Towards Establishing Partnerships with Relevant Local Organizations for the Utilization of the New Research Reactor Planned for the Monju Site

Research Institute of Nuclear Engineering, University of Fukui
Director and Specially Appointed Professor Masayoshi Uno

Conceptual design up to 2023 (project commissioned by the Ministry of Education, Culture, Sports, Science and Technology)

Under the consortium committee composed of JAEA, universities, academic associations, local governments, local economic organizations, the following three working groups(WG) were constructed.

WG1:Design, installation and operation of the reactor with geological surveys
(Main responsible agency: JAEA)

WG2:Planning of the experimental equipment to be installed in the reactor
(Main responsible agency: Kyoto University)

WG3:Establishing Partnerships with Relevant Local Organizations for the reactor
(Main responsible agency: University of Fukui)

Conceptual design up to 2023 (project commissioned by the Ministry of Education, Culture, Sports, Science and Technology)

Mission of University of Fukui

(1) Accompanying collaboration

Investigate promising neutron beam and irradiation technologies for industrial use, promote trial use of existing reactors, exchange opinions with local companies, disseminate information, and establish a system of local industry–academia–government collaboration (Fukui-style) based on previous examples

(2) On-campus education

Conduct seminars on neutron utilization mainly on campus

Establish a department in the University of Fukui and create a curriculum to produce human resources skilled in neutron utilization in the future

(3) Cooperation with Fukui Prefecture projects

Work in cooperation with Fukui Prefecture to disseminate information and conduct need assessments

Detailed design from 2024 (joint research)

Local Measures Working Group (LMWG)

Purpose: to get advice concerning to local collaboration and regional promotion

SG1 : Examination of the role of the cooperate system in promoting reactor utilization and preparation for the trial use

SG2 : Planning of the facilities of a multiuse center

SG3 : Development of a roadmap for training professionals in neutron utilization

The results of the activity of 3 SGs are reported in the consortium meeting and items as policy measure by the government or the prefecture will be reflected to “Reinan E cost plan”

Reinan E cost plan is prefectural plan for the formation of the area accumulated human resource, company, technology and funds at the south part of Fukui prefecture by regional economy revitalization and town development to utilize various energy including nuclear, renewable … energy.

Study items for Subgroup (SG) 1

1. Structure and functions of an accompanying collaboration system to promote utilization
(1) The need for a utilization promotion corporation
(2) Its role and scope of the authority
(3) Its expected functions based on the discussions regarding strategies to encourage utilization

2. Means to promote utilization including
(1) Discussions on trial use
(2) Local industry engagement
(3) Academic utilization
(4) Training and supply of neutron specialists

SG1 activities

- Identification of the necessary functions and issues facing the utilization promotion corporation at each stage, from design to operation
- Review of the outcomes and challenges of neutron trial use (2006–2010) at JRR-3
- Examination of the activities of Comprehensive Research Organization for Science and Society (CROSS), Neutron Science Center
- Visiting the local companies and introduction of the new research reactor though industry–academia collaboration initiatives at the University of Fukui and at the workshops sponsored by Fukui Prefecture
- Consideration of the establishment of a local utilization community.

Required functions and current issues of the utilization promotion corporation

University of Fukui

After the start of operation

① Offer of trial use
② Mail-in service
③ Consultation for use
④ Operation and maintenance of beamline apparatus
⑤ Assessment of the application assignments
⑥ Human resource development
⑦ Public relation
⑧ …

Design and construction stages

① Offer of trial use
② Mail-in service
③ Consultation for use
④ Public relations
⑤ …

Issue

- Developing human resource to support and maintain the beamlines
- Developing human resource to serve as instructors for beamline operations

Study items for SG2

1. Functions and scale of the multiuse center
(1) Roles and functions
(2) Facilities
(3) Space
(4) Floor plan
required for the multiuse center

