

PANEL 4

JAEA Facilities for Irradiated Fuel Elements

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JAEA Research Reactors adjacent to PIE Facilities in Oarai R&D Center



JMTR

**Japan Materials Testing Reactor
& Hot Laboratory**

HTTR

**High Temperature Engineering
Test Reactor**

JOYO

**Experimental Fast Reactor
& PIE Facilities**



General Trends

- **Facilities for handling and examining irradiated fuel elements have been constructed with the research reactors over the past 40 years.**
- **First stage of such facilities was a simple purpose; implement ‘Post Irradiation Examination’ for gather the irradiation data and validate performance on fuels and materials.**
- **By last 40 years efforts, irradiation behaviors under normal water reactor operation has been recognized well and then introduced their knowledge to designs, standards, and operation procedures.**
- **However, it still needs to investigate fuels and cladding for high burn-up & high performance fuel developments.**
- **Recent GEN-IV type innovative reactors, such as Fast Reactor, High Temperature Gas-Cooled Reactor, and other type; Accelerator Driven System ask new fuels/materials and targets develop under the different irradiation conditions from water reactor.**
- **Facilities for irradiated fuel elements should respond many kinds of needs flexibly to install the updated equipment and tools with good services.**

JAEA Typical Facilities for Post Irradiation Examination

Post Irradiation Examination Facilities

Handling Many Types Fuels & Materials for FR & LWR

MMF-1 1973~
MMF-2 1982~



Material Monitoring Facility



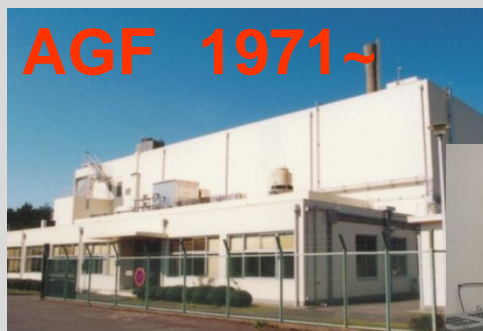
FMF-1 1972~
FMF-2 1993~



Fuel Monitoring Facility
(for FR JOYO & MONJU)



AGF 1971~



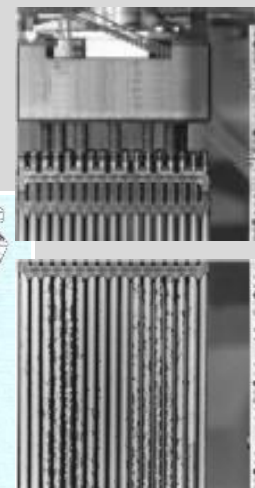
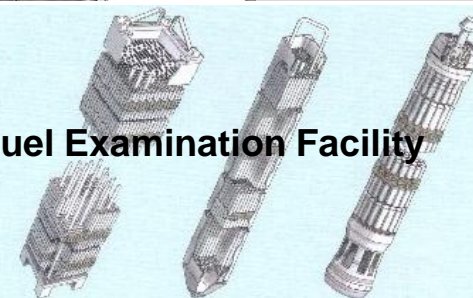
Alpha-Gamma Facility



RFEF 1978~



Reactor Fuel Examination Facility
(for LWR)

