

# ***Update on the GTRI (RERTR) Advanced Fuel Development Program***

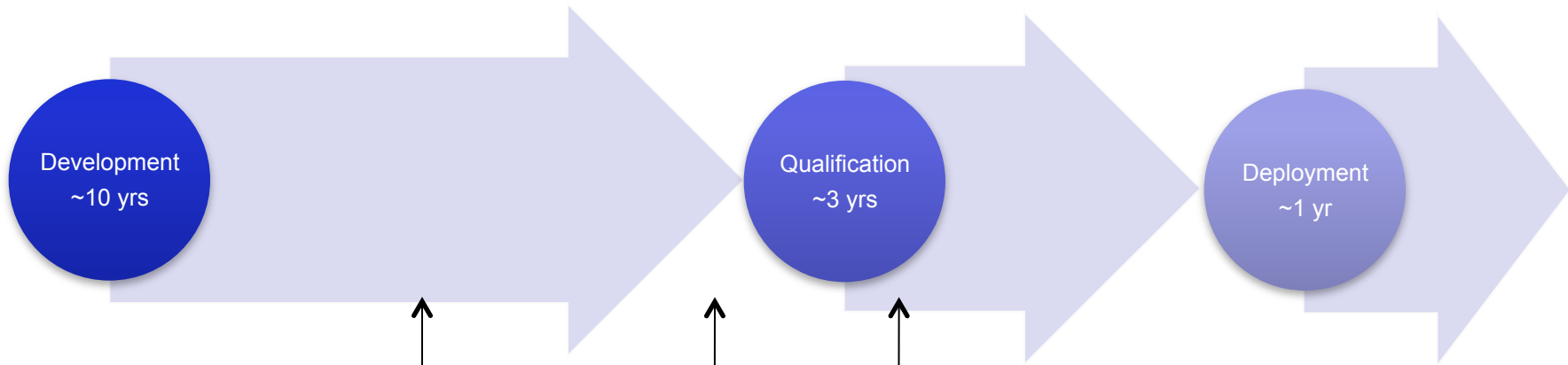
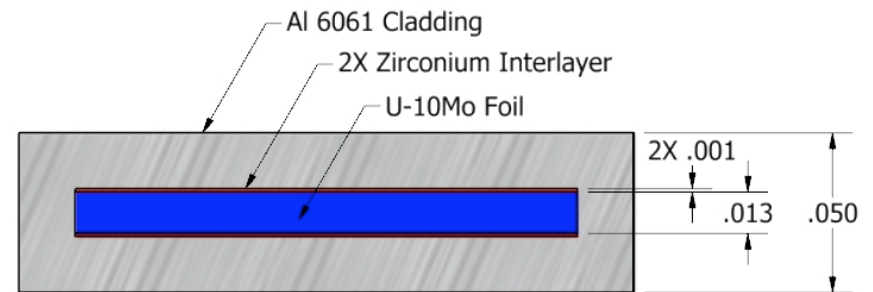
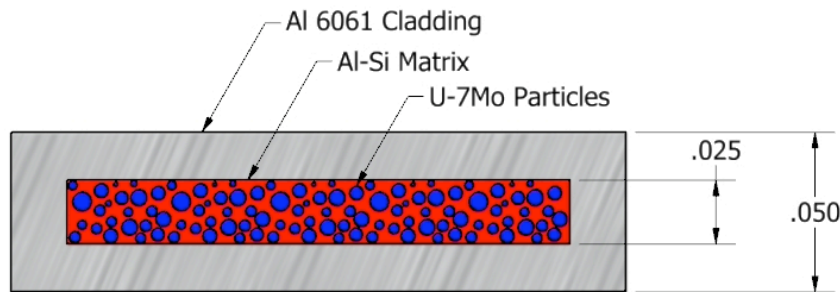
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# Fuel Technology Development Timeline



