S10-02

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Operations and Maintenance Ⅲ

Overview of the Modified STACY for Criticality Research on Fukushima Fuel Debris

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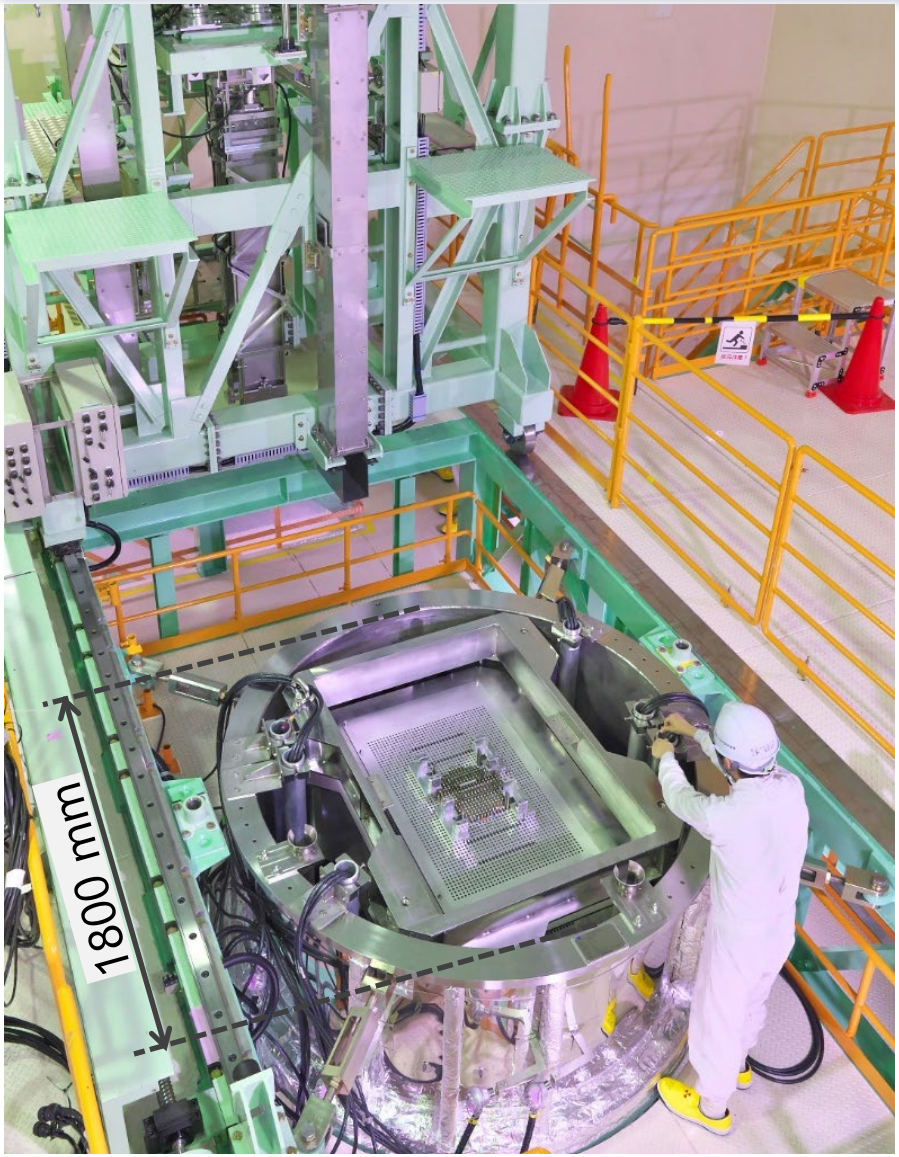
Today's presentation

- Introduction
- Configuration of Modified STACY
- Specification
- Multi-purpose design for critical experiment

