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Completion of the First Approach to Critical for the Seven Percent Critical Experiment

ANS Nuclear Criticality Safety Division Topical Meeting

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Sandia is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company, for the United States Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000.

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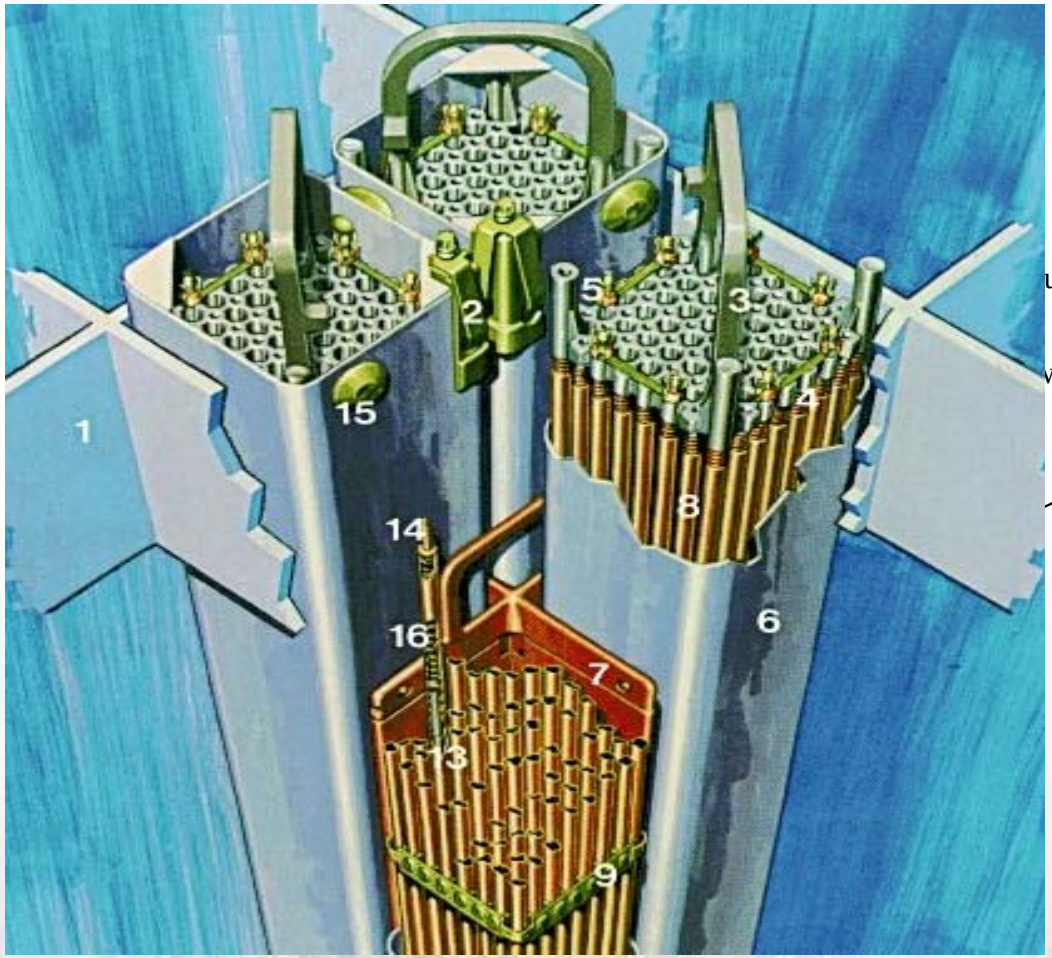
Agenda

- **Seven Percent Critical Experiment (7uPCX)**
  - Purpose
  - Assembly Hardware
  - Dimensions
  - Approach to Critical
  - Results of First Critical

7uPCX

- **Nuclear Energy Research Initiative (NERI) project**
  - Perform Criticals for 5-10wt. % ^{235}U
- **Areva, ORNL, University of Florida and SNL**
- **Sandia Pulsed Reactor Facility**
- **Reactor Physics Measurements**
  - Fully Reflected
  - Square Pitched
- **NNSA Nuclear Criticality Safety Program Sponsorship**

Fully Reflected Design



uel rods

vater holes

water reflector (extends to tank walls – not shown)

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SPRF/CX Critical Assembly Hardware

- **BUCCX Hardware**
  - Core Tank
  - External Core Tank Hardware
  - Fully Reflected Design
    - 15 cm Water

