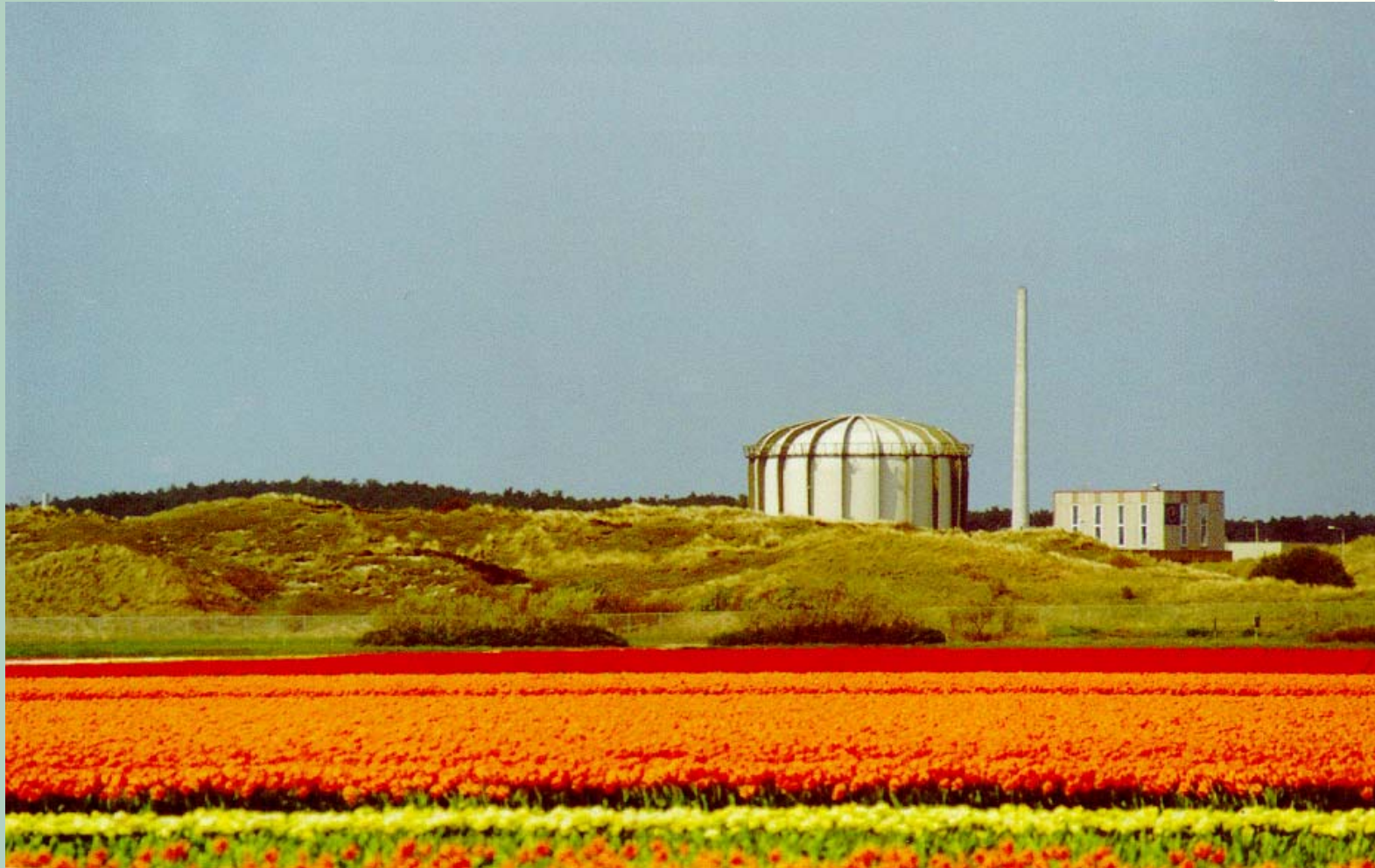


Irradiation Qualification of a Chilean Test Fuel Element

Fred J. Wijtsma Reactor Manager HFR/LFR



Contributors

CCHEN, Chile	NRG, the Netherlands
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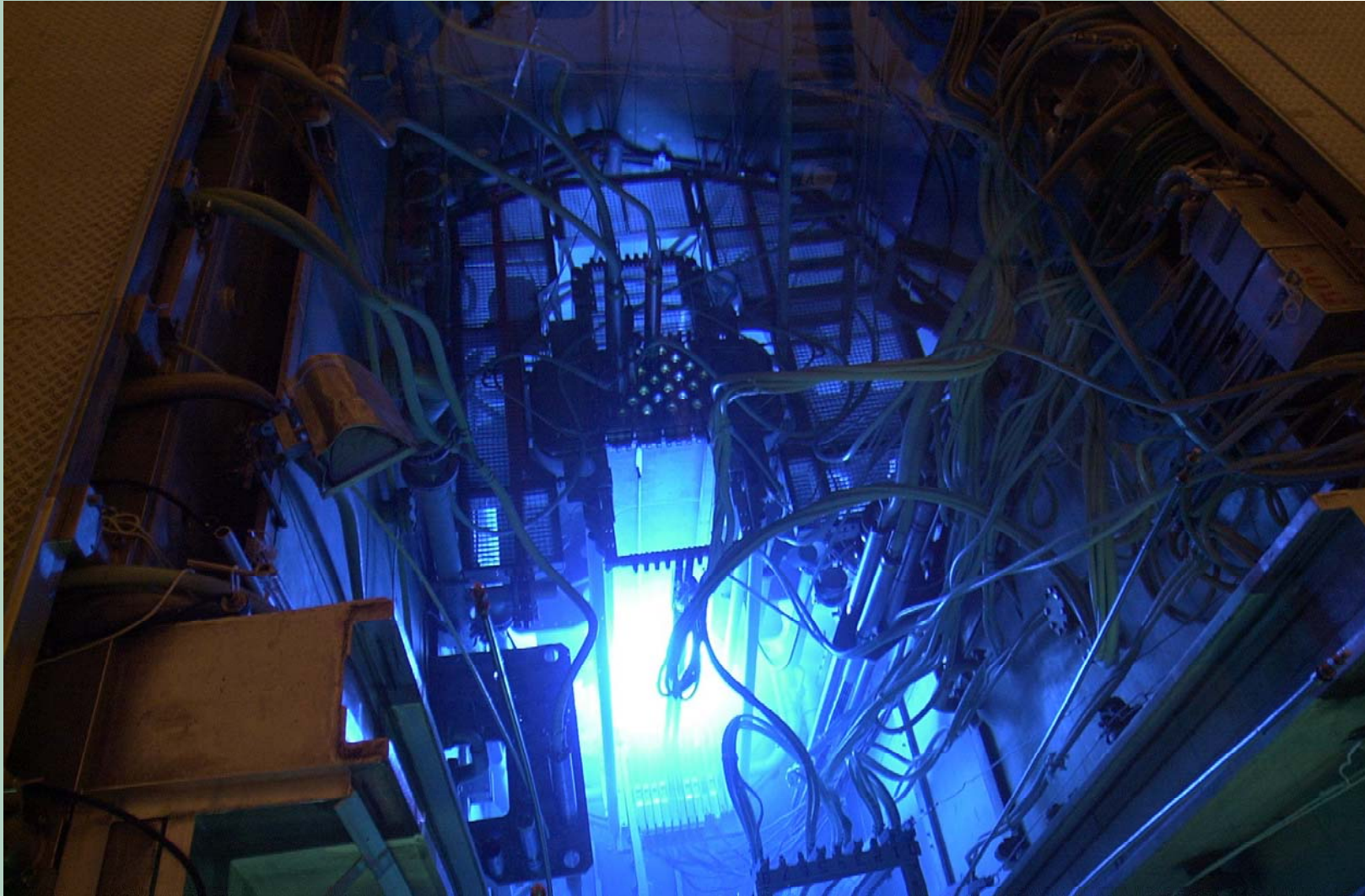
Introduction

- This presentation describes the qualification of a U_3Si_2 fuel element.
- Design and neutronics design computations by combined effort of NRG and CCHEN
- Thermo-hydraulics (Relap5) computations by NRG
- Element manufacturing by Fuel Fabrication Plant of the Chilean Commission for Nuclear Energy (CCHEN).
- Irradiation performed in the HFR-Petten.
- Post Irradiation Examination in the hot cells of NRG-Petten.
- The project was funded by the IAEA.

