

# IAEA activities in support of development and utilization of neutron sources

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Physics Section and Nuclear Science and Instrumentation Laboratory  
International Atomic Energy Agency

# Outline

- **Organization**
- Highlights of recent achievements
- Neutrons4NA initiative
- CANS
- BNCT
- Next steps



# Division of Physical & Chemical Sciences (NAPC)



**Nuclear Science, Nuclear Data, Nuclear Physics, Radiation and Isotope Sciences & Applications, Water Resource Management**

## Nuclear Data

Data Development

Data Services

Atomic & Molecular Data

## Physics

Accelerator & Research Reactor Applications

Nuclear Instrumentation

Nuclear Fusion

## Radiochemistry & Radiation Technology

Medical Radioisotope production, Radiopharmaceuticals

Radiotracers, NCS & NDT in industry

Radiation technology applications

Terrestrial Environment

## Isotope Hydrology

Isotopic methods for groundwater assessment

Water resource management

Scenario modelling

# Physics Section: main technical areas



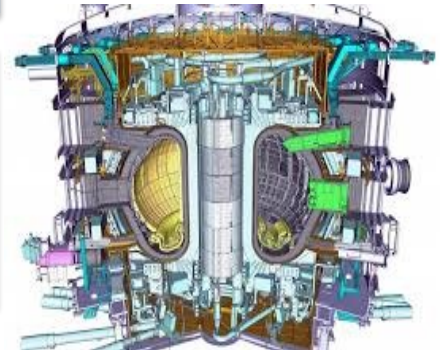
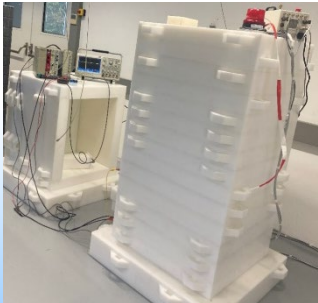
## 1.4.2 Research & Applications with Accelerators & Neutron Sources (incl. RR applications)



## 1.4.3 Nuclear Instrumentation (incl. laboratory in Seibersdorf)



## 1.4.4 Nuclear Fusion Science & Plasma Physics (incl. coop. with ITER)



# Subprogramme 1.4.2 Research and Applications with Accelerators and Neutron Sources



## Main Objectives:

- Support MSs in strengthening their capabilities to conduct research with accelerators and neutron sources (incl. RRs)
- Support MSs in strengthening their capabilities to expand the applications of accelerators and neutron sources (incl. RRs)

## Projects:

- 1.4.2.1 Accelerator and neutron source applications in multiple disciplines
- 1.4.2.2 Enhancing research with accelerators and neutrons



# Physics Section in numbers



- **Coordinated Research Projects:** 7 active
- **TC projects:** >50 active in >50 Member States
- **Meetings/Workshops/Schools:** >50/year
- **Major Conferences (3):** Accelerators, RRs, Fusion Energy
- **Data bases/portals (4):** accelerators, neutrons, instrumentation, fusion
- **Collaborating Centers (8):** ANSTO, TU Delft, Elettra, iThemba Labs, Univ. Paris Saclay, Univ. of Okayama, Univ. of Singapore, MIT PSFC
- **Cooperation agreements (9):** ITER, UNICRI, ITU, FIA, Elettra, RBI, PPPL, ASSIP, CEA
- **Events in cooperation:** >5/year

# E.g. Organization of Three Major Conferences



**29TH IAEA  
FUSION ENERGY CONFERENCE**

16–21 October 2023  
London, United Kingdom of  
Great Britain and Northern Ireland

**#Fusion2023**

Organized by the  
**IAEA**  
International Atomic Energy Agency

Hosted by the Government of  
United Kingdom of Great Britain  
and Northern Ireland  
through the  
**UK Atomic  
Energy  
Authority**

Next in 2025, 2027...

International Conference on  
**Accelerators for Research  
and Sustainable Development:**  
From Good Practices Towards Socioeconomic Impact

**23–27 May 2022**  
IAEA Headquarters, Vienna, Austria

Organized by the  
**IAEA**  
International Atomic Energy Agency  
Atoms for Peace and Development

CN-301  
#Accelerators2022  
[www.iaea.org/iaea/iaecconf22](http://www.iaea.org/iaea/iaecconf22)

Next in 2026

International Conference on  
**Research Reactors**  
Achievements, Experience and the Way to a Sustainable Future

11 – 15 November 2024  
Vienna, Austria

**#ResearchReactors2024**

Organized by the  
**IAEA**  
International Atomic Energy Agency  
Atoms for Peace and Development

