

IAEA activities in support of electrostatic accelerator facilities

Natko Skukan

N.Skukan@iaea.org

S. Charisopoulos

A. Simon

F. Foulon

D. Ridikas

nsil@iaea.org & physics@iaea.org

Outline

IAEA at a glance

Physics section activities in support of electrostatic accelerator facilities

Electrostatic accelerator in Seibersdorf project

IAEA at a glance



- Established 1957
- 172 Member States (September 2020)
- 2500+ staff from over 100 Member States
- HQ in Vienna
- Labs in Seibersdorf, Monaco & Vienna
- Regional offices in Toronto and Tokyo
- Liaison offices in New York and Geneva

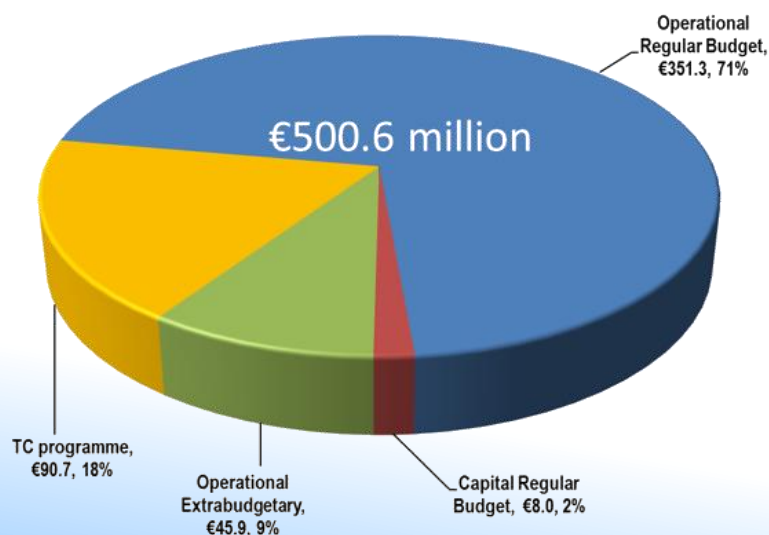
IAEA mission in short

- **Peaceful uses:** Promoting the peaceful uses of nuclear energy by its Member States
- **Safeguards:** Implementing safeguards to verify that nuclear energy is not used for military purposes
- **Nuclear safety:** Promoting high standards for nuclear safety

