

FUSION ACTIVITIES AT THE INTERNATIONAL ATOMIC ENERGY AGENCY

The main objective of the Fusion related activities done at the International Atomic Energy Agency is to strengthen research programmes in plasma physics and controlled nuclear fusion and nuclear fusion-related technology, including facilitating information exchange among researchers in those areas. With this purpose Coordinated Research Projects, Technical Meetings and Workshops are carried out as well as the publication of guidelines and reference documents to be used by the fusion international community. Besides, the IAEA organises the premier event in the field, the Fusion Energy Conference, and it is the co-publisher and editor of the highest impact factor journal in the field, the Nuclear Fusion journal.

Fusion related activities at the International Atomic Energy Agency (IAEA) are implemented mainly by Physics Section, with the main objective to strengthen research programmes in plasma physics and controlled nuclear fusion and nuclear fusion-related technology, including facilitating information exchange among researchers in these areas. In addition, under the Atomic & Nuclear Data Section there are two projects related to the acquisition of data to generate relevant nuclear databases for fusion: Atomic and Molecular Data for Fusion Experiments and Nuclear Data for emerging issues and advanced nuclear facilities. Finally, the highest impact factor journal in the field, Nuclear Fusion journal, is also co-published and edited by the Agency.

The IAEA has been closely involved with ITER since its inception, as the previous ITER co-operation phases and the ITER negotiations were held under its auspices. The conceptual and engineering design phases of ITER were carried out under the auspices of the IAEA, contained in a document named ITER Technical Basis published by IAEA in 2002 (<https://www.iaea.org/publications/6492/iter-technical-basis>). In 2007 the IAEA's assistance was crucial in finalizing the formal ITER Agreement signed by the seven ITER parties. The IAEA Director-General is also the Depository of the ITER Agreement. Currently IAEA has an observer status at the

ITER Council and relationship between two organizations is defined by the Cooperation Agreement since 2008.

In 1958 Soviet Union, the United Kingdom and the USA announced the declassification of national research on nuclear fusion and already 109 papers in the field of nuclear fusion research were presented at the Second United Nations Conference on the Peaceful Uses of Atomic Energy in Geneva in the same year.

In 1961, after consultation with leading scientists, the IAEA convened an international Conference on Plasma Physics and Controlled Nuclear Fusion Research. It changed its name to the most generic Fusion Energy Conference at its 16th edition in 1996. The quality and volume of the papers submitted, the number of participants and countries represented over the years, all witness great interest and importance of this international forum. The number of papers submitted to the Conference has increased significantly, from the initially 100–150 papers submitted in the 1960s, to over 700 in the last decade. The Fusion Energy Conference is currently the world's largest in the field of nuclear fusion. It is the stage for the discussion of key physics and technology issues as well as innovative concepts of direct relevance to the use of nuclear fusion as an eventual source of energy. It has a biannual character and next edition (28th) will take place in Nice in Octo-



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ACTIVIDADES REALIZADAS EN EL ORGANISMO INTERNACIONAL DE LA ENERGÍA ATÓMICA EN EL ÁMBITO DE LA FUSIÓN

El objetivo principal de las actividades relacionadas con la fusión que se llevan a cabo en el Organismo Internacional de la Energía Atómica es consolidar los programas de investigación en física del plasma y fusión nuclear, así como en la tecnología necesaria para el desarrollo de la fusión como una fuente de energía, entre otras cosas facilitando el intercambio de información entre investigadores en esos ámbitos a nivel internacional.

Con este fin, se llevan a cabo proyectos coordinados de investigación y reuniones técnicas, y se publican directrices y documentos de referencia para su uso por la comunidad internacional de fusión. Además, el OIEA organiza la Conferencia sobre Energía de Fusión, principal evento en este ámbito, y es coeditor y redactor de la revista científica de mayor repercusión en esta esfera, la revista "Nuclear Fusion".

ber 2020, co-hosted by France and ITER IO.

One of the main roles of the Agency is to provide the frame and platform to strengthen international collaboration in key areas that facilitate the development of fusion as a future energy source. With this purpose a number of tools that facilitate coordination and the exchange of information at an international level are available such as Coordinated Research Projects (CRPs), Technical Meetings (TMs), Workshops and Consultancy Meetings.