Next in 2028 [physics@iaea.org](mailto:physics@iaea.org)

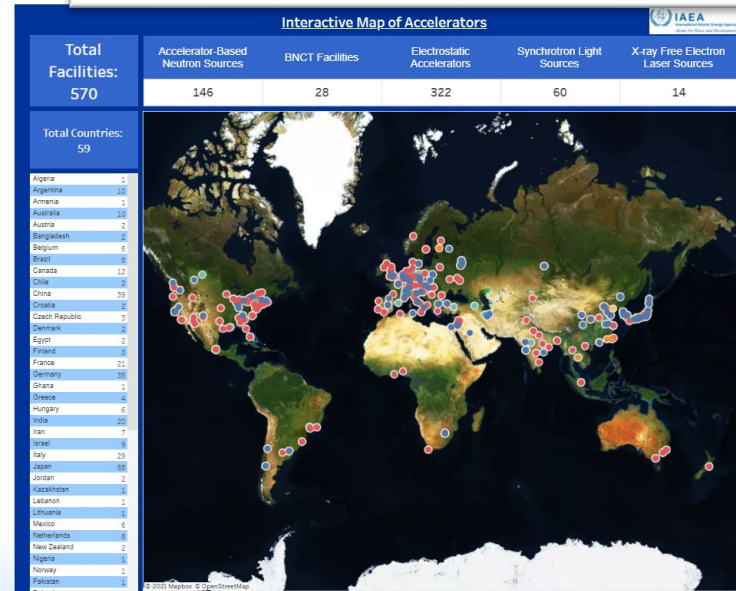
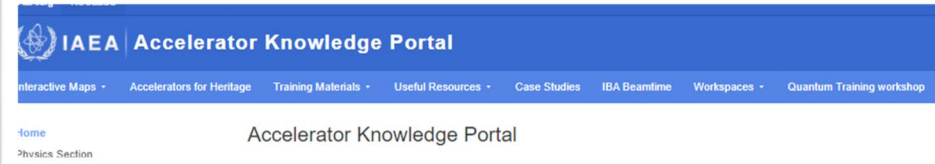
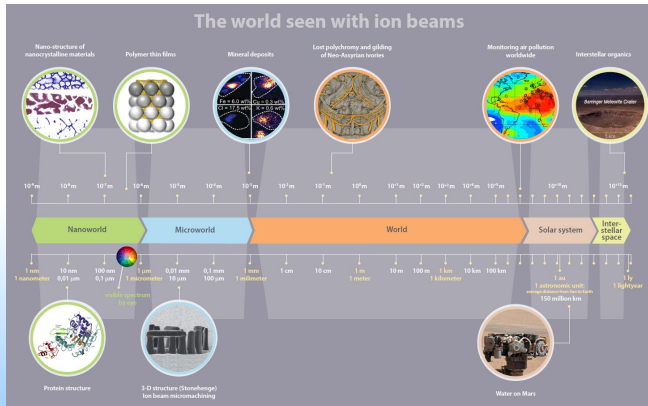
# E.g. managing thematic portals and data bases

- 1) **Accelerators:** <https://nucleus.iaea.org/sites/accelerators/>
- 2) **Neutrons:** <https://nucleus.iaea.org/sites/neutrons/>
- 3) **Fusion:** <https://nucleus.iaea.org/sites/fusionportal/>
- 4) **Instrumentation:** <https://nucleus.iaea.org/sites/nuclear-instrumentation>

## E.g. Accelerator Knowledge Portal

16000+ visitors/users in 2024; our interactive maps include

- 570+ ion beam accelerators
- 1200+ medical cyclotrons
- 400+ neutron beam instruments
- 1300+ XRF facilities





# Portals and databases (1/2)

- **Neutron Applications Portal**

<https://nucleus.iaea.org/sites/neutrons>, on-line since June 2022

- Number of visitors/users continues to grow

NA Neutron Applications Portal

Home IRRUR missions Neutron Applications Interactive Maps Training Materials Case Studies Useful Resources Workspaces Contact Us

Case Studies

Case Studies

Visit the Research Reactor Information Hub!

E-Learning

Check Out Our e-Learning Courses!

