



Fusion Power Report

Complete Coverage Of Worldwide Fusion Developments

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Page 39

SLANTS & TRENDS

Commercial Fusion seen by 2040, says South Korean President Roh Moo-hyun. Russians aim for 2050.

See Story on page 39

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A **panel** of the U. S. Department of Energy Fusion Energy Sciences Advisory Committee (FESAC), charged received reports from three panels at its October 23-24 meeting.

See Story on page 39

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The General Accountability Office (GAO), an agency that reports to the U. S. Congress, issued a critique of the U. S. fusion program

See Story on page 40

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Fusion Power Associates Board of Directors announced the recipients of its annual awards.

See Story on page 42

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The Atomic Physics Laboratory of the Joffe Institute in St. Petersburg, Russia has developed and offers to others a range of plasma diagnostics and neutral particle analyzers

See Story on page 43

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The U. S. Department of Energy has announced a reorganization of its Office of Science, of which fusion is a part, naming Dr. Patricia Dehmer as its head.

See Story on page 43

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The annual meeting of the American Association for the Advancement of Science will have two sessions on fusion at its February meeting in Boston.

See Story on page 44

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Inside This Issue

<i>Commercial Fusion by 2040 Says Korean President</i>	<i>Page 39</i>
<i>FESAC Receives Panel Reports.....</i>	<i>Page 39</i>
<i>General Accountability Office Critiques U.S. Fusion Effort</i>	<i>Page 40</i>
<i>Peter Golden Comments on Fusion</i>	<i>Page 41</i>
<i>Fusion Power Awards to Baldwin, Hawryluk, Wirth</i>	<i>Page 42</i>
<i>Bob Bussard Passes At Age 79</i>	<i>Page 45</i>
<i>John Greene Succumbs To California Fires.....</i>	<i>Page 45</i>
<i>Calendar</i>	<i>Page 46</i>

Commercial Fusion by 2040 Says Korean President

Korea will grow into one of the world's top five countries in nuclear fusion energy technology by 2021 and start commercial generation of electricity from nuclear fusion by 2040 said South Korean President Roh Moo-hyun, according to a September 14 news report in the Korean independent newspaper The Hankyoreh. Roh's remarks came at a dedication ceremony for the newly completed US\$330 million KSTAR superconducting tokamak.

Initiation of the KSTAR was in 1995, the same year that Congress killed a similar project, the Tokamak Physics Experiment (TPX), that was just beginning construction in the U. S. TPX scientists and engineers subsequently assisted Korea in the design and planning for KSTAR. The facility is located at the Korean National Fusion Research Institute in Daejeon.

Additional information is posted at <http://fire.pppl.gov> and at <http://www.knfp.net/english/>

Russia Aims for Commercial Fusion by 2050

In August, the Russian government adopted the main provisions of a draft strategy for developing a fusion power industry, including the construction of commercial fusion reactors by 2050, according to a story in the 13 September 2007 issue of the ITER Newline. According to the article the "third stage" of the strategy, "to design and start building commercial fusion power plants" would start "after 2031." Academician Yevgeny Velikhov was quoted by the Russian News Agency Novosti as saying, "If we fail to adopt this fusion research program now, we will soon lose the existing scientific potential and professional knowledge to implement the strategy."

The full article is posted at <http://www.iter.org/newline/issues/13/ITERnewsline.html>

FESAC Receives Panel Studies

The U.S. Department of Energy (DOE) Fusion Energy Sciences Advisory Committee (FESAC) met October 23-24 in Gaithersburg, MD. The FESAC received reports from three panels and endorsed them with minor editing to be done before being

transmitted by FESAC to DOE Under Secretary for Science Ray Orbach.

Martin Greenwald (MIT) presented his planning panel's report entitled "Priorities, Gaps and Opportunities: Towards a Long-Range Strategic Plan for Magnetic Fusion Energy." The panel had been asked in a February 7, 2007 letter from Ray Orbach "to identify the issues arising in a path to Demo, with ITER as a central part of that effort." In its hefty 203-page report, the panel identified 14 issue areas and addressed their prioritization according to their "importance, urgency and generality."

The panel noted that its analysis was "based on the tokamak and its low-aspect ratio and advanced variants" and that "stellarator issues were also reviewed." They noted "other elements, such as inertial confinement, were excluded and alternate concepts were considered only to the extent that they could influence or facilitate, in a significant way, the main-line sequence from ITER to Demo."