Various experimental device
for impurity insertion

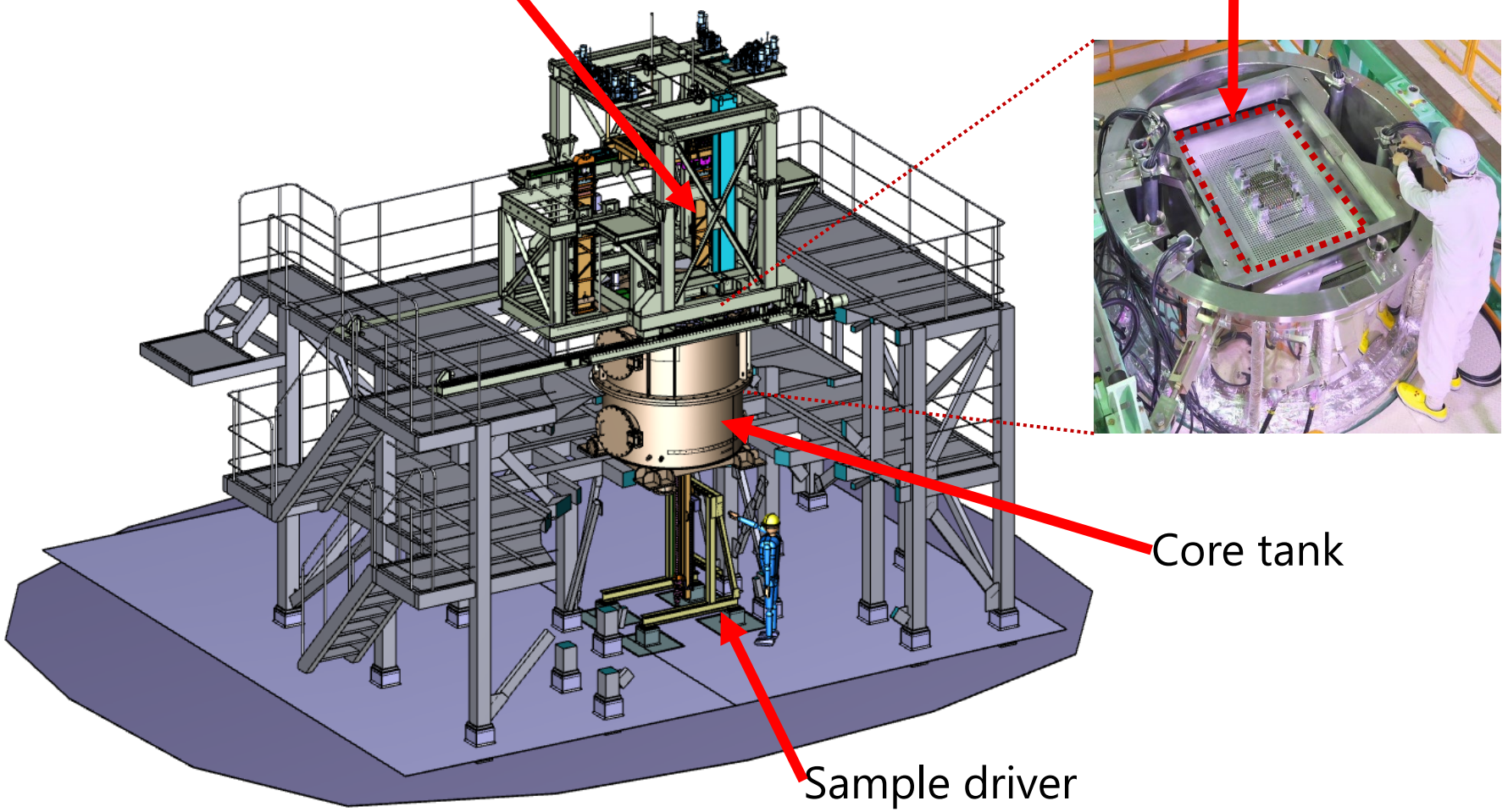
- Summary

Introduction



- Purpose of modification:
  To characterize the criticality of fuel debris from the TEPCO 's Fukushima Daiichi NPP accident .
- Category:
  A critical assembly with UO_2 fuel rods and light water (reflector/moderator)
- Feature:
  It can accommodate a wide range of impurity-loaded samples such as concrete.
- Status:
  First criticality is achieved in April 2024.
  Experiments are currently underway.

