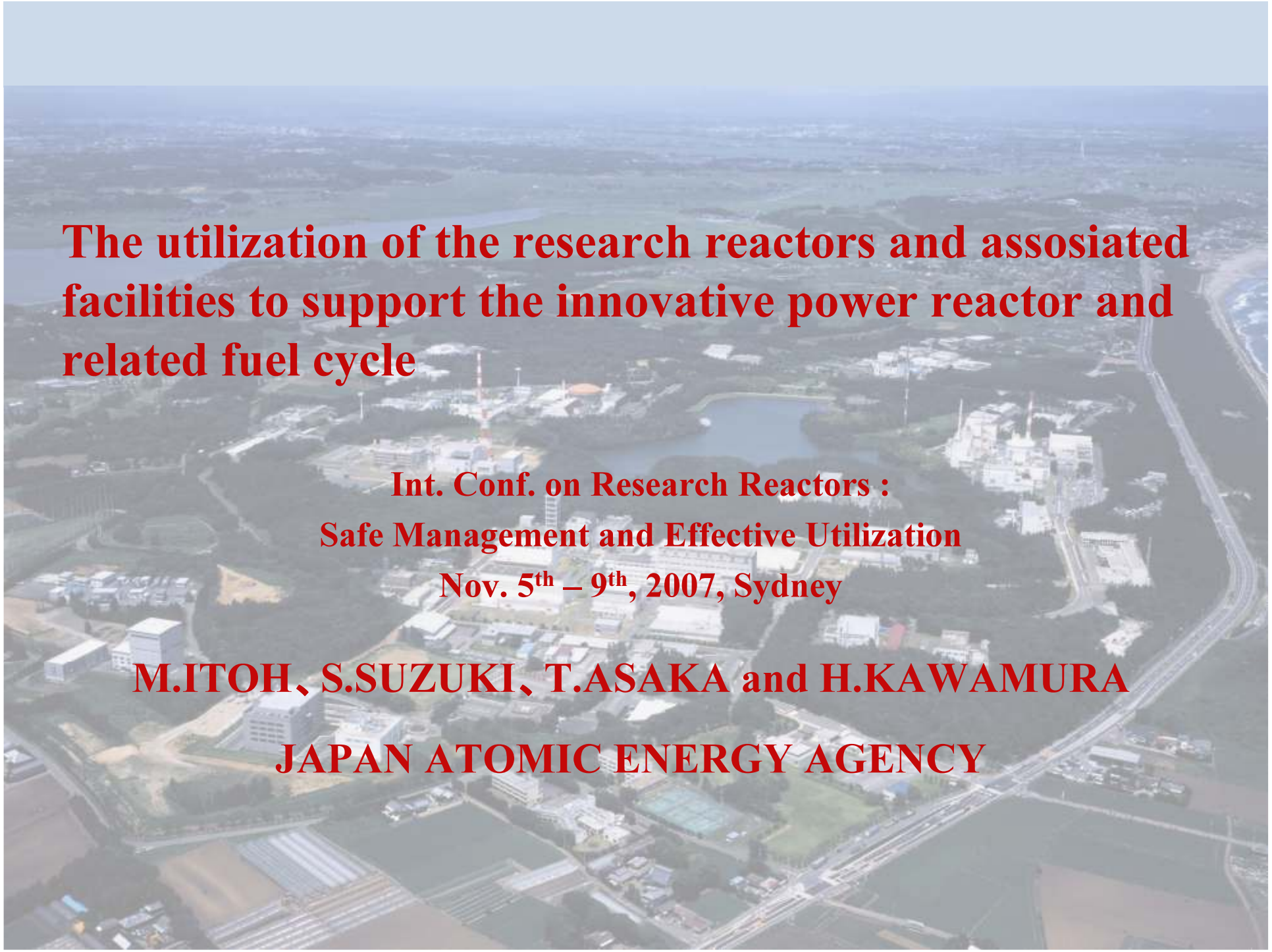


The utilization of the research reactors and assosiated facilities to support the innovative power reactor and related fuel cycle

Int. Conf. on Research Reactors :
Safe Management and Effective Utilization
Nov. 5th – 9th, 2007, Sydney

M.ITOH、S.SUZUKI、T.ASAKA and H.KAWAMURA

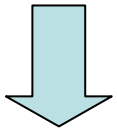
JAPAN ATOMIC ENERGY AGENCY

Contents

- Background
- The role of Oarai Research and Development Center
- Outline of Research Reactor Complex
- Research activity of ORDC
- Future perspectives

Background

- Maintain or increase nuclear power's present share of 30-40% of Japan's total power generation beyond 2030 (The time of replacement for the existing plant)
  - Life extension and/or replacement of existing LWR
  - Aim for the realization of demonstration fast breeder reactors and other related facilities by around 2025
- Fix the construction site for International thermonuclear experimental reactor (ITER)



Irradiation study for fuels and materials development is one of the key issues to maintain the present share of nuclear power generation

The role of Oarai Research and Development Center

Provide the irradiation field to support the following items

- Lifetime extension and replacement of the existing plants
- Realization of demonstration plant for FBR
- Fundamental study including the materials research for fusion reactor

Outline of Research Reactor Complex

- Research reactor

  Japan Materials Test Reactor (JMTR), Japan Experimental Fast Reactor “JOYO”, High Temperature Test Reactor (HTTR)

- Post-irradiation examination facilities

  JMTR Hot Laboratory, Fuels Monitoring Facility, Alpha Gamma Facility, Materials Monitoring Facility

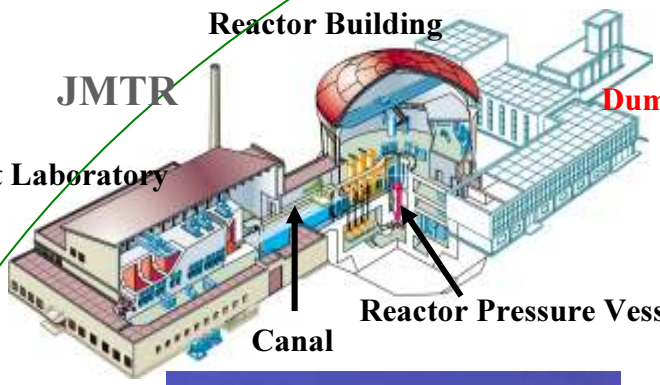
- Fuel research facility

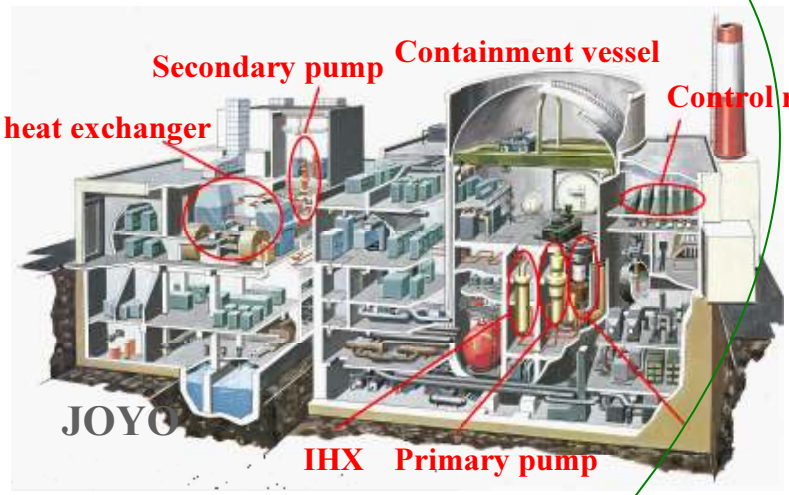
  Plutonium Fuel Research Facility

- Other facilities

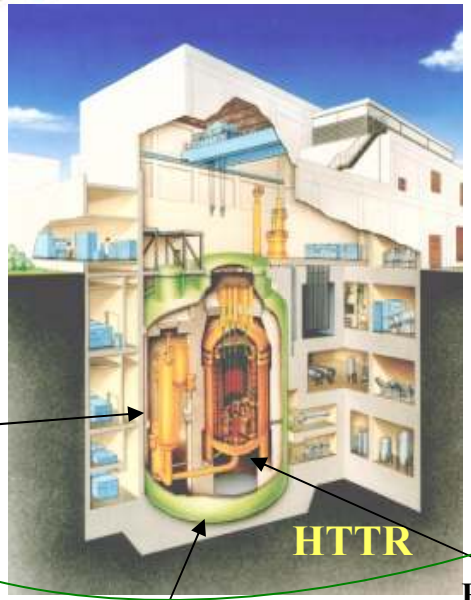
  International Research Center for Nuclear Materials Science, Tohoku University