In subsequent discussion of the report, which FESAC unanimously felt was excellent, some FESAC members asked whether a charge would be forthcoming on inertial fusion or other elements of the fusion program that would call for a similar analysis of issues on a path to Demo. Fusion office head Ray Fonck answered that no such charge was envisaged. The report is posted at <http://fire.pppl.gov>

Richard Hazeltine (U. Texas) presented the report of his panel, charged in an August 9, 2007 letter from Ray Orbach "to conduct a scientific and programmatic review focused on evaluating the NCSX (National Compact Stellarator Experiment) program and its potential effect on the U.S. fusion energy sciences program." The review is one of four reviews completed or underway of NCSX, caused by significant cost increases and schedule delays in the project, which is under construction at Princeton Plasma Physics Laboratory (PPPL). The report is posted at <http://fire.pppl.gov>

On August 9, USDOE Under Secretary of Science, Dr. Raymond Orbach, charged his Fusion Energy Sciences Advisory Committee (FESAC) to "conduct a scientific and programmatic review focused on evaluating the NCSX (National Compact Stellarator Experiment) program and its potential impact on the U.S. fusion energy sciences program." Orbach asked the review to be completed by the FESAC meeting on October 23-24.

Orbach says the review is needed quickly because the project "is projecting substantial (about \$40 million) and schedule (about 2 year delay) overruns." "These overruns are large enough to add new

burdens on the limited resources of the U.S. fusion energy sciences program, as well as undermine confidence of the Administration and Congress in the ability of the Office of Fusion Energy Sciences and the Office of Science to manage large and technically challenging construction projects," Orbach said. Ray Fonck, head of the U.S. fusion program told FESAC in July that the latest cost estimate for NCSX was about \$130 million. Since that time, DOE has held a cost and schedule review of the project. Orbach said that the FESAC review "will comprise part of the set of reviews that will be conducted to inform a decision" on the best course of action. Orbach said that "all options, including termination of the project, must be considered."

Among a series of questions posed, Orbach asked the FESAC to comment on the "role of the stellarator and NCSX in the long-term U.S. fusion energy sciences program" and "what other experimental facilities would be required to develop the required knowledge base" in order for the compact stellarator "to be a viable reactor concept."

Fusion office head Ray Fonck indicated that, in the coming months, his office "will recommend either to re-baseline or cancel NCSX." The current approved baseline cost of NCSX is \$102 million. If a new baseline is established, it is expected to be approximately \$150 million.

Bill Tang (PPPL) presented the report of his panel, charged in a June 8, 2007 letter from Ray Orbach "to assist in the evaluation of a computational initiative called the Fusion Simulation Project (FSP)." The letter asked FESAC to "critically review the FSP Workshop Report, assess its feasibility, and recommend a course of action." In the discussion, FESAC seemed generally supportive of the initiative but did not want to recommend its implementation absent a study of fusion program priorities as a whole and how the initiative would be included relative to its cost. Fusion office head Ray Fonck did not appear ready to issue a charge to FESAC to evaluate priorities within the fusion program as a whole. He indicated a preference for FESAC to conduct reviews of fusion program subelements separately.

During an extended discussion period on the second day of the meeting, some members of FESAC noted the growing national public discussion of future energy sources and global warming, and the general absence of references to fusion energy in the public discussion. Some FESAC members suggested that DOE revise or clarify its "fusion policy" with respect to developing fusion as an energy source. Fonck discouraged FESAC from making

such a suggestion. The report is posted at <http://fire.pppl.gov>

No new charges were given to FESAC at the meeting, though some new charges were anticipated prior to the next meeting, tentatively scheduled for February 19-20, 2008.

GAO Critiques U.S. Fusion Program

In July 2005 the U. S. Senate, in passing the FY2006 Department of Energy Appropriations Bill, adopted an amendment by Sen. Pete V. Domenici (R-NM) calling for a review of the U.S. fusion program by the General Accountability Office (GAO). The amendment stated, "The GAO shall consider any other magnetic fusion confinement system as a possible fusion demonstration facility that will follow ITER and, given the NNSA investment in the physics of inertial confinement fusion, the GAO shall evaluate the opportunities for the Office of Science to develop the appropriate science and technology to leverage the NNSA investments as an alternative to the tokamak concept."

