The European Research Reactor Conference, 16-20 April 2023, Antwerp, Belgium

IAEA
International Atomic Energy Agency

IAEA Activities in Support of Utilization & Applications of Research Reactors

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Three Pillars - Main Areas of Activity

IAEA also serves as the UN's scientific forum for international cooperation in **the area of nuclear research**

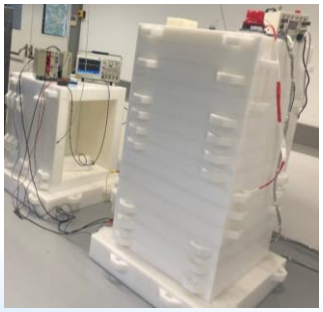
IAEA Physics Section: Main Technical Areas

Research & Applications with Accelerators & Neutron Sources

(incl. RR applications)

Nuclear Instrumentation

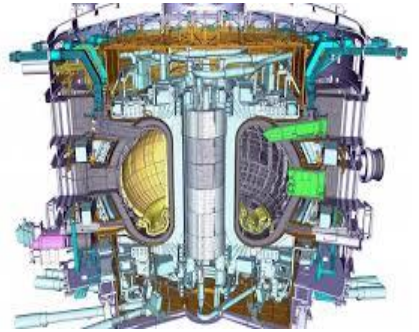
(incl. laboratory in Seibersdorf)



Nuclear Fusion

Research & Technology

(incl. coop. with ITER)

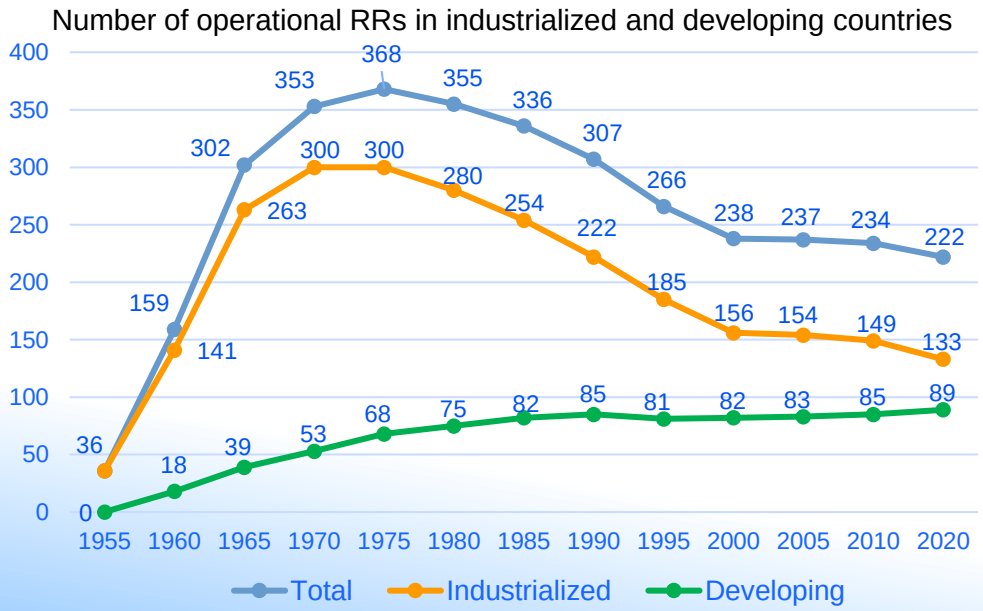


Contents of this presentation

- Research reactors worldwide
- IAEA activities in support of RR utilization: present & future
- Neutron Science Facility at SEIB
- IAEA RR Conference in Jordan

Key Issues and Challenges in RR Utilization

- Number of operational RR is decreasing globally
- Many RRs are not utilized to their full potential; absence of clear utilization purpose & strategy; lack of necessary budget
- Ageing, including ageing of staff; need for modernization/refurbishment of experimental facilities and effective transmission of knowledge
- Requests to assist in a new RR project; often the very 1st in the country



TOTAL	841
Operational	**222**
Temporary shutdown	10
Extended shutdown	13
Under construction	11
Planned	**13**
Permanent shutdown	56
Under decommissioning/ decommissioned	516

https://nucleus.iaea.org/RRDB/ (2023)

