



Fusion Power Report

Complete Coverage Of Worldwide Fusion Developments

Vol. 24 No. 5/6

May/June 2003

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SLANTS & TRENDS

The U. S. Department of Energy Fusion Energy Sciences Advisory Committee (FESAC) has prepared a plan aimed at operation of a demonstration fusion power plant (Demo) in approximately 35 years.

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The U. S. has set up an organization charged with assisting with negotiations for the construction of ITER.

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An ITER forum is being held May 8-9 to provide interested parties an opportunity to comment on the desired roles for the U. S. in ITER construction.

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A small pellet of fusion fuel was successfully compressed using the Z pulsed power device at Sandia National Laboratories in Albuquerque.

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The first four of 192 laser beams have been successfully tested at the National Ignition Facility (NIF).

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An Innovative Fusion Concepts Workshop will be held in Seattle May 28-29.

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FESAC Endorses 35-year Fusion Power Plan

The U.S. Department of Energy (DOE) Fusion Energy Sciences Advisory Committee (FESAC) has endorsed a "Plan for the Development of Fusion Energy" and transmitted the report to DOE Office of Science Director Raymond Orbach. The plan, prepared by a FESAC panel chaired by Princeton Plasma Physics Laboratory Director Rob Goldston calls for the operation of a demonstration electric power plant (Demo) in about 35 years that enables the commercialization of fusion.

The plan envisages a broadly-based "portfolio" of both magnetic and inertial fusion energy approaches and associated technologies over the next fifteen years at a total cost of approximately \$10 billion, at which time the technology for the first generation of fusion power plants would be selected for focused development over the next approximately 20 years.

The plan describes a development path based on "a set of overlapping scientific and technological challenges" in configuration optimization, study of burning plasmas, materials testing, component testing and fusion power demonstration. It notes a series of key decisions, including a 2008 decision needed to construct an International Fusion Materials Irradiation Facility (IFMIF).

The plan anticipates "major accomplishments" from the inertial fusion National Ignition Facility (NIF) and the International Thermonuclear Experimental Reactor (ITER) during the period 2009 - 2019. Data from NIF and ITER, combined with data from ongoing core experimental and theory/computation programs, would lead to the selection of the Demo path around 2019.

The report calls for initiating the plan in FY 2004 at a level of \$332 million, although the President's FY 2004 budget request is for only \$257 million. The plan calls for the fusion budget to continue to grow, to approximately \$570 million in 2008 and to peak at approximately \$900 million around 2013.

The plan states, "To achieve the goals of this plan, the program must be directed by strong management. Given constrained budgets, the wide variety of options and the linkages of one issue with an-

other, increasingly sophisticated management of the program will be required."

The plan is aimed at having fusion ready for commercialization in a timeframe as defined recently by President Bush. Bush called for having "clean, safe, renewable, and commercially-available fusion energy by the middle of this century." Bush said, "Commercialization of fusion has the potential to dramatically improve America's energy security while significantly reducing air pollution and emissions of greenhouse gases."

The full report is posted at <http://fire.pppl.gov>

U.S. Organizes for ITER Negotiations

Dr. N. Anne Davies, Associate Director for Fusion Energy Sciences, USDOE, has announced that she has created "a working mechanism to help us get started (on participation in ITER negotiations) immediately." She has named Ned Sauthoff (Princeton Plasma Physics Laboratory) to serve as U.S. ITER Planning Officer, with Charles Baker (UCSD) as his deputy. They are to "form a multi-institutional working team of people from around our program to assist us in meeting these many needs." Mike Roberts at DOE will oversee the effort, assisted by Warren Marton.

Davies has asked Sauthoff "to assemble a Burning Plasma Program Advisory Committee to strengthen community involvement in the working team's activities." Stewart Prager (University of Wisconsin) has been named to chair that committee.

Sauthoff indicated that he will be setting up a web site to facilitate community access to the working group's activities.

