

# Commissioning Experience for Reactor and Primary Cooling System of Jordan Research and Training Reactor (JRTR)

2017. 12. 06

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# Introduction

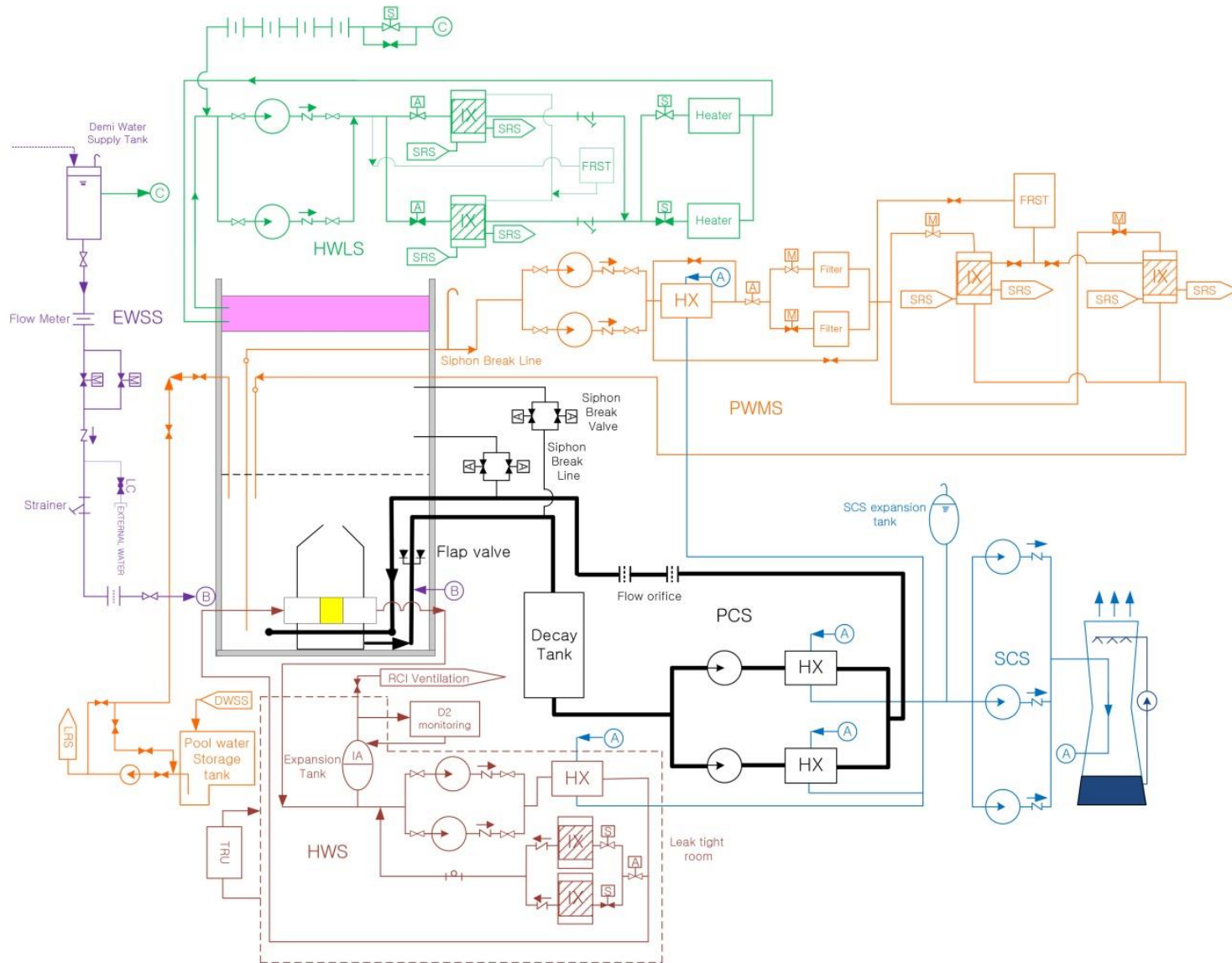




# Objective - Commissioning

- To **install** the RSA and connected systems
- To **prepare** SPT, PSI, IST, and RPT : Walk-down, Flushing
- To **check** the performance of system
  - To measure the system flow rate and pressure drop
  - To check function of pumps, flap valves and siphon break valves
  - To check alarm, lamp and interface
  - To fill the fresh resin
  - To form Initially hot water layer

