Development of an Integrated Management System for Suranaree University of Technology Research Reactor in Thailand.

Mr.Siranut Jun-on

IAEA “Technical Meeting on Integrated Management Systems for the Sustainable Safe Operation and Effective Utilization of Research Reactors” (EVT2405016)

Mito, Japan, 16 – 19 June 2025

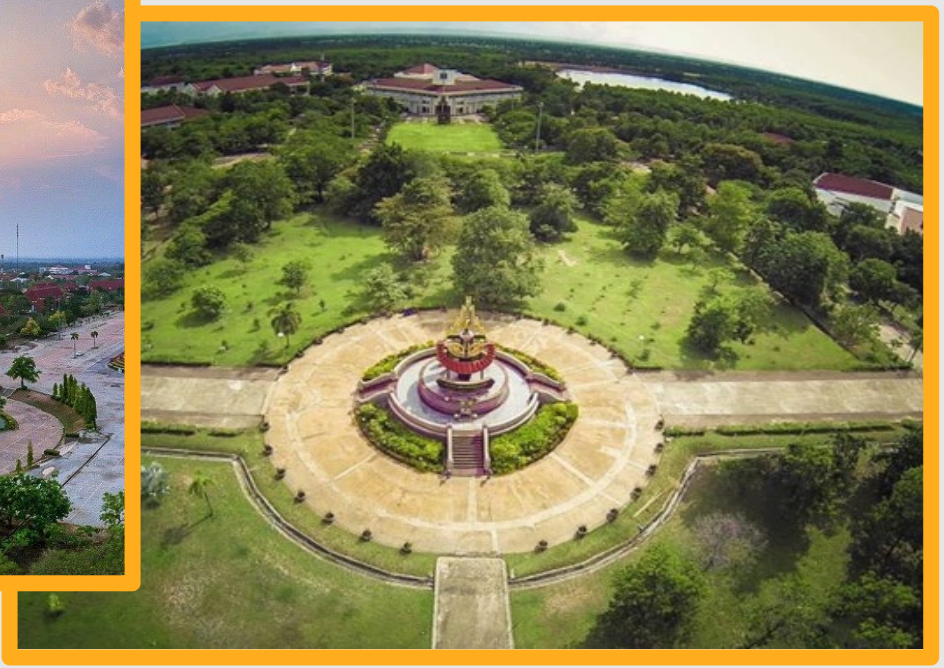
Boron Neutron Capture Therapy Research Center
Suranaree University of Technology THAILAND

Outline

- Introduction: Suranaree University of Technology (SUT)
- The SUT-BNCT Project: Overview & Objectives
- The Research Reactor (SUT-RR): Specifications & Key Features
- Facility Design: The Reactor Building
- Management: Organizational Structure & Human Resources

Suranaree University of Technology

- *Founded in 1990*
- *First Public Autonomous University (PAU) in Thailand*
- *One of 9 National Research Universities (NRU)*
- *2nd Largest Campus Area in Thailand*



Suranaree University of Technology (SUT)

STUDENTS

Undergraduate: 15,160
Masters : 835
Doctoral : 514
Total 15,160

STAFF

Academic Staff : 565
Supporting Staff : 930

SUT
Single Campus

Area
1,100 hectares

INTERNATIONAL COMMUNITY

Students: 198 from 16 countries
Faculty : 18
Researchers : 13

Suranaree University of Technology

- ***located in Nakhon Ratchasima Province***

(250 km north-east of Bangkok)

Boron Neutron Capture Therapy Research Center

Suranaree University of Technology

Suranaree University of Technology

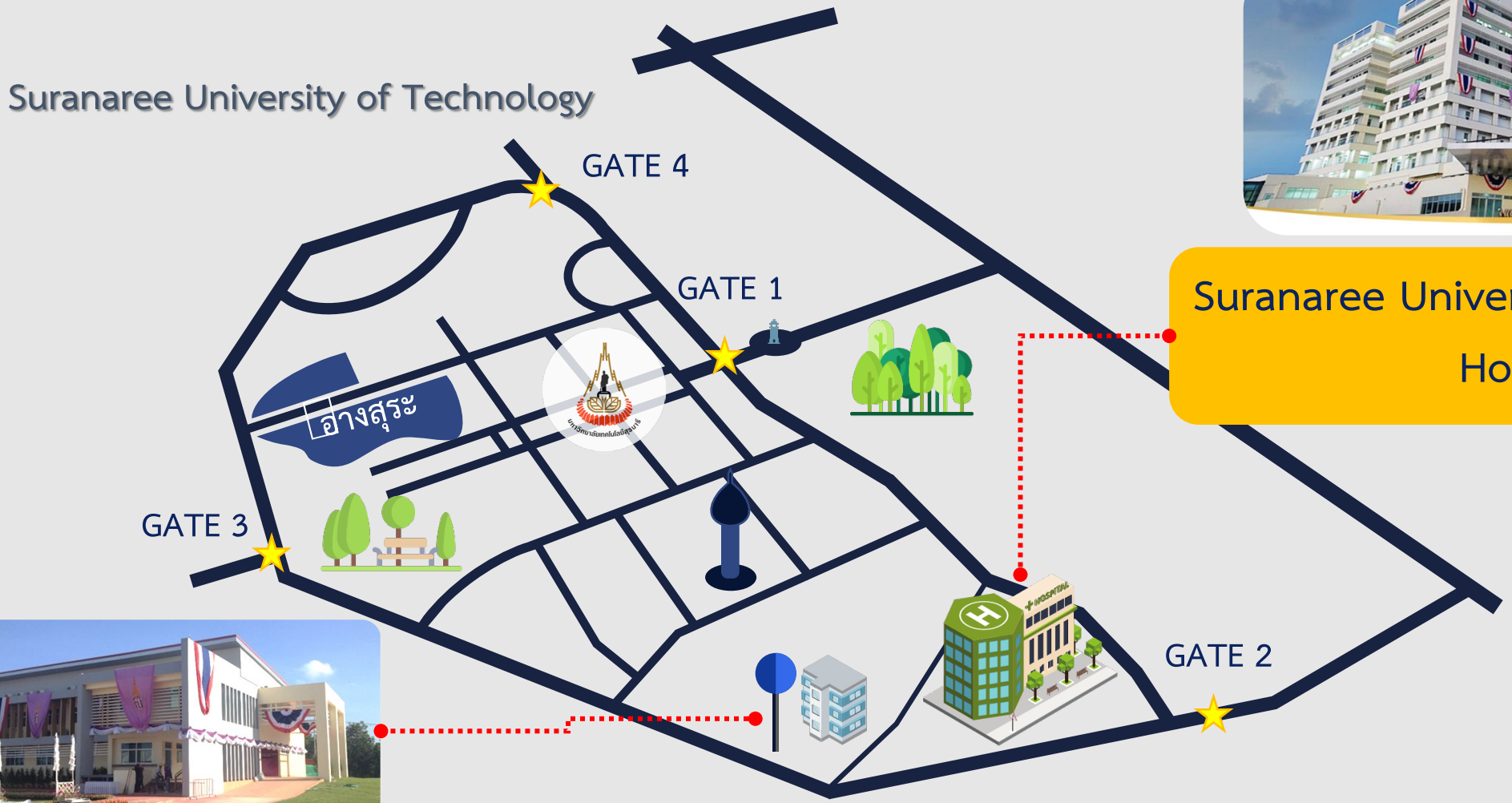
The SUT-BNCT Project is Thailand's first initiative to establish a dedicated Boron Neutron Capture Therapy (BNCT) center, featuring a 45 kW research reactor (SUT-RR) at Suranaree University of Technology. This facility aims to provide a safe and stable neutron source for both preclinical and clinical BNCT applications, as well as advanced research in nuclear science and engineering. The project integrates reactor development, radiation medicine, and academic collaboration to support national and regional cancer treatment capabilities.