On October 26, GAO issued its report to Congress. The report cautions that the DOE-advertised cost of the ITER project "may not fully reflect the costs U.S. participation" since the estimate "has not been independently verified, as DOE guidance directs, because the reactor design is not complete." The report also concludes that the Department's Office of Fusion Energy Sciences (OFES) "does not have a human capital strategy to address expected future workforce shortages." The report saves its harshest comments, however, for the Department's treatment of inertial fusion energy (IFE) and innovative alternate magnetic confinement programs.

With respect to inertial fusion, the report notes that the Department carries out three distinct inertial fusion efforts: one in DOE's National Nuclear Security Administration (NNSA) "relating to nuclear weapons," one in OFES "aimed at exploring the basic science for energy applications," and a congressionally-mandated program, managed by NNSA, "to develop technology needed for energy." The report says, "DOE has not assigned to either NNSA or OFES clear roles in developing inertial fusion energy." GAO says "there is no research plan that identifies key scientific and technological questions that need to be addressed to achieve inertial fusion energy or the cost, time frames, and detailed research and development tasks needed by each agency to solve those scientific and technological issues to further advance inertial fusion energy." "A lack of a coordinated research plan and clear responsibility among these programs for developing inertial fusion energy may delay the prog-

ress of inertial fusion energy as a promising alternative to magnetic fusion," the report says, adding, "Without a coordination research plan and clear responsibility for developing inertial fusion energy, DOE may not see progress in developing inertial fusion energy as a promising alternative to magnetic fusion."

In an appendix, the GAO report provides a "rebuttal" letter, dated October 10, 2007, from Raymond J. Fonck, head of OFES in which he denies the existence of the congressionally-mandated program, saying, "The report makes a fundamental assumption that an explicit program to develop inertial fusion as an energy source exists but is not coordinated. This is not agreed to by the Department, and no such program exists." Fonck says "The joint (OFES-NNSA) program on HEDLP (High Energy Density Laboratory Physics) will address underlying scientific issues that will be relevant to future considerations of inertial fusion energy." But GAO says, "While high-energy density physics explores a number of fundamental scientific issues related to inertial fusion energy, it does not address all of the scientific issues that would advance inertial fusion energy." GAO says that "DOE noted that, in 2003, its advisory committee developed a plan that identified critical milestones, research and development tasks, and budget needs to build an inertial fusion demonstration power plant within 35 years. However DOE decided not to implement this plan because fundamental scientific issues had not yet been resolved and there was no agreement between OFES and NNSA on which agency had the responsibility of developing inertial fusion as an energy source." "When DOE rejected its advisory committee's plan, it did not develop an alternative," the GAO report says. "A plan that identifies key scientific and technological questions as well as the cost, time frames, and detailed research and development tasks would help OFES and NNSA better coordinate three separately funded inertial fusion research programs that have different scientific and technological objectives," the report says.

With respect to alternative magnetic fusion approaches, the GAO report says "DOE may find it difficult to manage competing funding priorities to advance both ITER-related research and alternative magnetic approaches." The report says "DOE officials told GAO they are focusing limited resources on ITER-related research. As a result, as funding for ITER-related research has increased, the share of funding for the most innovative alternative magnetic fusion research activities decreased from 19 percent of the fusion research budget in fiscal year 2002 to 13 percent in fiscal year 2007. According to DOE officials, this level of funding is sufficient to meet research objectives." The GAO says,

"However, university scientists involved in fusion research told us that this decrease in funding has led to a decline in research opportunities for innovative concepts, which could lead to simpler, less costly, or faster path to fusion energy, and reduced opportunities to attract students to the fusion sciences and train them to fulfill future workforce needs."

The full report is posted on the GAO web site at <http://www.gao.gov/new.items/d0830.pdf> and is also posted at <http://fire.pppl.gov>

Peter Golden Comments on Fusion Development

Peter Golden, a public relations and marketing consultant, provided the following comment on fusion power development.

Friends -

Please forgive my presumption in sharing my response to Stephen O. Dean's "GAO Critiques" note of Oct. 29, 2007 (FPN07-58). As a casual, non-scientific observer of the fusion energy scene I continue to be frustrated by the lack of awareness on the part of both the general public, Congress and the executive branch regarding both the potential and development imperatives of fusion power. My assumption is that all, most or some of you play significant roles in fusion power R&D and share my frustration with what I think could be fairly called a barely coordinated, low-priority attitude with regard to fusion power in both USG policy and American public dialog.

