



Fusion Power Report

Complete Coverage Of Worldwide Fusion Developments

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George Bush and John Kerry both support fusion and ITER.

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Bush and Kerry on Fusion

Nature and Science magazines posed questions on science, environment and energy policy to Presidential candidates George Bush and John Kerry. Their responses are posted at <http://fire.pppl.gov>

With respect to fusion and ITER the questions and responses were as follows:

Nature: Should the United States participate fully in the construction of ITER, the proposed fusion research facility, and what steps would you take to help such international scientific projects to succeed?

Bush: I committed the United States to join ITER early in 2003. ITER is a critically important experiment to test the feasibility of nuclear fusion as a source of electricity and hydrogen. Along with several other nations, the United States is playing a critical role in launching ITER. In fact, ITER is the Department of Energy's top facilities priority.

Kerry: My energy plan will tap America's initiative and ingenuity to strengthen our national security, grow our economy and protect our environment. With regard to ITER, John Edwards and I support a strategically balanced United States fusion program that includes participation in ITER to supplement a strong domestic fusion science and technology portfolio. As president, my first priority internationally on this and other energy issues will be to engage other nations to find areas of cooperation and common ground.

Science: By siding with Japan, the United States has contributed to the current stalemate over where to build the International Thermonuclear Experimental Reactor (ITER). Would you shift support to Europe as a way to move this project forward? At what point would you withdraw U.S. support for this project?

Kerry: My energy plan will tap America's initiative and ingenuity to strengthen our national security, grow our economy and protect our environment. With regard to ITER, John Edwards and I support a strategically balanced United States fusion programme that includes participation in ITER to supplement a strong domestic fusion science and technology portfolio. As president, my first priority internationally on this and other energy issues will

be to engage other nations to find areas of cooperation and common ground.

Bush: I remain committed to building the ITER project, and based on recommendations from the Department of Energy, I believe Japan is the best location for ITER. My administration will continue to collaborate with all ITER participants, including our European partners, in realizing the promise of fusion energy through ITER. This project is one of the four "transformational technology" pillars of my climate change strategy, which focuses on building the emissions-free technologies of the future. From an inexhaustible and entirely clean fuel source, a fusion plant could generate huge amounts of electricity to power megacities and to produce hydrogen.

ITER UPDATE

US Designates ITER Team

Although the international partners (European Union, Japan, Russia, China, Republic of Korea and the United States) have still shown no sign that they can agree on a site for the International Thermonuclear Experimental Reactor (ITER) project, this has not deterred the US Department of Energy from setting up a project office to manage potential US contributions to the project.

Energy Secretary Spencer Abraham announced on July 13 that the project office would be located at the Princeton Plasma Physics Laboratory (PPPL) and would be managed by a partnership between PPPL and the Oak Ridge National Laboratory (ORNL). Ned Sauthoff (PPPL) has been designated as Project Manager of the "U.S. ITER Project Office." Carl Strawbridge (ORNL) will be Planning Control Manager, reporting to Sauthoff.

According to a proposed organization chart, the US is expecting to contribute to the following aspects of ITER: Design Integration, Magnets, Heating and Fueling, Conventional Systems, Diagnostics, Tritium and Plasma Facing Components. The US has reportedly offered to contribute "in-kind" about 10% of the estimated \$5 billion cost of ITER construction.

In announcing the decision, Secretary Abraham said "I am confident that our partners in ITER negotiations will recognize our choice of

PPPL/ORNL to manage US participation in ITER for what it is: the clearest possible indication that our Nation takes ITER - and our role in ITER - very seriously. PPPL/ORNL was chosen over competing bids from the Lawrence Livermore National Laboratory and the Idaho National Engineering and Environmental Laboratory.