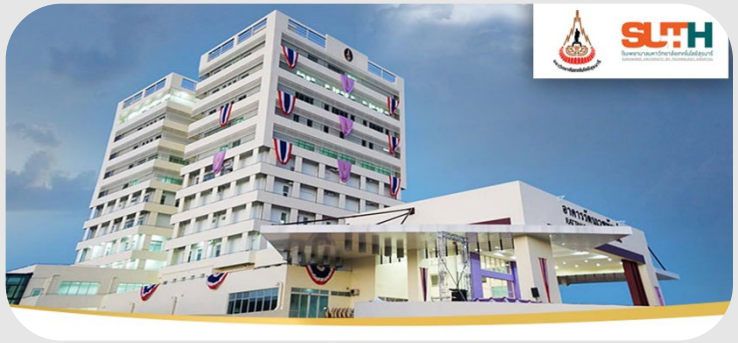
Suranaree University of Technology

- Inst. Engineering
- Inst. Science
- Inst. Agricultural Technology
- Inst. Social Technology
- Inst. Medicine
- Inst. Nursing
- Inst. Public Health
- Inst. Dentistry
- Inst. Digital Arts and Science

- School
- University Hospital
- University Farm
- Entrepreneurship Academy
- Technopolis

Suranaree University of Technology





Suranaree University of Technology Hospital

Boron Neutron Capture Therapy Research Center

SUT-BNCT Integrated Action Plan (IAP)

PHASE 1 Pre-project

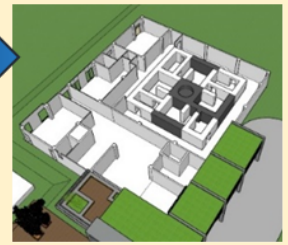
2014

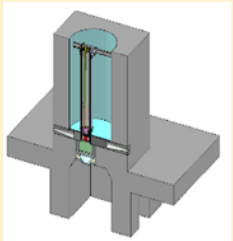
- Justification of the research reactor and considerations
- Inception of the project.
- Site survey

PHASE 2 Project Formulation

2015 – 2025

- Design of Research reactor
- Design of Building And Utility
- Research reactor construction.
- Reactor building construction.

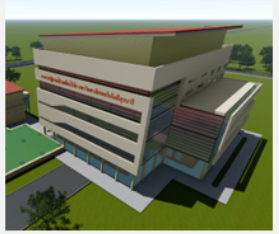




Site License - Construction license (In progress)*

PHASE 3 Implementation

2026 - 2030



- Install the research reactor and prepare for testing.
- Research reactor cold commissioning test.
- Research reactor hot commissioning test.

- Fuel license

Operations

2031 - 2051

- Operation
- Decommissioning

- BNCT
- Neutron radiography
- PGNAA / NAA
- Neutron Shielding Rubber

- Operational license

PARTICIPATION

BNCT SUTH

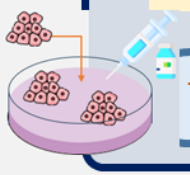
SUTH โรงพยาบาลมหาวิทยาลัยเทคโนโลยีสุรนารี

Research, development, and testing of medical products and advanced materials for medical equipment.

Neutron Radiography , PGNAA / NAA , Neutron Shielding Rubber

Design → System & Instrument Installation → Operation test

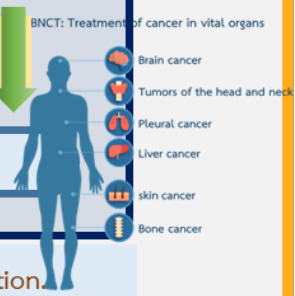
Treatment Planning Using Boron Compounds



- Boron delivery technique
- In-vitro exp. (Cell)

→ In-vivo exp. (Animal) → In-vivo exp. (Man)

SUTH CRC



- Pharmacist (Researcher)

Radiotherapists (radiation oncologists)
BNCT technic training

Submission to Clinical and Laboratory Standardization/ Medical Devices

Recruitment for operation.

Nurse (Researcher)

Otolaryngologist

Plastic Surgeon

Neurosurgeon

licenses in accordance with the specifications of the regulatory body.

