IAEA
International Atomic Energy Agency

Recent IAEA activities in support of Nuclear Physics Research & Applications

Danas Ridikas
for Physics Section

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

physics@iaea.org

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-pharma-ceuticals
- Radiation technology applications

Isotope Hydrology

- Isotopic (^{3}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

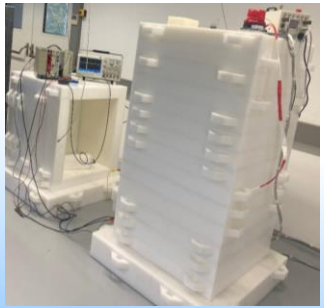
Physics Section: main technical areas

1.4.2 Research & Applications with Accelerators & Neutron Sources

(incl. RR applications)

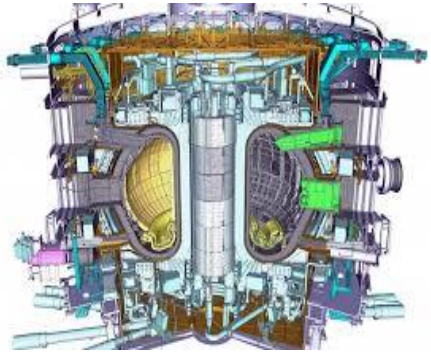
1.4.3 Nuclear Instrumentation

(incl. laboratory in Seibersdorf)



1.4.4 Nuclear Fusion Research & Technology

(incl. coop. with ITER)



Nuclear Science & Instrumentation Laboratory

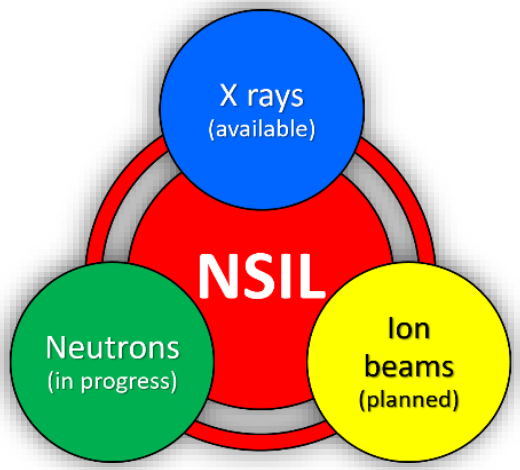
NSIL/Physics @Seibersdorf

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.