2. Location of the center
(1) Relationship with the University of Fukui Tsuruga Campus
(2) Access to Monju site

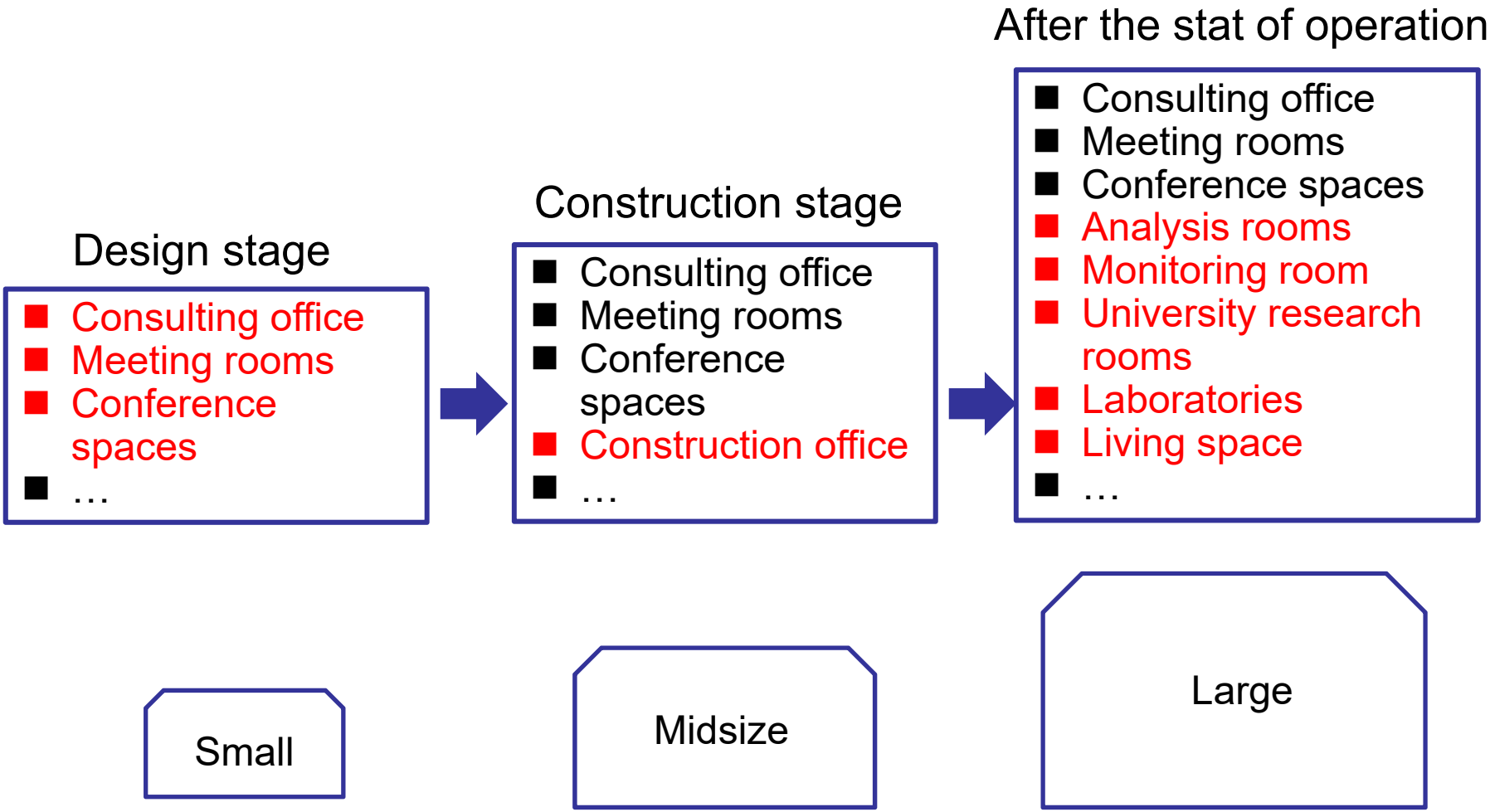
Location of Monju site and the multiuse center

University of Fukui

Functions and scale of the multiuse center

University of Fukui

- For not only academic utilization but also industrial utilization and regional economy revitalization
- For JAEA, universities and utilization promotion corporation



SG3: Human resource development and activities at the University of Fukui

- In the detailed design, the mission of the University of Fukui is "to build ties with the local community and develop human resources."
- During the conceptual design until last year,
  "One of the requests from local companies was to conduct joint research with the university" and "students in laboratories led by professors who use neutrons tend to prioritize curricula that support such research".
- Therefore we encourage and support our faculty members in conducting research involving neutron use .
- We provide financial support to such professors through Research Farms*.
- We prepare the curriculum required by the faculty members.
- We encourage the faculty members to present their research at on-campus seminars. We also invite external lecturers to introduce academic topics and research fields that students should become familiar with.
- For this purpose we appointed a specially designated professor form JAEA through a cross appointment system.