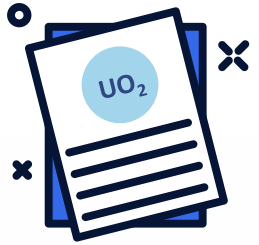
1

Application for a license to use land for establishing a nuclear facility

2

Application for a license to construct a nuclear facility

3



Application for permission to possess and import nuclear fuel

Public hearing

4

Application for a license to operate a nuclear facility

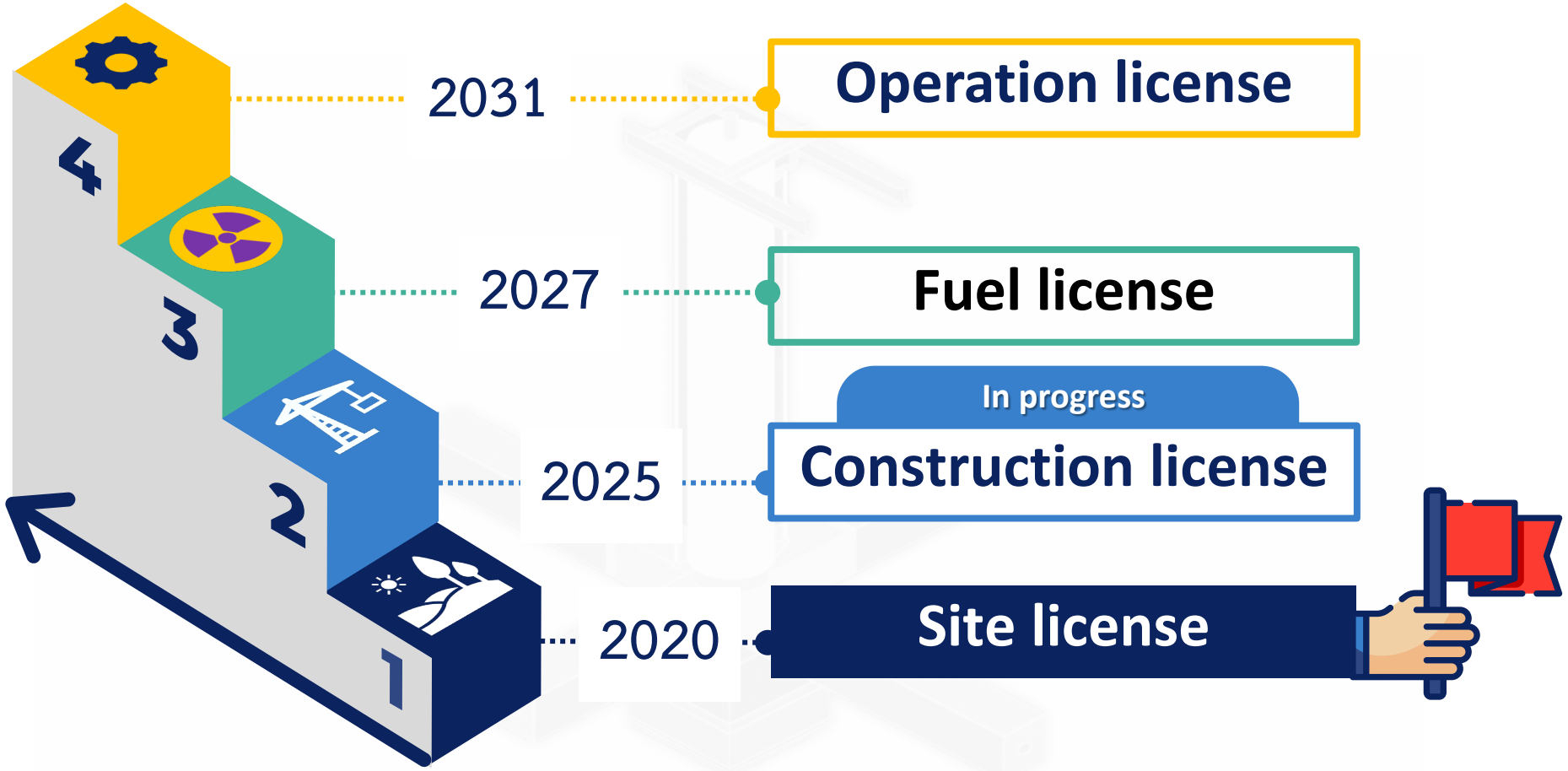
5

Application for a license to decommission a nuclear facility

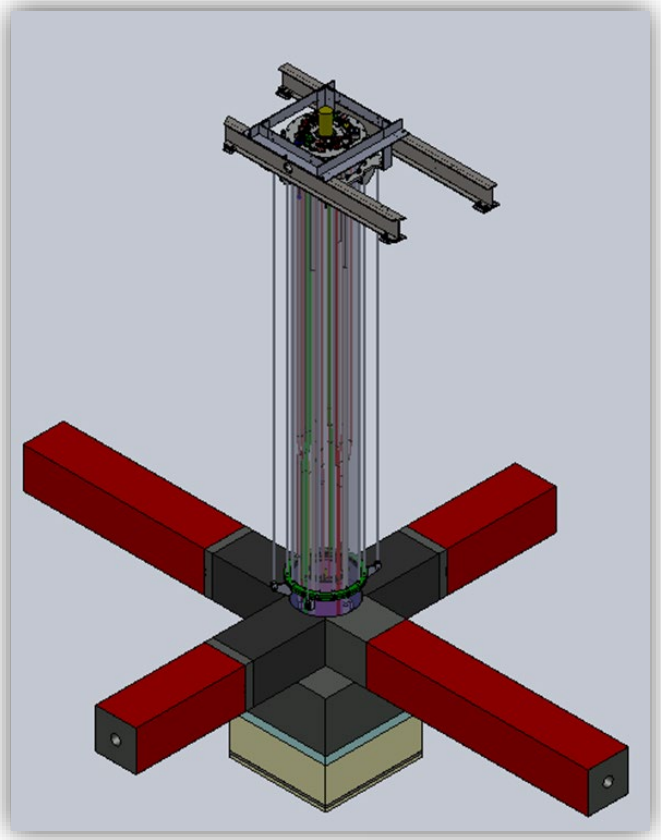
6

Submission of a request for the release of a nuclear facility from regulatory control

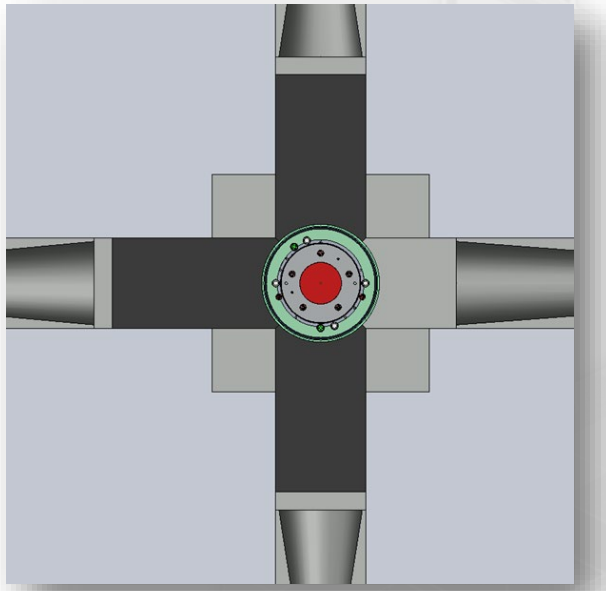
licenses in accordance with the specifications of the regulatory body.



Suranaree University of Technology Research Reactor (SUT-RR)

