Future R&D Programs Using Monju

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History and Current Status of Monju

・**Max. Output: 280 MWe (714MWt)**
・**Coolant: Sodium (3 Loop-Type)**
・**Fuel: Pu-U MOX fuel**

May 1983	**Construction permit** granted	Dec. 2006	**Modified system function tests** started
Oct. 1985	**Construction started**		
Apr. 1994	**Initial criticality**	Aug. 2007	**Entire system function tests** started
Aug. 1995	**Initial connection to the grid**		
Oct. 1995	**Attainment of 40% rated power**	Aug. 2009	System start-up test preparation & inspection started
Dec. 1995	**Secondary Sodium leakage**		

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Cause Investigation and Comprehensive safety review

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Jun. 2001	Modification permit applied
Dec. 2002	Modification permit granted
Mar. 2005	Plant modification works started
Oct. 2006	Modification permit applied for refueling

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Now on a process toward the restart

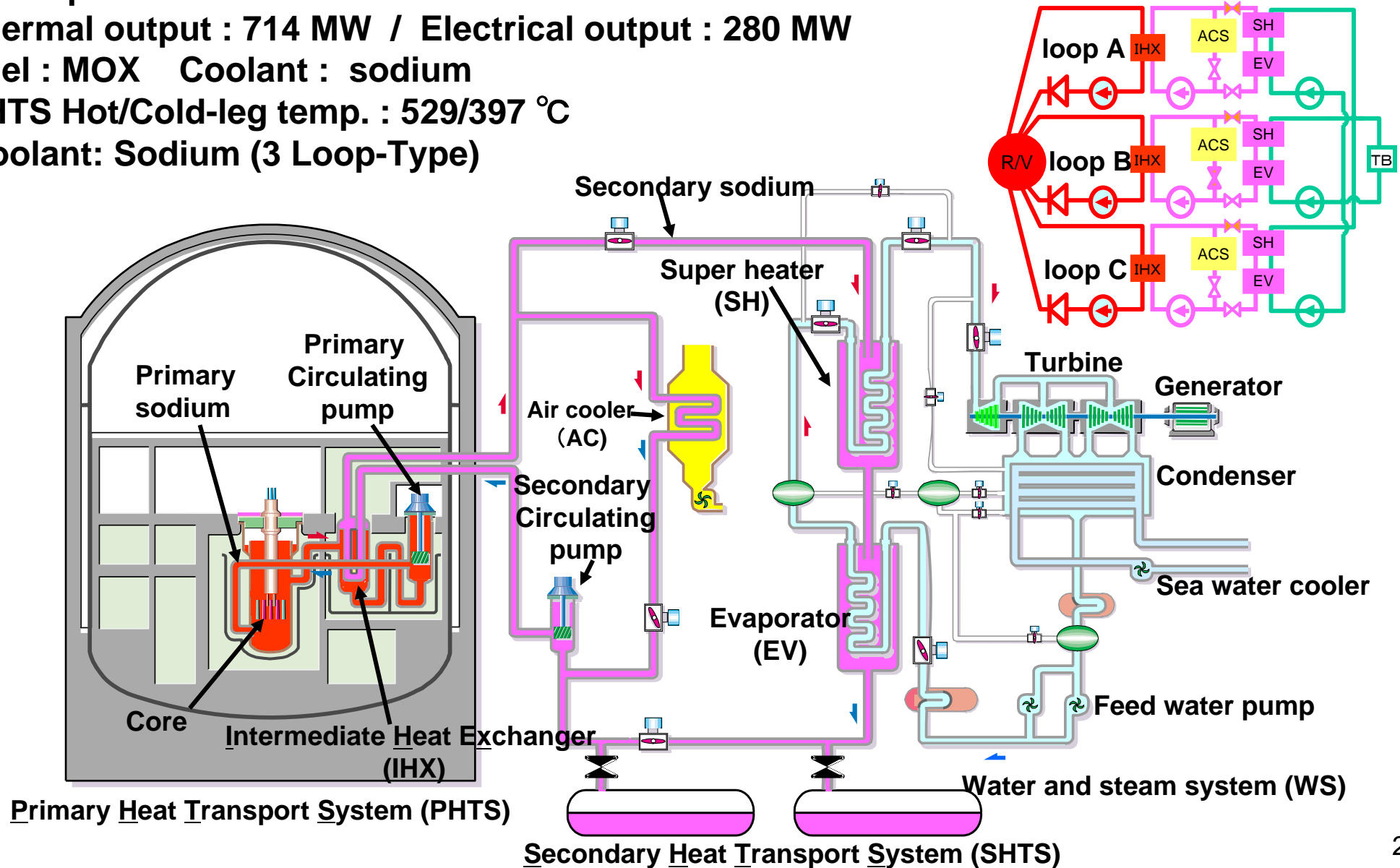# Prototype Fast Breeder Reactor: Monju

Plant Specifications
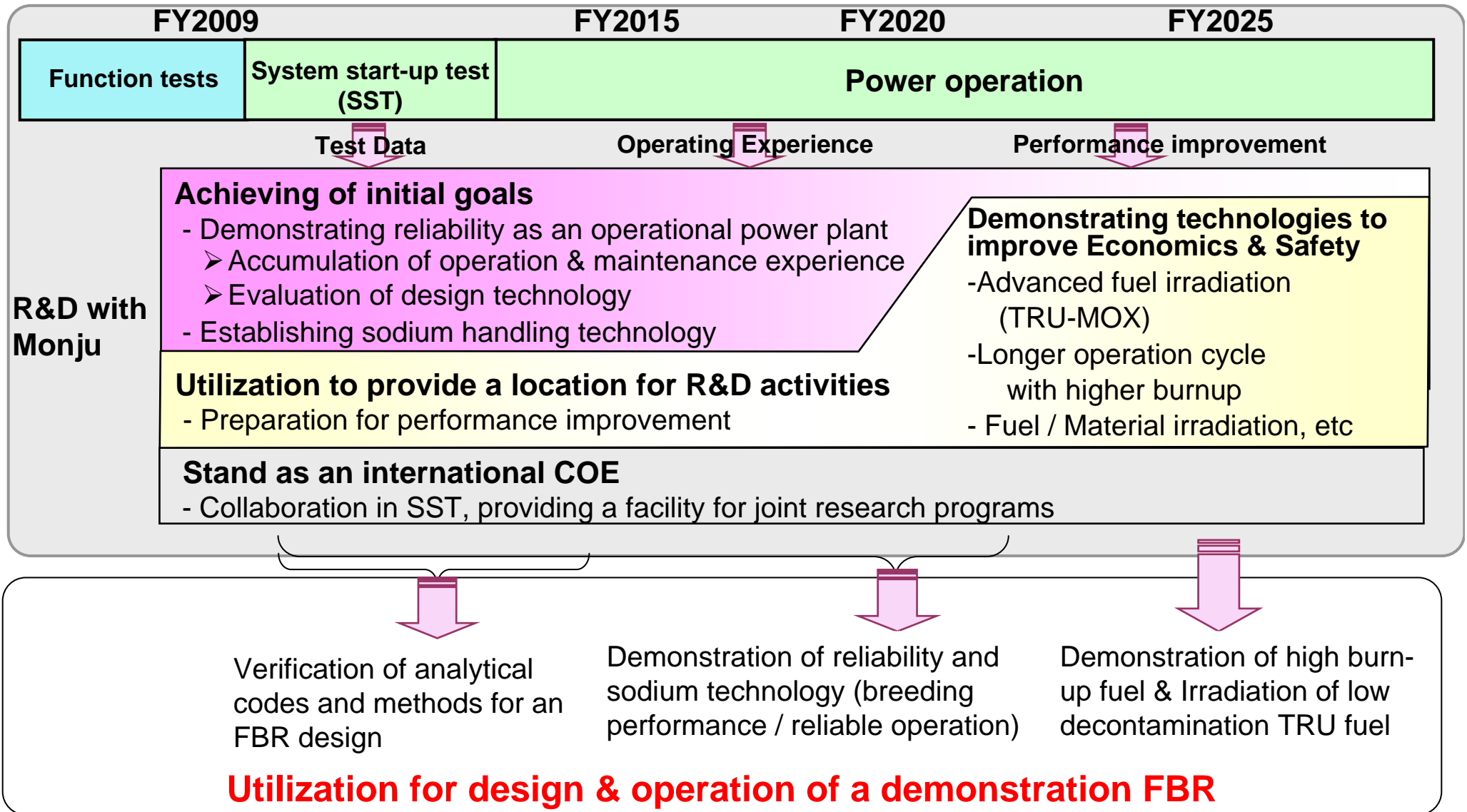**Thermal output : 714 MW / Electrical output : 280 MW**
Fuel : MOX   Coolant : sodium
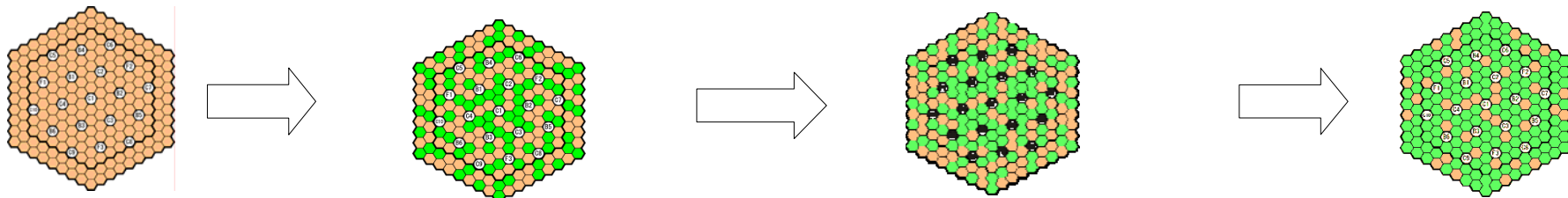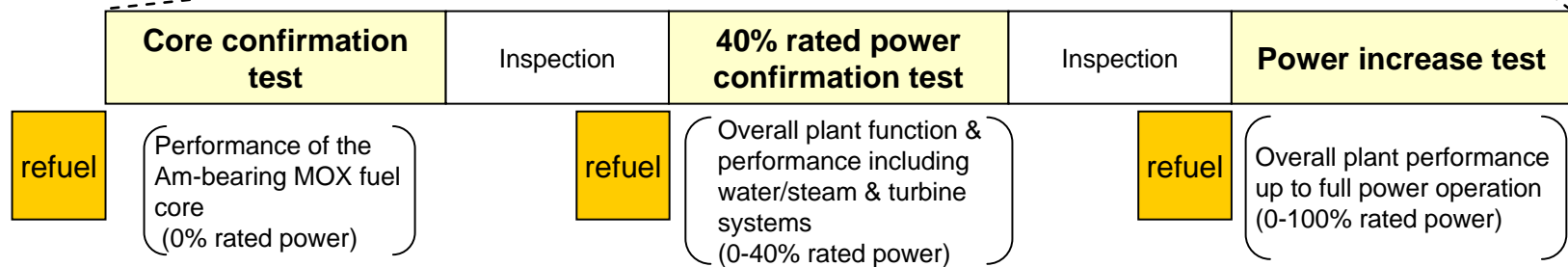**PHTS Hot/Cold-leg temp. : 529/397 °C**
 Coolant: Sodium (3 Loop-Type)

loop A

loop B

loop C

Secondary sodium

Super heater (SH)

Primary sodium

Primary Circulating pump

Air cooler (AC)

Secondary Circulating pump

Turbine

Generator

Condenser

Evaporator (EV)