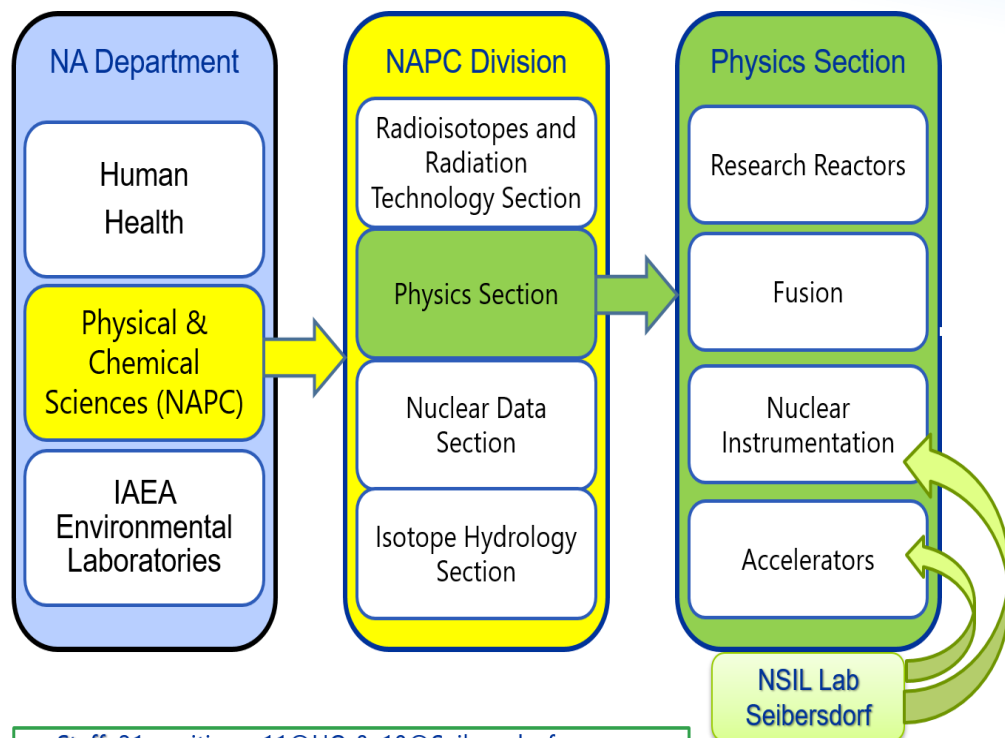
IAEA structure & budget



2016 Resources at a Glance



NA Department and The Physics Section



- **Staff:** 21 positions, 11@HQ & 10@Seibersdorf, plus consultants, interns, fellows; TOTAL: ~30-35
- **Budget:** ~4M Euros RB under 4 sub-programmes

Implementation tools and modalities

- Consultancy Meetings: 5 to 10 experts are invited to provide specialized advice and recommendations on particular scientific or other aspects of relevance for the IAEA's programmes and activities.
- Technical Meetings/Workshops: Technical events with 30-40 participants, aiming at enhancing interaction among experts, share knowledge and expertise, establish scientific collaborations and create topical networks.
- Coordinated Research Projects (CRPs): Networks of 10-15 research institutes from developed and developing countries that work in coordination for 3-5 years to acquire and disseminate new knowledge/technology. Periodic meetings are organized to report progress and plan/coordinate future activities.
- Training Workshops, Courses and dedicated Schools: Events enabling participants to acquire specific knowledge – theoretical or practical or both – on a given subject of interest. Organized at IAEA laboratories, ICTP Trieste, or at labs in member states
- Publications of technical documents and guides: Publications of reported results, shared good practices and lessons learned; produced by CRPs or Technical Meetings.
- National, regional, interregional Technical Cooperation (TC) projects: projects to build capacity via Expert Missions, training of personnel, purchase of equipment, assistance in establishing new facilities, ...

Direct support to accelerator labs through Technical cooperation (TC) projects

- facilitating hands-on training of scientific & technical personnel in accelerator operation and maintenance;
- assistance in refurbishment and modernization of beam lines and associated instrumentation;
- assistance in feasibility and design studies, business and strategy plans;
- providing technical support in specifications, procurement, installation, repairs & upgrades of exp. devices.



Direct support to ~ 20 laboratories in recent years through TC



Workshops and trainings:

Joint ICTP-IAEA Workshop: 21-29 Oct. 2019

<http://indico.ictp.it/event/8728/>

Joint ICTP-IAEA Workshop on Electrostatic Accelerator Technologies, Basic Instruments and Analytical Techniques



21 - 29 October 2019
Trieste, Italy

Further information:
<http://indico.ictp.it/event/8728/>
sm3421@slp.it

Topics

- Introduction to electrostatic accelerators and their operation
- Ion sources and vacuum systems at electrostatic accelerators
- Ion-beam optics, beam focusing, and monitoring devices
- Introduction to low energy nuclear reactions
- Ion-beam analytical techniques
- Selected ion-beam based applications
- Modern detector technologies
- Basic software for data analysis and accelerator control

7 Lecturers (22 lectures; 4 hrs exercises on PC)

- L. Conradie (iThemba LABS, Cape Town, SAF)
- M. Jaksic (RBI, Zagreb, Croatia)
- A. Lagoyannis (NCSR "Demokritos", Athens, GR)
- P. Pelicon (JSI, Ljubljana, Slovenia)
- D. Zafeiropoulos (INFN-LNL, Legnaro, Italy)
- N. Skukan (IAEA)
- S. Charisopoulos (IAEA)