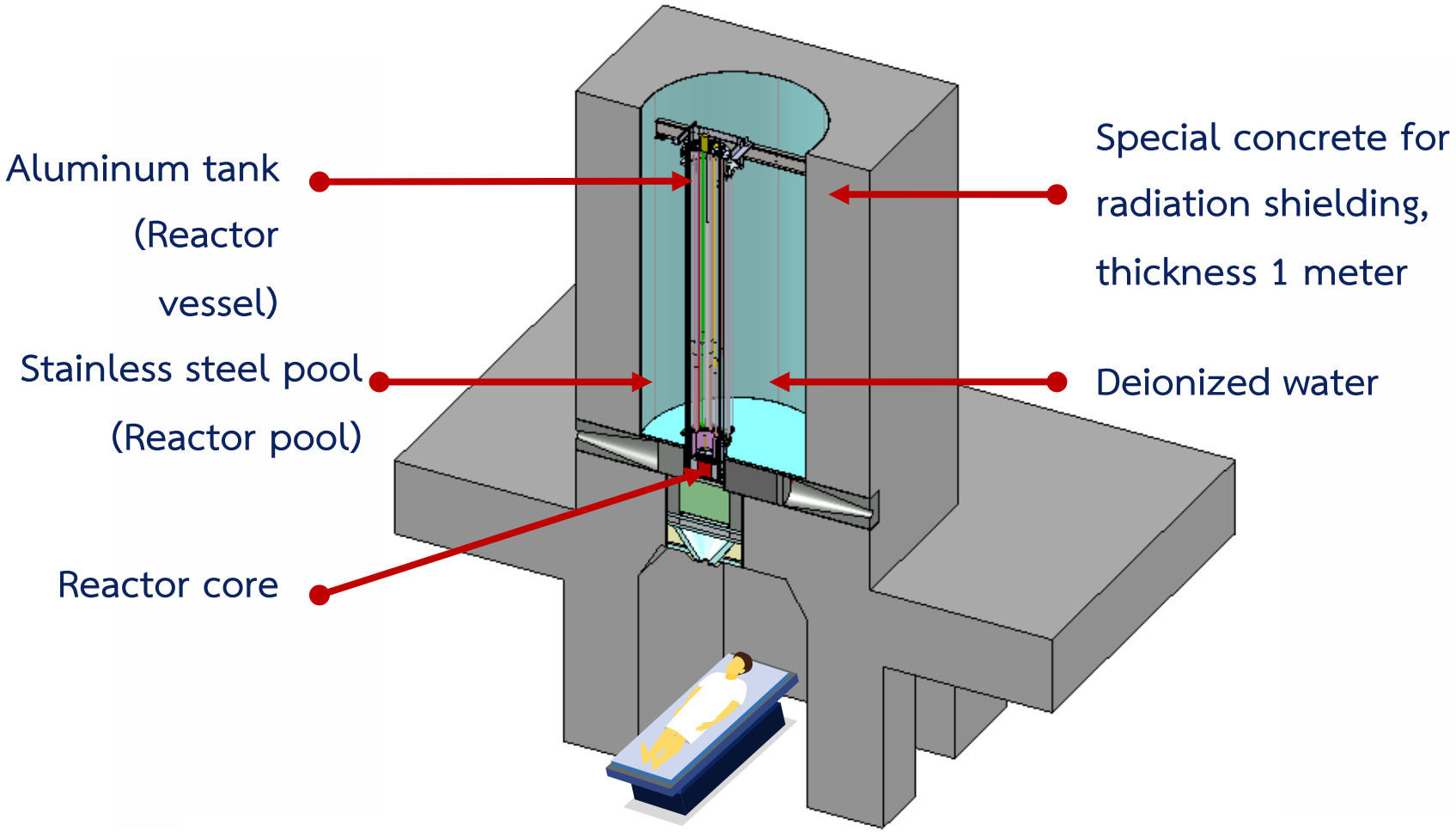


Top view of SUT-RR



- ❑ **Reactor type: Tank in pool**
- ❑ **Fuel meat: UO_2 (Low enriched Uranium)**
- ❑ **Reactor power:**
- ❑ **~ 45 kW for usage of Epithermal neutron**
- ❑ **~ 30 kW for normal usage**
- ❑ **Operating: 2.5 hours a day, 4 days a week**
- ❑ **One vertical neutron beam port**
- ❑ **Four horizon neutron beam ports**

Suranaree University of Technology Research Reactor (SUT-RR)



Utilization of the Suranaree University of Technology Research Reactor (SUT-RR)

Aims

- ❑ To apply nuclear technology in cancer treatment using the BNCT technique.
- ❑ Used for teaching some subjects related to nuclear technology.
- ❑ To provide training on the research reactor operation.
- ❑ To conduct research in
  - NAA → The vendor will provide us the training and Equipment.
  - Neutron Radiography
  - PGNAA

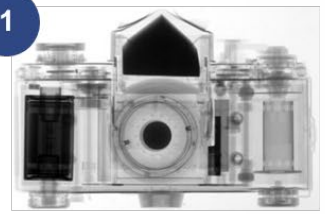
→
- Currently studying and planning the purchase of related equipment and tools.
- relevant personnel will be sent to train for use of various applications.

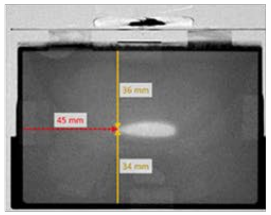
Utilization of the Suranaree University of Technology Research Reactor (SUT-RR)

Neutron radiography

For industries

1

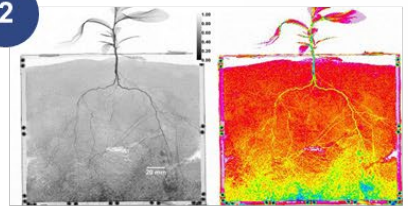




Analyze the filling of lithium-ion batteries for EV

ref: https: //www.psi.ch/de/niag/what-is-neutron-imaging, https://chargedevs.com/newswire/neutron-imaging-impro/

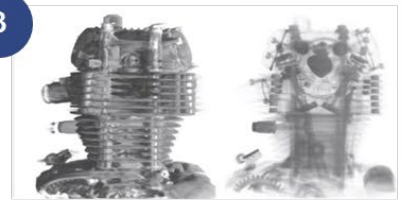
2



ref: https://berstructuralbioportal.org/neutron-imaging/

For **Biological** studies of plants and living things

3

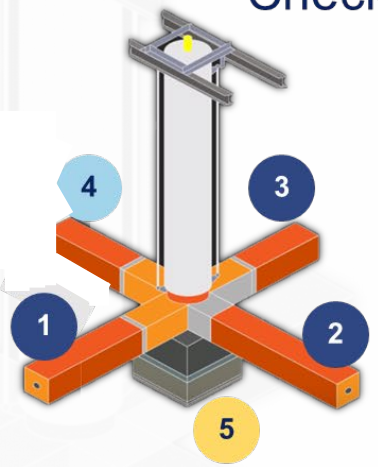


For **large samples** such as engines, exhaust pipes

ref: /https://www.psi.ch/sites/default/files/import/industry

4

Prompt Gamma Neutron Activation Analysis



Check the chemical composition

Check for toxins in food

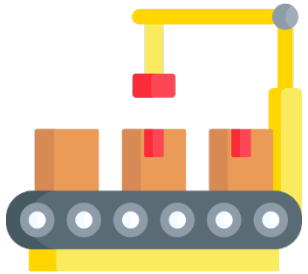
5

Boron Neutron Capture Therapy (BNCT)

Utilization of the Suranaree University of Technology Research Reactor (SUT-RR)

Neutron radiography

Manufacturing industry



- Inspection of internal structures and research of various materials in the industrial sector
- Used to detect internal defects in materials to improve production.
- Used to look at cracks or imperfections in internal parts.

Agriculture

- Biological studies plants and living things Study various processes related to water in living things for use such as ground breeding or conduct research to increase productivity
- Applications in geology and soil physics

Electric vehicle industry

- Used to check the quality or find defects in industrial materials such as fuel cells, batteries, and engine components.
- Used to measure excess electrolyte contained in lithium-ion battery cells to optimize production.
- Used to determine the amount of hydrogen in electrochemical analysis of fuel cells.

