FUSION POWER ASSOCIATES
EXECUTIVE NEWSLETTER

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http://fusionpower.org

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ROSENBLUTH HONORED BY EUROPEAN SOCIETY

ROSENBLUTH HONORED

U.S. fusion pioneer Marshall N. Rosenbluth has been awarded the 2002 Hannes Alfven Prize of the Plasma Physics Division of the European Physical Society (EPS) "... for his seminal theoretical contributions since the earliest days of fusion research in virtually all aspects of fusion plasma sciences, which now form the basis of modern plasma physics." The award citation also reads, "The work of Marshall N. Rosenbluth has enriched the understanding and has accelerated progress toward the realisation of fusion energy." The prize ceremony will be held in conjunction with the 29th EPS conference in Montreux, Switzerland, June 17th, 2002.

NIF MAKING GOOD PROGRESS

One year after a major "rebaselining," the National Ignition Facility (NIF) at the Lawrence Livermore National Laboratory (LLNL) is on track to begin commissioning ("First Light") in Fiscal Year 2004. The 192-beam, $2.2 billion laser will be brought up to full capability in stages, with full operation scheduled by September 2008. However, beneficial "user experiments" will begin in FY2005. The eventual aim of the facility is to "ignite" a small pellet of fusion fuel, releasing ten or more times more energy than the laser delivers to the pellet to ignite it. The facility will be used for basic science and weapons research and is considered to be an essential feasibility test for eventual commercial power plants based on inertial confinement fusion.

On September 28, the conventional facilities (500,000 square feet) part of the project was completed on time and on budget ($196 million). Even before the building was complete, NIF project managers were installing laser-related equipment. These included the target chamber, space frame, utility spine, spatial filter vessels and more. On September 26, for example, an integrated test was conducted, ahead of schedule, of the first amplifier slab "line-replaceable unit" (LRU). Inserting the LRU into the beamline forced the team to deal with a lot of issues: cleanliness, safety, off-normal conditions (e.g., "What do you do if the LRU gets stuck). Gina Bonano, associate project manager for NIF Assembly, Installation and Refurbishment, who recommended the test ahead of schedule, said the test "gives us confidence that if we plan, coordinate, and work together well, we can do more in that facility than we originally planned."

More than three-quarters of the NIF laser glass have been produced, in accordance all NIF specification.

LLNL Associate Director George Miller, who oversees the project, also noted "We have also installed the 1053 nm front end of NIF into the facility, completed the beam path for cluster 3 (1/4 of the facility) and done 10,000 shots without a failure on the pulsed power system (15 years of system lifetime). The facility is really coming together and we are pointing to first light to the target chamber in about 18 months and real experimental data."

For further information, see the NIF web site: http://www.llnl.gov/nif/

FESAC ENDORSES BURNING PLASMAS

The U.S. DOE's Fusion Energy Sciences Advisory Committee (FESAC) has transmitted the report of its Burning Plasma Physics panel to Acting Director of the DOE Office of Science, James Decker, saying "FESAC fully endorses the recommendations of the Burning Plasma Panel. In particular, we agree with the Panel recommendation that a burning plasma experiment would bring enormous scientific and technical rewards. We also agree that present scientific understanding and technical expertise allow confidence that such an experiment, however challenging, would succeed." Prof. Richard D. Hazeltine (University of Texas at Austin) chairs the FESAC. The Burning Plasma Panel was chaired by Prof. Jeffrey P. Freidberg (MIT).

The Panel found that "a burning plasma experiment is the crucial next step in establishing the credibility of magnetic fusion as a source of commercial electricity," and that "the next frontier in the quest for magnetic fusion energy is the development of a basic understanding of plasma behaviour in the regime of strong self-heating, the burning plasma regime." The Panel claimed that "a burning plasma experiment in a tokamak configuration is relevant to other toroidal magnetic configurations," and that "much of the scientific understanding gained will be transferable."

The Panel stated that "a burning plasma experiment, either international or solely within the U.S., will require substantial funding — likely more than $100 million per year," and recommended that these funds "should arise as an addition to the base Fusion Energy Sciences budget." The Panel recommended that the U.S. "should establish a proactive U.S. plan on burning plasma experiments and should not assume a default position of waiting to see what the international community may or may not do regarding construction of a burning plasma experiment."

Although the Panel stated that "sufficient scientific information is now in hand to determine the most suitable burning plasma experiment for the U.S. program," and that "NOW is the time for the U.S. Fusion Energy Sciences Program to take the steps leading to the expeditious construction of a burning plasma experiment," the Panel recommended that the U.S fusion community hold a "Snowmass" workshop in the summer of 2002, "for critical scientific and technological examination of proposed burning plasma experimental designs," followed by a FESAC review and recommendation on the "selected option" by January 2003, followed by a National Research Council panel review to be completed by Fall 2003, followed by a DOE recommendation to Congress in July 2004.