For further information contact Ned Sauthoff (sauthoff@pppl.gov)

US ITER Workshop

Fusion scientists and engineers interested in contributing to the development of U.S. plans for participation in ITER construction and operation attended an open U.S. ITER Forum May 8-9 at the University of Maryland, College Park, Maryland.

The Objectives of the U.S. ITER Forum are to:

- o Inform the broader U.S. fusion community on current ITER plans and negotiation activities, and to engage them in ITER preparatory work.
- o Involve the community in ongoing technology and physics R&D relevant to Burning Plasma Physics and ITER. Physics is carried out through the International Tokamak Physics Activity (ITPA).
- o Provide community input to the preparation of proposals for U.S. hardware contributions to ITER and for U.S. performance of ITER tasks.
- o Begin discussion of ITER as a scientific and technological research opportunity.

Detailed information is available online:

http://www.apam.columbia.edu/fusion/US_ITER_Forum.html

The Forum is sponsored by the University Fusion Association, the U.S. ITER Planning Office, and the DOE Office of Fusion Energy Science.

For further information, visit the web site or contact members of the Organizing and Program Committee:

Rejean Boivin (boivin@fusion.gat.com)
Cary Forest (cbforest@wisc.edu)
Mike Mauel (Chair) (mauel@columbia.edu)
Stan Milora (miloras1@ornl.gov)
Raffi Nazikian (rnazikian@pppl.gov)
Joseph Snipes (snipes@psfc.mit.edu)

Pulsed Power Fusion Advance

Scientists from the Sandia National Laboratories (Albuquerque) have reported successfully compressing a small pellet containing fusion fuel using X-rays from the Z pulsed power facility. The results were reported at the spring meeting of the American Physical Society, April 5-8 in Philadelphia. Although such experiments have been successfully performed previously using lasers, this is the first time such experiments have shown fusion reactions using the method of X-rays produced from a Z-pinch pulsed power device. Z-pinches have the attractive feature of being relative low in

cost. Calculations predicting scaling to high fusion yield were reported previously.

Concepts have been developed to permit these currently single shot experiments to become repetitively pulsed. Fusion power plants based on the Z-pinch would pulse about once every ten seconds and would have recyclable transmission lines that would be automatically replaced between pulses. Contact Craig Olson (cjolson@sandia.gov) for more information on Z-pinch fusion power plants.

Copies of the vugraphs from the Sandia presentation have been posted at http://fire.pppl.gov/aps_zpinch_leeper.pdf

Sandia labs issued the following press release:

FOR IMMEDIATE RELEASE

April 7, 2003
Philadelphia, Pa.

Huge pulsed power machine enters fusion arena. Z produces fusion neutrons, Sandia scientists confirm.

Throwing its hat into the ring of machines that offer the possibility of achieving controlled nuclear fusion, Sandia National Laboratories' Z machine has created a hot dense plasma that produces thermonuclear neutrons, Sandia researchers announced today at a news conference at the April meeting of the American Physical Society in Philadelphia.

The neutrons emanate from fusion reactions within a BB-sized deuterium capsule placed within the target of the huge machine. Compressing hot dense plasmas that produce neutrons is an important step toward realizing ignition, the level at which the fusion reaction becomes self-sustaining. The amount of energy a larger successor to Z could bring to bear offers the still-later possibility of high-yield fusion - the state in which much more energy is released than is needed to provoke the reaction initially to occur. The excess energy could be used for applications such as the generation of electricity, said Tom Mehlhorn, a project leader on the machine.

Z causes reactions to occur neither by confining low density plasmas in dimensionally huge magnetic fields, as do tokomaks, nor by focusing intense laser beams on or around a target, as in laser

fusion, but simply through the application of huge pulses of electricity applied with very sophisticated timing. The pulse creates an intense magnetic field that crushes tungsten wires onto a foam cylinder to produce X-rays. The X-ray energy, striking the surface of the target capsule embedded in the cylinder, produces a shock wave that compresses the deuterium within the capsule, fusing enough deuterium to produce neutrons.