Archeology

- historical aspect Used to take photos of archaeology, antiquities, and various historical objects.
- Non-invasive study of cultural heritage objects and biological samples.

Utilization of the Suranaree University of Technology Research Reactor (SUT-RR)

Prompt gamma neutron activation analysis (PGNAA)

Manufacturing industry

- Investigate lithium-ion battery composition to optimize production in the EV industry.
- Check the cement mixing process to see if it is suitable for the manufacturer's needs or not.

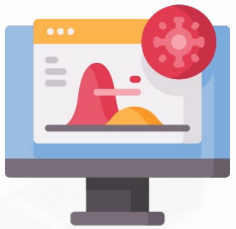
Mining industry

- Humidity analysis Carbon, sulfur and other compositional characteristics of coal samples in the power generation industry.
- Analyze the composition of the solution during the mining process. Increase mineral extraction efficiency

Forensic Science

- Detecting drugs in hair
- Detection of toxins in the body

Health

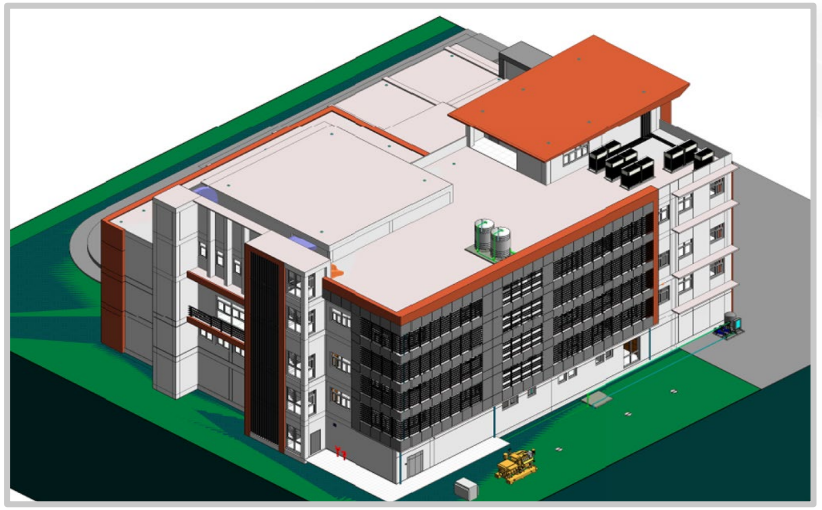


- Detect the amount of boron injected into patients for cancer treatment using the Boron neutron capture therapy (BNCT) technique.
- Measure various minerals in the body

Agriculture and food

- Check the amount of pesticides
- Check for impurities in agricultural products and food

Reactor Building



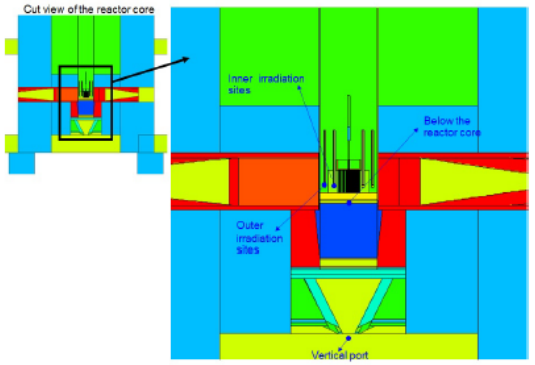
Reactor Building

Use BIM to design, build and operate including Decommissioning.

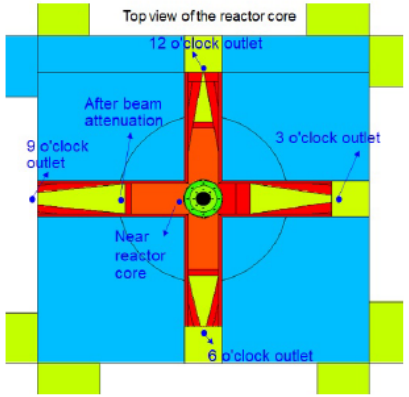
http://www.constructionthailand.net/

Reactor Building: Neutronics calculation

✓ **Neutronics calculation of the radiation field inside the BNCT-SUT reactor and building by MCNP**

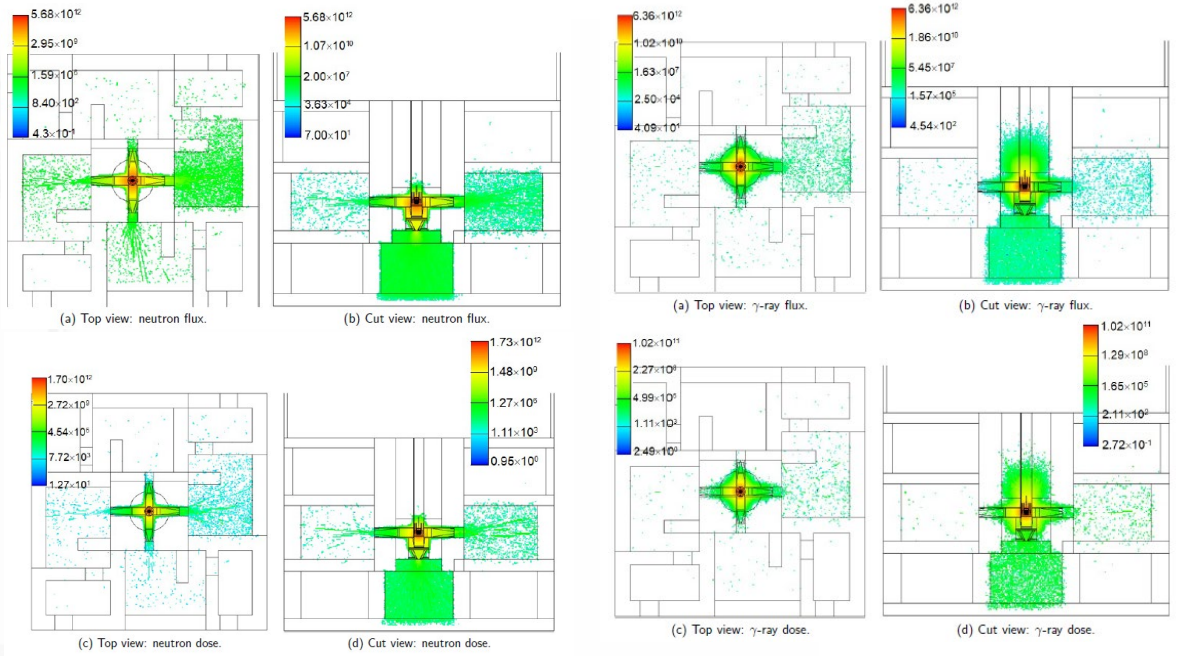


(a) Poloidal cut view at the BNCT-SUT reactor core and vertical beam port.



(b) Horizontal cut view of the beam port.

The picture show: Schematic view of the MCNP calculation model for BNCT-SUT reactor and building.



