Fusion Power Report

Complete Coverage Of Worldwide Fusion Developments

Vol. 23 No. 11/12 **November/December 2002** **Page 51**

SLANTS & TRENDS

Delegations from Canada, European Union, Japan and Russian Federation have assessed potential sites for ITER in Canada and Japan and are assessing European sites in December.

See Stories on page 52

* * *

The US Fusion Energy Sciences Advisory Committee has established a new panel "to develop a plan with the end goal of the start of operation of a demonstration power plant in approximately 35 years." The panel makes a preliminary report in late November and a final report in March.

See Story on page 54.

* * *

TEXTOR Tokamak in Julich has installed a new high power gyrotron to study heating and current drive in the experiment.

See Story on page 55.

* * *

University of Rochester scientists have developed a new capability to measure the symmetry of laser-imploded fusion capsule.

See Story on page 56

* * *

The Livermore Lab has demonstrated the planned technique for filling cryogenic targets designed to achieve fusion ignition.

See Story on page 56

***

.

Inside This Issue

Published by Fusion Power Associates – 2 Professional Drive – Suite 249 – Gaithersburg, MD 20879 – Stephen O. Dean, President
Editor: Stephen O. Dean **Managing Editor:** Ruth A. Watkins
Fusion Power Report (ISSN 0276-2919) published bi-monthly. Subscription rate: $775 per year (includes shipping).
Multiyear or email rates available on request. Send address changes or other requests to above address or by phone/fax/email:
(301)258-0545; FAX (301)975-9869; fpa@compuserve.com
Visit our Web Site at http://fusionpower.org

ITER Negotiators Launch Site Selection Process

Delegations from Canada, the European Union, Japan and the Russian Federation met in Toronto during the week of September 16 to negotiate the implementation of the ITER fusion project. A press release September 18, at the conclusion of the meetings, stated, "A notable accomplishment was the commencement of the process for the site assessment as a group of international experts began in the framework of the Negotiations with the assessment of Canada's proposed site at Clarington. An assessment of the Japanese site at Rokkasho-mura was carried out in October and the European sites at Cadarache in France and Vandellos in Spain will be carried out in early December.

The release stated, "Also of significance was the agreement on arrangements for the transitional phase towards the possible joint implementation of ITER in 2003. These arrangements would be under the auspices of the International Atomic Energy Agency (IAEA), represented at the Negotiations meeting by Dr. Robert E.H. Clark. Dr. Clark noted the IAEA is pleased to offer its continuing support."

The release notes, "In addition, significant progress was made on the full range of other issues including matters such as the treaty to implement ITER (the Joint Implementation Agreement) and organizational structure."

Japan provided a formal document of the site proposal of Rokkasho-mura at this meeting and explained its excellent characteristics for the ITER site. Representatives of Aomori prefecture stated that Aomori welcomes the opportunity to offer a site for ITER as well as the Negotiators' visit in October.

The negotiators and technical experts are having a full slate of meetings in Japan, Spain, France, and the Russian Federation with a view to finalizing the Joint Assessment of Specific Sites by early next year and completing the drafting of the Joint Implementation Agreement by mid-2003.

At the conclusion of the meeting, the delegations were unanimous in expressing their optimism at the substantial progress made on the issues critical to the implementation of the ITER project, in particular the successful beginning to the process for the Joint Assessment of Specific Sites.

The meeting of the negotiators in Rokkasho, Aomori Prefecture, Japan, was held on October 29 - 30, 2002. In addition, Japan invited all delegations to attend the International ITER Forum to be held on the 31st of October hosted by Aomori Prefecture. An ITER Symposium, hosted by Japan Federation of Economic Organizations, was held in Tokyo on the 1st of November.

The meetings to review the proferred sites in France and Spain will take place December 3-14.