'Complex' Monolithic

'Base' Monolithic

Dispersion

This presentation will focus on the Base Monolithic fuel system

## ***Overview of Presentation***

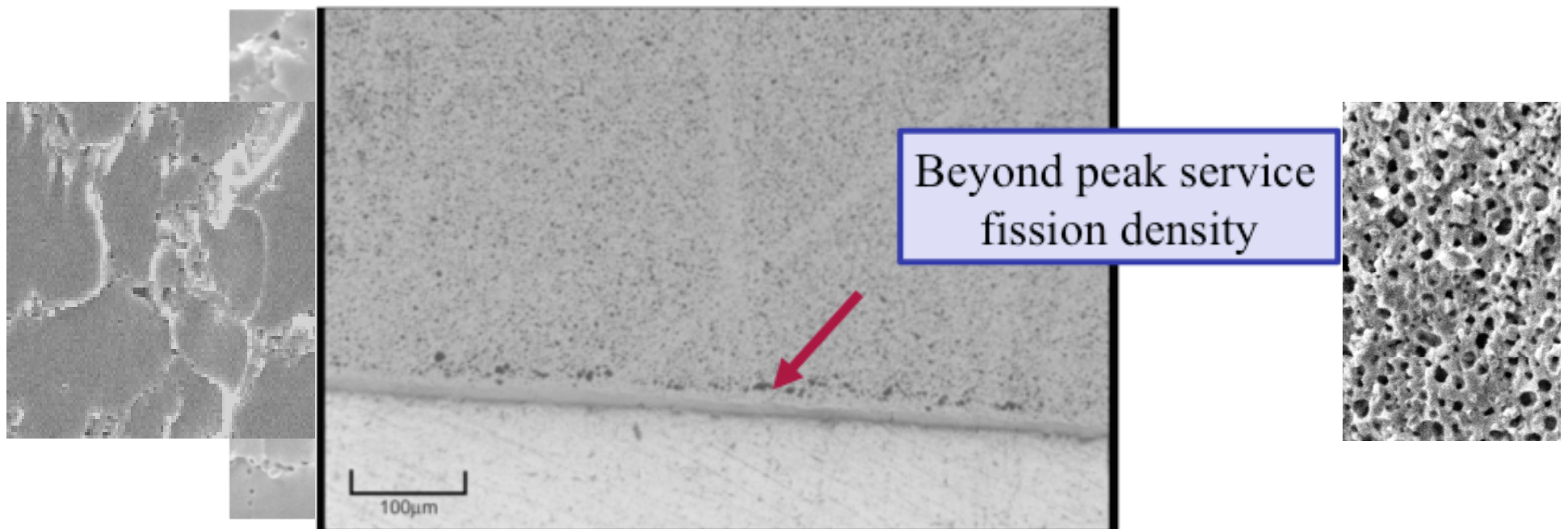
- 'Qualification' Program Plans
  - Material properties
  - Irradiation induced microstructural evolution
  - Engineering scale behavior
  - 'Off-normal' behavior
  - Fabrication technology scale-up and sensitivity studies

## *Material Properties*

- Fuel properties are more important for monolithic fuel, therefore higher fidelity properties are important to maintain margin
- Fresh fuel
  - Literature review
  - Confirmatory testing using standard techniques
- Irradiated fuel
  - Very limited literature
  - Remote techniques, infrastructure under development

## ***Microstructural Evolution***

- Fuel phase response to irradiation
  - Alpha to meta-stable Gamma phase transformation (general irradiation stability)
  - Fission gas bubble morphology
- U-Mo/Zr interface stability