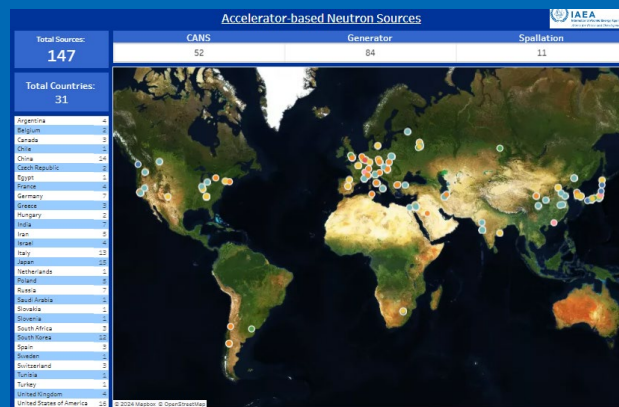
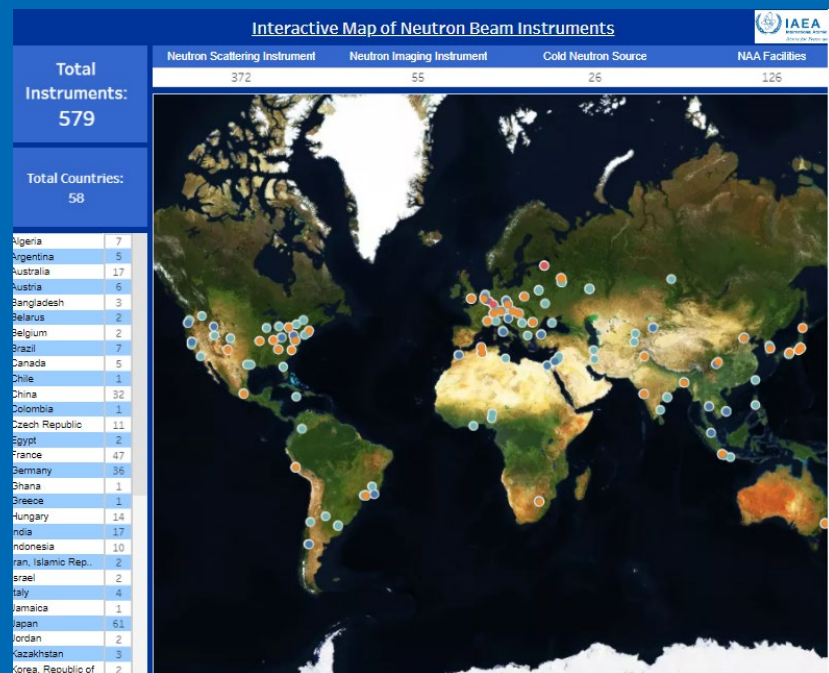
INTERNATIONAL CONFERENCE ON RESEARCH REACTORS

11-15 NOVEMBER 2024 VIENNA, AUSTRIA >

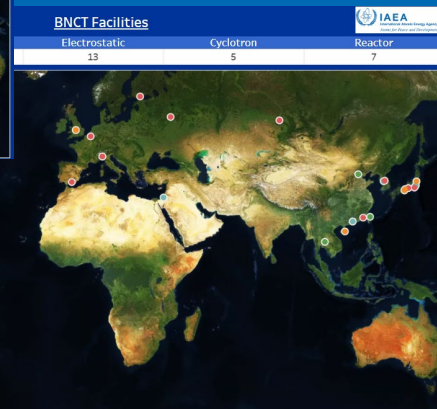
Explore the New Features of the Research Reactor Database!

# Portals and databases (2/2)

- **New online databases**
  - Neutron Beam Instruments, NAA facilities and Cold Neutron Sources
  - Accelerator based neutron sources (generators, CANS, spallation)
  - BNCT facilities (accelerator & RR based)