For further information, contact:

Canada:
Laura Ferguson, laura@itercanada.com
Jim Campbell, jicampbe@nrcan.gc.ca

European Commission:
Jean-Pierre Rager, jean-pierre.rager@cec.eu.int

French Site Information:
Jean Jacquinot, jean.jacquinot@cea.fr

Spanish Site Information:
Carlos Alejaldre, carlos.alejaldre@ciemat.es

Japan:
Satoru Ohtake, ohtake@mext.go.jp

Russian Federation:
Yury Sokolov, sokolov@minatom.ru

ITER Negotiations Continue in Japan

At their Sixth Negotiations Meeting, delegations from Canada, the European Union, Japan and the Russian Federation continued to progress on negotiating the implementation of the ITER fusion energy research project. The Meeting was held October 29-30 at Rokkasho-mura in the Aomori Prefecture - the location of the site that Japan has offered to host the ITER project.

At the start of the meeting, Mr. Yoshiro Mori, the former Prime Minister of Japan and the Chairman of League of Diet Members for Fusion Energy Promotion, made a welcoming address to the delegates. He said that energy issues are important to achieve human prosperity, world peace and earth

environment conservation and thus Japanese Government as a whole should promote the ITER project under international collaboration to realize the fusion energy. Then Mr. Morio Kimura, the Governor of Aomori Prefecture, stated that Aomori would like to host ITER and contribute to the international society through the promotion of the project.

Within the framework of the Negotiations, the joint assessment of the Japanese site at Rokkasho-mura was recently undertaken. This followed the assessment in September of the proposed Canadian site at Clarington. With the successful conduct of these two assessments, the site review process is at the halfway mark. The last two site assessments will be held in December at the two sites proposed by the European Union – one at Cadarache in France and another at Vandellos in Spain.

The EU Delegation distributed to Participants copies of the technical dossier supporting the French site candidature, and gave an overview presentation, emphasizing the strong scientific and technical infrastructure already existing at the site as an important factor for the success of the project.

Significant progress was also made on a wide range of other issues including matters such as the treaty to implement ITER (the Joint Implementation Agreement), procurement allocation and the intellectual property rights that would accrue to participants in the project. The Negotiators agreed that the international organization responsible for implementing the project would be called the ITER International Fusion Energy Organization.

It was agreed that technical activities would be conducted during the transition period between the end of the current Coordinated Technical Activities and the establishment of the ITER International Fusion Energy Organization. The ITER Transitional Arrangements will be established for this period. They will provide for technical and engineering continuity and prepare for the entry into force of the Agreement.

Further meetings are planned for the negotiators and technical experts over the next few months. It is intended to finalize the Joint Assessment of Specific Sites by early next year and complete the drafting of the Agreement by mid-2003.

At the conclusion of this Sixth Negotiations Meeting, the delegations reaffirmed their belief that the critical issues are being successfully addressed and they are well on their way to implementing the ITER fusion energy research project.

The next meeting of the negotiators will be held in Barcelona, Spain on December 9-10, 2002, followed by the Eighth Negotiations Meeting in St. Petersburg, Russia on February 18-19, 2003.

Japan invited all delegations to attend the International ITER Forum hosted by Aomori Prefecture to be held on the 31st of October.

ITER Background

ITER, which means "the way" in Latin, is an international fusion energy research and development project with the goal of taking the next major step in the development of fusion energy as a safe, clean and sustainable energy source for our planet. The ITER International Fusion Energy Organization is the entity that will implement ITER.

Fusion is the energy that powers the sun and the stars. Research into fusion has been conducted since the 1950's, and recent advances have intensified interest in the technology. It is inherently safe and clean - any change in the process will result in an immediate shutdown and no fuel waste or greenhouse emissions are produced.

ITER would be the world's largest international cooperative research and development project next to the space station and would be constructed for approximately $4 B US over 10 years and operated for about the same amount over 20 years.

The international ITER co-operation was launched in 1987. The design of ITER and building of key prototype components was completed in 2001. Negotiations began in November 2001 towards the joint implementation of the project – where it will be built, how the costs and procurement responsibilities will be shared, and how it will be managed and operated.

Current ITER participants are Canada, the European Union, Japan and the Russian Federation. China has approached the ITER participants regarding terms for joining the ITER negotiations. The U. S is considering whether to rejoin the ITER project.