Sea water cooler

Core

Intermediate Heat Exchanger (IHX)

Feed water pump

Primary Heat Transport System (PHTS)

Water and steam system (WS)

Secondary Heat Transport System (SHTS)

R&D Programs Using Monju

| FY2009 | FY2015 | FY2020 | FY2025 |

| Function tests | System start-up test (SST) | Power operation | | |

Test Data — Operating Experience — Performance improvement

R&D with Monju

Achieving of initial goals
- Demonstrating reliability as an operational power plant
  - Accumulation of operation & maintenance experience
  - Evaluation of design technology
- Establishing sodium handling technology

Demonstrating technologies to improve Economics & Safety
- Advanced fuel irradiation (TRU-MOX)
- Longer operation cycle with higher burnup
- Fuel / Material irradiation, etc

Utilization to provide a location for R&D activities
- Preparation for performance improvement

Stand as an international COE
- Collaboration in SST, providing a facility for joint research programs

Verification of analytical codes and methods for an FBR design

Demonstration of reliability and sodium technology (breeding performance / reliable operation)

Demonstration of high burn-up fuel & Irradiation of low decontamination TRU fuel

Utilization for design & operation of a demonstration FBR

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Monju System Start-up Test Schedule

Schedule	FY2005	FY2006	FY2007	FY2008	FY2009 or later

Modification Works

Modified System Function Tests

Entire System Function Tests and Refueling

▼ Criticality

System Start-up Tests

Core confirmation test	Inspection	**40% rated power confirmation test**	Inspection	**Power increase test**
refuel — Performance of the Am-bearing MOX fuel core (0% rated power)		refuel — Overall plant function & performance including water/steam & turbine systems (0-40% rated power)		refuel — Overall plant performance up to full power operation (0-100% rated power)

⬢ Current core fuels ⬢ Stocked fuels or new fuels to be fabricated

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WBS of R&D Programs Using Monju

1. Demonstrating reliability as an operational power plant

- 1) Achieving safe and reliable operation
- 2) Achieving system start-up tests
- 3) Evaluating design concept of Monju & its generalization

2. Establishing sodium handling technology

- 1) Establishing sodium handling management technology
- 2) Establishing plant maintenance technology
- 3) Construction of an integrated database system of Monju