Research Reactors – Purpose

Application	Number of RR involved	Number of countries
Education & Training	161	50
Neutron Activation Analysis	116	49
Radioisotope Production	82	41
Neutron Imaging	68	35
Material and Fuel Irradiation	67	26
Neutron Scattering	44	28
Geochronology	25	22
Silicon Doping	23	15
Gem Coloration	20	12
Nuclear Data Measurements	18	11
Neutron Therapy	15	12
Other	115	33

https://nucleus.iaea.org/RRDB/ (2023)

Planned activities for 2023

- CRP on Development of Coupled Neutronic and Thermal-Hydraulic Calculational Methodologies for Research Reactors including Analysis and Treatment of Uncertainties, cross-cutting (active)
- CRP on Boron Neutron Capture Therapy (BNCT), jointly with NAHU-Medical Physics and Dosimetry, cross-cutting (planned)
- TR Workshop on Advances on Boron Neutron Capture Therapy, 3-7 July, Japan
- TR Workshop: 6th AUNIRA: Advanced Use of Neutron Imaging for Research and Applications, 30 Oct – 3 Nov, South Africa
- Technical Meeting on the Applications and Commercial Products and Services of Research Reactors, 6-10 Nov, Austria
- Workshop on the Use of Nuclear Analytical Techniques in Investigating Intellectual Property Crimes, 29 Nov – 1 Dec, France
- **International Conference on Research Reactors 2023, 27 November – 1 December 2023, Dead Sea, Jordan**

Integrated RR Utilization Review (IRRUR)

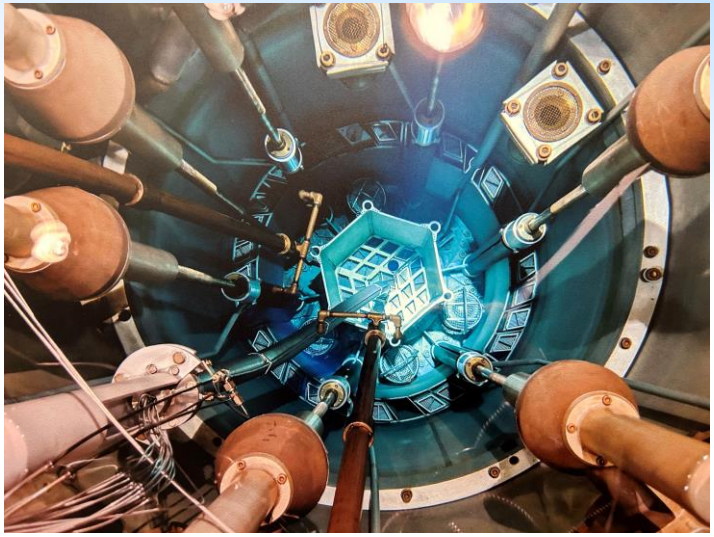
- Assessment of the utilization level of RRs, considering existing and potential capabilities, constraints, and needs for the products and services that the RR can provide.
- Identification of the challenges and opportunities towards effective, efficient, and sustainable utilization of the RR, and assess the potential that the RR could achieve in the mid-term.

- The IRRUR mission can be directed to all the major activities of the RR or limited to specific facility mission areas.
- Funded by a technical cooperation project, or by the inviting organization
- Pilot IRRUR mission to LENA RR at University of Pavia, 1-5 April 2019

- **2022: 3 missions to Chile, Peru and South Africa**

Integrated RR Utilization Review (IRRUR)

- **2023: 1 mission to Iran (Isfahan three RRs)**
- **2023: 2 missions to USA, NRAD-INL and MITR**



IAEA Services for RR Strategic Planning

- Assist RRs in developing and improving strategic planning
  - Templates, guidelines, & examples available
  - **Over 50 SP documents reviewed in the last five years; recommendations provided**
  - Follow-up and lessons learned workshops
- Workshops on Strategic Planning
  - Regional Workshop on Strategic and Business Planning for Research Reactors, 6-10 March 2023
  - Regional Meeting on Strategic Planning for New Research Reactor Projects, 12-16 June 2023
- E-Learning course on Strategic Planning

