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PPPL news

The Princeton Plasma Physics Laboratory is a United States Department of Energy Facility

NSTX Produces One Megampere Plasma Current Ahead of Schedule

Milestone is Reached Nine Months Early

By Anthony DeMeo

On December 14, the National Spherical Torus Experiment (NSTX) at the U.S. Department of Energy's Princeton Plasma Physics Laboratory (PPPL) produced a one million ampere plasma current — a new world record for a spherical torus device. Producing this plasma current sets the stage for the Laboratory to create and study plasma conditions that are relevant to the production of fusion energy.

Secretary of Energy Bill Richardson said, "I'm delighted that the NSTX experiment has met this technical milestone nine months ahead of schedule. We can now begin the scientific investigations that the machine is designed to do."

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> **—Bill Richardson**

One million amperes is the highest plasma current ever produced in a spherical torus device. The previous record is 310,000 amperes achieved in a smaller spherical torus called START — the Small Tight Aspect Ratio Tokamak — built by Culham Fusion Laboratory of U.K.

PPPL Director Rob Goldston lauded staff for achieving the milestone early. "This is a great example of the physics and engineering teams working closely together to bring about an important milestone well ahead of schedule. It is also a great example of PPPL and collaborating researchers working together closely for the success of the project. My congratulations to all involved," said Goldston.

Shaped Like a Sphere

NSTX, which began operating a year ago, is designed to test the physics principles of spherical torus plasmas. It produces a plasma that is shaped like a sphere with a hole through its center. This configuration may have several advantages, a major one being the ability to confine a higher plasma pressure for a given magnetic field strength. This could lead to a less expensive development path for fusion energy.

A large current flows inside the NSTX plasma and heats the plasma in the same way the current heats an electric toaster or light bulb. This plasma current also produces a magnetic field so that the resulting magnetic field line spirals around inside the plasma. The spherical torus provides a special shape in these magnetic field lines that is calculated to contain high-temperature plasmas efficiently.

The production of a one-million-ampere plasma current on NSTX required the appropriate plasma shaping, such as the width and height of the cross section of the plasma torus. Proper plasma shaping helps eliminate plasma instabilities. By October of 1999, the NSTX team had produced all of the desirable plasma shapes that they plan to use on NSTX, also a key aspect of preparation for research.

NSTX is a proof-of-principle experiment — a relatively inexpensive device, which will create conditions

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PPPL's Funding Increased for FY 2000

By Anthony DeMeo

This fiscal year, PPPL is receiving approximately $63 million in federal funding for research in fusion energy and plasma science — a 21 percent increase over the prior year.

"This funding increase is a wonderful boost to our program. Thanks to the support of Congressmen Rodney Frelinghuysen and Rush Holt and Senators Frank Lautenberg and Robert Torricelli, we will be able to accelerate our work on fusion energy and begin the removal of the successful Tokamak Fusion Test Reactor (TFTR) to make way for new research," noted PPPL Director Robert J. Goldston.

The new funding was effective October 1, with the start of the government's Fiscal Year (FY) 2000. It is part of approximately $249 million provided for the U.S. Fusion Energy Sciences Program in the FY 2000 budget.

The U.S. Department of Energy (DOE) is responsible for overseeing the Fusion Energy Sciences Program and provides PPPL's funding. The budget for fusion research was $222.6 million in FY 1999. In providing the increase for FY 2000, Congress commended DOE for its efforts to pursue the most promising paths toward producing electricity from fusion. Members also expressed their pleasure with the fusion program's emphasis on innovation.

In the interior of the sun and other stars, matter is converted into energy by the fusion, or joining, of nuclei of light atoms to form heavier elements. At PPPL, physicists use a magnetic field to confine hot, ionized gas, called plasma, at the temperature and density required for abundant fusion reactions. Scientists hope to eventually use the energy produced by fusion for the production of steam to generate electricity. Compared to fossil fuels and fission, now used in commercial power plants, fusion would have distinct advantages, including an inexhaustible fuel supply; no contribution to acid rain or global warming; and inherent safety, with the minimal use and production of radioactive materials.

PPPL is one of the world's leading centers for fusion research. The funding provided in FY 2000 will allow Princeton researchers to conduct experiments on the National Spherical Torus Experiment (NSTX), while proceeding with the disassembly of TFTR. One of the world's largest and most advanced fusion experiments, TFTR completed 14 years of world-record-breaking research in 1997. Its dismantling and removal will take three years and cost $46 million. Of this total, $9.9 million is included in PPPL's FY 2000 funding. The space occupied by TFTR will be available for a future fusion experiment.