COORDINATED RESEARCH PROJECTS (CRPs)

CRPs aim to enhance the capability of interested Member States through joint activities by developing advanced or innovative nuclear R&D programmes as well as to promote training and transfer of knowledge. Usually a CRP has a duration from three to four years. Currently there are 7 CRPs running in the field of fusion, namely:

- *CRP on Towards the Standardization of Small Specimen Test Techniques for Fusion Applications.*

The objective of this CRP is to provide a set of guidelines for Small Specimen Test Techniques (SSTT) employing common agreed best practices on main test techniques (tensile, creep, low cycle fatigue, fracture toughness, fatigue crack growth rate) for reference structural fusion materials as first step of a full standardization of the SSTT. This project has 14 participants from 10 Member States.

- *CRP on Network of Small and Medium Size Magnetic Confinement Fusion Devices for Fusion Research.*

The objective of this CRP is to maintain and expand a coordinated network of world-wide machines and laboratories capable of contributing to the success of fusion energy development in view of the next step fusion devices such as ITER and DEMO performing joint and comparative experiments to support plasma physics research, technology development, modelling and training. This project has 24 participants from 19 Member States.

- *CRP on Development of Compact Steady-State Fusion Neutron Sources.*

The objective of this CRP is two-fold: (i) to support research on and the development of steady-state



First Conference on Plasma Physics and Controlled Nuclear Fusion Research. (Photo: IAEA Archives Unit)

compact fusion neutron sources for scientific, technological and nuclear energy applications in both the fusion and the fission sectors; (ii) to support the transition from conceptual to engineering design activities for the considered compact fusion neutron sources with emphasis on fast tracks to early applications. This project has 14 participants from 10 Member States.

- *CRP on Pathway to Energy from: Materials Beyond Ignition (new edition starting at the end of 2019).*

The objective of this CRP is to provide an assessment of the material requirements, consequences and characteristic behaviours in pulsed, repetitively cycled inertial fusion energy systems. This project has 18 participants from 14 Member States.

- *CRP on Atomic Data for Vapour Shielding in Fusion Devices.*

The CRP focuses on the provision of fundamental atomic and molecular data for accurate modelling of the processes taking place during vapour formation and shielding. Liquid metal materials proposed as an alternative candidate for future fusion reactors are evaluated in this CRP. This project has 8 participants from 8 Member States.

- *CRP on Atomic Processes of Neutral Beams in Fusion Plasma.*

The objective of this CRP is to provide data for the principal atomic

processes relevant to heating and diagnostic neutral beams in fusion plasmas. Primary focus is on the processes of hydrogen (H/D/T) Neutral beam injection in the high temperature core plasma. This project has 12 participants from 10 Member States.

- *CRP on Plasma-wall Interaction with Reduced-activation Steel Surfaces in Fusion Devices.*

This CRP will enhance the knowledge base and develop new databases on the interaction of fusion plasma with the reduced-activation steel alloys that are being considered for constructing the plasma-facing components of a fusion reactor. It will seek to quantify the erosion due to exposure to plasma and to quantify the retention and transport properties of tritium in the surface. This project has 10 participants from 7 Member States.

TECHNICAL MEETINGS (TMs) AND WORKSHOPS

TMs and Workshops aim to present new results in the field, revise existing ones and open up discussions within the technical topics of the meeting among members of the community. The duration of each event is approximately 3-5 days. Participation is open to the IAEA Member States and International Organizations involved in fusion research and the final output is often the publication of papers in an international journal, production of reference reports or technical documents (TECDCs).



Participants at the 5th IAEA DEMO Programme Workshop at NFRI, Daejeon, South Korea.

Some of these events are periodic or single events, built on specific technical topics, e.g. TM on the Steady State Operation of Magnetic Fusion Devices; TM on the Control, Data Acquisition and Remote Participation for Fusion Research; TM on Fusion Data Processing, Validation and Analysis; TM on Divertor Concepts; TM on Atomic data and spectroscopic properties of Tungsten middle-charge states; Workshop on Challenges for Coolants in Fast Spectrum System; Chemistry and Materials and Workshop on Fusion Enterprises.