Copies of press releases and other ITER news are posted at <http://fire.pppl.gov>

FESAC ITER Deadline Passes

Following the two-week 2002 Fusion Summer Study, at which over 280 fusion scientists gathered to discuss the major next-step in the U.S. fusion program, a panel of the DOE Fusion Energy Sciences Advisory Committee (FESAC) met in Austin, Texas, to recommend "a burning plasma program strategy to advance fusion energy." The Panel, chaired by Prof. Stewart Prager (U. Wisconsin), recommended that the U.S. rejoin the international ITER project with the understanding that "The Department of Energy concludes, by July 2004, that ITER is highly likely to proceed to construction and terms have been negotiated that are acceptable to the United States." They said, "Demonstrations of likelihood could include submission to the partner governments of an agreement on cost sharing, selection of the site, and a plan for the ITER Legal Entity." The Panel found that ITER, FIRE (a U.S. design) and Ignitor (a potential Italian project) were all viable routes to study burning plasmas. Though they favored ITER, they said that "If ITER does not move forward, then FIRE should be advanced as a U.S.-based burning plasma experiment with strong encouragement of international participation." They also said, "If Ignitor is constructed in Italy, then the United States should collaborate in the program by research participation and contributions of related equipment, as it does with other major international facilities." The Panel cautioned DOE that the recommended program could not be accomplished on a flat budget, saying "A strong core science and technology program is essential to the success of the burning plasma effort, as well as the overall development of fusion energy. Hence, this core program should be increased in parallel with the burning plasma science initiative." The full FESAC endorsed the report in a September 13, 2002 letter to DOE Office of Science Director Ray Orbach.

A year later, in September 2003, the National Research Council, an arm of the National Academies, issued the report of its Burning Plasma Assessment Committee, chaired by Ray Fonck (U. Wisconsin) and John Ahearne (Sigma Xi). The 170-page report concludes that "a burning plasma experiment is critically needed to advance fusion science," that "undertaking a burning plasma experiment cannot be done on a flat budget," and that "if negotiations proceed successfully, the fusion science program will move ahead with the ITER endeavor." The Committee recommended that "the United States should participate in ITER," and that "if the ITER negotiations fail, the United States should continue, as soon as possible, to pursue the goal of conducting a burning plasma experiment with international partners." The Committee stated "A strategically balanced U. S. fusion program should be developed that includes U. S. participation in ITER, a strong domestic fusion science and technology portfolio, an integrated theory and simulation program, and support for plasma science. As the ITER project develops, a substantial augmentation in fusion science program funding will be required in addition to the direct financial commitment to ITER construction." The Committee acknowledged that it did not review the needs and prospects for inertial confinement fusion.

Since 2002, the U.S. has maintained a substantial effort on the design of the FIRE option as a contingency in case ITER did not proceed. That work is currently targeted for termination on September 30. N. Anne Davies, director of the U.S. fusion program, told a July 26-27 meeting of FESAC that if ITER failed to proceed the U.S., would have to reassess its program strategy.

US ITER Activities Summarized

At the July 26-27 FESAC meeting, Ned Sauthoff, Project Manager of the recently established US ITER Project Office, told the group the US was spending \$3 million this year in direct ITER support for "joint preparations directed at maintaining the coherence and integrity of the ITER design and at preparing for an efficient start of ITER construction," and for "organizational preparations directed at enabling the ITER Legal Entity to enter into effective operation with least possible delay following the entry into force of the ITER Joint Implementation Agreement."

Sauthoff said that the tentative ten percent US "in-kind" contributions to ITER construction are estimated (in US dollars) as follows:

Central Solenoid Magnets (4 of 7): \$107 M
Plasma-Facing Components: \$21 M
Ion Cyclotron System: \$45 M
Electron Cyclotron System: \$47 M
Vacuum Pumping and Fueling: \$22 M
Diagnostics: \$30 M
Tritium Processing: \$20 M
Steady State Power Supplies: \$21 M
Other: Unspecified amount

Sauthoff said that a request for proposals was issued in May to 4 US strand vendors for development and qualification of more than 100 kg of superconducting strand and offers were received from all four. He said that the US has "seconded" the equivalent of 3 person-years to the 69 person ITER International Team, which currently includes 31 from Europe, 21 from Japan, 13 from Russia and 1 from China.