Four offers to host ITER have been submitted. The first was from Canada with an offer to host ITER at its Clarington site near Toronto, submitted on June 7, 2001. On June 5, 2002 three additional site offers were submitted, two from the European Union, one at Cadarache, France and one at Vandellos, Spain, and one site from Japan at Rokkasho-mura in Aomori Prefecture.

Under the framework of the Negotiations, a group of international experts is conducting the Joint Assessment of Specific Sites.

Upcoming Negotiations Meetings are planned for Barcelona, Spain December 9-10, 2002 and St. Petersburg, Russia February18-19, 2003.

For more information, visit the following ITER-related websites:

- www.iter.org
- www.itercanada.com
- http://www-fusion.ciemat.es/fusion/iter/ITER-eng.html
- http://www-fusion-magnetique.cea.fr/
- www.efda.org
- www.jaeri.go.jp
- http://www.pref.aomori.jp/iter/index.html
- www.iterru.ru
- www.mext.go.jp

New US Planning Effort Starts

Following up on a request from US Department of Energy (DOE) Office of Science director Ray Orbach (FPR, Sep/Oct 2002) DOE's Fusion Energy Sciences Advisory Committee (FESAC) has established a panel "to develop a plan with the end goal of the start of operation of a demonstration power plant in approximately 35 years." The panel is being chaired by Rob Goldston, director of the Princeton Plasma Physics Laboratory. The panel plans to make a preliminary report to the full FESAC at its next meeting November 25-26 in Gaithersburg, MD. A final report is due in March. The panel held meetings October 3-4 at Princeton Plasma Physics Laboratory, October 28-31 at the Lawrence Livermore National Laboratory and November 15-17 in Orlando, Florida. Following its preliminary report to FESAC, the panel has scheduled a community workshop for January 13-14 and a panel meeting Jan 15-16 in San Diego, to help prepare its final report.

The charge letter from Orbach to FESAC chairman Richard Hazeltine (posted at http://fire.pppl.gov) says that the preliminary plan should "both provide a general plan to achieve the aforementioned goal and identify those significant issues that deserve immediate attention." The charge says that the more detailed plan, "upon which budgeting exercises can be based," would be "most useful" if it:

- Identifies all important technical and scientific issues, the tasks that would lead to their resolution, and the sequence in which these tasks should be accomplished in order to reach the program goal most effectively;

- Identifies specifically all of the major facilities needed to support the tasks, and provides the mission and approximate cost of each facility;

- Provides a set of general performance measures by which the progress toward the accomplishment of the tasks and/or the mission of related facilities can be measured;

- Identifies key decision points where choices can be made among the various concepts and technologies being pursued; and

- To the extent possible, an estimate of the overall cost of such a plan, and optimum funding scenario(s).

The following persons have been appointed to the panel by FESAC chair Hazeltine:

M. Abdou, UCLA
C. Baker, UCSD
M. Campbell, General Atomics
V. Chan, General Atomics
S. Dean, Fusion Power Associates
R. Goldston, PPPL, chair
A. Hubbard, MIT
R. Iotti, CH2M Hill
T. Jarboe, U. Washington
J. Lindl, LLNL
G. Logan, LBNL
K. McCarthy, INEEL
F. Najmabadi, UCSD
C. Olson, Sandia National Laboratories
S. Prager, U. Wisconsin
N. Sautoff, PPPL
J. Sethian, US Naval Research Laboratory
J. Sheffield, ORNL
S. Zinkle, ORNL

Messages may be sent to the group as a whole at: devpath@pppl.gov

JT-60 Results Featured in ANS Journal

The American Nuclear Society journal Fusion Science and Technology (September/November 2002 issue) is devoted to a set of papers summarizing the history and results from one of the world's major tokamak fusion experiments: JT-60. Writing in the Preface, Akio Kitsunezaki (Japan Atomic Energy Research Institute, Naka) writes "For Japan, JT-60 has been a historically remarkable project because this is the first large-scale project in which we attacked a large milestone without precedent in the world and succeeded to stand on the front line of the world fusion research." He says, "We are in the midst of a change in the history of fusion research and development from an age led by the world's three large tokamaks (JT-60, JET and TFTR) to the fusion experimental reactor, ITER."