# Reactor Cooling and Connected Systems



# System Classification

- Classification
  - Safety class 3
  - Seismic class I
  - Quality class: Q

➤ Applicable code: NS-R4 of IAEA

KEPIC MND, 2005 edition and 2006 addenda  
ASME Section III, Subsection ND, 2004 edition

# Walk-down and Flushing





# Walk-down and Closed Loop Flushing

- Walk-down

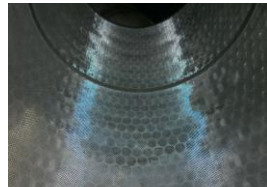
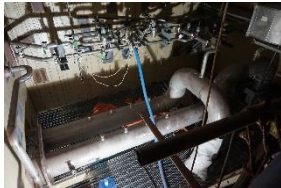


PCS room



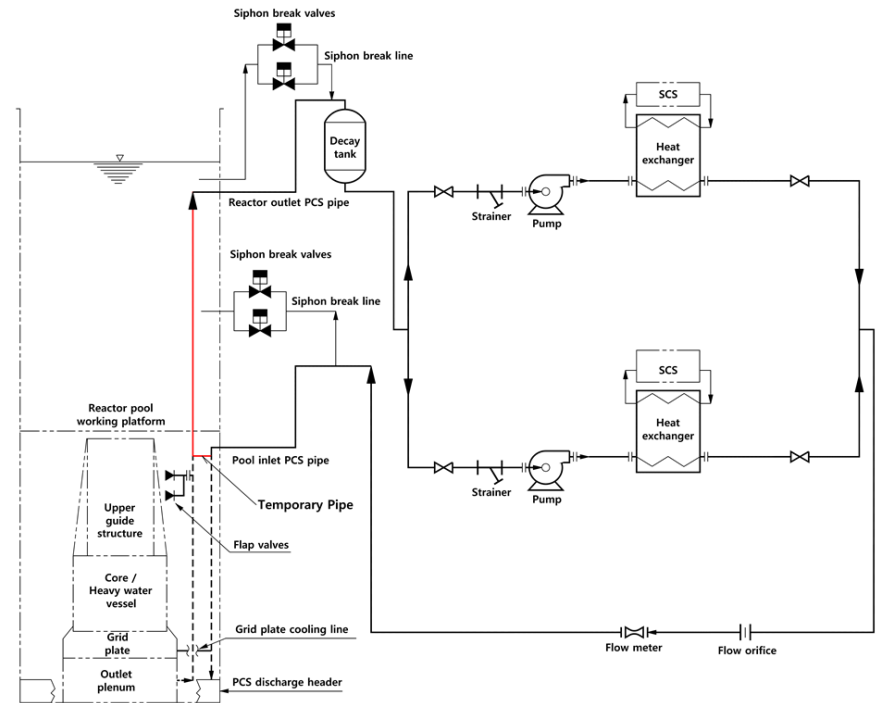
PWMS room

- Closed Loop Flushing



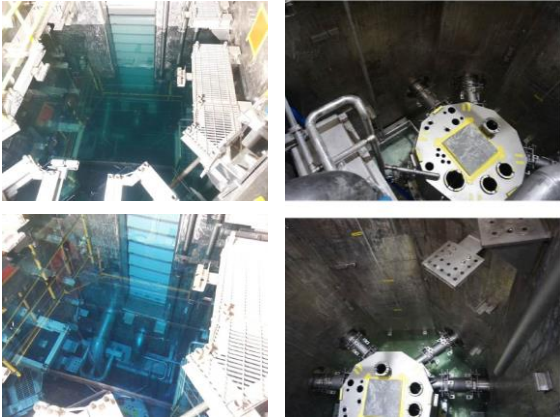
Water flushing  
Strainer mesh  
PCS, PWMS, HWLS, EWSS

