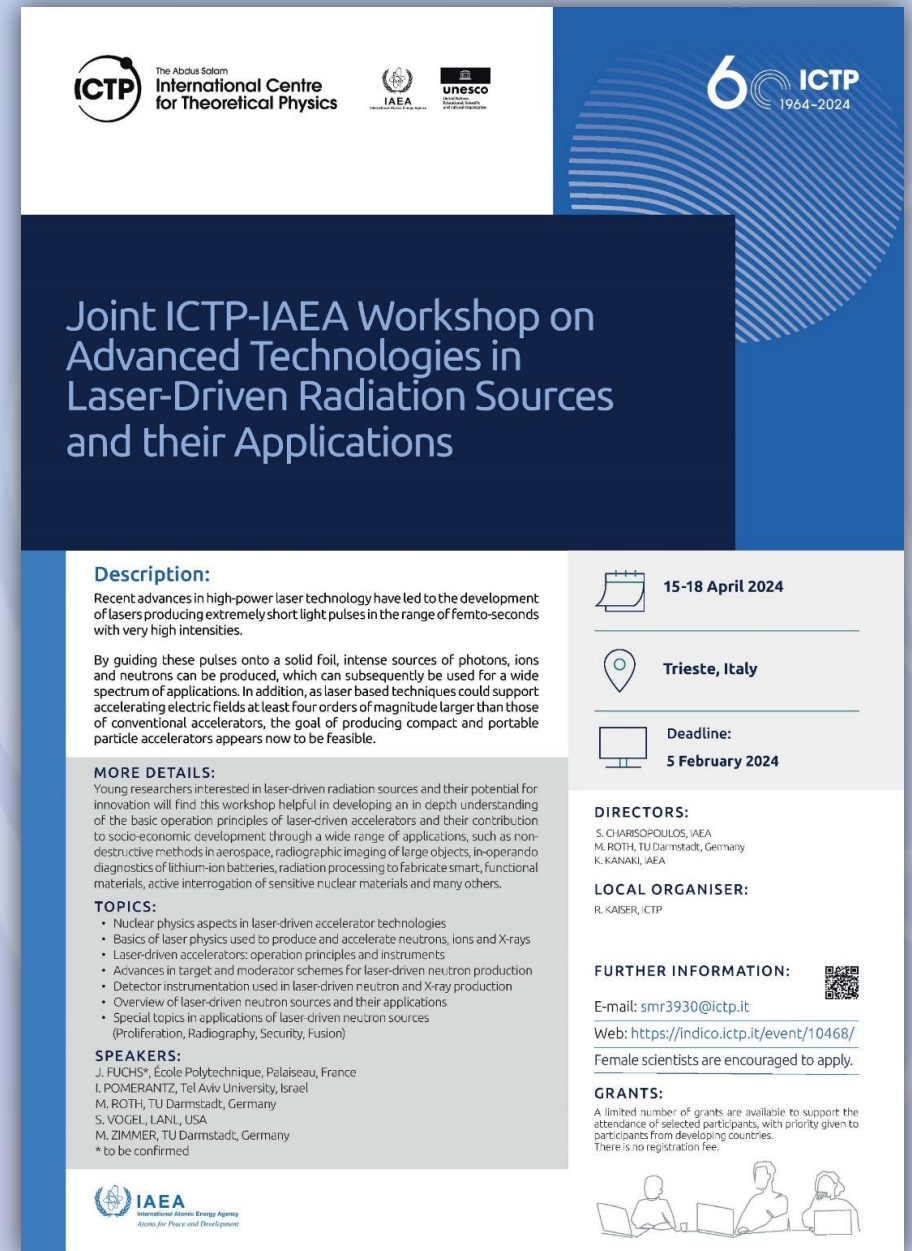


IAEA activities in support of sustainable development of accelerator facilities and the Ion Beam Facility Project

Sotirios Charisopoulos

International Atomic Energy Agency - IAEA
Dept. of Nuclear Science and Applications,
NAPC/Physics Section



The poster is a promotional flyer for a workshop. It features a blue and white color scheme with a stylized atomic symbol in the background. The top left corner contains the logos for ICTP, IAEA, and UNESCO. The top right corner features the ICTP 60th anniversary logo (1964-2024). The main title is centered in a dark blue box. Below the title, the poster is divided into several sections: Description, Dates, Location, Deadline, More Details, Speakers, Directors, Local Organiser, Further Information, and Grants. The bottom left corner has the IAEA logo, and the bottom right corner has an illustration of people working at computers.

ICTP The Abdus Salam International Centre for Theoretical Physics

IAEA International Atomic Energy Agency

unesco United Nations Educational, Scientific and Cultural Organization

60 ICTP 1964-2024

Joint ICTP-IAEA Workshop on Advanced Technologies in Laser-Driven Radiation Sources and their Applications

Description:
Recent advances in high-power laser technology have led to the development of lasers producing extremely short light pulses in the range of femto-seconds with very high intensities.

By guiding these pulses onto a solid foil, intense sources of photons, ions and neutrons can be produced, which can subsequently be used for a wide spectrum of applications. In addition, as laser based techniques could support accelerating electric fields at least four orders of magnitude larger than those of conventional accelerators, the goal of producing compact and portable particle accelerators appears now to be feasible.

DATE: 15-18 April 2024

LOCATION: Trieste, Italy

DEADLINE: 5 February 2024

MORE DETAILS:
Young researchers interested in laser-driven radiation sources and their potential for innovation will find this workshop helpful in developing an in depth understanding of the basic operation principles of laser-driven accelerators and their contribution to socio-economic development through a wide range of applications, such as non-destructive methods in aerospace, radiographic imaging of large objects, in-operando diagnostics of lithium-ion batteries, radiation processing to fabricate smart, functional materials, active interrogation of sensitive nuclear materials and many others.

TOPICS:

- Nuclear physics aspects in laser-driven accelerator technologies
- Basics of laser physics used to produce and accelerate neutrons, ions and X-rays
- Laser-driven accelerators: operation principles and instruments
- Advances in target and moderator schemes for laser-driven neutron production
- Detector instrumentation used in laser-driven neutron and X-ray production
- Overview of laser-driven neutron sources and their applications
- Special topics in applications of laser-driven neutron sources (Proliferation, Radiography, Security, Fusion)

SPEAKERS:
J. FUCHS*, École Polytechnique, Palaiseau, France
I. POMERANTZ, Tel Aviv University, Israel
M. ROTH, TU Darmstadt, Germany
S. VOGEL, LANL, USA
M. ZIMMER, TU Darmstadt, Germany
* to be confirmed

DIRECTORS:
S. CHARISOPOULOS, IAEA
M. ROTH, TU Darmstadt, Germany
K. KANAKI, IAEA

LOCAL ORGANISER:
R. KAISER, ICTP

FURTHER INFORMATION:

E-mail: smr3930@ictp.it

Web: <https://indico.ictp.it/event/10468/>

Female scientists are encouraged to apply.

GRANTS:
A limited number of grants are available to support the attendance of selected participants, with priority given to participants from developing countries. There is no registration fee.