Support of TC Projects

- Support to regional and national Technical Cooperation Projects
- Support to new RR projects, existing RR projects, external meetings, and more!
  - The 10th African Conference on Research Reactor Safety, Operation and Utilization, Cairo, Egypt, 27 – 29 November 2022; proceedings issued
  - The Meeting on Regional Network of Research Reactors of Latin America and the Caribbean (RIALC), Vienna, Austria, February 27 to March 3, 2023
  - Regional Workshop on Milestones Approach for New Research Reactor Project, Lusaka, Zambia, 13 to 17 March 2023
  - …

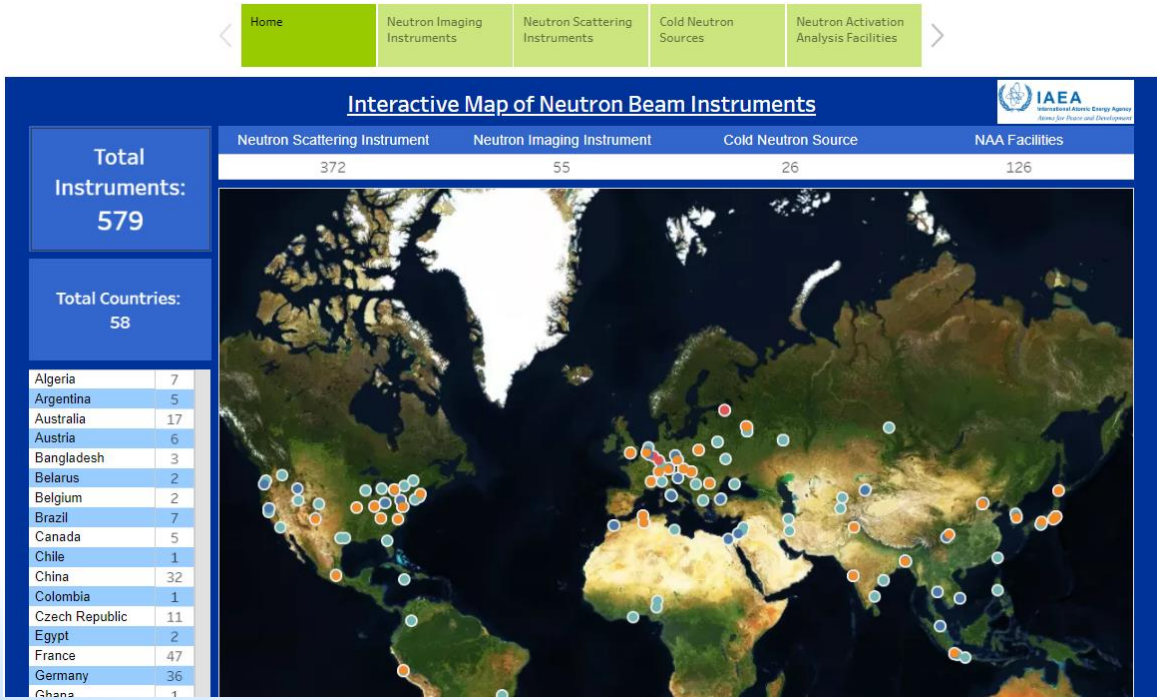
Proficiency testing and round robin exercises

- Interlaboratory comparison by **proficiency testing (PT) of analytical labs:**
  - Participation of about 80 labs world-wide per round
  - Comprehensive report and feedback provided
  - Demonstrated improvement of performance in Europe
  - Yearly exercises are conducted, jointly with X ray techniques
  - In 2021, significant upgrade of the statistical methods for data treatment, to adhere to ISO 13528:2015 “Statistical methods for use in PT by interlaboratory comparison”
  - All reports and more info: http://www.pt-nsil.com/

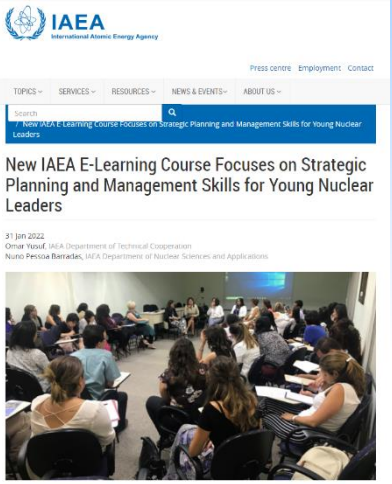
- **Neutron imaging round robin to test 2D and 3D** resolution and contrast, in cooperation with PSI, Switzerland
  - 5 sets of samples produced in 2019. Distributed to 15 labs worldwide, 1st exercise concluded in 2020.
  - 2nd phase in 2020-2022. Distributed to 7 labs.

