

# Recent IAEA activities in support of Nuclear Physics Research & Applications

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for Physics Section

**Physics Section**  
**Division of Physical and Chemical Sciences**  
**Department of Nuclear Sciences and Applications**

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# Outline

- **Organization and programmatic structure**
- **Technical areas supported by Physics**
- **Selected examples and recent updates**
- **Future plans**



# Three Pillars - Main Areas of Activity



**Safeguards  
&  
Verification**

**Safety  
&  
Security**

**Science  
&  
Technology**

# Division of Physical & Chemical Sciences



Nuclear/Radiation Sciences & Applications

Water resources management

Nuclear Data

Data Development

Data Services

Atomic and Molecular Data

**Physics**

Research & applications with accelerators & neutron sources

Nuclear Instrumentation

Nuclear Fusion

Radioisotope Products & Radiation Technology

Radioisotope production, radiotracers in industry

Radio-pharmaceuticals

Radiation technology applications

Isotope Hydrology

Isotopic ( $^3\text{H}$ ) methods for Ground water assessment; prediction; models etc.

# Physics Section in numbers



- **Staff:** 21 positions, 11 @HQs & 10 @Seibersdorf;  
+ consultants, interns, fellows; ~30 in total
- **Budget:** ~4M Euros RB under 3 sub-programmes;  
+ similar amount implemented under TC Programme
- **Coordinated Research Projects:** 10 active/new
- **TC projects:** >50 active in >50 Member States
- **Meetings/Workshops/Schools:** >50/year
- **Major Conferences (3):** Accelerators, RRs, Fusion
- **Data bases/portals (4):** accelerators, neutrons, fusion, instrumentation
- **Collaborating Centers (6):** ANSTO, Elettra, iThemba LABS, TU Delft,  
Univ. Paris Saclay, Univ. of Okayama
- **Cooperation agreements (4):** ITER, UNICRI, RBI, PPPL,
- **Events in cooperation:** >10/year

# Physics Section: main technical areas



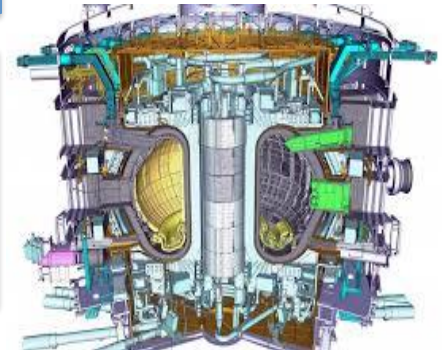
## 1.4.2 Research & Applications with Accelerators & Neutron Sources (incl. RR applications)



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



## 1.4.4 Nuclear Fusion Research & Technology (incl. coop. with ITER)



# Nuclear Science & Instrumentation Laboratory

## NSIL/Physics @Seibersdorf

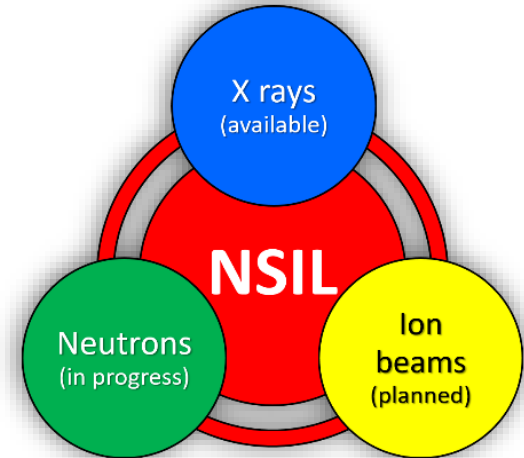


**Mission:** Assisting Member States in introducing and extending the use of nuclear instrumentation and radiation measurement techniques, including related capacity building

**Nuclear Instrumentation:** Enhanced capabilities and applications of nuclear instrumentation for various measurements, monitoring and diagnostic purposes

**Nuclear Spectrometry:** Enhanced usage of versatile, high precision, non-destructive, low-cost analytical techniques for characterization of materials and objects

**Neutron science:** Operation of compact neutron generators for research, demonstration of practical applications and training purposes.

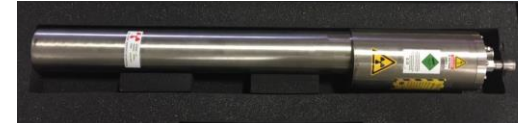


Available/planned facilities

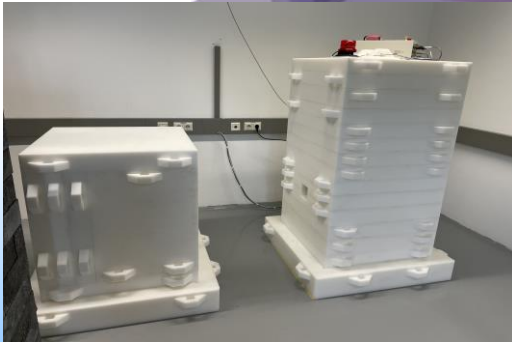
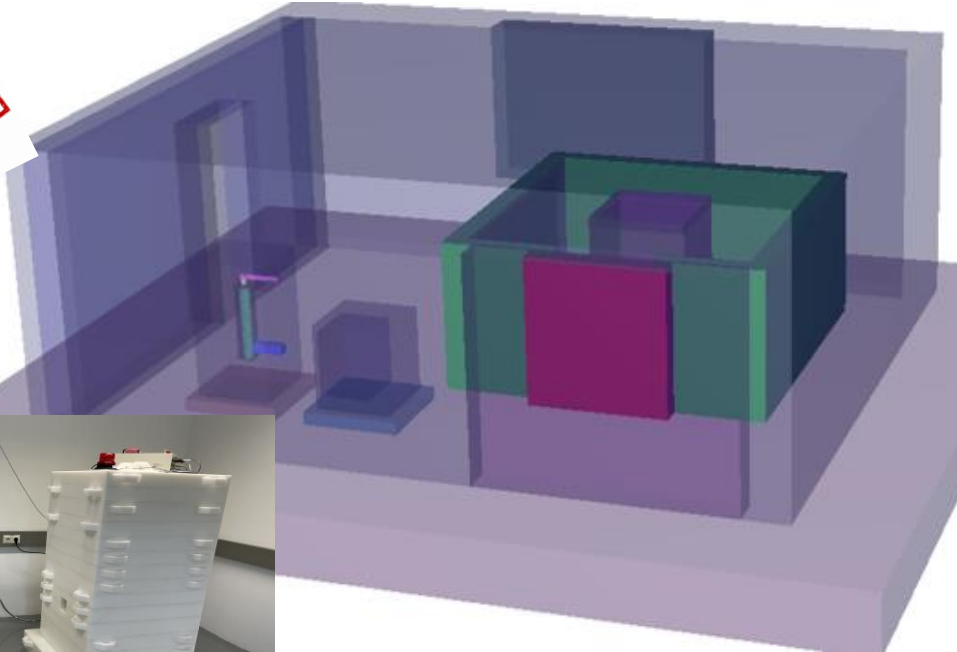
# Neutron Science Facility (NSF) at Seibersdorf