IAEA International Atomic Energy Agency
Atoms for Peace and Development

IAEA: An autonomous international organization within the United Nations system



IAEA



IAEA HQ in Vienna, Austria

173 Member States; 2500+ staff from over 100 Member States; HQ in Vienna

- Labs in Seibersdorf, Vienna and Monaco
- Regional offices in Toronto and Tokyo; Liaison offices in New York and Geneva

Mission: to serve the Member States

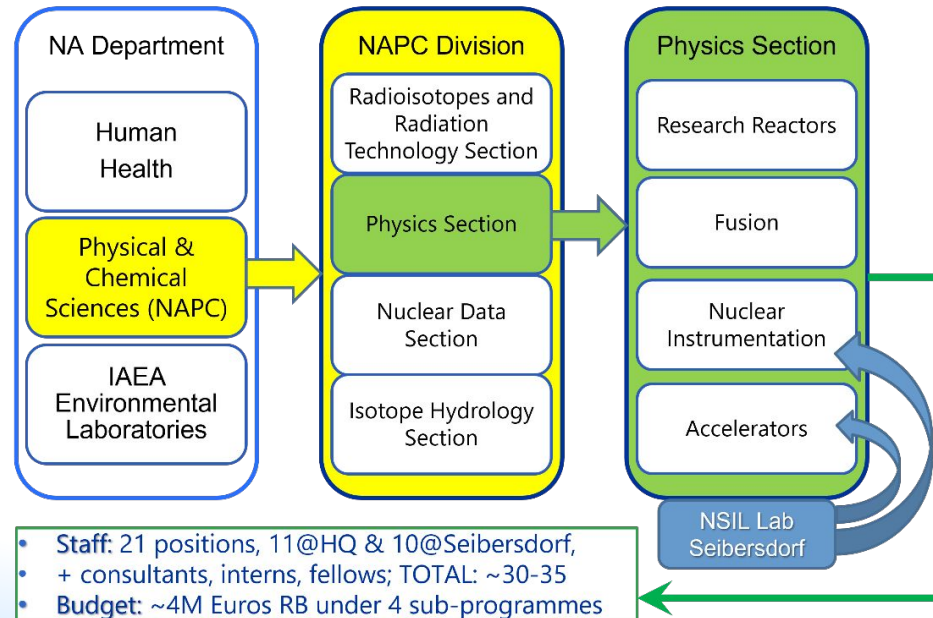
The IAEA

- assist its Member States, in planning & using nuclear science & technology for peaceful purposes
- facilitate transfer of knowledge in a sustainable manner to developing Member States
- develop nuclear safety standards and promote high levels of safety in applications of nuclear energy, and the protection of human health and the environment against ionizing radiation;
- verify through its inspection system that States comply with their commitments to use nuclear material and facilities only for peaceful purposes.

Structure



The Department of Nuclear Science and Applications (NA)



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

Relevance to the SDGs



The IAEA laboratories



Water Resources



Food & Agriculture

Human Health

Nuclear Science

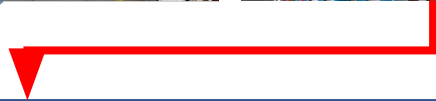
1. Insect Pest Control
2. Animal Production & Health
3. Plant Breeding & Genetics
4. Soil and Water Management & Crop Nutrition
5. Food Safety and Control
6. Dosimetry Laboratory
7. Terrestrial Environment
8. Nuclear Science and Instrumentation



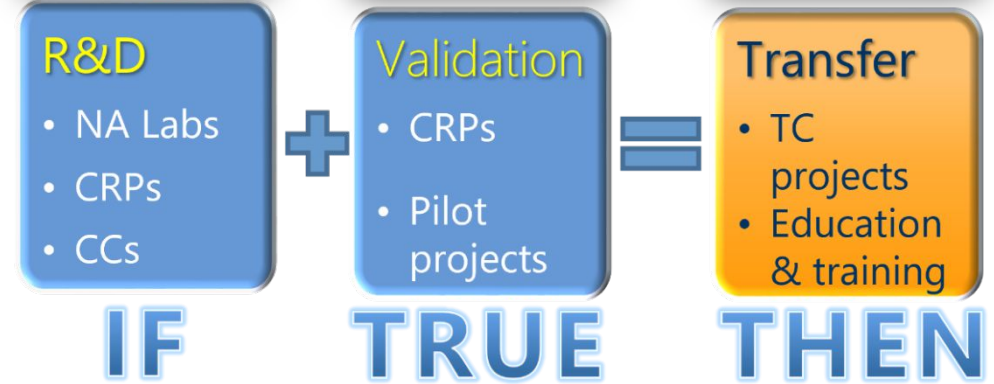
Marine Environment



Areas of work and Capacity Building methodology



<p>sustainable agricultural development</p> 	<p>food security and nutrition</p> 	<p>cancer diagnosis and treatment modalities</p> 
<p>cleaner water for more people</p> 	<p>protecting the environment</p> 	<p>Providing expertise for industrial applications</p> 



Key Principles for TC Projects

- Contribute to development goals
- Respond to Member States' needs
- Undertake peaceful use of nuclear technology
 - Comply to IAEA safety and security rules
- Ensure Member State ownership & shared responsibility
 - Ensure non-discrimination of stakeholders

The IAEA Technical Cooperation Programme

Primary mechanism for transferring nuclear technology to Member States, implemented through **National**, **Regional** or Interregional TC Projects

- Capacity building
- Networking
- Knowledge sharing
- Partnership building



Fellowships
Scientific visits

Expert assistance



Equipment &
materials

Conferences,
Symposia



Training courses
& workshops



The SESAME Interregional TC Project (2010-2023; ≈2M€)



(SESAME was inaugurated on May 16, 2017, in Jordan)

Over the last decade IAEA has provided **extensive support to train staff at SESAME to commission and run the facility**. This has included instruments, the training of 66 technical and scientific fellows in beamline technologies, and **over 30 expert missions to SESAME** to help build capacity in the installation and testing of equipment.

IAEA also facilitated the networking of SESAME staff with experts from other synchrotron facilities in Europe, the United States and Japan. **In 2018, Training Workshop held in SESAME, Jordan, with remote connection to Elettra**

New Interregional TC project in preparation: Expansion of network across all continents.

The RER6039 Regional TC Project (SEEIIST)



“Developing Human Resources for Setting Up an Ion Beam Therapy Centre within the Joint South East European International Institute for Sustainable Technologies”

ICTP, Trieste, Italy; 21-24 Jan. 2018

Start of RER6039: 2020-12-02
Duration: 4 years

Year	2020	2021	2022	2023	Total (€)
Budget (€)	153,720	189,630	71,190	85,680	500,220



- Decisions on
- Overall Workplan of TC project
 - Capacity building through scientific visits
 - Training program (3 Fellowships)
 - Next workshops

CNAO
Centro Nazionale di Adroterapia Oncologica

IAEA
International Atomic Energy Agency

HITRI
Heavy Ion Therapy Research Institute

HYBRID CME EVENTS

Hadrontherapy: status and perspectives. Development of a hadrontherapy facility: learning from the existing* and Scientific day on BNCT

OCTOBER 11TH | 12TH | 13TH 2023
PAVIA & ONLINE

Directors: Ester Orlandi, Saverio Altieri, Sotirios Charisopoulos

In collaboration with:

INFN, POLITECNICO MILANO 1863, UNIVERSITÀ DI PAVIA, Fondazione IRCCS Policlinico San Matteo, Regione Lombardia, ACC AM MED

Training at CNAO (Pavia, Italy) in 5 different topics for 12 months

1. Study of Slow Beam Extraction
2. Characterization of a new acquisition system for the Schottky Monitor of the CNAO Synchrotron
3. Development of a monitor for low intensity beams.
4. Development and test of electronics boards
5. Control system development.

Development Objective:

To build critical mass of human resources initially needed for the merits of the emerging hadron tumour therapy and research facility – SEEIIST.