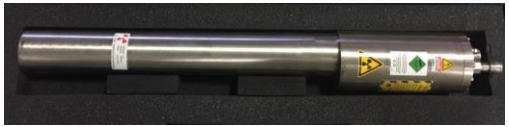


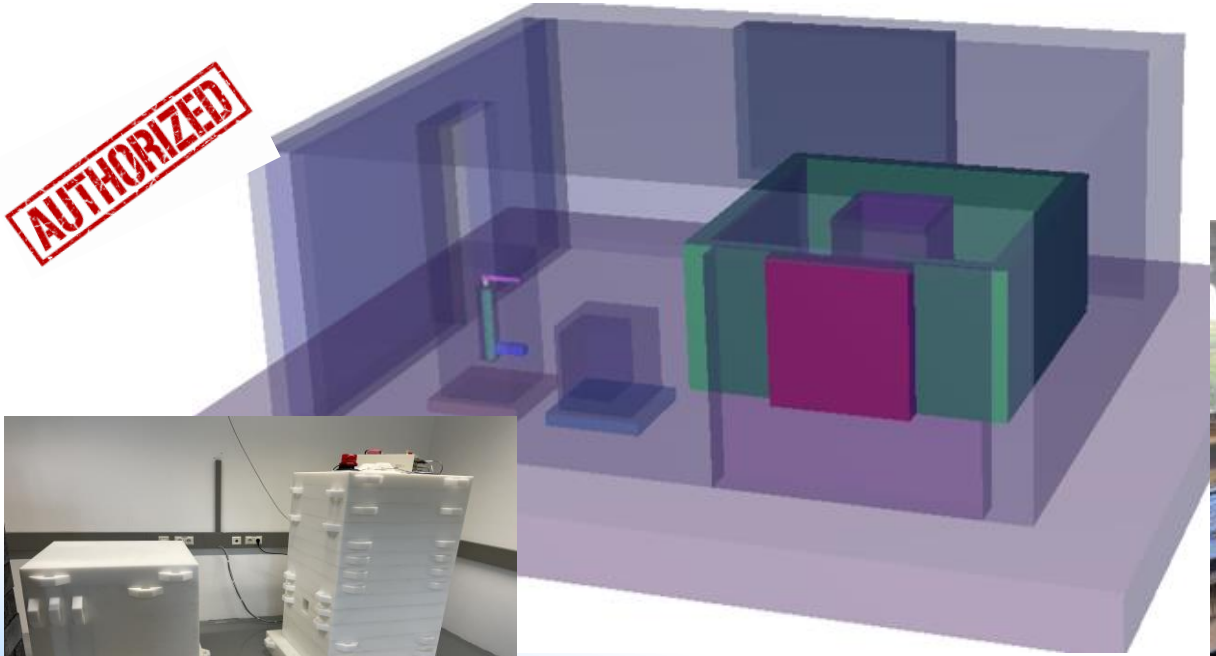
Available/planned facilities

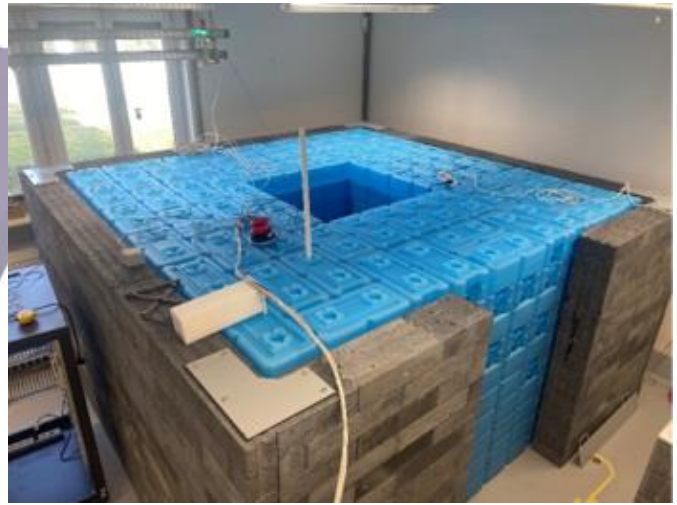
Neutron Science Facility (NSF) at Seibersdorf

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

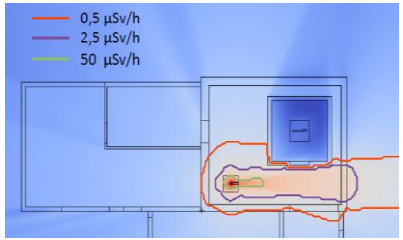


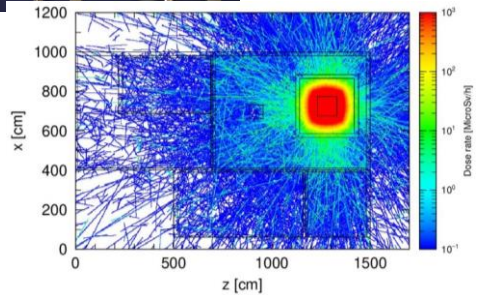




Training opportunities already available (1/3)

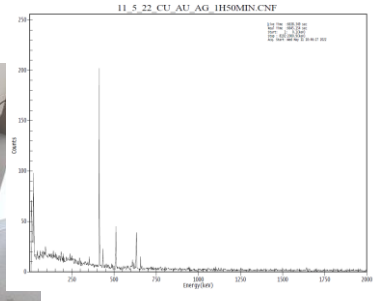
- Gamma and neutron radiation monitoring systems





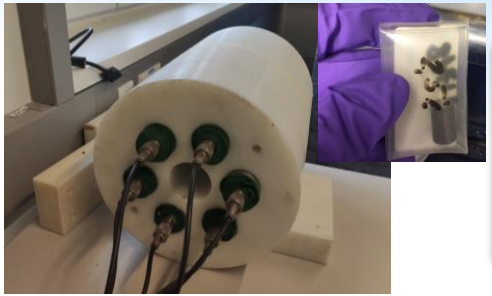
- Full scale Monte Carlo modelling tools: MCNP and PHITS

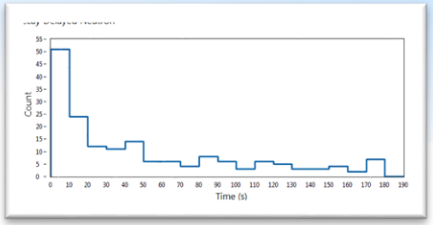
- Demonstration of Neutron Activation Analysis (NAA) capabilities



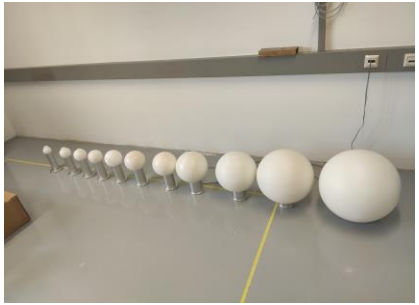
Training opportunities already available (2/3)

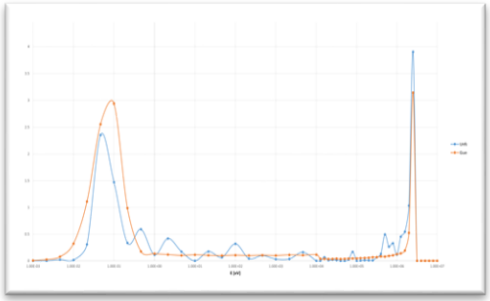
- Delayed Neutron Counting
  (uranium samples from SGs)



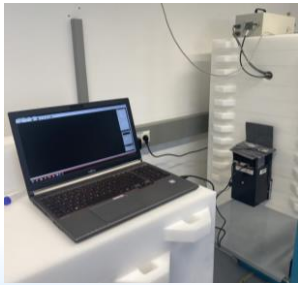


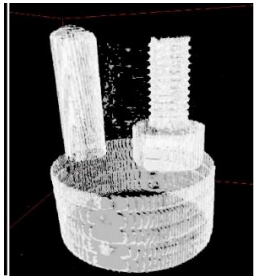
- Bonner spectrometer & other neutron instrumentation





- Dual neutron/X-ray radiography/tomography system





Training opportunities already available/delivered (3/3)

- The very 1st 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-learnin

What Are Particle
Accelerators?

