



# ITER ITA NEWSLETTER

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## THE INTERNATIONAL ATOMIC ENERGY AGENCY'S FUSION ACTIVITIES IN 2004-2005

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### The IAEA's Programme on Plasma Physics and Controlled Nuclear Fusion

The current experimental and theoretical research on controlled nuclear fusion is largely focused on the magnetic confinement perspective as a source for energy generation. ITER drives much of the present scientific and technological research programme implemented in most of the present experimental tokamak devices. The nuclear fusion and plasma physics activities of the International Atomic Energy Agency (IAEA) are envisaged to support all Member States and in particular help developing countries to participate in mainstream fusion research. As a clear sign of the new efforts related to the ITER design and the related research activities, the IAEA has upgraded its fusion activities from project status in 2002 and 2003 to a separate sub-programme in nuclear fusion research since the beginning of 2004. This includes a separate budget and separate funding possibilities. The sub-programme in nuclear fusion is undertaken by the Physics Section, and by the Atomic and Molecular Data Unit of the Nuclear Data Section, both of the IAEA.

The IAEA fusion activities are conducted in accordance with the guidance of the International Fusion Research Council (IFRC) and the subcommittee on Atomic and Molecular Data for Fusion.

Programmes to harness the potential of nuclear fusion for electrical power production are being pursued in about 46 countries in 292 fusion research institutions, laboratories, university institutes and departments, and other official institutions, as reported in the 2001 IAEA World Nuclear Fusion Survey. The numbers have changed in the last three years, as fusion is a very active and strongly developing techno-scientific research discipline. The new statistics in the World Survey, to be published by the IAEA in 2005, will incorporate these changes.

Progress so far has clearly established the feasibility of controlled thermonuclear fusion on the basis of the underlying physics; however, the remaining scientific, technological and economic issues need to be closely addressed before fusion power can become a viable energy option. The programme of the IAEA in 2004 and 2005 takes these premises into account and aims to play a catalytic role in the fusion area by fostering information exchange, promoting research and development, organizing consultancies and technical meetings, monitoring the global activities, and supporting technical cooperation projects.

The foreseen plasma physics and fusion activities of the IAEA in the last quarter of 2004 and the year 2005 promote the exchange of ideas on basic topics that need further and enhanced understanding in order to utilize fusion as an energy source option for the benefit of mankind. The IAEA continues to support the most advanced alternatives, i.e. magnetic and inertial confinement, in relative proportions to the status of development, on the road to fusion, and scientific and technological spin-offs for social benefit. ITER, in this phase, is the most visible expression of present achievements in the area of magnetic confinement. The IAEA supports fusion activities worldwide, provides the auspices for ITER activities and, in line with this role, offers common ground for high level ITER meetings.

The IAEA's aim to foster the exchange of scientific and technical information on peaceful uses of atomic energy worldwide is reflected by holding the biennial Fusion Energy Conference. This year's conference will be in Vilamoura, Portugal, and will be hosted by the Government of Portugal through the Instituto Superior Técnico, Centro de Fusão Nuclear. Many conferences on fusion, plasma physics and nuclear data are supported by the IAEA, e.g. the recent International Conference on Nuclear Data for Science & Technology, ND2004, in Santa Fe, New Mexico and the Second International Conference on the Frontiers of Plasma Physics and Technology in Goa, India in 2005.

The Agency maintains the FENDL-2 nuclear cross-section data library, which has been adopted as the reference library for neutronics design calculations for ITER. An upgraded version, FENDL-2.1, of the library is scheduled for release in 2005.

### **IAEA Technical Meetings**

Through the guidance, recommendation and support of the IFRC many international technical meetings (TMs) on important issues of plasma physics and fusion research have been initiated. Member States are strongly committed to the support of these meetings.