NSF is based on two neutron generators,

- **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

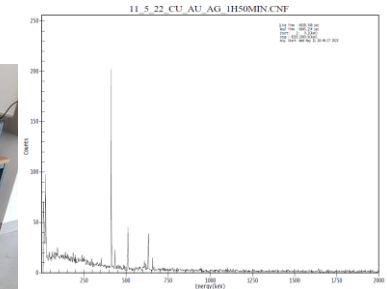
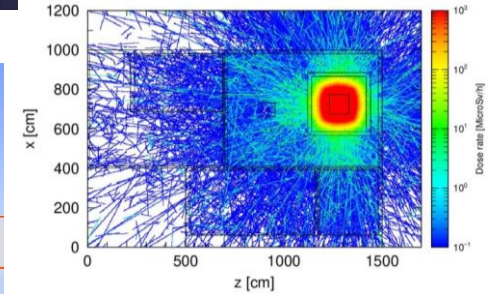
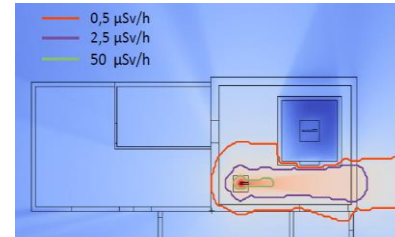


**AUTHORIZED**



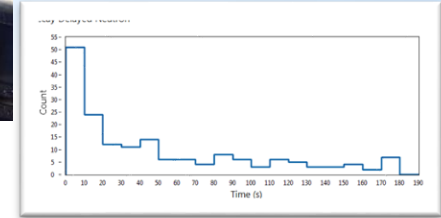
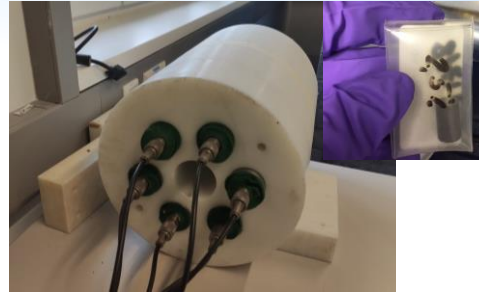
# Training opportunities already available (1/3)

- Gamma and neutron radiation monitoring systems
- Full scale Monte Carlo modelling tools: MCNP and PHITS
- Demonstration of Neutron Activation Analysis (NAA) capabilities

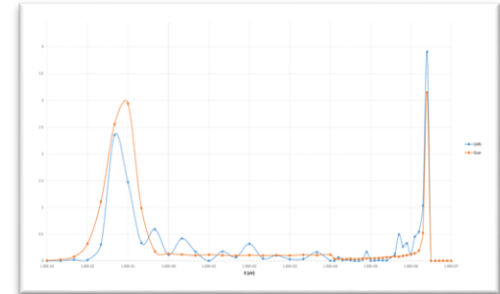
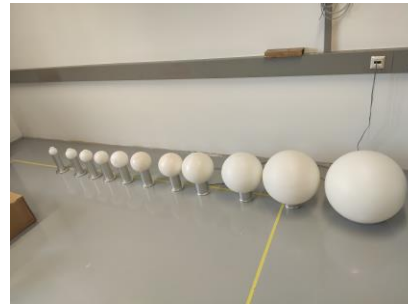


# Training opportunities already available (2/3)

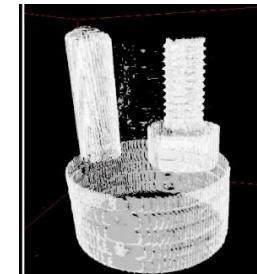
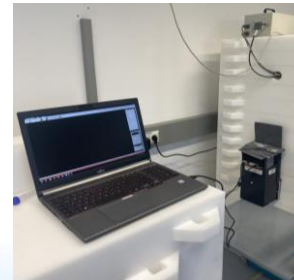
- Delayed Neutron Counting  
(*uranium samples from SGs*)



- Bonner spectrometer & other neutron instrumentation



- Dual neutron/X-ray radiography/tomography system



# Training opportunities already available/delivered (3/3)



- The very 1<sup>st</sup> TR workshop has been completed in November



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

Michael Amdi Madsen, IAEA Office of Public Information and Communication

NOV  
24  
2022



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

### Related stories

- Fingerprinting Ma Updates Neutron Analysis E-learning
- What Are Particle Accelerators?
- Neutrons Blast Fu Materials in New
- IAEA Breaks Grou Expand and Mode Seibersdorf Labor
- IAEA Nuclear Secu and Demonstratic Nears Completio