UZB006: A national TC project



objective

To improve and develop educational processes in nuclear science and applications of nuclear techniques and methods in the economic sector of the Republic of Uzbekistan



outcome

Academic programmes in the field of nuclear science and technologies established at the National University of Uzbekistan (Tashkent) and the Samarkand State University;
=> new lab courses in **nuclear spectroscopy**, **nuclear electronics**, **accelerator and reactor physics**



activities

6x fellowships (up to 6 months) – **2x scientific visits** – **4 expert missions**
Procurement of new scientific instruments and analysis software



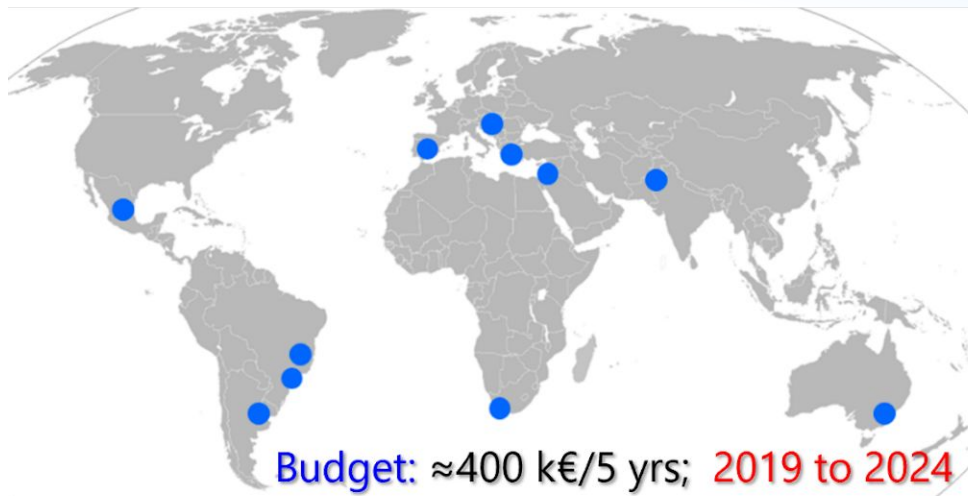
Similar projects: Cambodia, Botswana, Laos ...

The tools



- [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](#): 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 on a given subject of interest. Organized at IAEA labs, 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.
- [Collaborating Centres](#): IAEA Member State institutions/organizations are designated as *IAEA Collaborating Centres (CC)* to cooperate in the implementation of selected programmatic activities of the Agency.
- [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, ...

G42008: A CRP facilitating experiments with Ion Beam Accelerators



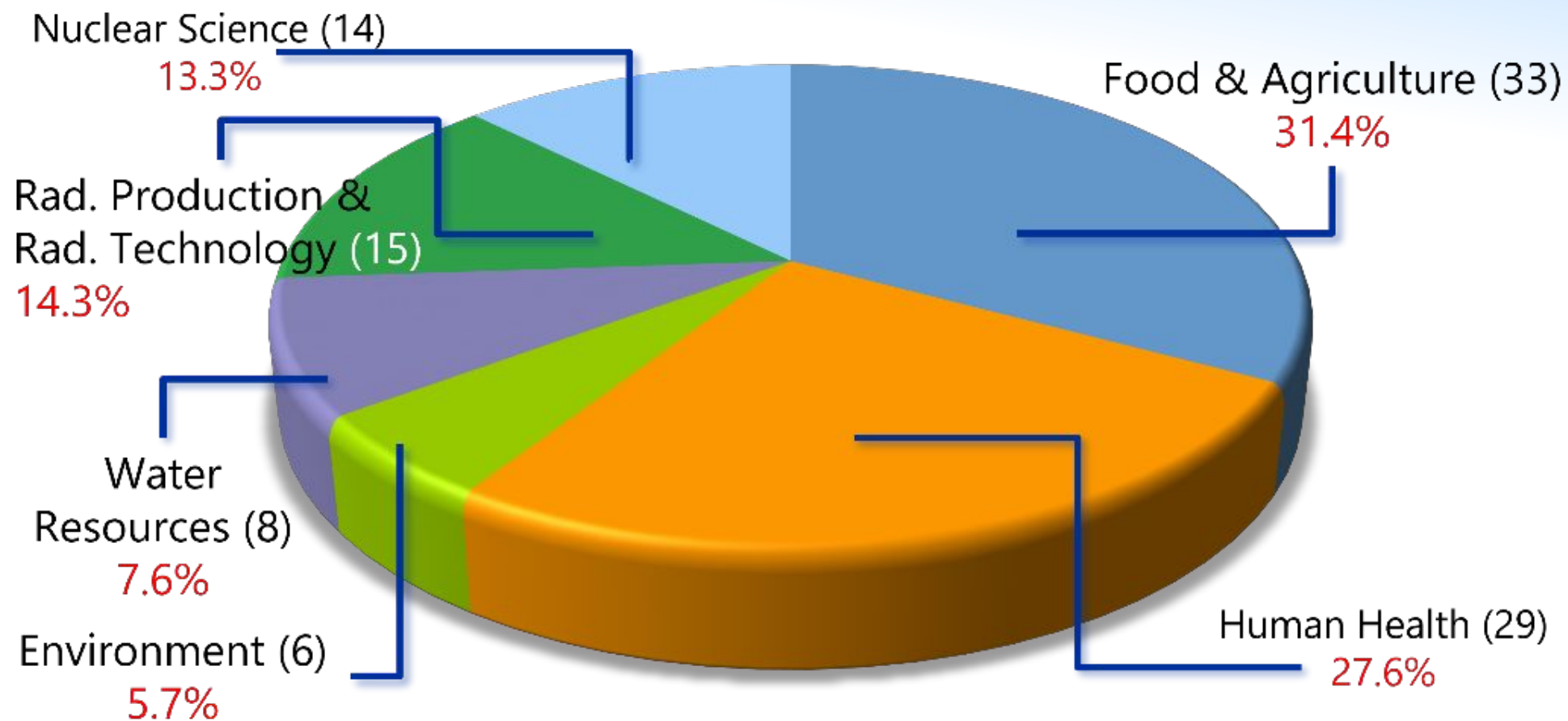
The launch of this CRP was recommended by experts in a Consultancy Meeting (March 2018)



- ❑ 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

IBA/Nuclear Techniques covered	So far
<ul style="list-style-type: none">• PIXE/PIGE• μ-PIXE• RBS, Channelling• NRA• (ToF)-ERDA,• MeV SIMS,• AMS• Nuclear reaction studies	<p>19 experiments completed/planned</p> <ul style="list-style-type: none">• Biology (2)• Ecology (6)• Geology (1)• Agriculture (3)• Archaeology (2)• Materials science (4)• IBA/Nuclear physics (1)

Coordinated Research Projects – NA Department (2022)