Configuration



External view of the modified STACY

Specifications

Fuel element	PWR-type rod (9.5 mm in diameter, 1.5 m in length)
^{235}U enrichment	5 wt% (licensed for up to 10 wt%)
Fuel rod	Up to 900
Volume ratio Vm/Vf	0.9 ~ 11
Temperature of light water moderator	≤ 70 ° C
Reactivity control	adjustment of water level in core tank by feed pumps and drain valves
Excess reactivity	max. 30 cent
Reactivity worth with sample driving	max. 30 cent
Thermal power	max. 200 W

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  1. Grid plates
  2. A sample driver
  3. Refillable fuel rods
  4. Structural material rods
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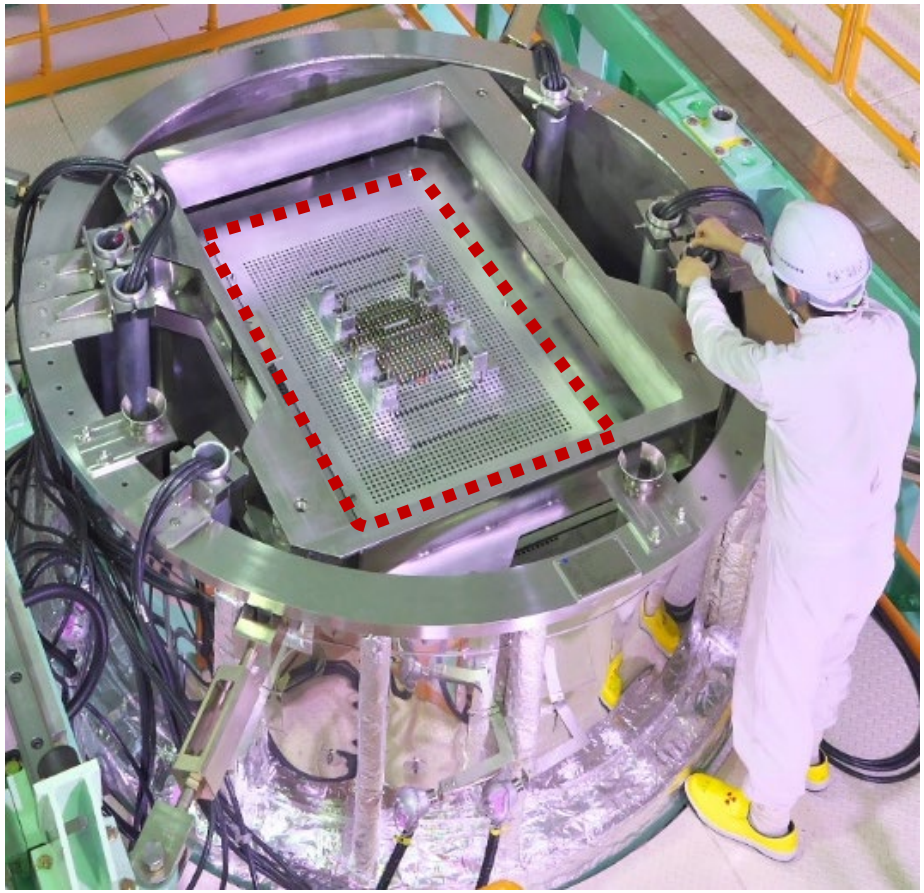
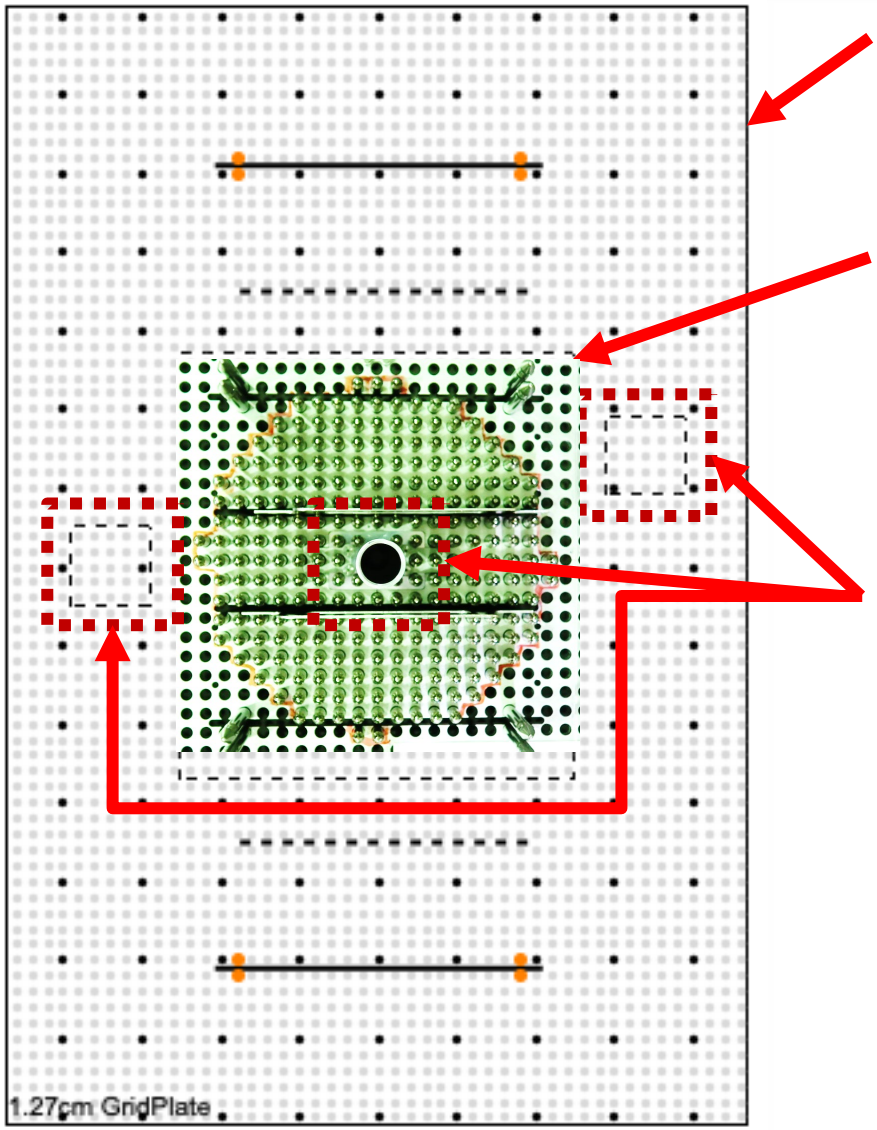
Multi-purpose design
(1)Grid plates(pitch size)