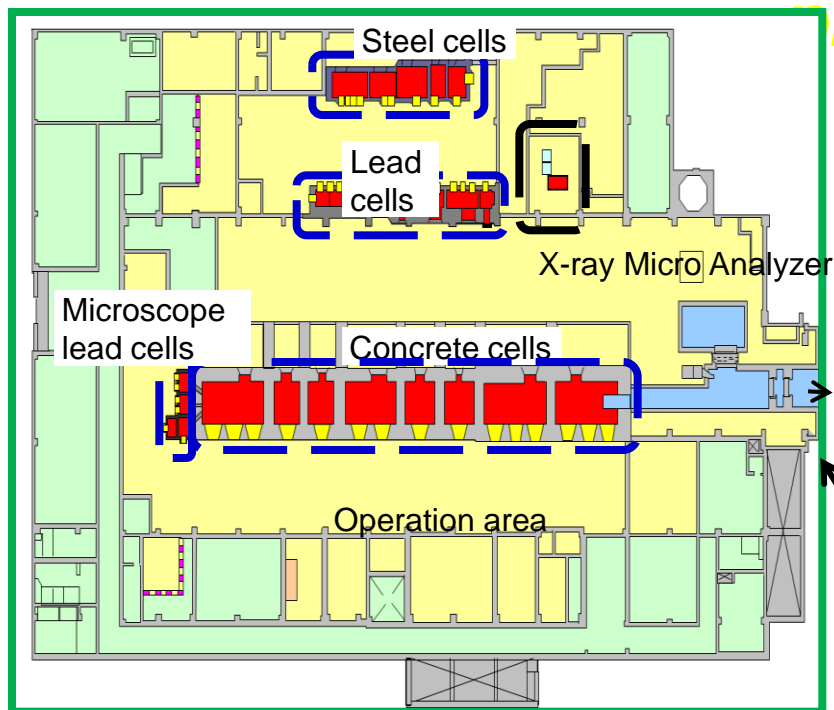


for Fuel Pins & Materials

for Fuel Assembly

JMTR-Hot Laboratory

*connected through JMTR water canal
to examine & re-irradiate fuels & materials*



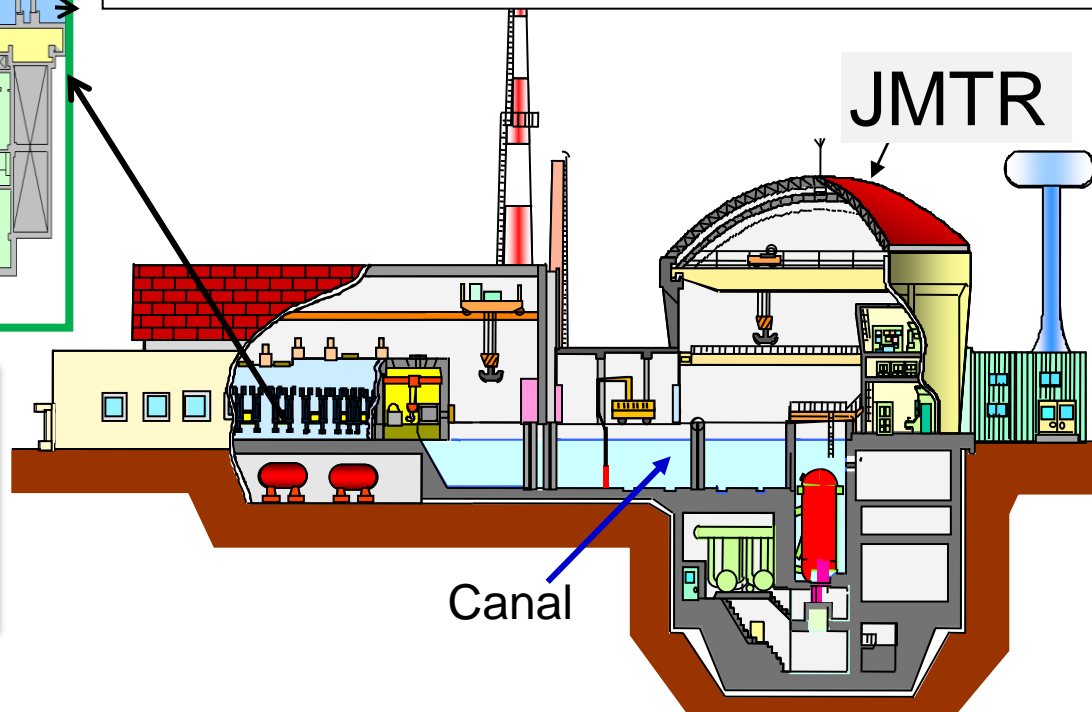
PIE for fuels

Eddy current, X-ray micro analysis,
Gamma scanning, Microstructure, Hardness

PIE for materials

Crack propagation, Creep, Tensile, Fatigue,
Fracture toughness, impact , Bulge

Concrete Cell (1971~)	: 8
Microscope Lead Cell	: 4
Lead Cell (1971~)	: 7
Steel Cell (1982~)	: 5