Research reactors of JAEA

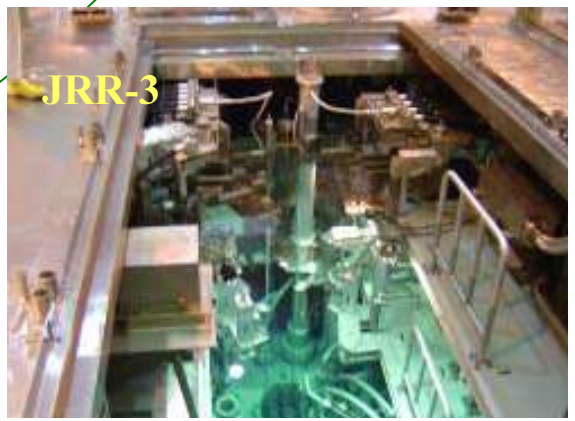




Oarai Research and development center

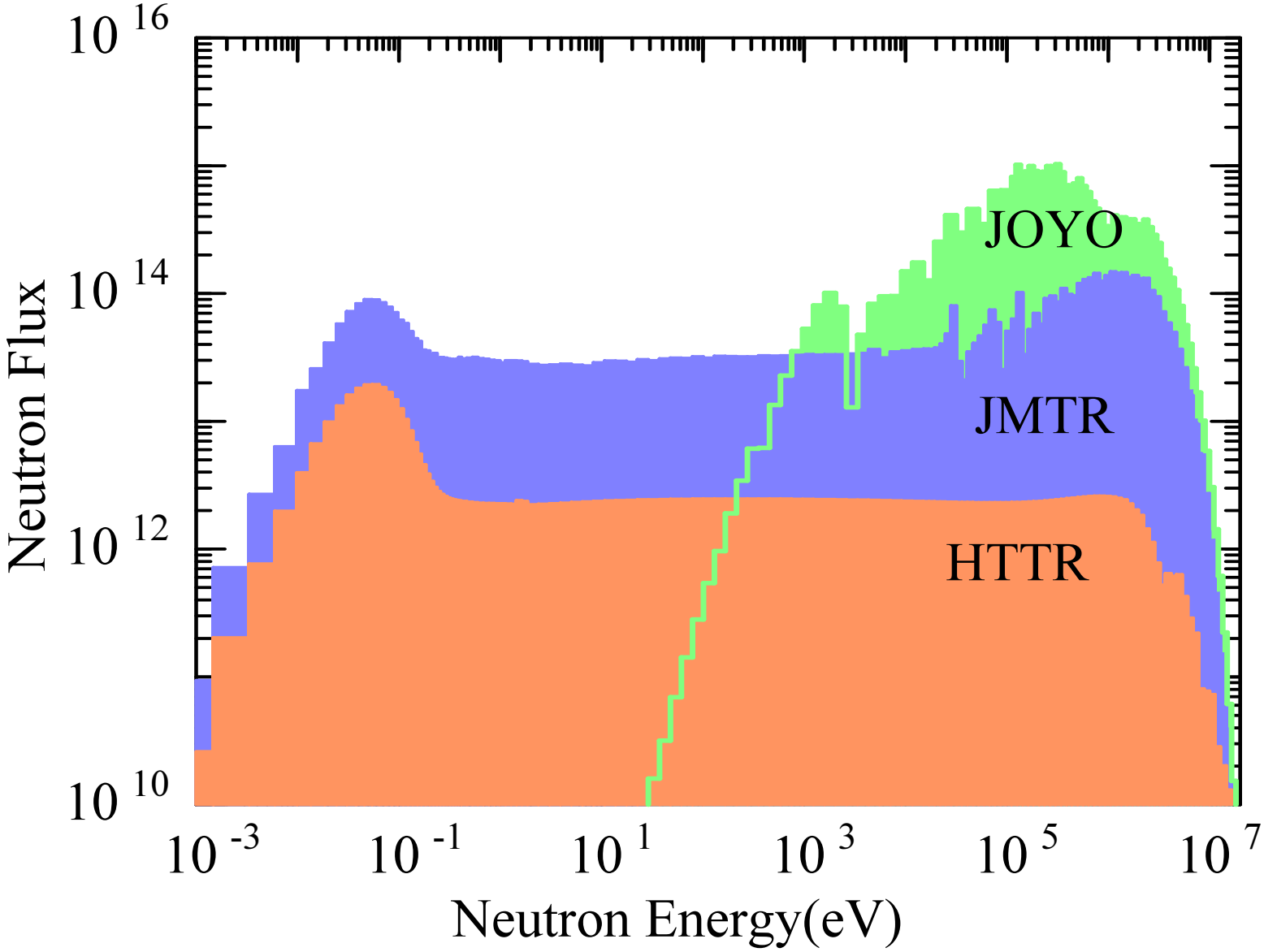


Tokai site



Specification of research reactors

RR	JMTR	JOYO	HTTR
Neutron Flux($n/m^2 \cdot s$)			
Fast Neutron	4×10^{18}	4×10^{19}	7×10^{17}
Thermal neutron	4×10^{18}	-	2×10^{17}
(Total)		5.7×10^{19}	
Coolant temperature (C)	(light water)	(sodium)	(helium)
Inlet	49(max.)	350	395
Outlet	56	500	950



Neutron Spectrum of Research reactors in ORDC

Research activity of ORDC

- major activity -

○ For existing reactor (LWR)

- IASCC researrch of aging problem for LWR
  - focus to in-situ experiment
- Safty research for high burnup fuels of LWRs

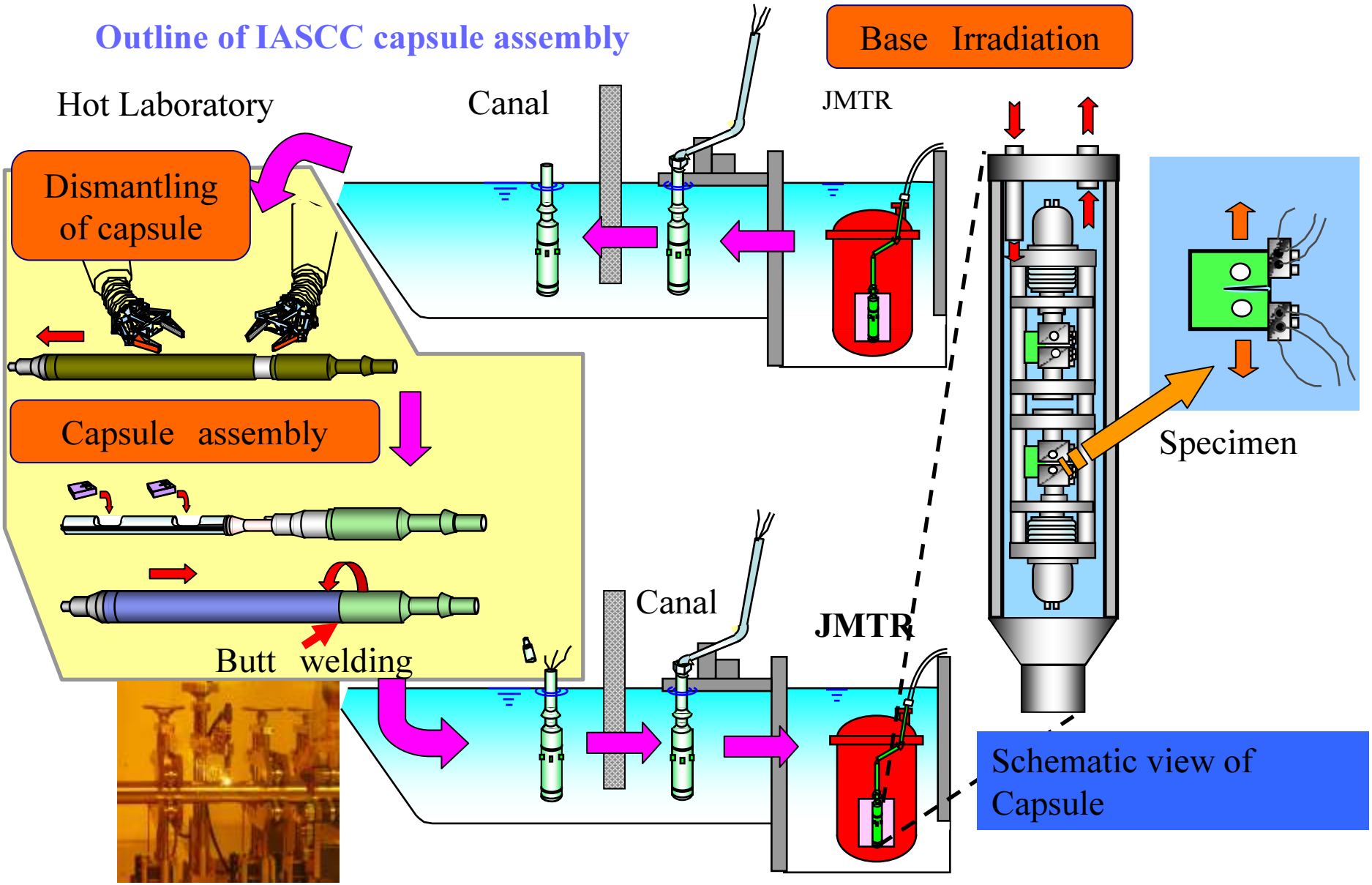
○ For innovative reactor (such as FBR)