Neutrons Blast Fu
Materials in New

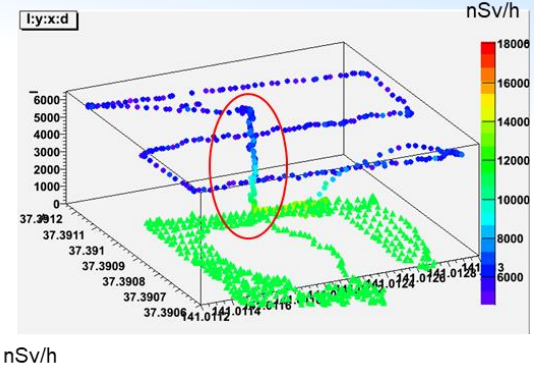
IAEA Breaks Grou
Expand and Mode
Seibersdorf Labor

IAEA Nuclear Secu
and Demonstratio
Nears Completion

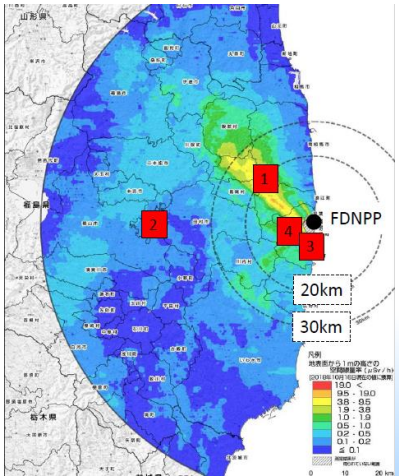
E.g. Support to Fukushima Prefecture (Japan)