17 Trainees from 13 countries

<age> = 33; 1/3 women

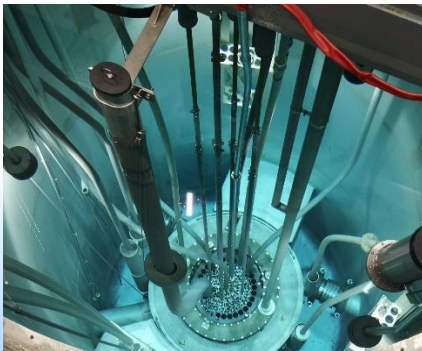
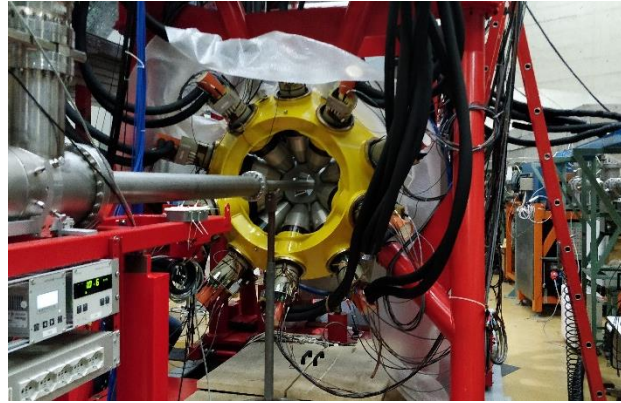
2 Lab visits (full day)

- Laboratori Nazionali di Legnaro, Italy
- Jozef Stefan Institute, Ljubljana, Slovenia



Joint ICTP-IAEA Workshop

(lab visits: LNL and JSI)



1st Training Workshop on Hands-on Operation and Maintenance of Electrostatic Accelerators

RBI, Croatia, December 2019

Topics (theory and practical)

- Vacuum + leak detection
 - Ion sources (duoplasmatron, sputtering, RF)
 - Beam optics/optical elements
 - Accelerator control and stabilization
 - TV calibration
-
- 8 participants (2 f/6 m) from 8 countries
 - A successful workshop as the first one of this type

Lessons learned

- Less topics but elaborate more
- More hands-on exercises
- Small groups (max 3 per hands-on exercise)

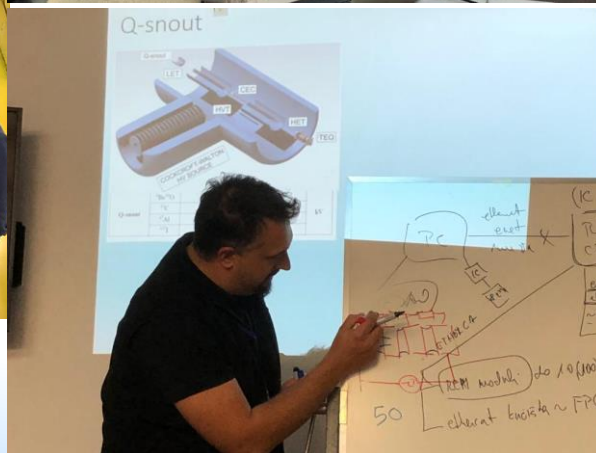
1st Training Workshop on Hands-on Operation and Maintenance of Electrostatic Accelerators

RBI, Croatia, December 2019

Planned to be organized biannually on specific topics

Will alternate with:

Training workshop on advances in ion beam techniques and their applications (IBA techniques)



Virtual Training Course on IBA techniques; In cooperation with

Mar 2021

Training Workshop on Advances in Ion Beam Techniques and their Applications,
Virtual, 1st to 5th March 2021, Ruđer Bošković Institute (RBI), Zagreb, Croatia