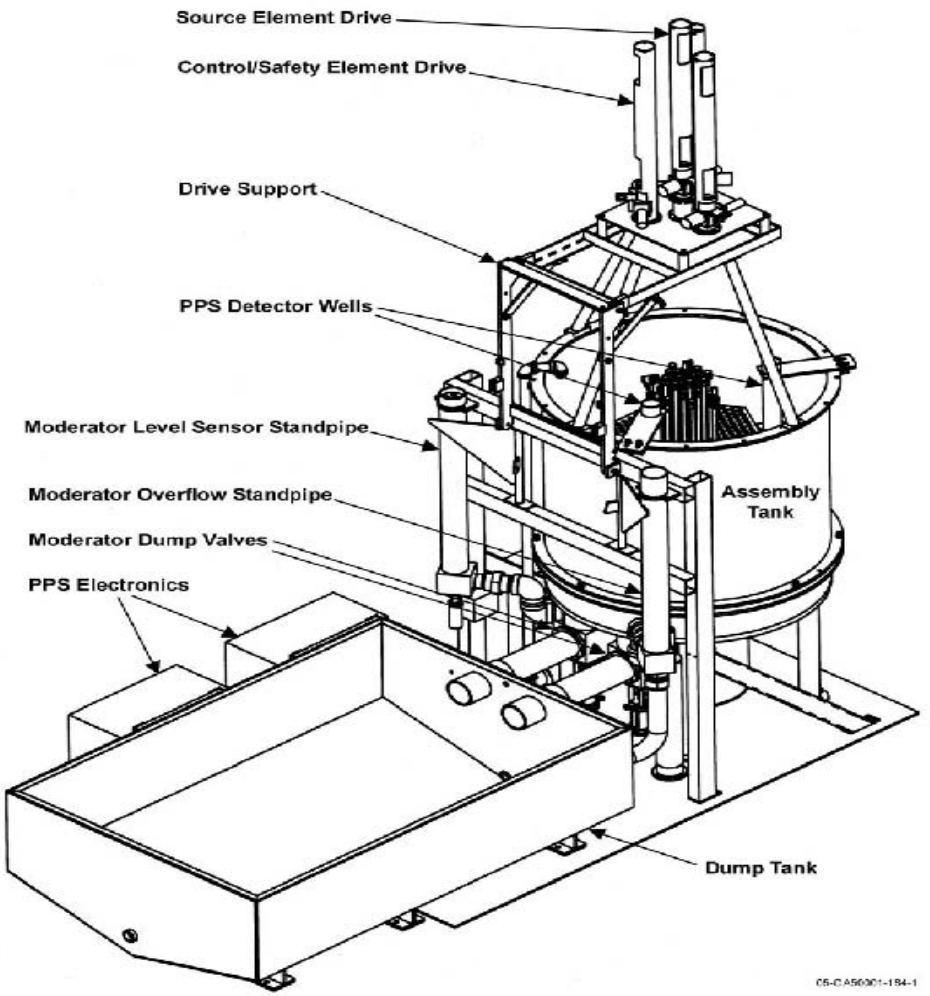
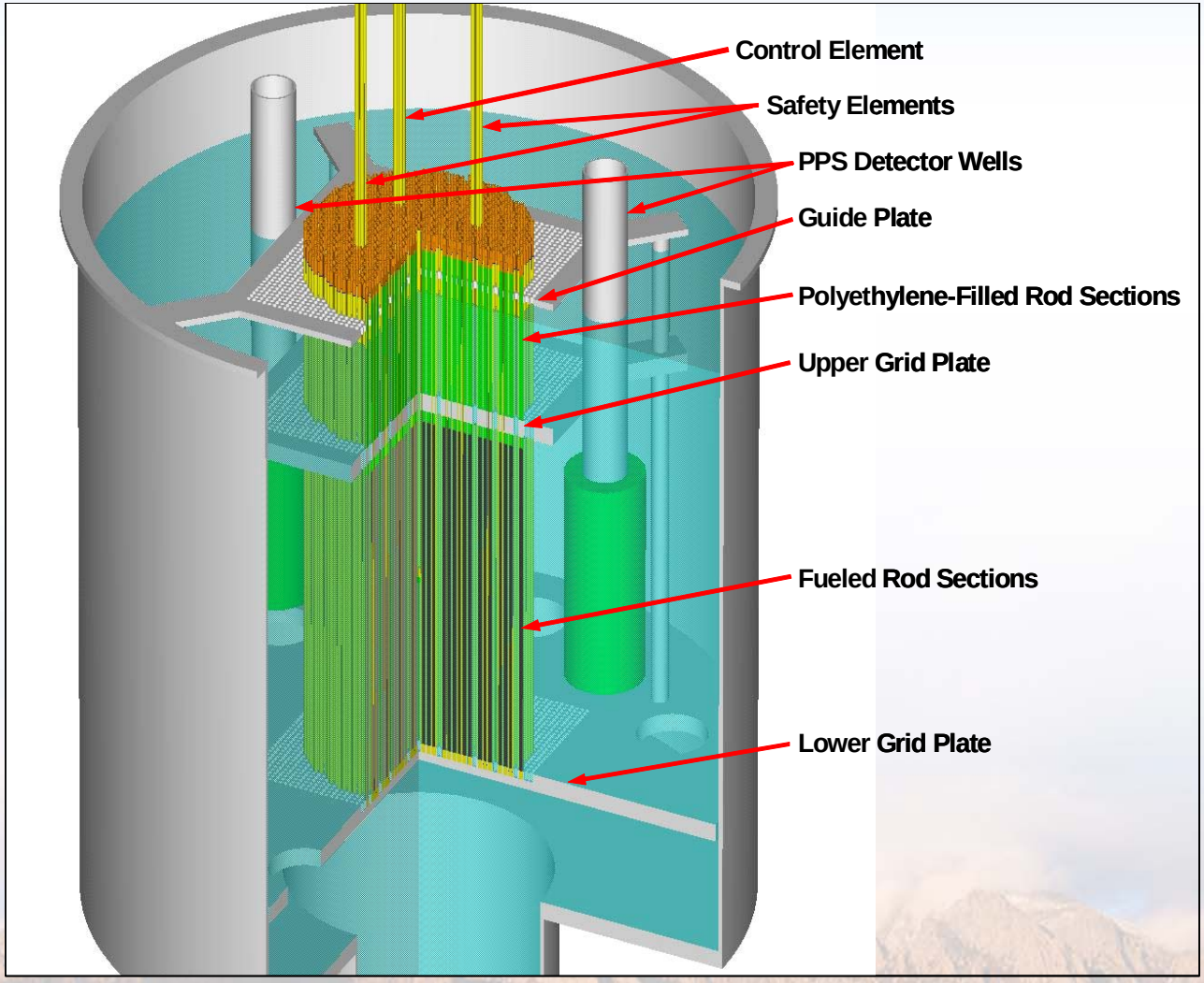


Figure 1. Overall Concept of the Critical Assembly.

SPRF/CX Critical Assembly Hardware



7uPCX Core Properties

Fuel	UO_2
Uranium Enrichment (wt. %)	6.90
Fuel Pellet Diameter (cm)	0.5258
Fuel Pellet Stack Mass (g)	108.72
Cladding Material	3003 Aluminum
Clad OD (cm)	0.6376
Clad Thickness (cm)	0.036
Grid Plate Material	6061 Aluminum
Grid Plate Thickness (cm)	2.54
Grid Plate Pitch (cm)	0.8001

Location	Axial Position (cm)
Top of Tank	82.55
Top of Guide Plate	71.76
Water Surface	68.26
Top of Top Grid Plate	53.02
Top of Fuel	48.78
Bottom of Fuel	0.00
Top of Lower Grid Plate	0.00
Bottom of Water	-19.05