Officials of the fusion programs in Europe and Japan expressed surprise and dismay at the slow U.S. decision-making schedule proposed. Europe, Japan and Russia are proposing to proceed with an international burning plasma experiment by the end of 2002 and have been pressing U.S. officials to rejoin the international effort. Recently (FPN01-82) the chair and ranking minority member of the House of Representatives Committee on Science urged the Energy Secretary to start sending U.S. representatives to the international meetings planning that experiment.

The complete FESAC report and accompanying documents have been posted at http://fire.pppl.gov

BUSH NAMES DOE SCIENCE CHIEF

President George W. Bush announced his intention to nominate Raymond L. Orbach to be Director of the Office of Science at the Department of Energy (DOE). Orbach is currently the Chancellor of the University of California at Riverside and a Professor of Physics. He served as Provost of the College of Letters and Science at the University from 1982 to 1992.

Orbach has held numerous visiting professorships at universities around the world, including the Imperial College of Science and Technology in London, the Ecole Superieure de Physique et Chimie Industrielle de la Ville de Paris, France and Tel Aviv University. He received an undergraduate degree from California Institute of Technology and a Ph.D. from the University of California at Berkeley.

He is a member of the Division of Condensed Matter Physics of the American Physical Society.

The White House press release can be viewed at: http://www.whitehouse.gov/news/releases/2001/12/20011211-8.html

HOUSE LEADERS URGE US ITER ACTION SOON

On November 1, House Science Committee chairman Sherwood Boehlert and ranking minority member Ralph Hall wrote to Energy Secretary Spencer Abraham "to urge you to begin sending a representative to the international discussions regarding the International Thermonuclear Energy Reactor (ITER), which, as you know, is a major fusion research initiative." The Congressmen state, "Obviously, time is of the essence with the ITER initiative, and the U.S. should begin to assess the project's feasibility, evaluate what role the U.S. might play in it, and participate in discussions to refine the project and select a site." They say, "If we do not begin to examine ITER soon, we may lose the chance to join as a partner."

FPA APPOINTS ADDITIONAL DIRECTORS

The Fusion Power Associates (FPA) by-laws provides that the Board of Directors may appoint up to five additional Board Members from outside the membership.

The Board has voted to appoint the following individuals to serve 3-year terms on the FPA Board of Directors, commencing January 1, 2002:

Robert Aymar, ITER Director
Harold K. Forsen, Bechtel (retired)
Stephen P. Obenschain, US Naval Research Laboratory
Per F. Peterson, University of California at Berkeley
John Sheffield, Joint Institute for Energy and Environment

A list of the other Board members was given in the November/December newsletter:

FRONTIERS IN FUSION RESEARCH

Fusion Power Associates held its annual meeting September 25–26, 2001 at the Canadian Embassy auditorium in Washington, D.C. The theme of the associated symposium was "Frontiers in Fusion Research." Summaries of many of the talks presented at the symposium can be viewed by going to the Fusion Power Associates web page (fusionpower.org) and clicking on Fusion Program Notes (FPN02-01).

EDITOR'S NOTE

The Executive Newsletter is being shortened from four pages to two pages in recognition that more timely information is being provided by our Fusion Program Notes. These notes can be accessed from our web page (http://fusionpower.org) and then clicking on Fusion Program Notes.

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MAR/APR 2002
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U.S. FUSION PIONEER HAROLD P. FURTH PASSES AWAY AT 72
U.S. TO CONSTRUCT NEW "COMPACT" STELLARATOR

FURTH PASSING

U.S. fusion pioneer Harold P. Furth has died at age 72. Furth was an early fusion researcher at the Lawrence Livermore Laboratory and later became director of the Princeton Plasma Physics Laboratory (1981-1990). He was active in research there until his death.

Furth was the originator, in the mid-1970s, of the Tokamak Fusion Test Reactor (TFTR) project, the most advanced and highest performance fusion device ever constructed in the United States. He published over 200 scientific papers and holds some 20 patents. He made countless contributions to the science of fusion plasmas and the fundamentals of plasma physics. He provided technical and managerial leadership to the world fusion program almost from its inception and throughout his career. He received numerous awards, including Fusion Power Associates Leadership Award in 1982 and its Distinguished Career Award in 1995. He was a Fellow of the American Physical Society, the American Association for the Advancement of Science, and a member of the American Academy of Arts and Sciences. He served on the Board on Physics and Astronomy of the National Research Council's Commission on Physical Sciences, Mathematics and Resources. He received the E.O. Lawrence Memorial Award from the U.S. Atomic Energy Commission in 1974, the James Clerk Maxwell Prize in Plasma Physics from the American Physical Society in 1983, and the Delmer S. Fahrney Medal from the Committee on Science and The Arts of The Franklin Institute in 1992.