From 11 to 13 October 2004, the Republic of Korea will host the 3rd IAEA TM on Physics and Technology of Inertial Fusion Targets and Chambers, followed by a Research Coordination Meeting (RCM) related to the Coordinated Research Project (CRP) on Elements of Power Plant Design for Inertial Fusion Energy. This TM provides an opportunity to discuss recent achievements on the main research activities related to inertial fusion energy (IFE). The topics to be discussed are: (i) target design and physics, performance and energy gain scaling; (ii) chamber design and physics, performance and material development; (iii) target fabrication injection and tritium handling; (iv) assessment of safety, environmental and economic aspects of IFE fusion drivers.

For 2005 the IAEA plans to hold a number of technical meetings related to magnetic fusion, seven of which will be strongly ITER-related. An overview of the IAEA meetings for the first semester of 2005 is given below.

The 4th IAEA TM on Steady State Operation of Fusion Devices will be held in Gandhinagar, India from 1 to 5 February. The meeting will provide an opportunity for developed and developing countries to share their achievements on physics and technology to support continuous operation of a fusion reactor. The main technology aspects to be addressed are, among others, superconducting magnets, heating and current drive systems, and plasma facing materials. On the physics side, discussions will develop around the physics modelling and theory basis for long pulse steady state operation, advanced scenarios and feedback control, particle control and power exhaust.

From 2 to 4 March 2005, Italy will host the 2nd IAEA TM on Theory of Plasma Instabilities: Transport, Stability and their Interaction followed by a workshop on Plasma Physics Capacity Building in Plasma Applications and Diagnostic Techniques (7–11 March). These seminars are co-organized by the IAEA and the Abdus Salam International Centre of Theoretical Physics (ICTP), and will take place in Trieste. This meeting will provide a forum for open discussions on the physics issues of linear and non-linear theory in large and small scale plasma instabilities, integrated modelling, turbulence and magneto-hydrodynamic (MHD) effects. Special attention will be paid to the modelling and prediction of instabilities generated by fast alpha particles and their role in plasma confinement in burning plasmas, a topic of significant importance for ITER and future fusion power plant operation.

The 3rd IAEA TM on ECRH (electron cyclotron resonance heating) Physics and Technology for ITER will take place in Como, Italy from 2 to 4 May 2005. The meeting will be followed by a meeting of the ITER ITPA (International Tokamak Physics Activity) Topical Group on Steady State Operation and Enhanced Performance. A joint session on 4 May will provide an opportunity for the participants to exchange their ideas on the two topics. The ECRH auxiliary heating system is of major importance for ITER in order to achieve effective burning temperature and profile control, external current drive, and neoclassical tearing mode suppression. Physics studies concerning wave-plasma coupling are being developed and new technology devel-

periments are being tested in order to better predict operation and to optimize the ECRH system for ITER. The meeting will address issues on: (i) ECRH wave physics, (ii) heating and current drive, (iii) transmission systems, (iv) gyrotrons, (v) system integration and optimization.

The TM on Negative Ion Beams, which will be held from 9 to 11 May in Padua, Italy, will restart a series of meetings, the last of which was held in 1991. This topic is among the most important ones connected with next step fusion devices. It is well established that the neutral beams used for heating in fusion require to be produced from negative ion sources, due to the increased efficiency of neutralization at the high ion energies required. These neutral beams are used to heat the plasma and shape the current profile by momentum transfer. They represent an important tool for controlled operation of advanced scenario discharges and are being implemented in practically all medium and large size devices. The meeting will provide a forum for discussions on the topics of: (i) status and performance of neutral beam injectors, (ii) long-pulse operation, (iii) RF ion sources, (iv) source characteristics, (v) beam characteristics, (vi) new developments.

The 5th IAEA TM on Control, Data Acquisition, and Remote Participation for Fusion Research will take place from 11 to 13 July 2005 and will be hosted by the Research Institute for Particle and Nuclear Physics, Budapest, Hungary. The meeting will address the issues of new developments and perspectives in the areas of control, data acquisition and remote participation for nuclear fusion research around the world. The topics to be covered are: (i) machine control and monitoring; (ii) plasma control; (iii) control and data acquisition systems for diagnostics; (iv) special techniques for long duration discharges; (v) signal processing; (vi) database techniques for information storage and/or retrieval; (vii) user interfaces for control and data acquisition systems; (viii) impact of new computer languages; (ix) operating system requirements for present and future fusion experiments; (x) techniques for remote participation.