***Ion energy loss
PIXE***

***Data acquisition
Detectors for IBA
NRA and PIGE***

***RBS
ERDA***

***Microprobe system, basics and experiment
Microprobe – PIXE imaging
MeV SIMS***

***Microprobe – low current techniques – Ion
beam induced charge (IBIC)
and single ion implantation***

-4 MOVIES PRODUCED:

<https://nucleus.iaea.org/sites/accelerators/Pages/IBA-video-demonstrations.aspx>

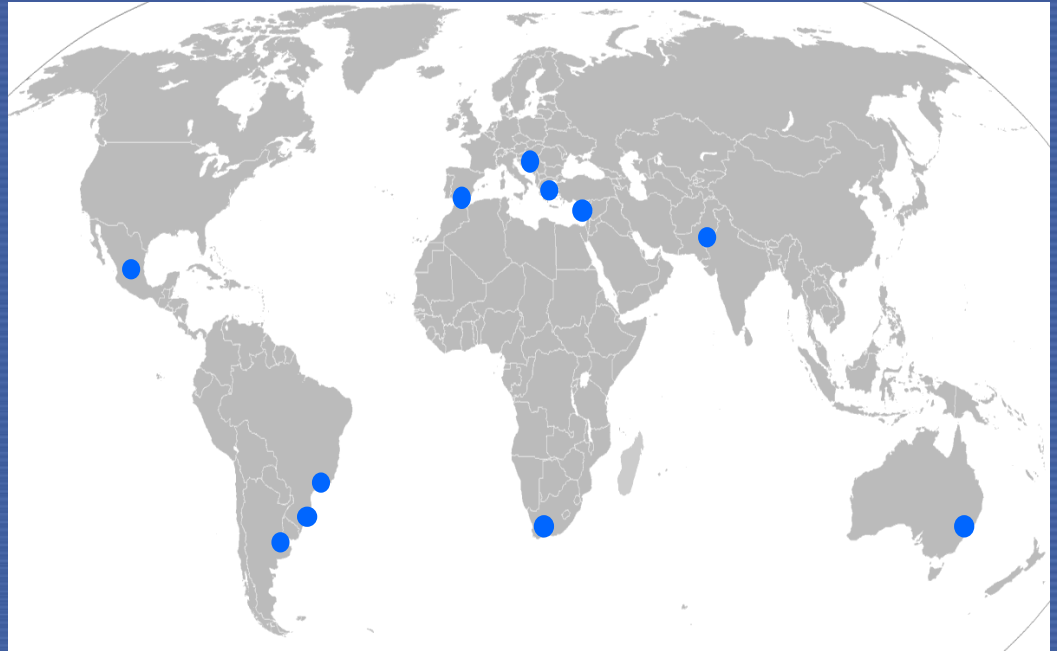
- 34 participants
- Physical trainings of this type: 8-10 participants
- Some of the trainings can be conducted virtually but not all!

CRP G42008: Facilitating Experiments with Ion Beam Accelerators

Transnational access to IBA facilities
on the world level (2019 →)

Currently: 11 centres strategically
distributed in different areas of the
world

(where potential users are most
expected)