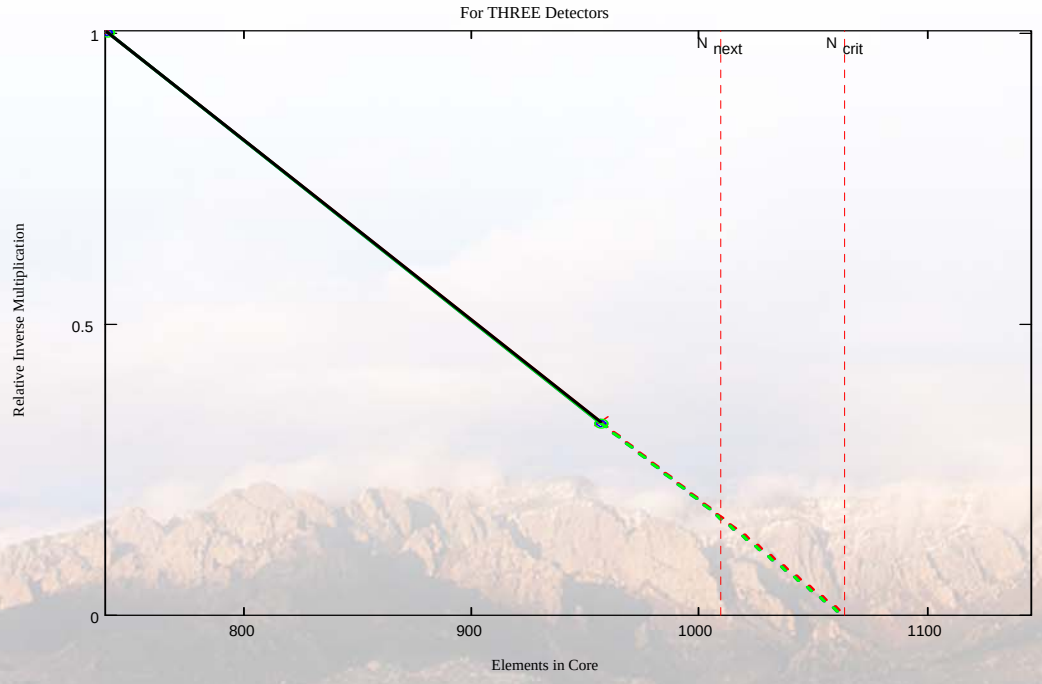
Approach to Critical

- **Inverse Multiplication**
  - Fuel Elements Approach Variable
  - Constant Water Height
  - 15 cm of water on all sides
  - Control and Safety Elements Fully up
    - Fuel Followed Rods in Core

$$M = \frac{1}{1-k} \qquad \frac{1}{M} = \frac{C_0}{C}$$

Approach to Critical Process for 0800 cm Pitch

- **k=0.90**