### **IAEA Research Coordination Meetings**

The IAEA encourages the exchange and training of scientists and experts in the field of peaceful uses of atomic energy. Besides fellowship programmes, the IAEA organizes CRPs related to major topics of research. Within a time scale of about 4 to 5 years, several meetings of the participants take place. These RCMs are supported by the IAEA; observers are welcome. The meetings usually take place in Vienna, but many Member States support these activities and host the meetings in their own countries.

An RCM on Tritium Inventory in Fusion Reactors will take place from 18 to 19 October 2004. The objective of this CRP is to gather and generate new data relevant to the overall inventory of tritium in fusion reactors and to publish recommended sets of data as a TECDOC, or as an issue of the IAEA series Atomic and Plasma-Interaction Data for Fusion, and include the data in the on-line IAEA AMDIS system.

The last RCM of the project Data for Molecular Processes in Edge Plasmas will take place from 1 to 2 November 2004. The objectives include assessing significant developments that have occurred since completion of a related CRP in 1993 on Atomic and Molecular Data for Fusion Edge Plasmas, and the RCM will focus on the assessment and collection of new data for molecular processes in edge plasmas which are available from both experimental and theoretical studies, and the identification and fulfilment of new data requirements.

From 7 to 10 November 2004, the first RCM of the recently initiated CRP Joint Research Using Small Tokamaks will be held in Lisbon, as a satellite meeting of FEC2004. An expected result of this CRP would be, among others, a visible contribution to understanding plasma turbulence, transport and edge physics, dimensionless scaling of turbulence properties, modelling, etc. Diagnostic development and calibration techniques capable of improving some of the present and future diagnostic designs are also expected outputs of this programme.

The last RCM of the CRP on Dense Magnetized Plasmas will take place from 1 to 3 June 2005 in Kudowa Zdroj, Poland. It will provide the opportunity to present conclusions of the individual projects (10 in total), to prepare joint publications and to plan future activities. Besides fusion research, this CRP will feature studies on plasma-facing materials under irradiation by X rays, particles and neutrons. It will also support the

development of plasma focus device technology for applications making use of neutron and X ray beams (material science, medicine, etc.). The RCM will be the last of a series of three and will provide the opportunity to present conclusions of the individual projects (16 in total), to prepare joint publications, and to plan future activities.

### **Plasma Physics Programme in Cooperation with ICTP**

In 2005 two workshops related to Plasma Physics and Fusion will take place at the Abdus Salam International Centre for Theoretical Physics (ICTP) in Trieste, Italy. The workshop on Plasma Physics Capacity Building in Plasma Applications and Diagnostic Techniques, from 7 to 11 March 2005, will follow a technical meeting as already mentioned above.

The workshop on Nuclear Structure and Decay Data: Theory and Evaluation, to be held at ICTP in Trieste from 4 to 15 April 2005, constitutes a unique opportunity for scientists to gain extensive and up-to-date training on the evaluation of nuclear structure and decay data, as developed for the Evaluated Nuclear Structure Data File (ENSDF) and Nuclear Data Sheets for the nuclear physics community. Reliable evaluated nuclear structure and decay data are of vital importance in a large number of energy and non-energy based applications, including nuclear fusion.

Finally, young plasma physicists from developing Member States of the IAEA can apply for grants by the ICTP/IAEA Sandwich Training Educational Programme (STEP). This programme aims at offering IAEA fellowship opportunities to Ph.D. candidates from developing countries in scientific fields covered by both the IAEA Technical Cooperation Programmes and falling in the scientific and technical competence of the ICTP and its associated institutions. The goal of STEP is to strengthen the scientific capability of young scientists and researchers from developing IAEA Member States in order to better contribute and serve the scientific and technical development of their home countries.