Air flushing  
Lint-free cloth  
HWS

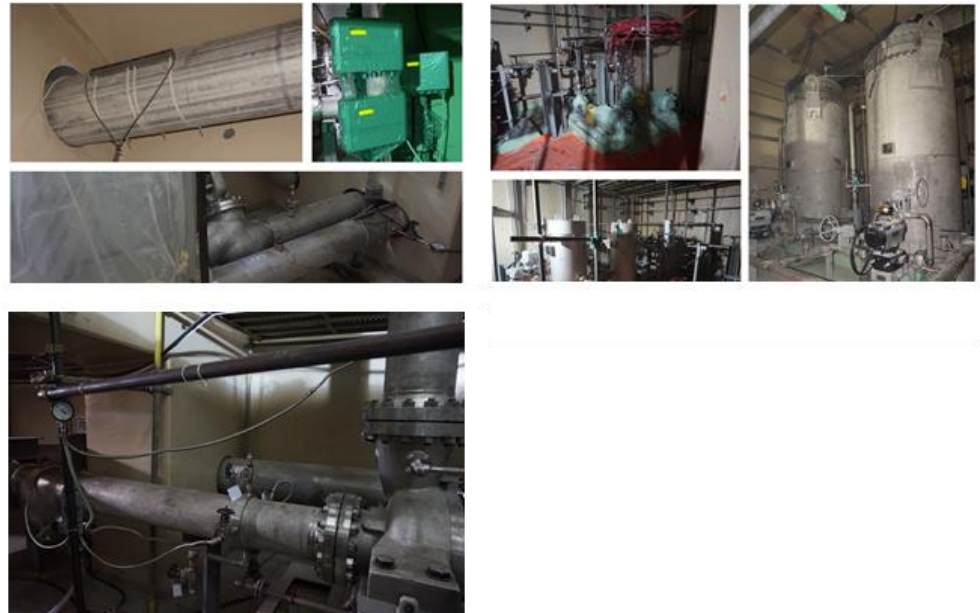


# Open Loop flushing and Preliminary Test

- **Open Loop Flushing**



- **Preliminary Test (Flow rate and Pump Operation)**



# System Performance Test



# Objective

- This test is to **measure** the system flow rate and pressure drop of Primary Cooling System (PCS) and **check function** of PCS pumps, flap valves and siphon break valves. This test is also to check alarm, lamp and interface check.

# Acceptance Criteria

- **PCS Pump Performance – two pump operation**
  - Pump performance shall comply with KEPIC MOY (In-Service Test of Pumps)
  - PCS Pumps shall be operated at least 2 hours to measure the operation parameters in order to make the system stable.
  - The NPSH margin (NPSHa/NPSHre)
- **PCS Pump Performance – one pump operation**
  - PCS pump shall not be rotated in the reverse direction with the anti-reverse rotation device (ARRD) when the reverse flow is occurred.
- **PCS Pump Performance – Interlock**
  - If any one of isolation valves HCV-001 at the upstream of PCS pump PP-001 and HCV-003 at the downstream of PCS heat exchanger HX-001 is closed, PCS pump PP-001 shall not be started when the hand switch HS-001 is turned to “ON”. This operation status shall be displayed on the OWS.



Isolation valve

# Siphon Break Valve

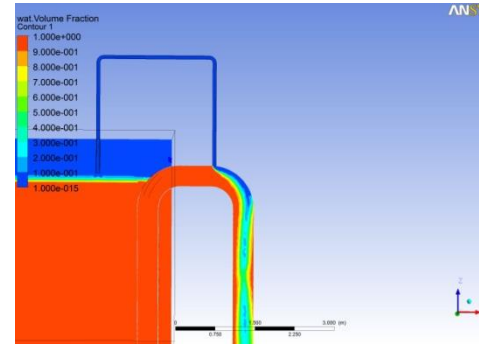
## • Experiment and CFD analysis for Siphon Break Design