3. Utilization to provide an asset for R&D activities toward commercialization

- 1) Monju performance improvement

Note: A [   ] comes from 'Framework for Nuclear Energy Policy' by AEC

R&D on Core Neutronics and Design

R&D on Plant Dynamics
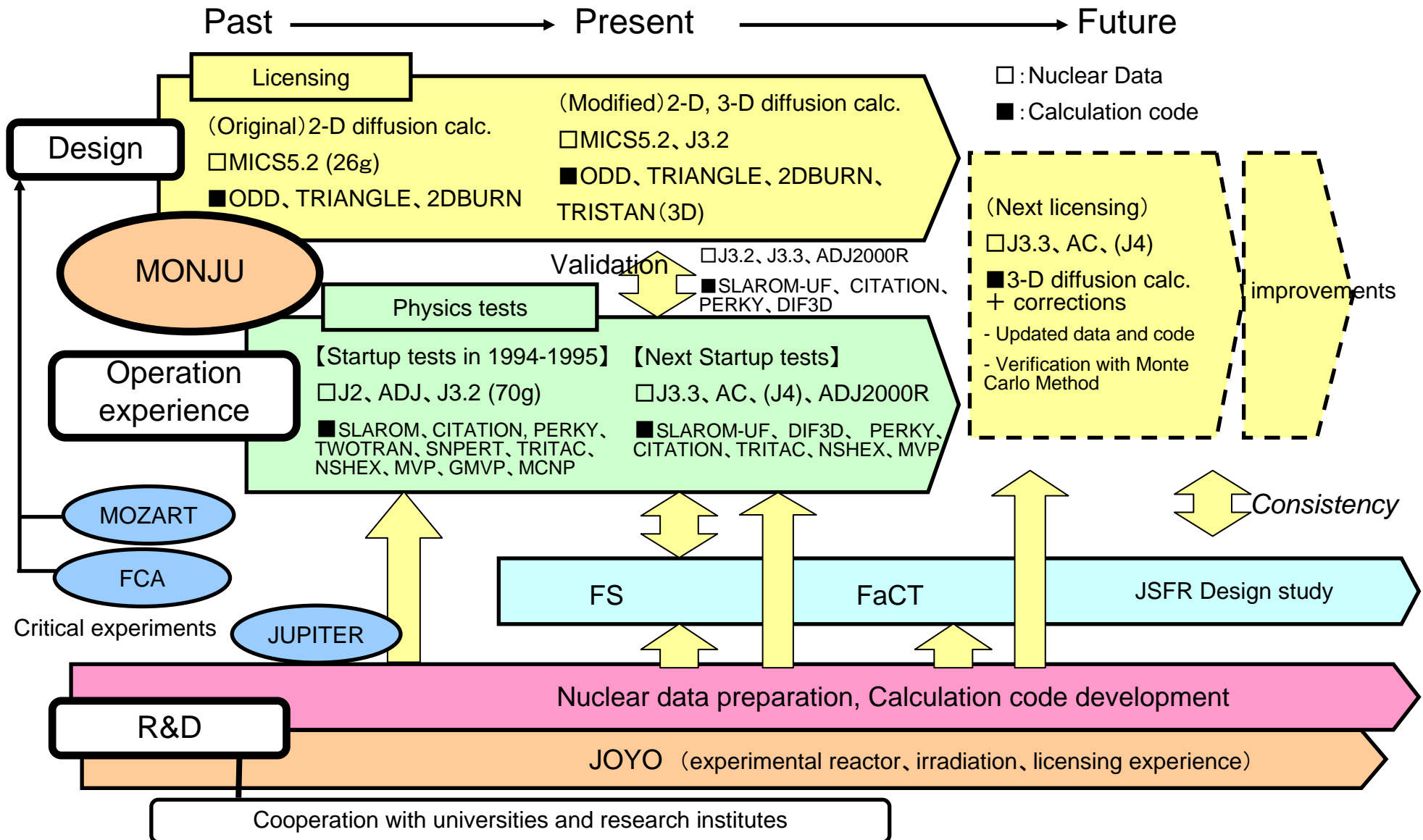
(1) Detailed Analyses of RV Upper Plenum Thermal-hydraulics