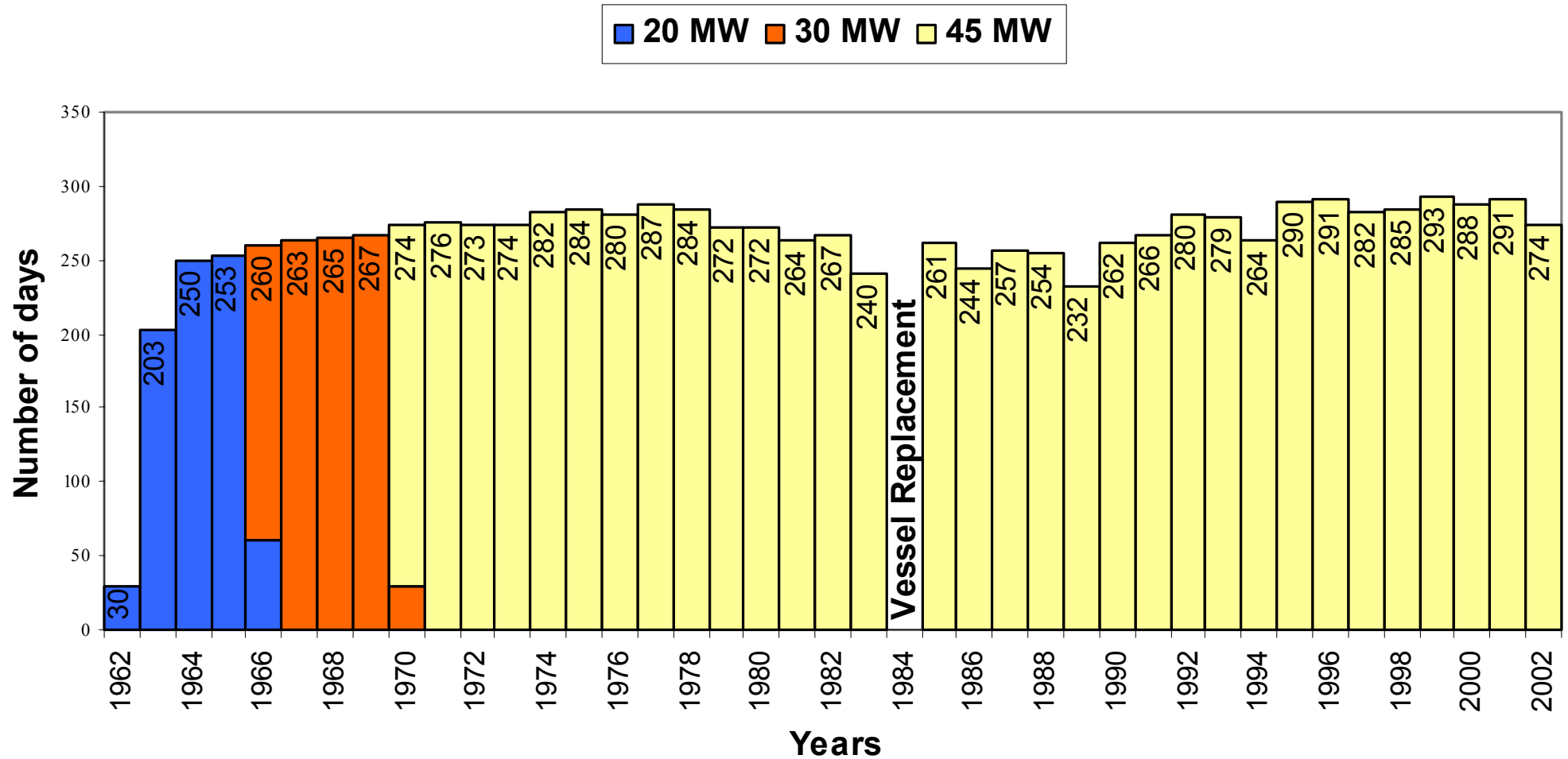
HFR General Characteristics

- Owner JRC-EC, operator NRG
- MTR tank-in-pool type, 45 MW nominal power
- Operating since 1961
- Wide range of experimental positions
 - In-core
 - Poolside facility
 - Horizontal beam tubes
- Material research and radioisotopes production
- ~ 300 full power days per year
- Technical lifetime beyond 2015