  - 740 Fuel Rods 0800 Pitch
- **k=0.95**
  - 956 Fuel Rods 0800 Pitch
- **Project next fuel loading for k=1.00**
  - Load half of projection
- **Continue Process Until Diverging Neutron Flux is Observed**



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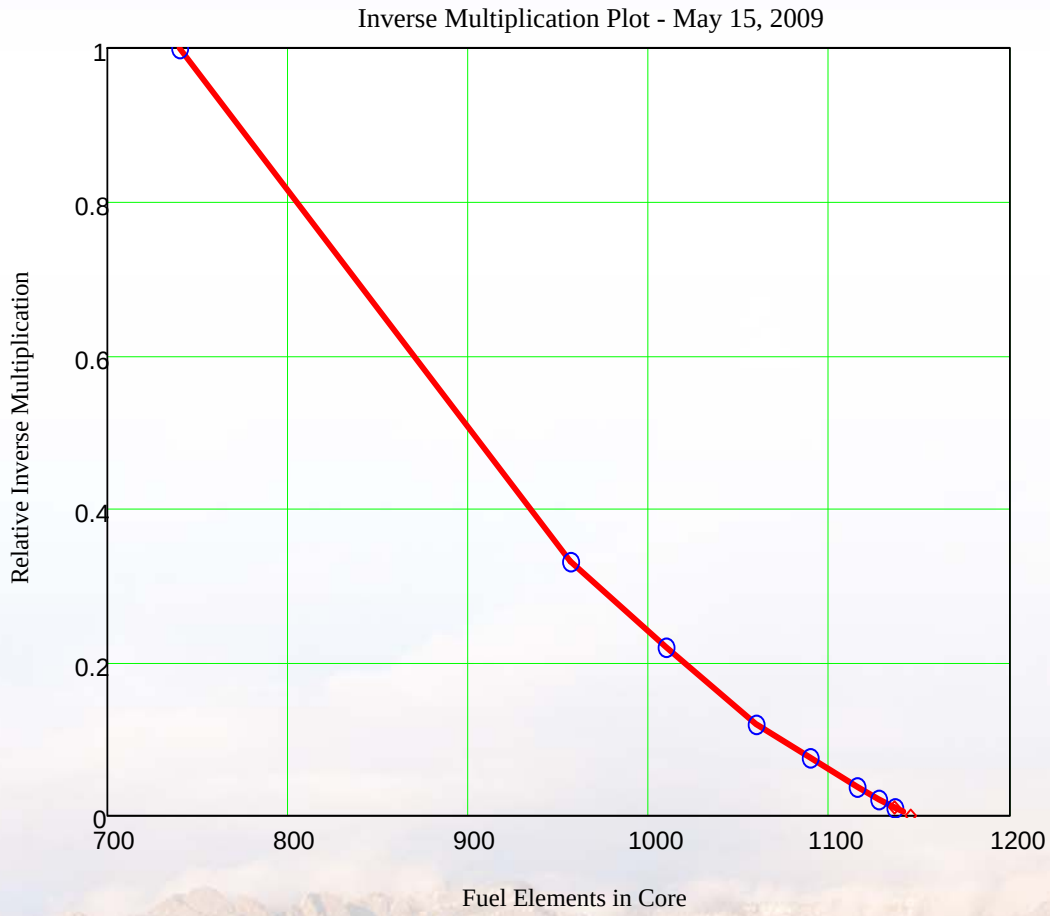
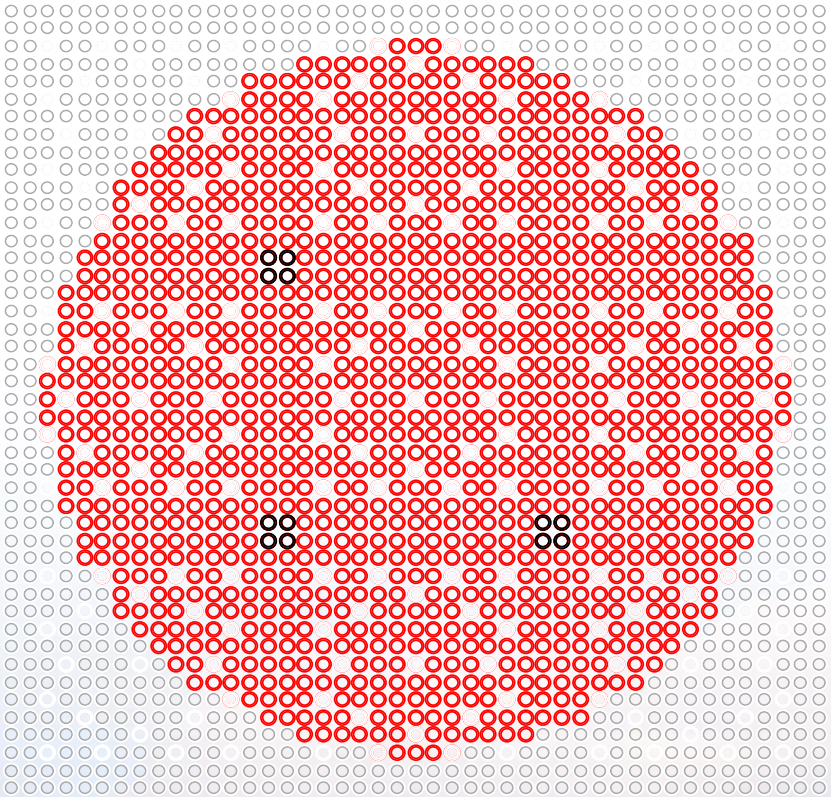
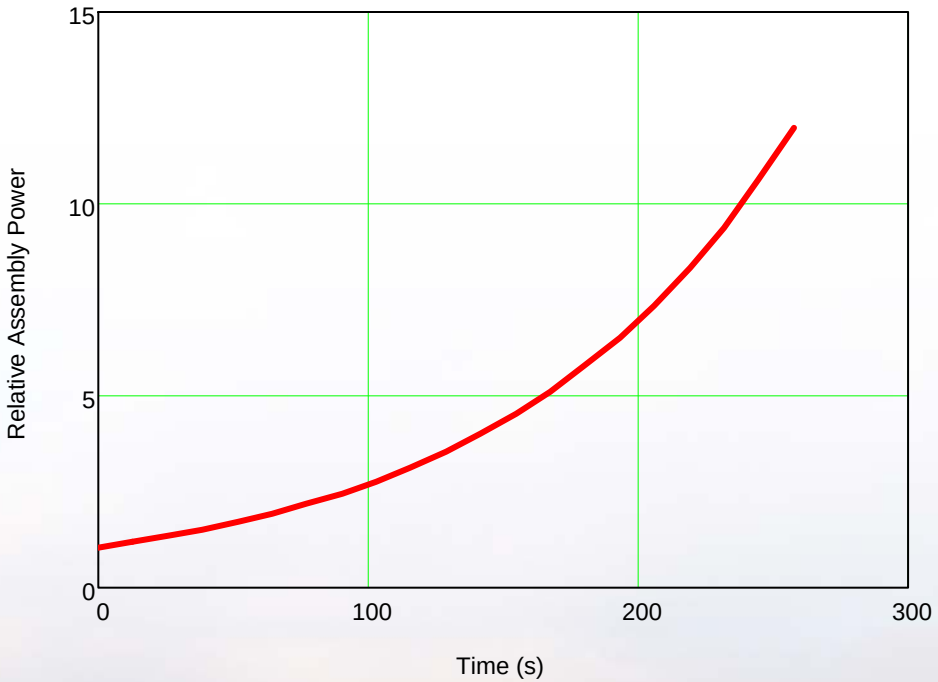
Approach to Critical