Sauthoff's presentation is posted at <http://fire.pppl.gov>

Baker Moves to New Mexico

Dr. Charles C. Baker, Director of the U.S. fusion program's Virtual Laboratory for Technology, will retire from the University of California at San Diego (UCSD) effective August 13. He will retain his appointment as an adjunct professor at UCSD and thus plans to keep some ties to the university.

He will move to the Albuquerque, New Mexico area in mid-August. He will continue in the role of director of the Virtual Laboratory for Technology and continue serving on the DOE's Fusion Energy Sciences Advisory Committee (FESAC). Thus, his national fusion responsibilities will be largely unchanged. He will do this as part-time work under a personal services contract with the Sandia National Laboratories (SNL) in Albuquerque and will have an office at SNL.

Fusion Priorities Panel Provides Interim Report

Charles Baker, chair of the Fusion Energy Sciences Advisory Committee (FESAC) Panel on Program Priorities provided an interim report to FESAC at

its meeting July 26-27 in Gaithersburg, MD. A version of the interim report is posted at http://www.mfescience.org/fesac/comments/att-0026/Draft_PP_interim_report_R_pdf and other information, including the charge letter, are posted at <http://www.mfescience.org/fesac/index.html>

The FESAC was asked by DOE on October 23, 2003 for a "prioritized balancing of the (fusion) program" assuming the construction of ITER and "includes ITER as an integrated part of the whole."

In its interim report, the Panel proposes three "overarching themes" and fifteen "more scientific questions central to the advancement of fusion energy." The Panel says that "for each topical scientific question, an accompanying research approach was formulated, spanning the next ten years." They say "The approaches identified a limited number of research thrusts needed to address the most important aspects of each question. These research thrusts provide much of the core information required to develop campaigns."

Baker indicated that the next phase of the Panel's work would be to develop the "campaigns," which would cut across the scientific questions, and to prioritize the campaigns. He said that many members of his panel were uncomfortable with proceeding with the next phase of the activity assuming ITER was moving ahead when in fact it was not. Several members of FESAC, including its chairman, expressed similar reservations. DOE fusion director, N. Anne Davies, firmly resisted any suggestion that the Panel delay its activity or write two scenarios, one with ITER and one without. DOE is assuming ITER is going ahead in all its internal planning, she said.

It was pointed out that the budget assumptions given to the panel by DOE in October 2003 were seriously out of date. In addition to a case based on the FY 2003 funding level of \$257 million plus inflation plus construction funds for ITER, DOE told the FESAC to consider a case in which the funding level for FY 2004 was \$335 million, increasing to \$393 million in FY 2009 and a case intermediate between these two cases. The actual funding levels turned out to be \$247 M in FY 2003 and \$263 M in FY 2004 and the President only asked for \$264 M in FY 2005. Davies promised to provide new budget guidance for the study.

A final report is due at the next FESAC meeting, scheduled for December 14-15 in Gaithersburg, MD.

LDX Begins Plasma Experiments

On Friday August 13, the first plasma physics experiments were conducted using the Levitated Dipole Experiment (LDX). LDX was built at MIT's Plasma Science and Fusion Center as a joint research project of Columbia University and MIT. This major milestone for the project signifies the completion of the fabrication of the experimental device and the initiation of scientific studies.

The Levitated Dipole Experiment (LDX) is a first-of-its-kind experiment incorporating three superconducting magnets and exploring the physics of high-temperature plasma confined by magnetic fields that resemble those surrounding magnetized planets, like Earth and Jupiter. The goal of the experiment is to study the properties of the confined plasma and to determine whether larger dipole magnets could someday be used to create a source of fusion power.

In the experiment, a large superconducting charging coil was used to inductively energize a compact, high-current superconducting ring to more than 750,000 amperes. After disconnecting all cryogenic and diagnostic services from the superconducting ring, it was twice lifted to the center of a large 16-foot diameter ultra-high vacuum chamber where it maintained a strong dipole magnetic field for over four hours of scientific experiments.

Four dozen deuterium plasma discharges, each lasting from 5 to 10 seconds in duration, were formed with 10 second pulses of multi-frequency microwave heating up to 6.2 kW. Each plasma contained a large fraction of energetic and relativistic electrons that created a significant pressure that caused outward expansion of the magnetic field.

