



Fuel Researches in the HTTR project

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1. Fuel Fabrication Process
2. Evaluation of Fuel Performance during the operation
3. Post-irradiation Examinations of the First Loading Fuel of the HTTR

II. Upgrading technologies for VHTR Fuel

1. Burnup Extension for the SiC-Coated Fuel Particle
2. ZrC-Coated Fuel Development

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I. Establishment of HTGR Fuel Technologies

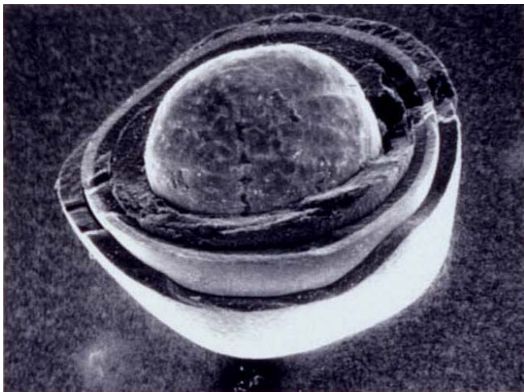
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The High Temperature Gas Cooled Reactor Fuel

Coated Fuel Particle



Fuel Compacts



Fuel Rods

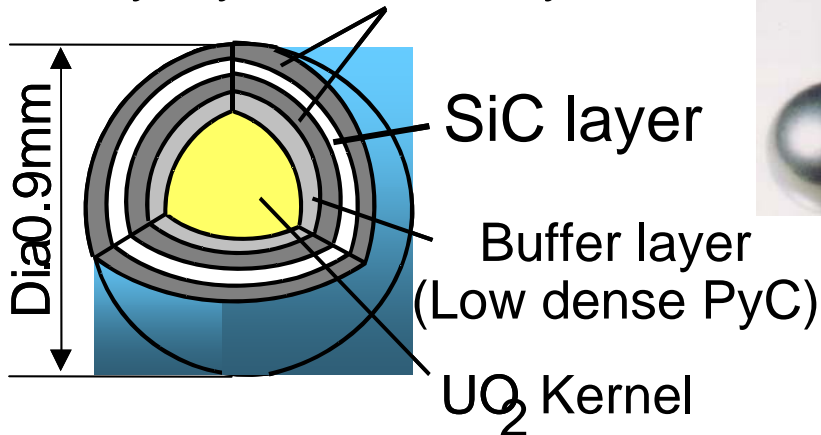


Graphite Block

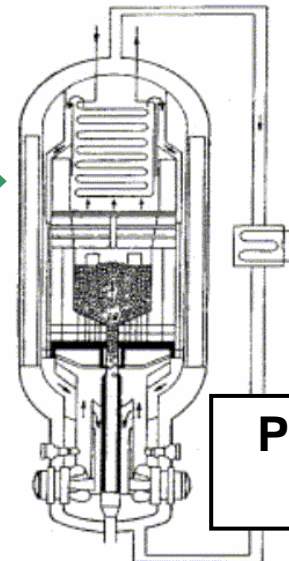


Block Type HTGR

High density Pyrolytic Carbon layer

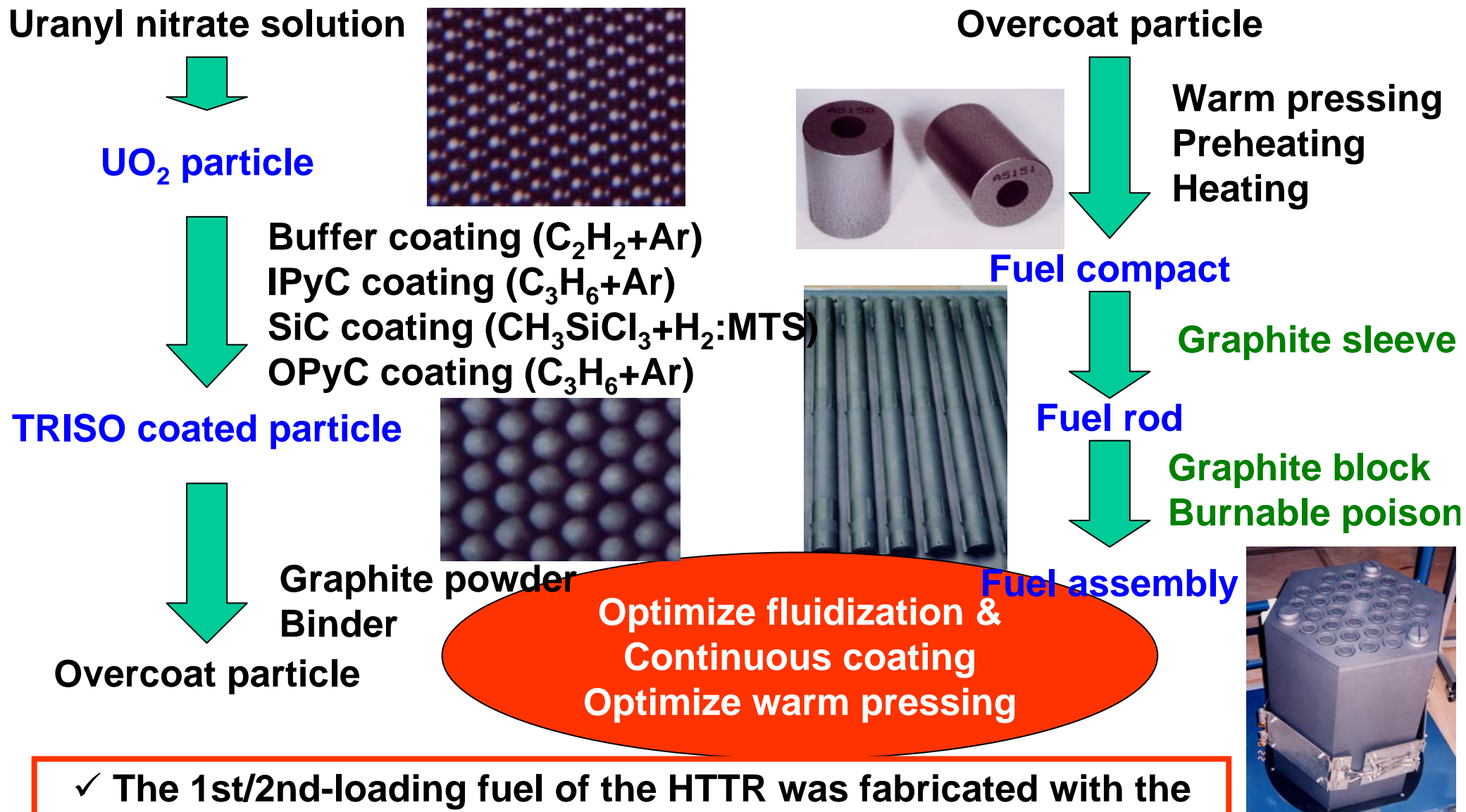


Spherical fuel element



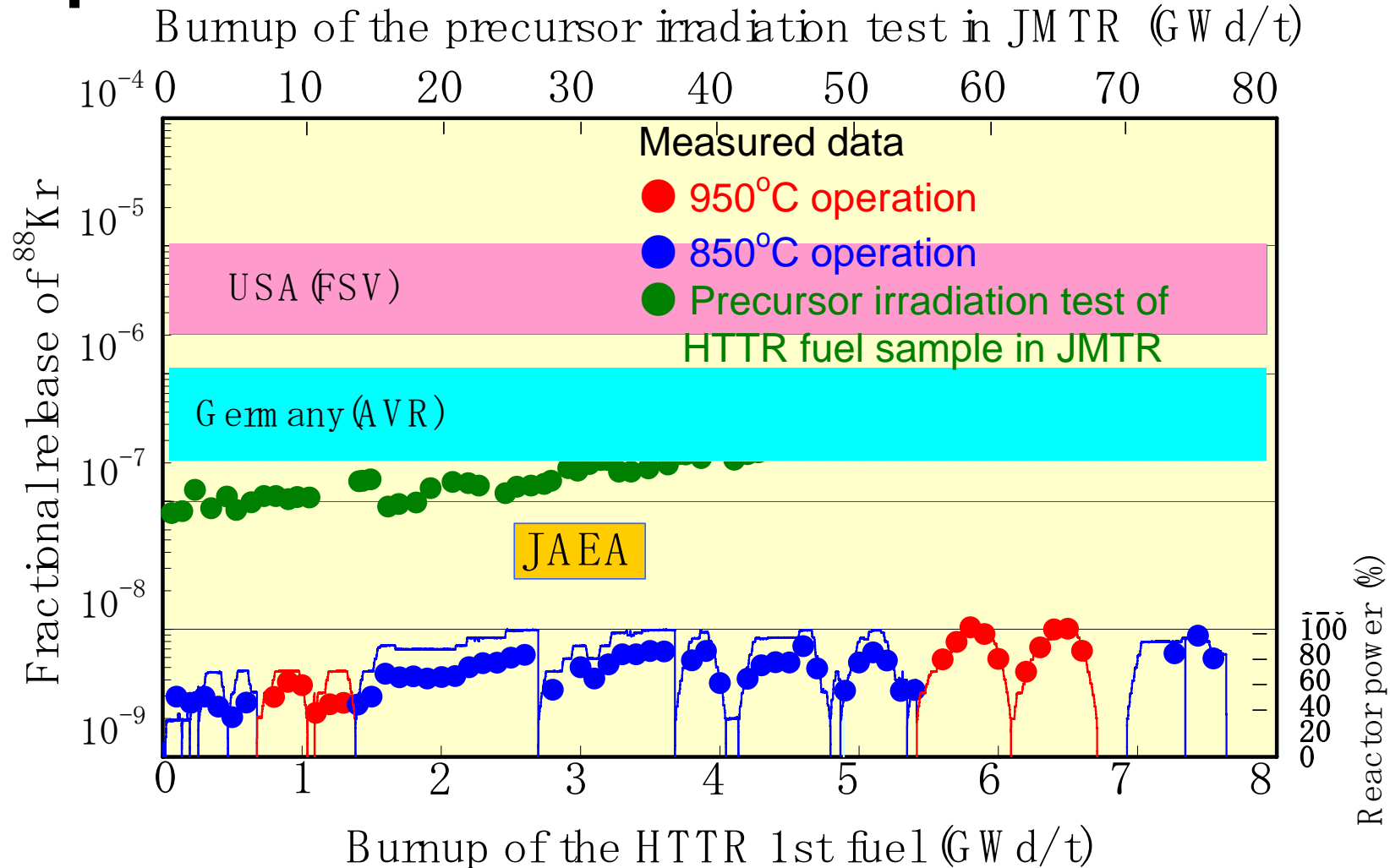
Pebble Type HTGR

1. Fuel Fabrication Process



✓ The 1st/2nd-loading fuel of the HTTR was fabricated with the commercial scale by the Nuclear Fuel Industries, Ltd.
(~2 ton of U)

2. Evaluation of Fuel Performance during the operation



- ✓ The fractional release of the fission gas is very low.
- ✓ High quality fuel was successfully fabricated.

3. Post-irradiation Examinations of the First Loading Fuel of the HTTR

- The 1st fuel will be unloaded in 2011
- Fuel rods will be dismantled at a hot cell in the HTTR
- Many tests will be carried out



γ -ray spectroscopy (Rod)
Appearance (Compact)
Dimensional change (Compact)
Fuel failure fraction
Burn-up
X-ray radiography
Ceramography
SEM / EPMA