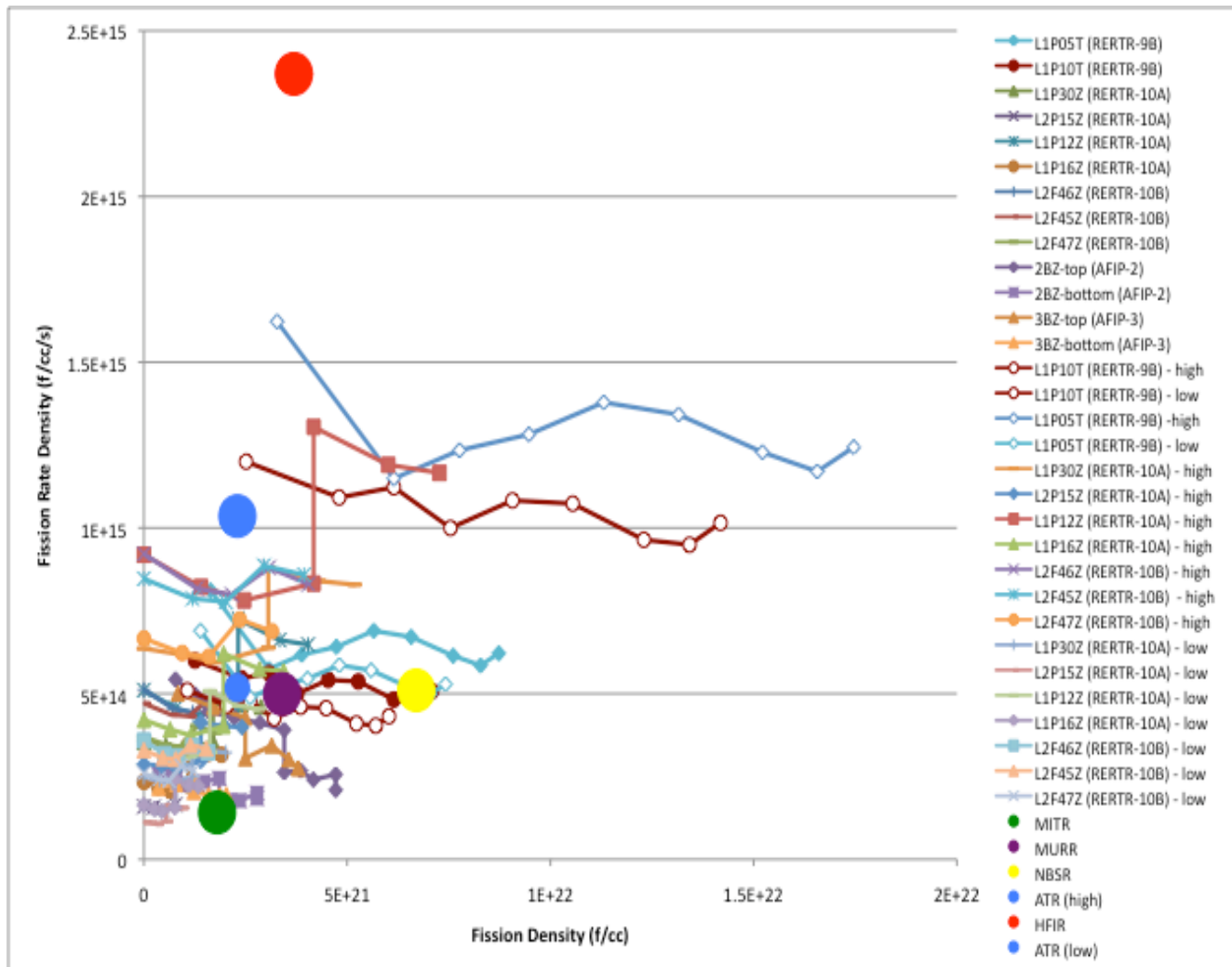
Inter

(L1P08T, RERTR-9B)

## *Engineering Scale Behavior*

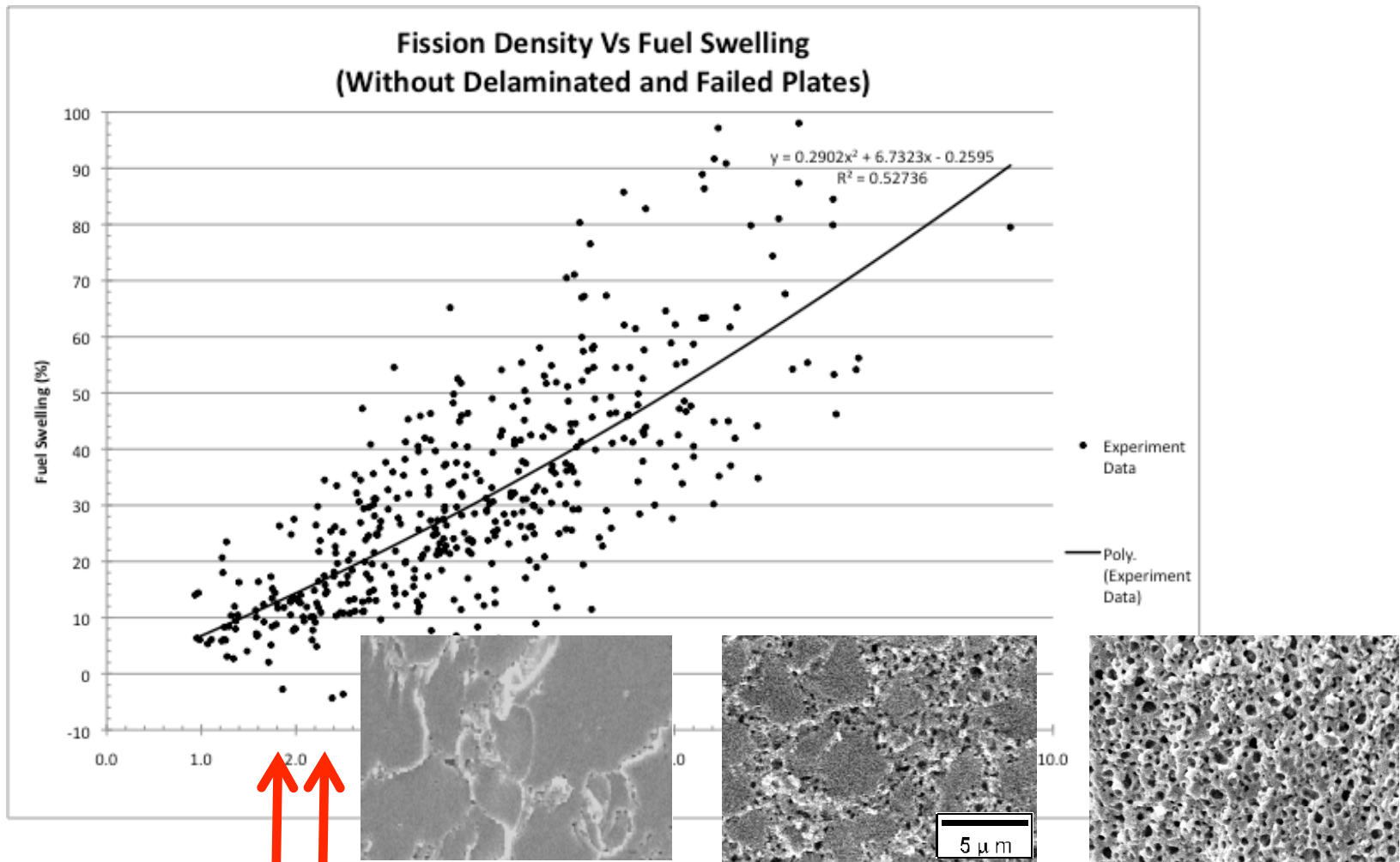
- Fuel swelling
  - Dependence on temperature, fission density and fission rate
- Mechanical stability
  - Irradiation induced dimensional change
  - Hydro-mechanical forces
- “Prototype” demonstration