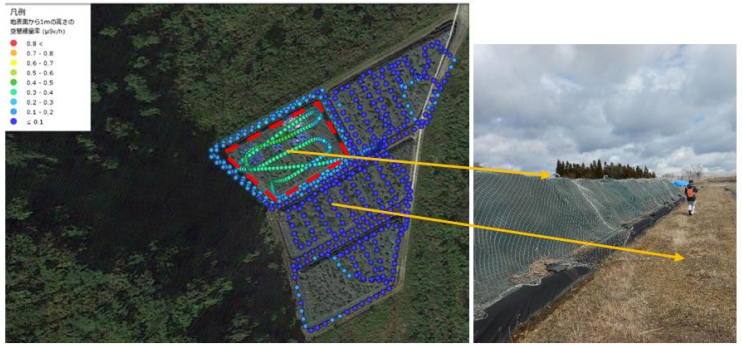
Developed/adapted hardware/software

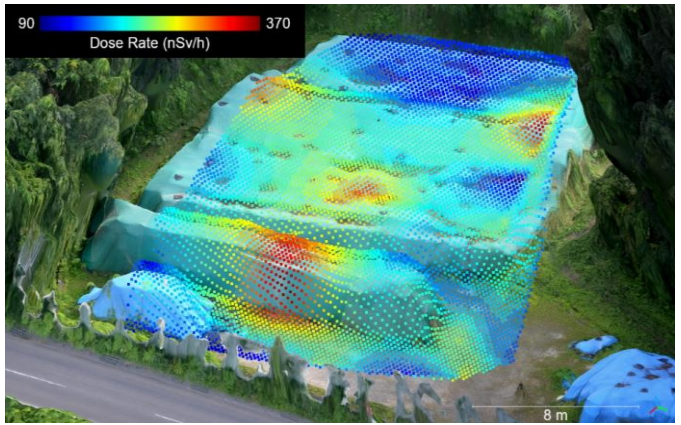
Developed/adapted methodology



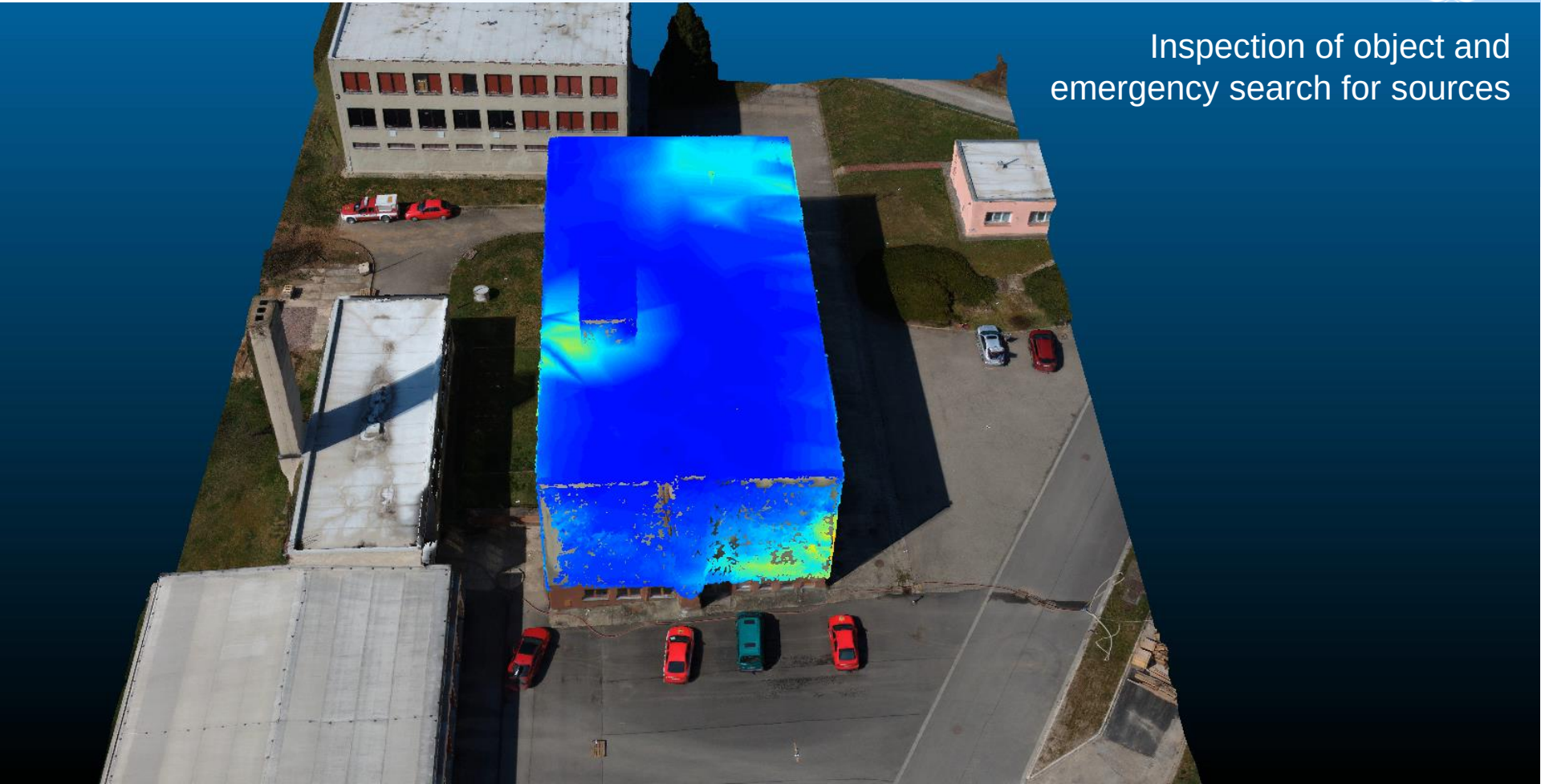
A number of trial measurements completed





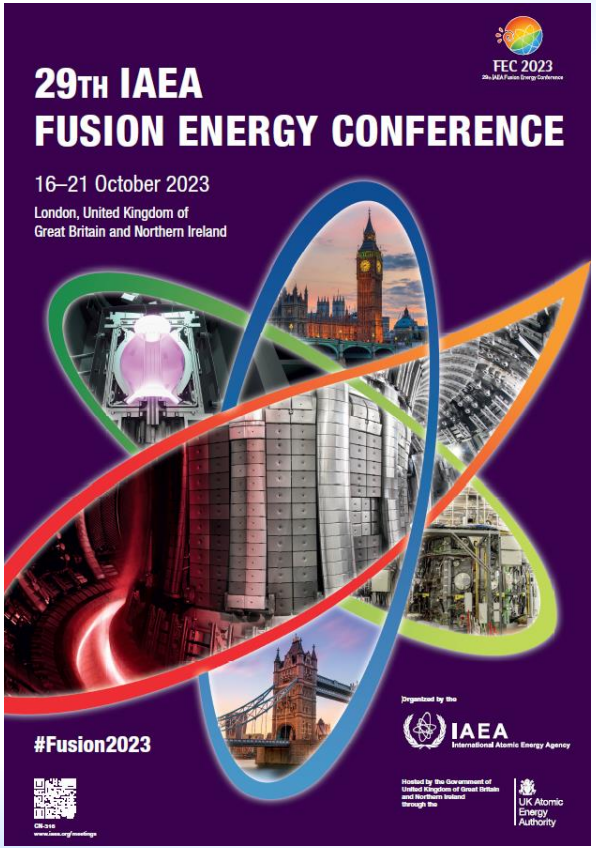


E.g. New developments using instrumented UAVs



Inspection of object and emergency search for sources

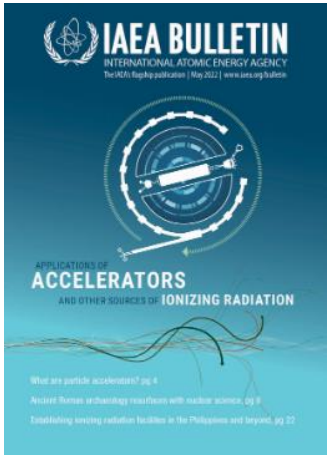
E.g.: Organization of major Conferences



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.

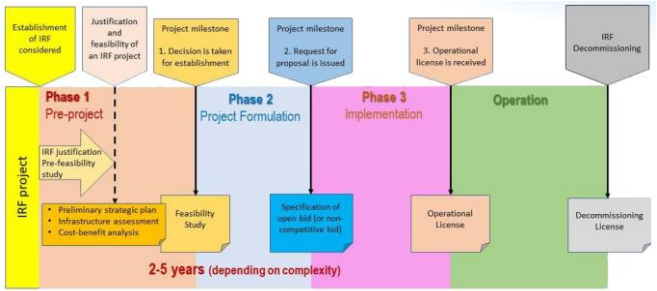
- Opening by the DG and 3 DDsG, Rays of Hope & NUTEC Plastics
- Streamed live + recorded videos and materials available
- ~200 in person participants ~300 registered virtually, 72MSs; 112 orals and 70 posters
- Four side events, featuring (a) Recent Developments, (b) IAEA Collaborating Centres, (c) Women 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
- 2nd Conference in series is planned in 2026

