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IBF: The IAEA Ion Beam Facility project

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Why Particle Accelerators ?

✓ **Particle accelerators are fascinating machines:**

They are used not only in fundamental research for an improved understanding of matter and the universe but also in plethora of socioeconomic applications due to their unique analytical and irradiation capabilities.

✓ **Particle accelerators are everywhere!**

Accelerator-based applications cover almost all areas of life: from industry and medicine to aerospace technologies, from environmental monitoring and cultural heritage to food quality and drug development.

Accelerator labs play key role in capacity building by providing education and training in high-tech sectors and, on the long-term, to the increase of competitiveness of local economies.

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IAEA and Particle Accelerators

- ✓ The IAEA supports its Member States in strengthening their capabilities to adopt accelerator technologies and benefit from the use of accelerators
- ✓ Activities focusing on accelerator-based research and applications in multiple disciplines are being implemented by the Physics and RPRT Sections
- ✓ Among these, activities facilitating access to accelerator facilities and capacity building are of key importance and of primary interest

Physics Section's expertise in accelerator technologies

disseminating expertise in accelerator technologies

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- facilitates hands-on training of scientific and technical personnel in accelerator operation and maintenance
- assists in refurbishment and modernization of beam lines and associated instrumentation
- assists in feasibility and design studies and the preparation of business and strategy plans
- provides technical support in specifications, procurement, installation, repairs & upgrades of experimental devices.

collaboration with TC Dept.

- Algeria
- Egypt
- Ghana
- Nigeria
- South Africa

- Bangladesh
- Croatia
- Jordan
- Lebanon
- Mexico
- Slovakia
- Syria
- Thailand

Support in procurement of the 1.7MV Pelletron accelerator; technical assistance in starting up the laboratory and the development of a new beamline for a nuclear microprobe; additional upgrades of the accelerator & setups; training of staff in accelerator technology and ion beam analysis.

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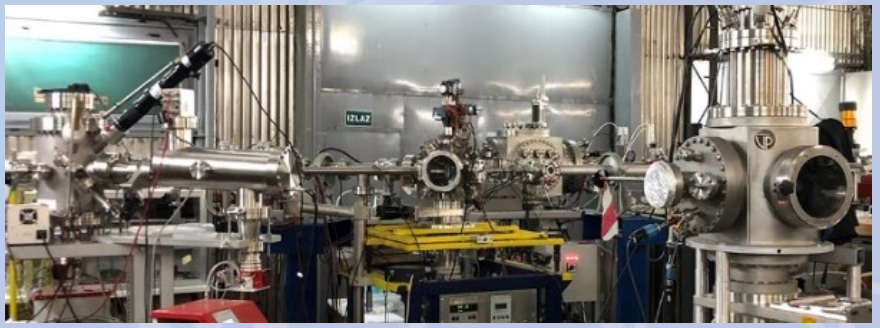
facilitating access to state-of-the-art accelerator facilities

IAEA – Elettra (Trieste) Cooperation Agreement

- Joint IAEA-Elettra XRF Beamline
- Dedicated beam-time for users; So far, more than 20 research groups from more than 18 Member States conducted experiments
- Recent beamline and end-station improvements
- UHVC 'Mirror Facility' commissioned at NSIL, Seibersdorf for pre-experiment training
- In 2018, Training Workshop held in SESAME, Jordan, with remote connection to Elettra

IAEA – RBI (Zagreb) Cooperation Agreement



- New He ion source for dual-beam irradiation capabilities commissioned (fusion research)
- 20 days of beamtime available, annually, for research groups from developing countries
- Biannual hands-on training courses on:
  - Electrostatic accelerator technology and associated instrumentation, incl. operation & maintenance (Dec. 2019; Nov. 2021-virtual)
  - Advances in Ion Beam techniques & their applications (March 2021-vIrtual, next in Nov. 2022)

G42008: A CRP facilitating experiments with Ion Beam Accelerators

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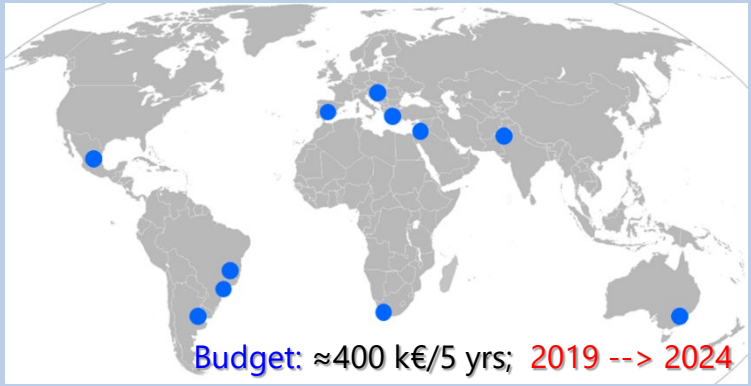