Recent Installation of Post-Irradiation Tools for New JMTR

**Shielding Capability for high
BU Fuels (Max 110 GWd/t)**

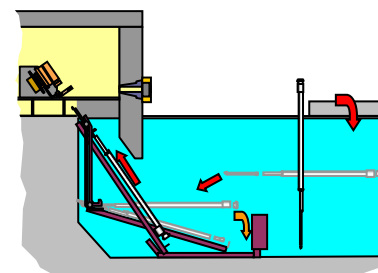
**Scanning Electron
Microscope (SEM)**

**Power Manipulator for large
size Capsule Installation**



**Heavy shielded
Master-Slave
Manipulators**

**Improved Capsule
assembling Device**



**JMTR
Hot Laboratory**

Chemical Research Laboratories

Basic Testing for LWR & FR irradiated fuels

CPF

Chemical Processing Facility



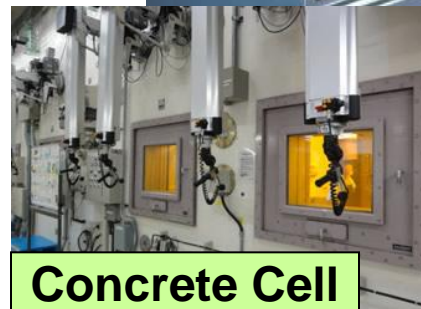
CELL Line



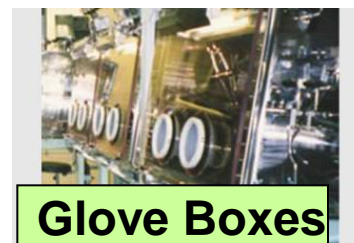
Analysis Lab.

BECKY

Back-end Fuel Cycle Key Elements
Research Facility



Concrete Cell



Glove Boxes



Steel Cell

**Lessons learnt from
Long-Term Operational Experiences
of JAEA Hot Facilities handling Irradiated Fuels**

1) Basic philosophy

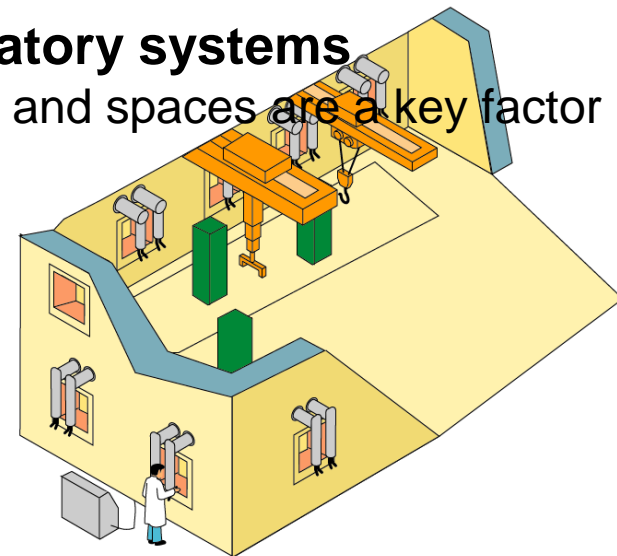
- 3S (Safety, Security, Safe-Guard) is a basic principle for operation and maintenance with remote technologies..
- Good combination among technician, manager, and researcher is inevitable factor.
- Back-end plan is important to operate facilities.
- Wide user's service & continuous improvement efforts determine excellence of facility.