Will confirm fuel behavior under real-HTGR condition

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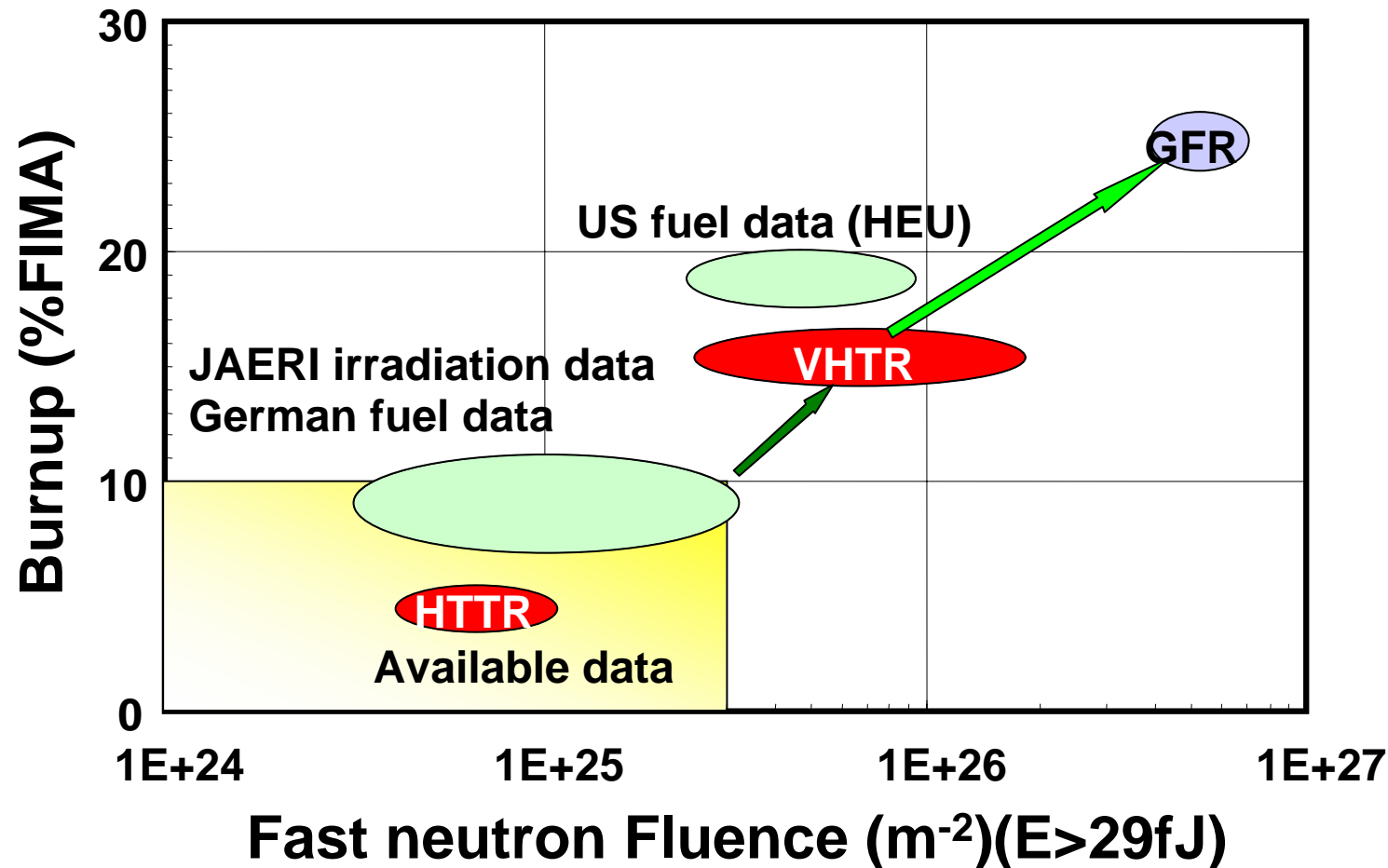
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Target for VHTR Fuel Technologies



Proceeds to upgrade fuels technologies for VHTR system

- ✓ Burnup extension for the SiC coated fuel particle
- ✓ Developing ZrC-coated fuel particle for the advanced fuel

1. Burnup Extension for the SiC-Coated Fuel Particle

33 GWd/t (HTTR) → over 120 GWd/t (VHTR)

□ Irradiation Tests (up to 90GWd/t)

- 91F-1A capsule irradiation test by JMTR
- HRB-22 capsule irradiation test by HFIR of ORNL