While I am hardly in a position to speak critically about the current state of affairs, I think we all would agree that the combination of global warming, ever-rising energy prices and future energy needs compel a more refined, focused and financed approach to fusion power in such diverse areas as basic physics, materials sciences, device technology, electrical energy storage and distribution and so on. And at the national level increased awareness on the part of politicians and policy makers of the potential and comparative costs of fusion power development.

Part of the problem, of course, is the inability of both public and commercial interests to discern the distinction between basic science and technological development; another are constraints placed on fusion power by competing technological, industrial, agricultural and regional interests. Noting all of this, the tasks of leadership associated with progressive action in any epoch are no less incumbent

upon those of us who sense the potential of fusion in any epoch. Put another way, the "institutional advancement," (capacity building, fundraising, promotion and outreach) that is a fundamental "process" in academe might bear further examination by FPA members and supporters. As a science and technology initiative that should be stirring the imagination of the American people, fusion power instead seems to be lost in the shadows, the excellent work of ITER and NIF notwithstanding.

How many of you have devoted your careers in pursuit of what many of your colleagues view as no more than a distant chimera? How many have watched budgets in basic physical sciences diminish over the years (or fall far behind that of other disciplines) while life sciences have captured the interest of gifted students who might otherwise be attracted to high-energy physics and the cluster of other disciplines that inform fusion power?

While my own ability to speak to these issues is limited (I am an itinerant writer and marketer, with some experience in the technology sector and a general interest in policy development.), I have no doubt that you as a group and individually have the potential to lead the way forward in addressing some of the issues I have raised here today. Like yourself my time and means are limited. However, it does not seem extreme to me to say the fate of the nation and even the planet is in large part contained in our ability to produce, store and distribute clean, low-cost power.

Toward this end I am willing to pursue a discussion and call upon you, the larger academic community, our political representatives at the national and state level and leaders in industry and commerce to come to terms with this imperative: The creation of a viable means to produce fusion power, whether achieved through international collaboration or a national effort, must be planned, funded and accelerated in ways far beyond the current level of coordination and support.

This mandate and vision, to you whose careers and efforts are at stake, must be far more apparent and compelling to you than me. But the potential of your efforts, mooted by a host of factors, appears to remain clouded by contention and lack of understanding. Thus a question I am sure you have all considered to the point of somnolence arises once again: What is to be done?

My sincere thanks for your interest and indulgence and all the best as you work toward fulfilling the dream of fusion power in what I am sure are imaginative and highly productive ways.

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FPA 2007 Awards to Baldwin, Hawryluk, Wirth

Fusion Power Associates Board of Directors announces the recipients of its 2007 Distinguished Career, Leadership and Excellence in Fusion Engineering Awards. The Awards will be presented at Fusion Power Associates Annual Meeting and Symposium, December 4-5, in Oak Ridge, TN.

DISTINGUISHED CAREER AWARD

The Board has selected David E. Baldwin to receive its 2007 Distinguished Career Award. This Award was established in 1987 to recognize individuals who have made distinguished lifelong career contributions to fusion development.

In selecting Dr. Baldwin, the Board noted his "many scientific contributions to fusion research over several decades" and his "leadership of the fusion programs at the Lawrence Livermore National Laboratory and General Atomics." The Board also noted "the key policy roles you have played over many years in guiding the national and international fusion efforts."

LEADERSHIP AWARD

The Board has selected Richard J. Hawryluk to receive its 2007 Leadership Award. This Award was established in 1980 to recognize individuals who have shown outstanding leadership qualities in accelerating the development of fusion.

In selecting Dr. Hawryluk, the Board noted his scientific leadership previously of the Princeton Large Torus (PLT), Princeton Divertor Experiment (PDX) and Tokamak Fusion Test Reactor (TFTR) projects and, more recently, the National Spherical Torus (NSTX) and National Compact Stellarator (NCSX) projects. In addition, the Board also noted his "recent involvement with the ITER Working Groups that are providing much needed input for final design decisions for ITER."

FUSION ENGINEERING AWARD

The Board has selected Brian D. Wirth, a professor of nuclear engineering at the University of California, Berkeley, to receive its 2007 Excellence in Fusion Engineering Award. This Award, in memory of MIT Professor David J. Rose, was established in 1987 to recognize individuals in the early part of their careers who have shown both technical accomplishment and potential for becoming exceptionally influential leaders in the fusion field.