View in Reactor Pool

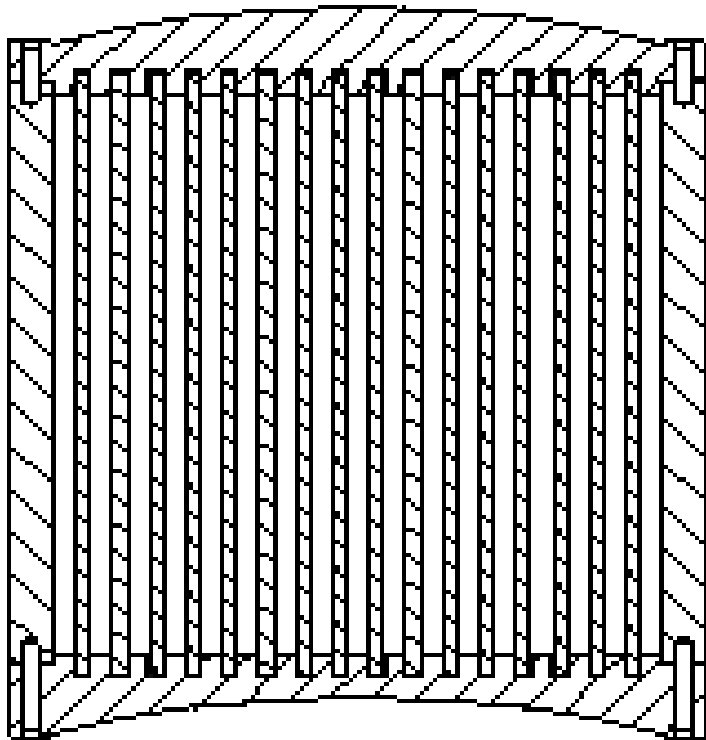


Operational History

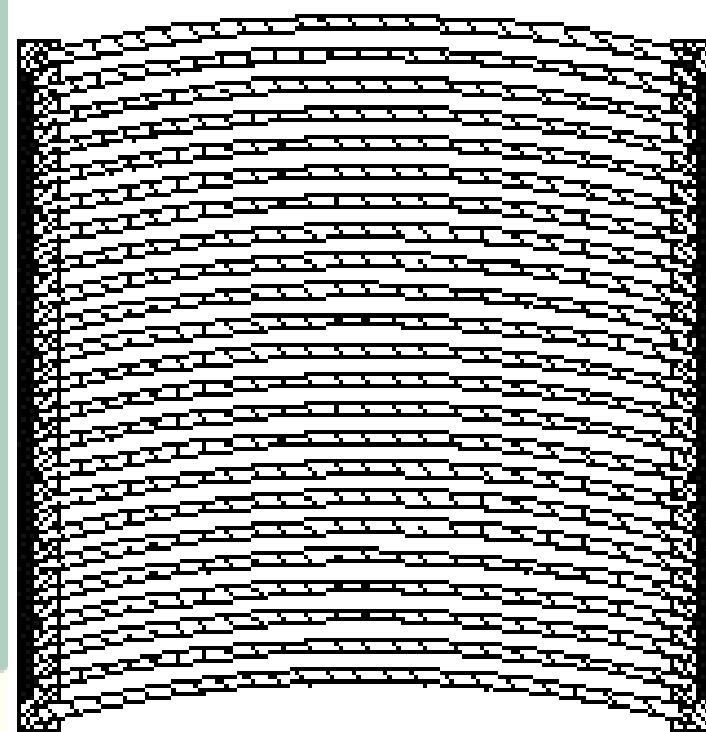


Design of Test Element

RECH-1 (LEU)



HFR (HEU)



Uranium Mass Specifications of HEU/LEU Elements

<i>Identification</i>	<i>Type</i>	<i>^{235}U [g]</i>	<i>TotU [g]</i>	<i>Poison</i>
LCC01 RECH-1	LEU	229.1	1159.7	none
HFR	HEU	450	483.8	^{10}B
HFR	LEU	550	2784.8	^{113}Cd

Fabrication of Test Element

- Fabrication and assembling by the Fuel Fabrication Plant of the Chilean Commission for Nuclear Energy
- Three inspection visits by the NRG inspecteur
- The element and the documentation complied with all requirements
- The element was transported by air from Chile to the Netherlands