IAEA Portals and Databases

- **Neutron Applications Portal**
  - Case studies, interactive maps, training materials, and more!
  - https://nucleus.iaea.org/sites/neutrons
- **New online databases**
  - BNCT facilities (RR + accelerators)
  - Accelerator based neutron sources (generators, CANS, spallation)
  - Neutron Beam Instruments (imaging and scattering instruments, cold moderators, NAA facilities)
  - https://nucleus.iaea.org/sites/neutrons/SitePages/InteractiveMap-of-NBInstruments.aspx



IAEA E-learning Courses

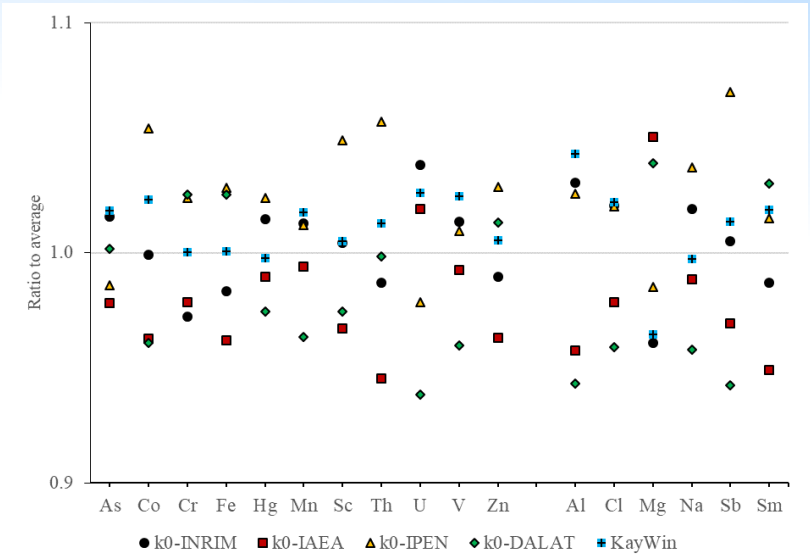


- **E-learning course on NAA**
  - Over 800 users from over 70 MSs
- **E-learning course on Neutron Imaging**
  - Over 400 users from over 70 MSs. Advanced course forthcoming.
- **E-learning course for Research Reactor Personnel**
  - Over 800 users; all UN official languages soon
- **E-learning course on Strategic Planning for National Nuclear Institutions**
  - Over 380 users; Spanish version to be released soon
- **E-learning course on Nuclear Analytical Techniques for Forensic Sciences**
  - Includes NAA, accelerator techniques, and X-ray techniques
  - Over 500 users; bilingual English and Spanish
- **Physical and Chemical Sciences in W4NSEC – Women for Nuclear Science Education and Communications**
- **Joint IAEA-ANL Training course on Strategic Planning and Management for Young Leaders (2020-2021)**
- **Specific Considerations and Guidance for the Establishment of Ionizing Radiation Facilities**