- Transnational access to IBA facilities across the world for researchers without local access to an accelerator
- Currently, 11 accelerator laboratories distributed in different geographical areas, where potential users are most expected
- Travel grants to external non-local users after submission and successful evaluation of a research proposal to/by the IAEA and acceptance by the host laboratory.
- some support to beam providing labs for consumables

The launch of this CRP was recommended by experts in a Consultancy Meeting (March 2018)

IBA/Nuclear Techniques covered

- PIXE/PIGE
- μ-PIXE
- RBS, Channelling
- NRA
- (ToF)-ERDA,
- MeV SIMS,
- AMS
- Nuclear reaction studies

So far

10 experiments
at
7 beam providers

- Geology (2)
- Air quality (3)
- Biomedicine
- Agriculture
- Archaeology
- Materials science
- IBA/Nuclear physics

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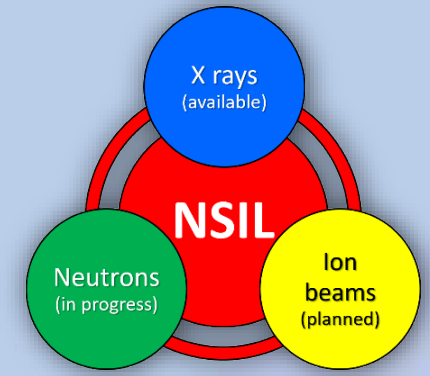
Nuclear Science & Instrumentation Laboratory (NSIL)

NSIL provides experimental tools to **foster the effective use of nuclear instrumentation and related capacity building** and helps Member States to **establish, operate, maintain and utilize** nuclear instrumentation and spectrometry techniques in support of a wide range of applications



Objective: operate three complementary probes for irradiation and analysis:

- **X-rays**, using existing diverse instruments for X-ray Fluorescence
- **Neutrons**, facility established, final stage before its full utilization
- **Ion-beams**, through the planned ion-beam accelerator facility.

IBF project: Feasibility Study 1/3

A comprehensive feasibility study for the establishment of an Ion Beam accelerator Facility has been performed to assess whether and how the acquisition and operation of an ion accelerator at Seibersdorf could match the NSIL's mission and existing program of teaching and training, and the provision of services across many fields of relevance to the IAEA Member States and internal to IAEA users.

Stakeholder analysis and quantification of user needs

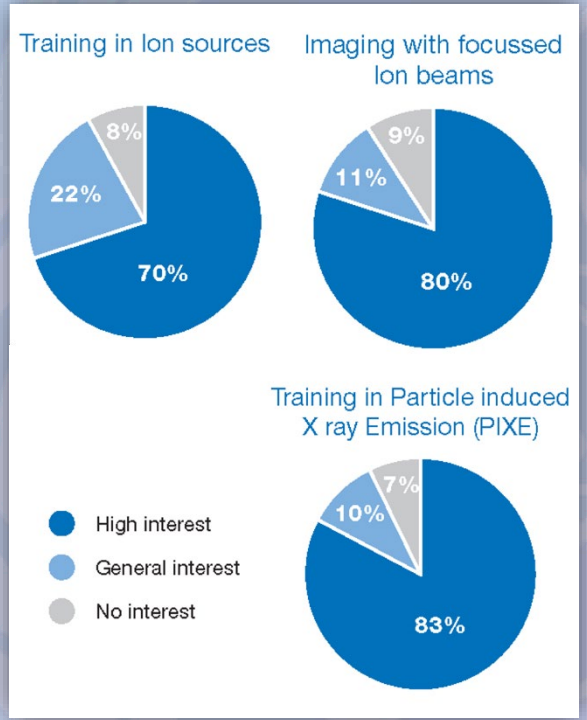
For this purpose **internal-to-IAEA stakeholders** have contributed through **interviews** and **external stakeholders** through a **questionnaire** aimed at evaluating the current needs of Member States for training, for ad hoc services, including for access to particle accelerators for research and development. **More than 60 replies** were received representing close to **40 Member States** indicating the most commonly demanded topics

IBF project: Feasibility Study 2/3

Stakeholder analysis and quantification of user needs

The most commonly demanded topics:

- **Training in:**
  - Accelerator technology such as ion sources and vacuum systems
  - End stations: design & assembly;
  - Radiation detectors; control systems & nuclear electronics
  - Ion Beam Analysis (IBA) techniques:
- **Services relevant to:**
  - IBA for bulk analysis of air pollution, environmental studies, etc.
  - Nuclear Microprobe: micro-PIXE, RBS, NRA; particulate reference materials
- **Applied research using:**
  - IBA for bulk analysis of air quality, archaeological samples, minerals
  - 2&3D imaging and spatially resolved analysis using a microprobe.