<< Detailed Calculation >>

°C
550
525
500
475
450
425
400

0.5 m/s

<< Whole-plant Dynamics Analysis Model >>

Primary Heat Transport System

Secondary Heat Transport System

RV   IHX   AC   SH / EV   SG
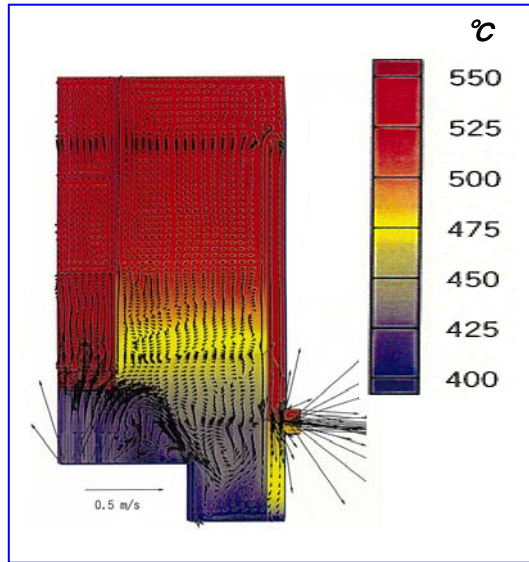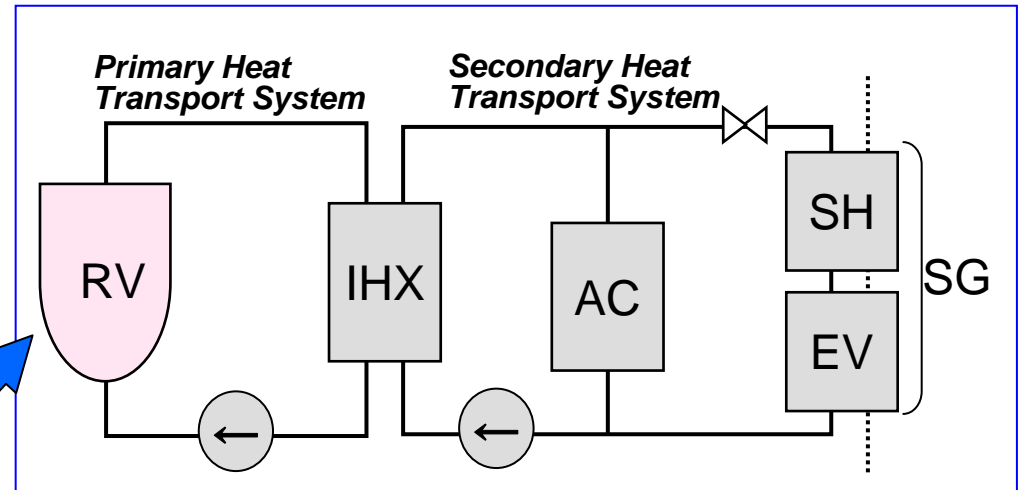
Flow rate Temperature

Integrate into Whole-plant Dynamics Analysis Model

UCS

Higher Temperature Region

Boundary Layer

Core   Lower Temperature Region

Sodium Surface

Over flow

E

Detail mesh (Energy Eq.)

C   D2

Inner Barrel

D1

A   B   F

Flow holes

Outlet of Fuel Subassemblies   Outlet of Blanket Subassemblies
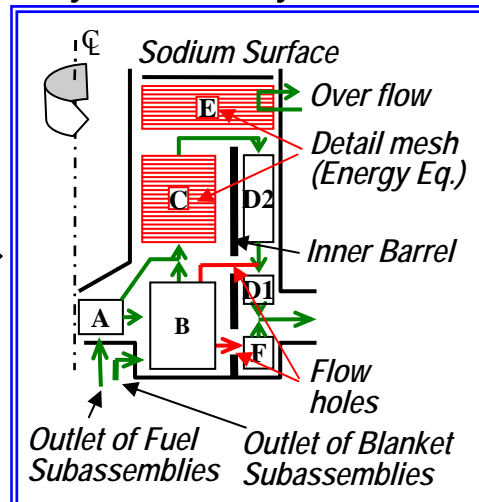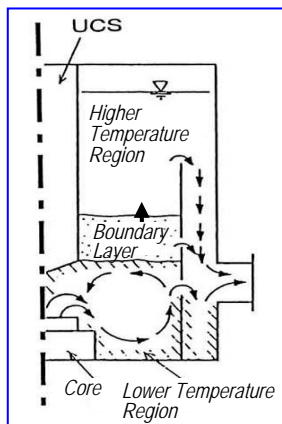
(3) Modeling of other main components
- Construct FNM of other components
(IHX, AC, SG, etc.)

(4) Whole-plant Dynamics Simulation
· Verification by Monju start-up test results

>> **Enable to Evaluate Plant Dynamic Behavior in Short Calculating Time and Appropriate Accuracy for Future FBR**

(2) Construction of Flow Network Model (FNM)

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R&D on Behavior of Radioactive Materials

Radioactive materials behavior in sodium cooling systems

・**Evaluation of production and transfer behavior of corrosion products and fission products in LMFBR cooling systems.**

