

# Nuclear Science

## Objective

To support Member States in strengthening their capabilities in the development and application of nuclear science as a tool for their technological and economic development. To support Member States in enhancing sustainable operation, including effective utilization, of research reactors and implementing new research reactor projects and nuclear capacity building programmes based on access to research reactors.

## Nuclear Data

In order to innovate in the dissemination of its nuclear data to users, the Agency released a new web tool to plot and download nuclear reaction data. Using a highly efficient interface, experimental reaction data and evaluated reaction data can be plotted and retrieved (Fig. 1).

A joint Technical Meeting with the Jülich Research Centre on tungsten in edge plasmas, held virtually, resulted in the creation of numerical databases required for the development of fusion reactors. Such data are used for computational simulation of the design, with the current focus on simulations/atomistic modelling of plasma and hydrogen interactions with fusion reactor wall material.

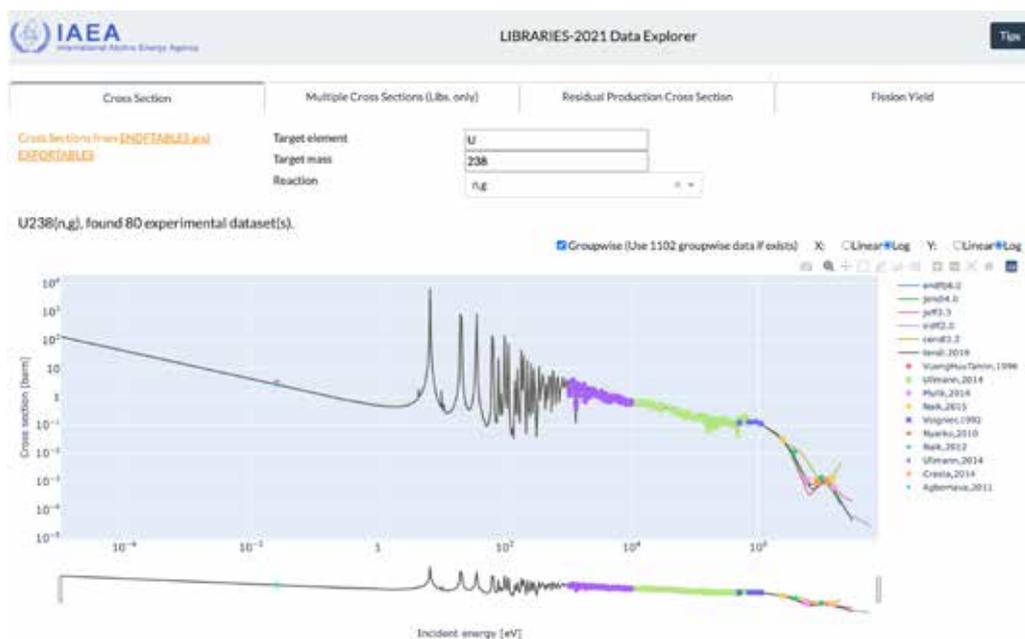


FIG. 1. The Libraries-2021 Data Explorer for retrieval and plotting of nuclear reaction data, using the example of the uranium-238 neutron capture reaction.

## Research Reactors

### *Utilization and applications of research reactors*

The Agency published *Neutron Scattering with Low and Medium Flux Neutron Sources: Processes, Detection and Applications* (IAEA-TECDOC-1961), providing up to date technical information on neutron scattering techniques and on instrumentation for neutron scattering, and presenting the main applications of neutron scattering that could be implemented at low and medium flux neutron sources.

The Agency published *Considerations of Safety and Utilization of Subcritical Assemblies* (IAEA-TECDOC-1976), supplementing the Agency safety standards by providing practical information on safety in the design and operation of subcritical assemblies.

At a Technical Meeting on State of the Art Research Reactor Based Radioisotope and Radiopharmaceutical Production, participants provided the latest updates on new and existing facilities and methods to produce radioisotopes and radiopharmaceuticals, including novel ones.

In preparation for the Integrated Research Reactor Utilization Review mission to the RECH-1 research reactor in Chile, requested by the Chilean Nuclear Energy Commission, a Consultancy Meeting, held virtually owing to COVID-19-related restrictions, reviewed the current utilization of RECH-1 and provided advice on the potential and constraints for utilization planning.

### *New research reactor projects, infrastructure development and capacity building*

The Agency published *Specific Considerations in the Assessment of the Status of the National Nuclear Infrastructure for a New Research Reactor Programme* (IAEA Nuclear Energy Series No. NR-T-5.9), which provides a comprehensive means to determine the status of the infrastructure conditions relevant to research reactor projects, and conducted a training



FIG. 2. Hands-on training during the EERRI group fellowship training course.

workshop that provided participants with practical knowledge on application of this Agency-developed methodology.

During the 16th Eastern European Research Reactor Initiative (EERRI) group fellowship training course, held in Austria and Hungary, seven participants received intensive training, including theoretical classes and hands-on exercises at research reactor facilities, covering a broad range of topics related to planning, commissioning, safe operation, maintenance and effective utilization of research reactors (Fig. 2). Overall, the EERRI course has trained 132 participants since 2009.

### *Research reactor fuel cycle*

The Agency published *Research Reactor Spent Fuel Management: Options and Support to Decision Making* (IAEA Nuclear Energy Series No. NF-T-3.9), which provides a comprehensive set of management strategies for research reactor spent fuel and assists in the decision making process for selecting the preferred option for each Member State's situation.

