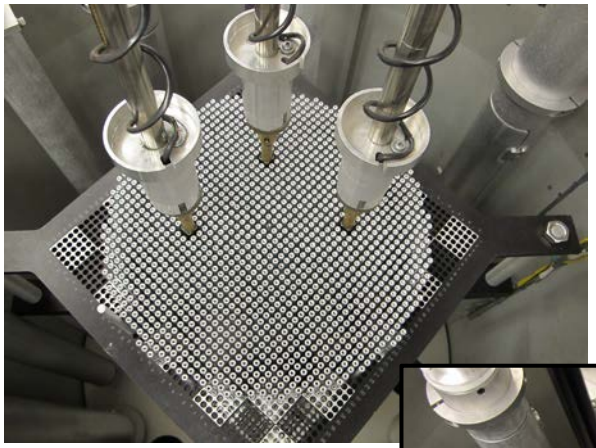
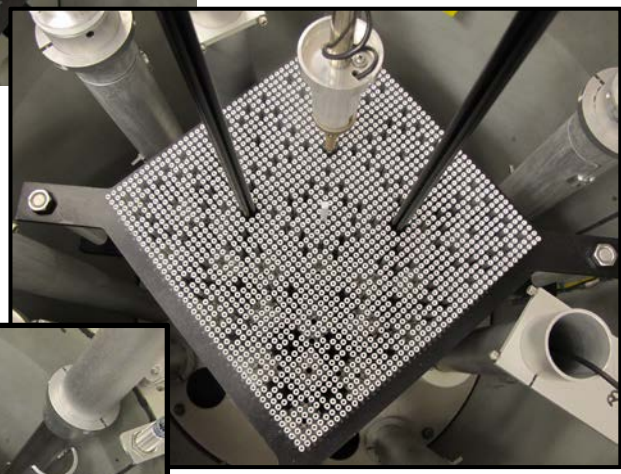
IER208

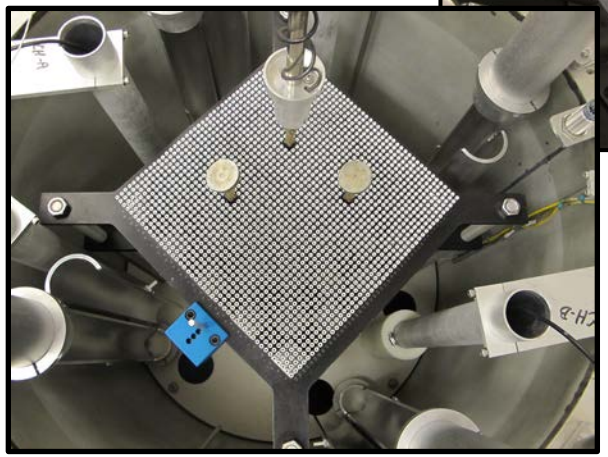


IER208









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