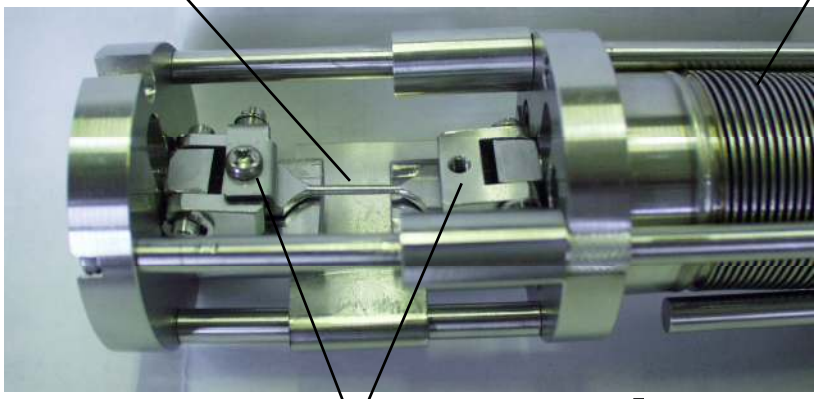
- In-pile creep rupture test for FBR cladding materials
- Advanced fuel behaviour under neutron field
- Investigation of minor actinide containing MOX fuel

○ For other activities

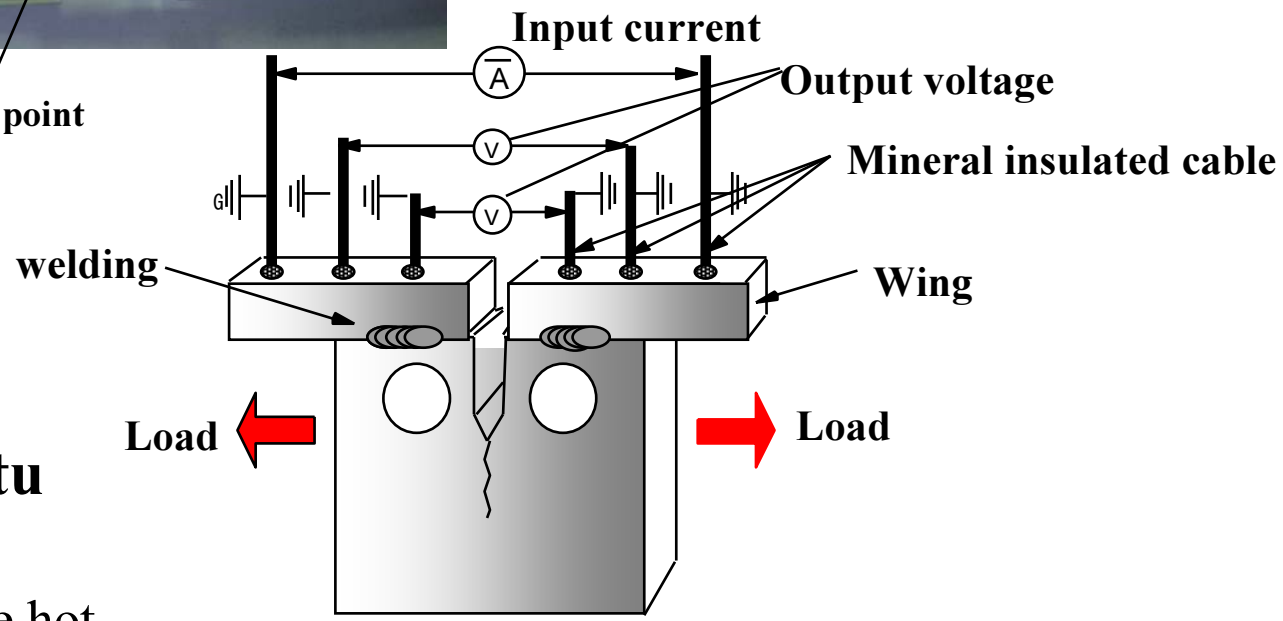
- high temperature materials for HTTR
- foundamental sutudy including fusion materials research

Re-assembling work of irradiation capsule for in-situ IASCC test





Crack initiation test unit for UCL specimen

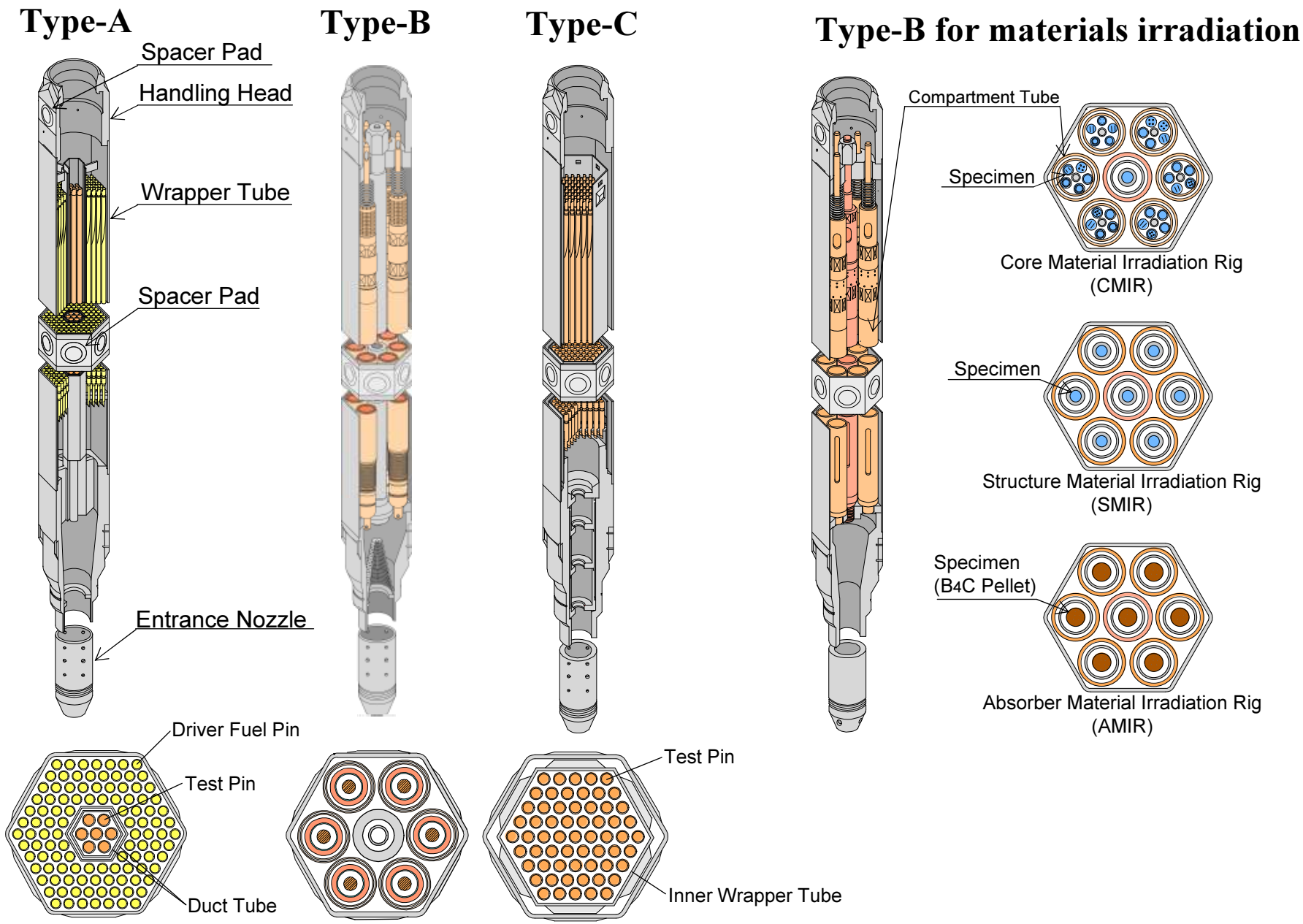


Test piece for crack growth test
(Stainless steel)

Measurement of crack length using the DC-PDM

Specimens for In-situ IASCC Experiment

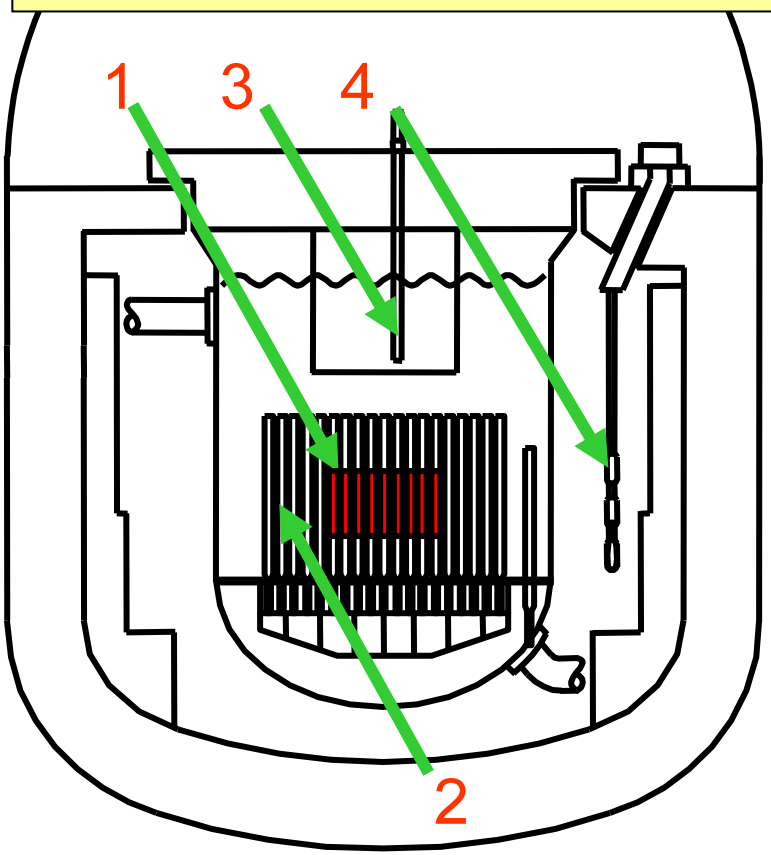
(Work is conducted in the hot cell)