Transport from Chile



Receipt of Element

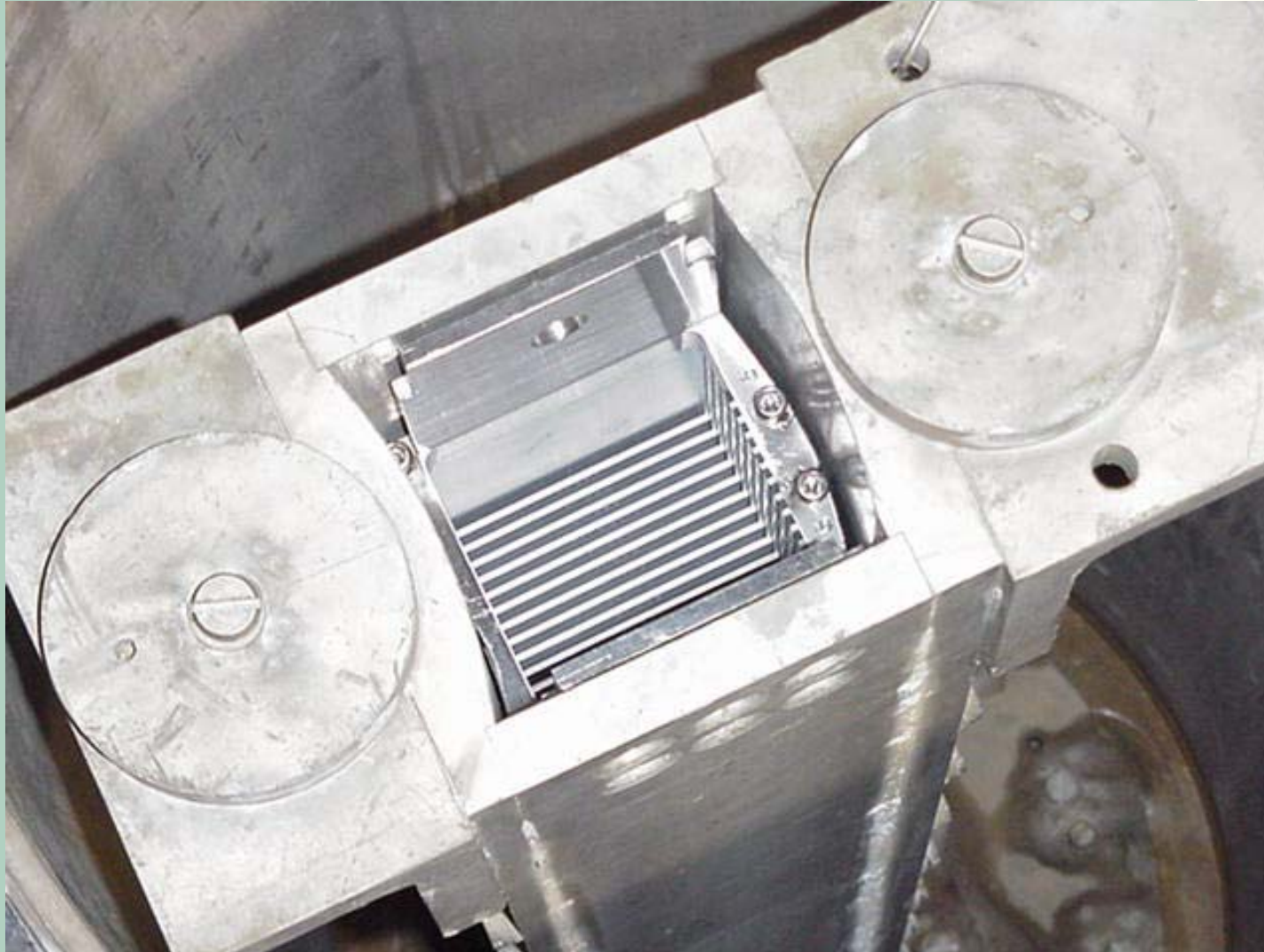


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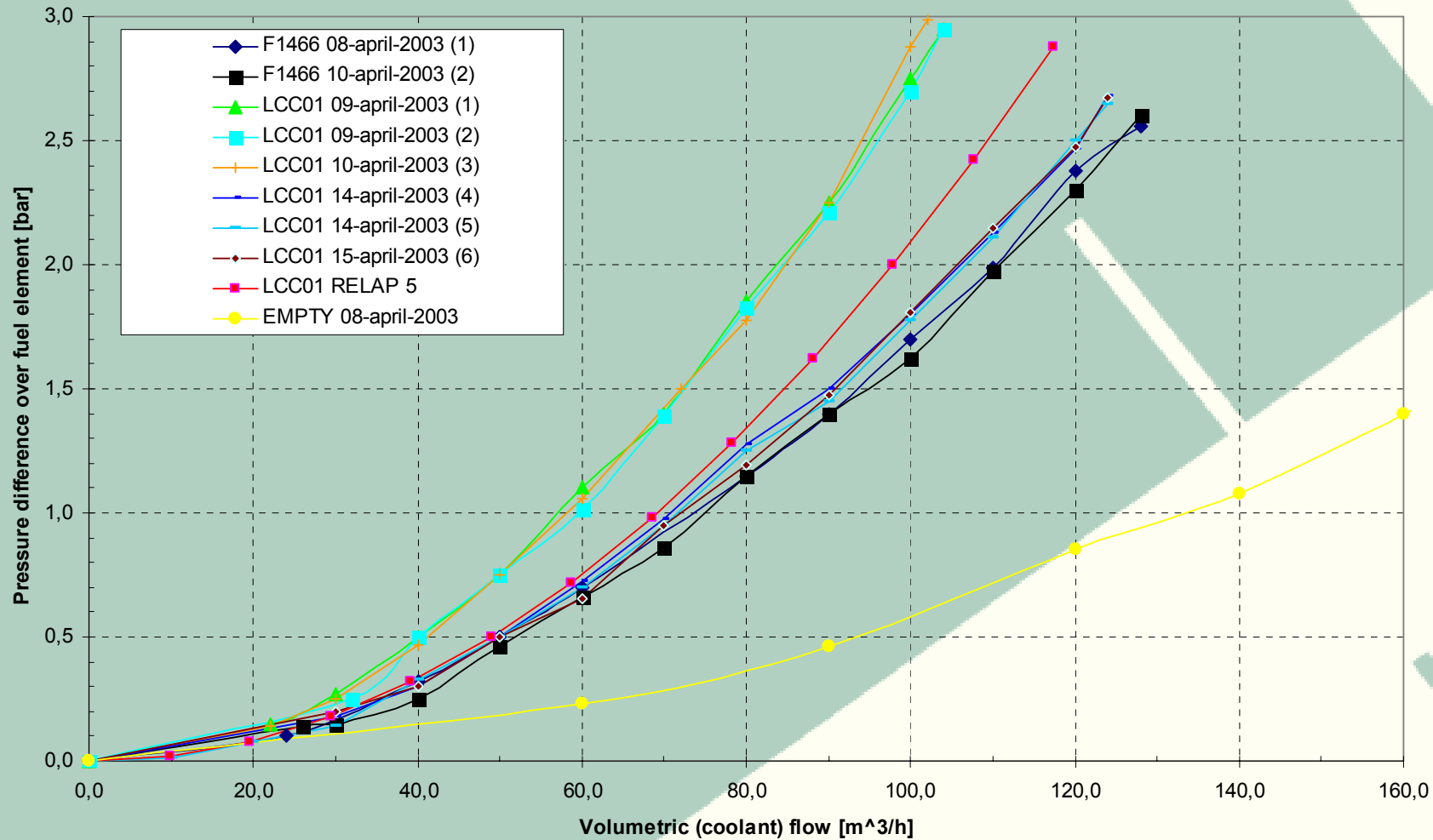
Hydraulic Pressure Drop

- Determination of flow/ Δp -curve
- Comparison HFR HEU and LEU test elements
- Additional test requirements
- Increased Δp at duration test
- Frequent inadvertent start/stop of pumps
- Dimensional inspection after hydraulic testing