"Pulsed power electrical systems have always been energy-rich but power-poor," said Ray Leeper, a Sandia manager. "That is, we can deliver a lot of energy, but it wasn't clear we could concentrate it on a small enough area to create fusion. Now it seems clear we can do that." A partial confirmation of the result came about when theoretical predictions and lab outcomes were determined to be of the same order of magnitude. Predictions and measurements of the neutron yield were both of the order of 10 billion neutrons. The predicted neutron yield depends on the ion density temperature and volume. Those quantities were independently confirmed by X-ray spectroscopy measurements.

Neutron pulses were observed as early as last summer but researchers were wary that the output was produced by interactions between the target and ions generated by Z's processes, rather than within the capsule itself.

Ion-generated neutrons were not the point of the experiment, since they would not scale up into a high-yield event in any later, more powerful version of Z. But a series of experiments completed in late March demonstrated that the production was within the capsule itself. To show this, researchers inserted xenon gas within the capsule. The gas prevented the capsule from getting hot during compression. Thus, the neutron yield dropped dramatically, as predicted.

The action takes place within a container the size of a pencil eraser, called a hohlraum, at the center of the Z machine, itself a circular device about 120 feet in diameter. Sandia researchers Jim Bailey and Gordon Chandler led the experimental team and Steve Slutz performed theoretical calculations. Sandian Carlos Ruiz and Gary Cooper of the University of New Mexico performed the neutron measurements.

Sandia is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin company,

for the U.S. Department of Energy's National Nuclear Security Administration. With main facilities in Albuquerque, N.M., and Livermore, Calif., Sandia has major R&D responsibilities in national security, energy and environmental technologies, and economic competitiveness. Sandia is a National Nuclear Security Administration laboratory. Story and image available at <http://www.sandia.gov/news-center/news-releases/2003/nuclear-power/Zneutrons.html>

Sandia Media Contact: Neal Singer, 505-845-7078, nsinger@sandia.gov

NIF Progress

The National Ignition Facility (NIF) continues to meet its technical performance, cost and schedule milestones. NIF, to become the world's largest laser, is under construction at the Lawrence Livermore National Laboratory.

Conventional facilities were completed in September 2001, with "first light" through a four-beam "quad" oscillator, preamplifier and main power amplifier in October 2002.

In March 2003, performance testing continued with a completed four-laser beamline. NIF will eventually have 192 beams. A 6000 Joule shot to the target chamber was successful. Multiple target chamber diagnostics recorded the shot data, including a recently-deployed Streaked X-ray Diagnostic (SXD) camera system.

The NIF experimental program is scheduled to begin in late 2004 with the four beam system. Full 192 beam operation is expected about four years later, with ignition planned in 2010.

University Group Urges Increased Fusion Funding

The University Fusion Association (UFA) has sent a letter to members of the Subcommittee on Energy and Water Development of the House Committee on Appropriations of the U.S. Congress, urging them to add \$25 million to President Bush's Fiscal Year 2004 budget request for the DOE Office of Fusion Energy Sciences. The President has requested \$257 million. The February 25 letter, signed by the UFA 12-member Officers and Executive Committee, says "Without additional re-

sources, carrying out the necessary preparations for ITER in FY04 with the present budget request of \$257 million (unchanged from the FY03 request) will result in destroying critical elements of the base science and technology part of the fusion program." The letter notes, "In FY04 and in subsequent years, as we move forward with the ITER project, the necessary additional funding must be provided to ensure that there is a strong U.S. fusion program to participate in and make use of the advances we achieve in ITER."