Software/Tools

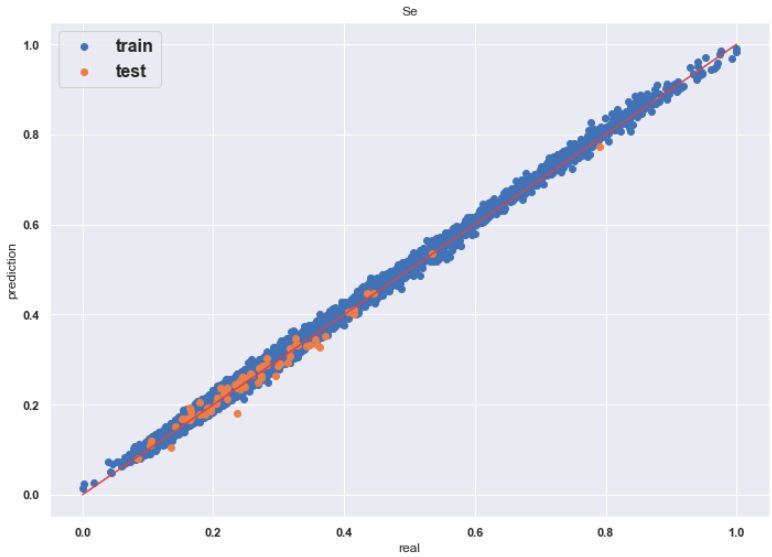
IAEA intercomparison of k_0-NAA software

- Menno Blaauw main expert
- Presented at 8th k0 Users Workshop 2022
- TECDOC has been accepted, all data and results will be available



Artificial Neural Networks for NAA

- Proof of concept on a very simple case
- Presented at 8th k0 Users Workshop
- Paper published https://link.springer.com/article/10.1007/s10967-022-08568-8
- Code and results available at https://github.com/IAEA-Physics-neutrons



Publications (2022-2023)

Home / Publications / Research Reactor Benchmarking Database: Facility Specification and Experimental Data (Revision)

Research Reactor Benchmarking Database: Facility Specification and Experimental Data (Revision)

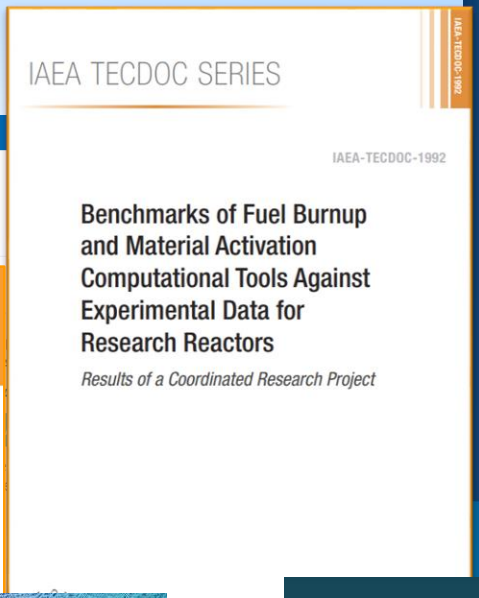
Technical Reports Series No. 480 (Rev.1)

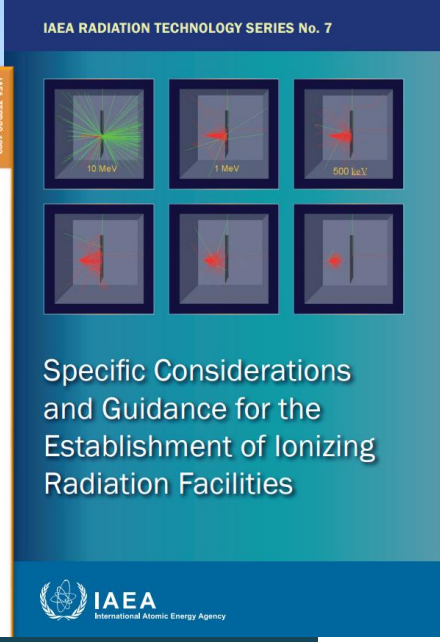
English STI/DOC/010/480 (Rev.1)

