Plan for Neutron Irradiation Facilities in The New Research Reactor at The MONJU Site

Makoto Inagaki[1], Koichi Takamiya[1], Tsutomu Miura[2], Kohshin Washiyama[3], Kazuhiko Akiyama[4], Takahito Osawa[5], Yoshitaka Kasamatsu[6], Naoki Shirai[7], Kunihiko Tsuchiya[5], Go Yoshida[8], Nobuhiro Sato[1]
(Kyoto Univ.[1], AIST[2], Fukushima Med. Univ.[3], Tokyo Metro. Univ.[4], JAEA[5], Univ. Osaka[6], Kanagawa Univ.[7], KEK[8])

Abstract

A new research reactor with a power of less than 10 MW is planned to be constructed at the MONJU site in Tsuruga City, Fukui Prefecture, Japan.
This presentation focuses on the neutron irradiation instruments related to neutron activation analysis (NAA) and research RI production, and the design of the hot laboratory.

New research reactor

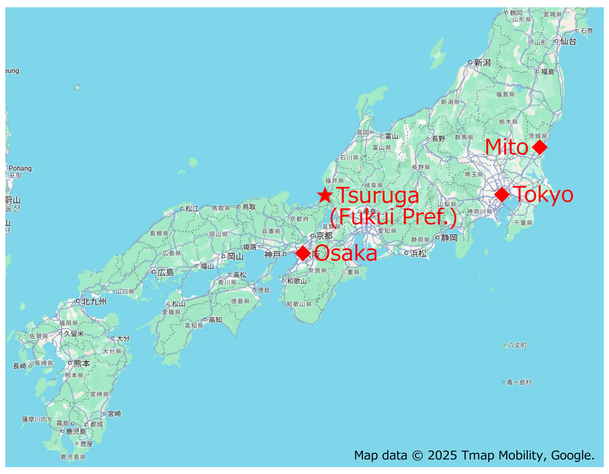
In September 2020, the Ministry of Education, Culture, Sports, Science and Technology of Japan (MEXT) has decided on the reactor type as follows:

Medium-power reactor with a thermal power of less than 10 MW, which is highly versatile and mainly used for neutron beam application research

Tasks of each contributing organization

JAEA: Design, construction, and operation of the reactor
Kyoto Univ.: Wide-range utilization/operation
Univ. Fukui: Establishment of cooperation with related local organizations

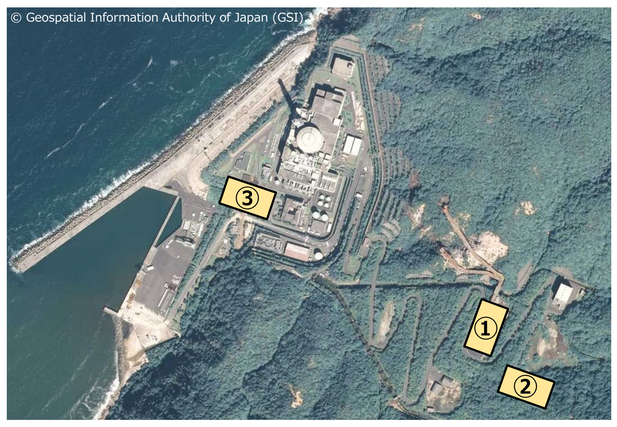
Location



Tokyo to Tsuruga:
3.2 hours by Shinkansen
Osaka to Tsuruga:
1.4 hours by limited express train

Tsuruga station to MONJU site:
about 30 minutes by car

MONJU is a sodium-cooled fast breeder reactor operated by JAEA in Tsuruga City, Fukui Prefecture.
It is currently under decommissioning.



Proposed construction site (3 candidates)

Experimental instruments

Instruments for the following experiments, the priority installation instruments, are planned to be installed.

Instruments for beam experiment

- Small-angle neutron scattering
- Neutron imaging
- Neutron powder diffraction
- Neutron reflectometry

Instruments for irradiation experiment

- Neutron activation analysis (NAA)

Instruments for the following experiments, which are typically located in the reactor room, are under study for installation*.