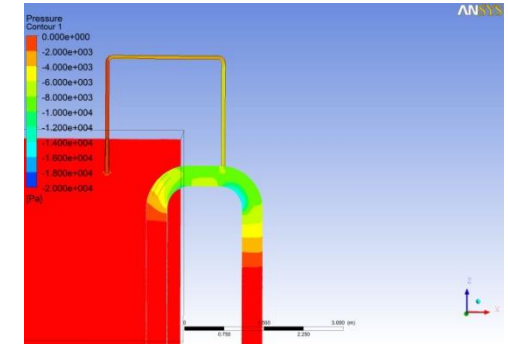
Experimental facility

Line for 10" pipe break

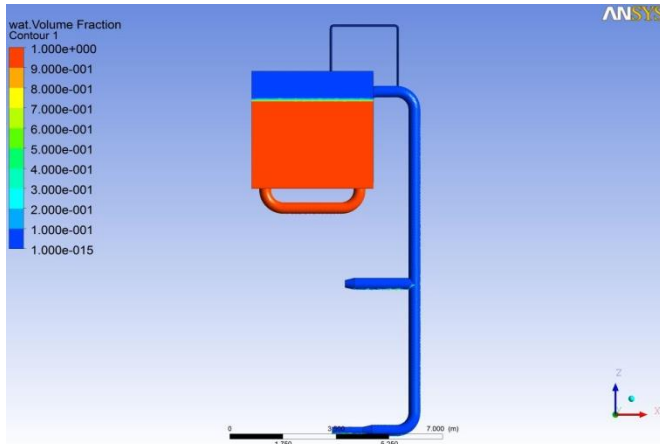
### Experiment



water volume fraction



Pressure distribution



CFD analysis

Siphon break line size(inch)	Two phase model	Turbulence model	Numerical Undershooting height(m)	Experimental Undershooting height(m)
1	Homogeneous model	SST model	Siphon break is failed	Siphon break is failed
1	Inhomogeneous model	SST model	Siphon break is failed	
1.5	Homogeneous model	SST model	1.81	1.53
1.5	Inhomogeneous model	SST model	1.21	
2	Homogeneous model	SST model	0.99	0.77
2	Inhomogeneous model	SST model	0.69	
2.5	Homogeneous model	SST model	0.77	0.34
2.5	Inhomogeneous model	SST model	0.36	

### Undershooting height

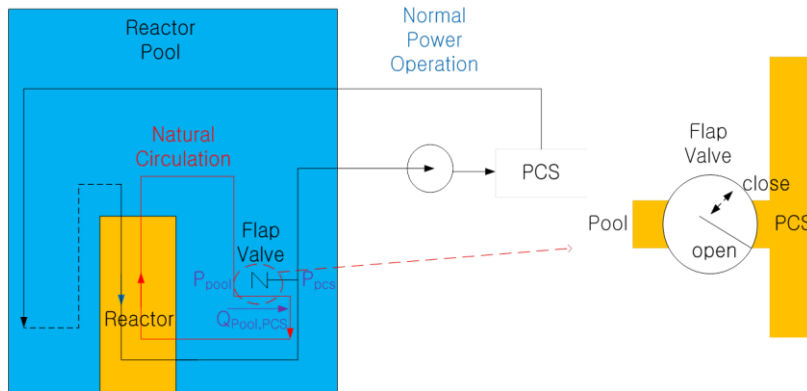
# Acceptance Criteria

- **Siphon Break valve - interlock**
- Siphon break valves shall be opened automatically by the signal of the RPS Lo-Lo-Lo pool water level.
- These siphon break valves shall be opened when the PCS flow is reduced to the Lo-Lo flow.
- Siphon break valves shall be opened when the supply of compressed air or electricity is failed.
- Each hand switch is used to manually open the valves by an operator in the MCR and SCR.



# Flap valve & Flywheel

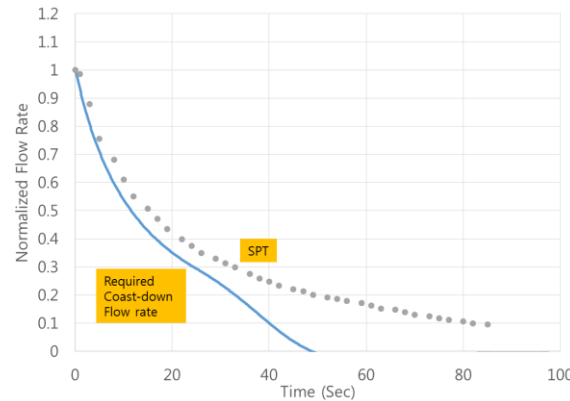
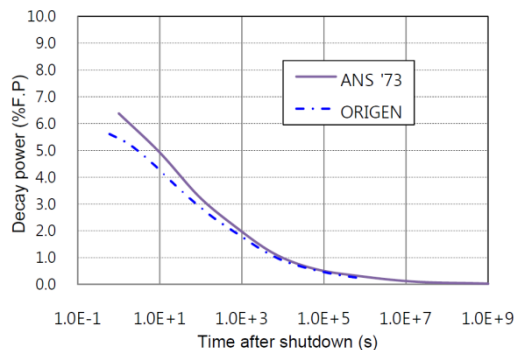
- Residual heat cooling by natural circulation**