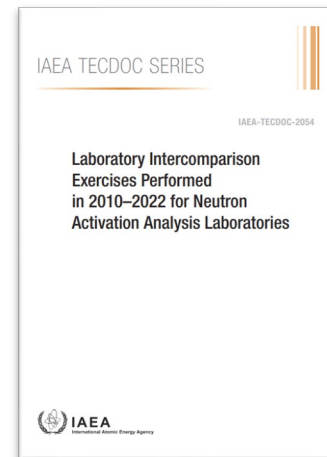
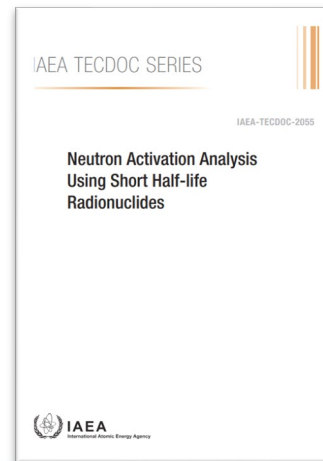
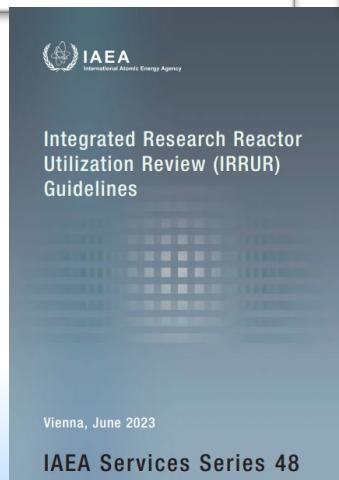
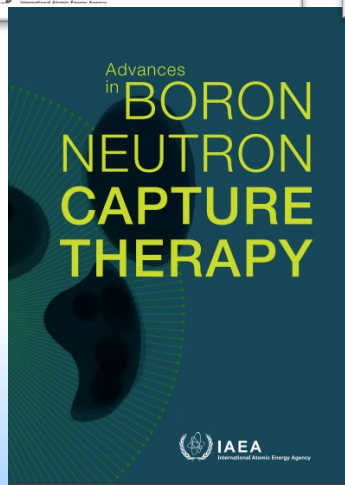
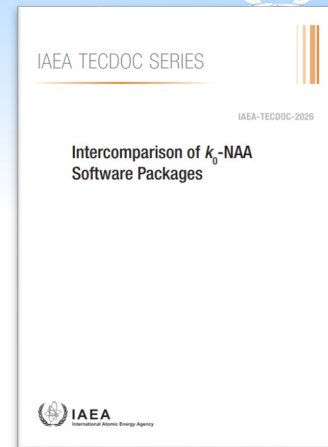
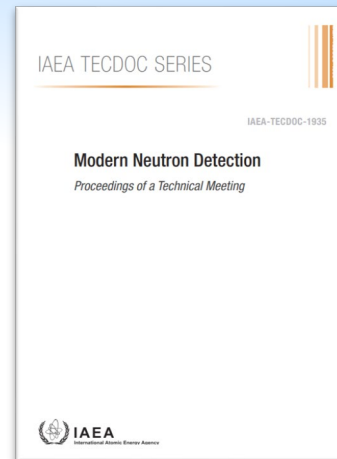
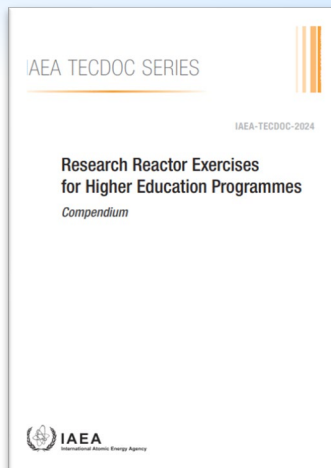
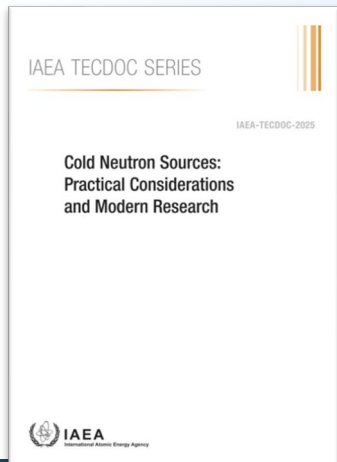
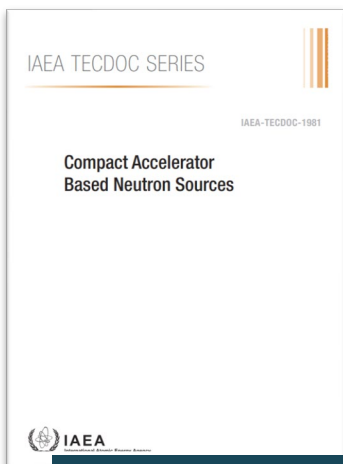


Argentina	1
Belgium	1
China	6
Finland	1
Israel	1
Italy	1
Japan	10
Russia	1
South Korea	1
Spain	1
Taiwan, China	1
Thailand	1
United Kingdom	1