The letter is posted at <http://fire.pppl.gov>

FESAC Letter on FY2004 Budget

At its meeting March 5-6 in Gaithersburg, Maryland, the U.S. Department of Energy Fusion Energy Sciences Advisory Committee (FESAC) expressed dismay with the Department's FY2004 fusion budget submission to Congress and especially with the distribution of funds within subelements of the fusion program. In a letter dated March 5, FESAC chairman Richard Hazeltine (University of Texas) said that "devastating cuts to certain program elements are alarming; this note expresses our most serious concerns." The full text of the letter follows:

March 5, 2003

Dr. Ray Orbach
Director, Office of Science
U.S. Department of Energy
1000 Independence Avenue, S.W.
Washington, D.C. 20585

Dear Dr. Orbach:

The fusion energy sciences budget for FY2004, as described in the President's request, stunned FESAC members. Both its total amount and its devastating cuts to certain program elements are alarming; this note expresses our most serious concerns.

The fusion program is about to address major new challenges. Community consensus strongly supports the President's decision to join the ITER project; we are eager to embark on scientific research urgently focused on burning plasma physics and the energy goal. The aspect of the FY2004 budget that

seems most baffling is its apparent disregard for these momentous changes.

1. We applaud the recent decision by the Administration to enter negotiations regarding US participation in the ITER project. As you know, FESAC has recommended participation in ITER, in concert with a strong domestic program. However, design and construction of ITER will be extremely demanding with regard to fusion technology. Thus FESAC is puzzled by the elimination in FY2004 budget of funding for fusion technology. This loss will seriously compromise US participation in ITER as well as other burning plasma research activities.

2. The study of future energy systems is a central component of fusion research. Its evolving conceptualization of an eventual fusion power plant has helped us visualize our target, while allowing us to identify key scientific challenges. As the energy goal becomes closer and more central to fusion research, such systems studies provide even more important insights. Yet the FY2004 budget significantly reduces funding for this type of research.

3. FESAC recommendations regarding the burning plasma initiative have emphasized the importance of maintaining scientific and technological breadth in the program. The Secretary of Energy renewed this emphasis in his recent announcement concerning US participation in ITER. Yet funding for FIRE, a domestic burning plasma experiment that could provide an alternative to ITER, has been eliminated. Similarly inertial fusion energy (IFE) is an important element of a balanced US fusion program: it provides the principal alternative to magnetic fusion and takes advantages of NNSA investments in the National Ignition Facility. The FY2004 budget, however, eliminates chamber technology for both MFE (magnetic fusion energy) and IFE.

4. Effective US participation in ITER will require several activities in the US program, including estimation of the US costs for a range of possible component contributions; conduct of negotiations; planning for the management of US activity; and preparatory research for long lead-time procurements. The present budget does not allow for these activities.

In summary, FESAC finds the Presidential request for fusion research funding in FY2004 to be not only meager but also harmfully distorted. It terminates components of the program that are truly essential. Fusion research has accepted new challenges and identified new priorities, consistent with the President's stated agenda; fusion scientists want to get on with the job. What is needed is a funding allocation that respects the magnitude and nature of the task at hand.

Yours truly,
Richard Hazeltine
Chair, Fusion Energy Sciences Advisory Committee

Academies Panel Seeks Input

The National Research Council of the National Academies Burning Plasma Assessment Committee (BPAC) seeks fusion community comment.

The committee is now actively engaged in the drafting of its final report due out later this year. At this important stage in its work the committee invites the plasma science and fusion science communities to submit statements and comments relevant to its charge. Comments can be emailed to burningplasma@nas.edu.

They are charged with the following task:

The committee will carry out an assessment of a program of burning plasma experiments and its role in magnetic fusion research. The study will have three components.

* An assessment of the importance of a burning-plasma experimental program to (a) fusion energy sciences and technology and the development of fusion as an energy source, (b) plasma physics, and (c) science in general.

* An assessment of scientific and technical readiness to undertake a burning plasma experimental program.