1148 Fuel Elements





Fuel Rod
Control/Safety Rod
Empty Position

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Results of First Critical 5/15/2009

Fuel Elements	Ch. A (cps)*	Ch. B (cps)*	Projected DC (elements)
740	73.0	71.3	-
956	219.1	215.6	1063.4
1009	328.0	326.6	1113.7
1059	603.6	594.2	1119.3
1089	936.0	932.1	1142.6
1115	1948.3	1934.6	1139.1
1127	3155.5	3139.0	1146.3
1136	6447.5	6389.0	1144.7
1140	Converging neutron flux		
1144	Converging neutron flux		
1148	Diverging neutron flux		
* The detector count rates are given in counts per second (cps)			

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Results of First Critical 5/21/2009

Fuel Elements	Ch. A (cps)	Ch. B (cps)	Projected DC (elements)
1120	2365.1	2342.6	-
1128	3368.0	3336.1	1146.9
1136	6282.6	6209.3	1145.3
* The detector count rates are given in counts per second (cps)			

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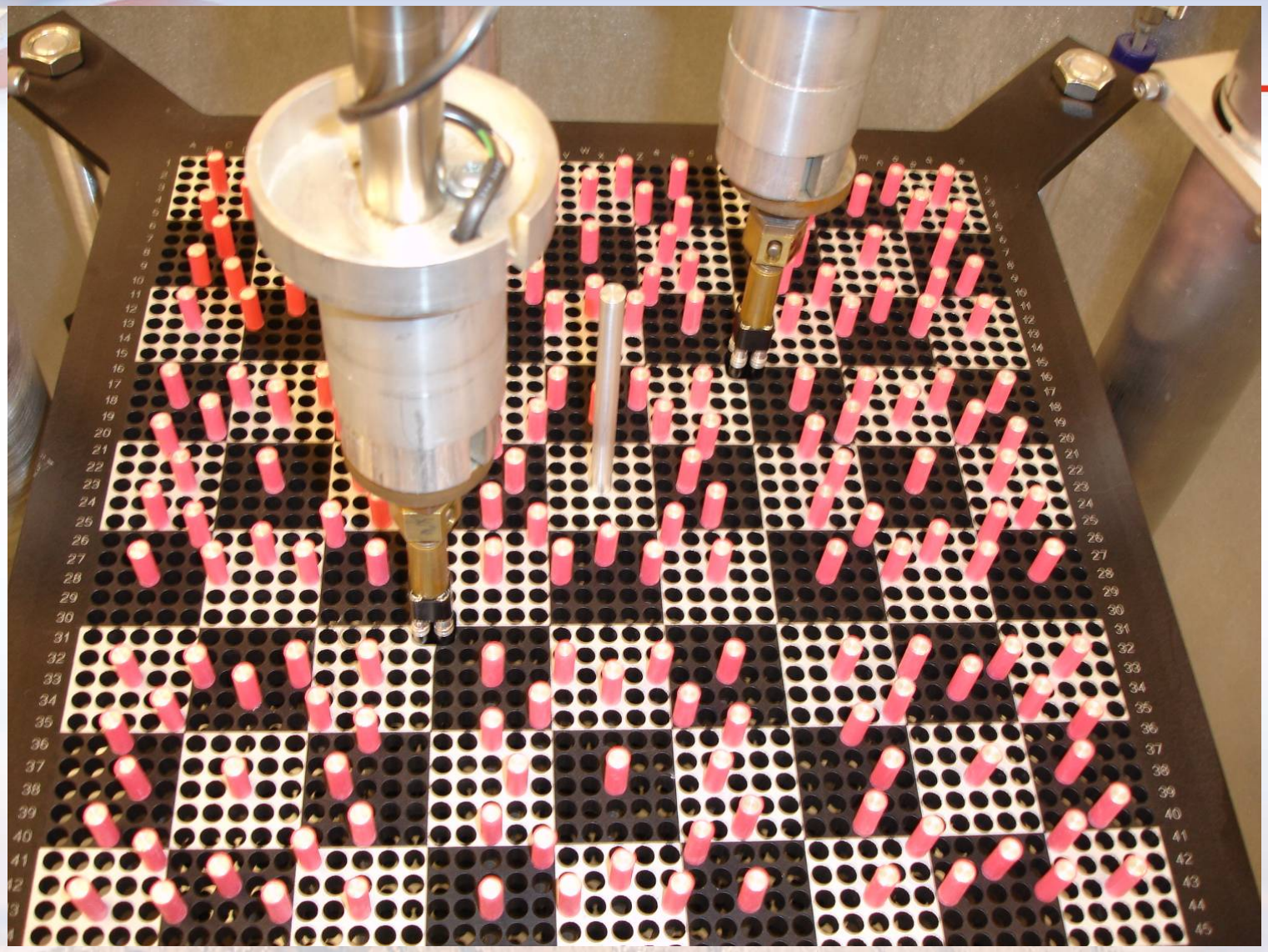

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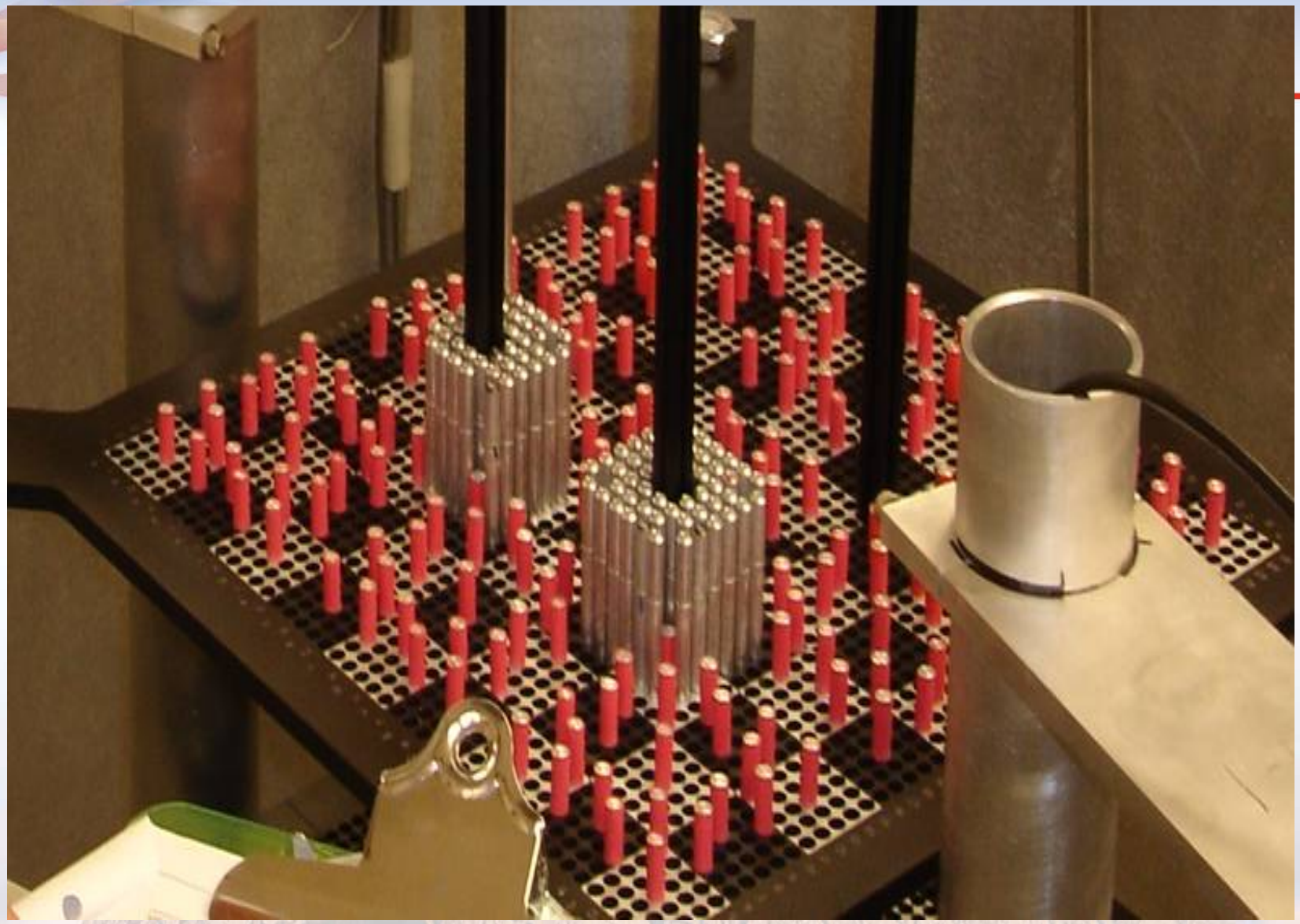