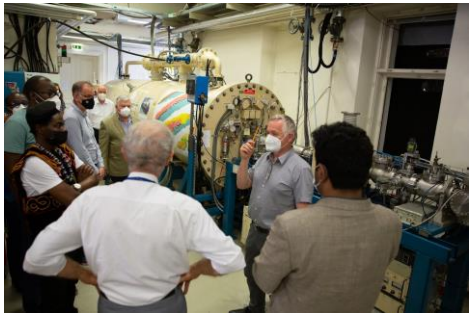


AccConf2022@IAEA

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

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IAEA.org NUCLEUS

IAEA | Accelerator Knowledge Portal

Home | Interactive Maps | Accelerators for Heritage | Training Materials | Useful Resources | Case Studies | IBA Beamtime | Workspaces | About Us

Interactive Map of Accelerators

IAEA

Total Facilities: 577

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

Total Countries: 59

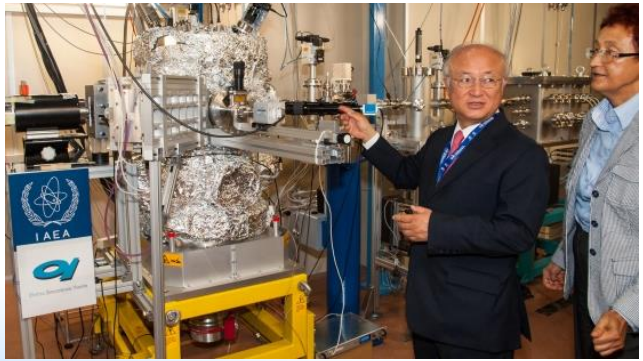
Algeria	1
Argentina	10
Armenia	1
Australia	10
Austria	2
Bangladesh	2
Belgium	9
Brazil	8
Canada	12
Chile	2
China	40
Croatia	2
Czech Republic	3
Denmark	2
Egypt	2
Finland	3
France	21
Germany	35
Ghana	1
Greece	4
Hungary	6
India	20
Iran	7
Israel	9
Italy	29
Japan	68
Jordan	2
Kazakhstan	1
Lebanon	1

Users		New Users	
Accelerators	9,646	Accelerators	7,128
Fusion Portal	8,260	Fusion Portal	6,195
RRDB	6,459	RRDB	4,224
ARIS	5,912	ARIS	5,544

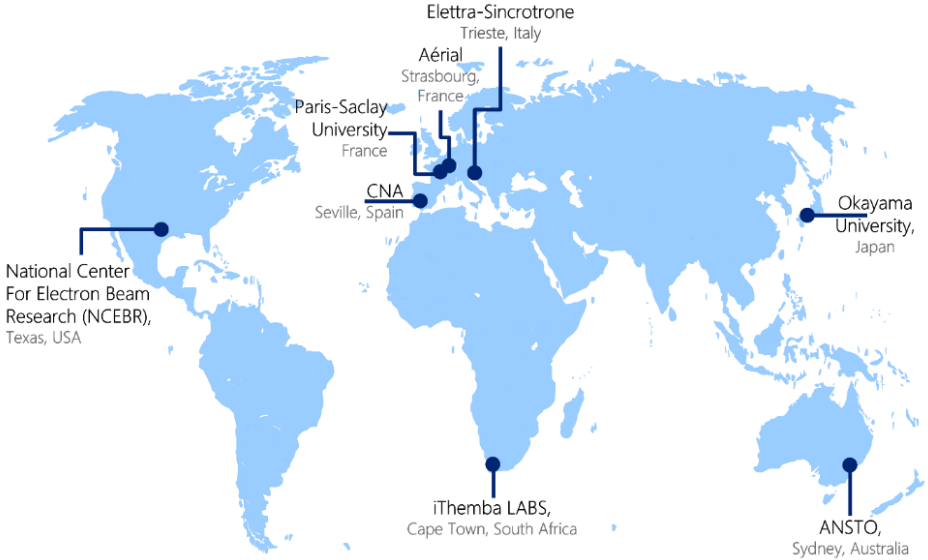
E.g. Access to state of the art accelerator facilities

- **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

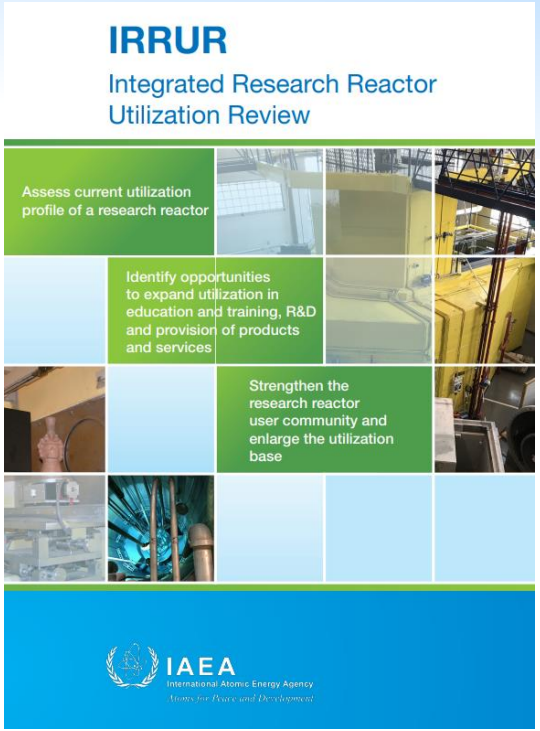
Thematic areas of CC:

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

E.g. Integrated RR Utilization Review missions

Objectives

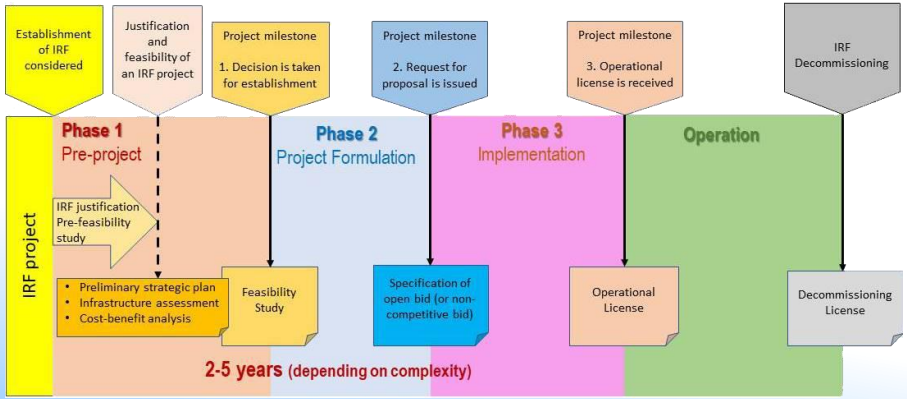
- Assess current utilization profile
- Identify opportunities to expand utilization
- Strengthen user community and enlarge the utilization base



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



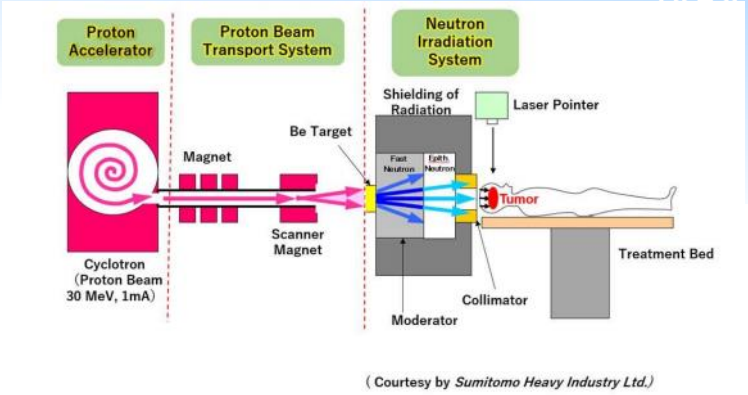
CONTENTS

E.g. Publication:

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

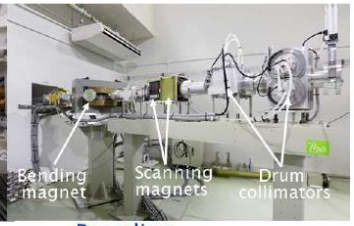
1) Introduction
2) Accelerator based BNCT
3) Beam design
4) Dosimetry and neutron field parameters
5) Facility design
6) Operation and management
7) Pharmaceuticals and radiopharmaceuticals
8) Boron concentration determination
9) Radiobiology
10) Methods and models for dose calculations
11) Treatment planning
12) Reporting
13) Clinical trials

+ A number of Appendices, Annexes and Protocols, including regulatory aspects and facility examples

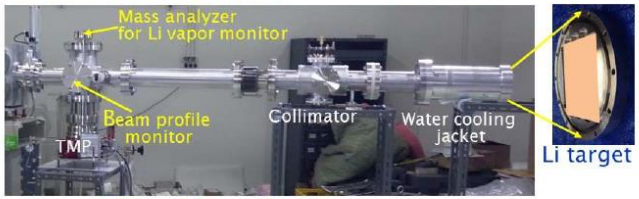


(Courtesy by *Sumitomo Heavy Industry Ltd.*)

Dynamitron (2.8MeV, 15mA)



Beamline



Target beamline

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	Download PDF final report
PTNATIAEA/18	February 2020 - May 2021	Soil	Download PDF final report
PTNAAIAEA/17	July 2019 - March 2020	Land-plant Siliceous	Download PDF final report