For information on how to obtain a copy of this issue contact the editor, Nermin Uckan (uckanna@ornl.gov) or visit the ANS web site (http://www.ans.org).

TEXTOR Gets A New High Power Gyrotron

Engineers from the FOM-Instituut voor Plasmafysica 'Rijnhuizen" together with their Russian colleagues have installed a new 140 GHz gyrotron at the TEXTOR tokamak of the Institut fur Plasmaphysik of the Forschungszentrum Julich in Germany. The gyrotron was manufactured by Gycom, a world leading manufacturer of high power and high frequency gyrotrons. After many months of intense preparations, the work of the project team culminated on Thursday November 7 with the achievement of the first 10 s, 670 kW pulse. Followed somewhat later by the completion of the acceptance test and official signing of the acceptance protocol. During the factory acceptance test in Moscow already 850 kW had been achieved for up to 3 s pulses, and over 1 MW for short (100 ms) pulses. The specifications for the gyrotron are a power of 800 kW in pulses of over 3 s.

The gyrotron is one of the major new tools at TEXTOR, which are at the basis of the FOM research programme on high temperature, fusion plasma physics. The 140 GHz microwaves are absorbed by the electrons in the plasma at a harmonic of the electron cyclotron frequency. The microwaves can be used both to heat the plasma, ECRH, as well as to drive current, ECCD. In the past the FOM researchers on TEXTOR performed their research on ECRH and ECCD with a 0.2 s, 300 kW, 110 GHz gyrotron. This meant that both the pulse length and power were rather limited compared to typical timescales and power levels in TEXTOR, which comes equipped with over 2 MW of heating through neutral beam injection, NBI, and with 2 MW of heating through ion cyclotron resonant waves, ICRH. Both have pulse lengths of 10 s, i.e. the maximum duration of a TEXTOR discharge. The new gyrotron brings ECRH at once on a par with NBI and ICRH in terms of pulse length and power. But not in the measure of localization of the heating or current drive, on this point ECRH/ECCD by far surpasses the capabilities of either NBI or ICRH.

The extreme localization of the ECRH and ECCD is at the heart of the FOM research programme on TEXTOR: with it the researchers intend to study and manipulate the structure of the plasma on the mesoscale. For example, structures in the magnetic field known as magnetic islands will be controlled by proper localization of the ECRH or ECCD in or near the island. A second example is the fine tuning of the magnetic winding number profile through ECRH/ECCD, which should provide a handle on the transport in tokamaks.

For further information, contact:
Egbert Westerhof
http://www.rijnh.nl/users/E.Westerhof

Record High Magnetic Fields Produced in UK

Using a new technique, researchers from Imperial College, London, and the Rutherford Appleton lab in the United Kingdom have created super-strong magnetic fields that are more intense than previous magnetic fields created on Earth and up to a billion times stronger than Earth's natural magnetic field. Such intense magnetic fields may enable researchers to recreate extreme astrophysical conditions, such as the atmospheres of neutron stars and white dwarfs.

At the Rutherford Appleton Laboratory near Oxford in the UK, researchers at the VULCAN facility aimed intense laser pulses, lasting only picoseconds at a dense plasma. The resulting magnetic fields in

the plasma were on the order of 400 MegaGauss. To determine the magnitude of the fields, the researchers made polarization measurements of high-frequency light emitted during the experiment. Recent measurements suggest that the peak magnetic field in the densest region of the plasma approaches 1 GigaGauss. Due to technological advances, peak laser intensities are likely to increase still further and consequently even higher magnetic fields may soon be possible, the researchers said., making it possible to put models of extreme astrophysical conditions to the test.

Measurements on Omega Laser Advance

A capability has been developed on the OMEGA laser at the University of Rochester to simultaneously implode a fusion capsule in a direct-drive configuration while acquiring two nearly orthogonal images of the implosion via x-ray radiography. The implosion is driven using 40 of OMEGA's 60 beams; the remaining beams are used to illuminate a pair of backlighter foils with 10 beams each. The energy of the 40 drive beams can be adjusted to produce either a symmetrical implosion with 2% rms illumination nonuniformity or a nonideal implosion with a slowly changing and controlled 5:1 variation in drive uniformity around the 1120-micron diameter4 capsule. This data is useful for validating the performance of numerical codes when there is departure from ideal symmetry.