# Selected Publications

<https://www.iaea.org/publications>





# E.g. IAEA Neutron Science Facility (NSF) at SEIB

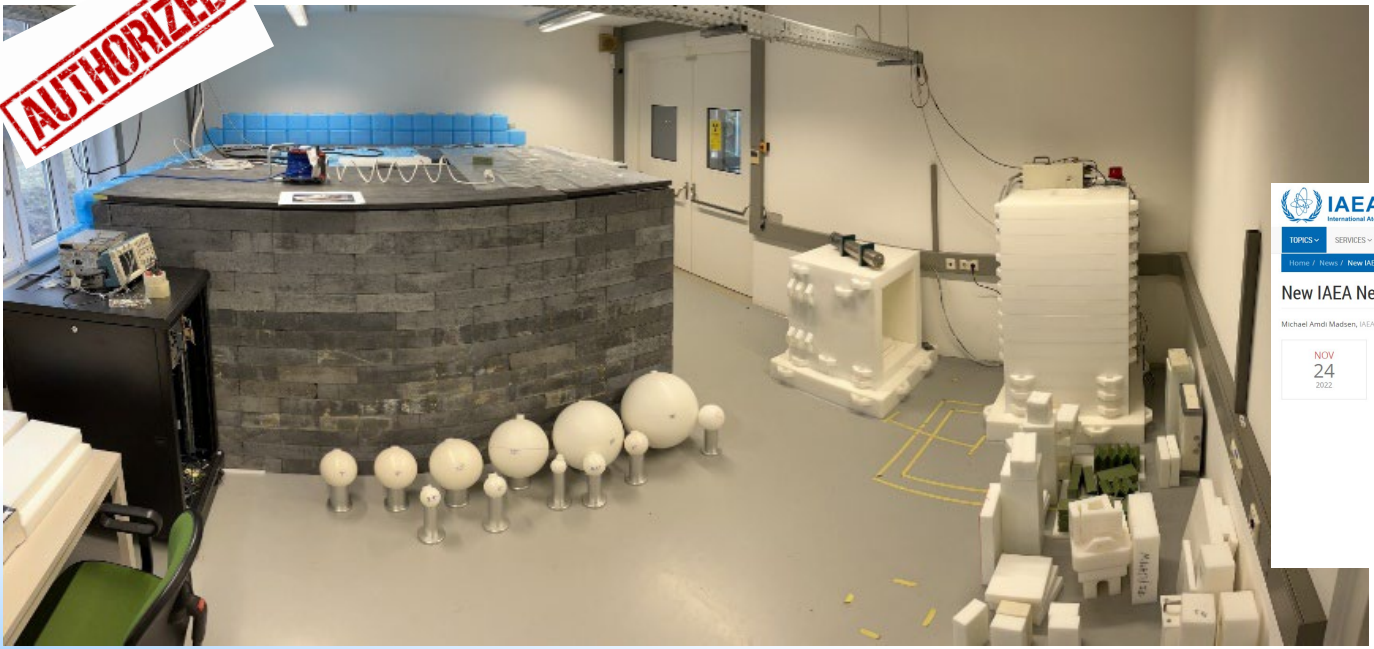



NSF is based on two neutron generators, **operational since 2022**

- **D+D reaction → 2.45 MeV neutron source** (fission neutrons, 5e6 n/s); US EB funded
- **D+T reaction → 14.1 MeV neutron source** (fusion neutrons, 5e8 n/s); Australia donation



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### New IAEA Neutron Facility Delivers First Hands-on Training

Michael Andri Madsen, IAEA Office of Public Information and Communication

NOV 24 2022



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Francois Idjwelle handles a neutron generator at the new IAEA facility in Seibersdorf, Austria. (Photo: D. Calma/IAEA)

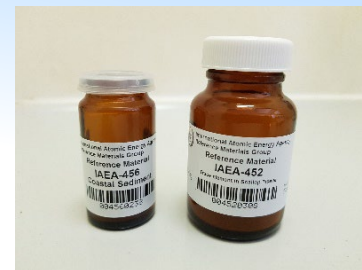


# Proficiency Tests for NAA & other Analytical Techniques



Organized twice a year in support IAEA Member States laboratories to:

- identify analytical problems
- improve the quality of their analytical results
- acquire / maintain their accreditation
- provide a regular forum for discussion and technology transfer in this area
- **In 2023: +90 analytical laboratories participate, representing +50 countries**



Scheme of the proficiency test:

- Provision of various samples at no cost
- Full anonymity of laboratories is granted
- Issue of final reports



## Previous Proficiency Tests

PTNATIAEA/20	April 2022 - December 2022	clay sample plant sample	<a href="#">Download PDF final report</a>
PTNATIAEA/19	May 2021 - March 2022	clay sample plant sample	<a href="#">Download PDF final report</a>
PTNATIAEA/18	February 2020 - May 2021	Soil	<a href="#">Download PDF final report</a>

More info: <http://www.pt-nsil.com/>

# Scheme of IAEA Collaborating Centres



- **ANSTO, Australia** (2021-2024) on New and Advanced Techniques & Applications of Nuclear Science & Technology Towards a Sustainable Environment
- **TU Delft Reactor Institute, Netherlands** (2021-2024) on NAA & neutron-beam based methodologies
- **Okayama University, Japan** (2022-2026) on Boron Neutron Capture Therapy (BNCT)