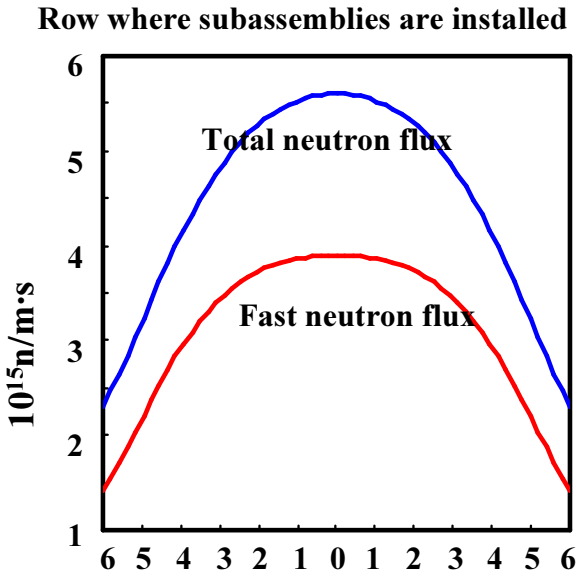


Irradiation Test Subassemblies for JOYO

Irradiation field of JOYO

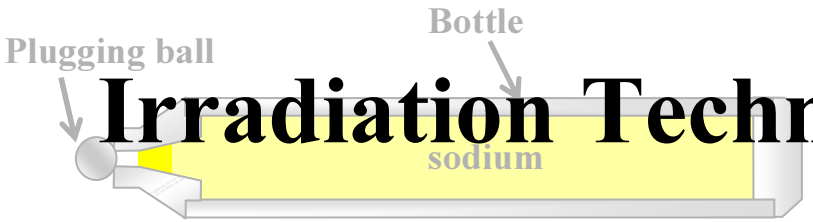
1. Fuel region (450～750℃)
2. Reflector region (400～700℃)
3. Upper core region (550℃～)
4. Irradiation hole outside reactor vessel (200～600℃)

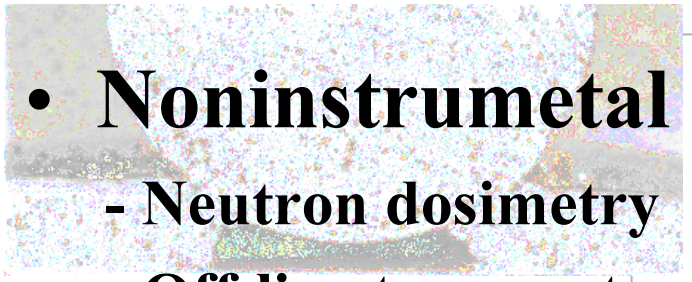




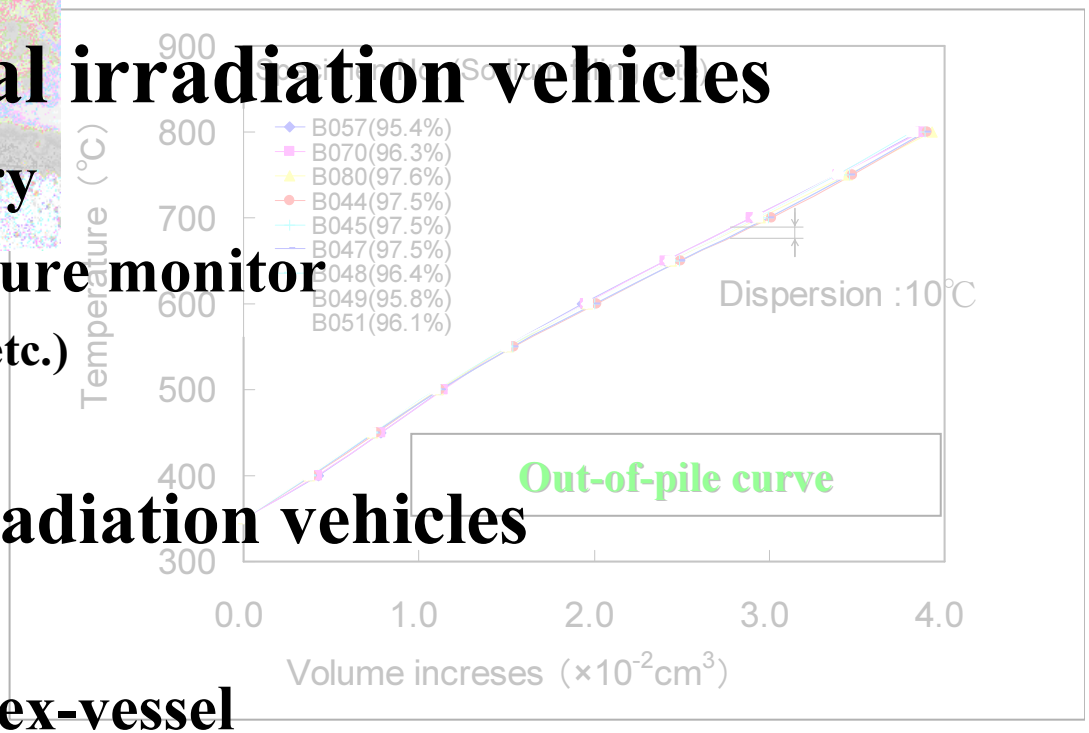
	Unit: n/cm²·s		Spectrum ratio
	Total neutron flux	Fast neutron flux (E≧0.1MeV)	
1	(4～5)×10^{15}	(3～4)×10^{15}	0.6～0.7
2	10^{14} ～ 3×10^{15}	3×10^{13} ～ 2×10^{15}	0.3～0.5
3	10^{11} ～ 10^{12}	10^{10} ～ 10^{11}	10^{-1}
4	～ 10^{12}	～10^{10}	～10^{-2}

Irradiation Technology of JOYO

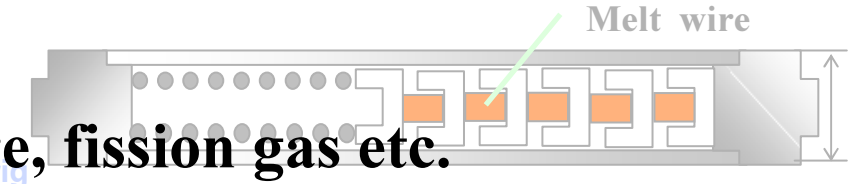




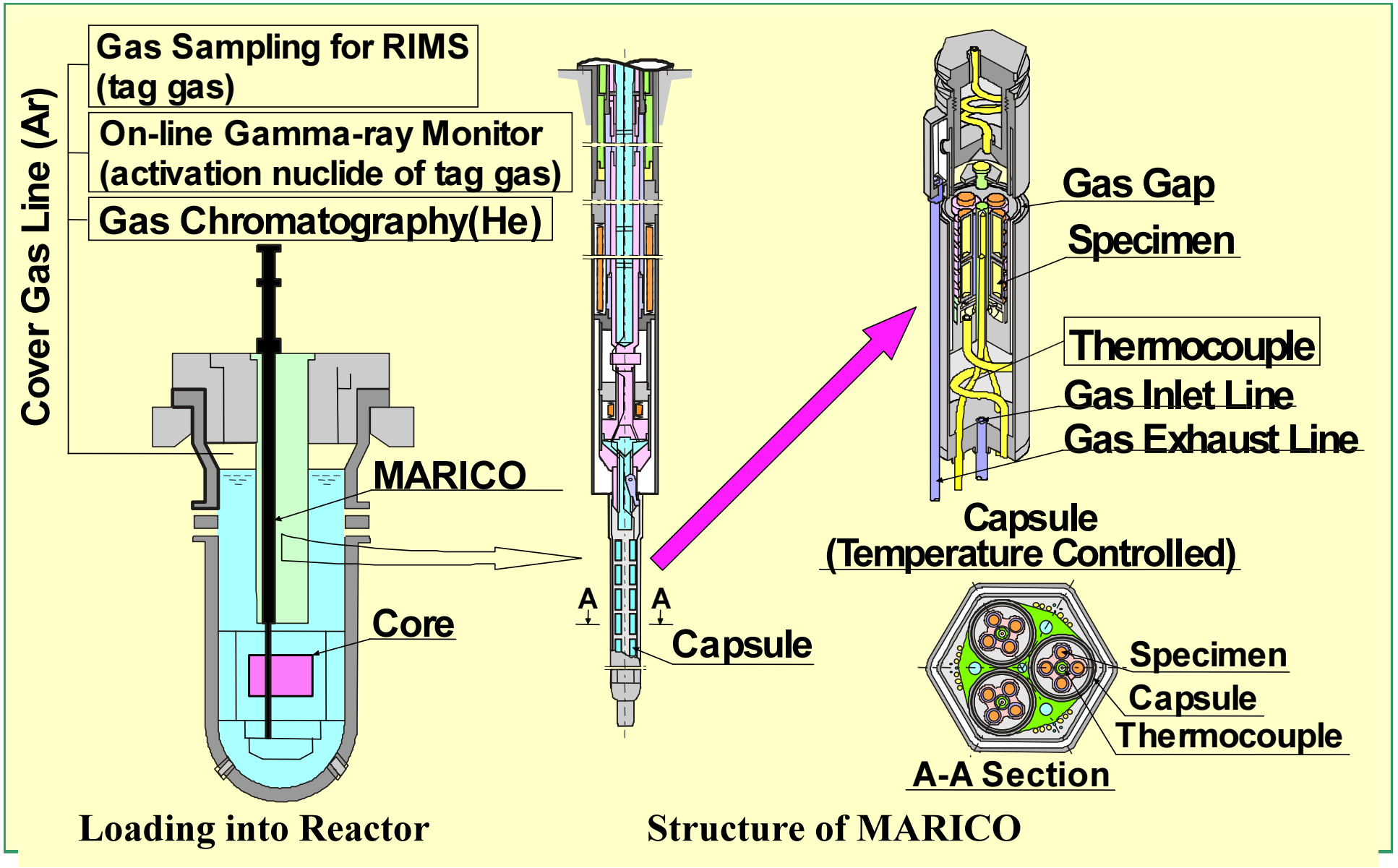
- **Noninstrumetal irradiation vehicles**
  - **Neutron dosimetry**
  - **Off-line temperature monitor**
    (TED, Melt wire, SiC etc.)