LLNL Tests Laser Ignition Targets

Scientists at the Lawrence Livermore National Laboratory (LLNL) in the US have successfully filled a prototype ignition target in the Deuterium Test System there as part of the National Ignition Facility (NIF) preparations program. They note that all current designs of indirect-drive ignition targets for NIF include cryogenic solid-fuel layers in the target capsule. These targets require special cryogenic support equipment. Recently, the LLNL scientists have successfully tested some critical scientific prototypes of this equipment.

Because many of the ignition capsules would burst if filled to the required pressures, they must be cooled to cryogenic temperatures before they are removed from their fill cells, and then maintained at these low temperatures until shot. The LLNL tests consisted of inserting an assembled indirect-drive target, including a capsule in a hohlraum with thin polymer windows over the laser entrance holes (LEH), into a fill cell, diffusion filling the capsule to 400 atmospheres with deuterium without breaking the thin LEH windows, and cooling the target after fill. The target was then removed from the cold fill cell by attaching it to a specially designed cryostat. The target, with the filled capsule, was maintained in this cryogenic state for several days. This is the first test demonstration of these crucial steps for fielding indirect-drive ignition targets. Its success adds technical confidence to the design concept of the NIF cryogenic target systems, the scientists say.

TFTR Decommissioning Completed on Schedule

Decommissioning and removal of the Tokamak Fusion Test Reactor (TFTR) at the Princeton Plasma Physics Laboratory (PPPL) has been successfully completed. TFTR was one of the world's largest and most successful experimental fusion machines. TFTR was shut down in 1997 following 15 years of operation. During its experimental life, it set records for fusion performance and made major contributions to the development of fusion as a long-term energy alternative. The PPPL team finished the removal of TFTR on schedule and under budget.

"This marks the end of an important chapter in the history of fusion," said Raymond L. Orbach, Director of the Office of Science, which oversees PPPL for the U.S. Department of Energy. "The Tokamak Fusion Test Reactor achieved many firsts that brought us closer to an era of fusion power. Now that the decommissioning of TFTR has been completed safely, on schedule and under budget, in keeping with Office of Science best practices, we look forward to continued contributions in fusion power research from PPPL."

PPPL Director Robert J. Goldston noted, "The unprecedented scientific success of TFTR experiments has now been followed by its safe dismantling and removal. Not only did TFTR greatly advance fusion science, but its safe, cost-effective, and efficient decommissioning also demonstrates the promise of fusion as an environmentally attractive, economical energy source."

TFTR was the world's first magnetic fusion device to perform extensive scientific experiments with plasmas composed of 50/50 deuterium/tritium (D-T), the fuel mix required for practical fusion power production, and also the first to produce more than 10 million watts of fusion power. In 1995, TFTR attained a world-record temperature of 510 million degrees centigrade - more than 25 times that at the center of the sun.

Since the completion of D-T experiments on TFTR in 1997, PPPL has focused on nurturing the best new ideas in fusion research, both in advanced tokamaks and in innovative confinement configurations. Two major experimental projects, along with increased theory and computation, will anchor this program. The first, the National Spherical Torus Experiment (NSTX), is already producing an increased understanding of fusion physics. The second, the National Compact Stellarator Experiment (NCSX), now being designed, will provide further insight into the capabilities of stellarators, particularly for stable, continuous operation.

Work on the removal of TFTR began in October of 1999. The experiment stood 24-feet tall with a diameter of 38 feet. It contained an 80-ton doughnut-shaped vacuum chamber, 587 tons of magnetic field coils, a 15-ton titanium center column, and a massive stainless-steel support structure. TFTR's use of a fuel mixture containing tritium, a mildly radioactive form of hydrogen, added to the challenge of its safe and environmentally sound removal.