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

E.g. 2021 Event statistics

EVTDB | MS I/N-GO Stats | IDXs | Event Report

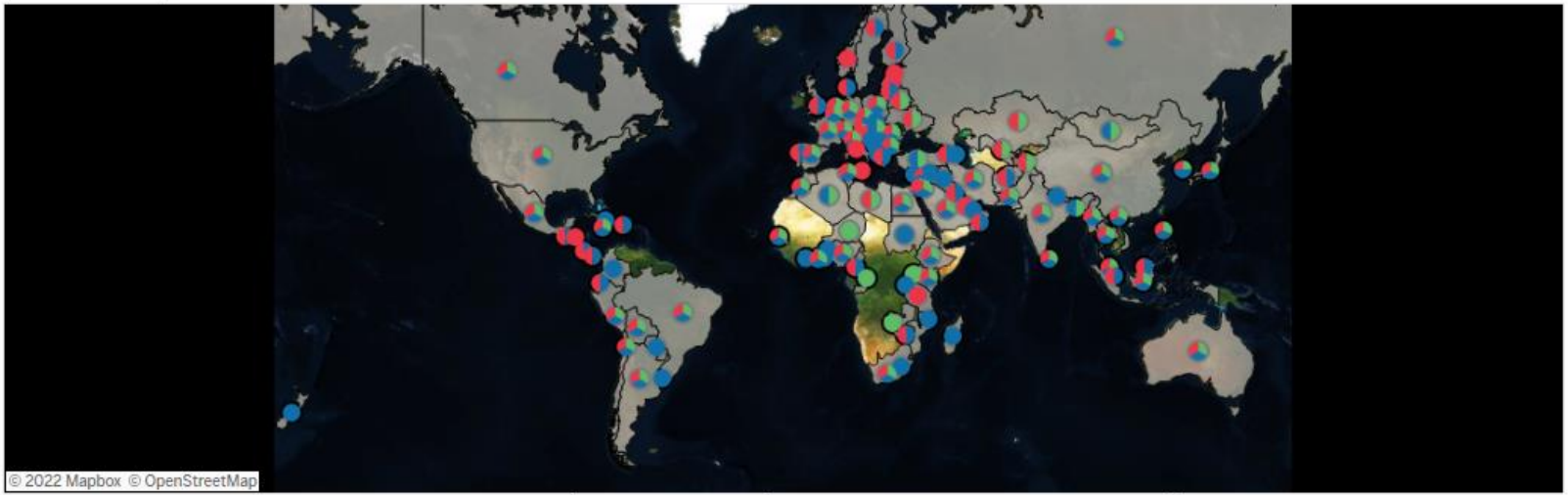
Year 2021 2021 | Owner (All) | EVT (All)

MS/IGO/N... (All) | Preparer (All) | Q (All)

IAEA

1.4.2
1.4.3
1.4.4

Tot. EVTs	1.4.2	1.4.3	1.4.4
55	13	20	22



MS/IGO/..	
USA	30
Thailand	25
China	24
Germany	24
Japan	24
France	23
Italy	22
Russia	22
UK	21
Argentina	20
India	20
Pakistan	18
Spain	17
Australia	16
Iran	16
South Africa	16
Brazil	15
Indonesia	15
Slovenia	15
Malaysia	14
Canada	13
Romania	13
Belgium	12

CM	RCM	TM	TR	N. of Participants	Mr	Ms	Tot. MSs	Tot. IGOs/NGOs
25	5	12	13	2,634	1,968	666	128	7

E.g. Coordinated Research Projects

CRAIS | Country Stats | Institute Stats | PR Index | CRP Report

Tot. CRPs	Acc-RR	Fusion	Instrumentation
10	4	5	1

RA	RC	TC	Tot. RA/RC/TC	Tot./Year (Euro)	Tot. Inst.	Tot. MSs/IOs
70	52	1	123	245,000	102	48

IAEA

Acc-RR
Fusion
Instrumentation

Choose CRP code

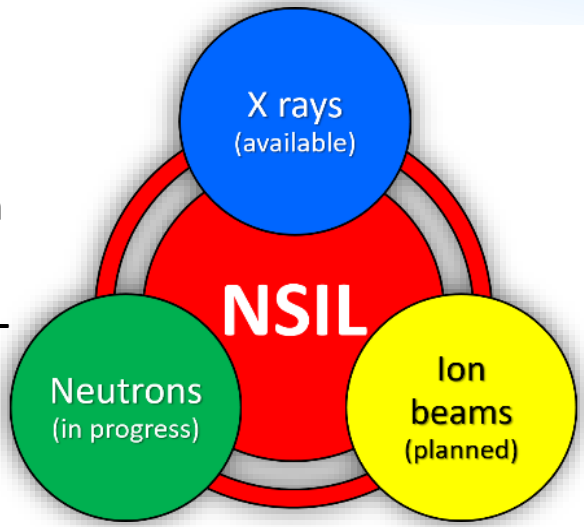
(All)

Countri..	
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

Future developments at NSIL/Physics

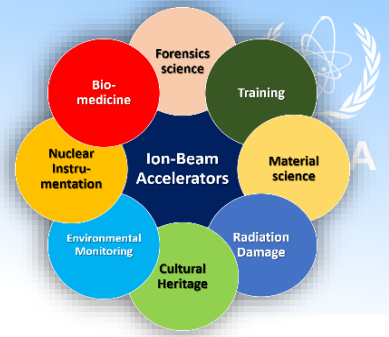
NSIL/Physics aims to **enhance the in-house capacity** in available laboratory facilities and instrumentation by operating **three complementary probes** for irradiation and analysis purposes:

- **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)