- Two types of grid plates:
  - 1.50 cm pitches Vm/Vf: 1.716,
  - 1.27 cm pitches Vm/Vf: 2.925
- Design concept:
  - The 1.50 cm pitch provides almost optimal neutron moderation.
  - The 1.27 cm pitch creates an under-moderation condition.
- Reconfigurable
  - It is also possible to newly manufacture and use the grid plate.

Multi-purpose design
(1)Grid plates(ease of insertion)



- Core configuration area:
  Size: approximately 60 x 90 cm
- The center section:
  Size: approximately 30 x 30 cm
  Replaceable: for future experimental purposes.
- Three replaceable components: for positioning experimental equipment.
  - Center:
    Assumed to be pseudo fuel debris
  - Center and surrounding area :
    Assumed to be a detector

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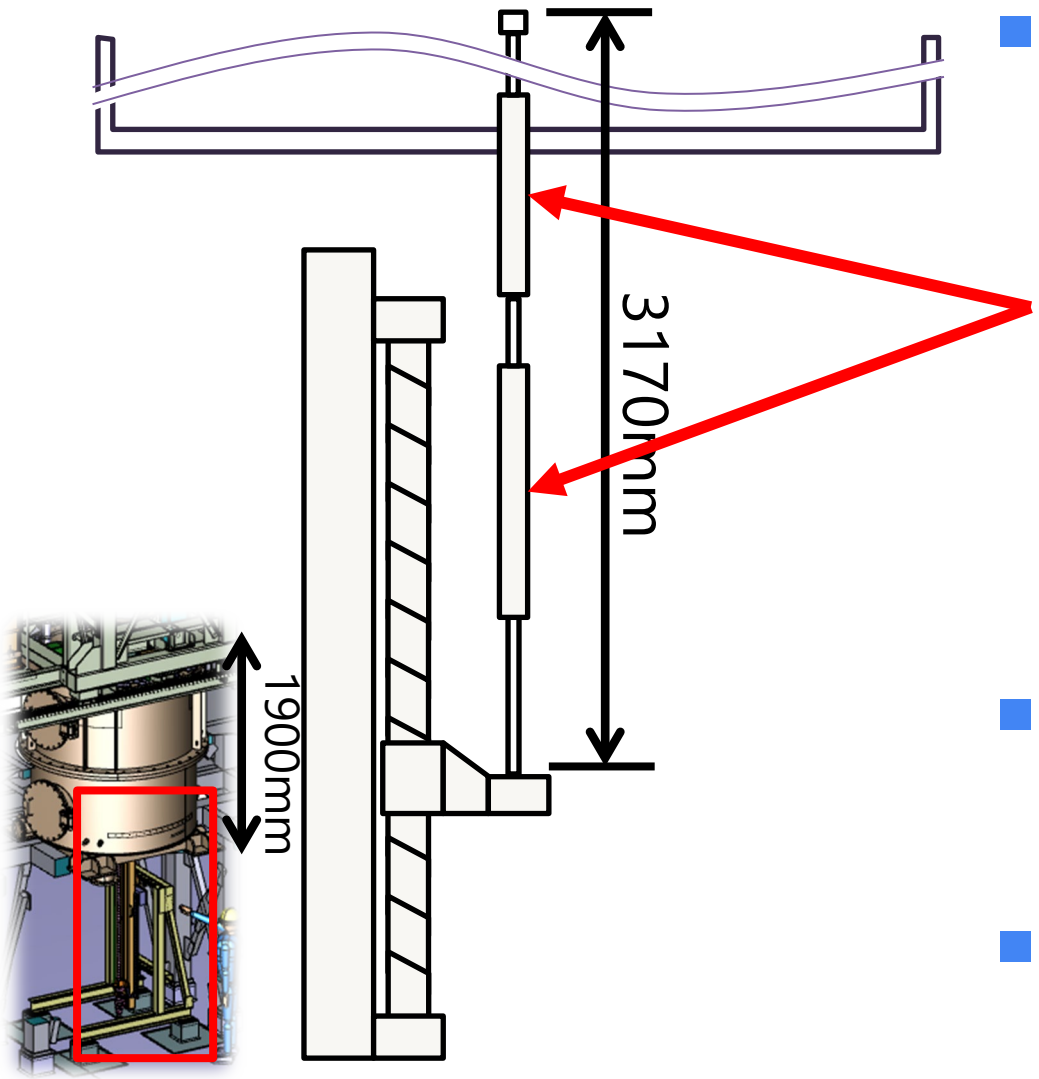
Multi-purpose design
2. The sample driver

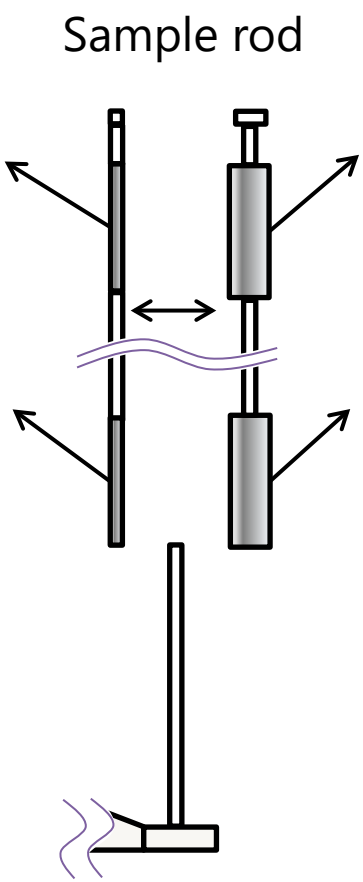


- Sample Driver Overview
  - Used to insert small samples or devices into the core during operation
  - Examples:
    - Gold foil (for thermal power calibration)
    - Sample simulating fuel debris
    - Neutron detector
    - Sealed RI
- Structure
  - Aluminum sample rod
  - Electric motor(max. 10.0 mm/s)
- Safety Limit
  - maximum of 30 cents

Multi-purpose design
2. The sample driver(Sample space)

- a small-diameter type

- a large-diameter type.