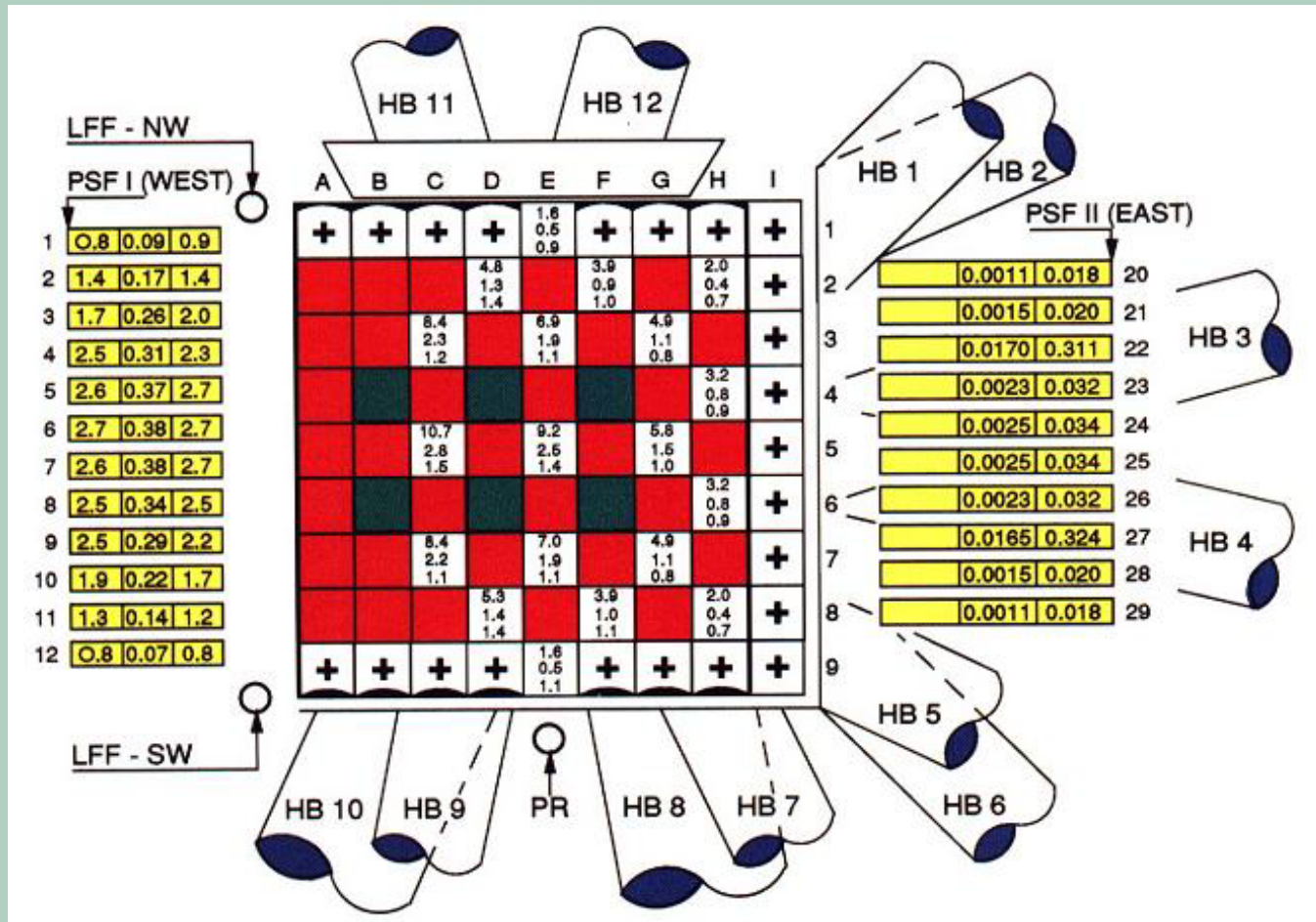
Hydraulic Test Equipment



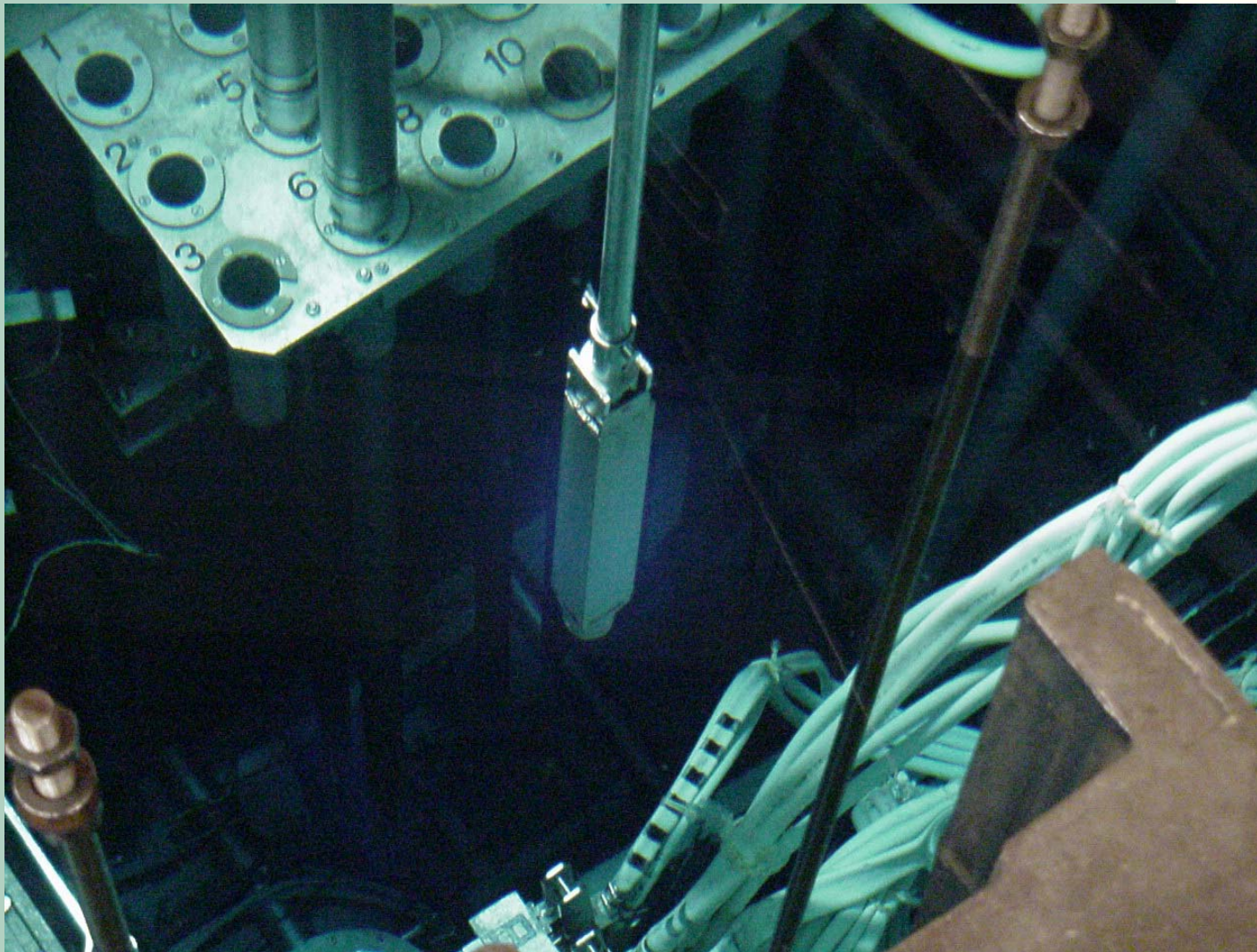
Hydraulic Test Results