Instruments for beam experiment

- Triple-axis spectrometer
- Nuclear and particle physics

Instruments for beam experiment

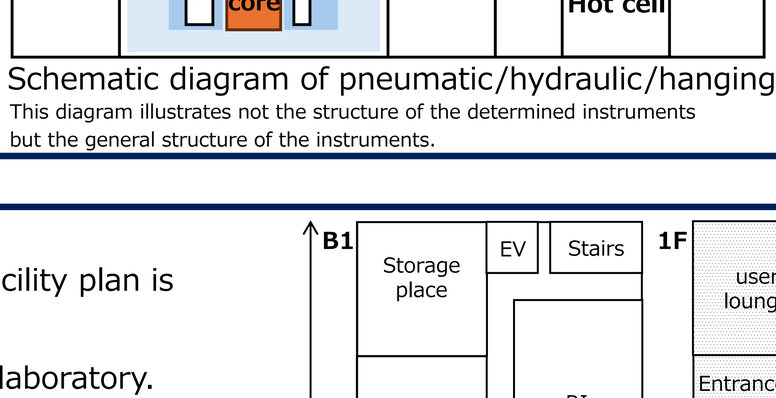
- Research RI production
- Material irradiation
- Biological irradiation
- Positron beam

* Studies were initiated in advance because instruments located in the reactor room involve the licensing of the construction of the reactor.

Irradiation instruments related to neutron activation analysis (NAA)

NAA-related neutron irradiation instruments considered for installation:
Pneumatic, Hydraulic, and Hanging irradiation instruments.

- The number of these instruments should be at least as many as in KUR and JRR-3.
  KUR: Research reactor operated by Kyoto Univ. 5 MW.
  JRR-3: Research reactor operated by JAEA. 20 MW.
- These instruments can also be used for RI production.

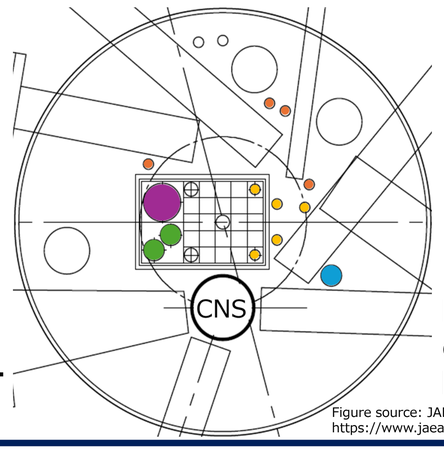


Schematic diagram of pneumatic/hydraulic/hanging instrum.
This diagram illustrates not the structure of the determined instruments but the general structure of the instruments.

NAA-related irradiation holes considered for installation

- For pneumatic (Φ 50 mm): 6 holes
  - Neutron spectrum can be adjusted by changing the distance from the reactor core.
    (two each for high, medium, and low intensities)
  - One of the low-intensity units will be used for cyclic irradiation.
  - One of the high- or medium-intensity units will have a function to cut thermal neutrons by shielding.
- For hydraulic (Φ 50 mm): 5 holes
  - 2 or 3 units would be dedicated to RI production for industrial use, and 3 or 2 units would be for research use.
- For hanging (Φ 100 mm): 1 hole
  - Designed to irradiate relatively large samples by hanging them from the top of the reactor.
  - This instrument is similar to the slant irradiation instrument of KUR.

The above plan has not been determined.



Example of vertical experimental hole layout.
Figure source: JAEA (modified)
https://www.jaea.go.jp/news/newsbox/2025/031701/s01.pdf

Hot laboratory

- The area of the hot laboratory in the current overall facility plan is approx. 23 m x 34 m.
- The scale should be equal to or larger than KUR's hot laboratory.
- To be capable of wet chemistry.
- To provide space for experiments using equipment brought in from other facilities.

⇒ To secure the necessary area, the hot laboratory needs to be multi-storied.