A particular mention should be done to the IAEA DEMO Programme Workshop series. The objective of this workshop is to discuss a subset of key DEMO scientific and technical issues with the aim of defining the facilities and program activities that can lead to their resolution. This event is the reference forum to discuss the steps to be done after ITER

and where opportunities to make greater progress through international collaboration are identified, ideally leading to coordination or joint work where beneficial. Usually this meeting is attended by managers and senior scientists working on fusion. Next edition of this Workshop will take place in October 2019 in Sochi (Russian Federation).

CONSULTANCY MEETINGS (CMs)

In this type of meeting a reduced number of experts (< 10) are invited to discuss and assess a particular topic and provide advice to the IAEA on related programmatic matters. CMs take place usually to define and plan further activities to be carried out by the Agency such as new CRPs or prepare new publications.

Other instrument used by the IAEA is to support some activities like conferences, training workshops, meetings and ICTP schools, organized in

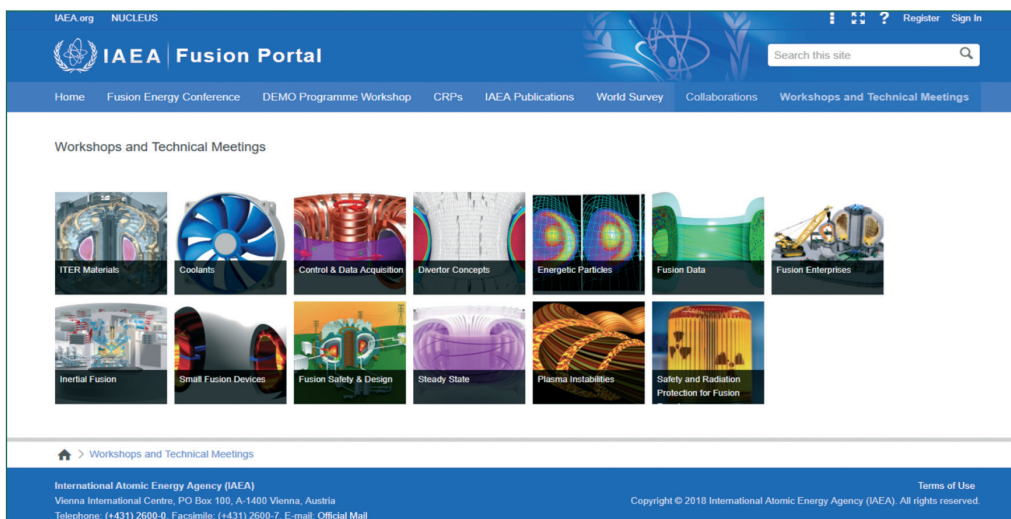
cooperation and with the purpose of promoting transfer of knowledge and contributing to capacity building. Good examples of such events are the Reflectometry Workshop, the Symposium on Fusion Engineering Conference (SOFE) in 2019, the International Conference in Innovative Fusion approaches in 2019 and the Costa Rica Training Workshop in Fusion for the Latin-American Region 2019.

In the last three years the Fusion activities related to technology carried out at the IAEA have increased, reflecting the general trend in the field where planning, design, construction and licensing processes including decommissioning plans, are part of the different national or international fusion roadmaps. In this regard **the Agency is working on the production of guidelines and reference documents to be used by the fusion international community that will facilitate and optimise different process and exchange of information.** An example of this is the above-mentioned CRP Towards the Standardization of Small Specimen Test Techniques For Fusion Applications that has as goal to define the specimens type to be irradiated in a fusion dedicated neutron source like the DONES accelerator, as necessary step to develop a coordinate the effort to have a coherent materials database at international level.

Other example of a related work is the recently published Technical Document (TECDOC) on Safety Classification of Mechanical Components. This TECDOC represents the first international guidelines document on Safety and Standards

for Fusion and can be found at <https://www-pub.iaea.org/MTCD/Publications/PDF/TE1851web.pdf>

All the information related to the fusion activities at the IAEA, including relevant project or event materials, publications outreach brochures, announcements for future planned events and much more can be found at the IAEA's FUSION PORTAL: <https://nucleus.iaea.org/sites/fusionportal/>



IAEA Fusion Portal (<https://nucleus.iaea.org/sites/fusionportal/Pages/Fusion%20Portal.aspx>).