In 1999, Furth said, "It is very good to imagine things, but actually to do things and get results that make scientific sense is a solemn and inspiring path." He was greatly admired and will be sorely missed.

CONGRESS GETS FUSION BUDGET REQUEST

U.S. President George W. Bush has sent his Fiscal Year 2003 budget request to Congress. The President asked for $257.3 million for the DOE Office of Fusion Energy Sciences, compared to $247.5 M appropriated in FY 2002 and $242.0 appropriated in FY 2001. The President also asked for $451.8 M for inertial confinement fusion in DOE's weapons budget as part of the nuclear weapons stockpile stewardship program. This compares to $505.4 M in FY 2002 and $428.5 M in FY 2001. The largest fraction of the latter program is for construction of the laser-based National Ignition Facility (NIF), which would be fully funded at $214 M in FY 2003, compared to $245 M in FY 2002 and $197.3 M in FY 2001. As in the past, the DOE did not request continuation of funding for the congressionally-mandated high average power laser (HAPL) program, which received $24 M in FY 2002 and $24.8 M in FY 2001. The DOE also did not request funds to continue the congressionally-mandated effort on fast ignition, which was funded at $5.5 M in FY 2002.

In addition to the $9.8 M increase to the OFES fusion budget, that effort will have available to it an additional $19.6 M for new work due to the completion of decommisioning of the Tokamak Fusion Test Reactor (TFTR) facility at Princeton Plasma Physics Laboratory (PPPL). The OFES will use that $29.4 M of additional funding to increase operating time on its three major experimental facilities (DIII-D at General Atomics, Alcator C-Mod at MIT, and NSTX at Princeton) to near maximum capacity. These facilities have been underutilized for years due to budget shortfalls. The OFES will also allocated $11 M to begin fabrication of a new National Compact Stellarator Experiment (NCSX) at Princeton. No mention of a possible return of the United States to the International Thermonuclear Experimental Reactor (ITER) project is made in the budget request. This possibility is currently under consideration by the Secretary of Energy but presumably would require additional funds. OFES funding for inertial fusion energy and non-toroidal alternate concepts would be kept level or slightly reduced in the request.

The budget submission indicates that, within the weapons inertial confinement fusion program, "reductions have been made in program funded activities in NIF diagnostics, cryogenics and other areas that will delay the NIF experimental program, including some ignition related work." These preparations for operations programs would be funded at $34.4 M in FY 2003, compared to $41.5 M in FY 2002.

U.S. TO BUILD NEW STELLARATOR

A key element in President Bush's Fiscal Year 2003 Budget submission to Congress is the announcement that the U.S. plans to build a new, modest-sized, fusion experiment at the Princeton Plasma Physics Laboratory. The $70 million device, known as the National Compact Stellarator Experiment (NCSX), will complement an international effort to develop the Stellarator concept for fusion power plant and other applications. The Stellarator was invented at Princeton in the early 1950s by Princeton University Professor Lyman Spitzer. Spitzer has stated that the idea came to him while riding a chair lift in Aspen, Colorado.

Stellarators are complex, twisted magnetic field configurations that for many years did not seem to confine plasma very well. They were surpassed beginning in the late 60s by the simpler tokamak configuration invented in Russia. The idea has been kept alive, mostly in Europe and more recently in Japan where two billion-dollar class stellarators are underway. The new Princeton device has been dubbed an "innovative concept" because the "compact" configuration proposed has both tokamak and stellarator features. The proponents hope to blend the good plasma confinement and smaller size aspects of the tokamak with the disruption free, steady-state features of the stellarator. Princeton's Hutch Neilson notes that the stellarator may eventually turn out to be "simpler than the tokamak" by eliminating the conducting structures close to the plasma, the active feedback control systems and the profile control systems that are needed to make the tokamak steady state. The NCSX is planned to begin operation in mid 2007.

The international stellarator effort contributes to the continued development of the scientific underpinnings of fusion research by advancing the theory and experimental database for toroidal magnetic configurations in general. Design and eventual data interpretation in this intrinsically three-dimensional magnetic geometry requires the latest capability in advanced scientific computing.

For further information, contact: Hutch Neilson (hneilson@pppl.gov) or visit the Princeton web site (http://www.pppl.gov).

ENERGY SECRETARY RESPONDS ON ITER

In a January 3, 2002, letter from U.S. Energy Secretary Spencer Abraham to House Science Committee chair Sherwood Boehlert, the Secretary states, "I have agreed to explore the current ITER option before us to determine if it is appropriate for the Department -- and for the Nation -- in the light of the President's National Energy Policy. We will proceed carefully and deliberately since a U.S. commitment to ITER could imply commitment beyond this Administration. I anticipate completing our initial review in the next few months." The Secretary's letter was in response to a November 1, 2001, letter to him from Boehlert and ranking minority member Ralph Hall urging him to send representatives to ITER planning meetings (Jan/Feb Newsletter).