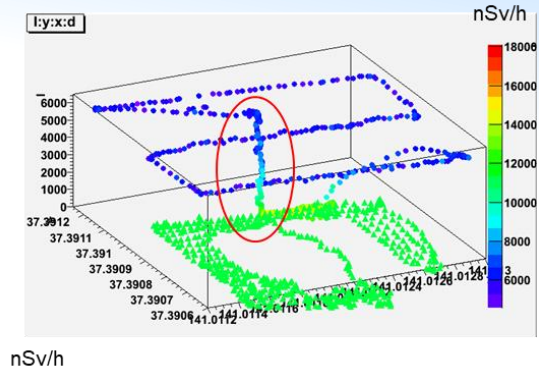


# E.g. Support to Fukushima Prefecture (Japan)

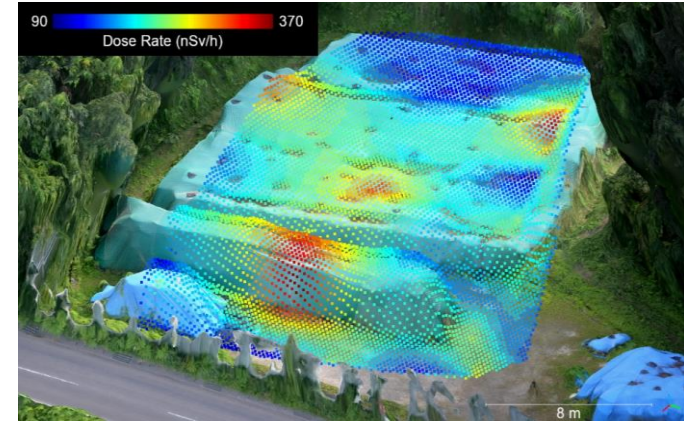
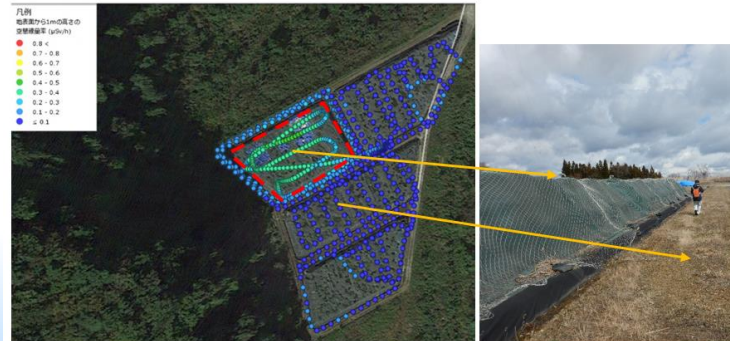
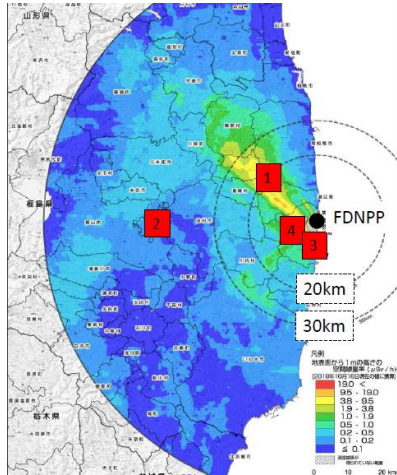
## Developed/adapted hardware/software



## Developed/adapted methodology



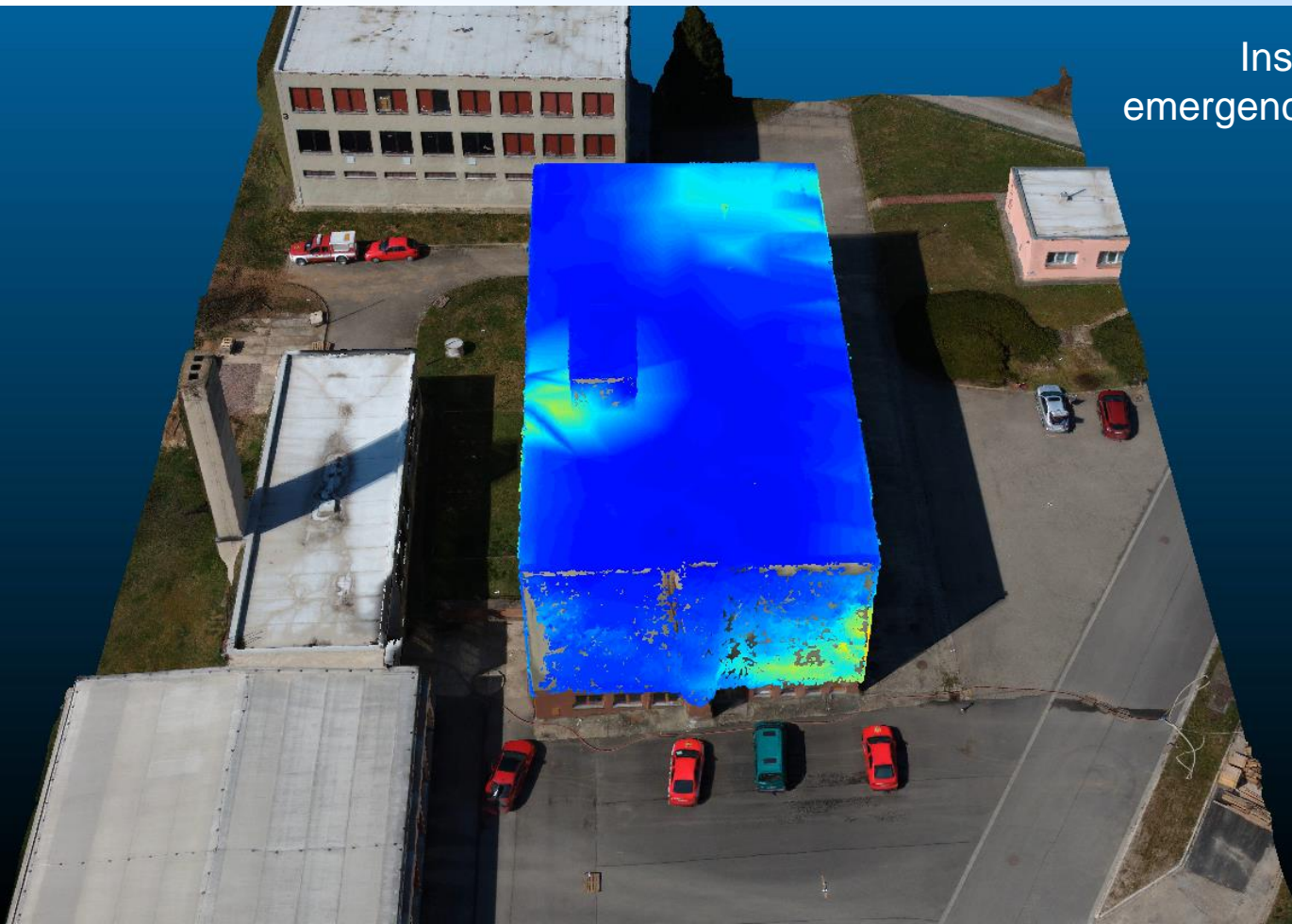
## A number of trial measurements completed



# E.g. New developments using instrumented UAVs



Inspection of object and  
emergency search for sources



# E.g.: Organization of major Conferences

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



23–27 May 2022

IAEA Headquarters, Vienna, Austria



## 29th IAEA FUSION ENERGY CONFERENCE

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



#Fusion2023



## International Conference on Research Reactors:

Addressing Challenges and Opportunities to  
Ensure Effectiveness and Sustainability

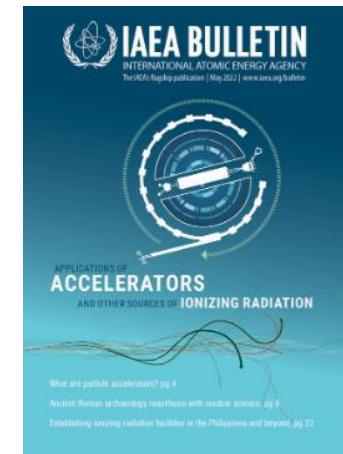
27 November – 1 December 2023; Dead Sea, Jordan



# AccConf2022@IAEA

The Conference reported on ALL accelerator based technologies and techniques used in cutting-edge research and applications in the field of energy, food and agriculture, environment, biology, medicine, forensics, cultural heritage, materials science, and some other areas.