## QME-1 test

1. Leakage test
2. End load test
3. Seismic test
4. Flow reversal test

- The coastdown flow rate shall be maintained above the required flow rate after the electrical power supplied to two PCS pumps is cut at the same time.



$$I_p \frac{d\omega}{dt} + M = 0 \quad (M : \text{friction torque} + \text{hydraulic torque})$$

$$I_p \frac{d\omega}{dt} + C\omega^2 = 0 \quad \left( C = \frac{M_{ss}}{\omega_{ss}} \right)$$



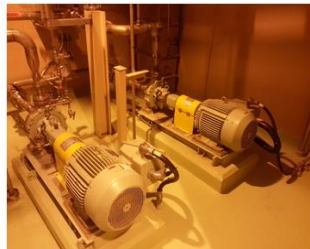
# PWMS & HWLS

- Pump test
- Flow rate
- Storing and refilling of reactor pool water
- Filling of the fresh resin

- Pump and heater test
- Flow rate
- Initial forming of Hot Water Layer
- Makeup flow rate
- Filling of the fresh resin



PWMS pump



PWMS pump



PWMS AOV



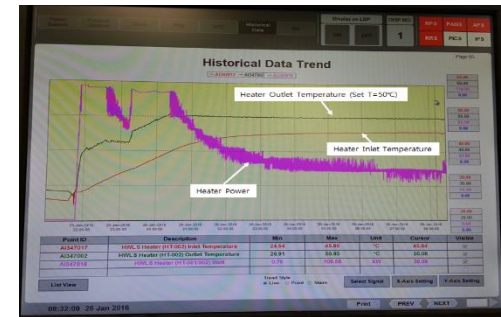
PWMS I/X



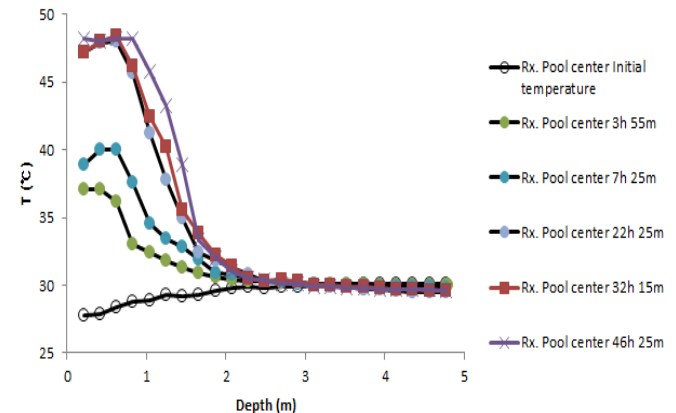
PWMS Filter



Filling of fresh resin



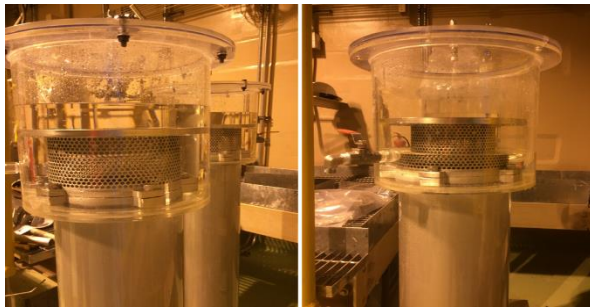
Heater temperature after heater control logic changing



Pool temperature distribution after HWLS operating

# HWS

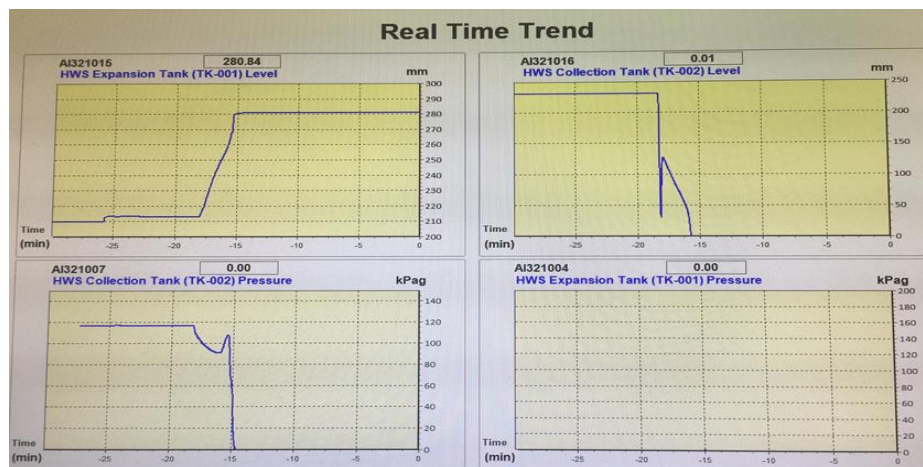
- Helium leak test, Heavy water filling and chemical property check, Canned pump test, Main and purification flow rate