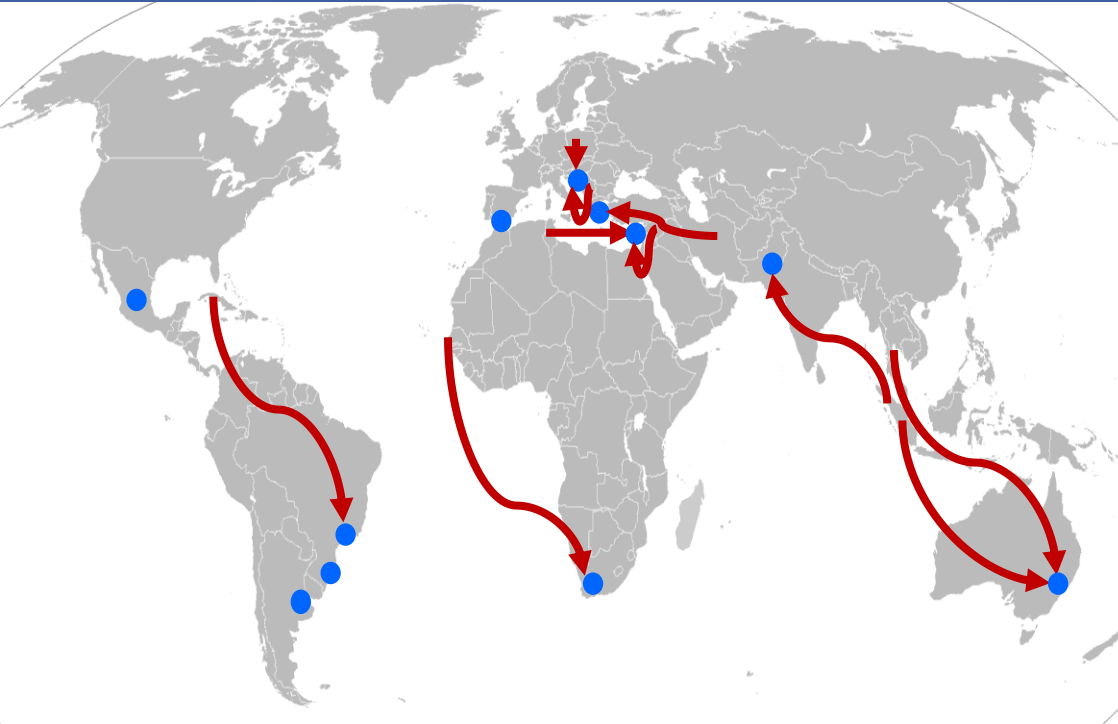
Scientists from countries without IBA accelerator facilities can apply for the beam time

Goal ~16 Projects/year

Budget ≈400 k€/5 yrs

CRP: Facilitating Experiments with Ion Beam Accelerators

Planned or performed experiments- COVID influenced the implementation (travels)



13 experiments to 7 beam providers; IBA and nuclear physics:

Geology (2)

Air quality/ecology (3)

Biomedical

Biology

Agriculture

Archaeology

Materials science (2)

Detector (semiconductor) physics

IBA/Nuclear physics

(cross-sections measurement)

<https://nucleus.iaea.org/sites/accelerators/Pages/beamtime.aspx>

IAEA publications



TecDoc and other series



Use of accelerator-based neutron sources

Ion beam techniques for the analysis of light elements in thin films, including depth profiling

Development of a Reference Database for Ion Beam Analysis

Trends of Synchrotron Radiation Applications in Cultural Heritage, Forensics and Materials Science

Hands-on Training Courses Using Research Reactors and Accelerators

Integration of Nuclear Spectrometry Methods as a New Approach to Material Research

Utilization of Accelerator Based Real Time Methods in Investigation of Materials with High Technological Importance

Improvement of the Reliability and Accuracy of Heavy Ion Beam Analysis

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

New TecDoc tentative title:



Operation and Maintenance Guidelines for Low Energy Electrostatic Accelerators

- The document drafting started years ago (also some SNEAPers were involved)
- Updated with some new topics
- “a source of useful information and knowledge to supplement and complement that provided by equipment manufacturers, and to provide educational and training material for accelerator personnel and users”
- Will be released soon (a few months)

E-learning courses

Examples:

Introduction to electrostatic accelerators: from basic principles to operation and maintenance