# U-Mo Testing Ranges



\*Peaking factors not included

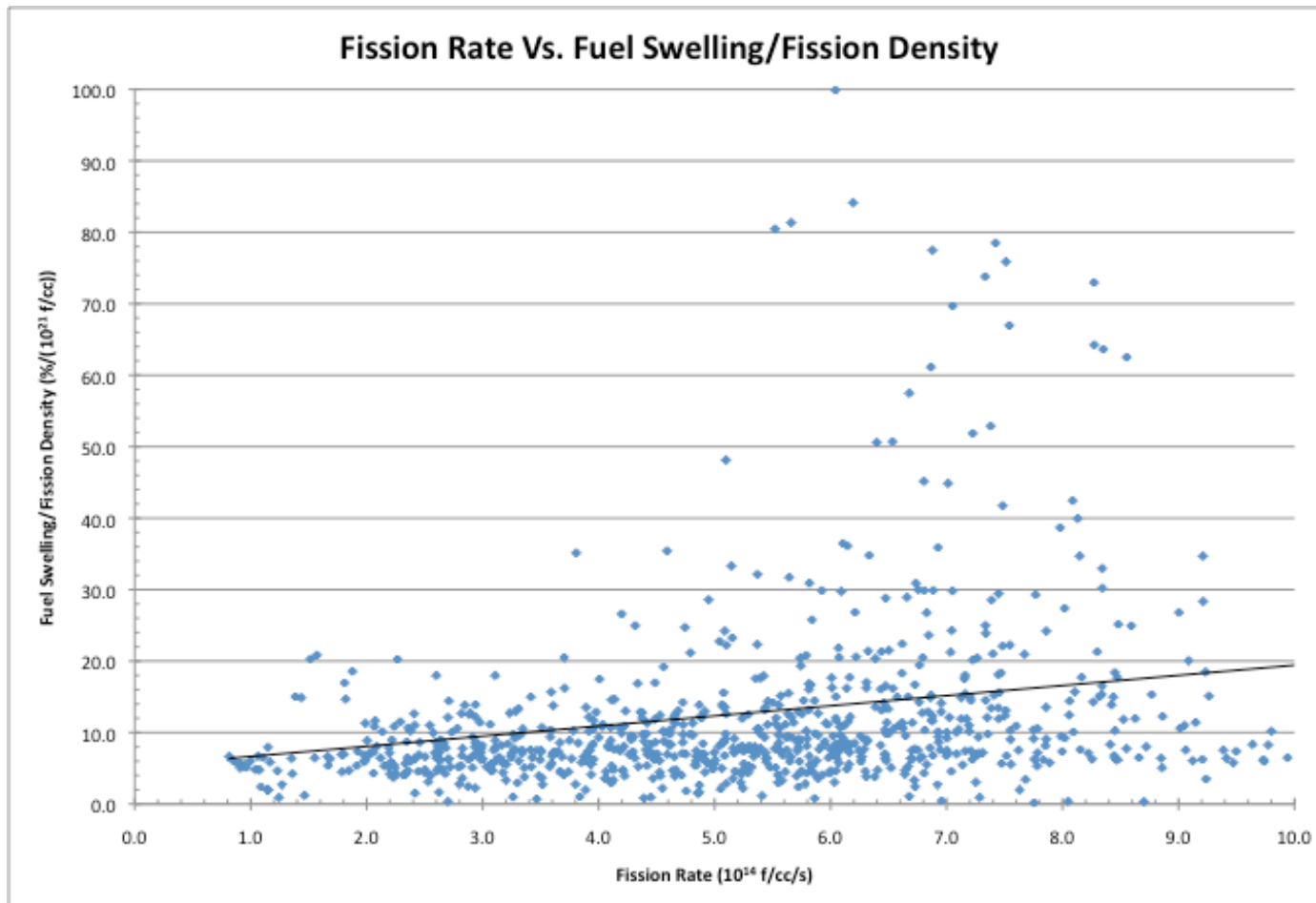
# Fuel Swelling (as a function of fission density)