□ Post-irradiation Tests

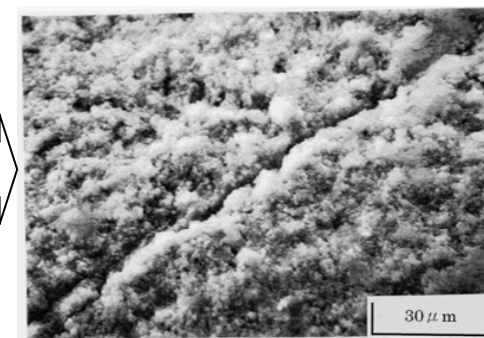
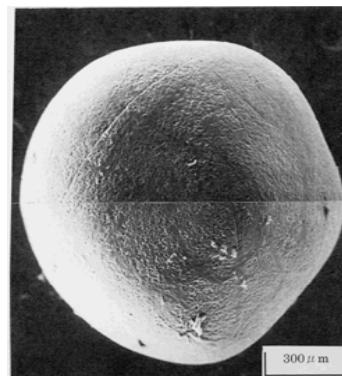
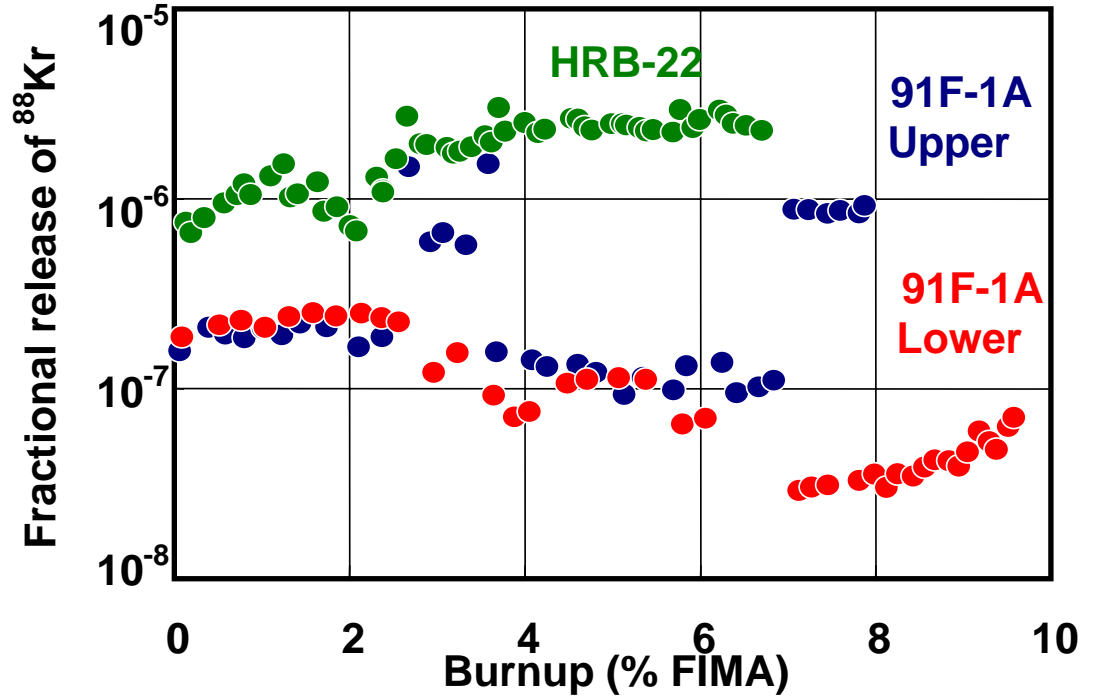
- X-ray microradiography
- Ceramography
- SEM
- EPMA

□ Analysis

- Fission Gas Release
- Failure Fraction
- Model development

Next Research and Development

- Additional irradiation test (GIF, etc. : OSIRIS, ATR, HFR, HFIR, etc.)
- Model development (IAEA CRP-6)