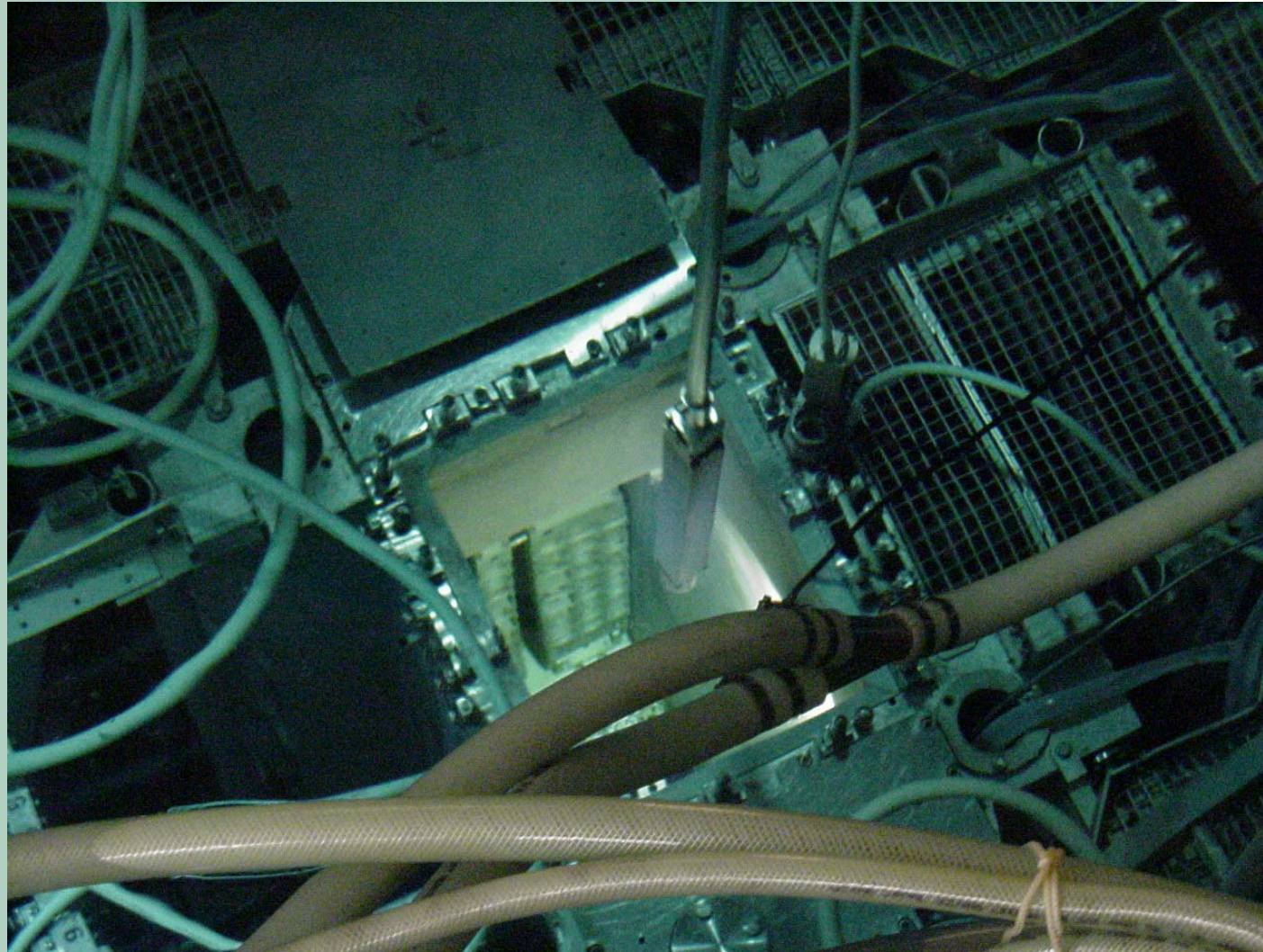
Cross Section Reactor Core



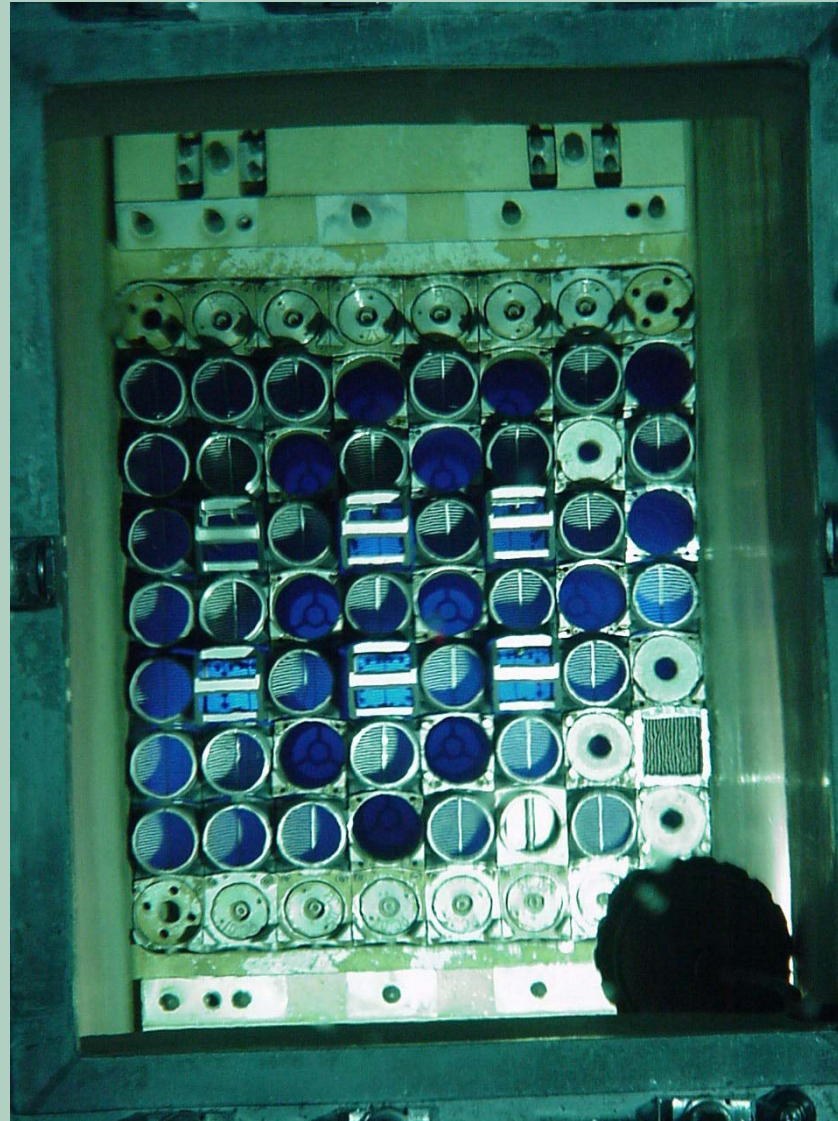
Handling of Test Element



Handling of Test Element (cont.)