- Opening by the DG and 3 DDsG, Rays of Hope & NUTEC Plastics
- Streamed live + recorded videos and materials available
- ~200 in person participants ~300 registered virtually, 72MSs; 112 orals and 70 posters
- Four side events, featuring (a) Recent Developments, (b) IAEA Collaborating Centres, (c) Women in Accelerator Science, and (d) Sustainability aspects.
- IAEA Bulletin on Accelerators issued
- Proceedings published electronically + special issue of EPJ Techniques and Instrumentation is in preparation
- 2<sup>nd</sup> Conference in series is planned in 2026



# AccConf2022@IAEA

## Highlights:

- Much appreciated event by very diverse community, filling the gap for similar int. events → will continue every 4 years
- Safety and regulatory aspects and challenges were addressed in a dedicated session
- New guidance document on Specific Considerations and Guidance for the Establishment of Ionizing Radiation Facilities, IAEA Radiation Technology Series No. 7 (2022) released as preprint
- Identify gaps for facilitating adoption of accelerator technologies and applications having high impact such as cancer management or irradiation/NDT technologies
- Expand and strengthen facilities at the IAEA Laboratories by establishment of accelerator-based Ion Beam Facility (IBF) and e-beam irradiator



# E.g. Thematic Portals and Data bases

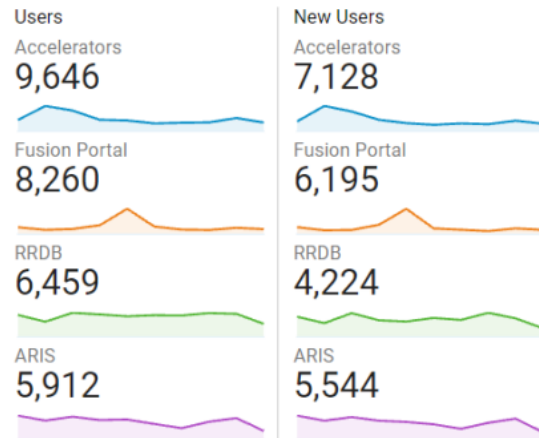
### Interactive Map of Accelerators



Total Facilities:	Accelerator-Based Neutron Sources	BNCT Facilities	Electrostatic Accelerators	Synchrotron Light Sources	X-ray Free Electron Laser Sources
577	146	33	324	60	14

Total Countries:  
59

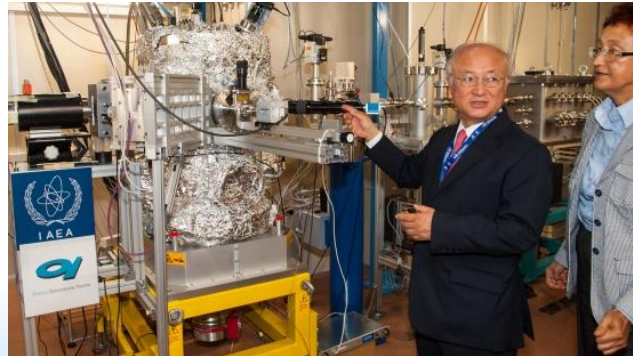
Algeria	1
Argentina	10
Armenia	1
Australia	10
Austria	2
Bangladesh	2
Belgium	9
Brazil	8
Canada	12
Chile	2
China	40
Croatia	2
Czech Republic	3
Denmark	2
Egypt	2
Finland	3
France	21
Germany	35
Ghana	1
Greece	4
Hungary	6
India	20
Iran	7
Israel	9
Italy	29
Japan	68
Jordan	2
Kazakhstan	1
Lebanon	1



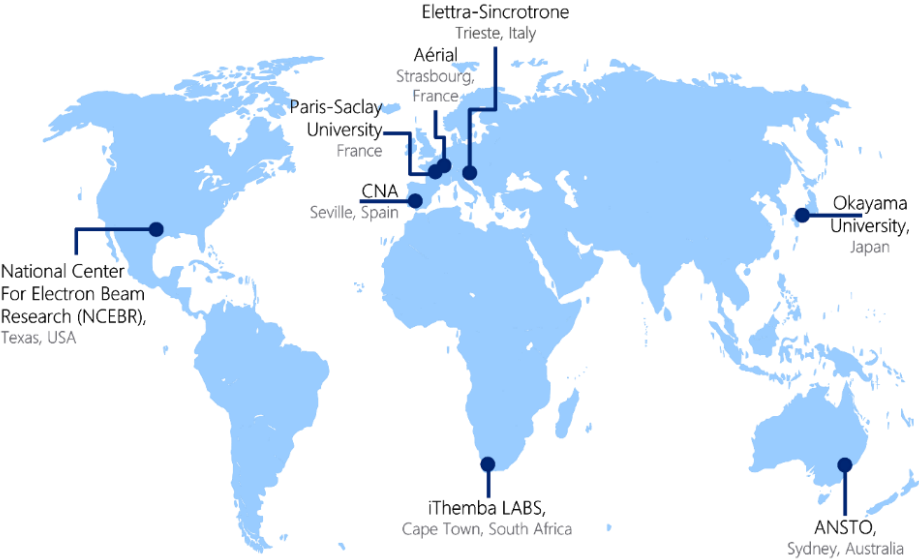
# E.g. Access to state of the art accelerator facilities



- **IAEA-RBI agreement; co-shared infrastructure**
  - **20 days of the beam time** available for the developing countries
  - **Annual training workshops**, with emphasis on hands-on-training
  - New He ion source for **dual-beam capability** commissioned (fusion research)
- **IAEA-Elettra agreement; joint XRF beamline**
  - **Dedicated beam-time for users**; +20 research groups from +15 MSs annually
  - **Annual training workshops**, with emphasis on hands-on-training
  - Recent improvements of the beam line and end-station
  - UHVC '**Mirror Facility**' for training commissioned at NSIL Seibersdorf



# E.g. Scheme of IAEA Collaborating Centres



**IAEA CC implementing activities with direct involvement of particle accelerators**

## New: Centre for Ion Beam Applications National University of Singapore



Thematic areas of CC:

- Ion Beams for Materials Science
- Microscopy and Nano fabrication
- Forensics & Heritage Sciences
- Accelerators for Radiobiology

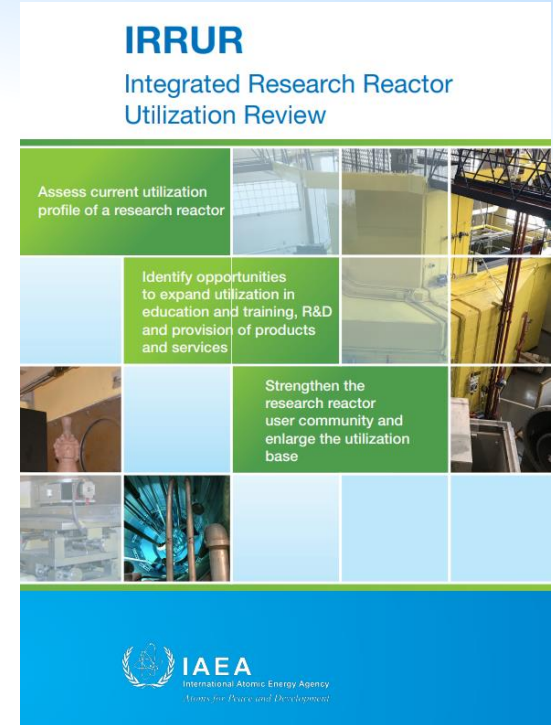
# E.g. Integrated RR Utilization Review missions