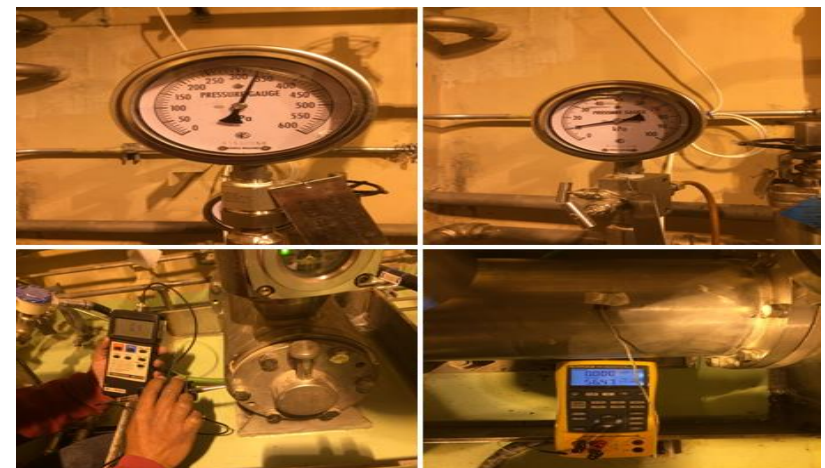
HWS I/X



Leak test    HWS Pump / Heat exchanger / Expansion tank



HWS expansion/ collection tank level and pressure

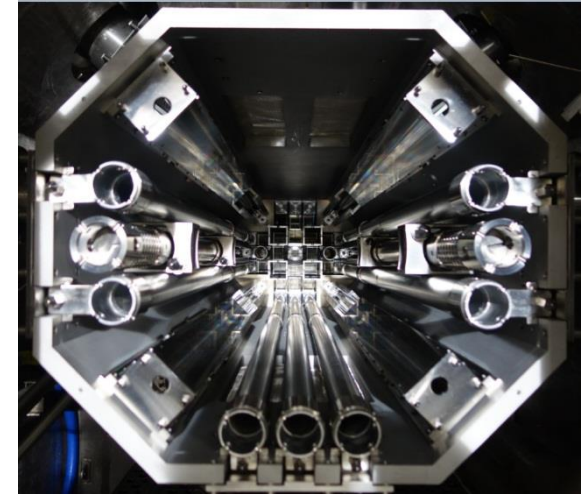
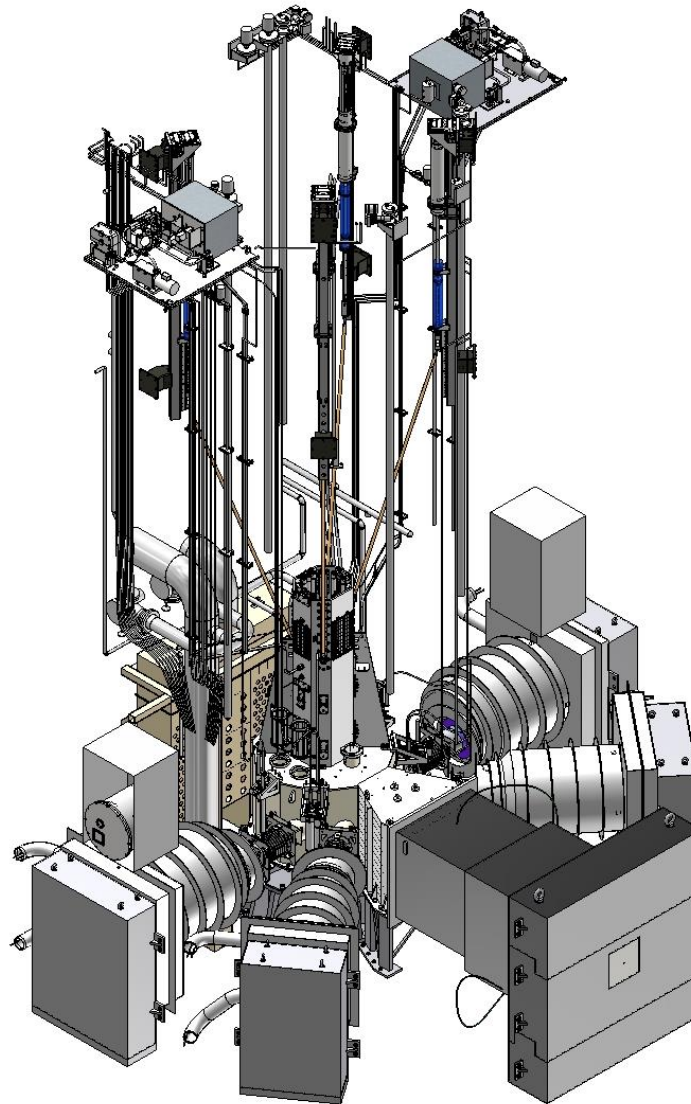