University of Fukui Research Farm

The research farm is a collaborative research initiative designated to strengthen internal and external research ties. It is led by a faculty member who acts as the group representative to faster innovation.

PILOT FARM

Registration with the Research Farm

CROSS FARM

Expansion of its membership and/or merge with other groups

VISIONARY FARM

Description of strategic research plan with financial support from the university

Establishment of a research base capable acquiring competitive funding

Activity of SG3 in 2024

- SG meetings
  - SG3-2 (June 26): Schedule for this year and plans for next year
  - SG3-3 (August 30)
  - SG3-4 (March 7)

- Seminar
  - First seminar on the new test research reactor (August 28)
    Introduction of Prof. Asano's research
  - Second seminar on the new test research reactor (September 25)
    Introduction of Prof. Hirata's research case study
  - Third seminar on the new test research reactor (October 31)
    Introduction of Prof. Matsuo's research

- Visiting of JRR-3 and others (September 10)

Neutron scattering of functional materials and expectations for the new test research reactor

University of Fukui

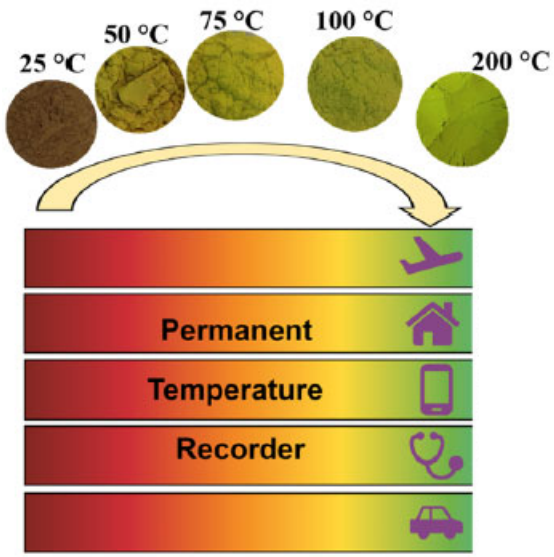
Professor Takayuki Asano, Department of Applied Physics, School of Engineering, University of Fukui

The functions of functional materials that are useful in our daily lives are closely related to the microstructure (crystal structure) of the materials.

⇒ **Microstructural information is essential when searching for new functions**

An example of function–structure correlation (chromic crystal)

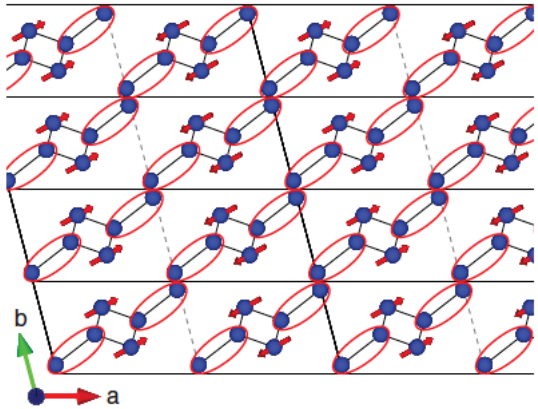
$CuMoO_4$: Special material that changes color with temperature and pressure



Magnetic fields can also change the color of the material

Magnetic structures on the order of one millionth of a millimeter is essential

Magnetic neutron diffraction ⇒



Discovery of a unique magnetic structure that holds the key for controlling magnetic fields

Structural evaluation of thin polymer films using neutron reflectometry

University of Fukui

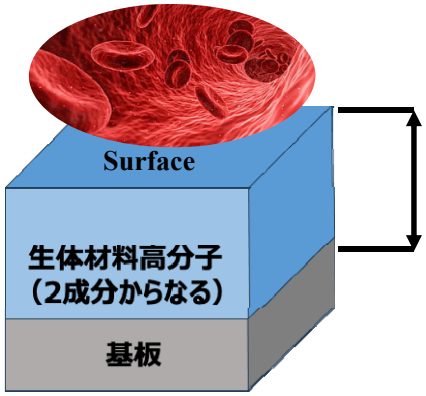
Lecture Toyoaki Hirata, Frontier Fiber Technology and Science course,
School of Engineering, University of Fukui