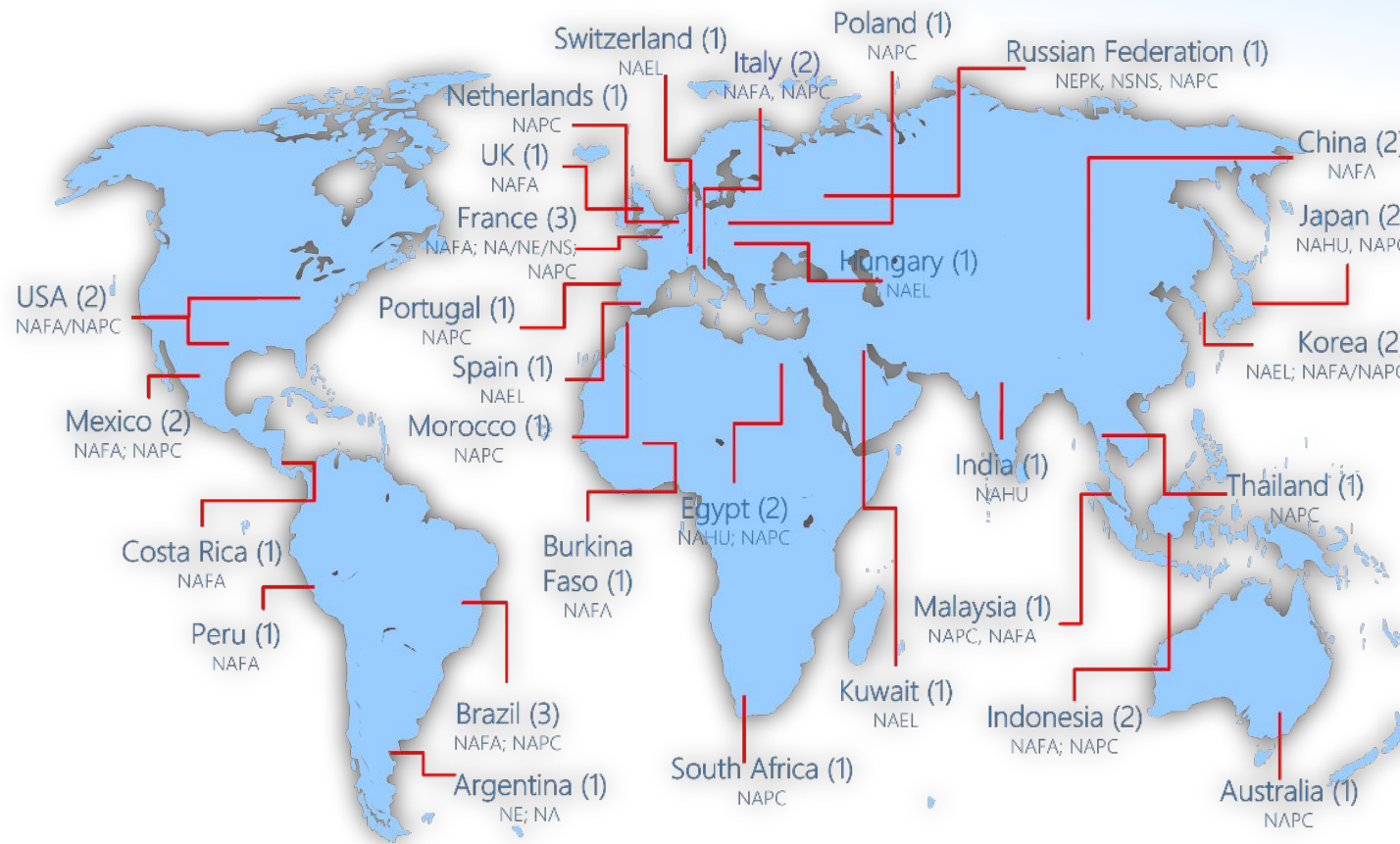


NACA, 2022 data

IAEA Collaborating Centres



IAEA Member State institutions organizations are designated as **IAEA Collaborating Centres** to cooperate in the implementation of selected programmatic activities of the Agency.



The designation process takes effect with the signing of an Agreement between the IAEA and the CC organization. This is a legally binding document defining the cooperative undertakings, duration of designation, objectives, activities, and expected results and outcomes stated in a jointly agreed Work Plan, which addresses R&D work, educational and training activities and, in many cases, cost-free services to the IAEA and its Member States.

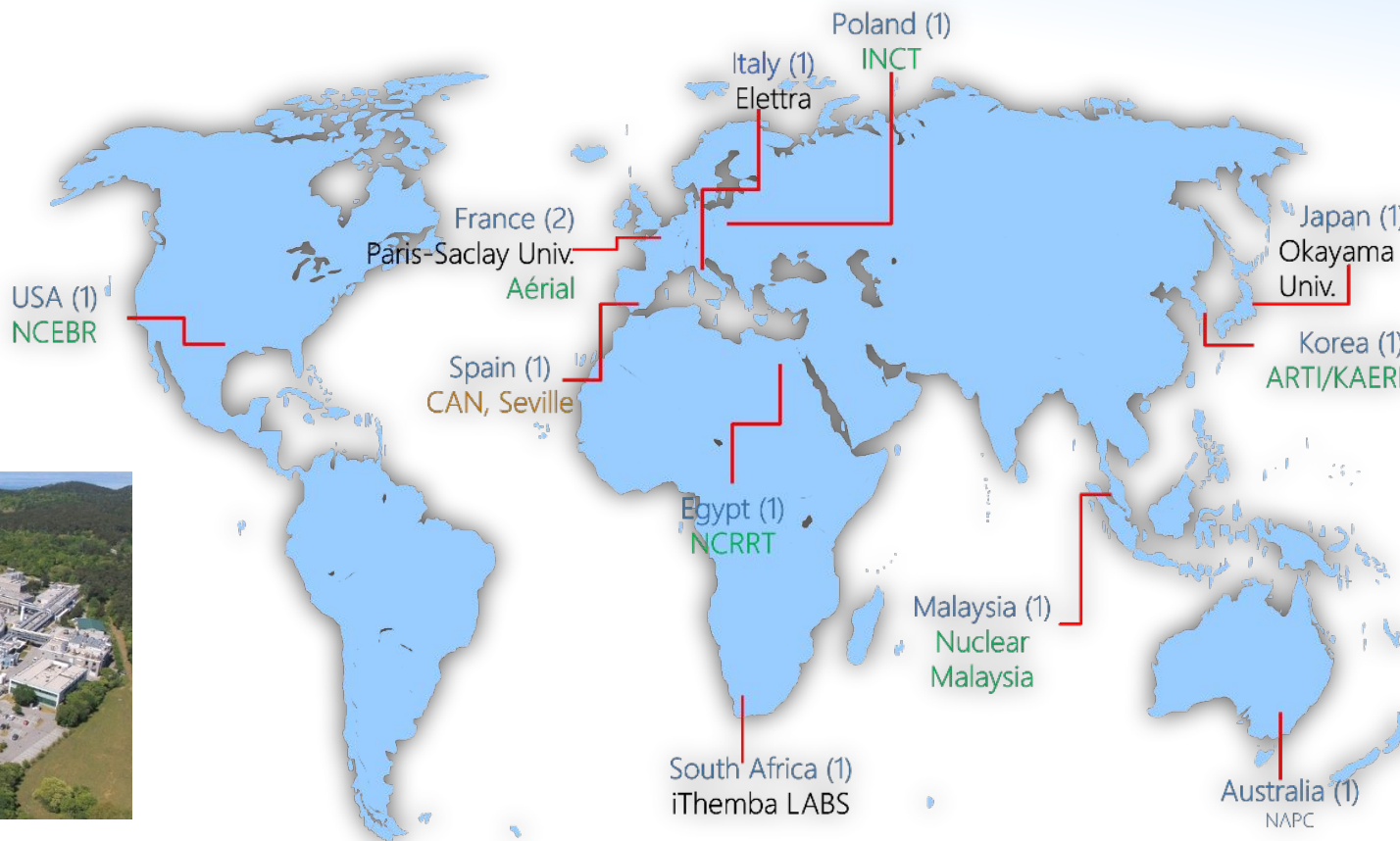
IAEA Collaborating Centres



Elettra Sincrotrone, Trieste, Italy

Synchrotron applications
and technologies

Support the IAEA in the
implementation of activities
in the IAEA Programme
“Nuclear Techniques for
Development and
Environmental Protection”



Signing ceremony, 9 Nov. 2021

Work plan

- Assistance to developing MSs **intending to build synchrotron facilities** including training of their **scientists & technologists** in light sources design and beamline design control systems & detectors.

- Assistance to developing MSs in implementing new methodologies for **expanding the application fields of synchrotron and FEL techniques.**

Technical Meeting: Advanced methodologies for the analysis of materials in energy application using Ion Beam Accelerators (8–11 Oct. 2018, Vienna)



new CRP (10 facilities, 10 countries, 34 scientists)

Objectives

- Identify data needs and **measure fundamental cross-sections** for nuclear reactions with fusion relevant materials
- Identify data needs and **measure stopping powers** in fusion relevant materials with Helium ions
- Define **international standards** for the analysis of fusion-relevant materials
- Define and **produce reference samples** for **Round-Robin tests** in the IBA fusion community



Phase 1

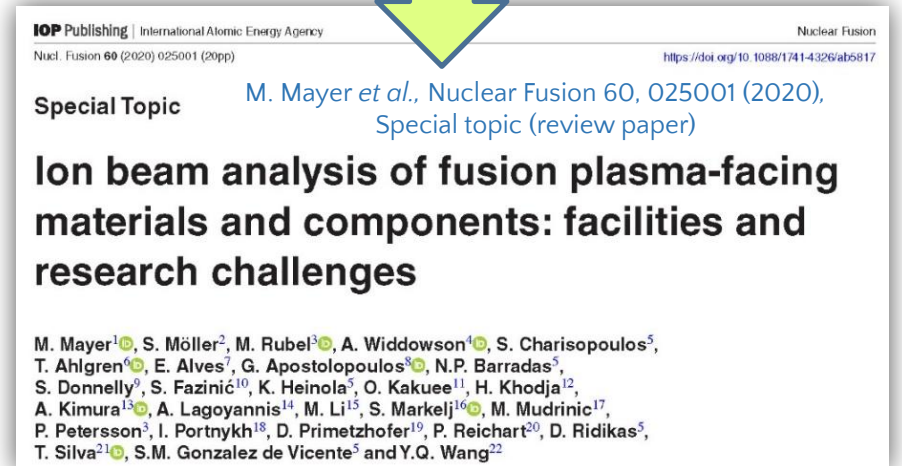
- Cross section measurements
- Stopping power measurements
- Preparation or provision of reference samples for the development of good practices & standardization of measurements
- Conducting experiments with reference samples for the development of good practices & standardization of measurements
- Evaluation of analysis software for the development of good practices & standardization of measurements
- Round robin test with pre-characterized reference samples