・**Evaluation of radioactivity distribution in LMFBR plant.**

CT or Other: 3%

Main-Pump: 22%

Core: 32%

IHX: 37%

HL: 1%

CL: 1%

Total: 18.5 TBq

Distribution of the accumulation of ^{54}Mn in Monju primary cooling system
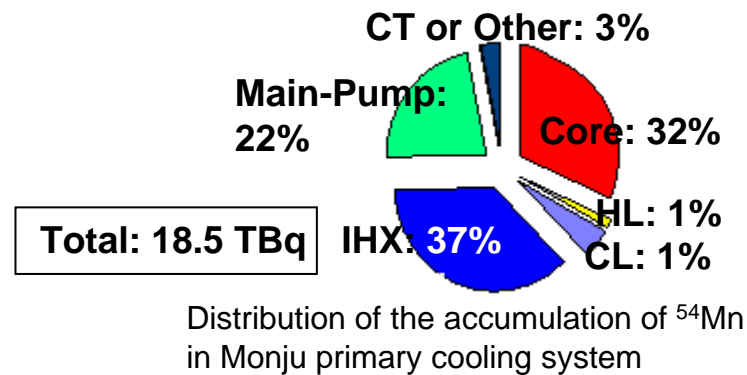
Development and validation of dose rate estimation system for LMFBR maintenance
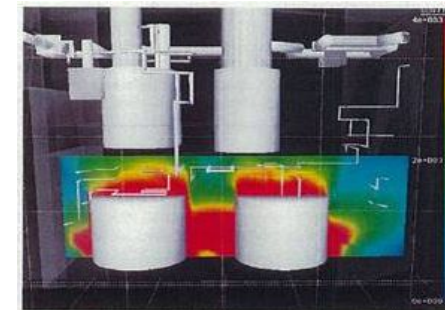
Prediction of dose rate in primary coolant system room of Monju by DORE system

Demo Plant and Commercial Plant

The calculation results will be applied to the radiation shielding design.

The sodium cleaning experience of sodium components and spent fuels using sodium cleaning system will be applied to the design of fuel handling and its support systems.
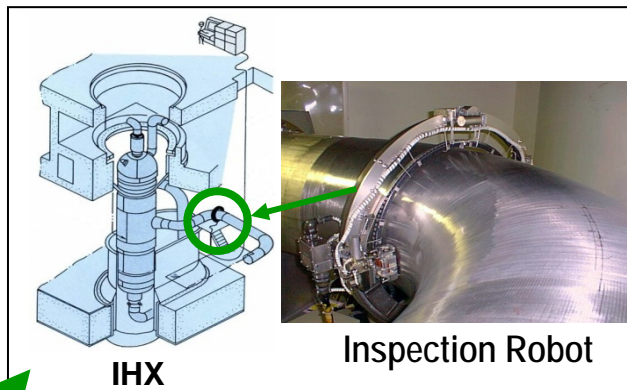
This research progress will be reflected to the establishment of operation and maintenance management system.

Planning of construction of a new Sodium Test Facility in Shiraki, Tsuruga
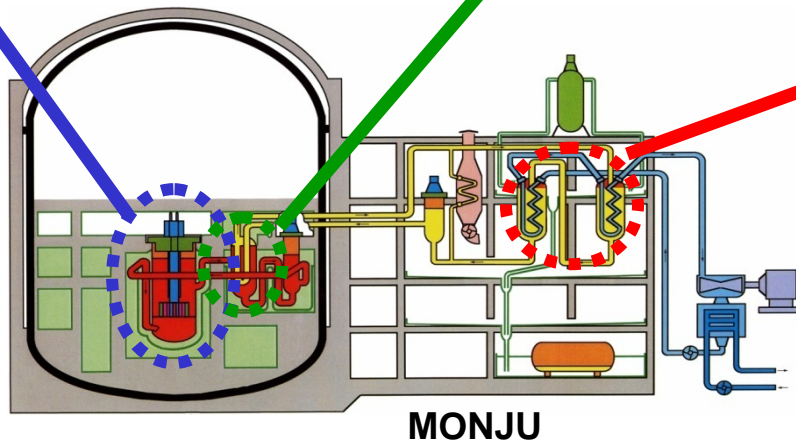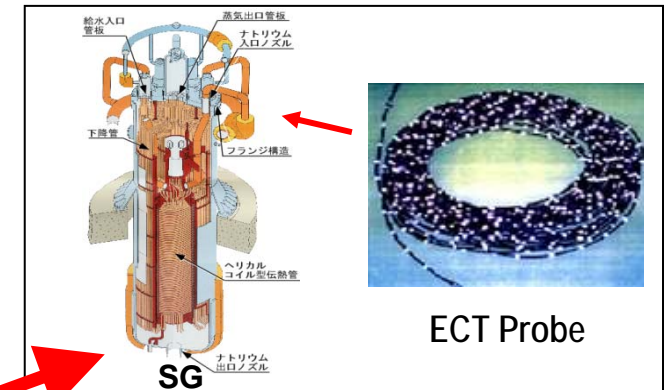
R&D on Devices for In-Service Inspection