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IBF project: Feasibility Study 3/3

Ion beam applications (Ion beam techniques)	Option A 1.7 MV Tandem	Option B 3 MV Tandem
Capacity building through education and training (accelerator technology and ion-beam based techniques)	Full	Full
Environmental monitoring - air and water quality - climate change studies (RBS, PIGE, PIXE, Micro-Focused Ion Beams)	Full	Full
Geological elemental mapping, such as soil or sediment characterization (RBS, PIGE, PIXE, Micro-Focused Ion Beams)	Full	Full
Analysis of biological samples – toxic element identification – medicine (PIXE, IBIL, Micro-Focused Ion Beams, NRA, MeV-SIMS)	Full	Full
Analysis of structural materials for energy applications including fusion (RBS, PIGE, PIXE, NRA, IBIC, IBIL)	Full	Full
Cultural heritage studies (RBS, PIGE, PIXE, Micro-Focused Ion Beams, external Micro-Focused Ion Beams)	Full	Full
Neutron production complementary to other facilities at SEIB (via low energy p+Li reaction)	Full	Full
Dosimetry and cancer research (high energy ion beam irradiations)	Partial	Partial

Ion beam applications (Ion beam techniques)	Option A 1.7 MV Tandem	Option B 3 MV Tandem
Nuclear data for various fields of nuclear technology (all ion beam techniques)	Partial	Partial
Multilayer analysis, depth profiling, 3D imaging of materials of technological interest (RBS, EBS, Micro-Focused Beams, ToF-ERDA)	Partial	Full
Materials modification and testing by irradiation, including materials for energy applications, irradiation of semi-conductors, space electronics, etc. (high energy proton and heavier ion beam irradiations and characterizations)	Partial	Full
Surface analysis of materials of technological interest, e.g. photovoltaics (RBS, EBS, Micro-Focused Ion Beams, ToF-ERDA, MeV-SIMS, IBIC, IBIL)	Partial	Full
Forensic studies: combined techniques applied to various domains (RBS, EBS, Micro-Focused Ion Beams, ToF-ERDA, MeV-SIMS)	Partial	Full
Food quality & security – nutrition value (PIGE, PIXE, Micro-Focused Ion Beams, NRA)	Partial	Full
Mutation breeding studies of seeds, plants, rice etc. (high energy proton and heavier ion beam irradiations)	Limited	Partial

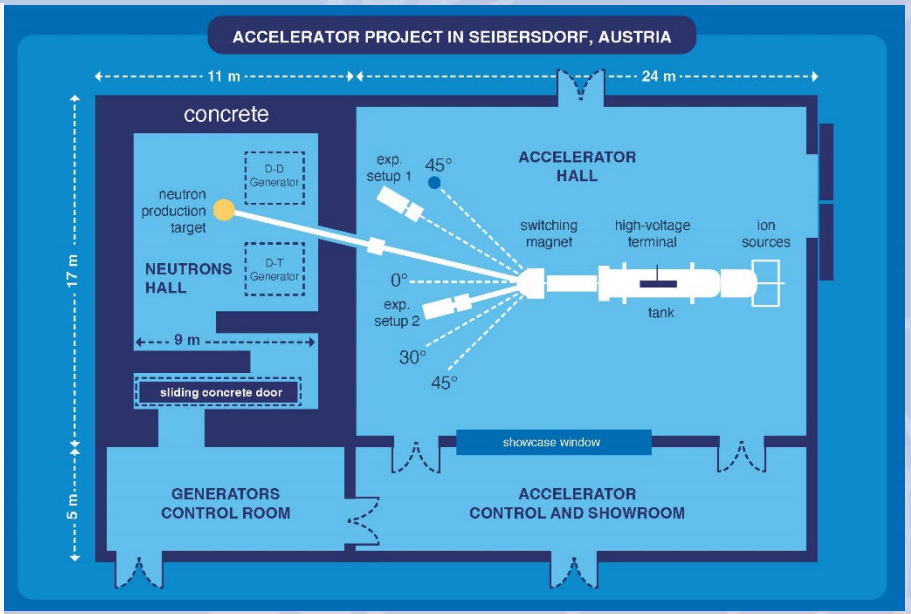
The IBF project at a glance

KEY TECHNOLOGY AND FACILITIES

- 3 MV Electrostatic accelerator (TANDEM) equipped with ion sources delivering a wide variety of ions, from the lightest element (protons) to the heaviest ones (gold).
- An experimental hall dedicated to the production of fast neutrons with accelerated proton beams and two neutron generators, for a broad spectrum of applications.
- State-of-the-art scientific instruments for the detection of particles, X-rays, and γ-rays and experimental setups for Ion-Beam Analysis (IBA) techniques.
- Digital electronics and signal processing for Data Acquisition and Analysis.

PROPOSED ACTIVITIES

- Prepare a Technical Design Study for the site and building requirements and the Technical Specifications for all technology components of the facility.
- Prepare building and other necessary infrastructure.
- Purchase, install and commission the accelerator and associated instrumentation.
- Establish guidelines for access to the facility and develop training programmes.



Ion Beam Accelerator	€ 2 400 000
Beamlines	€ 480 000
End-stations and Nuclear Instrumentation	€ 880 000
Building	€ 850 000
TOTAL	€ 4 610 000

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Thank you!

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