* An independent review and assessment of the plan for the U.S. magnetic fusion burning plasma experimental program as developed by the Department of Energy through the FESAC and Snowmass processes. The committee will make recommendations on the program strategy aimed at maximizing the yield of scientific and technical understanding

as the foundation for the future development of fusion as an energy source.

Criteria for judging experiments will include the prospects for (a) achieving technical objectives, (b) extracting scientific and technological understanding and making progress of broad and generic applicability, and (c) contributing to the next steps in the experimental program.

An interim report addressed the importance of the science and the readiness to undertake a burning plasma experiment. It provided interim advice to the Department of Energy regarding reentering negotiations to be a participant in a multinational burning plasma experiment (ITER). A copy of this interim letter report is available at http://books.nap.edu/html/BPAC/letter_report.pdf and at <http://fire.pppl.gov>

The Committee is not asked to evaluate fusion as an energy option. The committee will discuss and analyze the budget implications of its recommendations on program strategy but will not make budget recommendations per se.

Please note that all community input received shall be posted on the BPAC web site and made available through the NRC's public access file for this committee as required by the Federal Advisory Committee Act.

For further information on this committee check out the "Committees" page on the BPA web site www.national-academies.org/bpa.

DOE Seeks Innovative Fusion Proposals

The U.S. Department of Energy has issued a solicitation for Research in Innovative Approaches to Fusion Energy Sciences. A copy of Program Notice 03-19 "Research in Innovative Approaches to Fusion Energy Sciences" was published March 4, 2003 in the Federal Register. Applications were due by May 1, 2003.

The notice has been posted on the DOE Grants and Contracts website:

(<http://www.science.doe.gov/grants/Fr03-19.html>). The notice has also been posted in the DOE Industry Interactive Procurement System (IIPS) at <http://e-center.doe.gov/>

Copies of the notice may also be requested from:

Francis Thio (francis.thio@science.doe.gov)
Program Manager, ICC
U.S. Department of Energy
Office of Fusion Energy Sciences, SC-55
19901 Germantown Road
Germantown, MD 20874
(301) 903-4678
Fax: (301) 903-1225

The notice states that proposals exploring new and innovative approaches for creating compact plasma with high beta and high temperatures in pulsed or steady state, and for active control of magnetized plasmas "are particularly welcome." The notice says, "Applications for research on existing large facilities, or initiatives in Inertial Fusion Energy, should not be submitted in response to this Notice." The notice says that about \$6 million of Fiscal Year 2004 funding will be available to fund new work or renewals of existing work. It says applications for scientific assessment of new concepts will be limited to a maximum of \$150,000 per year and applications requiring funding as low as \$50,000 "are welcome and encouraged."

Innovative Fusion Concepts Workshop

The Innovative Confinement Concepts 2003 Workshop (ICC2003) will be held on May 28 - May 30 (noon) at the Crowne Plaza Hotel in Seattle. The University of Washington will host the workshop.

The workshop will provide a forum to hear about and discuss progress on innovative concepts in fusion energy and to explore new ideas and proposals. As last year, a "Skunkworks" will be included, providing an opportunity for exploring novel ideas for fusion energy -- physics and/or technology. Members of the world-wide fusion community are invited to participate in the workshop.

The workshop will include oral presentations on active research areas. In addition, all participants are invited to submit abstracts for poster presentations at the workshop. Programmatic issues will also be addressed. Considerable time has been set aside for discussion.

Registration and hotel information are found on the web site <http://www.engr.washington.edu/epp/icc/>.

The registration fee is \$260 if paid before May 1, and \$310 after that. There will be a banquet Thursday night at a cost of \$30. A special hotel rate of \$99 (plus taxes) is available through May 13.

Program information and detailed provisions for submittal of abstracts can be found at <https://wormhole.ucllnl.org/ICC2003/>. The deadline for submittal is May 11. Abstracts must be less than one page in length and should be submitted in pdf format if at all possible.