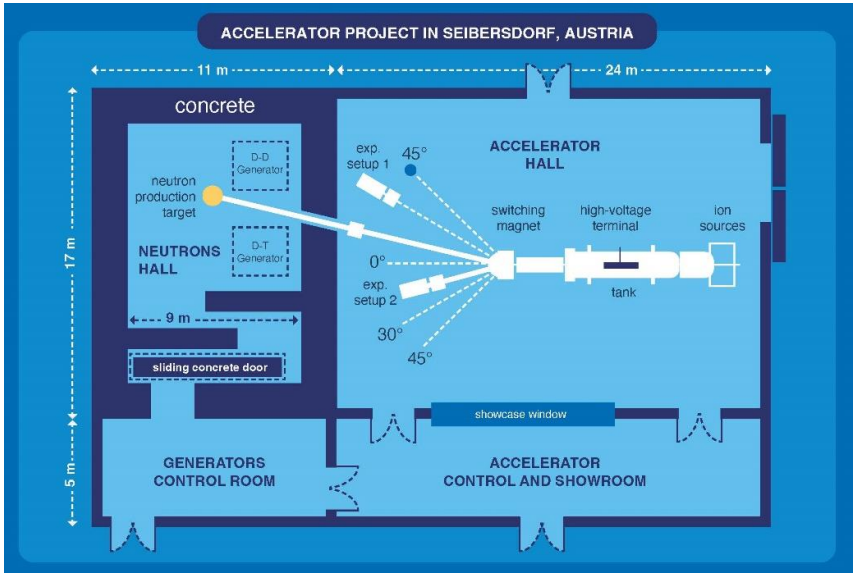


Comprehensive survey conducted in 2018: high interest from the user communities (>60 replies from 40MSs as well as internally within IAEA) :

- → **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.

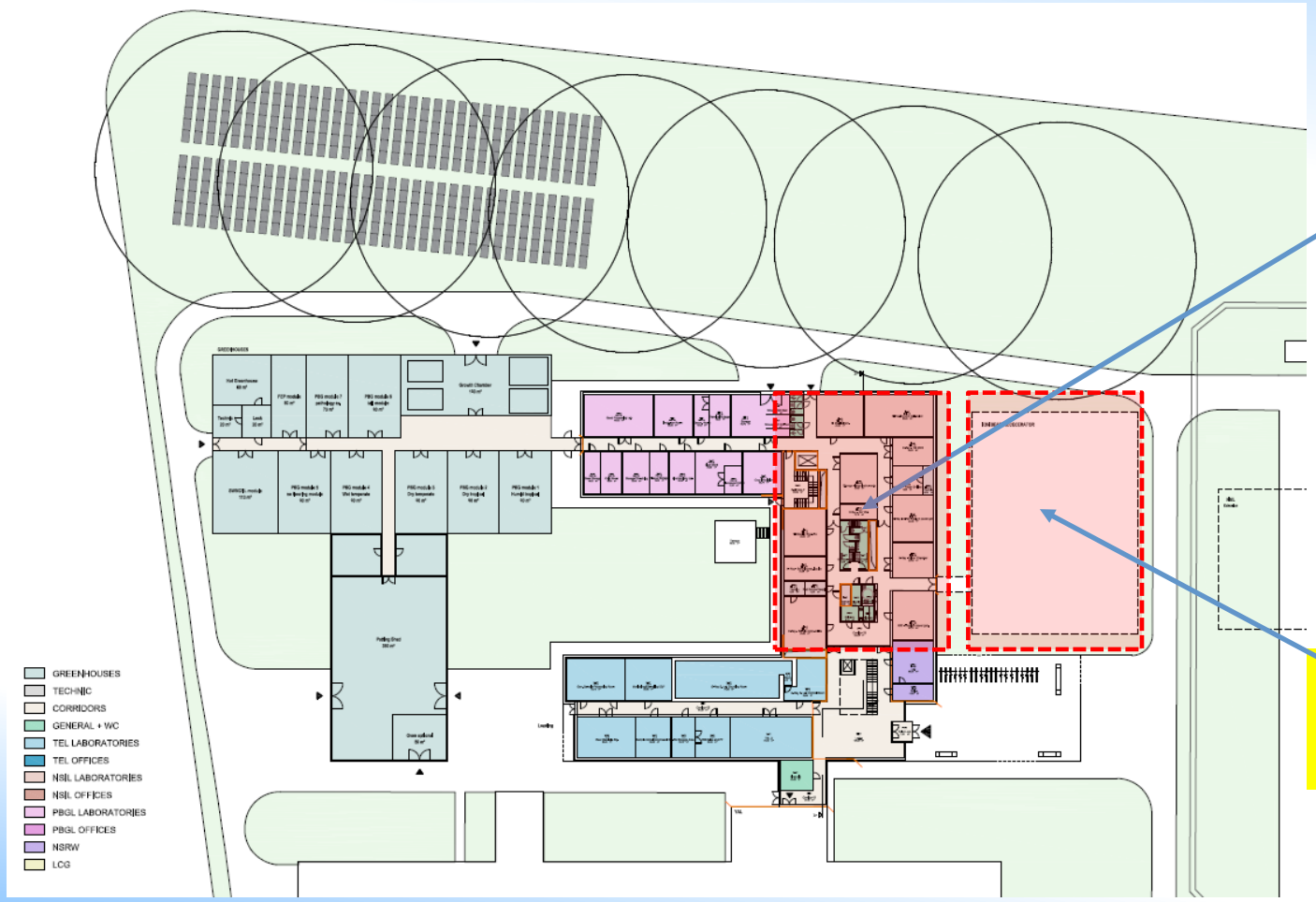
Feasibility study showed that, to match the NSIL's mission and stakeholder needs, the most **optimal and cost effective technology option would be 3.0 MV tandem.**

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)

IAEA
International Atomic Energy Agency

Thanks for your attention!


Physics

Facilitating the Peaceful and Practical Uses of Nuclear Science and Technology

By the Numbers

Four Key Areas


Nuclear Sciences and Instrumentation Laboratory

Fostering the effective use of nuclear instrumentation and related capacity building

By the Numbers

Four Key Areas


Nuclear Science and Instrumentation Newsletter

No. 02. August 2021

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Editorial


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