IAEA fusion activities are periodically updated on the Agency's web page [www.iaea.org](http://www.iaea.org) and the web pages of the Physics and Nuclear Data Section accessible through [www-naweb.iaea.org/napc](http://www-naweb.iaea.org/napc).

### **23RD SYMPOSIUM ON FUSION TECHNOLOGY (SOFT), VENICE – A PERSONAL VIEW**

**by Dr. W.R. Spears, ITER Garching Joint Work Site**

This conference, examining the advances in our leading-edge technology, took place on 22–24 September 2004 against the wonderful and historic backdrop of Venice, at a monastery of the Cini Foundation, on the Island of St. Giorgio, directly opposite St. Marks. The strong connection between the ancient and modern was brought home to us in the very first talk, from the Mayor of Venice and MEP Prof. P. Costa, who reminded us of Venice's particular problem with global warming, and urged us to do our part to develop an energy source that should help to avoid it drowning. Prof. Sir C. Llewellyn-Smith, head of the UK Fusion Programme and Chairman of Euratom CCE-FU, took up this theme and elaborated how we should reach our goal, showing in particular the urgency of pursuing a fast track, proceeding with ITER and the International Fusion Materials Irradiation Facility (IFMIF) without further delay, and envisaging that the subsequent machine would be prototypical of future commercial fusion power plants.

The conference proceeded through plenary and oral sessions, and through poster sessions, covering plasma heating, fuelling, control and diagnostics, magnets and power supplies, plasma-facing components, blanket and vessel, remote handling, materials technology, the experiences gained on existing experiments, and projections for future experiments and fusion power plants. There were 570 participants, from 25 countries, of whom a third came from outside Europe. It was particularly gratifying to see the rapid progress being made by China in its programme, with the first plasma in the EAST tokamak being foreseen in 2005, and in general to see the increasing numbers of young engineers now becoming involved in fusion engineering in all countries. There were other striking results – JET has found how to control pressure and current profiles, there is

increasing technology transfer taking place on remote handling between fission and fusion, the IFMIF design and schedule are already fully developed, and Cadarache seems to have solved in detail the logistics of ITER large component delivery, and to be already socially prepared to host ITER as soon as a decision is made, ... – but a complete list would be impossible.

There was an interesting panel discussion with industry. Industry would like to be involved in projects as early as possible to avoid later problems with the design. However, from the project side, the participation of expert individuals from industry was most desirable, but companies were generally reluctant to release such people. There was considerable concern expressed over the viability of the ITER procurement arrangements, with its dominance of in-kind contributions, and multi-party involvement in specific procurements. Risk mitigation planning would be vitally important to making ITER a success, and a strong ITER project team would be needed to keep control. Industry also expressed concern about the delay in decision making. If decisions on ITER are not taken very soon, projects would end in industry and the people involved would move on to other things. This was considered an important message for politicians to get.

There were permanent exhibitions from most European industries involved in fusion R&D and experimental construction, in particular on Wendelstein 7X. There were also permanent exhibitions from several Euratom Associations, from EFDA, from “ITER Cadarache” and from the ITER Project.

Amazingly, despite St. Marks being just a three minute boat ride away, people stayed in the conference, took part in lively discussions following the talks and around the posters, made new contacts and renewed old acquaintances from around the globe. This struck me as a much more upbeat SOFT conference than those of previous years, pregnant with the feeling that the ITER decision was positive and imminent, and with the first thoughts that we had glimpsed a glimmer of light from the end of the tunnel to a viable fusion power source.

My congratulations to the SOFT organizers, Consorzio RFX. The next SOFT conference will be in Warsaw, in 2006.

Items to be considered for inclusion in the ITER ITA Newsletter should be submitted to C. Basaldella, ITER Office, IAEA, Wagramer Strasse 5, P.O. Box 100, A-1400 Vienna, Austria, or Facsimile: +43 1 2633832, or e-mail: [c.basaldella@iaea.org](mailto:c.basaldella@iaea.org) (phone +43 1 260026392).

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