- **Instrumental irradiation vehicles**
  - **loading position**
    core, upper plug, ex-vessel
  - **measurement object**
    temperature, pressure, fission gas etc.

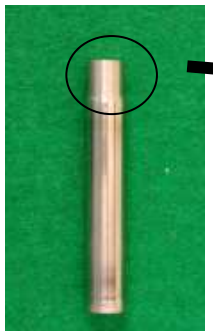


Example of Fused metal monitor



Monitoring of Creep Rupture

In-pile creep test sample



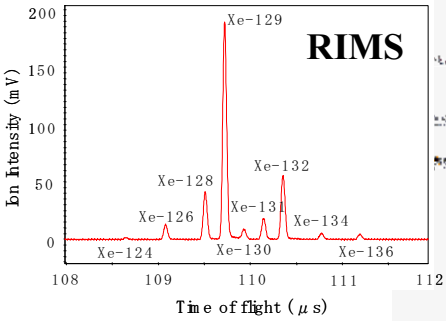
Tagging gas(0.3ϕ mm)

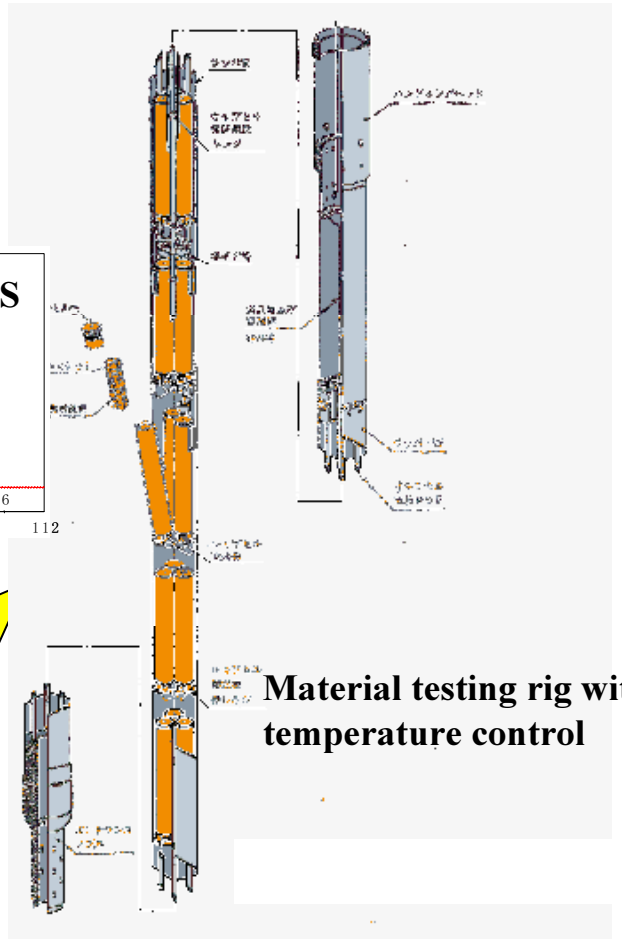
End plug

Cladding

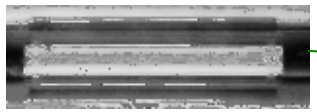
Leser welding

(6.9ϕ ×42.5mm)

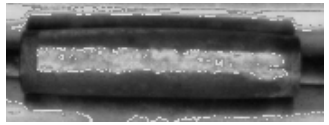




Material testing rig with temperature control



Before irradiation



After irradiation

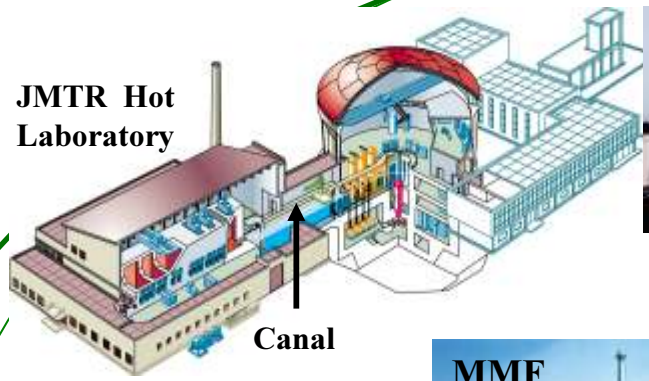
In-pile creep test sample

Put the sample into the canister in irradiation vehicle

Breach detection for in-pile creep rupture test by tagging gas analysis and radioactivity measurement of cover gas

Reassemble the capsule in MARICO irradiation vehicle

Fuel Examination Facilities



JAEA

15km

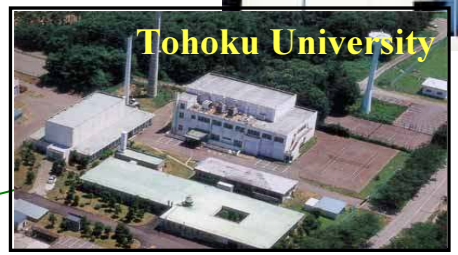
Tokai site

Chemical processing Facility
(CPF)