Current Burnup Limits for  $UAl_x$



# Fuel Swelling (as a function of fission rate)

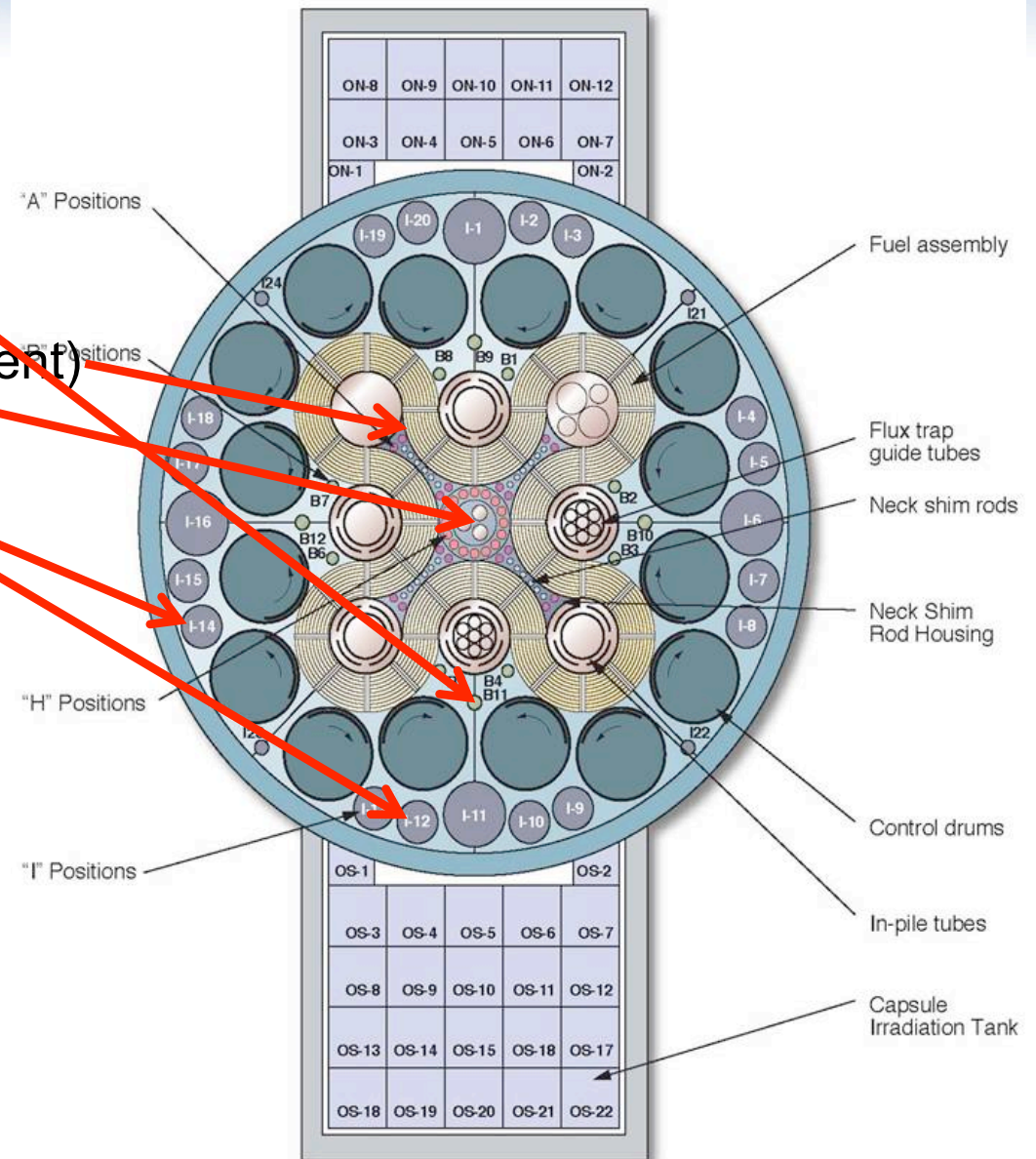


## *Engineering Scale Behavior*

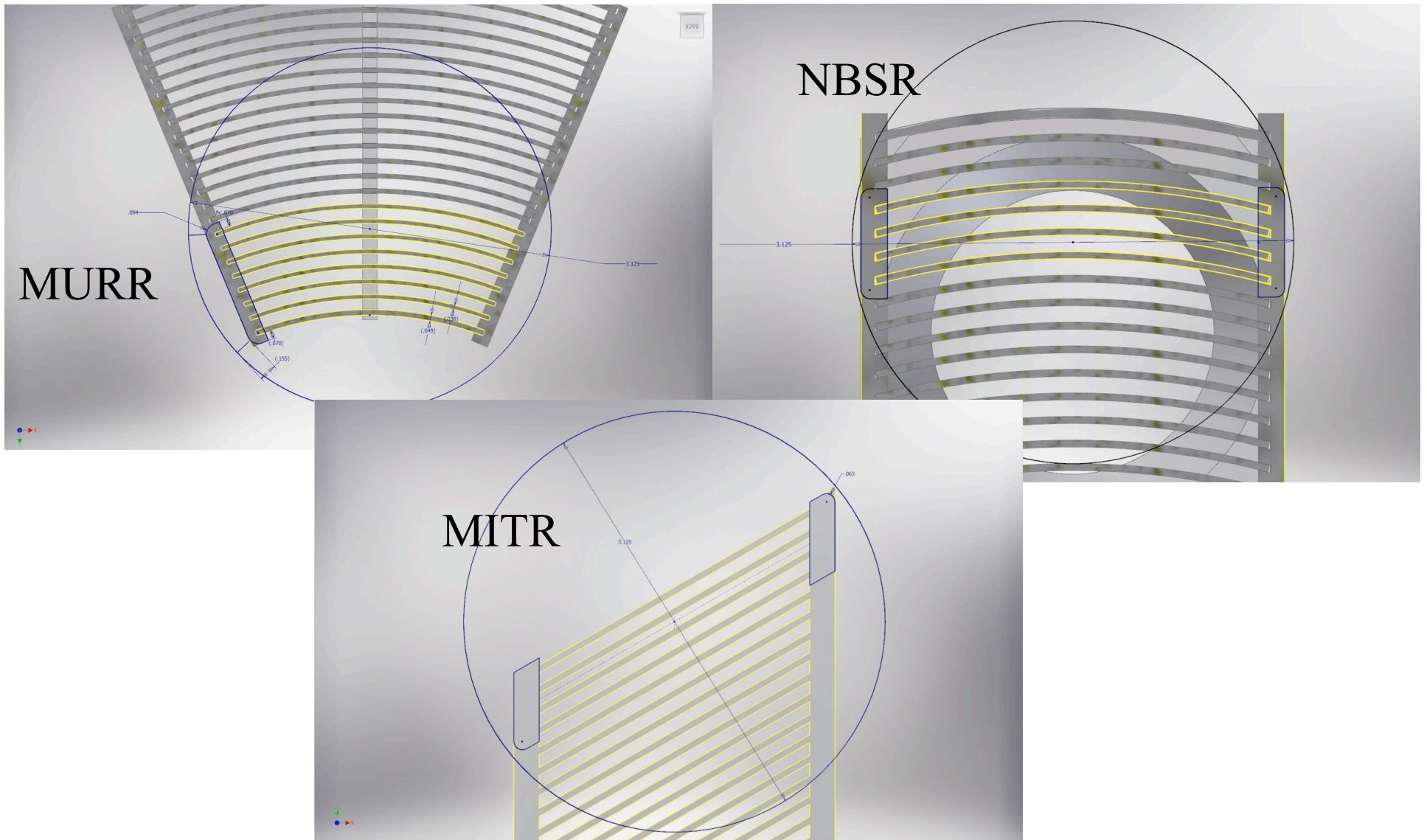
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# Performance Testing