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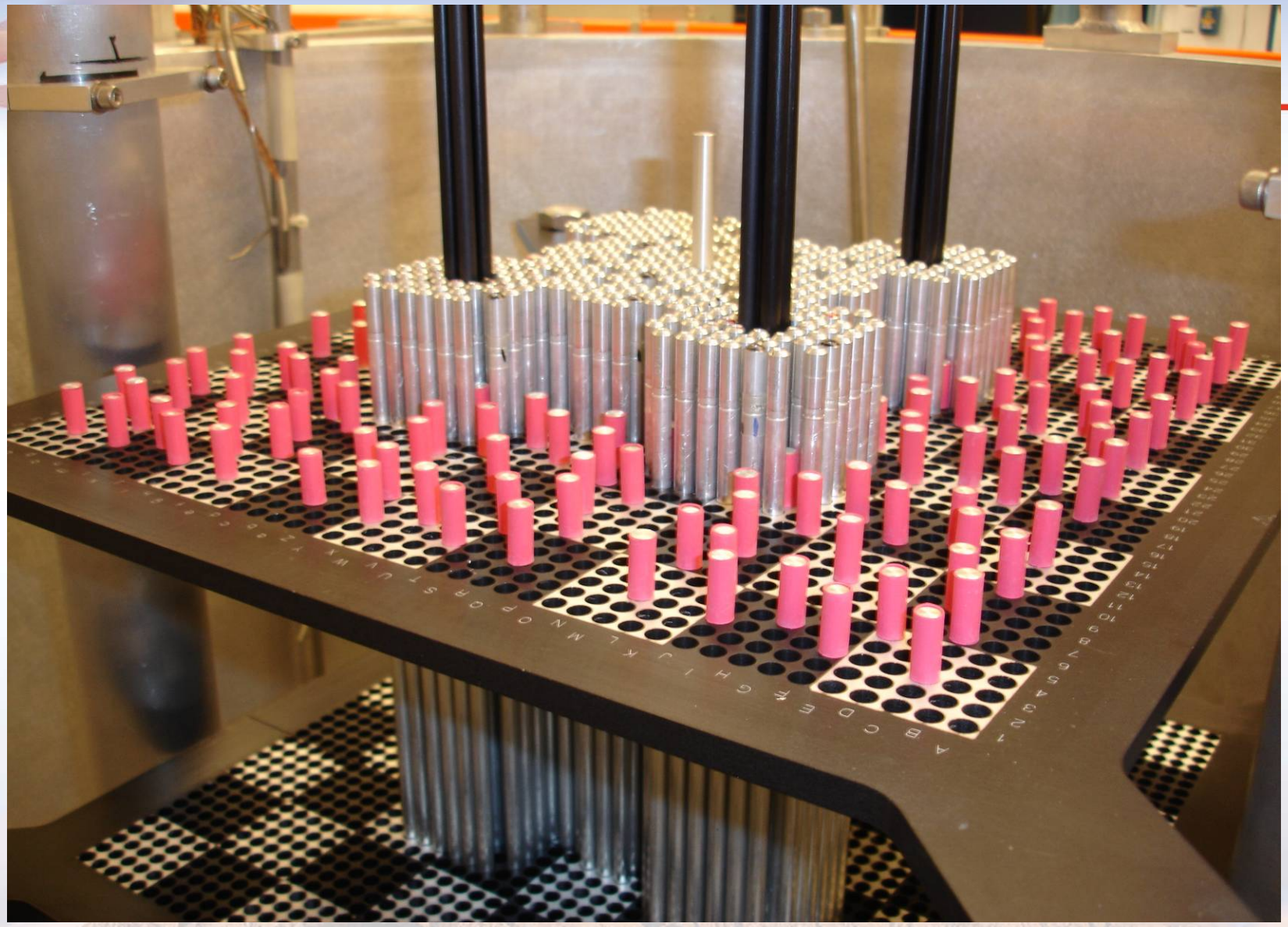

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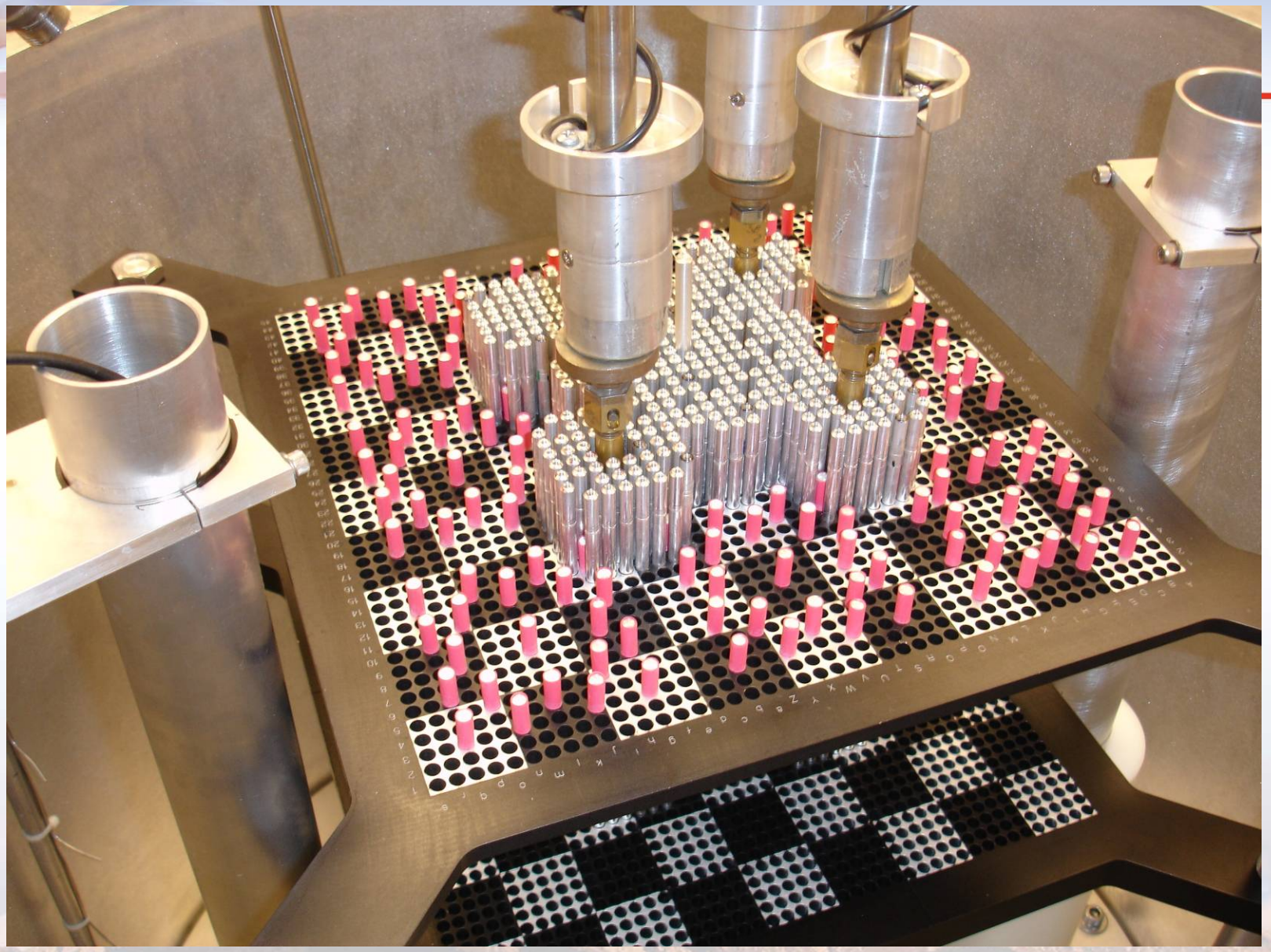