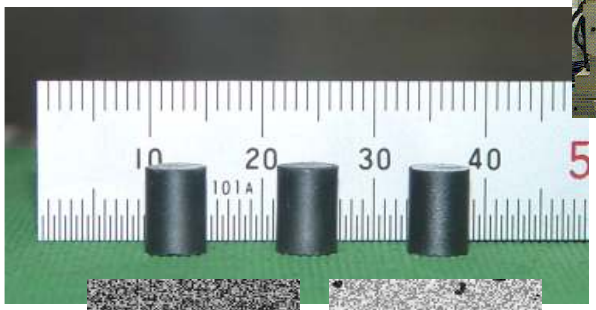
Actinide Examination Facility

RFEF

Oarai site



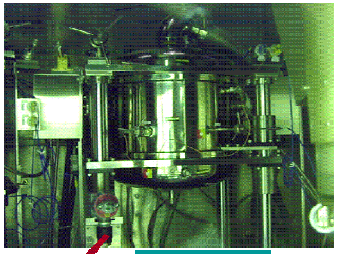
Operation Area of AGF



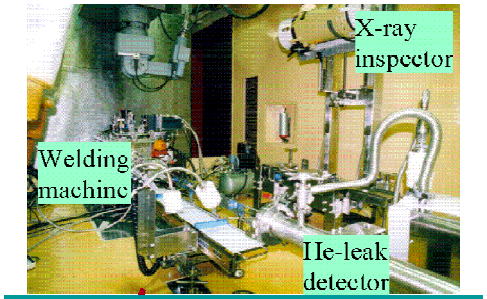
$(U_{0.66}Pu_{0.29}Am_{0.05})O_2$

Sintered pellet of Am-MOX

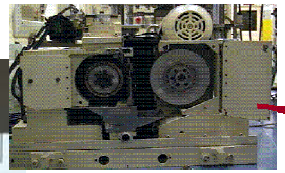
Pre-sintering Furnace



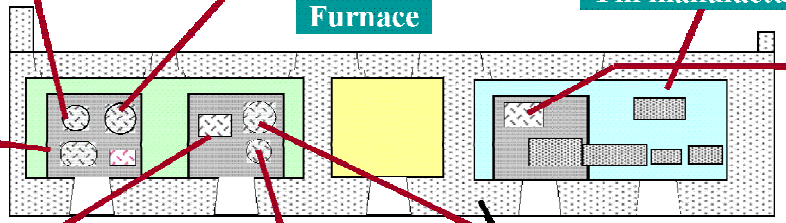
Sintering Furnace

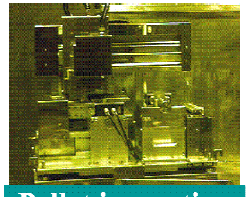


Pin manufacturing and inspection

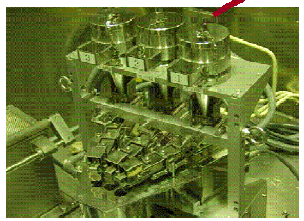


Grinder

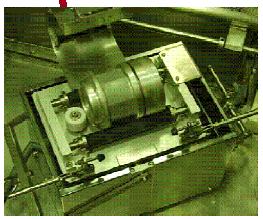




Pellet inspection

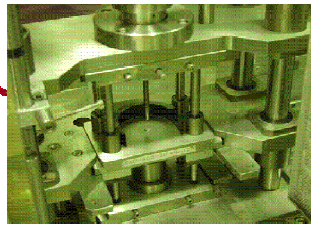


Material feeder



Ball mill

Shielded cell



Pressing unit

Remote fabrication apparatuses in the hot cell

Remote fabrication technology for Am-MOX fuel

Facilities Utilization forMA related Research

MMF
PIE of core and structural material

PIE

PIE

FMF
PIE of irradiated S/A
Intermediate inspection of S/A
Construction of irradiation rig and S/A

Irradiation

PIE

PFRF
Pu、MA fuel

AGF
PIE and analysis of irradiated fuel
Am-MOX fuel fabrication
Advanced fuel research

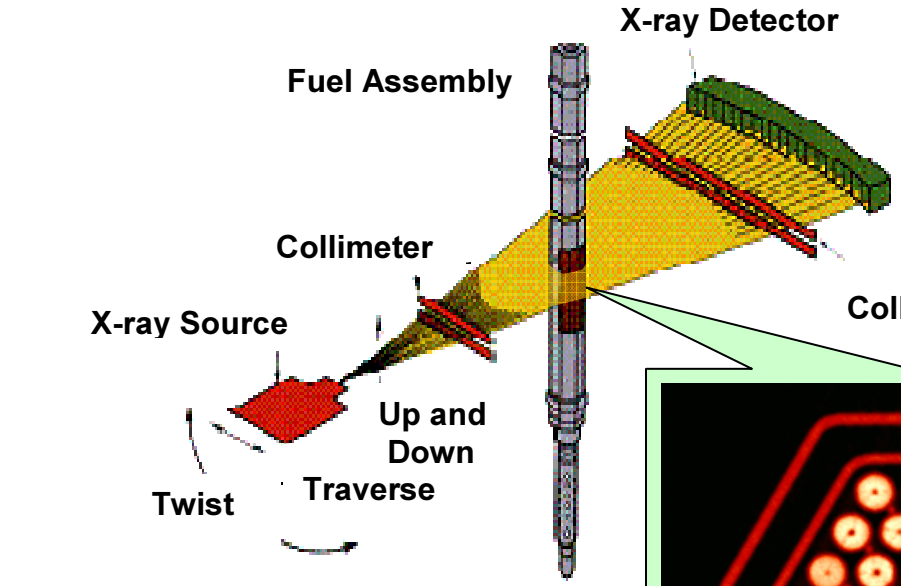
CPF

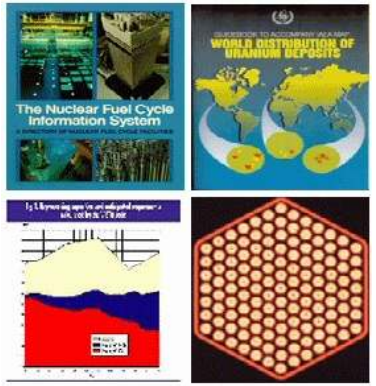
MA supply

Collaboration

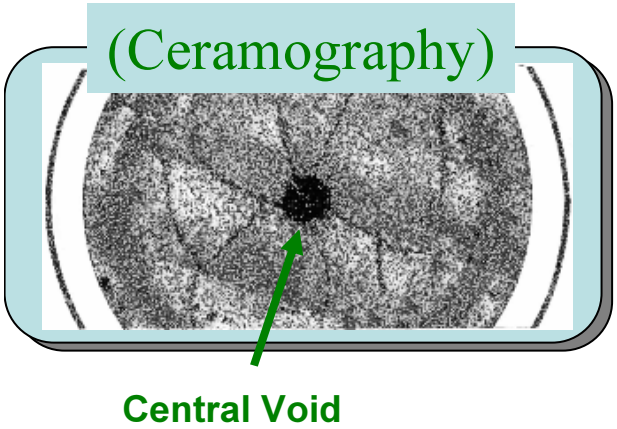
Oarai Branch,Tohoku University

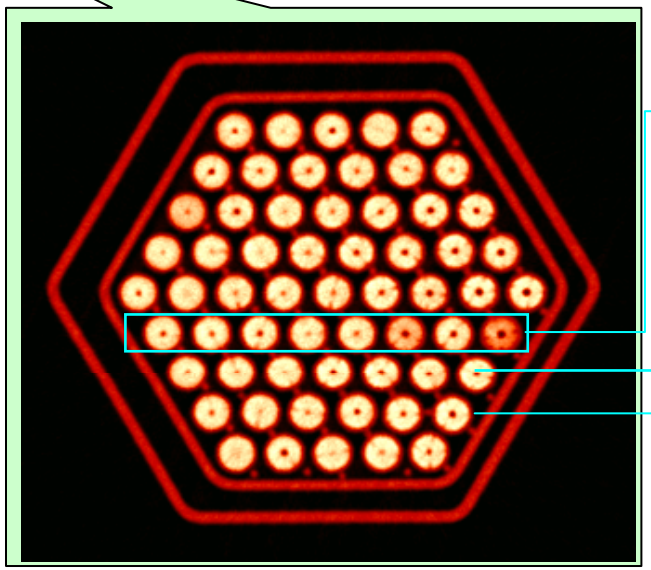
High purity Ar gas glove boxes



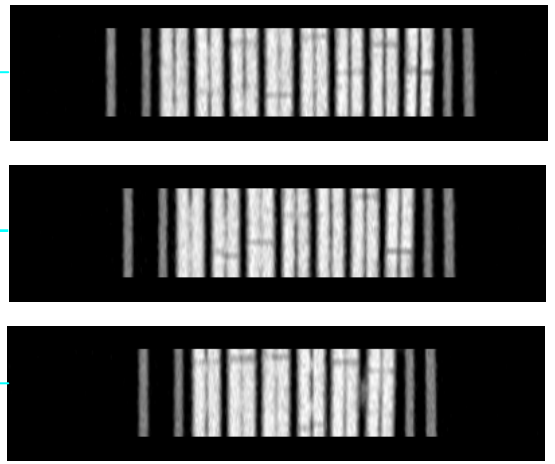


From IAEA-INFCIS

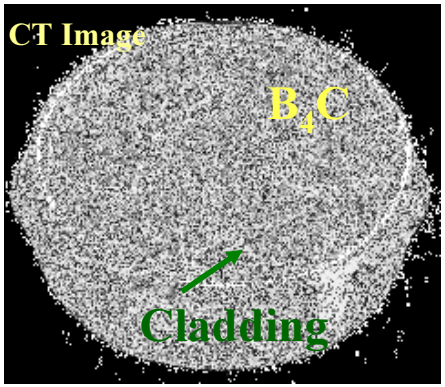




Cross Sectional View
(X-ray CT image)



Longitudal View



Control rod

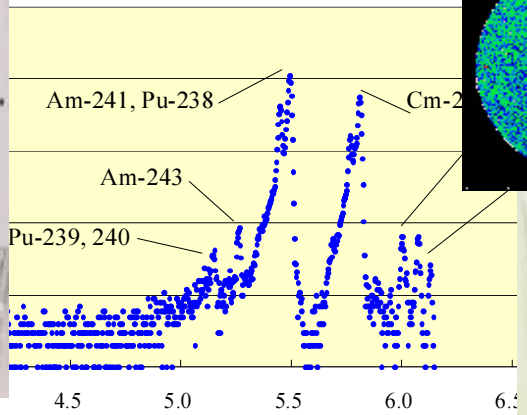
Application of X-ray computer tomography technology to fuel subassembly inspection