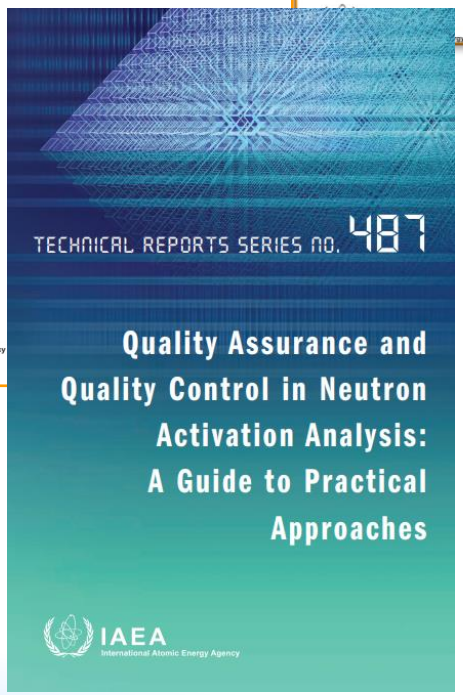
1 page | € 42.00 | Date published: 2022

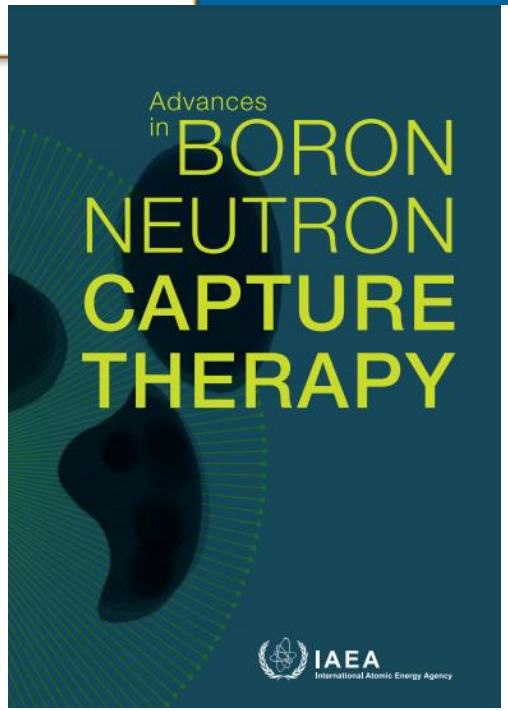
Download ZIP (100.02 MB)

Get citation details









https://www.iaea.org/topics/research-reactors/bibliography

IAEA Collaborating Centres

- **Research Institute Delft** was re-designated as IAEA Collaborating Centre for the period 2021-2024, for neutron activation and neutron-beam based methodologies

- **ANSTO** was re-designated as IAEA Collaborating Centre for the period 2020-2024, for new and advanced techniques and applications of nuclear science and technology towards a sustainable environment

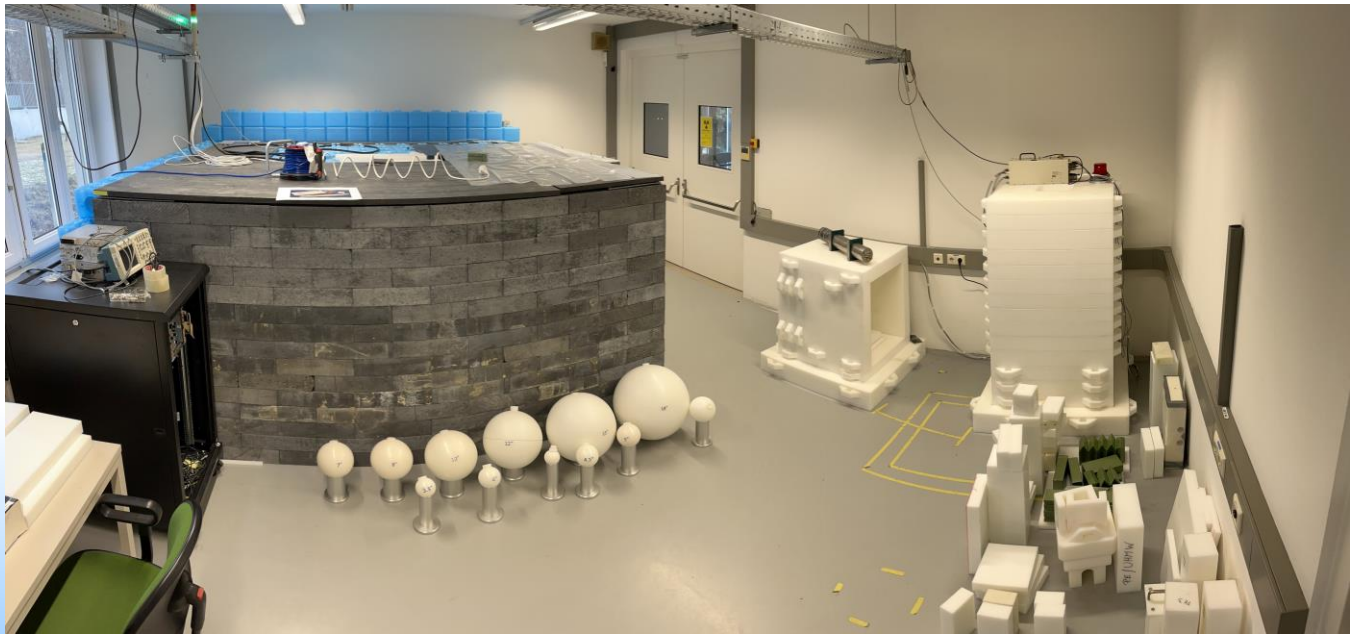
- **Okayama University** was designated as an IAEA Collaborating Centre for the period 2022-2026, for Boron Neutron Capture Therapy