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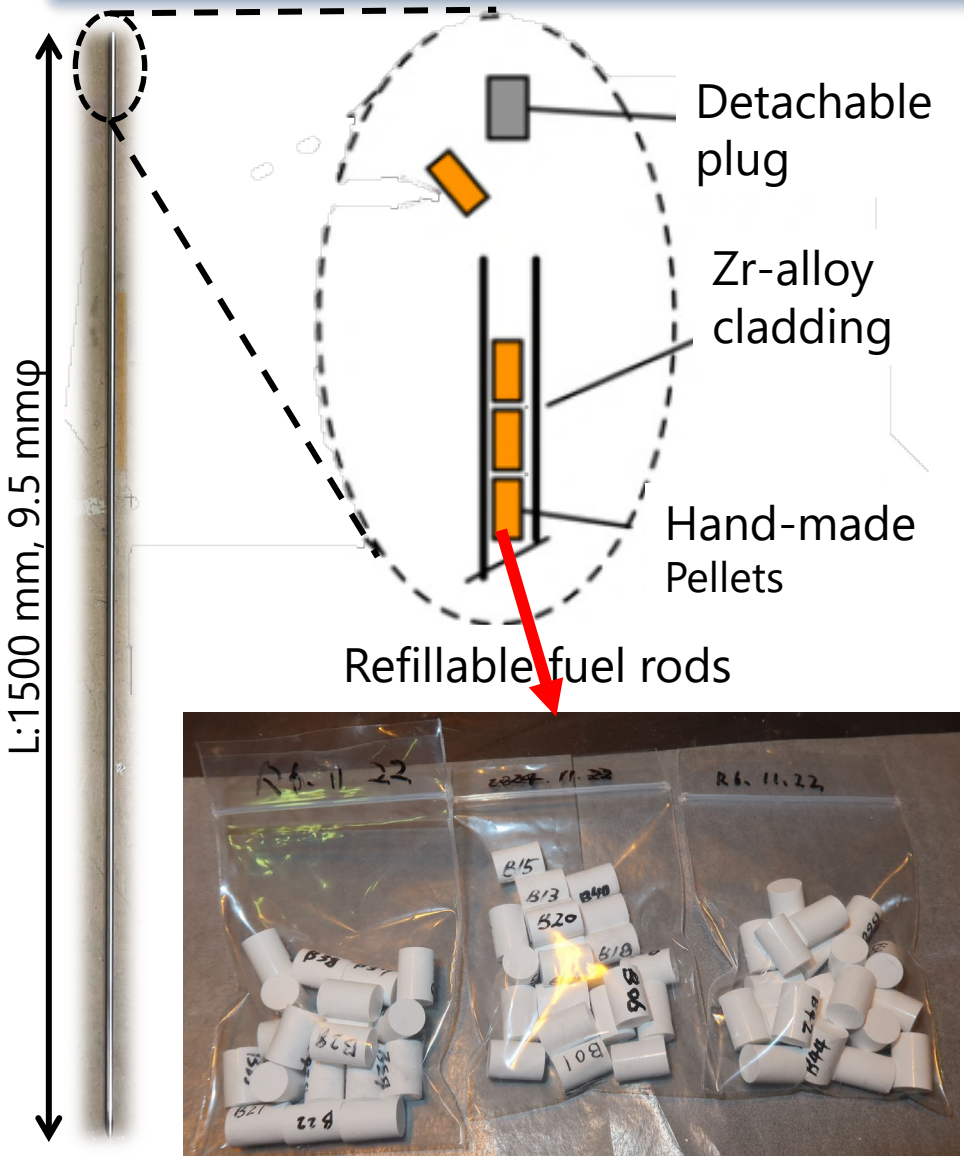
Multi-purpose design
3. The refillable fuel rods



$CaCO_3$ pellets

- Purpose:
  - Enable experimenters to fabricate and insert custom fuel rods into the core.
- First Experiment Campaign:
  - Inserted $CaCO_3$ pellets
  - Purpose: measure replacement reactivity of concrete components
  - Post-irradiation analysis equipment was also prepared
- In the future
  - the pellets can be mixed with UO_2 powder.