Many measurements were recorded including multi-cord x-ray spectroscopy that measures the energetic electron temperature profile, arrays of magnetic flux loops and sensors that measure the pressure-driven diamagnetic currents, visible video photography that measures the evolution of the plasma structure, microwave interferometry that measures plasma density, and electrostatic probes inserted to measure the parameters of the edge

plasma. Detailed analysis of the measurements are just underway.

The experiments were conducted by a team of five graduate students, two undergraduate students, and several technicians, superconducting magnet engineers, and plasma scientists, and include Alex Boxer, Jennifer Ellsworth, Darren Garnier, Alex Hansen, Ishtak Karim, Jay Kesner, Rick Latons, Scott Mahar, Mike Mauel, Phil Michael, Joseph Minervini, Eugenio Ortiz, Austin Roach, Don Strahan, Alex Zhukovsky, and Michelle Zimmermann.

Additional details, photographs, and video are available at the LDX homepage at <http://www.psfc.mit.edu/ldx/>.

Rochester Tests Targets

Beginning in April 2004 and continuing through the present, scientists at the University of Rochester Laboratory for Laser Energetics (LLE) have performed implosion experiments on deuterium-filled cryogenic targets using the OMEGA laser. They have successfully produced targets with cryo layer smoothness close to 2 micron rms and produced record neutron yields for deuterium-filled targets in close agreement with the predictions of 1-D multi-dimensional hydrodynamic codes.

Further information on the programs at LLE can be found at <http://www.lle.rochester.edu/> or by contacting Wolf Seka (seka@lle.rochester.edu) or John Soures (jsou@lle.rochester.edu).

FPA Announces 2004 Awards

Fusion Power Associates Board of Directors announces the recipients of its 2004 Awards. Previous recipients are posted at <http://fusionpower.org> and click on Awards. The awards will be presented at the FPA 2004 annual meeting and symposium, December 13 in Gaithersburg, MD.

LEADERSHIP AWARDS

FPA 2004 Leadership Awards will be presented to **Raymond Fonck** (University of Wisconsin) and to **Farrokh Najmabadi** (University of California, San Diego).

In selecting Dr. Fonck, the Board recognizes his many scientific contributions to the study of plas-

mas in both tokamak and alternate confinement concepts and especially notes the important leadership role he played in securing priority for the study of burning plasmas both within the fusion community and through his role as co-chair of the National Academies' Burning Plasma Assessment Committee.

In selecting Dr. Najmabadi, the Board recognizes his many contributions to a variety of fusion concepts and especially commends him for his recognition of the importance of the inter-related physics/technology systems aspects of these concepts. The Board also notes the important role he has played as leader of the national fusion power plant studies, which have provided perspective and guidance for the near-term fusion research effort.

DISTINGUISHED CAREER AWARD

The FPA 2004 Distinguished Career Award will be presented to Prof. **Bruno Coppi** (MIT). In selecting Prof. Coppi, the Board recognizes his seminal contributions to plasma and fusion science over many decades. The Board notes that the world fusion effort is especially in his debt for his early and continuing recognition of the importance of high magnetic field in the design and operation of tokamak fusion devices and for his tireless efforts to urge the construction of a fusion ignition experiment.

FUSION ENGINEERING AWARD

The FPA 2004 Excellence in Fusion Engineering Award, established in memory of MIT Professor of Nuclear Engineering David J. Rose, will be presented to **Camille Bibeau** (Lawrence Livermore National Laboratory). In selecting Dr. Bibeau, the FPA Board recognizes her many technical contributions to the design, construction and operation of laser systems, as evidenced by her exemplary publications record and her role as Project Leader of the Mercury diode-pumped solid state laser program at LLNL. The Board especially recognizes her outstanding communications skills in providing clear and understandable presentations on highly complex topics to a variety of audiences.

Dean Receives Statesman Award

Fusion Power Associates president Steve Dean was presented the "Senior Statesman of the Fusion Program" Award at the American Nuclear Society

16th Topical Meeting on the Technology of Fusion Energy, September 14-16 in Madison, Wisconsin. The award was presented by the conference General Chair, Prof. Gerald L. Kulcinski (University of Wisconsin) "on behalf of the Fusion Community."