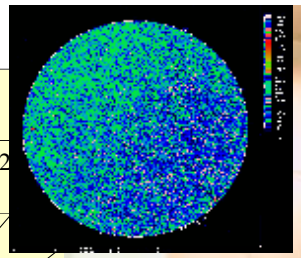
Operation Area of AGF

Glove box for sample preparation

Solution of Am Sample in V-capsule irradiated in JOYO

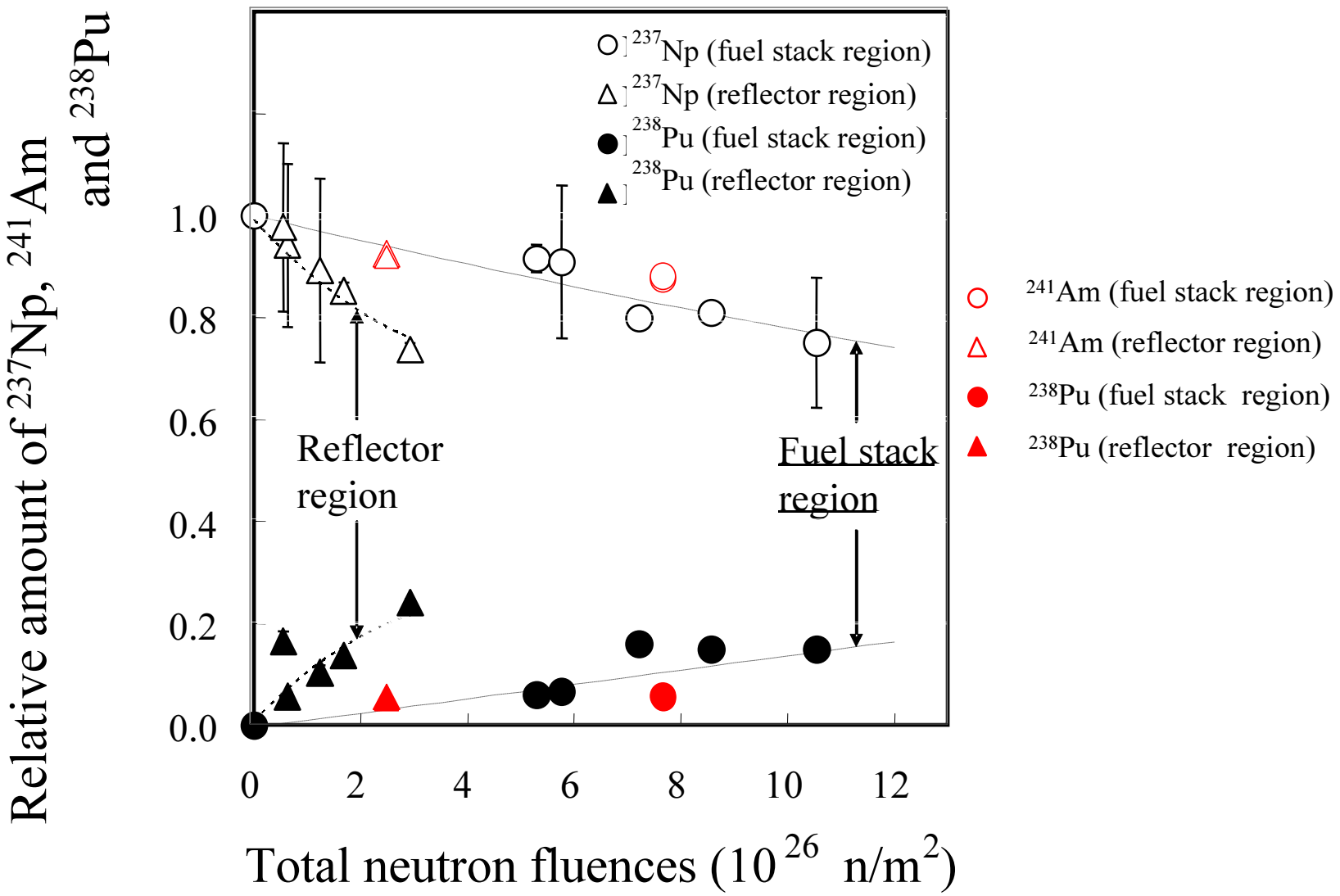
Mass spectrometer





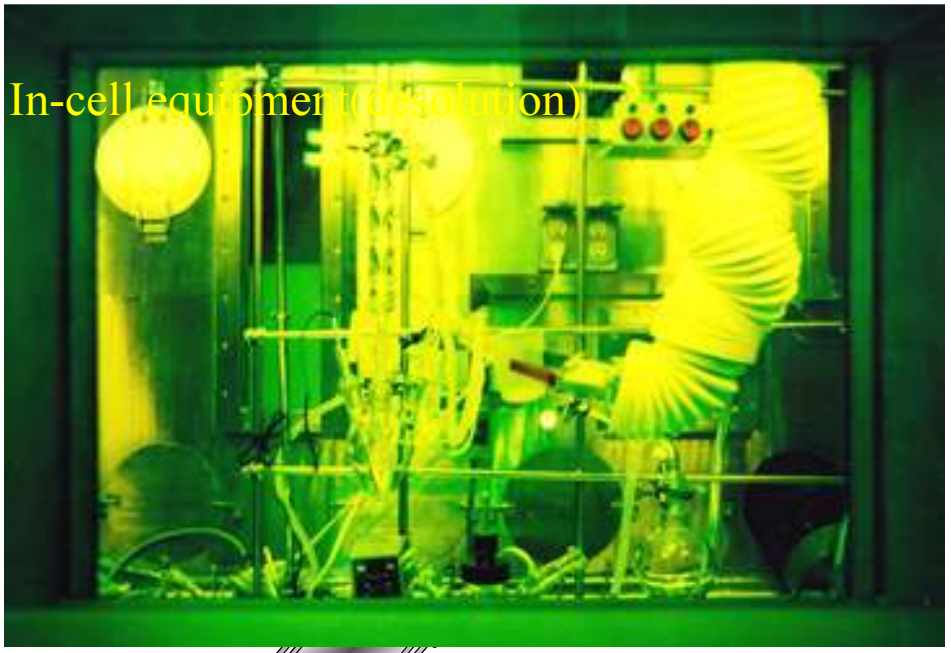
In-cell equipment(EPMA)

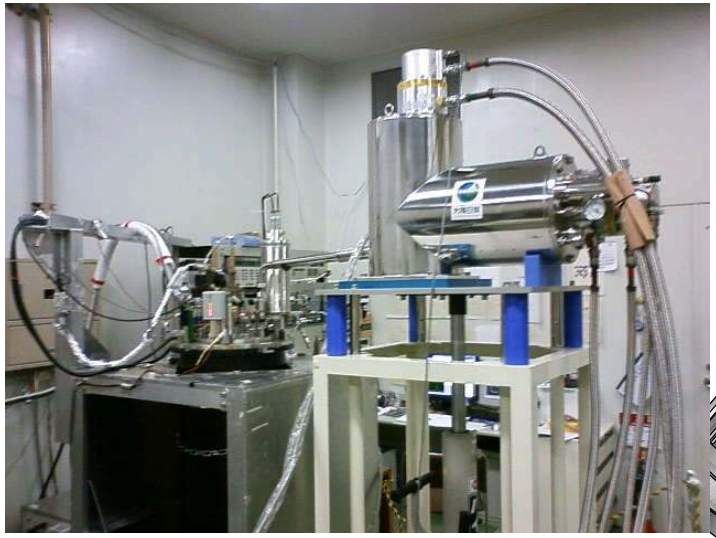
Some of equipment for chemical analysis for actinides and burnup



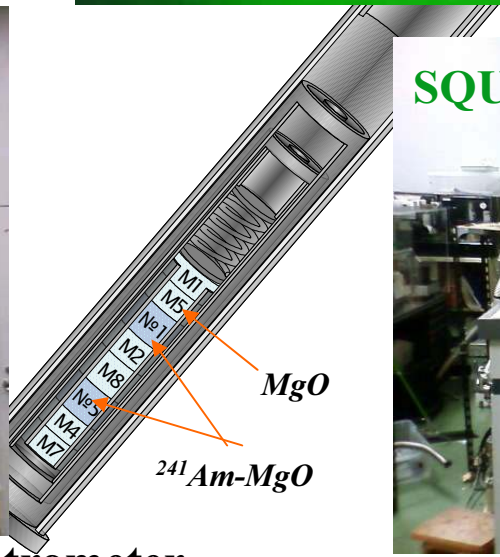
Example of transmutation behavior for Np and Am irradiated in JOYO

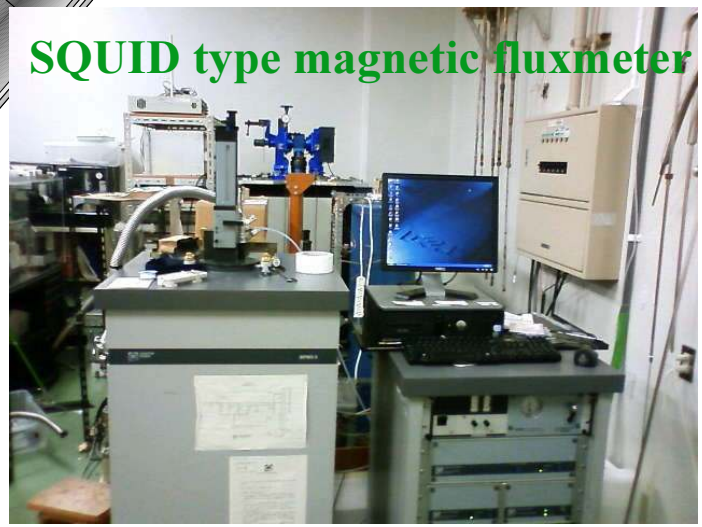
Actinide research facility
Oarai branch, Tohoku Uni.