Special functions that are useful in our daily lives emerge from the interfaces between different polymers and from the mixed state within thin films

⇒ **Microstructural information is essential for high performance**

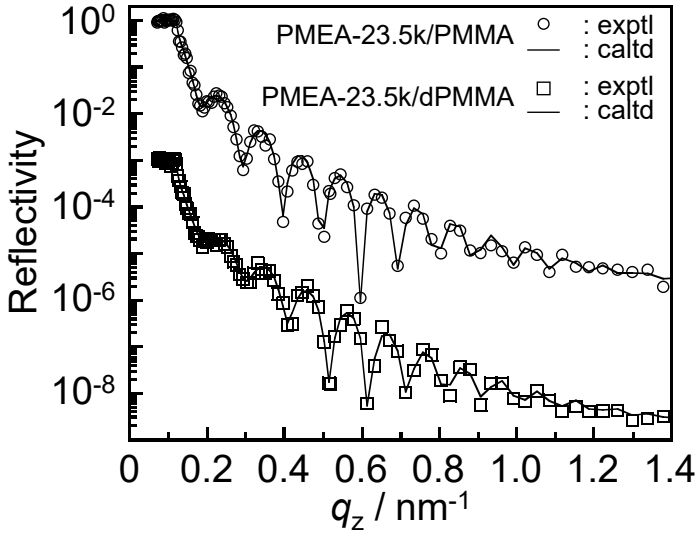
Example of function :artificial blood vessels

The microstructure of the polymer material that comes into contact with the blood is key for preventing blood from clotting



The cohesive structure of two components within a thickness of about 1/10,000 mm is important

Neutron reflectometry ⇒



shows the distribution of two components in the direction of thickness

Hirata, T. *et al.*, *Langmuir* **31**, 3661 (2015)

Expectations for the use of neutrons in the medical field

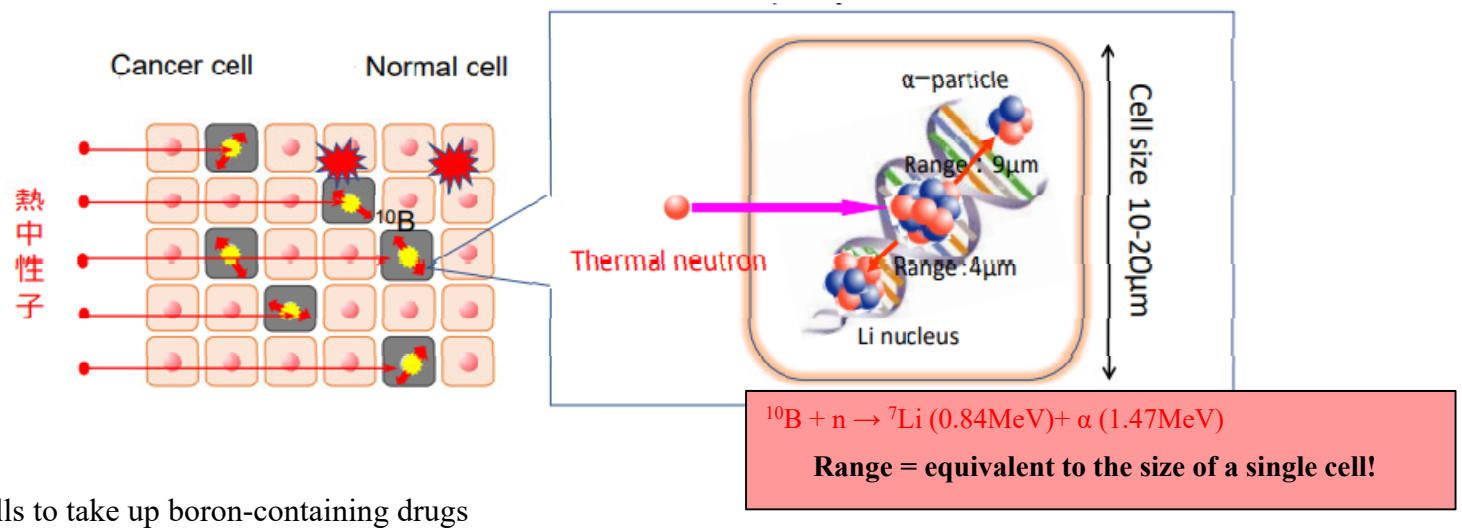
University of Fukui

(Organized) Associate Professor Yuichiro Matsuo, Nuclear Power and Energy Safety Engineering course, Division of Engineering, University of Fukui