## Objectives

- Assess current utilization profile
- Identify opportunities to expand utilization
- Strengthen user community and enlarge the utilization base



The screenshot shows a news article from the IAEA website. The main headline is "IAEA wraps up SA mission into multipurpose research reactor" by Theresa Smith, dated Nov 25, 2022. The article features a large photograph of a group of people in white lab coats standing in a large industrial facility, which is the SAFARI-1 research reactor. Below the main image, there is a "TRENDING THIS WEEK" section with several smaller articles, including "Western Cape Premier Alan Winde credits 'energy g...'", "Lessons for South Africa from the global energy U-turn", "Togo solar plant gets 20MW upgrade, making it the large...", "Enhancing regional power trade in the horn of Africa", and "\$90M to set up net-zero energy solutions platform for S...".



The diagram illustrates the IRRUR mission process. It is titled "IRRUR Integrated Research Reactor Utilization Review". The mission is broken down into three main objectives, each represented by a green box with a corresponding photograph of a reactor facility:

- Assess current utilization profile of a research reactor**: Accompanied by a photo of a reactor core.
- Identify opportunities to expand utilization in education and training, R&D and provision of products and services**: Accompanied by a photo of a laboratory setting.
- Strengthen the research reactor user community and enlarge the utilization base**: Accompanied by a photo of a person in a lab coat.

At the bottom of the diagram, the IAEA logo is displayed with the text "International Atomic Energy Agency" and "Atoms for Peace and Development".

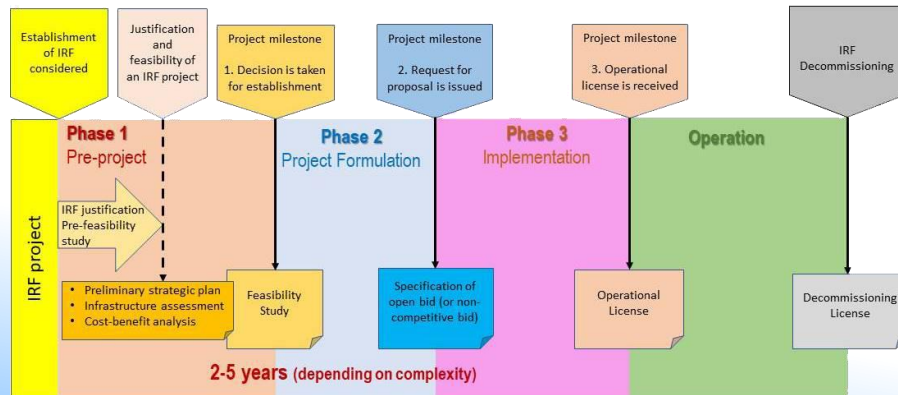


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# E.g. Publication:

## Specific Considerations and Guidance for the Establishment of Ionizing Radiation Facilities, Radiation Technology Series No 7

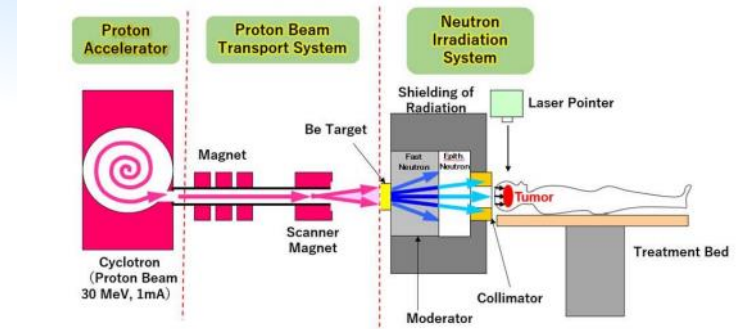
- Ch. 1: Introduction
- Ch. 2: Phases and Milestones
- Ch. 3: Considerations for Feasibility Study
- Annex I: Basis for Infrastructure Assessment



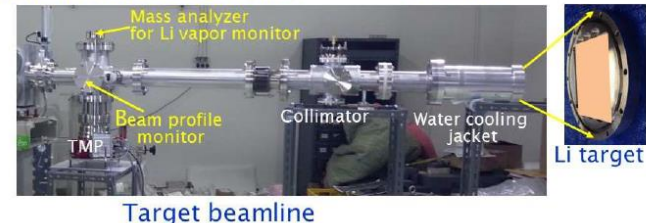
# E.g. Publication:

## Advances in Boron Neutron Capture Therapy, TECDOC series, in preparation, +350 pages

- 1) Introduction
  - 2) Accelerator based BNCT
  - 3) Beam design
  - 4) Dosimetry and neutron field parameters
  - 5) Facility design
  - 6) Operation and management
  - 7) Pharmaceuticals and radiopharmaceuticals
  - 8) Boron concentration determination
  - 9) Radiobiology
  - 10) Methods and models for dose calculations
  - 11) Treatment planning
  - 12) Reporting
  - 13) Clinical trials
- + A number of Appendices, Annexes and Protocols, including regulatory aspects and facility examples



( Courtesy by Sumitomo Heavy Industry Ltd.)



# E.g.: development of e-learning tools

<https://elearning.iaea.org/>



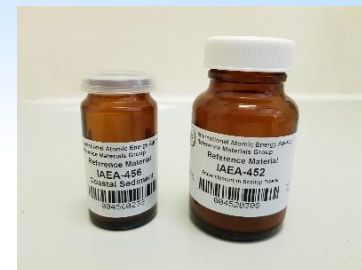
1. **Introductory training course for research reactor personnel (English/Spanish)**
2. **Neutron Activation Analysis**
3. **Neutron Imaging**
4. **Nuclear Analytical Techniques for Forensic Science**
5. **Portable X-ray Spectrometry Techniques for Characterization of Valuable Archaeological/Art Objects**
6. **Quality Assurance of X-ray Fluorescence Analysis of Airborne Particulate Matter**
7. **Introduction to Total reflection X-ray Fluorescence**
8. **Introduction to X-ray Emission Spectrometry**
9. **Introduction to electrostatic accelerators: from basic principles to operation and maintenance**
10. **Specific Considerations and Guidance for Establishment of Ionizing Radiation Facilities (forthcoming)**
11. **Ion-beam Engineering of Materials for Quantum Technologies (forthcoming)**
12. **Introduction to in-situ techniques for radiological characterization of sites**
13. **Strategic Planning for National Nuclear Institutions**