The award to Dr. Dean states that it is "in recognition of his many contributions to the development of fusion energy, including:

- * stimulating the development of young scientists,
- * maintaining a focus on the end product of fusion,
- * keeping industry and utilities involved, and
- * providing a platform for policy discussions"

Dean presented an invited paper at the meeting, "Historical Perspective on the United States Fusion Program." He traced policy and progress over the approximately 55 year history of the U. S. fusion program. He said, "Fusion research has been underway for a little over fifty years. Some believe that commercial fusion power is still another fifty years away. Under present U. S. government policy, there is no timetable for fusion. However, if timely commitment is made to engineering development, admittedly not a likely scenario, fusion power could still be on the grid in a demonstration power plant far sooner."

Dean said, "Since 2000, the USDOE budget and policy for fusion has been inconsistent with the recommendations of its Fusion Energy Sciences Advisory Committee, which recommended a program in which science and technology were in balance, as also were efforts on magnetic and inertial fusion energy." "Current policy needs to change to bring these program elements back into balance," he said.

Copies of Dean's paper are available on request from Fusion Power Associates (fusionpwassoc@aol.com).

Dr. Dean holds a BS (Physics) from Boston College, a SM (Nuclear Engineering) from MIT, and a Ph.D. (Physics) from the University of Maryland. He worked 17 years for the U. S. government, as a research scientist at the U. S. Naval Research Laboratory and as a senior fusion program manager at the U. S. Department of Energy and its predecessor agencies. Upon leaving government in 1979, he co-founded Fusion Power Associates and has served as its president since that time. He has served on numerous government advisory committees, including

the US-USSR Joint Fusion Power Coordinating Committee, the DOE Fusion Energy Advisory Committee and the Secretary of Energy Task Force on Strategic Energy Research and Development. He is a Fellow of the American Nuclear Society and a member of the American Physical Society. He is the recipient of several awards, including the Naval Research Laboratory's Research Publications Award and twice a recipient of the U.S. Department of Energy's Distinguished Associate Award.

Lindl Decides to Focus on NIF

John Lindl has decided to resign from leadership of the LLNL Fusion Energy Program, as of October 1, in order to work full time on making NIF a success. Over the past year, he has spent increasing amounts of time on developing a NIF activation and early use plan as well as on better understanding the leverage that various types of target improvements can have on the ability to achieve ignition as soon as possible after NIF is completed. Lindl says, "NIF is now at a critical period as we activate progressively more beams and transition toward a much greater focus on developing all the program capabilities the project will be need for success (targets, cryo system, diagnostics, user specified special optics, etc).

Lindl has been selected as a Teller Fellow (one of 3 at LLNL this year) which will facilitate taking a broad multi-institutional view in putting together the NIF plans. He says, "I do not intend to disappear from the other parts of the fusion enterprise but NIF will be my focus and other activities will be on a more ad hoc basis."

Snyder Wins Rosenbluth Award

Dr. Philip B. Snyder, a theoretical plasma physicist at General Atomics (GA), is the recipient of the 2004 General Atomics Marshall Rosenbluth Fusion Theory Award.

Dr. Snyder has been at GA since 1999 and in this short time has made important contributions to understanding the behavior of the tokamak edge plasma. Both experimental results and computational modeling show that the overall fusion plasma performance depends critically on the pressure at the plasma edge. Hence developing a predictive understanding of the edge plasma is critical for enhancing the

confidence of the performance of next step burning plasmas, including ITER. Dr. Snyder's research is therefore building an excellent scientific foundation for a highly relevant and important topic.

The award, which includes a plaque and a stipend of \$25,000, recognizes outstanding young theorists in the field of plasma physics. It was created in 2003 to honor one of fusion's greatest scientists, Professor Marshall Rosenbluth, who had contributed so much to GA's fusion and plasma physics research throughout his career. The recipient of the award is chosen based on recommendations from a highly regarded external selection committee.