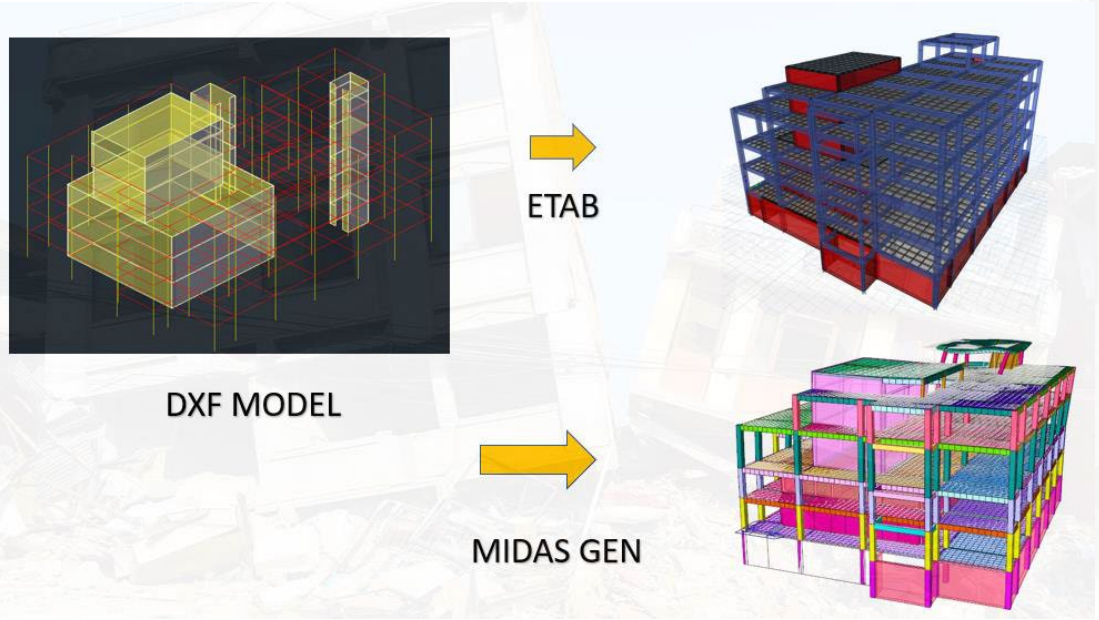
Neutron and Gramma-ray flux and dose distribution in the irradiation room.

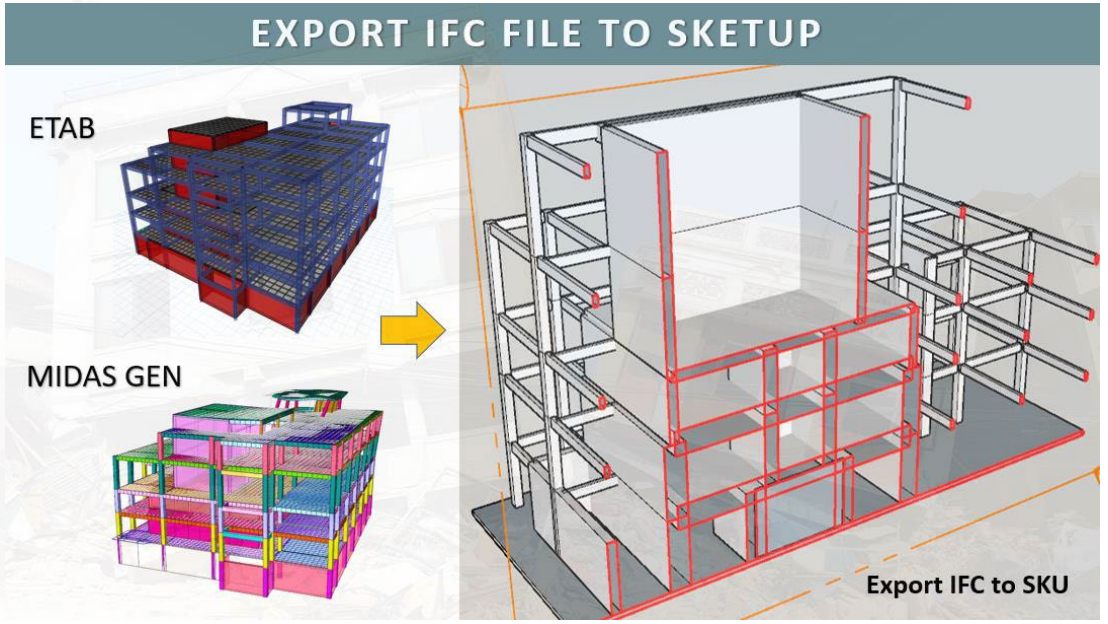
Functions

Detection	Delay	Response
• Intrusion Sensing • Alarm Communication • Alarm Assessment	• Barriers • Dispensable Barriers	• Interruption: - Communication to Response Force - Deployment of Response Force

Reactor Building: SEISMIC DESIGN

- ✓ Suranaree University of Technology's research reactor building was designed in accordance with the highest safety regulations. which is designed to be able to withstand the vibration of earthquakes as standard IAEA-TECDOC-1347 : INTERNATIONAL ATOMIC ENERGY AGENCY at the level with immediate building access able (Immediate Occupancy Level : IO) is Minimum design level acceleration = 0.10 g