Questions should be sent to Bick Hooper (hooper1@llnl.gov)

U. S. Fusion Budget History Posted

The history of U.S fusion budgets, both Office of Fusion Energy Sciences and Office of Inertial Confinement Fusion, from inception to present is posted at <http://aries.ucsd.edu/FPA/OFESbudget.shtml>

It can also be accessed from Fusion Power Associates home page: <http://fusionpower.org> -- then click on Fusion Program Notes and then on "budget history" at the top of the page.

Journal of Fusion Energy Seeks Associate Editors and Papers

The Journal of Fusion Energy (Kluwer Academic/Plenum Publishers) seeks additional Associate Editors. Associate Editors will be expected to solicit papers from among their peers for publication in the journal, with the aim of obtaining at least one and hopefully several papers per year, to obtain appropriate reviews and to recommend publication. The journal publishes both technical papers, program review committee reports and policy essays.

Information on the journal can be found on the site: <http://www.wkap.nl/journalhome.htm/0164-0313>

Persons interested should contact:

Dr. Stephen O. Dean, editor
Journal of Fusion Energy
fpa@compuserve.com

Calendar

May 11-15 International Conference on Physics of Low Temperature Plasma. Kiev, Ukraine. <http://www.necin.gov.ua>

May 13-15 4th General Scientific Assembly of Asia Plasma & Fusion Association on New Development of Plasma Physics and Fusion Technology. Hangzhou, China. <http://www.ipp.ac.cn/APFA2003/APFA.htm>

May 19-21 Fifteenth Topical Conference on Radio Frequency Power in Plasmas. Jackson Lake, Wyoming. <http://uw.physics.wisc.edu/~forest/RF2003>

May 19-21 16th IAEA Topical Meeting on Research Using Small Fusion Devices. Vienna, Austria. Contact: j.Pucadyil@iaea.org

May 28-30 Fourth IEEE International Vacuum electronics Conference. Seoul, Korea. <http://ivec2003.snu.ac.kr>

June 1-6 Seventh International Conference on Electron Beam Technologies. Varna, Bulgaria. Contact: vutove@ie.bas.bg

June 2-5 30th IEEE International Conference on Plasma Science. Jeju, Korea. <http://www.ieee.org/icops2003>

June 6-15 IEEE International Microwave Symposium. Philadelphia, PA. Contact: r.snyder@ieee.org

June 15-19 IEEE Pulsed Power Conference. Dallas, Texas. <http://www.p3e.ttu.edu/ppc2003.htm>

June 23-26 34th AIAA Plasmadynamics and Lasers Conference. Orlando, Florida. <http://www.aiaa.org/calendar/index.hfm?cal=0>

July 7-11 30th European Physical Society Conference on Controlled Fusion and Plasma Physics. St. Petersburg, Russia. <http://www.ioffe.ru/EPS2003>

July 7-11 Joint Sixth ICFA Advanced & Novel Accelerators and Twenty-ninth ICFA Advanced Beam Dynamics Workshop on Laser-beam Interactions. Oxford, England. <http://www.clf.rl.ac.uk/news/meetings/3rdIWlaserBeamInteractions/3rdlaserInteractions.htm>

July 8-12 Fifth International Workshop on Microwave Discharges: Fundamentals and Applications. Greifswald, Germany. <http://www.inp-greifswald.de/md-s>

July 14-16 2nd IAEA Technical Meeting on ECRH Physics and Technology for ITER. Kloser Seeon, Germany. <http://www.ipp.mpg.de/eng/for/veranstaltungen/tms/eeon/>

July 15-20 Twenty-sixth International Conference on Phenomena in Ionized Gases. Greifswald, Germany. <http://www.icpig.uni-greifswald.de/>

July 21-23 4th IAEA Technical Meeting on Control, Data Acquisition and Remote Participation for Fusion Research. San Diego, CA <http://fusion.gat.com/conferences/iaia-tm-computing/>

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