Phase 2

- Analysis and inter-comparison of
 - cross-section measurements
 - stopping power measurements
 - Round Robin results
- Analysis of results from experiments for the standardization of the IBA techniques
- Drafting a TECDOC on international good practices and procedures for IBA techniques



joint publication (review)



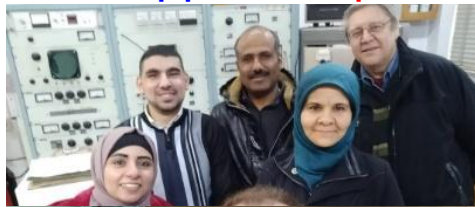
Disseminating expertise in accelerator technologies

The IAEA Physics Section:

- 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 exp. devices.

in
collaboration
with TC Dept.

- Algeria
- Egypt
- Ghana
- Nigeria
- South Africa
- Bangladesh
- Croatia
- Jordan
- Lebanon
- Mexico
- Slovakia
- Syria
- Thailand



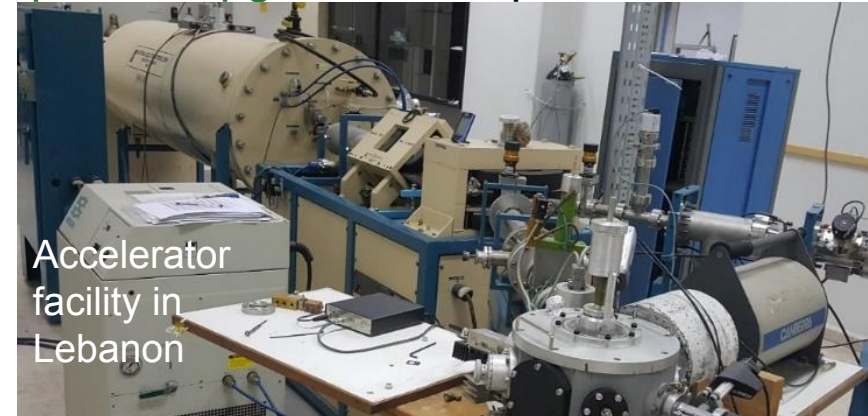
Accelerator facility in Jordan



Accelerator facility in Bangladesh



Accelerator facility in Thailand



Accelerator facility in Lebanon

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.

Training young scientists and accelerator operators



IAEA

Training Workshop: Hands-on Operation & Maintenance of Electrostatic Accelerators; RBI, Zagreb, 9-13 Dec. 2019



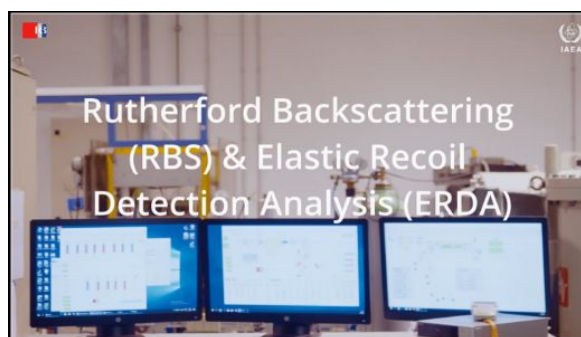
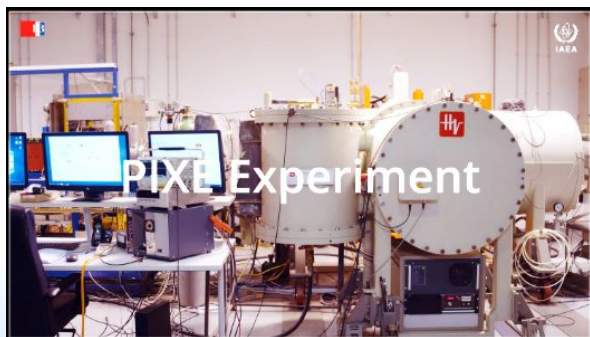
- ✓ Accelerator controls, control software, voltage measurements and stabilization, Dew point measurements, Magnetic hysteresis evaluation, Terminal voltage calibration.
- ✓ Vacuum systems: setting up & measurements, leak detection, RF&DC discharges in gases.
- ✓ Ion sources: beam extraction, beam current measurements, changing source parameters, element selection & optimization, changing Duoplasmatron operation
- ✓ Beam optics: Basic theory, beam focusing & steering, quadrupole alignment, beam brightness & size measurements.

Repeated: iThemba LABS, J'burg, SAF, Dec. 2022, & RBI, Zagreb, Croatia, Oct. 2023

Training Workshop: Advances in Ion Beam Techniques & Applications (Virtual), RBI, Zagreb, Croatia, 1-5 March 2021

Intro-lecture (60-90 min) – Demo video (≈20 min.) – Discussion/Questions/Exercises (90 min) – Homework (data analysis)

36 trainees (10 from Africa) – [17 female] – 16 Member States



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

Repeated: RBI, Zagreb, Croatia, Nov. 2022; Planned: RBI, Zagreb, Croatia, Dec. 2024 & CNEA, Bariloche, Argentina, April 2025

Training young scientists and accelerator operators

Joint ICTP-IAEA Workshop on Electrostatic Accelerator Technologies, Basic Instruments and Analytical Techniques 2019

21 - 29 October 2019
Trieste, Italy

Further information:
<http://indico.ictp.it/event/8728/>
enr333@ictp.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



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



7 Lecturers

(22 lectures; 4 hrs exercises on PC)

17 Trainees <age>=33; 1/3 females

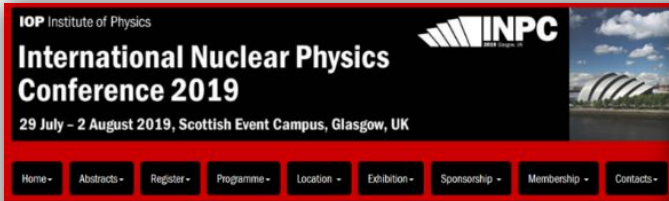
Argentina (1), Cameroon (1), Egypt (1),
Ghana (1), Greece (1), India (3), Iran (2),
Lebanon (1), Nepal (1), Senegal (1),
South Africa (1), Ukraine (1), Uzbekistan
(2)

2 Lab visits (full day)

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




Scientific events in cooperation with the IAEA



IOP Institute of Physics
International Nuclear Physics Conference 2019
29 July - 2 August 2019, Scottish Event Campus, Glasgow, UK

Home - Abstracts - Register - Programme - Location - Exhibition - Sponsorship - Membership - Contacts



EUROSCHOOL on Exotic Beams
2019
AUG 25-31
Fuglsøcentret
Aarhus, Denmark

Lecturers and topics
Anu Kankainen Nuclear astrophysics

SPINFLAN UNIVERSITY
JINR
GSI FAIR
GANIL



ecaart 14
2022 in Romania

In cooperation with
ecaart14.nipne.ro/

MUZUL NATIONAL BUKHENTIAL
nuclear physics
IAEA International Atomic Energy Agency

Sponsors



Organized in co-operation with IAEA
International Atomic Energy Agency
Atoms for Peace and Development