Establishment of an IAEA Neutron Science Facility

Nuclear Science and Instrumentation Laboratory (NSIL) at Seibersdorf

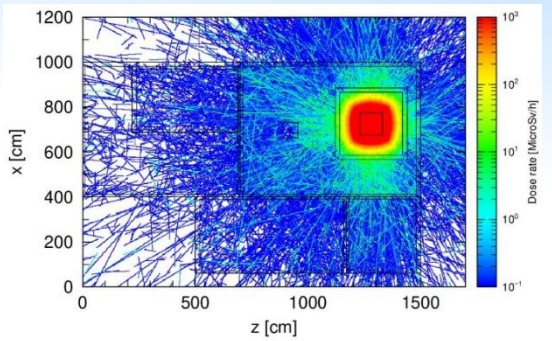
NSIL aims to **enhance the in-house capacity** in available laboratory facilities and instrumentation by operating **three complementary probes** for irradiation and analysis purposes, including capacity building:

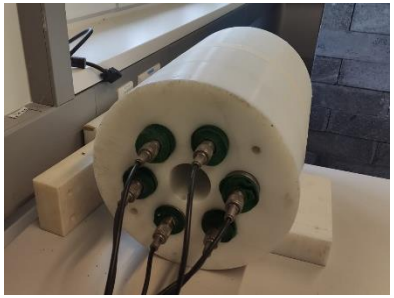
- **X-rays**, using existing equipment and recent upgrades (Energy Dispersive X-ray Fluorescence and Wavelength Dispersive X-ray Fluorescence)
- **Neutrons, by newly established neutron science facility with D-D (2.45 MeV) and D-T (14.1 MeV) neutron generators**
- **Ion-beams,** through the planned establishment of a compact ion-beam accelerator facility (2023-)

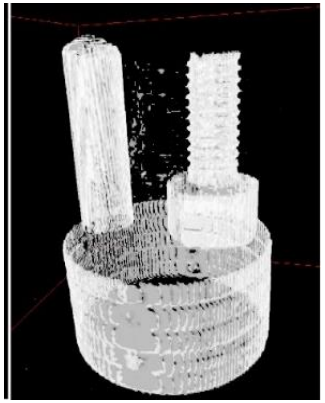


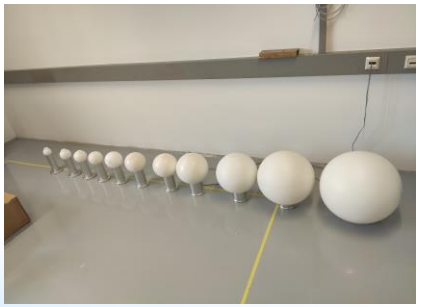
Training Opportunities Available and Planned

- Gamma and neutron radiation monitoring systems
- Full scale Monte Carlo modelling tools: MCNP and PHITS
- Dual neutron/X-ray radiography/tomography system
- Delayed Neutron Counting *(uranium samples from SGs)*
- Bonner sphere spectrometer & other neutron instrumentation
- NAA using HPGe gamma spectrometer









IAEA International Conference on RRs:
Achievements, Experience, and the Way to a Sustainable Future

- 27 November – 1 December 2023, Dead Sea, Jordan
- Technical Programme to be issued shortly
- https://www.iaea.org/events/conference-on-research-reactors-2023

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Thank you!