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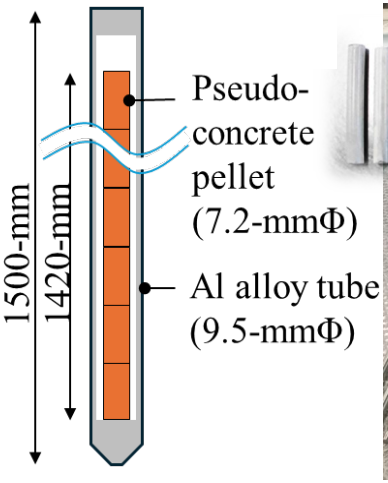
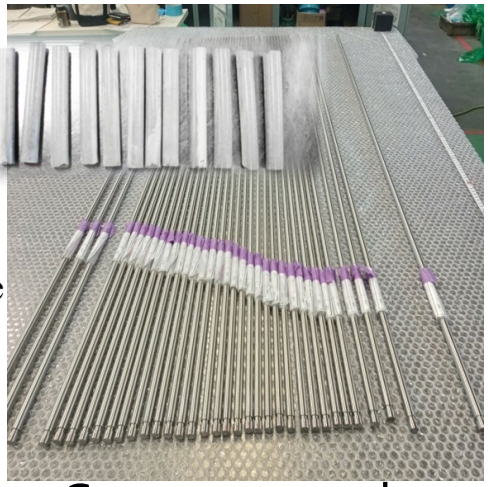
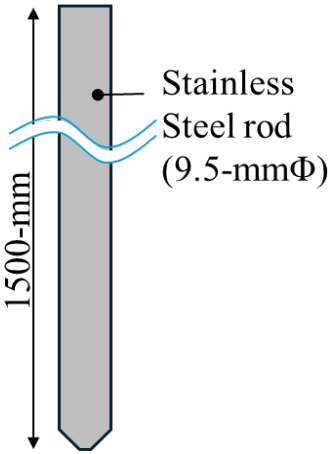
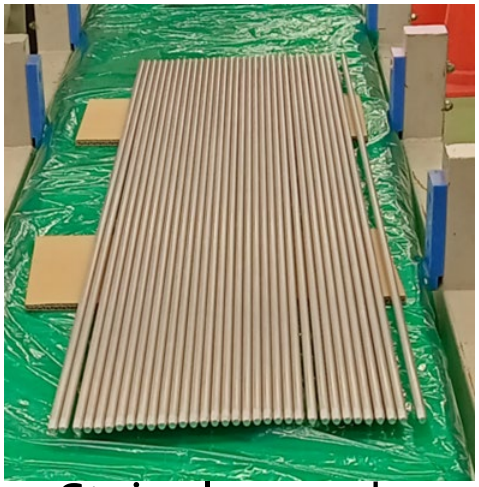
Multi-purpose design
4. Structural materials