A new coordinated research project was initiated entitled 'Development of Coupled Neutronic and Thermal-Hydraulic Computational Methodologies for Research Reactors including Analysis and Treatment of Uncertainties', which will allow Member States to improve research reactor modelling and simulation and thus ensure enlargement of the range of usefulness of research reactor facilities without compromising safety.

A Workshop on Dry Storage of Research Reactor Spent Fuel provided participants with detailed information on fuel degradation mechanisms for long term storage, ways of managing such challenges and illustrations of real-world examples of the various approaches to dry storage of research reactor spent fuel.

### *Research reactor operation and maintenance*

A Technical Meeting on Research Reactor Ageing Management, Refurbishment and Modernization allowed Member States to share experiences and lessons learned in improving conditions of reliability, availability and maintainability of research reactors.

At a Technical Meeting on Good Practices for the Operation and Maintenance of Research Reactors, operators, designers and regulators of research reactors discussed and exchanged information and experiences related to good practices in the operation and maintenance of research reactors to further improve their performance, safety and reliability.

## **Accelerator Applications**

By signing a Memorandum of Understanding, the Agency and the United Nations Interregional Crime and Justice Research Institute agreed to increase collaboration in preventing and countering criminal activities around the world using nuclear science and technology. Nuclear analytical techniques provide powerful tools to characterize products subject to counterfeiting and/or illicit trafficking, such as medicines, drugs, food, cultural heritage objects and timber.

The new publication *Sustainability and Self-reliance of National Nuclear Institutions* (IAEA-TECDOC-1943) presents the outcomes of a regional workshop, which addressed the challenges faced by Member States regarding self-reliance and sustainability of their national nuclear institutions.

The new publication *Compact Accelerator Based Neutron Sources* (IAEA-TECDOC-1981) provides an overview of the various types of compact accelerator based neutron source technologies and their applications that are currently available or planned for the future.

Upon request from national accelerator facilities, the Agency conducted five expert missions, one to Algeria, two to Croatia, one to Greece and one to Italy, to assess the

status of the accelerator infrastructure and associated instrumentation, troubleshooting, possible fault correction and repairs. Experts provided advice on effective operation and maintenance as well as utilization programmes of these facilities.

The Agency conducted a joint workshop hosted by the Australian Nuclear Science and Technology Organisation, held virtually, on nuclear and isotopic techniques for cultural heritage. Physicists, materials scientists, chemists, archaeologists, conservators, curators and heritage science stakeholders collected proposals on the application of nuclear and isotopic techniques for cultural heritage, conservation science and archaeology.

## Nuclear Instrumentation

A major upgrade and expansion of the interactive worldwide map of X ray fluorescence (XRF) facilities was implemented and made available through the Agency's Nuclear Science and Instrumentation Portal. It now includes the technical and contact details of 1226 XRF laboratories in 116 Member States.

During a joint Agency–Abdus Salam International Centre for Theoretical Physics School on fully programmable systems on chip and their applications for nuclear and related instrumentation, participants familiarized themselves with underlying software design tools and hardware platforms through tutorials and project examples in the field of nuclear applications.

The Agency released through the Cyber Learning Platform for Network Education and Training four hands-on demonstration/training video materials for assisted practical training as well as self-learning resources in support of practices on radiotracer and sealed source methodology and technology as applied to industry and environment.

The Agency organized three advisory meetings, held virtually, with Malaysia, the Philippines and Singapore, where it provided advice and recommendations regarding ongoing national projects using instrumented drones for radiation monitoring and mapping.

## Nuclear Fusion

The Agency, in cooperation with the Princeton Plasma Physics Laboratory (United States of America), conducted a Theory and Simulation of Disruptions Workshop, addressing plasma disruptions in tokamaks. Understanding, predicting and mitigating disruptions is one of the principal challenges confronting the ITER project.

Over 450 participants from more than 50 countries participated in the first Agency webinar on fusion commercialization, 'Pushing for Fusion Energy – What is happening now?', and discussed the status of fusion development, as well as examining the potential for public–private collaboration to speed up the process of developing fusion as a future reliable source of energy that is also commercially viable.

The Agency conducted a Workshop on Computational Nuclear Science and Engineering that provided participants with critical skills and tools in mathematical techniques for modelling and simulation of complex systems, high performance computing, and computational methods for processing and analysing large datasets, applied in nuclear science and engineering. Given the high demand for training in this area, the Agency also released a new e-learning course on computational nuclear science and engineering.

The Agency cooperated in the annual International Polytechnic Summer School, jointly organized by the Peter the Great St. Petersburg Polytechnic University (Russian Federation) and the School of Physical Sciences of the Graduate University for Advanced Studies (Japan). In 2021, the school provided students with an introduction to plasma physics and controlled nuclear fusion research and technology, as well as offering a possibility to learn directly from the authors of the contemporary scientific publications contributing to the development of the physics basis for controlled nuclear fusion.



# Nuclear Techniques for Development and Environmental Protection

---

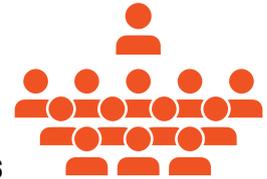
participation in

**59** conferences and symposiums



**74**

technical, consultancy and research coordination meetings



**91**

active coordinated research projects



**20** webinars

**14** e-learning modules

**10** tutorial videos

**22**



databases in total

**2 new**

databases in 2021

OA-ICC News Stream

**20 190**

unique visitors

## Human Health Campus



**113 829**

**users**

**402 112**

**page views**

**1133**

**active  
research contracts**



**publications**



**72**

**guidelines, manuals  
and protocols**



**148**

**external publications**

**40**



**active Collaborating Centres**

within the Department of  
Nuclear Sciences and Applications



**training courses and workshops**

with **2579** trainees