# E.g. Worldwide Open Proficiency Tests for Nuclear and Related Analytical Techniques Laboratories



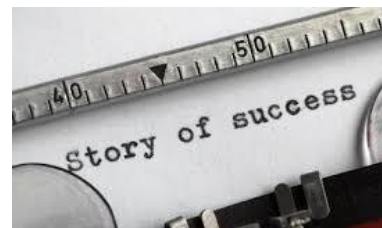
Organized twice a year in support IAEA Member States laboratories to:

- 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 2021: +100 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

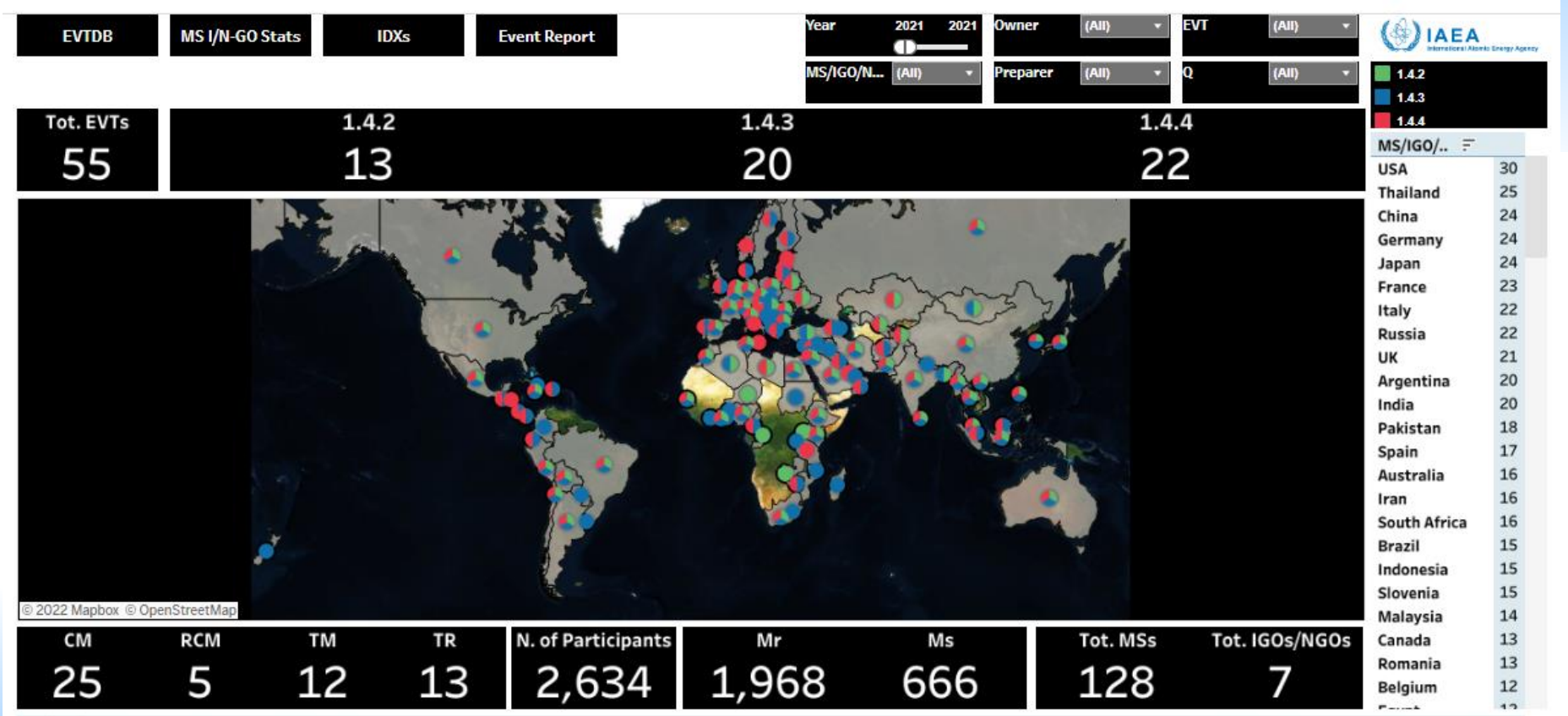


## Previous Proficiency Tests

PTNATIAEA/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>
PTNAAIAEA/17	July 2019 - March 2020	Land-plant Siliceous	<a href="#">Download PDF final report</a>

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

# E.g. 2021 Event statistics



# E.g. Coordinated Research Projects



CRAIS	Country Stats	Institute Stats	PR Index	CRP Report
<b>Tot. CRPs</b> <b>10</b>	<b>Acc-RR</b> <b>4</b>		<b>Fusion</b> <b>5</b>	
			<b>Instrumentation</b> <b>1</b>	



- Acc-RR
- Fusion
- Instrumentation



Choose CRP code  
(All)

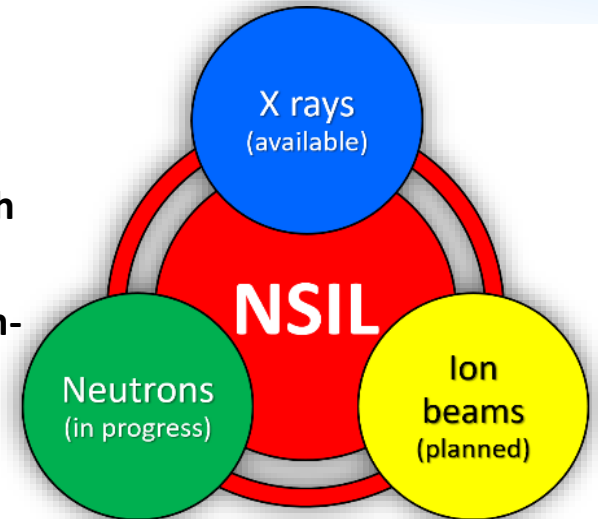
Country..	
China	10
Russia	8
UK	7
USA	6
France	5
Japan	5
Spain	4
Hungary	3
Italy	3
Algeria	2
Argentina	2
Australia	2
Canada	2
Czech Repub..	2
Germany	2
Greece	2
India	2
Portugal	2
Singapore	2
South Africa	2

<b>RA</b> <b>70</b>	<b>RC</b> <b>52</b>	<b>TC</b> <b>1</b>	<b>Tot. RA/RC/TC</b> <b>123</b>	<b>Tot./Year (Euro)</b> <b>245,000</b>	<b>Tot. Inst.</b> <b>102</b>	<b>Tot. MSs/IOs</b> <b>48</b>
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# Future developments at NSIL/Physics

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

- **X-rays**, using existing equipment and recent upgrades (Energy Dispersive XRF and Wavelength Dispersive XRF)
- **Neutrons**, by the establishment of a neutron science facility with D-D and D-T neutron generators (**2019-2022**)
- **Ion-beams**, through the planned establishment of a compact ion-beam accelerator facility (**2023-**)
- This will allow expanding IAEA's **support to Member States** in:
  - **Capacity building** through education and training,
  - Facilitation of **applied research**, and
  - Provision of **specialized services** to internal and external users.