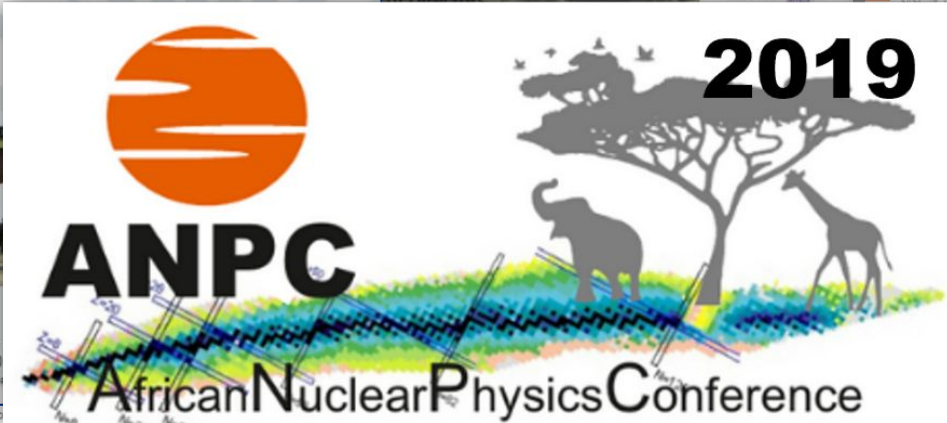


Nuclear Photonics
Kurashiki Japan

3rd International Conference on Nuclear Photonics (NP2020)
June 1-5, 2020, Kurashiki, Okayama, Japan

Nuclear Photonics 2020 is organized in cooperation with the International Atomic Energy Agency

OSAKA UNIVERSITY
INSTITUTE OF LASER ENGINEERING
Osaka University
RCNP
IAEA International Atomic Energy Agency



ANPC 2019
African Nuclear Physics Conference



ECAART 14
14th European Conference on Accelerators in Applied Research and Technology
17-23 July 2022
SIBIU, ROMANIA



ecaart 13
Split, Croatia, May 2019



INPC 2022
Cape Town, South Africa

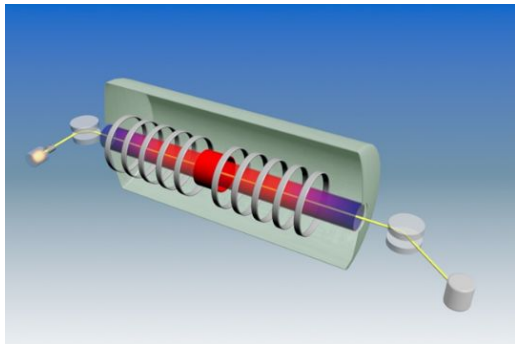


IBMM 2022
22nd INTERNATIONAL CONFERENCE ON ION BEAM MODIFICATION OF MATERIALS
Lisbon, 10 - 15 July 2022

e-learning and publication of technical documents and report series



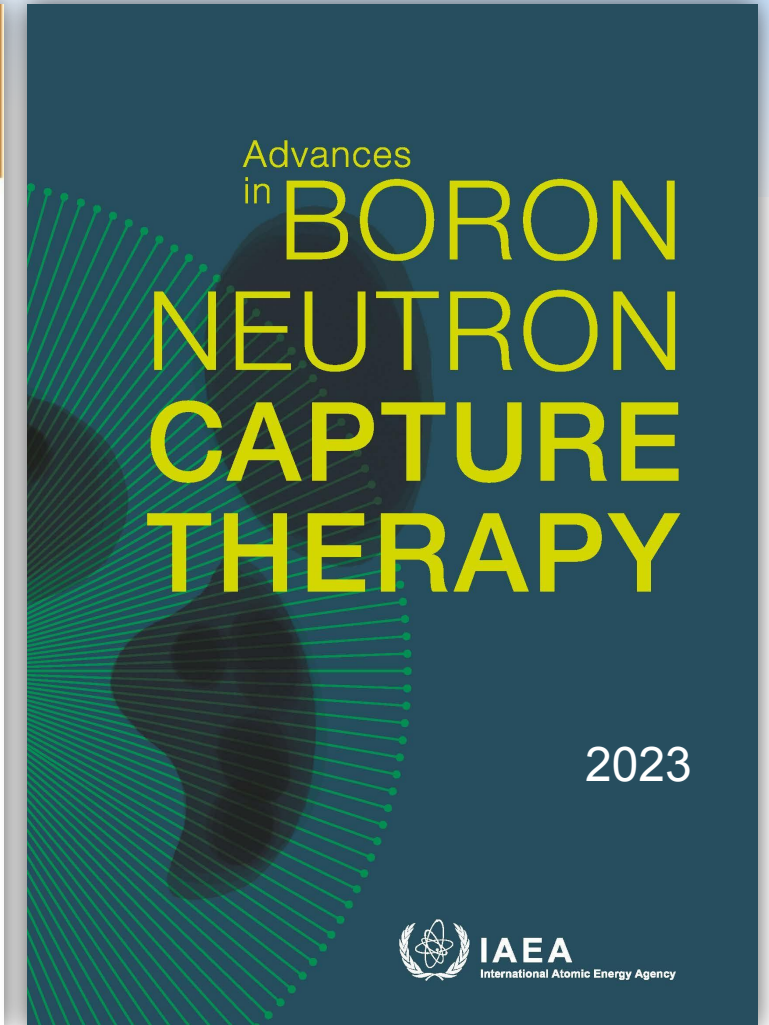
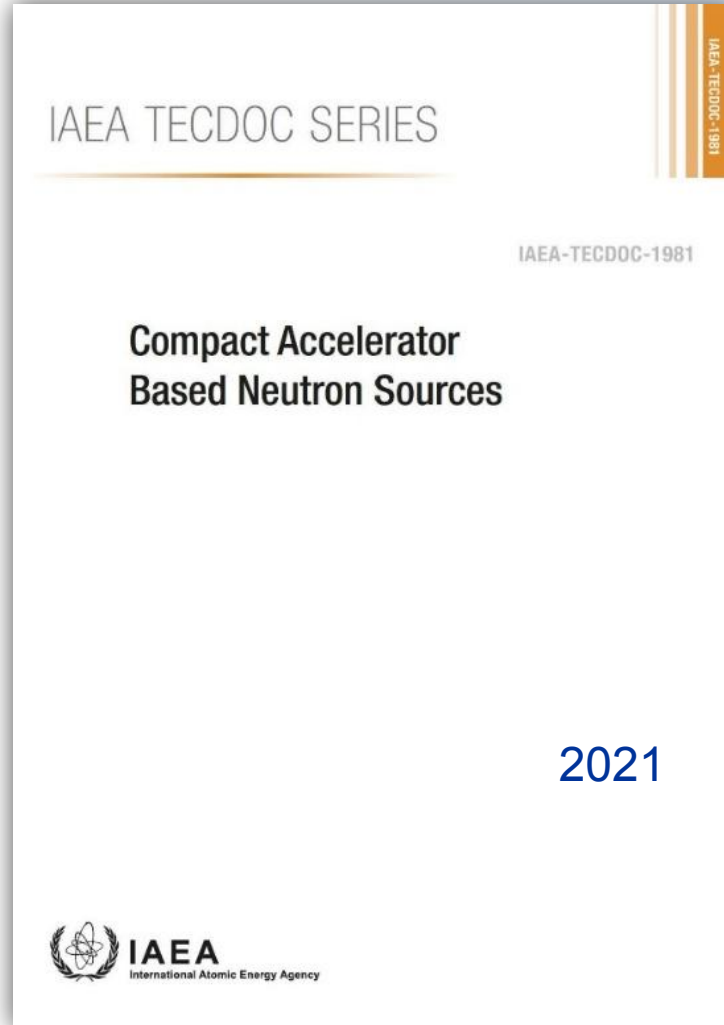
<https://elearning.iaea.org/m2/course/view.php?id=761>



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

- The electrostatic accelerator
- Ion sources
- Beam transport
- Vacuum
- Safety considerations

recommended for students, laboratory staff and users of these facilities



Motivated by a 2018-recommendation by SAGNE, the IAEA's Standing Advisory Group for Nuclear Energy to perform a comprehensive feasibility study for an ion beam accelerator facility, for nuclear capacity building and studies related to radiation damage, material science, environmental studies, etc. This study should provide options in terms of scope, capital and operational costs of the facility for decision making.