The most challenging aspect of the TFTR disassembly was the segmentation of the 100-cubic-yard vacuum vessel. Use of conventional technologies such as abrasive sawing and flame cutting could not satisfy health and safety concerns. PPPL's engineering team effectively addressed all challenges by developing an innovative system - Diamond Wire Cutting used in conjunction with a concrete filling technique - which reduced worker radiation exposure, airborne emissions, and waste generation. PPPL's unique and innovative application of Diamond Wire Cutting earned the Laboratory the New Jersey Society of Professional Engineers' 2002 Outstanding Engineering Achievement Award.

New UK Website on Plasma Physics Established

The UK Institute of Physics, Plasma Physics group has recently opened a new web site at: http://www.plasma-physics.info.

This site provides:

* an open forum for discussions and creating networking opportunities across Europe.

* a system for advertising one day meetings and includes an electronic 'Abstract submission system' to help organise events.

*details of bursaries available from the IOP Plasma Physics Group and how to win them.

* a forum for students and established researchers to pose and discuss technical problems related to Plasma science.

American Physical Society Award to Sandia's Director

The American Physical Society (APS) has awarded Sandia National Laboratories Director C. Paul Robinson the George E. Pake Prize for his outstanding leadership and research accomplishments.

Robinson joined Sandia in 1990 and became labs director and president in August 1995. He served as chief negotiator from 1988-90 and headed the U.S.delegation to the U.S./U.S.S.R. Nuclear Testing Talks in Geneva. In the early 80s, while a vice president of Ebasco, Robinson also served for a time as a member of Fusion Power Associates Board of Directors.

In awarding Robinson the Pake Prize, APS cited him "for his leadership roles as Director of Sandia National Laboratories and as head of the U.S. delegation to the U.S./U.S.S.R. arms control talks in Geneva, and for his pioneering contributions to the development of high explosives lasers, e-beam initiated chemical lasers, and molecular laser isotope separation methods."

Said Robinson of his award, "I could not be more pleased that the APS selected me for the George E. Pake Prize. I've always felt that I must be one of the luckiest people on the Earth, to be able to pursue a career in physics and also get the chance to serve the nation as a U.S. ambassador. But the Pake Prize is yet another unexpected reward. I want to thank all of the people at Sandia who team with me daily to do the wonderful work of this great laboratory; I am quite sure that it was your contributions that made the difference in this selection."

The George E. Pake Prize recognizes and encourages outstanding work by physicists combining original research accomplishments with leadership in the management of research or development in industry. The prize consists of $5,000, a certificate recognizing the recipient's achievements, and an allowance for travel to an award ceremony.

Partnership in Basic Plasma Science and Engineering

The Directorates for Engineering, Geosciences, and Mathematics and Physical Sciences of the NSF and the Office of Science/Office of Fusion Energy Sciences of the Department of Energy are continuing in FY2003 the joint Partnership in Basic Plasma Science and Engineering begun in FY1997 and continued in FY2000. As stated in the original solicitations (NSF 97-39 and NSF 99-159), the goal of the initiative is to enhance plasma research and education in this broad, multi-disciplinary field by coordinating efforts and combining resources of the two agencies. The initiative will address fundamental issues in plasma science and engineering that can have impact in other areas or disciplines in which improved basic understanding of the plasma state is needed.

The Program Solicitation for the FY 2002 NSF/DOE Partnership in Basic Plasma Science and Engineering has been published. This is the main announcement of opportunity under the partnership. This is the third announcement (made on a three year cycle). It can be found at

http://www.nsf.gov/pubs/2002/nsf02184/nsf02184.htm

Calendar

Nov 11-15 44th Annual Meeting of the APS Division of Plasma Physics. Orlando, Florida. http://www.aps.org/meet/DPP02

Nov 17-21 15th ANS Topical Meeting on the Technology of Fusion Energy. Washington, DC http://www.ans.org/meetings/

Nov 25-26 USDOE Fusion Energy Sciences Advisory Committee (FESAC) public meeting. Marriott Hotel, Gaithersburg, MD. Contact: albert.opdenaker@science.doe.gov

Dec 3-4 Fusion Power Associates Annual Meeting and Symposium, "Fusion Power: Looking to the Future." Washington, DC http://fusionpower.org

Dec 9-14 International Conference on the Frontiers of Plasma Physics and Technology. Bangalore, India. Contact: tara.desai@mib.infn.it