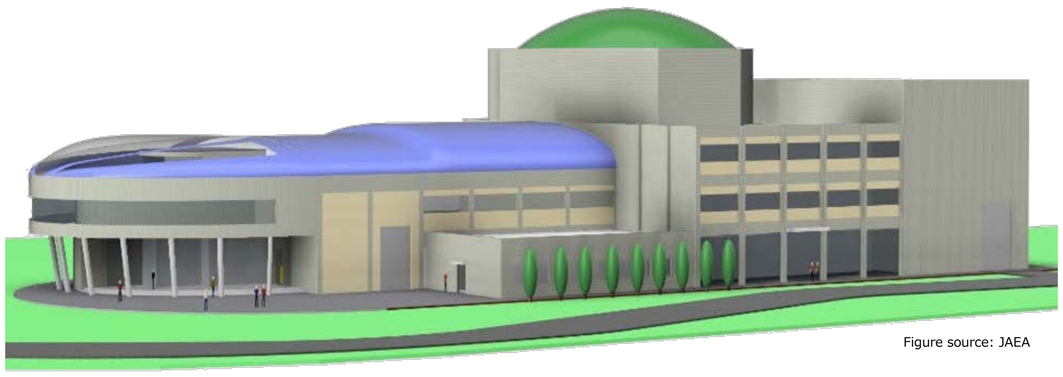
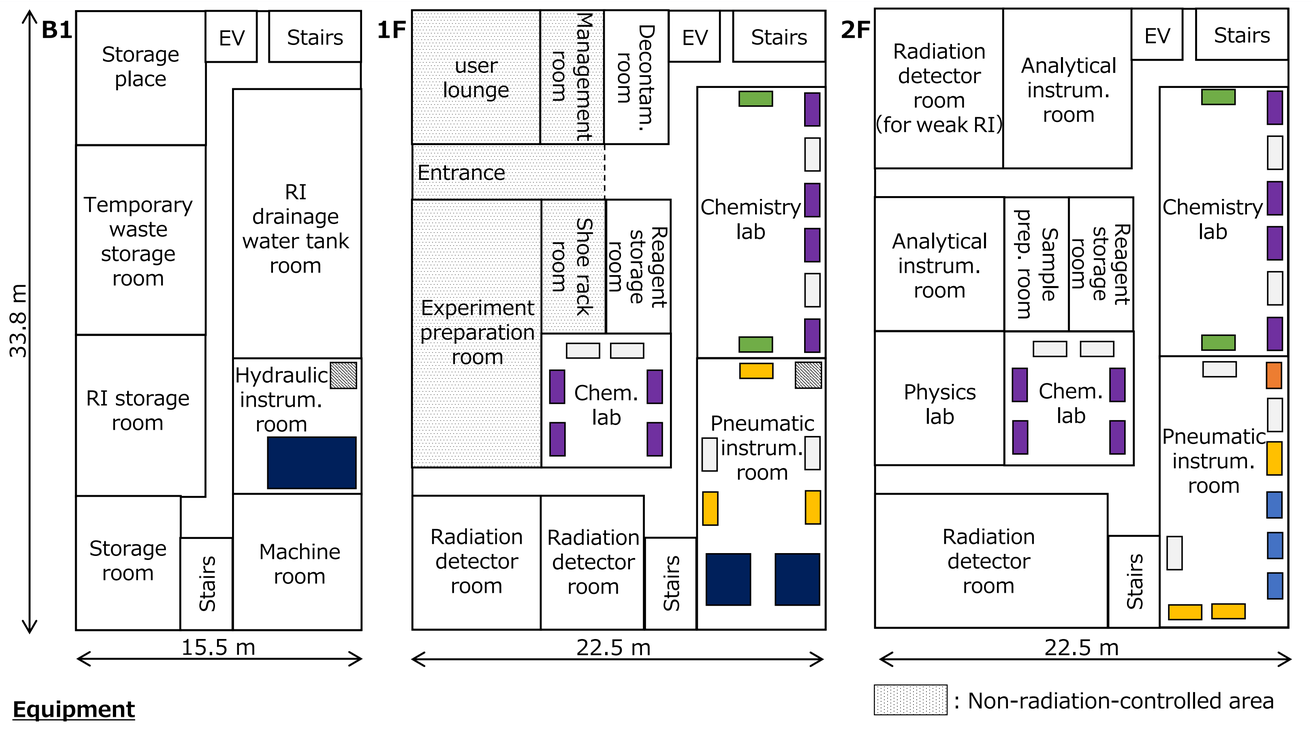


Figure source: JAEA
Conceptual image of new research reactor.



Equipment

Small hot cell for pneumatic instrum. : 3 units (■)
Small hot cell for cyclic irrad. with Ge detector : 1 unit (■)
Hot cell for pneumatic/hydraulic instrum. : 3 units (■)
Hood for handling irradiation capsules : 6 units (■)
Controlled-atmosphere glove box : 4 units (■)
Chemical hood with acid-resistant scrubber : 16 units (■)
EV for sample irradiated by hydraulic instrum. : 1 unit (▨)
Experimental table (■)

Draft layout of the hot laboratory (not a definitive plan).

Summary

- JAEA, Kyoto University, and University of Fukui are collaborating to construct a new research reactor at the MONJU site.
- Neutron irradiation instruments related to neutron activation analysis and a hot laboratory will be constructed.
- The scale of the neutron irradiation instruments and the hot laboratory should be equal to or larger than that of KUR and JRR-3, and the hot laboratory should be capable of wet chemistry.
- The hot laboratory should provide space for various experiments, such as experiments using equipment brought in from other facilities.