2) Maintain systems & control the inside atmosphere on negative-pressure

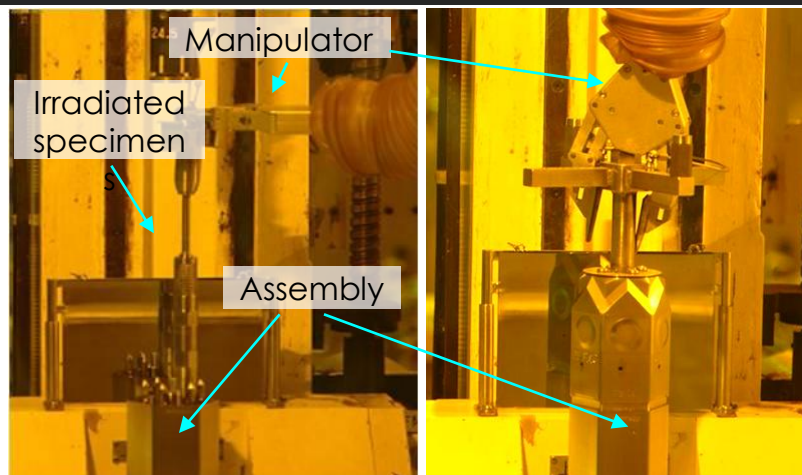
- Moving parts must repair or replace some day, prepare the design and system for it.
- Off-time small ventilation system is recommend for money saving and convenient safety inspection
- Inert N_2 atmosphere is preferable for PIE, but need much budget to maintain it.
- Radio waste should be minimized by designing of easy system & tools modification, periodical inside arrangement & cleaning, classification of raw waste.

3) Always prepare additional spaces and preparatory systems

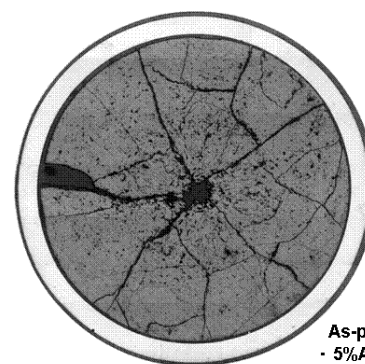
- For mid-term & future needs, preparatory arrangements and spaces are a key factor to satisfy them promptly.



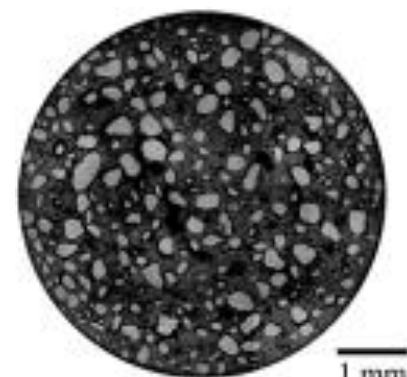
Examination tools of the newest type are necessary to increase stakeholders satisfactions (1)



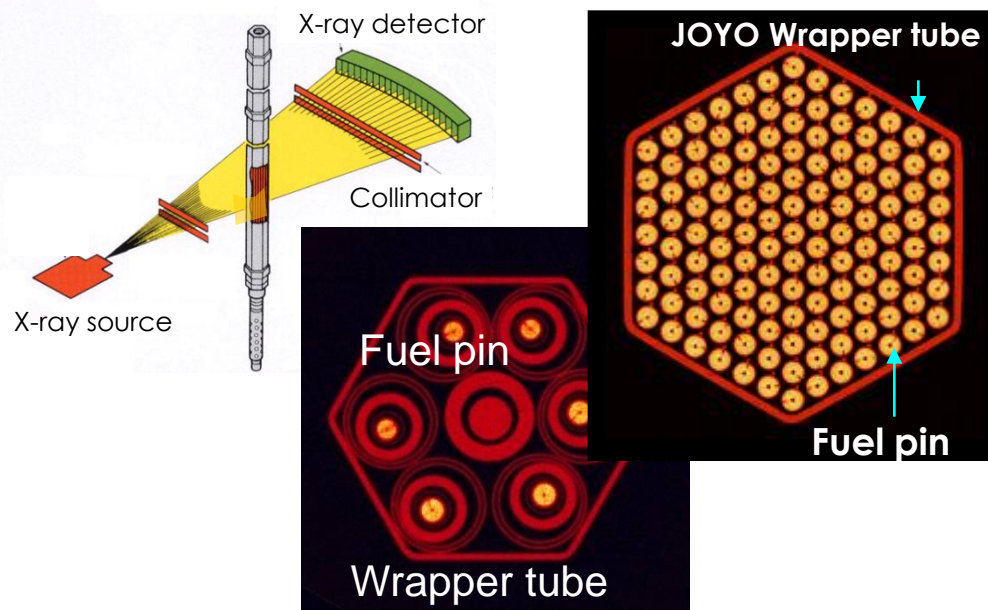
Reassembling JOYO irradiated Fuel



As-polished
• 5%Am-MOX
• O/M:1.98
• X/L = 0.5
• LHR:430W/cm



Testing of Advanced Fuels



Computed Tomography by X-ray CT



Severe Accident Fuel Test by HF induction Furnace in Shielded Cell

Examination tools of the newest type are necessary to increase stakeholders satisfactions (2)