Professor Sachiko Yoshihashi, Department of Energy Science and Engineering, Graduate School of Engineering, Nagoya University

Introducing the current status and issues concerning to the medical and biological application of neutrons and examples of advanced research

Boron neutron capture therapy (BNCT): Radiation therapy that kills only cancer cells while minimizing damage to normal tissue.



Inducing cancer cells to take up boron-containing drugs
When irradiated with thermal neutrons, boron-containing drug captures the thermal neutrons, initiating a nuclear reaction

Issues include the accumulation of boron-containing drugs

Curriculum materials and mini-seminar

- Seminar 1: Introduction to neutrons
  (What can we do with neutrons, neutron experimental facilities, usefulness of neutrons, basic knowledge of neutrons, scattering and absorption of neutrons)
- Seminar 2: Neutron scattering methods 1
  (Classification of neutron scattering methods, neutron diffraction, neutron magnetic diffraction, neutron reflection, small-angle neutron scattering)
- Seminar 3: Neutron scattering methods 2
  (Total scattering method, neutron spin echo method, imaging)
- Seminar 4: Neutron experimental facilities
  (Stationary neutron source (nuclear reactor), pulsed neutron source (accelerator), comparison of stationary and pulsed neutron sources, small neutron source (accelerator), and other neutron sources)
- Seminar 5: Neutron experimental equipment
  (Angular and wavelength dispersion methods, neutron beam experimental equipment)
- Seminar 6: Representative research examples
  (Functional materials, architecture and engineering, life sciences and agriculture, electrical and electronics field, nuclear energy field)
- Seminar 7: Recent developments concerning the New Research Reactor Planned for the Monju Site

Feedback for improvement

Comments received

・Although the curriculum is intend for undergraduate students each session contains too much information for a single class

・The content is considerably advanced for beginners. It may be more effective to divide the material into basic and advanced sections.

・It would be more interesting to begin with a concrete example demonstrating the advantage of neutron research rather than starting from the basic theory and progressing to applications

・The current content focuses only on neutron beam experiment, however including information on neutron irradiation would be also beneficial.

Further improvement of the materials

・Preparation of on demand videos and uploading the materials and videos to the university server accessible to SG3 members and Research Farm affiliates.

Current status of neutron beam experiments (technical consultation)

To expand participation in the Research Farm

Individual presentations at the faculty meetings

- Mechanical engineering course (November 7 2024)
- Electronic materials engineering course (November 29 2024)
- Applied physics course (May 2025)
- Frontier Fiber Technology and Science course (June 2025)

Research farm member activities as a result of consultations

- Professor Asano
  Neutron magnetic scattering experiments were conducted at JRR-3 in March.
- Professor Hirata
  Small-angle neutron scattering experiments were conducted at JRR-3 in May

Summary and future plans

As the part of the detailed design stage, the mission of the University is to build strong ties with the local community and foster human resource development. These efforts are undertaken by LMWG which comprises 3 SGs

SG1:Identification of the necessary functions and issues of the utilization promotion corporation
SG2:Investigation of the functions and scale of the multiuse center
SG3:Building of ties with the local community and development of human resource
Especially, for the human resource development at the university of Fukui

- Provide the financial support to faculty member who use neutrons through the Research Farm and technical consultation by the expert
- Preparation of curriculum materials one the base of the seminars by the supported faculty members
- Conduct model lessons (mini seminars on the new research reactor)

In the future (this year)

- Continuation of the investigation in SG1 and SG2
- Preparation of the on-demand videos and uploading the videos and curriculum materials on the university server accessible to SG3 and Research Farm members to receive opinions for the feedback.