In selecting Professor Wirth, the Board noted his "many scientific contributions to the international fusion materials research program and, in particular, your outstanding papers on computational simulation of radiation damage events in irradiated fusion materials."

A list of previous recipients of FPA Awards and Members of the FPA Board of Directors is posted at <http://fusionpower.org>

Dr. Baldwin can be contacted at
Baldwin@fusion.gat.com
Dr. Hawryluk can be contacted at
rhawryluk@pppl.gov
Prof. Wirth can be contacted at
bdwirth@comcast.net

Ioffe Institute Offers Plasma Diagnostics

The Atomic Physics Laboratory of the Ioffe Institute in St. Petersburg, Russia has developed and offers to others a range of plasma diagnostics and neutral particle analyzers. Their equipment has been deployed on a wide range of international fusion projects, including MAST, LHD, JET, TFTR, JT-60U.

Information about the equipment is presented on their website
<http://www.ioffe.rssi.ru/ACPL/npd/npd.htm>.

For more detailed information including prices and delivery conditions, contact either of the following:

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DOE Office of Science Reorganizes

U.S. Department of Energy Under Secretary for Science Raymond Orbach has announced a reorganization of the Office of Science, naming Dr. Patricia Dehmer as Deputy Director for Science Programs. In that capacity, she will "provide scientific and management oversight for the six program offices," including the Office of Fusion Energy Sciences. The other five program offices are basic energy sciences, biological and environmental sciences, advanced scientific computing research, high energy physics, and nuclear physics.
important position.

Two Fusion Symposia at AAAS Annual Meeting

There will be two 3-hour sessions on fusion, running in parallel, at the annual meeting of the American Association for the Advancement of Science (AAAS) on Saturday February 16, 2008 (<http://www.aaas.org>). The annual meeting will be held in Boston, MA, February 14-18.

The session titled Progress in Magnetic Fusion Energy Research: 50 Years of International Collaboration and Future Prospects Symposium was organized by Miklos Porkolab (MIT) and co-organized by Barrie Ripin (Research Applied, Bethesda, MD).

The following talks are scheduled:

Fusion Research: 50 Years of International Scientific Collaboration
Evgeny P. Velikhov, Kurchatov Institute, Moscow, Russian Federation

Fusion Power, and Who Needs It? An Updated Assessment
Predhiman Kaw, Institute of Plasma Research, Bhat, India

US International Collaboration in Fusion Research and Participation in the ITER Project
Raymond Fonck, Associate Director, DOE Office of Fusion Energy Sciences, US DOE, Washington, DC USA

Progress in Fusion Research Via the International Tokamak Physics Activity: A Collaboration Paradigm
Ron Stambaugh, General Atomics, San Diego, CA

Advances in Technology To Realize Fusion Energy in the International Context

Kathryn McCarthy, Idaho National Laboratory, Idaho Falls, ID

Strengthening and Accelerating the Development of Fusion Energy: An International Challenge
Chris Llewellyn Smith, Culham Science Center, UKAEA, Culham, Oxon, United Kingdom

The session titled High-Powered Lasers: Fusion Ignition and Concomitant Scientific Opportunities was organized by Richard Boyd and Karl van Bibber (LLNL).

The following talks are scheduled:

Basics of Inertial Confinement Fusion
John Lindl (LLNL)

OMEGA Extended Performance Laser System Project
Robert McCrory, University of Rochester

National Ignition Facility
Edward Moses (LLNL)

Fast Ignition Realization Experiment Project
Hiroshi Azechi, Osaka University

High-Power Laser for Energy Research Project
Mike Dunne, Rutherford Appleton Laboratory, UK

High Energy Density Science with High-Powered Lasers
Raymond Jeanioz, UC Berkeley

Chris Keane Leaves DOE/NNSA, Rejoins LLNL

Dr. Christopher Keane, DOE/NNSA Assistant Deputy Administrator for Inertial Confinement Fusion & the NIF Project, has left the agency and rejoined his previous employer, the Lawrence Livermore National Laboratory (LLNL). Keane has accepted a position in the Physics Directorate at LLNL.

Col. Mike Donovan, Ph.D., the senior military officer in NNSA and a laser scientist, replaces Keane on an "acting" basis until a successor is named. Donovan will speak at Fusion Power Associates annual meeting and symposium, Fusion Energy: Preparing for the NIF and ITER Era, December 4-5 in Oak Ridge, TN.