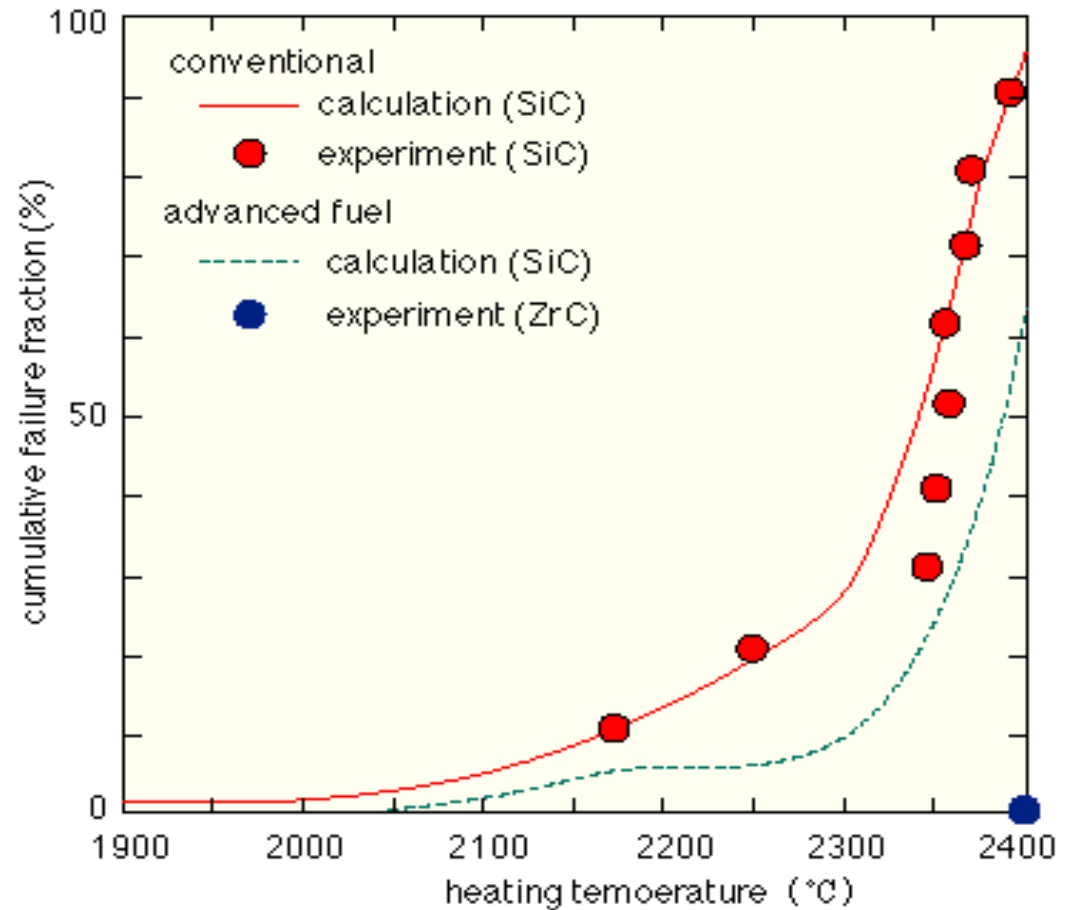
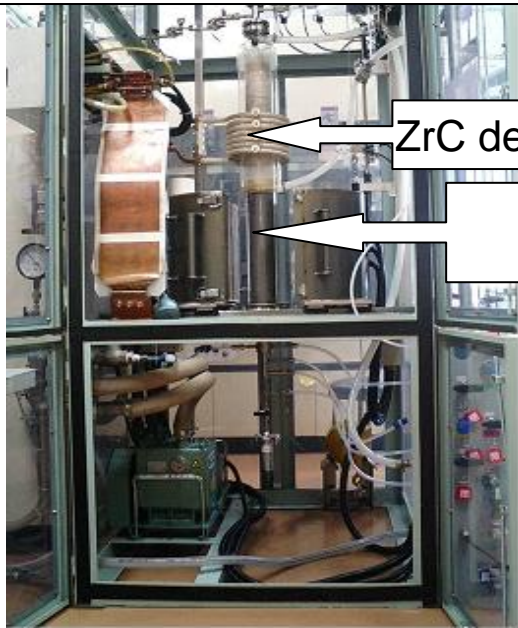


2. ZrC-Coated Fuel Development (1/2)

Limitation of SiC

- cannot be used at higher temperatures than the currently designed HTGR
- corrosion by Pd (transuranium nuclides has larger yield)

- ✓ Fabrication by Bromide process
- ✓ Better irradiation performance than SiC-coated particles