Details of the award can be found at <http://fusion.gat.com/awards/rosenbluth.html>

US, Russians Urge Nuclear Effort

Representatives of seven U.S. Department of Energy national laboratories and nine Russian scientific nuclear organizations have developed a joint document that advocates greater global use of nuclear energy.

In addition to providing a virtually limitless supply of secure and reliable energy, greater use of nuclear energy would greatly reduce the risk of nuclear weapon proliferation and nuclear terrorism and reduce the worldwide amount of carbon emissions, the directors said.

U.S. and Russian representatives developed the document July 19-21 at the International Atomic Energy Agency headquarters in Vienna, Austria. The meeting was a follow up to the address by Russian President Putin to the Millennium Summit in September 2000, the Bush-Putin Summit in 2002, and the speech by President Bush at the National Defense University in February 2004. On each of these occasions the idea was advanced that nuclear power should play an appropriate role in the energy mix in the 21st century while providing protection against proliferation.

The joint document says the participants believe that of all current or imminently developable energy technologies, only nuclear power is capable of meeting the growing world demand for safe, clean, plentiful, and economically viable sources of electricity, fresh water, and hydrogen. "With government encouragement and the right regulatory and economic conditions, nuclear energy could supply a

substantial part of U.S. and Russian energy needs and 30-40 percent of the world electricity demand by 2050," the document says.

All of the delegates signed the joint document, which will be submitted to their respective governments for consideration.

Calendar

Sep 13-17 9th International Conference on Plasma Surface Engineering. Garmisch-Partenkirchen, Germany. <http://www.akplasma.org/pse2004.php3>

Sep 13-18 10th International Conference and School on Plasma Physics and Controlled Fusion. Alushta (Crimea), Ukraine. Contact: garkusha@ipp.kharkov.ua

Sep 14-16 16th Topical Meeting on the Technology of Fusion Energy. Madison, Wisconsin. <http://fti.neep.wisc.edu/tofe>

Sep 20-22 US-Japan Workshop on New Developments in Compact Torus Research. Santa Fe, New Mexico. Contact: intra-tor@lanl.gov

Sep 20-24 23rd Symposium on Fusion Technology (SOFT). Venice, Italy. <http://soft2004.igi.cnr.it>

Sep 27 – Oct 1 2nd International School of Advanced Plasma Technology. Varenna, Italy. Contact: plasma@net.nagasaki-u.ac.jp

Oct 5-8 14th International Toki Conference on Plasma Physics and Controlled Nuclear Fusion and 4th International Conference on Atomic and Molecular Data and Their Applications. <http://itc14.nifs.ac.jp>

Oct 11-15 IAEA-TCM: Technical Meeting on Physics and Technology of Inertial Fusion Energy Targets and Chambers. Daejeon, Republic of Korea. <http://aries.ucsd.edu/PUBLIC/IAEAIFECRP/tcm3.shtml>

Oct 25-29 12 International Congress on Plasma Physics. Nice, France. <http://www-fusion-magnetique.ces.fr/ICPP2004/>

Nov 1-6 20th IAEA Fusion Energy Conference. Tivoli Marinotel, Vilamoura, Portugal. <http://www.cfn.ist.utl.pt> U.S. Participants contact: steve.eckstrand@science.doe.gov

Nov 15-18 American Nuclear Society Winter Meeting. Washington, DC. <http://ans.org>

Nov 15-19 46th Annual Meeting of the APS Division of Plasma Physics. Savannah, Georgia, USA. Contact: stewart@physics.utexas.edu

Dec 13 Fusion Power Associates Annual Meeting and Symposium. The Fusion Energy Option, Gaithersburg, MD. <http://fusionpower.org>

Dec 14-15 Public Meeting of USDOE Fusion Energy Sciences Advisory Committee. Gaithersburg, MD. Contact albert.opdenaker@science.doe.gov

Jan 15-20 15th Symposium on Applications of Plasma Processes and 3rd EU-Japan Joint Symposium on Plasma Processing. Podbanske, Slovakia. <http://www.fmph.uniba.sk/SAPPXV>

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