Navratil Elected Chair of FPA Board of Directors

The Fusion Power Associates (FPA) Board of Directors has elected Gerald Navratil (Columbia University) to serve as its Chairman for a two year term effective November 1. He succeeds Miklos Porkolab (MIT). Navratil was previously Vice Chair of the Board.

The Board also elected Farrokh Najmabadi (UC-San Diego) as Vice Chair. Stephen O. Dean and Ruth Ann Watkins were re-elected President and Vice President for Administration and Finance, respectively.

The annual meeting of the FPA Board will take place the evening of December 4 at the Doubletree Hotel in Oak Ridge, TN, in association with the FPA Annual Meeting and Symposium, December 4-5 at the same location.

A listing of members of the FPA Board and information on the annual meeting are posted at <http://fusionpower.org>

Bob Bussard Passes at Age 79

Dr. Robert W. Bussard has passed away at age 79. He was living in Santa Fe, NM, with his wife, Dolly. As director of the newly-formed Fusion Technology Division in the U.S. Atomic Energy Commission in the early 1970s, reporting to then-head of the U.S. fusion program Bob Hirsch, Bussard played a key role in formulating and managing an ambitious, comprehensive fusion engineering technology program, as the fusion budget grew over ten-fold from around \$30M to over \$300M in just a few years. He brought a vision, sense of mission and engineering development perspective to the U.S. fusion program during those growth years.

The following obituary has been contributed by Bob Hirsch:

On Saturday, October 6, Bob Bussard succumbed to cancer and passed at the age of 79. Bob was a physicist and engineer who had a remarkable career in technology at Princeton, Los Alamos, the Atomic Energy Commission, and companies that he founded, including Erg, Inesco, and EMC2. His ability to describe, quantify and analyze complex systems was unique., and he had the capacity to present his concepts in a convincing and understandable manner to the specialist as well as the

layman. Among his many inventions was the "Bus-sard Ram Jet," a concept for space travel at close to the speed of light. He was instrumental in the development of a weapons system deployed during the Vietnam war.

His passion in his later years was practical fusion power. Most recently he developed a truly innovative configuration for Inertial Electrostatic Fusion using a complex magnetic cusp structure in place of grids to create a tiny but deep electrostatic well for compact fusion power. Nick Krall, the famed plasma theorist, became involved with Bob over a decade ago with the thought that he could quickly identify the fatal flaws that would invalidate Bob's concept. To his surprise, Nick could find no fatal flaws, and he assisted Bob thereafter. Bob's concept is one of a very few that offer the potential of practical fusion without neutrons and radioactivity.

Bob was tireless in his research and unique in his ability to attract government support for his work, most recently from the Navy. Before his passing, Bob ran what he believed was a definitive experiment that supported his theoretical model. An interruption in his funding did not allow him to replicate his results for others to see. With new Navy support, his work will continue at a laboratory in Santa Fe under the leadership of veteran researchers from Los Alamos and elsewhere. Leaving a legacy to the world of clean energy motivated him for the last three decades of his life.

Bob will be remembered fondly as a great friend and a bright, innovative physicist, who was a warm, caring and dedicated human being. His wife Dolly survives him.

Fusion Scientist John Greene Victim of CA Fires

John Greene, a fusion theoretical physicist and long-time researcher at the Princeton Plasma Physics Laboratory and a senior advisor to the fusion theory group at General Atomics died October 21 due to complications related to the California fires.

John and wife Alice were living in an assisted living facility in Rancho Bernardo near San Diego. On that evening John developed some respiratory problems and was taken to the hospital. But he went downhill quickly and passed away that night. Apparently he suffered no pain - just some discomfort in breathing for a short time.

For further information, contact: Beulah Koz (koz@fusion.gat.com) General Atomics Theory and Computational Sciences

Calendar

Dec 10-14 13th International Conference on Fusion Reactor Materials. Nice, France. <http://www-fusion-magnetique.cea.fr/icfrm13.index.htm>

Feb 14-18 American Association for the Advancement of Science Annual Meeting (two fusion sessions). Boston. <http://www.aaas.org/meetings/>

Feb 19-20 USDOE Fusion Energy Sciences Advisory Committee Public Meeting. Gaithersburg, MD <http://www.ofes.fusion.doe.gov/fesac.shtml>

February 20-22 IAEA Workshop on Challenges in Plasma Spectroscopy for Fusion Machines. Jaipur, India. http://bitmesra.ac.in/iaes_cps08/index.htm

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