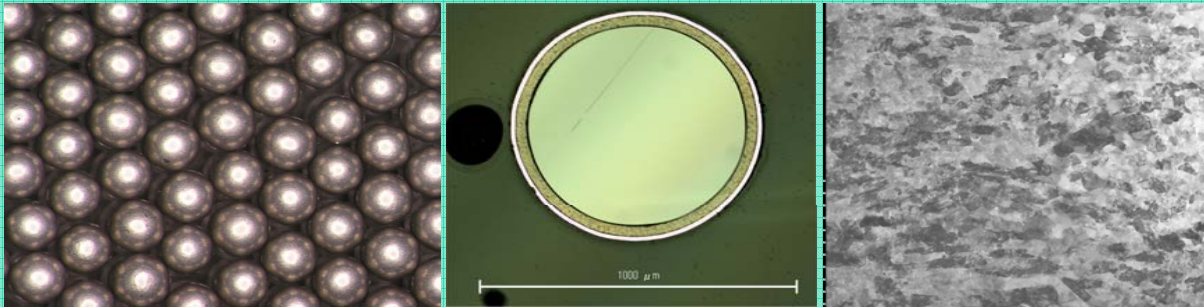


On-going research and development program

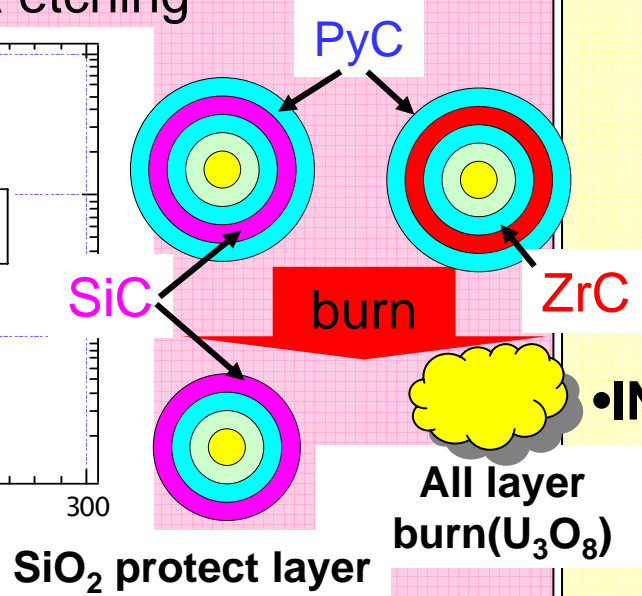
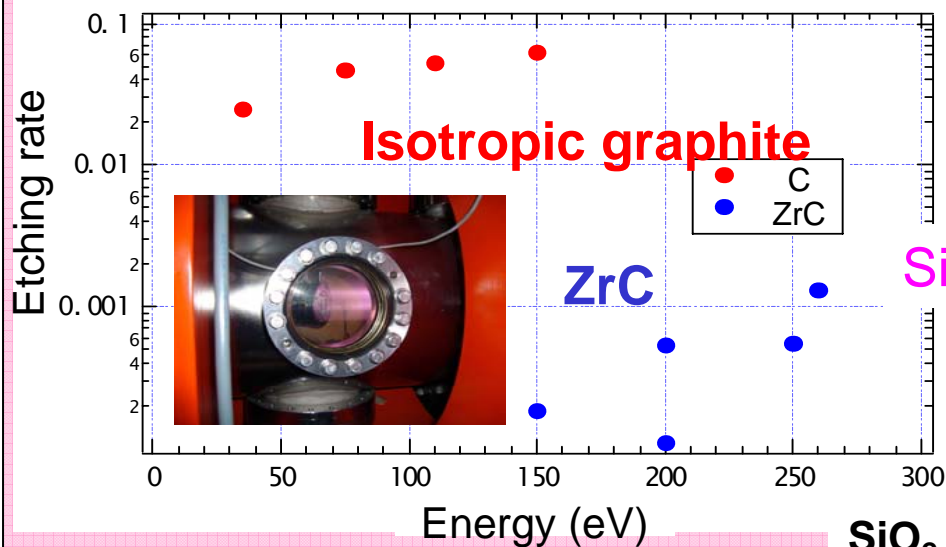
- ✓ Optimization of deposition condition for larger-scale coater.
- ✓ Development of inspection technologies.
- ✓ Investigation of ZrC behavior under irradiation.