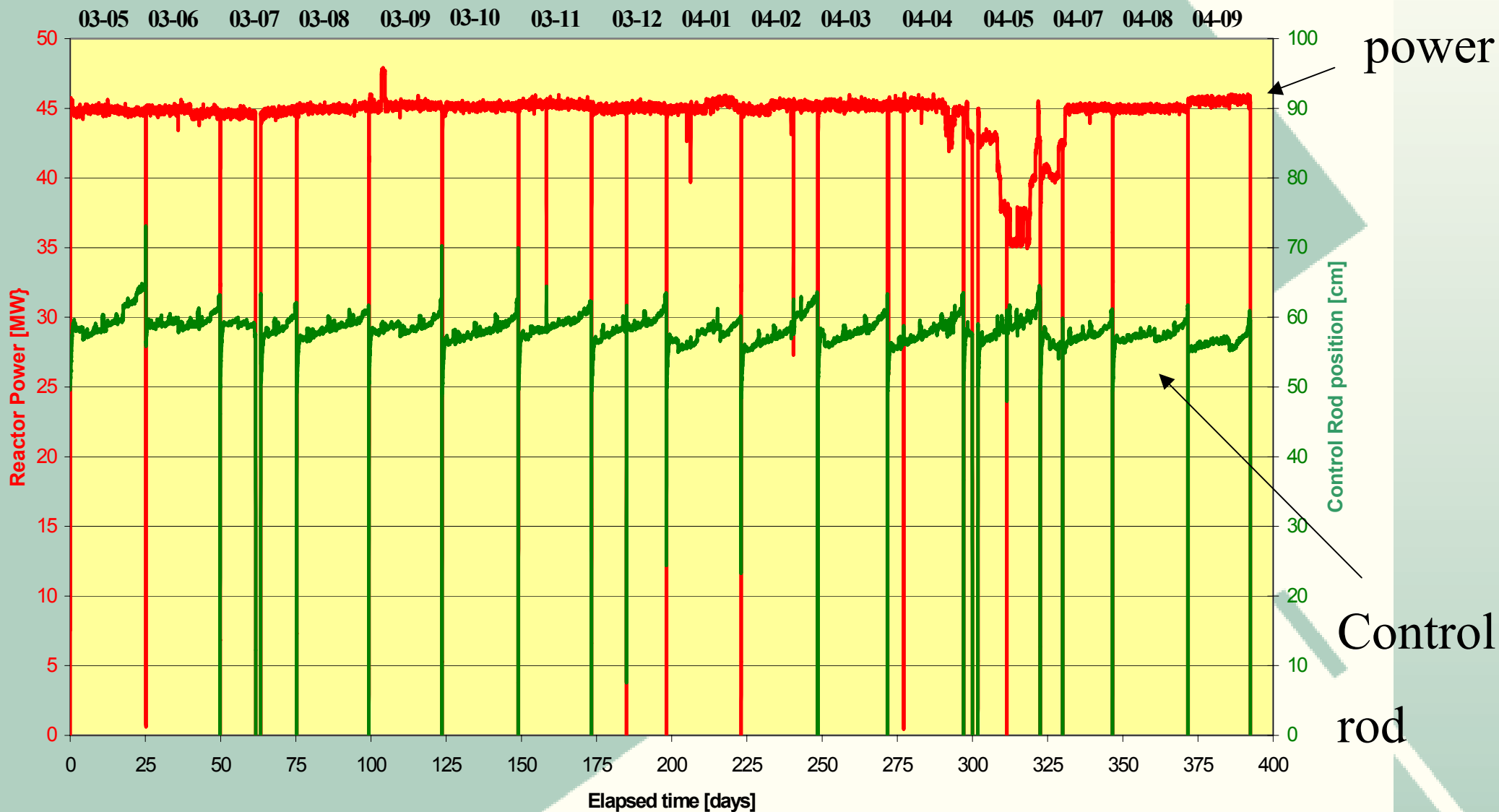
Loading of Test Element



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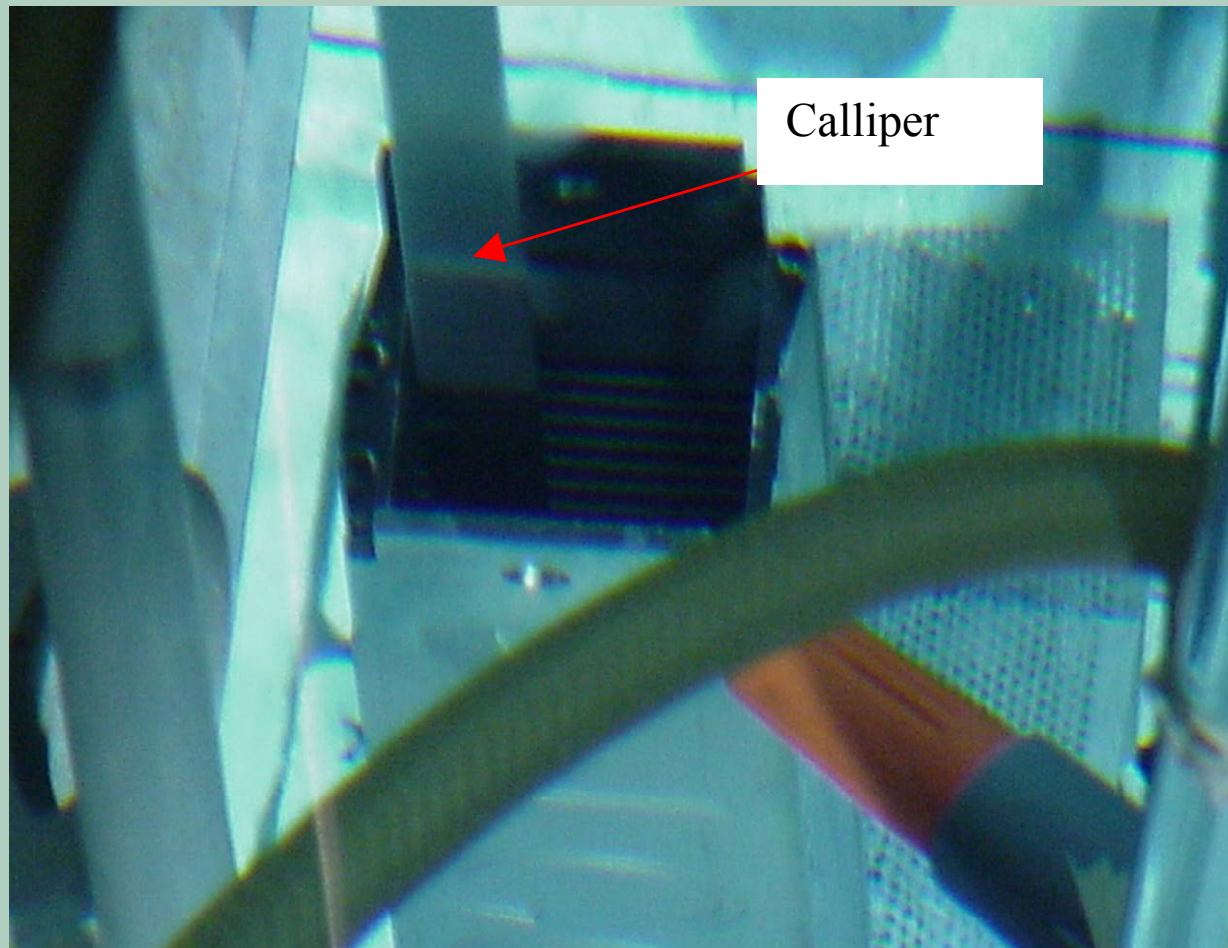
Irradiation history

HFR Cycles

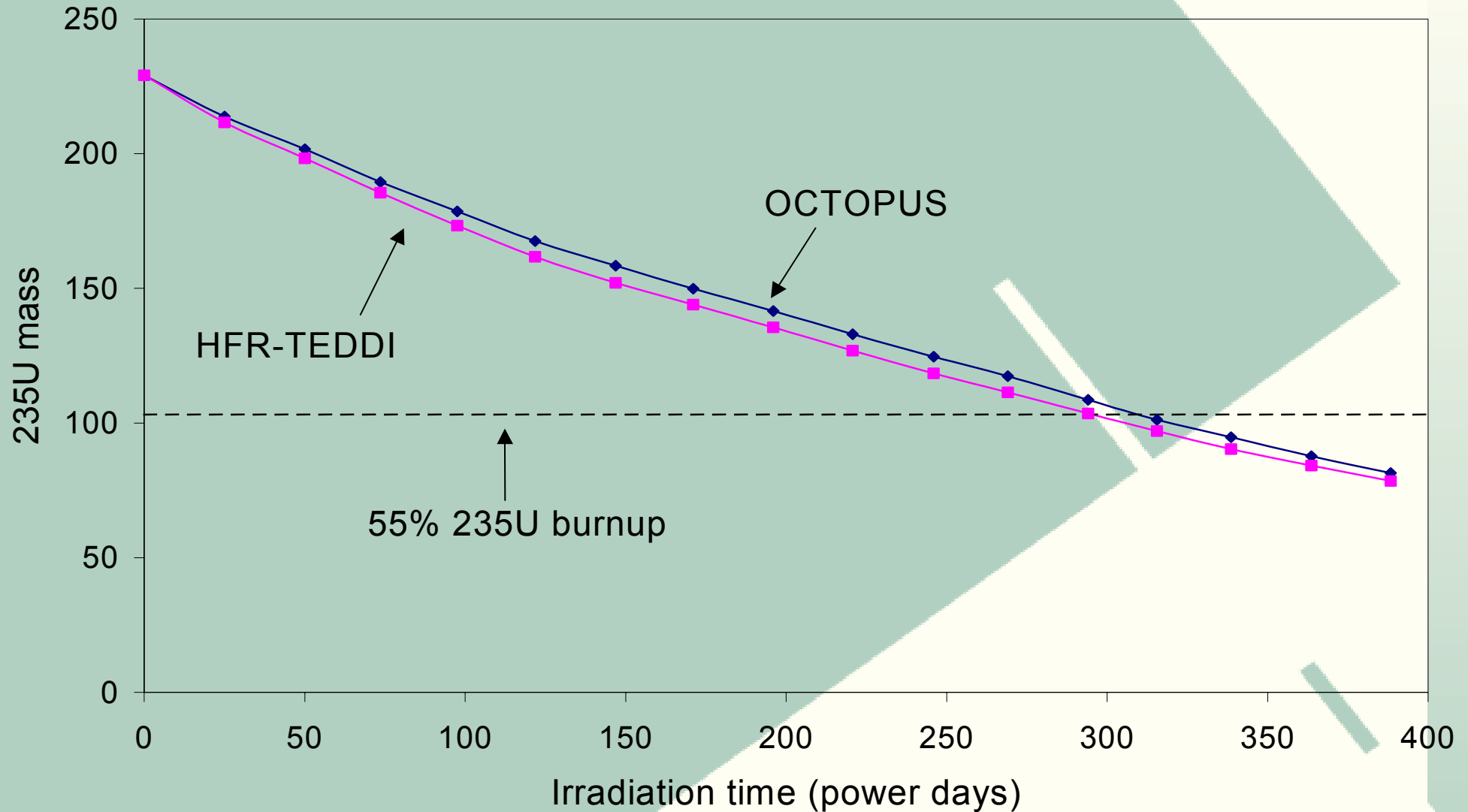


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Gap Measurements during Reactor Stop



Burn-up Computation



Post Irradiation Examination

- Visual inspection of the complete element.
- Removing the top and foot of the element
- Gamma scanning of the complete element.
- Dismantling of one plate from the element.
- Visual inspection of the dismantled plate.
- Gamma scanning of the dismantled plate.
- Oxide layer thickness measurements on the dismantled plate.
- Plate thickness measurements on the dismantled plate.