Nuclear magnetic resonance spectrometer



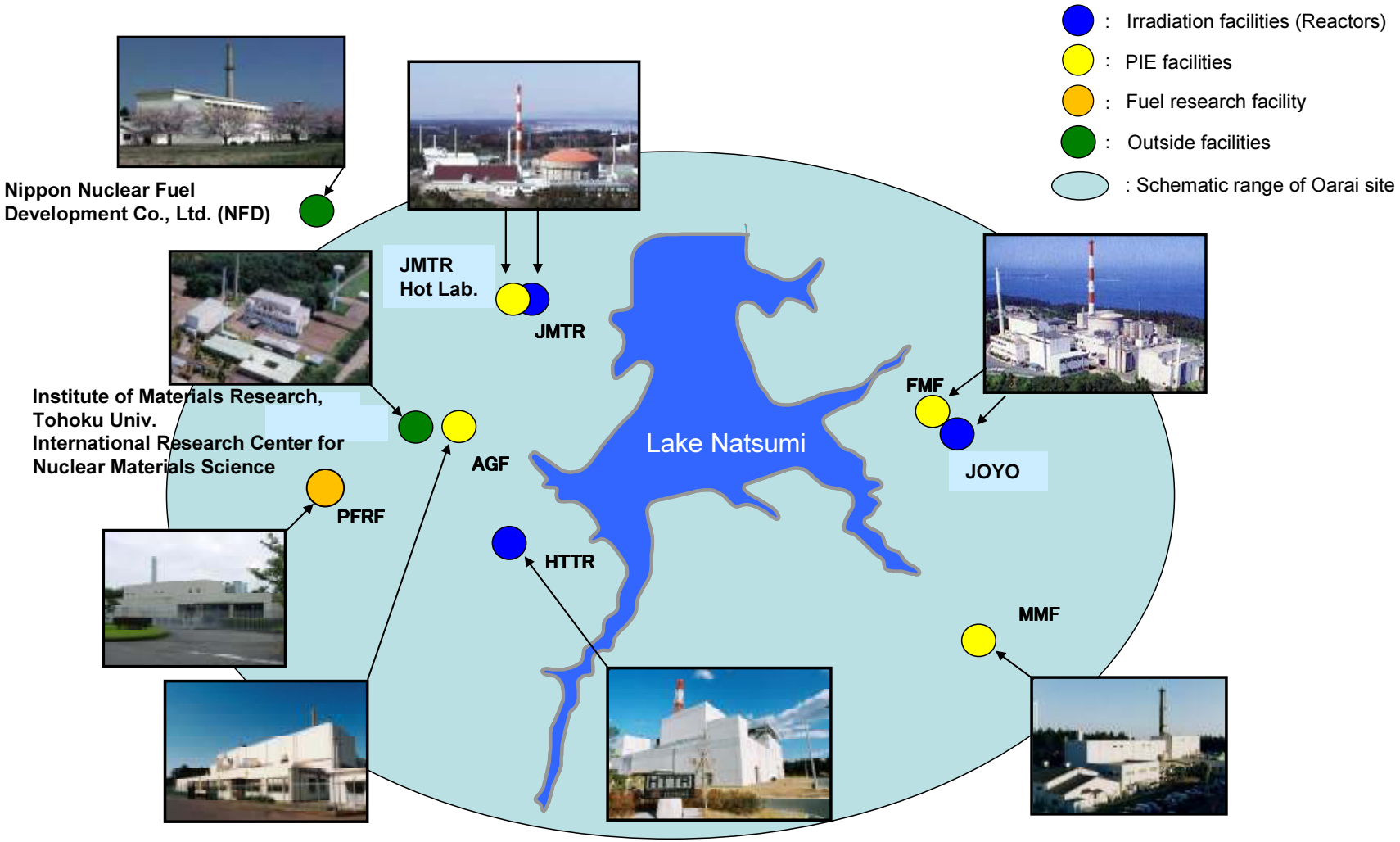


Close collaboration with Orai branch, Tohoku University in the area of actinide related study

Future perspective

Provide the research field for irradiation studyinclude outside researchers

Muturally complementary relationship



Research reactors complex in Oarai site

Research reactor complex for irradiation study

Achieve the user friendly facility

- Increase the operating rate of reactor
- Develop the excellent Irradiation technology and PIE technology suitable for user's needs
- Shorten the turnaround time
- Realize the reasonable irradiation and PIE cost
- Establish the simple irradiation procedure and satisfied technological support system to use more easily(improve the accessibility and usability)

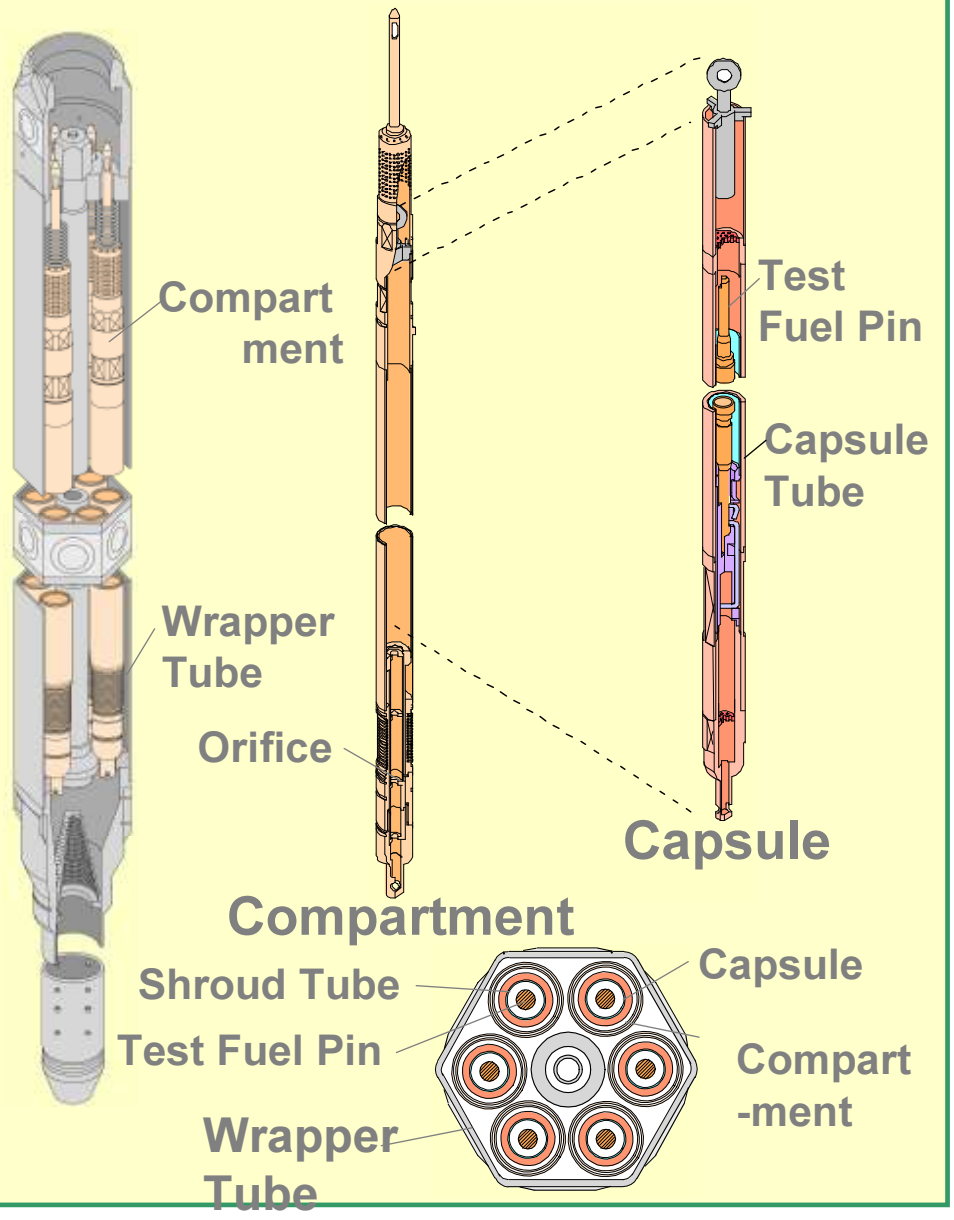
Capsule Type Irradiation vehicle(Type B subassembly)

This vehicle is used for the fuels, which are difficult to conduct under current JOYO license because of uncertainly of their irradiation behavior

The compartment is equipped with a capsule which has sufficient strength to withstand the stress which arises at fuel cladding failure, and with capability to catch fuel particle which is released from cladding breach

Possibility under License

MA Contents	≦ 50 %
Melting Area of pellet	Oxide : ≦20 % Others : No Melt
Burn up	≦ 200 GWd/t



Conclusion

- ORDC provides all sort of research facilities as the research ground for lead researchers in the field of irradiation study, and serves cultivation field as young researchers also.
- Improvement the quality of reactor irradiation technology such as in-situ measurement and coupling irradiation technologies with specially designed irradiation vehicles and the PIE technology are going on under close relationships with university persons as users.
- Investigation to manage the RR complex as an international center of excellence is in progress.