Knowledge gained from research on TFTR is being put to use on NSTX, which began operation in February, 1999. This new device is being used to study an innovative plasma confinement concept, which could lead to smaller, more economical, fusion power plants. PPPL scientists will continue to develop other magnetic confinement alternatives, including advanced tokamaks and compact stellarators, while maintaining their collaborations with researchers at other fusion laboratories in the U.S. and abroad. Laboratory scientists will continue to apply knowledge gained in fusion research to near-term applications, including space propulsion, textile manufacturing, materials science, and solar physics. ●

PPPL NEWS

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Sauthoff Elected President of IEEE-USA

Ned Sauthoff, Head of the Laboratory's Off-site Research Department, is the President-Elect of the Institute of Electrical and Electronic Engineers-USA (IEEE-USA) for the year 2000.

Ned Sauthoff

Sauthoff is the fourth IEEE-USA President directly elected by the IEEE's U.S. members. His post is a three-year assignment to the IEEE's Board of Directors: President-Elect in 2000, President in 2001, and Past-President in 2002.

Goals as President-Elect

Sauthoff said among his goals as President-Elect, he will work to enhance the effectiveness of IEEE-USA's member services and career products; advocate portable pensions, continuing education, and intellectual property protection; oppose employment discrimination; and exploit the breadth and depth of IEEE perspectives to synthesize balanced IEEE-USA positions in both career and technology policy areas.

"This position gives me an opportunity to serve and to help the members of IEEE-USA make a difference," he said.

During his campaign, Sauthoff stated, "The IEEE-USA must serve the U.S. members within IEEE's global context, enabling U.S. members to achieve life-long career vitality and contributing to the development of sound U.S. public policy. Its member services and activities in non-technical professional development, careers, and technology policy complement IEEE's position as the preeminent source of electrotechnology information."

Sauthoff has participated in many activities and served in several capacities at IEEE-USA, the most recent being as a member of the group's Board of Directors and as IEEE-USA Vice Chairman of Technology Policy Activities.

Sauthoff came to PPPL in 1975 after receiving a Ph.D. in astrophysics from Princeton University. He received a master's degree in nuclear engineering in 1972 and a bachelor's degree in physics in 1971, both from the Massachusetts Institute of Technology. Prior to his present position, Sauthoff had been Head of the Laboratory's Plasma Science and Technology Department. He is a Princeton resident.

PPPL Director Rob Goldston said, "Dr. Sauthoff has a superb record of scientific and managerial accomplishment at PPPL. I am glad that his capabilities have been recognized by the IEEE-USA, and I am sure that he will make very important contributions, while continuing to contribute to the Laboratory."

Congratulations, Ned! ●

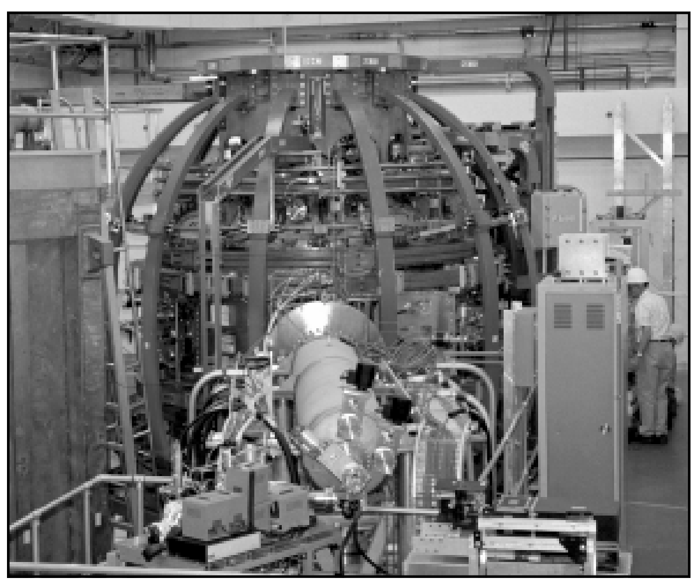
Megampere

Continued from page 1

suitable for the study of fusion-energy-relevant plasma behavior and advanced plasma heating and current-drive techniques. It is not planned to produce significant fusion energy in this device.