Before
Test

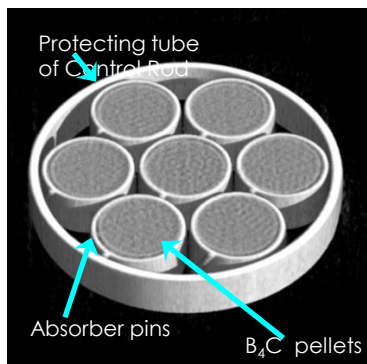
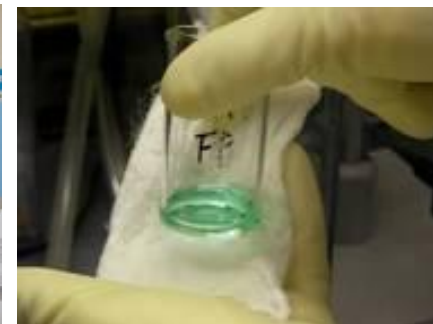


After
Test

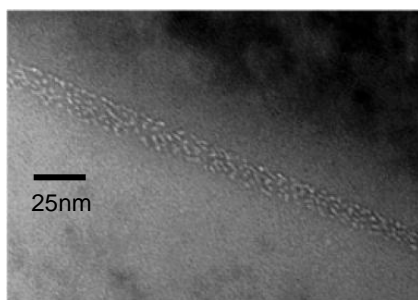
**Tensile test for Irradiated
Fuel Cladding**



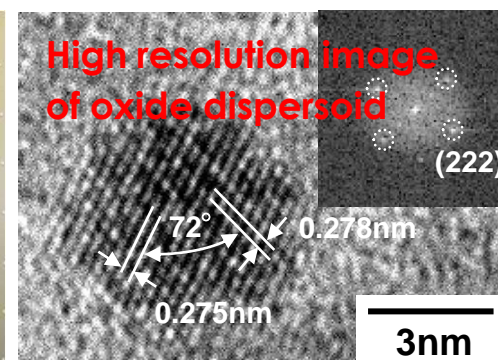
**Thermal Ionization Mass Spectroscopy
(TIMS) in GB for Isotope Analysis from
Irradiated Fuel Solutions**



**X-ray CT & Microstructure of
B₄C pellets in Control Rod**



**FE-TEM (JEM 2010F) equipped with
Energy Dispersive X-ray Spectrum (EDS)**

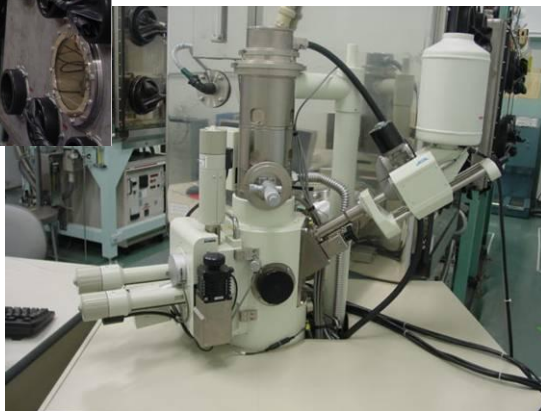


Mid Term Perspectives of PIE Facilities

- *Multi purpose; Fuels, RI supply, Debris, Wastes,*
- *Facility & Sample Sharing*
- *Global Joint Research with visiting researchers*
- *Human Resource Development*



**High-purity Ar
glove boxes**



**SEM connected
with glove box**



**Experimental scenery
with visiting researchers**