2. ZrC Fuel Development (2/2)

- ◆ ZrC coating test by surrogate particles
- ◆ Coating condition for stoichiometric ZrC



- ◆ Development of advanced inspection method
- ◆ Treatment technique by plasma etching



✓ Difference of etching rates (ZrC and PyC) allows selective removal of PyC layer

R&D program for ZrC-CFP started with US in the framework of I-NERI

•ORNL

- ✓ Irradiation test by HFIR from 2007 ($\sim 10^{26} \text{m}^{-2}$, 1300°C)



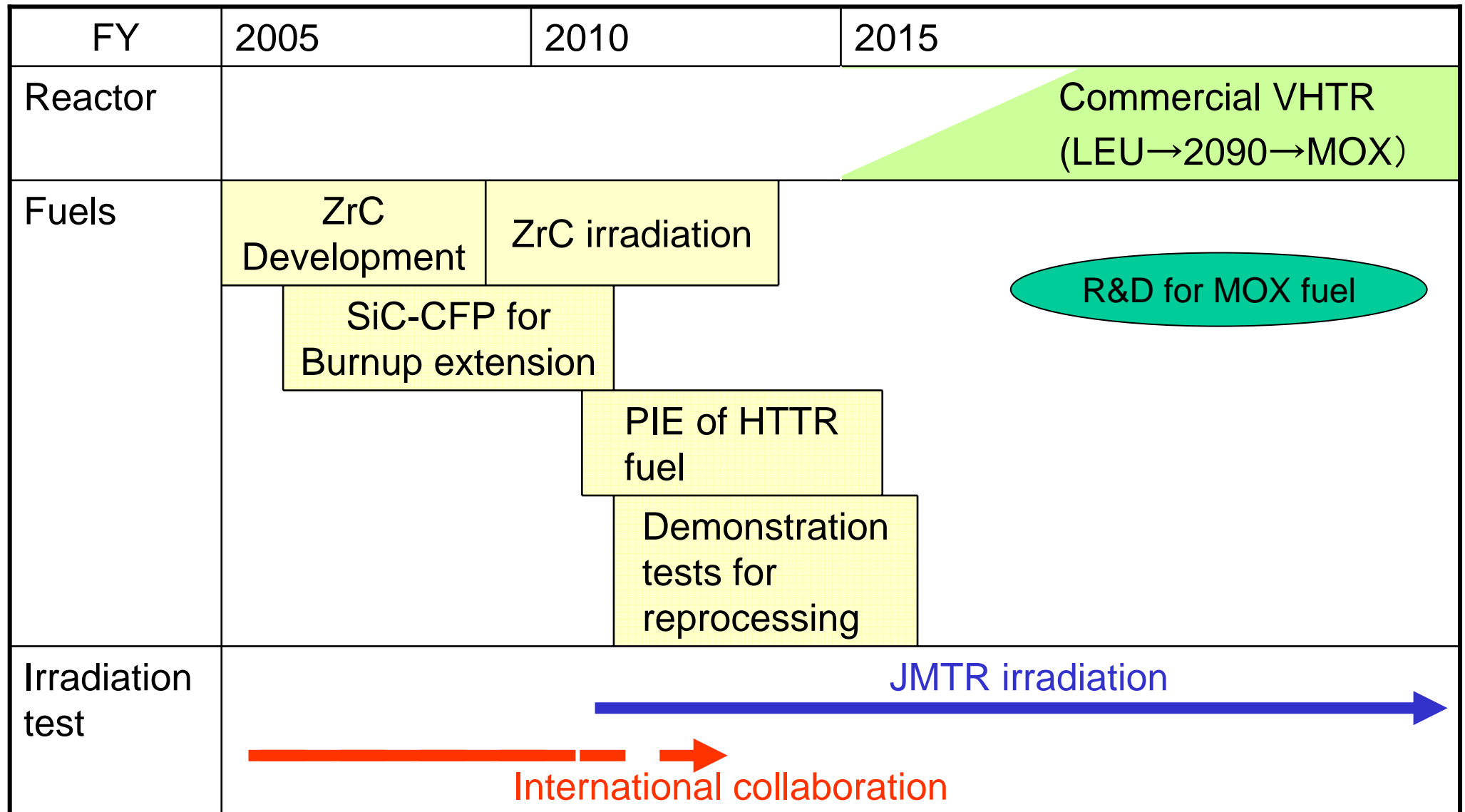
- ✓ Post irradiation examination from 2008

•INL

- ✓ Model development for ZrC based on "PARFUME" (INL) and JAEA code



Road Map for HTGR Fuels Development



End

Thank you for your attention!