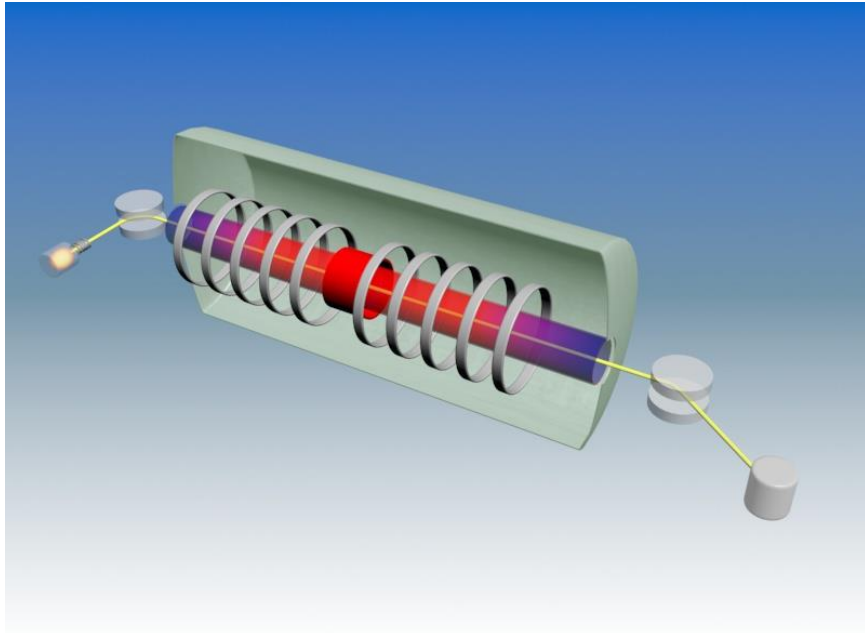
Ion-beam Engineering of Materials for Quantum Technologies

Introduction to X Ray Emission Spectrometry

Neutron Activation Analysis

Neutron Imaging

Nuclear Analytical Techniques for Forensic Science



<https://elearning.iaea.org/> → Nuclear Technology & Applications → Sciences and Applications → Nuclear Techniques

<https://elearning.iaea.org/m2/course/index.php?categoryid=108>

Forthcoming trainings and workshops

IAEA Training Workshop on
“Ion Beam Driven Materials Engineering: New Roles for Accelerators for Quantum Technologies”
Virtual event
IAEA Headquarters
Vienna, Austria
4–7 May 2021 – **just running (78 participants)!**
Ref. No.: EVT1904257

Target Audience:

PhD students and early career researchers (up to 7 years after PhD degree) actively involved in ion beam techniques working in an accelerator laboratory and/or in the field of quantum technologies.

Nomination deadline: 24 March 2021;

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

2nd Training Workshop on ~~Hands-on~~ Operation and Maintenance of Electrostatic Accelerators

To be organized virtually end of November 2021

Target Audience:

Young accelerator operators, engineers and scientists working at accelerator facilities

Form:

- Short videos/presentations regarding O&M issues
- “Round table” discussion from experienced and developing laboratories
- Possible several presentations from experienced laboratories in the field of O&M
- Experienced laboratories interested in participation – giving opinions/advice
please contact me: n.skukan@iaea.org
- Plan: to create a database of videos in O&M-please video-record your O&M; the video you may think is “straightforward” could help laboratories with less expertise

Accelerator Knowledge Portal & Interactive maps of accelerators



IAEA.org NUCLEUS

IAEA Accelerator Knowledge Portal

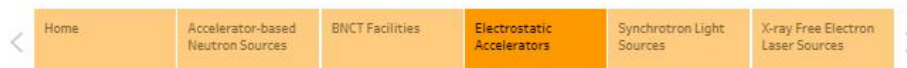
Interactive Maps Accelerators for Heritage CRPs Useful Resources Case Studies IBA Beamtime Workspaces Quantum Training workshop

Home
Physics Section
Radioisotope Products and Radiation Technology
Section
Help
How to Register
FAQ

Interactive Map of Accelerators

Welcome to the world-wide **Interactive Map of Accelerators**, developed and maintained by the IAEA Physics Section. This data base focuses on various* accelerator facilities supporting scientific research, either received from the organizations operating these facilities or it was collected from different publicly accessible sources. It undergoes a process of only 'light review' by our physics team.