# Ion Beam Facility at Seibersdorf (project)

**Comprehensive survey conducted in 2018:** high interest from the user communities

(>60 replies from 40MSs as well as internally within IAEA) :

- **Training** in accelerator technology and applications,
- **Services** relevant to ion beam and nuclear microprobe analysis,
- **Enhanced access** to and use of Ion Beam Analysis techniques.

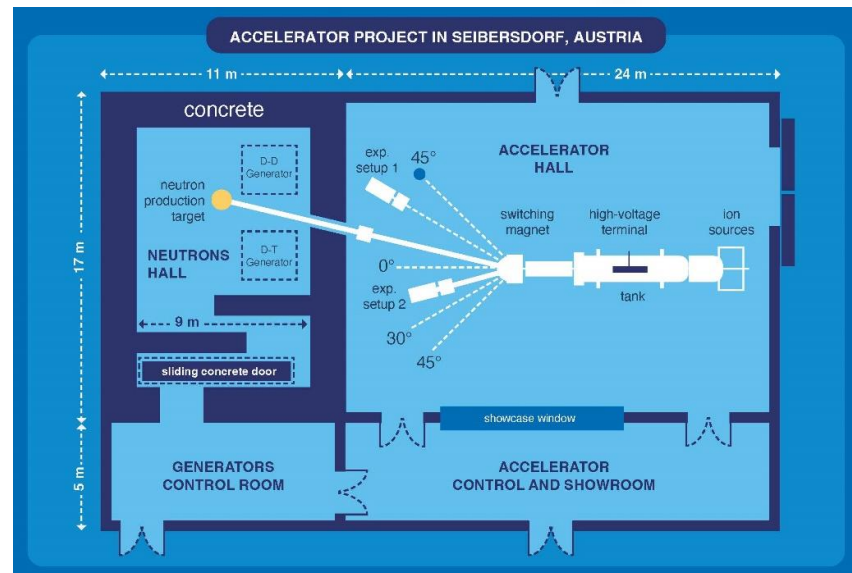


**Feasibility study showed that,** to match the NSIL's mission and stakeholder needs, the most **optimal and cost effective technology option** would be **3.0 MV tandem**.

**Total capital costs:** ~4.6 M€

**Staff required:** ~3 persons

**Operational costs:** ~100 k€/year



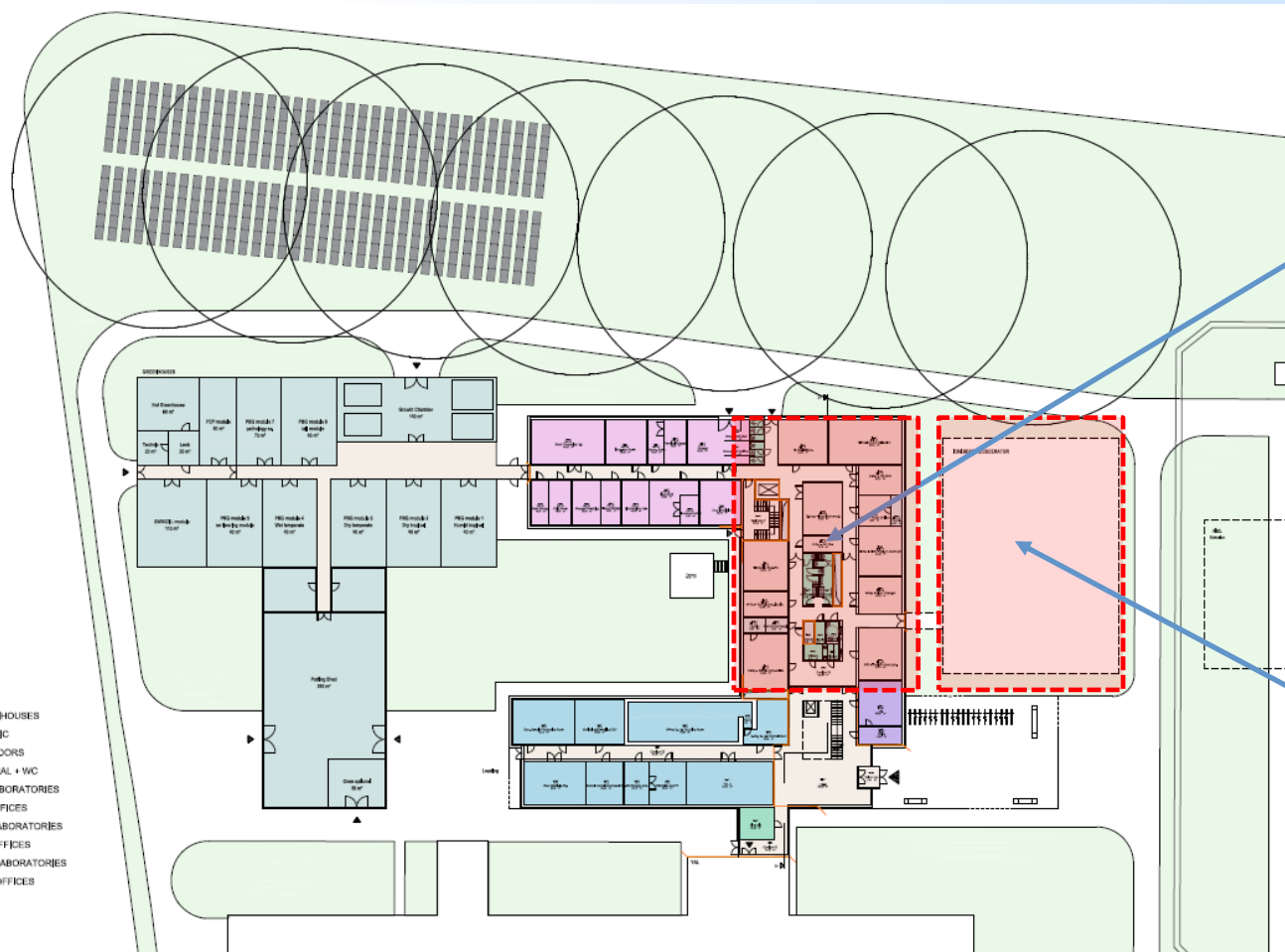
**Call for Extrabudgetary Support & Donations-in-Kind!**

# New buildings for IAEA Laboratories in 2024!

Physics/NSIL  
Instr. and XRF Facilities  
(in progress)

Physics/NSIL  
Ion Beam Facility  
(project)

- GREENHOUSES
- TECHNIC
- CORRIDORS
- GENERAL + WC
- TEL LABORATORIES
- TEL OFFICES
- NSIL LABORATORIES
- NSIL OFFICES
- PBGL LABORATORIES
- PBGL OFFICES
- NSRW
- LCG





**IAEA**  
International Atomic Energy Agency

**Thanks for your attention!**



Physics

Facilitating the Peaceful and Practical Uses of Nuclear Science and Technology

The IAEA Physics Section helps Member States evaluate frameworks for the efficient, sustainable and safe use of advanced nuclear technologies such as particle accelerators, research reactors, nuclear fuel cycle and associated instrumentation. Applications of these nuclear technologies help structure in various fields such as energy, health, food and agriculture, nuclear safety and security, cultural heritage, remote science, industry and the environment.