Abraham notes in his letter, "Representatives of other governments have asked that the Department review its current policy towards ITER." He said, "We have been following closely the progress by the ITER Parties in developing a more attractive, lower cost design for the proposed facility, and most recently, the movements toward concrete site proposals and detailed preparations to begin construction."

In a related development, the prestigious British science journal, Nature, in its January 17 issue, editorialized, "any real exploration of long-term, sustainable energy must include a thorough technical evaluation of nuclear fusion." They said, "Bush would do well to buy back into ITER, and to help to rebuild it as a model of scientific collaboration." They said, "If the United States does rejoin the project, it will send important political signals to the nation's allies, who are concerned about the unilateralist leanings of the George W. Bush administration."

In the same issue of Nature, science writer Geoff Brumfiel quotes new Bush science advisor John Marburger as saying, "I definitely think that our participation (in ITER) should be reconsidered." The article also quotes U.S. Fusion Energy Sciences Advisory Committee chair Richard Hazeltine as saying, "I think the (U.S.) community is very excited about the possibility of rejoining ITER," but also quotes DOE fusion head Anne Davies as saying, "We're just at the beginning stages of considering what our position should be." Brumfiel says that Davies said that Congress and the administration must pledge their full support before U.S. fusion researchers could resume participation.

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U.S.HOUSE SCIENCE COMMITTEE PRESSES ADMINISTRATION ON FUSION FUNDING AND ITER POLICY

Sandia's Z-Beamlet Recognized

The Z-Beamlet facility at Sandia National Laboratory has won a "special mention" for engineering in R&D Magazine's 36th annual competition for the renovated laboratory of the year. The award was announced on March 20 in New Orleans and will be described in the May 2002 issue of the magazine. The panel of judges included architects, researchers, equipment suppliers, lab design consultants and editors of the magazine.

Z-Beamlet was created by taking NIF prototype beam from Lawrence Livermore National Laboratory and using it as a backlighter diagnostic for the Z-pinch fusion experiments at Sandia. The facility is also being prepared for use in fast ignition tests of compressed fusion targets.

Science Committee Comments

The U.S. House of Representatives Committee on Science has issued a statement, "Views and Estimates," concerned with the President's Fiscal Year 2003 budget submission. Included in the document is the following comment on fusion.

"The Administration's request for the Fusion Energy Sciences Program is $257.3 million, far short of the $335 million approved by the House in H.R. 4 [energy legislation]. Fusion's potential to wean the Nation from fossil fuels is tremendous, but much research remains to be done before that potential can be realized. The Committee notes with approval that the Administration is reassessing the potential U.S. role in the International Thermonuclear Experimental Reactor (ITER), which may significantly advance the science by achieving sustained-burning plasma. The Committee believes that U.S. participation in such important international research endeavors deserves serious consideration."

The entire document, and other additional views, including those of the committee's Democrats, can be accessed at: http://www.house.gov/science/welcome.htm

U.S. May "Accelerate" Fusion Research

Speaking at a Conference of G8 Energy Ministers, May 2 in Detroit, US Secretary of Energy Spencer Abraham said, in part, "Advanced technology, and the contributions of science, play a critical role in our future energy plans. Along with promising innovations such as hydrogen fuel cells, the President is anxious to accelerate fusion power as a realistic source of energy.

"We are now engaged in serious consultation here in the United States and around the world on how best to pursue a fusion program. President Bush is particularly interested in the potential of the international effort known as ITER and has asked us to seriously consider American participation. This major international effort will answer a critical scientific question: Can a fusion reaction — the kind of reaction that powers the sun — be harnessed here on earth for the benefit of all mankind?"

The whole text of the Secretary's remarks is at: http://www.energy.gov/HQDocs/speeches/2002/mayss/PublicEnergyForumLunch.html

Average Power Laser Progress

A High Average Power Laser (HAPL) Workshop was held at General Atomics, April 4-5, 2002. This was the 4th in a series of workshops. The three previous workshops, all held during 2001, were at the US Naval Research Laboratory (February 6-7 and May 31 - June 1,

2001) and in Pleasanton, CA (November 13-14, 2001). The workshops bring together all elements of a coordinated effort required to develop a fusion energy power plant based on high average power lasers. The program is currently running at a congressionally mandated level of about $25M per year in spite of DOE continuing to leave it out of its budget requests.

After an overview by John Sethian (NRL), sessions were held on lasers (Mercury at LLNL and Electra at NRL), high gain target design (talks from NRL and LLNL), target fabrication and injection (talks from Schafer Corp., GA, and LANL), final optics (talks from UCSD and LLNL), and chambers (talks from U. Wisconsin, LLNL, UCSD, UCSB, INEEL and SNL), and materials (talks from SNL, UCSD, U. Wisconsin, ORNL and UCLA).