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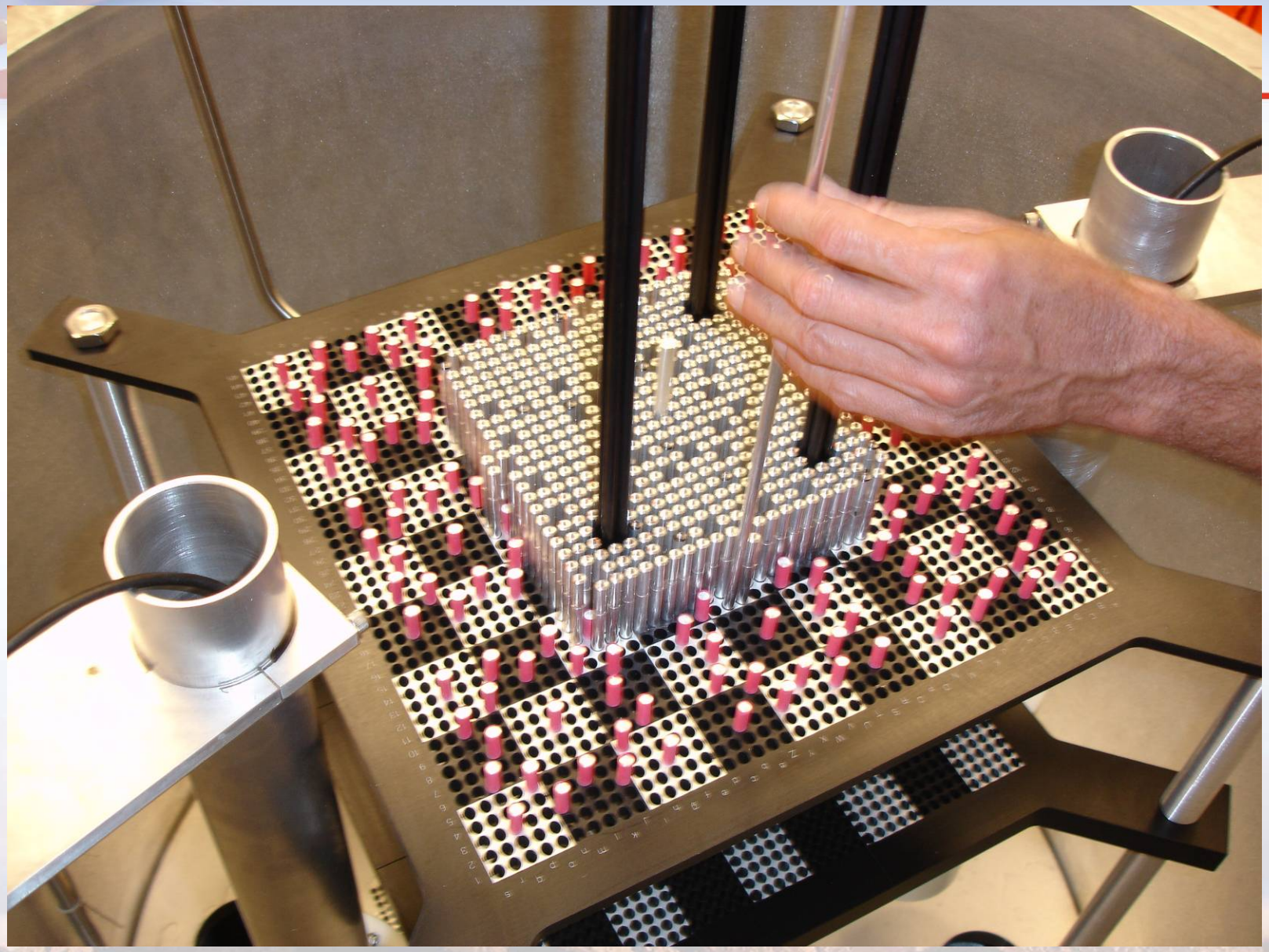