- RERTR-12 Mini-plates
- AFIP-7
- RERTR-FE (mixed ATR element)
- Design Demonstration Experiments



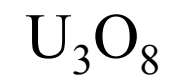
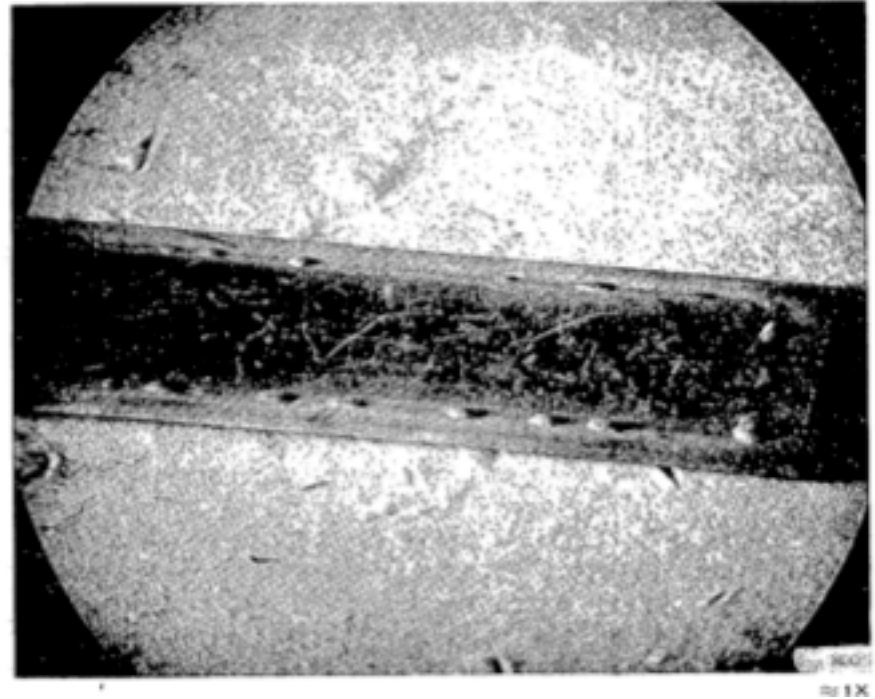
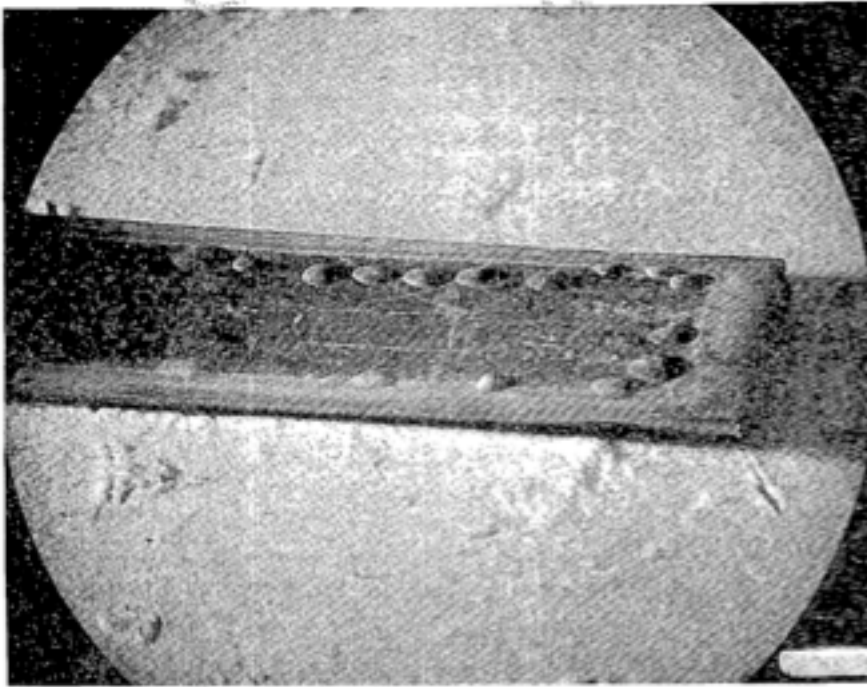
# Design Demonstration Exps. Conceptual Layout