In his overview, Sethian stated that the HAPL program is a "coordinated, focussed, multi-lab effort to develop the science and technology for laser fusion energy, based on lasers, direct drive targets and solid wall chambers." He said the program, was one in which a "systems approach" was being used so that "key components would be developed together." He said, "significant progress has recently been made in all key areas." He said the plan was to have the "proof of principle" R&D completed by 2006, assuming the current $25M per year level. Following that, he anticipated the construction of an "integrated research experiment", featuring a reactor scale laser beam line, during 2006-2012. There would follow a power plant laser-fusion test facility, to be operational approximately in 2020. The plan would require budget increases to approximately the $150M per year level during the 2006-2012 period.

Power Plant Workshop

A US/Japan Workshop on Power Plant Studies with EU Participation was held April 6-7, 2002 in San Diego. Approximately 25 people participated. Copies of the presentations are posted at http://aries.ucsd.edu/LIB/MEETINGS/0204-USJ-PPS/

Overview talks were presented on "Overview of LHD Experiments and Helical Reactor Design," by Akiko Sagara; on "Progress of the EU Power Plant Study," by David Massonier; and "Overview of US Power Plant Studies," by Farrokh Najmabadi. A talk was also presented, and a paper distributed, on "Design Windows and Roadmaps for Laser Fusion Reactors," by Yashuji Kozaki. Other noteworthy talks were given on "System Studies for EU Power Plant Studies," by Ian Cook and on "Future Trend of Compact Tokamak Power Reactor," by Satoshi Nishio. There was a special session on Socio-economics, with talks by Steve Dean, Satoshi Konishi, Ron Miller and G. C. Tosato. Other sessions dealt with detailed design issues.

People News

Robert W. Conn will step down as Dean of the School of Engineering at the University of California at San Diego July 1. He has been Dean since 1994.

Mike Holland will step down as budget examiner at the Office of Management and Budget (OMB), Executive Office of the President April 29. Mike was the fusion budget examiner. He will be moving to the Office of Science and Technology Policy, Executive Office of the President.

Franco Porcelli has become the new editor of Physics Letters A, for the section concerning Plasma and Fluid Physics. He succeeds Miklos Porkolab.

He can be contacted at phys.lett.a@polito.it

Kurt Schoenberg has been named Deputy Division Leader of the LANSCE Division at Los Alamos. LANSCE is the Los Alamos Neutron Science Center.

Joel Schultz, MIT Plasma Science and Fusion Center, is the recipient of the IEEE 2002 Fusion Techology Award.

Lance Snead (ORNL) and Neal Morley (UCLA) are the recipients of the Miya-Abdou award recognizing outstanding contributions to fusion nuclear technology by persons relatively early in their careers.

Alexei G. Sitenko, an outstanding plasma and nuclear physicist, passed away February 11 at the age of 75. He was a member of the Ukrainian Academy of Sciences.

James Van Dam has been named Interim Director for the Institute of Fusion Studies, University of Texas at Austin. He succeeds Richard Hazeltine, who has returned to full time teaching and research. Francois Waelbroeck has been named Assistant Director.

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2002 AWARDS TO FREIDBERG, HAZELTINE, SETHIAN, CALLEN, GRIEGER, NAKAI, KODAMA, RIVENBERG AND THOMAS

FPA AWARDS

Fusion Power Associates Board of Directors announces the recipients of its 2002 Awards in the categories of Leadership, Distinguished Career and Excellence in Fusion Engineering. Current and previous recipients are also posted on the FPA web site.

FPA **Leadership Awards** have been presented annually since 1980 to individuals who have shown outstanding leadership qualities in accelerating the development of fusion. Three individuals have been selected to receive this award in 2002:

Prof. Jeffrey P. Freidberg, Head of the Department of Nuclear Engineering at MIT, is selected in recognition of "the many scientific contributions you have made to fusion research and to the education of students, as well as the leadership you have provided to a series of studies and panels of the US Department of Energy's Fusion Energy Sciences Advisory Committee."

Prof. Richard D. Hazeltine, University of Texas at Austin, is selected in recognition of "the many scientific contributions you have made to fusion research, as well as the leadership you have provided to the Institute of Fusion Studies as its Director, to the USDOE Fusion Energy Sciences Advisory Committee as its Chairman, and to the national fusion effort over many years."

Dr. John D. Sethian, US Naval Research Laboratory, is selected in recognition of "your leadership of the Electra laser program and especially your leadership in organizing and coordinating a systems approach to the national High Average Power Laser Program."

FPA **Distinguished Career Awards** have been presented annually since 1987 to individuals who have made distinguished, lifelong, career contributions to fusion development. Three individuals have been selected to receive this award in 2002.