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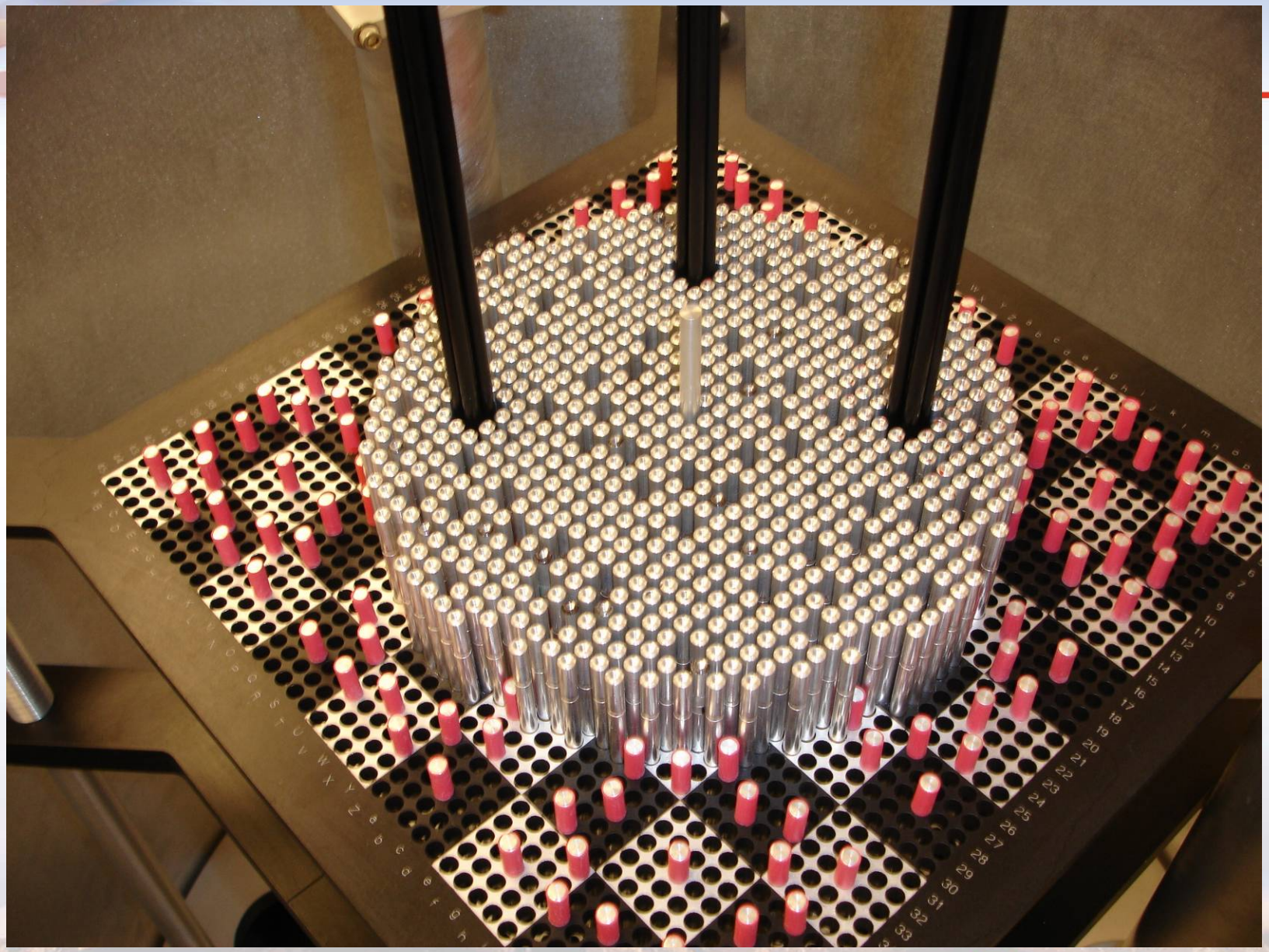

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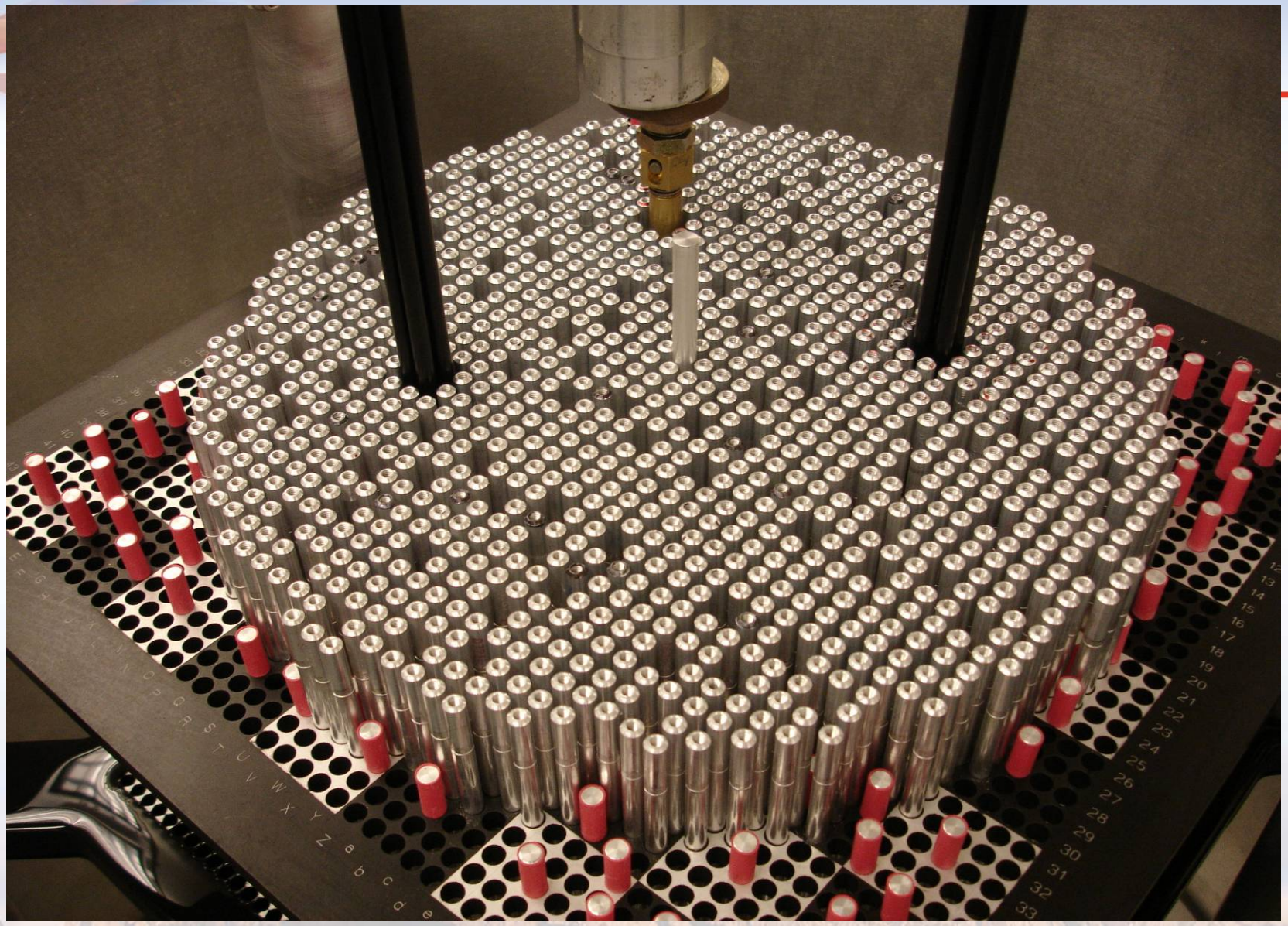

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Future Work

- **Fully Loaded 0.800 cm Pitch**
  - No water holes
- **Approach for 0.855 cm Pitch**
- **Fully Loaded 0.855 cm Pitch**
  - No water holes

- **Questions**

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