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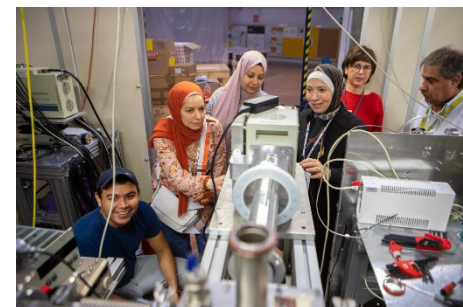




# 1.4.2 Acc&RR highlights of 2024

## Scientific - Technical events (1250+ participants):

- IAEA RR Conference 11-15 Nov. 2024, VIC, Austria; 300+ in person and 200+ virtual participants, jointly with NE and NS
- 10 Technical Meetings on
  - neutron beams; market analysis; RR applications; small power RRs; RR utilization design; Neutrons4NA initiative
  - establishment of accelerators; radiocarbon dating; forensic science;; heritage science
- 9 TR workshops on
  - RR feasibility study; NAA techniques; RR bidding process; RR strategic planning
  - accelerator technologies; synchrotron techniques; IBA techniques; environmental pollution; cultural heritage with synchrotrons;
- 2 ICTP schools on
  - laser-driven radiation sources; synchrotron applications
- 2 EVT in cooperation: AONSA neutron school (India), Microprobe Conference (Portugal)
- **Webinars:** BNCT, NTD-Si, Atoms4Heritage series...





# Outline

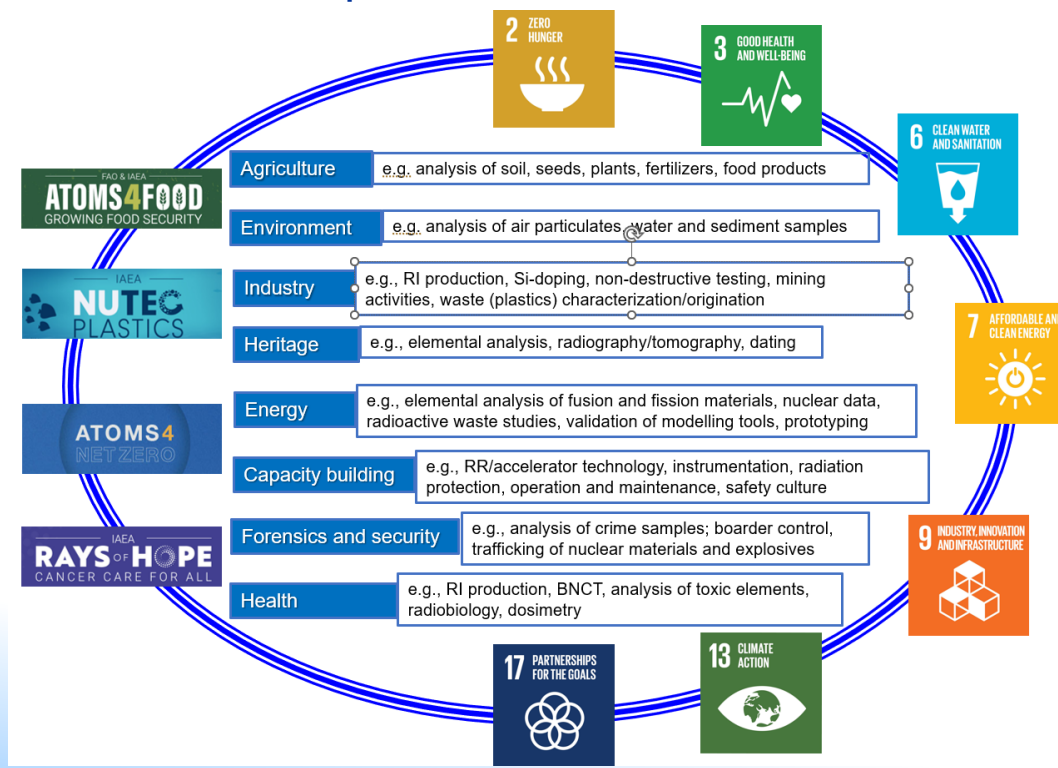
- Organization & involved staff
- Highlights of recent achievements
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# Neutrons4NA initiative: rationale