Prof. James D. Callen, University of Wisconsin at Madison, is selected in recognition of "the countless scientific contributions you have made to fusion research, as well as the leadership you have provided to the national fusion theory effort, over many decades."

Dr. Guenter Grieger, Federal Republic of Germany, is selected in recognition of "your many career contributions to both the scientific and managerial aspects of fusion research. In addition to being the heart and soul of stellarator research over many decades, you also took time to provide leadership to the European Union's overall fusion research program."

Prof. Sadao Nakai, Japan, is selected in recognition of "your many career contributions to both the scientific and managerial aspects of inertial fusion research, especially as director of the Institute of Laser Engineering at Osaka University."

FPA **Excellence in Fusion Engineering Awards** were established in 1987 in memory of MIT Professor of Nuclear Engineering David J. Rose and are presented to individuals in the early part of their careers who have shown both technical accomplishment and potential to become exceptionally influential leaders in the fusion field.

The 2002 recipient of this award is **Prof. Ryosuke Kodama** of the Institute of Laser Engineering, Osaka University. Prof. Kodama is selected in recognition of "your technical leadership for a series of important experiments associated with the potential of fast ignition of inertial fusion targets and your overall potential to be an exceptionally influential leader in the fusion field."

The FPA Board of Directors also announced that **Special Awards** for Education and Outreach were presented to **Paul Rivenberg** and **Paul Thomas** of MIT on June 27. The awards recognize outstanding contributions to educating students and the general public on fusion and plasma science research.

FUSION SUMMER STUDY

Over 280 fusion researchers, including over 30 non-US participants, concluded a two-week Fusion Summer Study in Snowmass, Colorado, on July 19. The gathering provided "a forum for the critical assessment of major next-steps in the (US) fusion energy sciences program," with the aim of providing "crucial community input to the long-range planning activities" undertaken by the US Department of Energy and its Fusion Energy Sciences Advisory Committee (FESAC). A primary focus of the meeting was to review three

proposed magnetic fusion burning plasma experiments (Ignitor, FIRE and ITER) and to review progress and plans in the area of inertial fusion energy. The meeting produced six major conclusions in each area, as follows:

For magnetic fusion energy (MFE), the forum concluded:

1. The study of burning plasmas, in which self-heating from fusion reactions dominates plasma behavior, is at the frontier of magnetic fusion energy science. The next major step in magnetic fusion research should be a burning plasma program, which is essential to the science focus and energy goal of fusion research.

2. The three experiments proposed to achieve burning plasma operation range from compact, high field, copper-magnet devices to a power-plant-scale superconducting-magnet device. These approaches address a spectrum of both physics and fusion technology, and vary widely in overall mission, schedule and cost.

3. Ignitor, FIRE and ITER would enable studies of the physics of burning plasma, advance fusion technology, and contribute to the development of fusion energy. The contributions of the three approaches would differ considerably.

(i) Ignitor offers an opportunity for the early study of non-stationary burning plasmas aiming at ignition.

(ii) FIRE offers an opportunity for the study of burning plasma physics in conventional and advanced tokamak configurations under quasi-stationary conditions and would contribute to plasma technology.

(iii) ITER offers an opportunity for the study of burning plasma physics in conventional and advanced tokamak configurations for long durations with steady state as the ultimate goal, and would contribute to the development and integration of plasma and fusion technology.

4. There are no outstanding engineering-feasibility issues to prevent the successful design and fabrication of any of the three options. However, the three approaches are at different levels of design and R&D.

There is confidence that ITER and FIRE will achieve burning plasma performance in H-mode based on an extensive experimental database. Ignitor would achieve similar performance if it either obtains H-mode confinement or an enhancement over the standard tokamak L-mode. However, the likelihood of achieving these enhancements remains an unresolved issue between the assessors and the Ignitor team.

5. The development path to realize fusion power as a practical energy source includes four major scientific elements:

(i) Fundamental understanding of the underlying science and technology, and optimization of magnetic configurations.
(ii) Plasma physics research in a burning plasma experiment.
(iii) High performance, steady-state operation
(iv) Development of low-activation materials and fusion technologies.

6. A strong base science and technology program is needed to advance essential fusion science and technology and to participate effectively in, and to benefit from, the burning plasma effort. In particular, the development path for innovative confinement configurations would benefit from research on a tokamak-based burning plasma experiment.

The magnetic fusion energy conclusions will be reviewed by a panel of the FESAC, chaired by Prof. Stewart Prager of the University of Wisconsin, at a meeting August 6-8 in Austin, Texas, and by the full FESAC at its September 11-12 in Gaithersburg, Maryland.

For inertial fusion energy, the forum concluded:

1. The National Ignition Facility (NIF) is expected to produce a burning inertial fusion plasma. The National Nuclear Security Administration is currently building the National Ignition Facility.