Four Key Areas



**Accelerator Applications**  
Accelerators are used in both fundamental and applied research. They are used in the development of new materials and in the production of radioisotopes for medical diagnosis and therapy. They also provide neutron sources for research in physics, biology, chemistry and materials science and energy, as well as for education and training of scientists and engineers.



**Research Reactor Utilization**  
Research reactors play an important role in the development of nuclear science and technology. They are used worldwide for fundamental and applied research in physics, biology, chemistry and materials science and energy, as well as for education and training of scientists and engineers.



**Fusion**  
Fusion could be a safe and environmentally friendly source of energy in the future. The International Fusion Energy Programme, including the largest magnetic confinement experimental reactor called ITER, currently has 35 countries as members and over 100 more are engaged in fusion research as members of laboratory networks.



**Nuclear Instrumentation**  
Successful use of nuclear technology depends on reliable measurements. The laboratory provides access to both national and international facilities.

By the Numbers

over 100 Physics Section projects in leading

**13** COORDINATED RESEARCH PROJECTS COVERING MORE THAN 100 RESEARCH INSTITUTIONS AND ORGANIZATIONS

Supporting more than **50** NATIONAL COOPERATION PROJECTS IN MORE THAN 100 MEMBER STATES

Our activities and information provide the most recent developments of **225** RESEARCH REACTORS OPERATED BY 16 MEMBER STATES

**218** NATIONAL RESEARCH CENTRES OPERATED BY 16 MEMBER STATES

**57** RESEARCH REACTOR UTILIZATION CENTRES OPERATED BY 16 MEMBER STATES

**40** FUSION RESEARCH CENTRES OPERATED BY 16 MEMBER STATES

**2** THE IAEA LABORATORY NETWORKS PROVIDE ACCESS TO BOTH NATIONAL AND INTERNATIONAL FACILITIES THROUGH **2** NETWORKS

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Nuclear Sciences and Instrumentation Laboratory

By the Numbers

Fostering the effective use of nuclear instrumentation and related capacity building

As part of the IAEA Physics Section, the Nuclear Science and Instrumentation Laboratory (NSI) helps Member States to establish, operate and maintain various nuclear instrumentation and spectroscopy techniques in support of a wide range of applications such as health care, food, agriculture, environment, heritage, cultural heritage, and related science.

Four Key Areas



**Nuclear Instrumentation**  
Successful use of nuclear technology depends on reliable measurements, monitoring and diagnostic equipment. These instruments allow the accurate measurement of both natural and man-made radionuclides.



**Nuclear Spectroscopy**  
Nuclear and related analytical techniques are an indispensable choice for comprehensive characterization of materials. In many cases these techniques are non-destructive, capable of measuring a variety of samples and fast-effective.



**In-situ techniques**  
Portable instruments have reached a high level of analytical performance and offer several advantages, including fast determination of radionuclide concentrations and activities, identification of hot spots, cost reduction for investigations, and fast determination of the continuous operational distribution.



**Access to accelerator facilities**  
The laboratory facilitates access to accelerator facilities through practical arrangements and Coordinated Research Projects, in particular for researchers from Member States without access to such facilities.



NSI currently leads 2 Coordinated Research Projects involving over 25 research organizations.

The laboratory provides technical support for more than 30 technical cooperation projects, including 18 national projects, involving more than 70 Member States.

More than 150 laboratories have participated in proficiency test exercises organized by NSI, to support their quality management efforts.

More than 300 fellows and scientists, visitors have been hosted by NSI, for technical training. The laboratory organizes regional hands-on training courses with the support from Technical Cooperation Projects.

In-house adaptive research in the last six months includes the assessment of capabilities of Existing European XFEL for the study of layered materials and the finalisation of a cooperation project for Rapid Environmental Mapping in support of the Fukushima Prefecture.

A significant progress towards the commissioning of the neutron Science Facility in Solihull has been made, including the optimization of the shielding for the D2 gas area, the evaluation of capabilities for Dual Neutron X-ray radiography and the commissioning of a Bessel Beam spectrometer.

This issue also includes a summary of the improvement brought to the Proficiency Testing scheme and the results of the last proficiency test.

Contributions from Austria, Czech Republic, Hungary and Morocco are presented in the section of Reports from Member States.

The views expressed here do not represent the views and policies of the IAEA except where explicitly identified.

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Editorial

The Nuclear Science and Instrumentation Laboratory (NSI) is pleased to bring you your attention the second issue of this Newsletter!

Since the release of Issue No. 1, a significant progress has been made in the development of various resources to strengthen the information exchange with laboratories of IAEA Member States, including the creation of online databases of different types of nuclear instrumentation facilities, the increase of training materials (video courses, video demonstrations and lectures, all available from the Nuclear Science and Instrumentation Portal: <http://www.iaea.org/iaea/nuclear-science-instrumentation>).

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NSI staff from left to right: Mr. Daniel Boller (Director General), Mr. Roshan Arora (Team Assistant), Mr. Anupam Ghosh (Team Assistant), Mr. Maria Magda Soares, Mr. Yulia Mamon (Assistant to Director), Mr. Hisham Razaqat (Senior Laboratory Technician), Mr. Pengping Cao (Senior), Mr. Farid Jibani and Mr. Hisham Al-Abied (Senior), Mr. Farouk Al-Husseini (Senior Laboratory Technician), Mr. Alexander Tschickner (Senior Laboratory Technician), Mr. Amour Pauline (Senior), Mr. Steven Mollard (Senior Project Officer), and Mr. Hilmi Mounir (Senior Laboratory Technician, Nuclear Science).

NSI also looks forward to receiving both contributions and feedback from different Member State counterparts and stakeholders in this Newsletter, to help the laboratory to best continue supporting projects, knowledge, scientific and technical visits, and addressing requests & development needs for national facilities worldwide.