Through the performed feasibility study, it was assessed whether and how an ion beam 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. For this purpose, a Stakeholder analysis and quantification of user needs was conducted.

Internal-to-IAEA stakeholders have contributed to the study through interviews and external stakeholders through a questionnaire. More than 60 replies were by 40 Member States indicating the most commonly demanded topics

Stakeholder analysis and quantification of user needs

The most commonly demanded topics:

□ Training in:

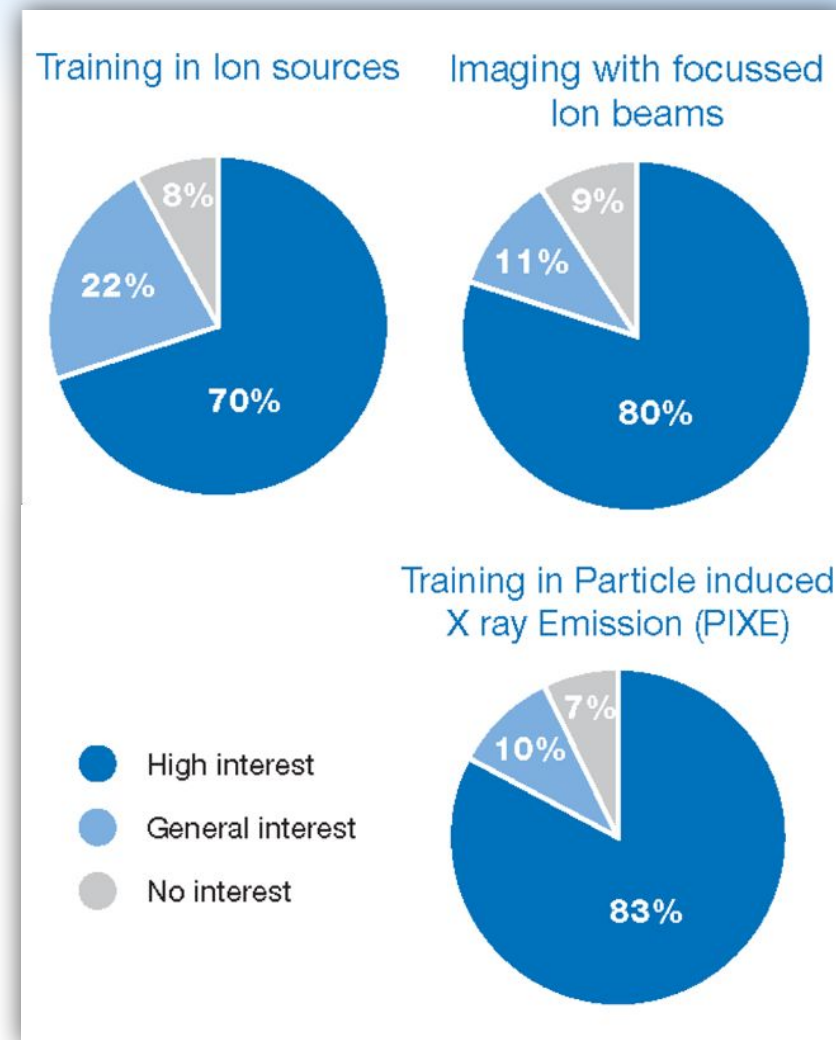
- Accelerator technology such as ion sources and vacuum systems
- End stations: design & assembly;
- Radiation detectors; control systems & nuclear electronics
- Ion Beam Analysis (IBA) techniques:

□ 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:

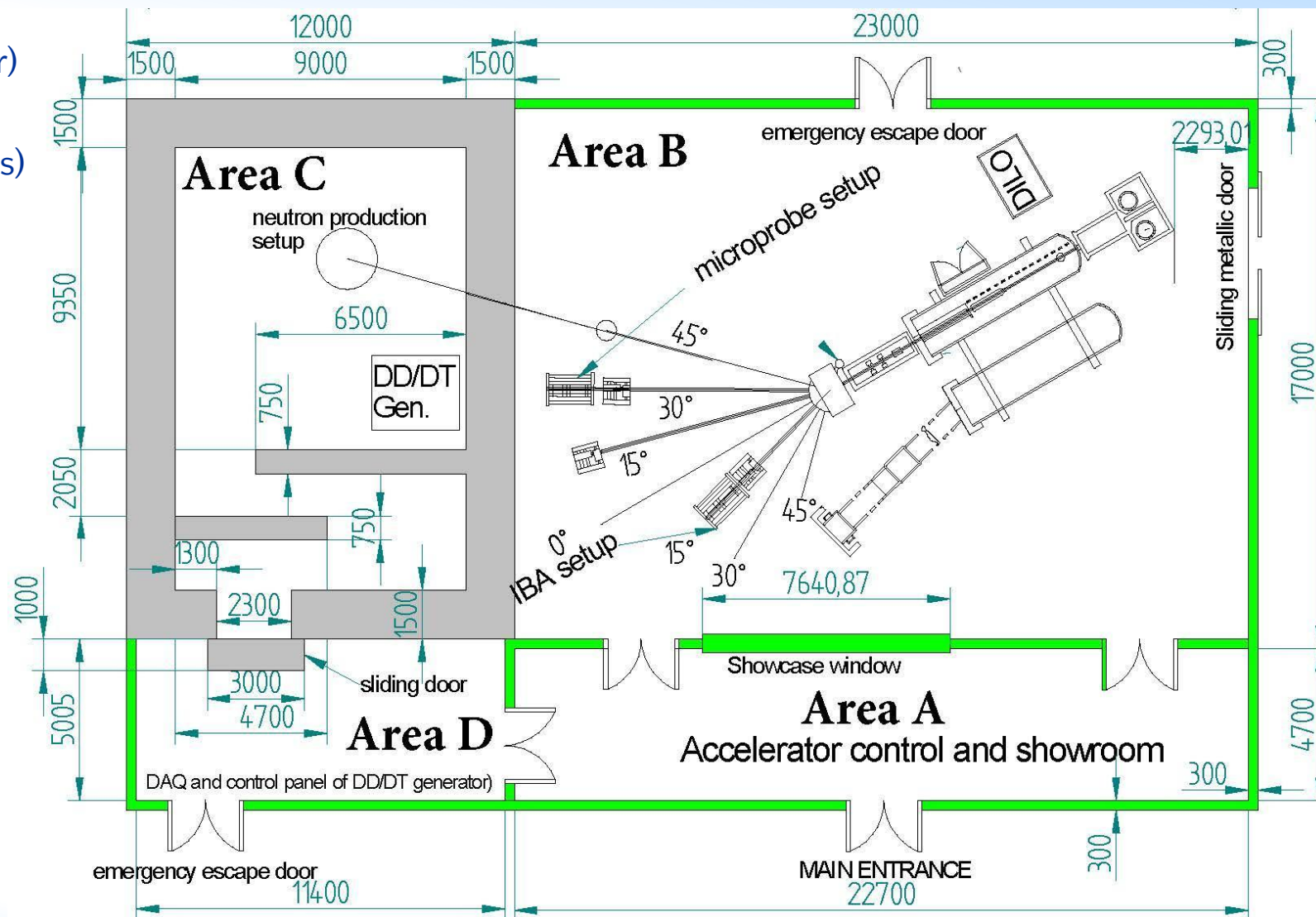
- IBA for bulk analysis of air quality, archaeological samples, minerals
- 2&3D imaging and spatially resolved analysis using a microprobe.