View through the Element in Hot Cell

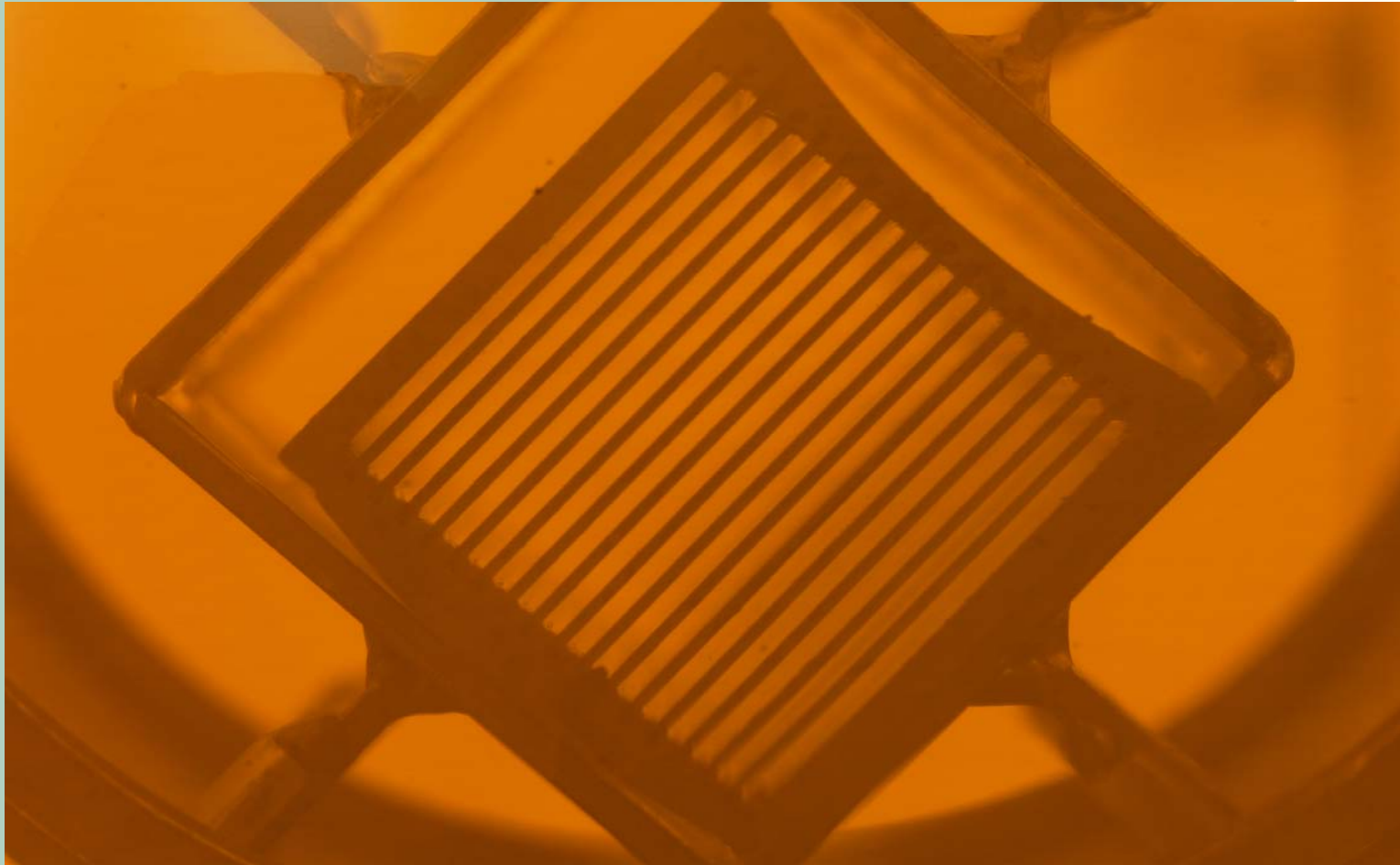
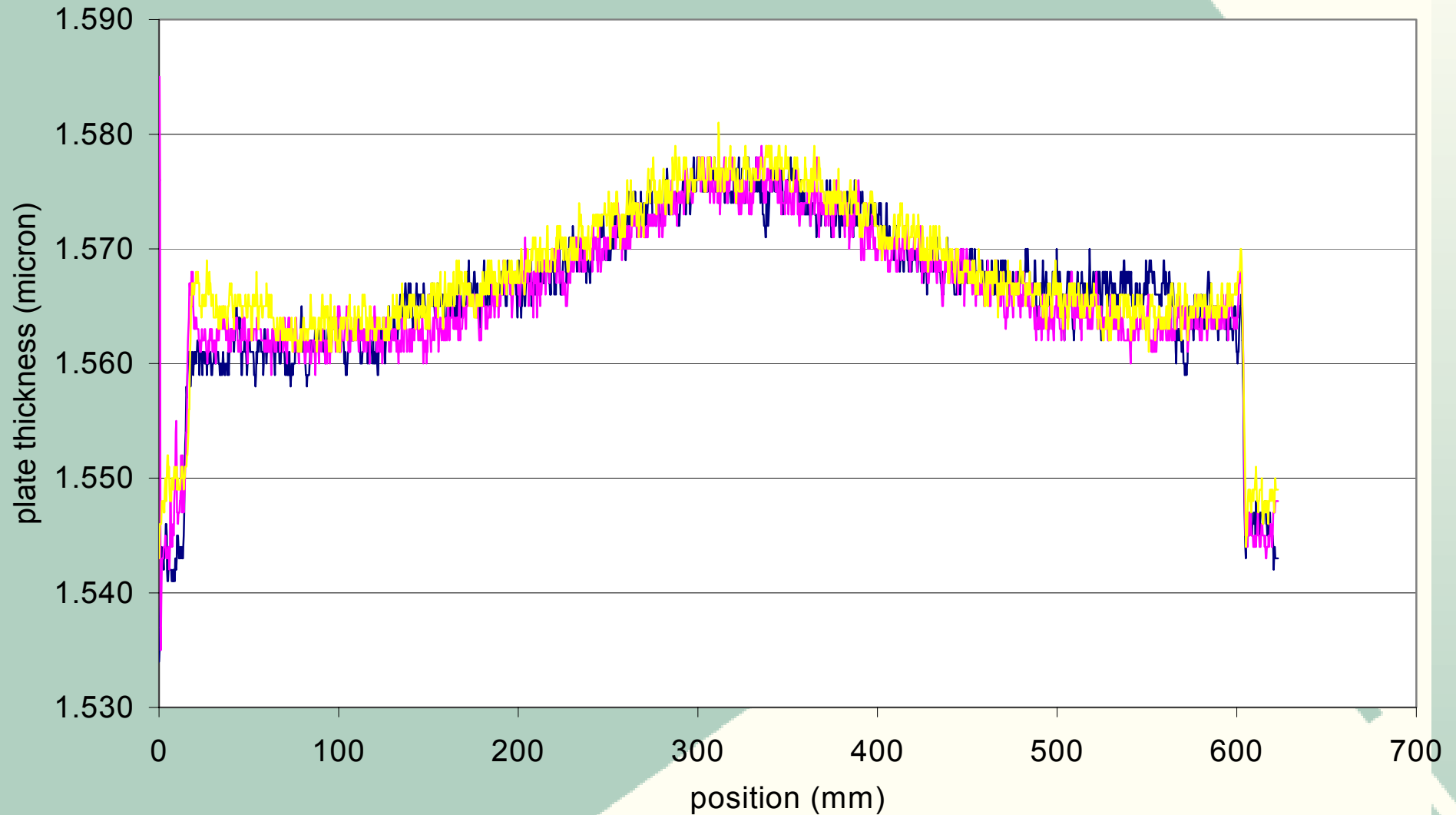


Plate Thickness Measurements



Conclusions

- The fabrication and inspection of the fuel element have successfully been performed according to the specifications
- The element has successfully been irradiated during 16 HFR cycles.
- No deviations have been observed.
- Detailed neutronics computations show that the ^{235}U depletion amounts to $64.5\% \pm 8.4\%$, which is more than 55%.

Conclusions (cont.)

- Post irradiation examination showed the proper behaviour of the fuel element.
- No remarkable features have been observed.
- The final conclusion is that according to inspections of fuel fabrication process, QA management system and results observed during irradiation of test fuel element at the HFR in Petten, the qualification irradiation project was successful and qualifies CCHEN as a LEU silicide fuel manufacturer at the given U-density.