HWS pump performance test

# Commissioning of RSA / I&C



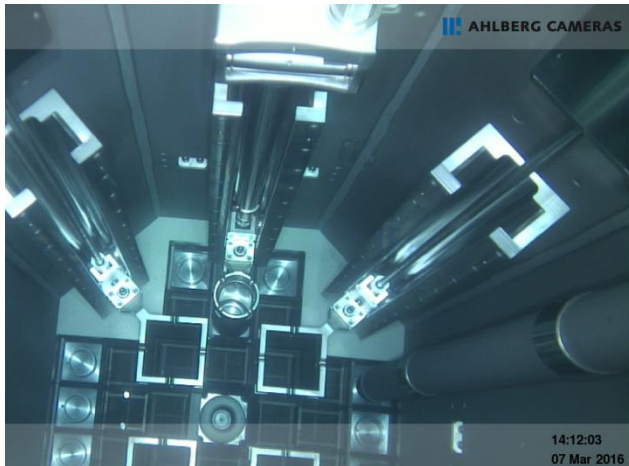
# JRTR Reactor Package



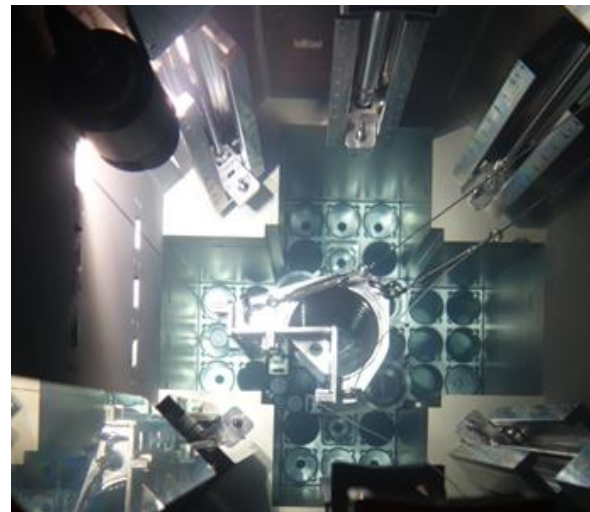
- Reactor Assembly
  - Reactor Structure Assembly
  - Beryllium Reflector Assemblies
  - CRDM
  - SSDM
  - Neutron Detector Housing
  - Gamma Detector Housing
  - Dummy Fuel Assembly
- Beam Port Assemblies
- Thermal Column Assembly
- Special Tools

# JRTR Reactor Package

- Pre-service inspection
- Manufacture, installation and Test
- CRDM and SSDM Performance test
- Special Tool Performance test
- Inner shell /Be inspection and measurement



RSA inspection using under water camera



Inner shell /Be inspection and measurement



## Operation in MCR



One Server: includes main program as well as OWS display

Two Clients: includes OWS display only

Two LDPs: displays mimics and tile alarms

Trends: displays (any) important process variables

- Simulator development for training
  - Normal Operation
    - Shutdown check, fluid system ON
    - Rx Startup, manual control, and approach to criticality
    - Power ascension, full power operation, and shutdown
  - Abnormality Handling during Operation
    - PCS pump failure
    - Loss of Electric Power
    - Loss of Coolant Accident
    - Loss of Heat-Sink
    - RPS CMF + LOCA

# Thank You