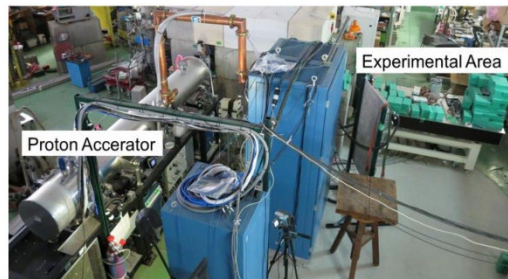
Tailored and stepwise approach through promotion, capacity building, technology transfer and facilitated access to **Neutrons4NA** and resulting socioeconomic development in the Member States



# Neutrons4NA: objective



**Bridging the gap between neutron generators, CANS and RRs:  
tailored and stepwise approach**



	Neutron generator	Compact accelerator-based neutron source	Research reactor / spallation source
Neutron source, n/s	$<10^{10}$	$<10^{14}$	$>10^{15}$
Capital cost, €M	0.1-0.2	3-10	60-700
O&M costs, €M	0.02	0.2-1.0	3-100
Staff, number	1	2-3	10-100

# Neutrons4NA: scope of support

- Well established facilities offering expertise and advice services to perform justification statement and feasibility study for decision making-process on investment:
  - Quantification of needs,
  - Choice of tailored and cost-effective technology,
  - Infrastructure assessment,
  - Cost-benefit and risk analysis.
- Long term facilitated support of the project at different stages of implementation, e.g.
  - Capacity building (hands on training...),
  - Share of experience from well-established and relevant facilities,
  - Share of experience regarding tailored and cost-effective technology selection.





# Neutrons4NA: project proposal

- **Proposed instrument/framework:** **IAEA Peaceful Uses Initiative (PUI)**
- **Duration:** 4 years minimum
- **Beneficiaries:** target MSs without access to neutron sources
- **Partners:** MSs with well-established facilities and technology providers
- **Coordination:** IAEA
- **Funding:** extrabudgetary contribution from conventional and non-conventional donors
- **Means of implementation:**
  - Expert missions
  - Scientific Visits and Fellowship training
  - National workshops
  - Review of strategic plans and feasibility studies
  - Annual progress meetings of PUI partners.



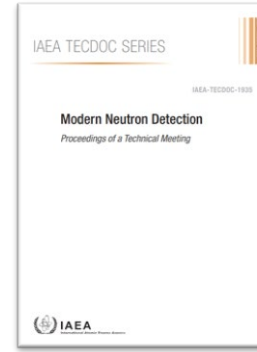
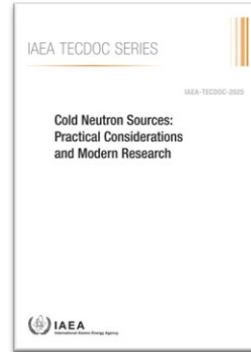
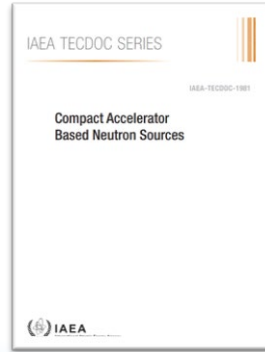
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# Activities in support of CANS

- **Meetings/Workshops:**
- **Data bases/portals :** accelerators, neutrons, instrumentation
- **Collaborating Centers (6):** ANSTO, Elettra, iThemba Labs, Univ. Paris Saclay, Univ. of Okayama,
- **Cooperation agreements:** CEA
- **Publications**





# Outline

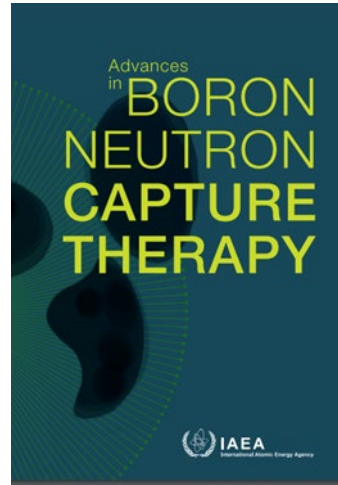
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# Activities in support of BNCT

- **Meetings/Workshops:**
- **Data bases/portals** : accelerators, neutrons, instrumentation
- **Collaborating Centers:** Univ. of Okayama,
- **Publications**
- **Webinars**



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# Next steps



- **New CRPs**
  - Boron Neutron Capture Therapy, EB funding secured
  - Neutron beam instrumentation at low and medium intensity neutron sources, planned
- **New Collaborating Centres**
  - TUM FRM2 Germany, letter of intent received
- **Publications in progress**
  - History, Development and Future of the SLOWPOKE and MNSR RRs; with IAEA PC
  - Research Reactor Produced Radioisotopes, update of TECDOC 1340; in draft
  - Applications of Research Reactors (Rev.1), Nuclear Energy Series; in draft
  - ...