2. Laser systems for inertial fusion energy have made impressive progress in efficiency, pulse rate, and lifetime. KrF lasers require further improvement in lifetime, and solid-state lasers require improvement in the cost of major components.

3. The heavy ion fusion program has made excellent progress in basic beam science. Several new science experiments have recently begun operations. Integrated experiments at moderate beam energy and current, including focusing intense beams in the chamber environment remain the important technical issues.

4. There has been impressive progress in z-pinch targets and good progress in conceptual power plant designs. Producing economical recyclable transmission lines at low cost remains the most important issue.

5. Chamber technology and target fabrication and injection are being placed on a sound scientific basis. For example, experiments on dry-wall damage limits are underway. Scaled hydraulics experiments have identified nozzle designs that can create all liquid jet configurations required for thick liquid chambers, and a target injection experiment is under construction. For heavy-ion fusion there is now a chamber design where the final focus magnets and chamber structures have predicted lifetimes exceeding 30 years.

6. There is broad international interest in fast ignition. If fast ignition is successful, it will produce higher energy gains than conventional targets. So far the target experiments have been encouraging, particularly the recent Japanese results. Fast ignition power production is at a rudimentary level for all drivers. An integrated research plan is required.

Further details are posted at the 2002 Fusion Summer Study web site (http://web.gat.com/snowmass/

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FRANCE, JAPAN SET NEW TOKAMAK RECORDS FESAC ADVISES DOE TO REJOIN ITER

FRANCE, JAPAN SET NEW TOKAMAK RECORDS

Scientists at the Association Euratom-CEA, Caderache, France, have achieved a three and a half minutes long plasma discharge on Tore Supra, sustained by 3MW of current drive power. It establishes a new world record in this domain. A total of 600 Megajoules of energy were injected and successfully exhausted compared to the previous record of 280MJ achieved in Tore Supra 1996. Tore Supra is the World's only operating tokamak using superconducting magnets, thus allowing study of steady-state (continuous) operating conditions relevant to fusion power plants of the future.

The laboratory states, "The capability to run long pulse plasmas on a regular basis opens the way to explore new scientific questions in ITER-relevant conditions, like the aging of the toroidal limiter under thermal cycling, limiter erosion and hydrogen trapping (co-deposition), real time discharge control and performance optimisation (confinement and stability) through a set of feedback control systems."

The laboratory notes, "This record value, very quickly achieved during the experimental campaign, is in no case a limit in performance. The range of accessible parameters has now to be explored in order to establish its actual capability. In principle, energies exceeding a gigajoule should be achieved by the overall assembly corresponding to discharge durations of hundreds of seconds." ITER, the proposed fusion engineering test reactor, is aimed at 1000 second operation, with upgrade potential to continuous operation.

Scientists working on the large JT-60U tokamak at the Japan Atomic Energy Research (JAERI) Institute Naka Fusion Research Establishment have reported recent progress on high power long pulse operation. A new world record for central electron temperature of 26 keV (about 300 million degrees) was maintained for almost 3 seconds using 3 Megawatts of injected electron cyclotron heating power from a set of gyrotrons, in a "reversed shear" enhanced confinement mode. The experiments also resulted in a new world record for a single gyrotron unit of 0.84 MW for a 5 second pulse. This meets the 0.8 MW per unit requirement for the gyrotrons planned for ITER. JT-60U also made progress in negative-ion based neutral beam injection, by injecting 2.6 MW of 360 keV beams for 10 seconds. Previous experiments at JT-60U had shown a falling off of injected power after about 4 seconds.

Dr. Shinichi Ishida, Head of Tokamak Program Division at JAERI said, "This means an important technical accomplishment for continuous injection of a negative-ion based neutral particle beam in the fusion reactors." Such beams are planned for use on ITER. Dr. Ishida also reported success in simplifying the method used for startup and current drive in tokamaks. Recently in JT-60U, startup and current drive was achieved using a combination of radiofrequency power and neutral beam injection, as opposed to the more traditional use of central solenoid (CS) coils. Up to ninety percent of the total plasma current (so-called bootstrap current) was driven this way, creating a plasma with high energy confinement comparable to that previously obtained only with central solenoid coils. Ishida said, "The demonstration of CS-less tokamak operation suggests the substantial simplification and the associated size reduction and increase in fusion power density of tokamak devices leading the economical fusion power plant." These latter results were obtained via a collaboration among JAERI, University of Tokyo, Kyoto University, Kyushu University and Kyushu Tokai University.