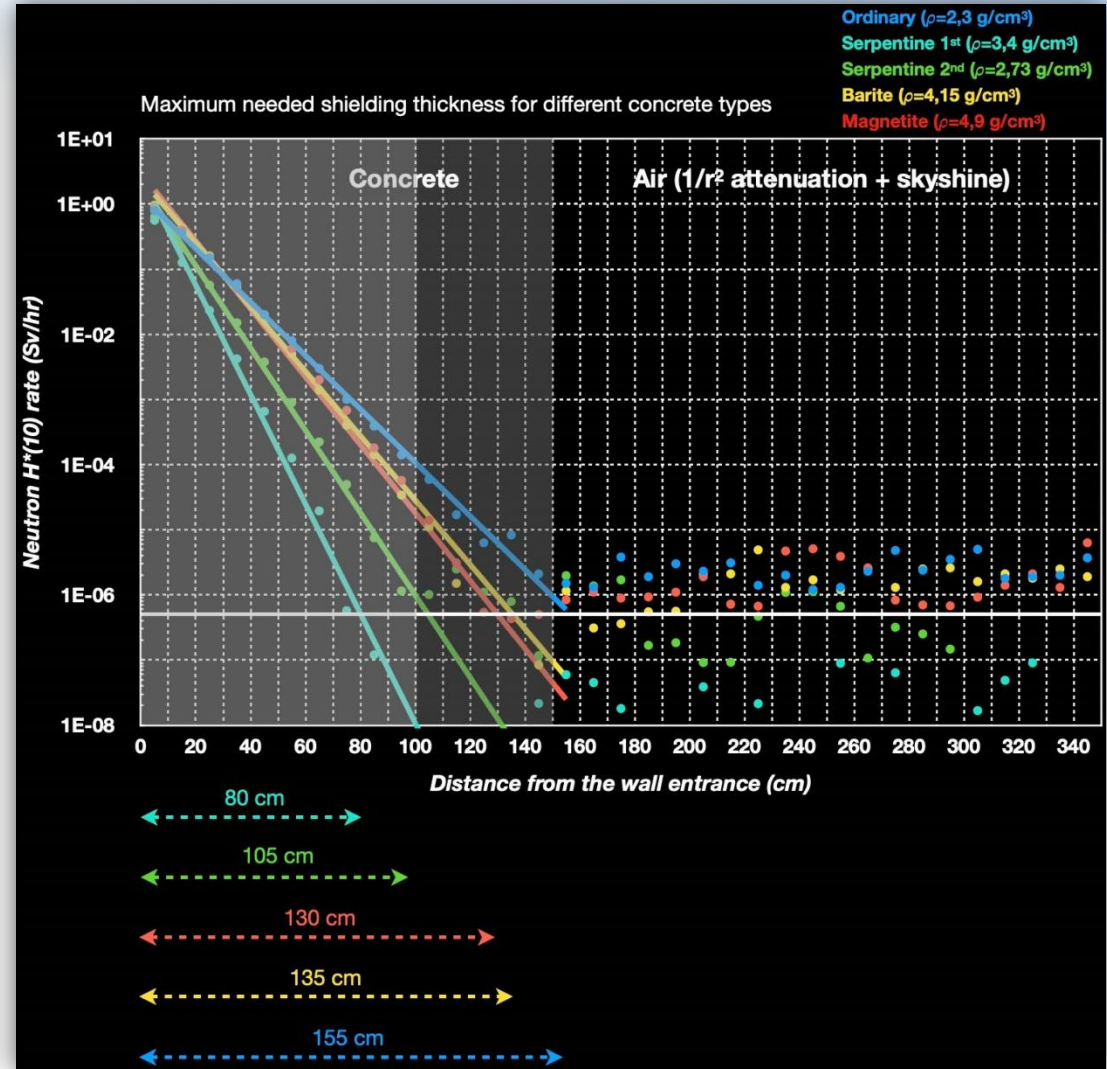
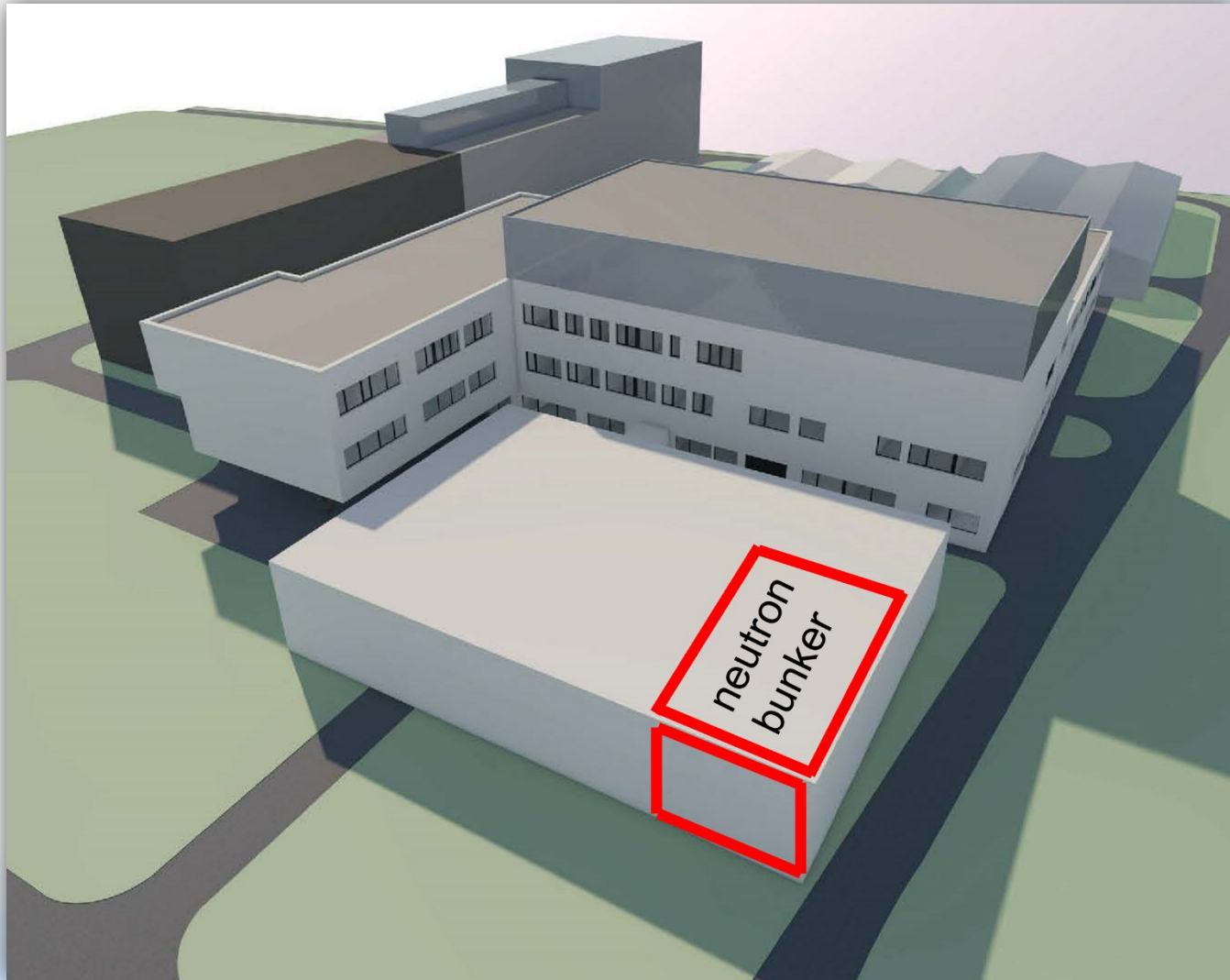
The Ion Beam Facility (IBF) project

- 3 MV Tandem with 2 sources (Duo & Sputter)
- Neutron hall (1.5 m concrete) to host:
 - a neutron production target (with protons)
 - DD & DT Generators
- IBA end-station & Microbeam (Phase 1)
- Detectors for γ -, X-ray & particles
- Digital electronics / DAQ systems

Building:	1.100.000 €
Accelerator :	2.640.000 €
Beamlines:	480.000 €
Exp. Setups / sc. instrum.:	680.000 €
Neutron production station and associated instrumentation:	200.000 €
TOTAL	5.100.000 €



The Ion Beam Facility (IBF) project



Thank you for your attention

s.charisopoulos@iaea.org