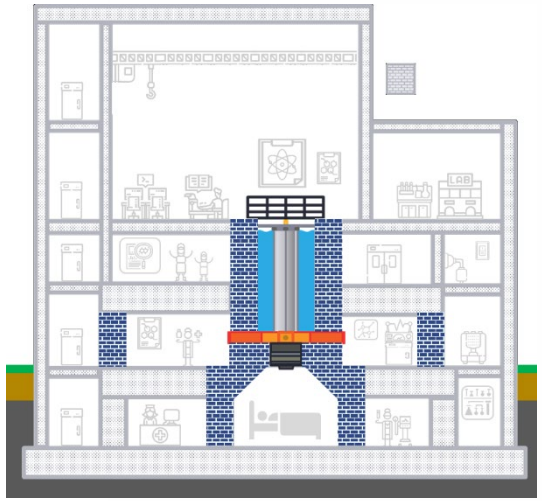


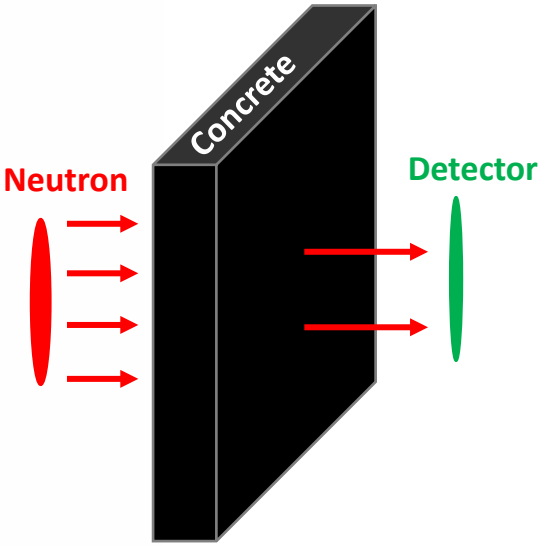
Reactor Building: SEISMIC DESIGN

- ✓ Design in accordance with the Ministerial Regulations 2021 and มยผ. 1301/1302-62 standards.
- ✓ Supports the design level Minimum design level acceleration = 0.10g, which meets the requirements of the IAEA standard - TECDOC-1347 (March 2003).
- ✓ Moving between layers (Story Drift) is less than $0.005h_{sx}$ according to มยผ. 1303- 57 standard., which is categorized as building immediately accessible (Immediate Occupancy , IO)
- ✓ Maximum displacement in the x-axis and the Y-axis is less than H/500
- ✓ Overturn Moment is greater than 1.50.
- ✓ The stability coefficient is less than 0.25 for wind loads and less than 0.10 for seismic loads.
- ✓ Wind design at wind speed 147.74 km/hr. accordance with the มยผ. 1311-50 standards as severe storm levels.

Reactor Building: Concrete testing

- ✓ Concrete that will be used in the reactor building is tested.
- ✓ Made high density concrete for Fire Protection Test of SUT-RR building.
- ✓ Radiation shielding tested by Thai Research Reactor (TRR-1/M1) Neutron Beam @TINT (Bangkok)





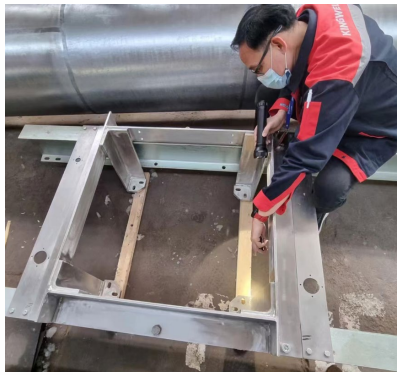
High density concrete (3,200 and 3,600 kg/cu m.)

Density (Kg. /cu. m.)	Cement (Kg.)	Sand (Kg.)	Water (Kg.)	Coal ash (Kg.)	Stone (Kg.)	additional substances (Kg.)	steel bar (Kg.)	Barite (Kg.)
3,200	382	355	251	68	520	20	1,226	385
3,600	262	428	150	47	692	5	1,630	465

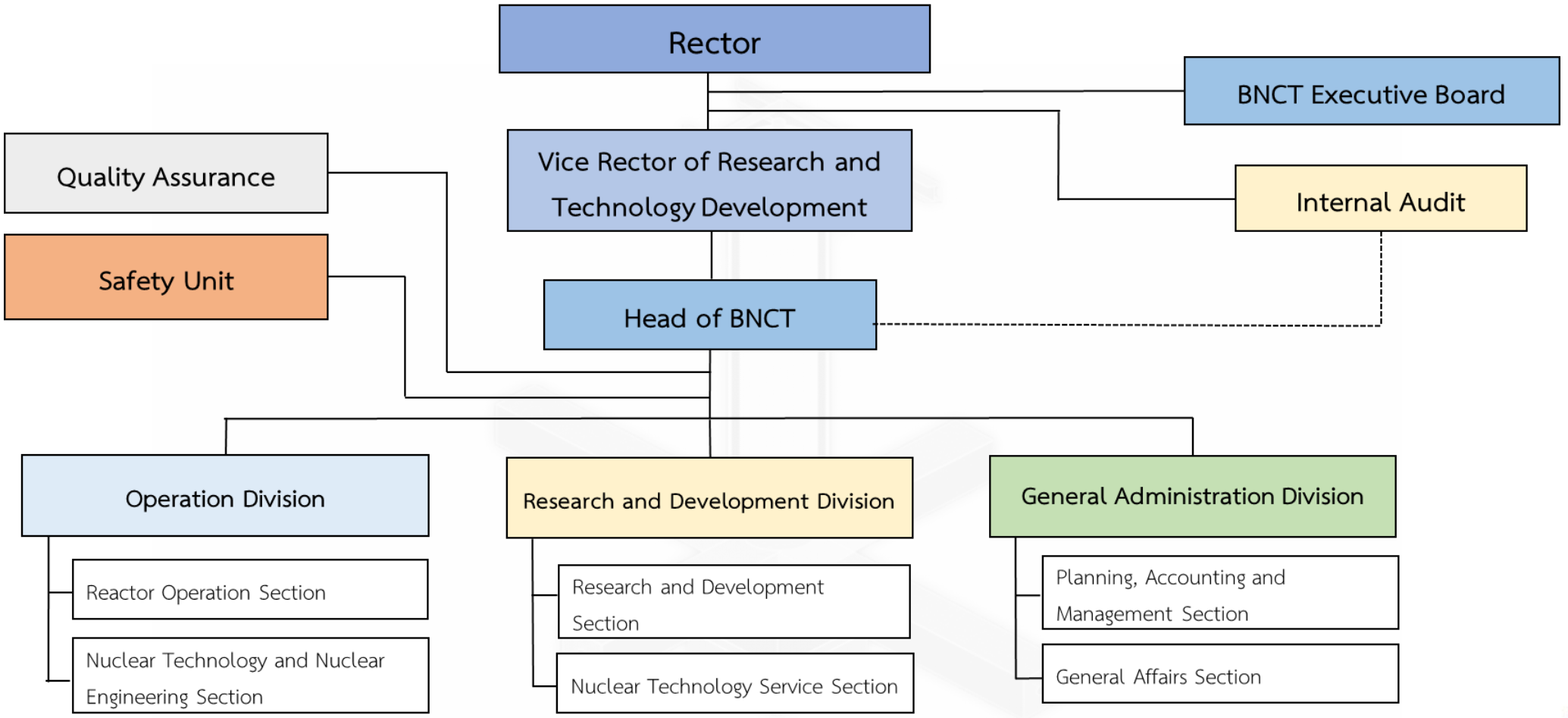
Inspection of the SUT-RR machine and components

- ✓ Before importing the SUT-RR into SUT, welding experts will examine the SUT-RR for structural integrity.
- ✓ Experts from KMUTT'S WELDING RESEARCH AND CONSULTING CENTER

KINGWELD



Organization of SUT - BNCT



Necessary knowledge and skills identified, and gaps in current capability assessed

Current human resource competences and capabilities

The personnel Current Status of SUT-RR

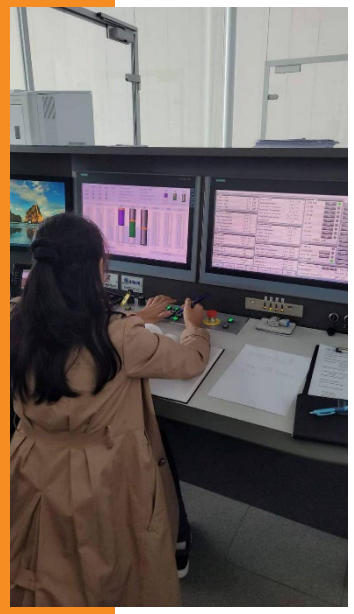
Education	Leader	Operation Section	Safety Unit Section	Admin. Section	Scholarship Student	Total (person)
Doctoral Deg.	1				1	2
Master Deg.		1	2			3
Bachelor Deg.		1	1	1		3