FESAC ADVISES U.S. TO REJOIN ITER

The U.S. Department of Energy Fusion Energy Sciences Advisory Committee (FESAC), at its meeting September 11, has accepted a report from its Panel on A Burning Plasma Program Strategy to Advance Fusion Energy, that recommends "we should now seek to join the ITER negotiations with the aim of becoming a partner in the undertaking . . . ." The Panel, chaired by Prof. Stewart Prager, University of Wisconsin, said "The desired role is

that the U.S. participates as a partner in the full range of activities, including full participation in the governance of the project and the program." The Panel opined this "will likely require additional funding of approximately $100M/yr." The panel also defined a "minimum acceptable role" for the U.S. in the ITER project, saying that it would be "a level of effort that would allow the U.S. to propose and implement science experiments, to make contributions to the activities during the construction phase of the device, and to have access to experimental and engineering data equal to that of all partners." They said the U.S. should also conduct a cost analysis of U.S. participation and review the overall cost of the ITER project.

The FESAC, chaired by Prof. Richard Hazeltine, University of Texas, transmitted the report to Dr. Raymond Orbach, DOE Office of Science Director. Orbach attended the meeting and seemed generally pleased with the recommendation. However, he urged the FESAC to address the issue of what would be required for a fusion energy development program aimed at "putting electricity on the grid."

Orbach Wants Fusion Electricity

Speaking to his Fusion Energy Sciences Advisory Committee (FESAC) at its meeting September 11, U.S. Department of Energy Office of Science Director Raymond Orbach called upon them "to develop a plan with the end goal of the start of operation of a demonstration power plant in approximately 35 years." The plan, he said, "should recognize the capabilities of all fusion facilities around the world, and include both magnetic fusion energy (MFE) and inertial fusion energy (IFE), as both MFE and IFE provide major opportunities for moving forward with fusion energy. He asked for a preliminary report by December 1, 2002 and "a more detailed plan" by March 2003 "or earlier."

Orbach told the meeting that it was his belief that the primary justification for fusion power was environmental, i.e., the need for power sources that did not contaminate the atmosphere. He also said he wanted fusion power plants that would be "environmentally benign or as close as possible to it."

Orbach said that the reason he was pressing the FESAC for a response by early December was that he wants "to give the President by mid-December the full scientific picture of how to get from here to there (fusion power)." He said he wanted "some guidelines as to the path." He said he thought "these were historic times for the fusion program" and commended FESAC for its efforts.

Another Academy Fusion Review Begins

The U.S. Department of Energy has asked the National Academies to conduct another review of aspects of the U.S. fusion program -- this time by a "Burning Plasma Assessment Committee." The Academy completed a review in April 2001 of the "quality" of the U. S. fusion energy sciences program.

The Committee is co-chaired by John Ahearne and Raymond Fonck. Ahearne is director of the Sigma Xi Center in Raleigh, NC. He is a physicist and member of the National Academy of Engineering, is a former chairman of the U. S. Nuclear Regulatory Commission and served for a time as a deputy assistant secretary at the U. S. Department of Energy. From 1972 to 1977 he served as an assistant secretary at the U. S. Department of Defense. He received his Ph.D. in physics from Princeton University. Fonck is a professor and senior fusion research scientist at the University of Wisconsin.

The Committee will function under the auspices of the Board on Physics and Astronomy of the National Academies, National Research Council. It will meet for the first time September 17-18 in Washington, DC. It aims for a "Progress Report" in December 2002 and a final report sometime in 2003.

In Memoriam: ITER Canada CEO Peter Barnard

Dr. Peter Barnard, Chairman and CEO of Toronto-based Iter Canada, passed away on August 29 at Toronto's General Hospital, at age 64. He had been struggling with prostate cancer for the past four years, though those who knew him never noticed any decrease in his boundless energy and enthusiasm during those years. Peter founded Iter Canada in 1997 and was instrumental in Canada becoming the first country to formally offer to host the multi-billion dollar Iter fusion engineering test reactor. Due to his failing health, he missed the latest Iter negotiating session in France but received a note from the Japanese delegation that read, in part, "The Japanese Delegation which today presented their bid is so much aware that the Iter process owes such a great deal to your dynamism, personal engagement and never ending optimism. All the more they are finding it particularly sad that you are missing."

Peter received his Ph.D. in Mechanical Sciences from Cambridge University, England, and was a graduate of the Advanced Management Program at Harvard University. He had a long and distinguished career in management and consulting, including a three year stint as Chairman of Ontario Hydro Technologies (1994-1997). More details can be found at http://www.peterbarnard.ca/

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ITER NEGOTIATIONS PROCEEDING APACE US INITIATES NEW PLANNING EFFORT

ITER Negotiators Launch Site Selection Process

Delegations from Canada, the European Union, Japan and the Russian Federation met at their Fifth Negotiations Meeting 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.

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.

Within the framework of the Negotiations, the joint assessment of the Japanese site at Rokkasho-mura was 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.

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. 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.

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).

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

Measurements on Omega Laser

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.

APS 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."