## ***Blister Testing***

- A measure of cladding integrity under off-normal conditions is necessary to support safety case analysis
- Irradiated fuel plates are furnace annealed at progressively increasing temperature until blisters form (considered a conservative approximation to in-reactor behavior)
- Preliminary studies are being performed on irradiated U-Mo mini-plates

## *Blister Morphology*



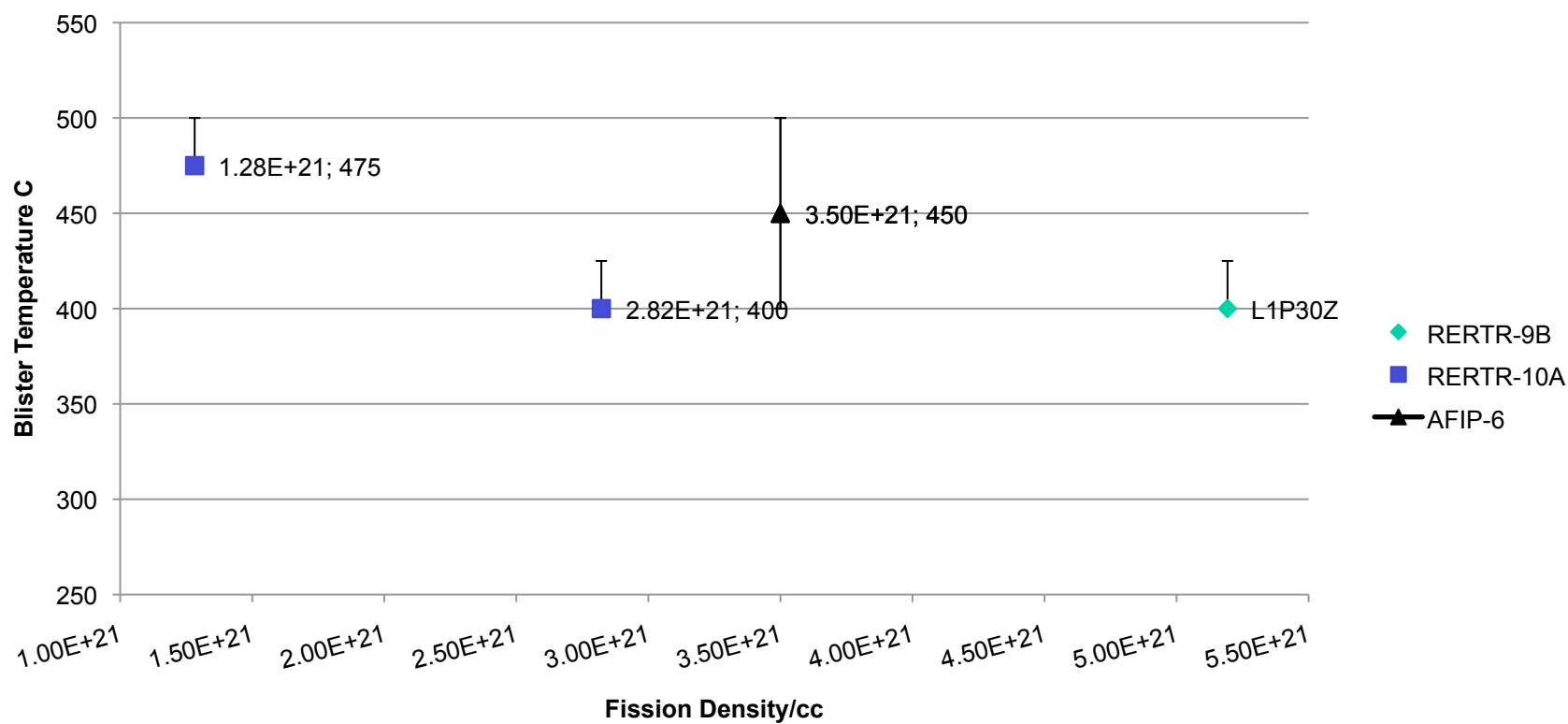
## ***AFIP-6 Blister Morphology***



**Blisters**

# Blister Threshold Data

## Blister Temperature for U-Mo Zr Interlayer HIPped Monolithic Plates





## ***Conclusions***

- The GTRI Fuel Development Program is actively pursuing the qualification of the U-Mo monolithic fuel system to support USHPRR conversion to LEU
- Qualification is focused on 4 key areas
  - Material properties definition
  - Microscopic fuel performance
  - Macroscopic fuel performance
  - “off-normal” performance limits