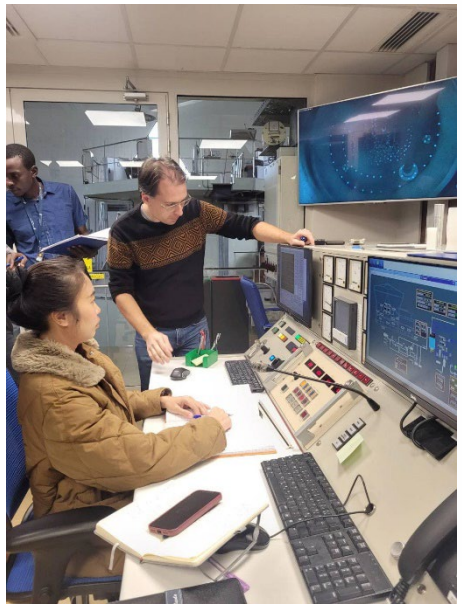
Human resource development: Workforce Planning for SUT - RR

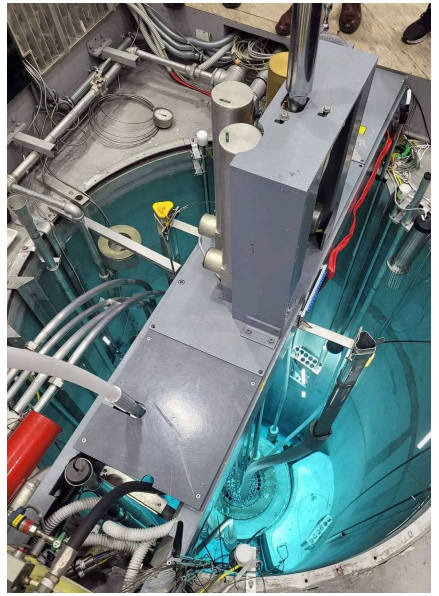
Section	Position	Number (persons)	Qualification
Operation	Engineer	6	B.Eng., M.Eng., Ph.D. (Nuclear /Mechanical/Electrical Engineering, , etc.)
	Technical	3	Technical (Electrical, Mechanical)
Safety Unit	Scientist	5	B.Sc., M.Sc. (Nuclear Engineering or Science/ Physics/Chemistry/Radioisotopes/Material, etc.)
	Health Physics	1	B.Sc. Nuclear Medicine/Nuclear Physics
	Laboratory Technical	2	High School Diploma (Science & Mathematics)
Research & Development	Engineer	3	Ph.D., B.Eng. (Nuclear Engineering/Physics, , etc.)
	Radiation Biologist	1	Ph.D. Radiation biologist
	Scientist	1	B.Sc. Radiography/Radioisotopes/Nuclear Engineering/ Physics/Chemistry, , etc.)
	Radiological Technology	1	B.Sc. (Radiological Technology)
Administrative	Administrative officer Administrative staff Total	3 1 27	B.B.A./B.A./B.F.A. (Management Communication Arts/Political Science)

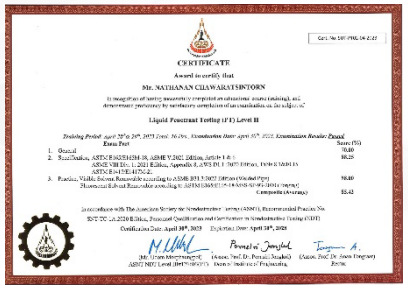
Human resource development

- ✓ Nuclear training and nuclear safety
- ✓ Radiation protection training
- ✓ Take the exam to receive the high-level radiation safety officer (RSO) license.
- ✓ Training on the use of SUT-RR by the manufacturer
- ✓ Other training related to operations.









Human resource development: Basic Science technology Competency

No.	Basic Science technology	Engineer	Scientist	Health Physics	Technical
1	Basic Mathmatics	✓	✓	✓	✓
2	Fundamental Physics	✓	✓	✓	✓
3	Basic Chemistry	✓	✓	✓	✓
4	Basic Electrical Engineering	✓	✓	✓	✓
5	Basic Engineering Mechanics	✓			✓
6	Basic Thermodynamics and Heat Transfer	✓			✓
7	Basic Mechanical Science	✓			✓
8	Basic Material Science	✓	✓	✓	✓
9	Basic Instrument &Control	✓	✓	✓	✓
10	Basic Engineering Drawings	✓			✓
11	Basic Radiation protection	✓	✓	✓	✓
12	Basic computer science	✓	✓	✓	✓
13	English llanguage	✓	✓	✓	✓
14	Quality system ISO9001:2015	✓	✓	✓	✓
15	Basic of accounting	✓	✓	✓	✓
16	Procurement regulation	✓	✓	✓	✓
17	Document management	✓	✓	✓	✓

Human resource development: Applied Science and technology Competency

No.	Applied Science and technology	Engineer	Scientist	Health Physics	Technical
1	Reactor engineering	✓	✓	✓	✓
2	System Structure and Componemt of MNSR	✓	✓	✓	✓
3	Utilization of research reactor and MNSR	✓	✓	✓	✓
4	Safety analysis of MNSR (MCNP programme)	✓	✓	✓	
5	Thermolhydrualic	✓			✓
6	Hydraulic Sysytem	✓			✓
7	OLC of MNSR	✓			✓
8	Operating Standards for research reactos	✓	✓	✓	✓
9	Operation and Maintenace of MNSR	✓			✓
10	Using the Autodesk Revit, Solid work	✓			✓
11	Nuclear Safety technology	✓	✓	✓	✓
12	Radiation protection	✓	✓	✓	✓
13	Nuclear fuel Cycle technology	✓	✓	✓	✓
14	Management Systems of 3S	✓	✓	✓	✓
15	Preventing accidents in industrial work	✓	✓		✓
16	Nuclear/Radioactivity Emergency preparedness	✓	✓	✓	✓
17	Safety and Security Culture self Assessment	✓	✓	✓	✓
18	Environmental Radioactivity Monitoring	✓	✓		

CONCLUSION

- SUT-BNCT Working under various specialist subcommittees, including the Technical and Engineering subcommittee, the Safety and Environmental subcommittee, and the Radiation Therapy subcommittee.
- This project will use a 45kw MNSR, mainly for research and training purposes, and most importantly for cancer treatment using BNCT technique.
- The SUT-BNCT project is currently applying for a building permit, which is expected to be received within this year. And Expected to receive the Operation license in 2031.
- The project has a staff of seven and will grow to 27 in the future.


THANK
YOU