*To navigate between different accelerator categories, please click on the relevant orange tabs at the very top. Other navigation tips are provided at the bottom of the page

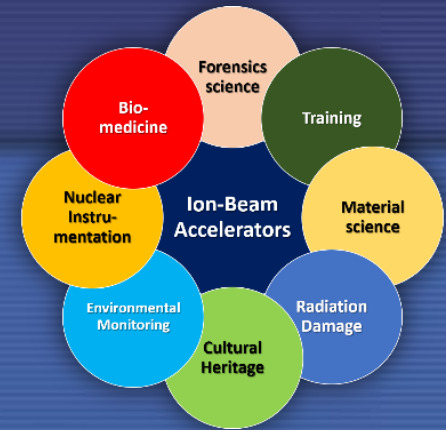


<https://nucleus.iaea.org/sites/accelerators>
email: physics-DB@iaea.org

Ion Beam Accelerator Project

Feasibility study conducted in 2018 defined needs for:

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



To match the IAEA Member States and internal IAEA users' needs:

1.7 MV Tandem or a 3 MV Tandem



Total investment cost:

3 M€ for 1.7 MV and 5 M€ for 3 MV accelerators.

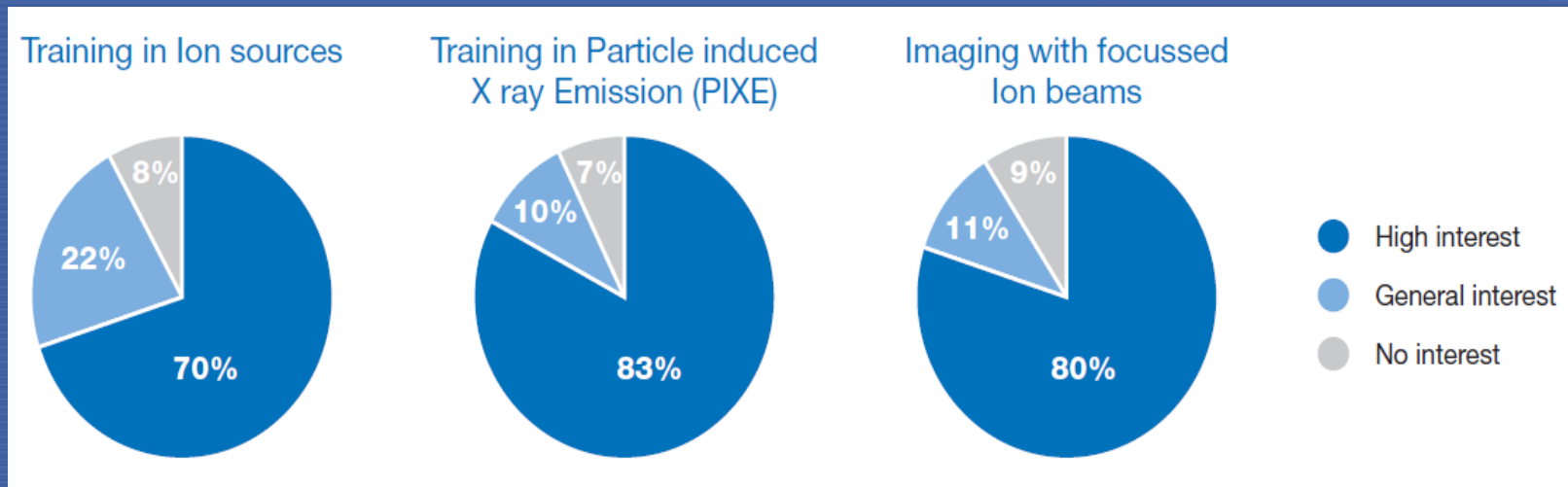
Staff required 3 to 5 persons

Annual operating cost : 100 to 150 k€

Call for Extrabudgetary support
from Member States for the Accelerator Project

Ion Beam Accelerator Project

Level of interest for applications of an Ion Beam Accelerator at IAEA Laboratories, according to the feasibility study conducted in 2018:



List of useful links

IAEA events

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

IAEA publications

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

IAEA e-learning

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

IAEA accelerator portal

<https://nucleus.iaea.org/sites/accelerators>

IAEA Nuclear science and instrumentation portal

<https://nucleus.iaea.org/sites/nuclear-instrumentation>

Get beamtime through IAEA

<https://nucleus.iaea.org/sites/accelerators/Pages/beamtime.aspx>

IBA methods – practical demonstrations

<https://nucleus.iaea.org/sites/accelerators/Pages/IBA-video-demonstrations.aspx>



Thanks for your attention!

N.Sjukan@iaea.org

Further Information: nsil@iaea.org &
physics@iaea.org



IAEA

International Atomic Energy Agency



Physics

Facilitating the Peaceful and Practical Uses of Nuclear Science and Technology

The IAEA Physics Section helps Member States develop expertise for the efficient, sustainable and safe use of peaceful nuclear technologies such as particle accelerators, isotopes, radiation, nuclear reactors, nuclear and associated infrastructure. Applications of these nuclear technologies help address a variety of issues such as energy, health, food and agriculture, nuclear safety and security, cultural heritage, human resource capacity and the environment.

Four Key Areas

- Accelerator Applications**
Accelerators are used in high technology and applied research in a wide range of fields including medicine, industry, agriculture, food, energy, health, food and agriculture, nuclear safety and security, cultural heritage, human resource capacity and the environment.
- Isotope and Radiation Applications**
Isotopes and radiation are used in a wide range of fields including medicine, industry, agriculture, food, energy, health, food and agriculture, nuclear safety and security, cultural heritage, human resource capacity and the environment.
- Nuclear Reactors**
Nuclear reactors are used in a wide range of fields including medicine, industry, agriculture, food, energy, health, food and agriculture, nuclear safety and security, cultural heritage, human resource capacity and the environment.
- Nuclear Instrumentation**
Nuclear instrumentation is used in a wide range of fields including medicine, industry, agriculture, food, energy, health, food and agriculture, nuclear safety and security, cultural heritage, human resource capacity and the environment.

By the Numbers

13 countries have joined the IAEA Physics Section since its establishment in 1957.

50 countries have joined the IAEA Physics Section since its establishment in 1957.

225 countries have joined the IAEA Physics Section since its establishment in 1957.

218 countries have joined the IAEA Physics Section since its establishment in 1957.

57 countries have joined the IAEA Physics Section since its establishment in 1957.

40 countries have joined the IAEA Physics Section since its establishment in 1957.

2 countries have joined the IAEA Physics Section since its establishment in 1957.

2 countries have joined the IAEA Physics Section since its establishment in 1957.



Nuclear Sciences and Instrumentation Laboratory

Facilitating the effective use of nuclear instrumentation and related capacity building

The IAEA Nuclear Sciences and Instrumentation Laboratory (NSIL) helps Member States to enhance, expand and sustain their nuclear instrumentation and related capacity building in a wide range of applications such as health care, food, agriculture, industry, energy, safety, security, and the environment.

Four Key Areas

- Health**
The NSIL helps Member States to enhance, expand and sustain their nuclear instrumentation and related capacity building in a wide range of applications such as health care, food, agriculture, industry, energy, safety, security, and the environment.
- Food**
The NSIL helps Member States to enhance, expand and sustain their nuclear instrumentation and related capacity building in a wide range of applications such as health care, food, agriculture, industry, energy, safety, security, and the environment.
- Industry**
The NSIL helps Member States to enhance, expand and sustain their nuclear instrumentation and related capacity building in a wide range of applications such as health care, food, agriculture, industry, energy, safety, security, and the environment.
- Energy**
The NSIL helps Member States to enhance, expand and sustain their nuclear instrumentation and related capacity building in a wide range of applications such as health care, food, agriculture, industry, energy, safety, security, and the environment.