Concreate rods



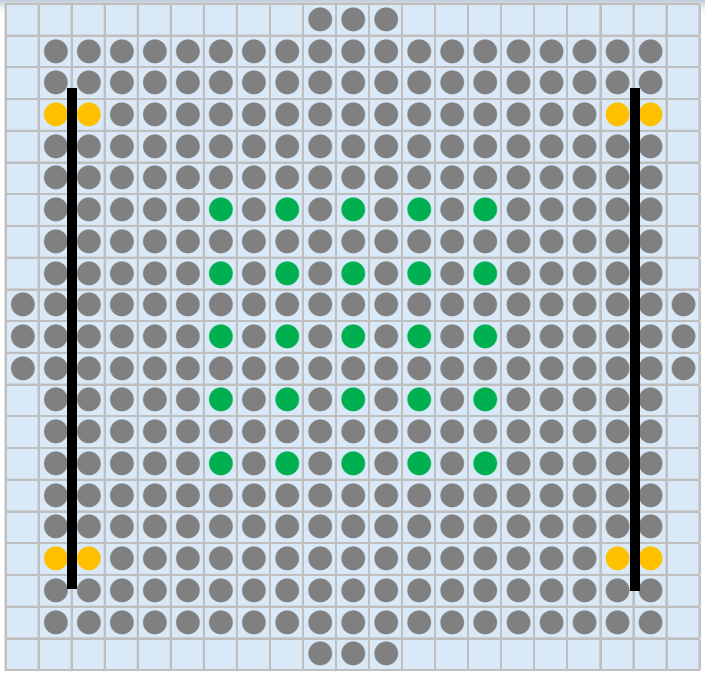


Staineless rods (SUS304)

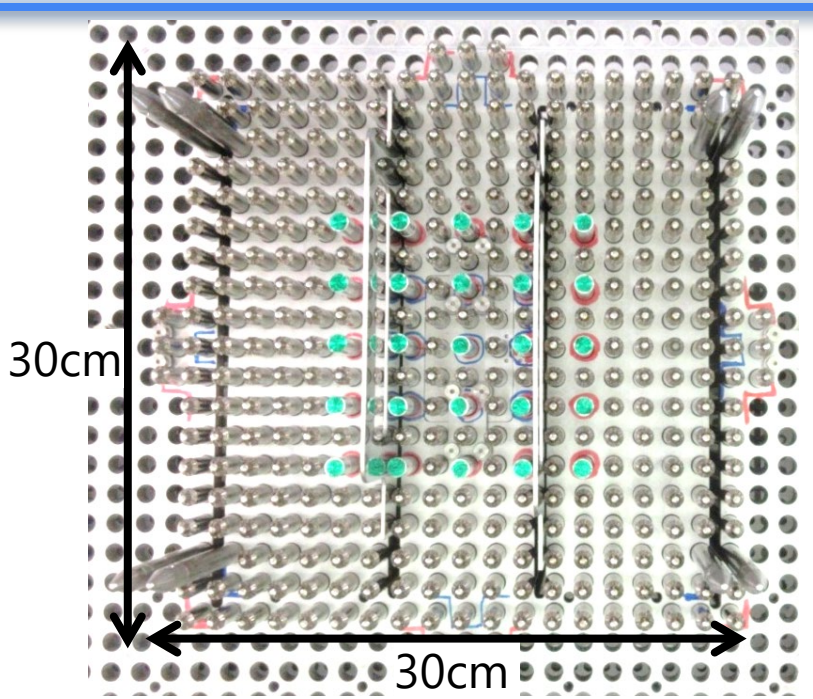
- Purpose:
  Enable experimenters to insert custom simulating fuel debris into the core.

- Structure:
  - structural material rods made of aluminum alloy and concrete were prepared.
  - The outer diameter of the structural material rod is identical to that of the fuel rod.
  - This allows structural rods to be loaded into the core using the same holes as the fuel rods.

An example experiment using structural material (concrete)



Core configuration map



Core configuration

- Fuel rod
- Structural material rods(concrete)
- Slit for Safety plate
- Guide pins for Safety plate

Experimental condition	
Type of grid plate	15.0 mm
Fuel rod	340
Structural material rod(concrete)	25
Predicted critical water level	455 mm

Result	
Initial critical water level	458.02 mm

Summary

- The modified STACY is equipped with various experimental systems, including:
  - Grid plates (for adjusting the moderation conditions)
  - The sample driver (for inserting small samples, detectors, sealed RI)
  - The refillable fuel rods (for fabricating and inserting custom fuel rods)
  - Structural material rods (for simulating fuel debris in the core)
- Following the fuel debris experiment program, STACY is expected to be utilized for a wide range of applications, such as:
  - Reactor physics research
  - Criticality safety studies
  - Training reactor operations

Thank you for your attention

Enjoy the facility tour tomorrow!