ISI Device for Reactor Vessel

Reactor Vessel

Guard Vessel

Inspection Robot
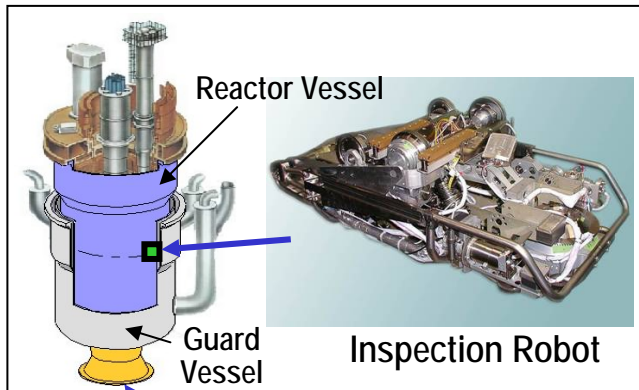
ISI Device for PHTS* Piping
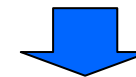
IHX

Inspection Robot

* Primary Heat Transport System

ISI Device for SG Tubes

SG

ECT Probe

MONJU

Demonstration of applicability and performance of the ISI Devices by the practical use in MONJU

・Improvement of performance (high sensitivity on small defects, quantitative evaluation)
・Improvement of reliability and easy handling
・Reduction in time and cost of each inspection

Item	2010	2015	After 2015
Monju	Criticality Entire System Function Test ▼ Sytem Start-up Test	Full Power Operation Current Core	Advanced Core
1.1) Achieving safe & reliable operation	Improvement of standard Feedback of SST activities	Feedback of full power peration	
1.2) Achieving system start-up tests	Preparation of SSTs Carrying-out of SSTs	Straightening-up of SSTs	
1.3) Evaluating design concept of Monju & its generalization	Evaluation of former SSTs	Evaluation of SSTs	Utilization of design of a demo-FBR
2.1) Establishing sodium handling management technology	Accumulation of plant data	Development of purification system & sodium cleaning system Development of analytical code on behavior of radioactive materials	

Item	2010	2015	After 2015
Monju	Entire System Function Test — Criticality ▼ — Sytem Start-up Test	Full Power Operation / Current Core	Advanced Core
2.2) Establishing plant maintenance technology	Development of apparatus for ISI	Application to Monju	Improvement
2.3 Construction of an integrated database system of Monju	Development of DB	Test-using of DB	Improvement
3.1) Monju performance improvement	Preparation of performance improvement	Design & Licensing	Operation

Conclusion

- Monju is challenging toward the restart.

- After system start-up tests are performed for around three years, Monju will operate at rated power 280 MWe.

- Monju will be expected to produce many useful experimental data for evaluation of design methods which can be utilized as design tools of a demonstration fast breeder reactor.

- Monju will be expected to establish ways of operation and maintenance of a fast breeder reactor. These will be systematized as documents.

- Monju will be utilized as an irradiated facility after attainment of the desired ends.