# E.g. IAEA Ion Beam Facility project at SEIB

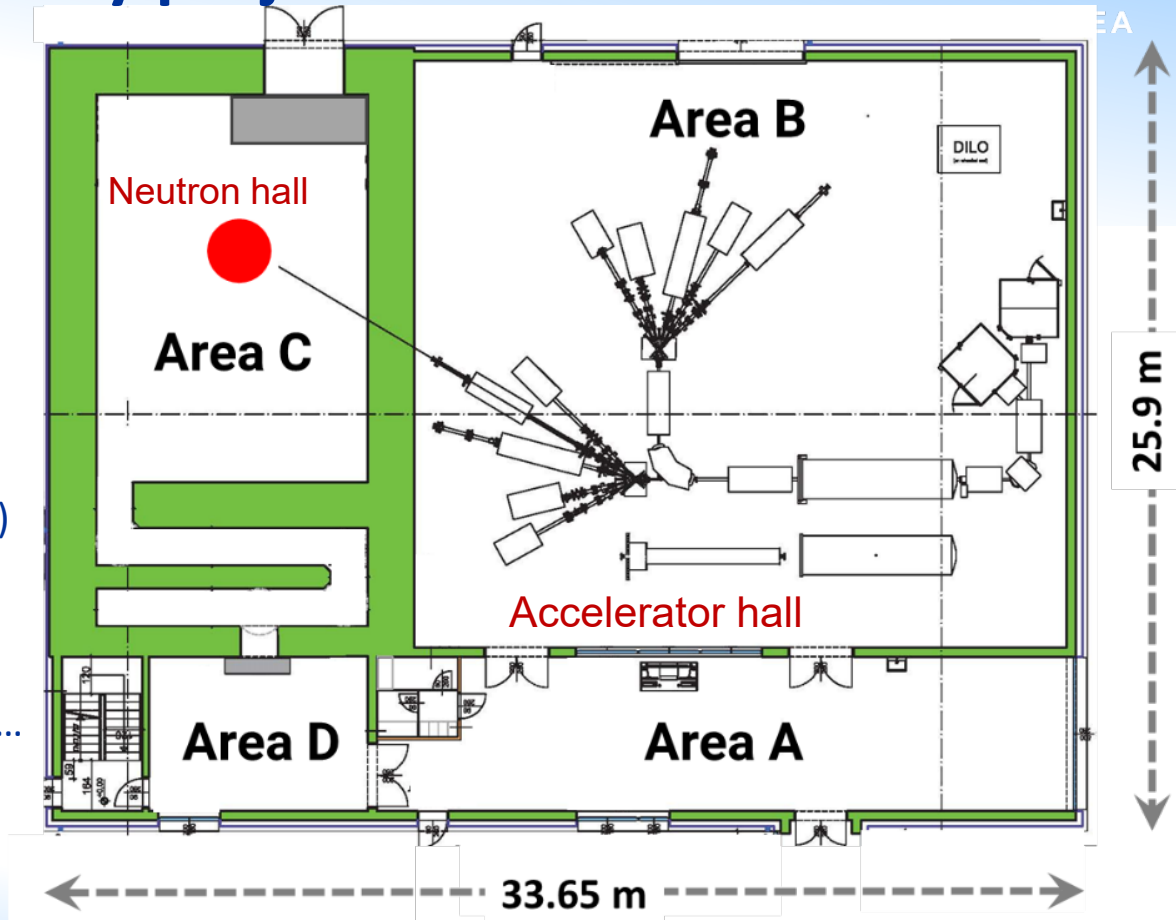


→ 6MeV protons (up to 50μA current)  
+ heavier ions

→ Multiple beam lines/end-stations  
(PIXE, PIGE, RBS, Microbeam, implanter...)

→ **Neutron production capability**

- **Max. source intensity:**  $5 \times 10^{11}$  n/s
- **Max. thermal flux:**  $10^6$  n s<sup>-1</sup>cm<sup>-2</sup>







# IAEA

International Atomic Energy Agency

# Thanks for your attention!



## IAEA BULLETIN

INTERNATIONAL ATOMIC ENERGY AGENCY  
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Neutrons save lives: Research reactors for production of medical isotopes and radiopharmaceuticals, pg 6  
Research reactor networks optimize operations to meet increasing demand, pg 14  
Keeping the world's ageing research reactors running, pg 16



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Ancient Roman archaeology resurfaces with nuclear science, pg 8  
Establishing ionizing radiation facilities in the Philippines and beyond, pg 22



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Uniting countries through fusion research and cooperation, page 22