Produce High-quality Scientific Results

NSTX Program Director Martin Peng said, "The goals of the next few years of research on NSTX are to produce high-quality scientific results and excellent plasma performance. If successful, NSTX will have an impact on the design of future devices. These machines would extend the temperatures, densities, and other plasma parameters to the levels necessary for fusion energy production." ●



The National Spherical Torus Experiment at PPPL.

Physicists Work to Improve TV Technology

By Anthony DeMeo

Anyone touring Circuit City or The Wiz cannot help being drawn to the myriad of video entertainment systems for sale. Television has come a long way from the days of 10-inch tubes, offering snowy black-and-white images, to today's 50-inch rear-screen projection systems. But the image quality of projection TV is inferior to that of picture tubes, and both systems require a considerable amount of space.

All of this is about to change with the advent of High Definition Television (HDTV), in particular, the flat-panel, hang-on-the-wall televisions that have been a staple of science fiction and viewers' fantasies. At first glance, a plasma set is arresting. Anyone spying it invariably walks up and peers around the back to be sure there isn't an attached piece of equipment built into the wall somewhere.

The work of two PPPL physicists, one an experimentalist and the other a theoretician, may lead to flat-panel displays that are larger, last longer, provide higher resolution images, and are less expensive. "I expect plasma display panels to fill a large segment of the market beginning in the next decade," noted PPPL experimentalist Hyeon Park. For about one year, Park and PPPL theorist Hideo Okuda have been working on an experimental diagnostic method and a computational model that will aid designers of flat-panel displays to better characterize the plasmas used in these devices.

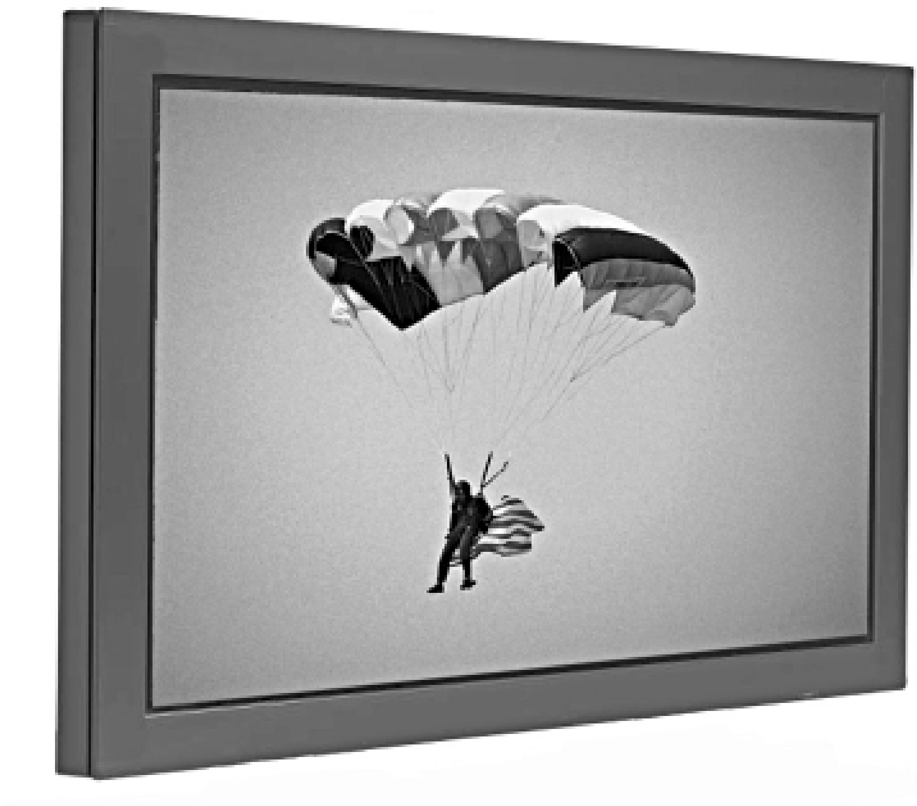
Presently, most flat displays employ one of three technologies to form the image — liquid crystals, light emitting diodes, or plasmas. Further down the road are more sophisticated technologies, including organic and biochemical displays. Liquid crystal displays (LCDs) are currently dominating the small display market where screen size is 15 inches or less, such as small-screen TVs, toy game monitors, and laptop computers. LCDs rely on a sophisticated switching technique that uses an array of thin film transistors to set up electric fields which allow the normally opaque liquid crystals to transmit light. Thin film transistor arrays are costly in the larger sizes desired for desk-top monitors and entertainment systems. Light emitting diodes, or LEDs, are used in enormous display panels, such as those mounted on buildings in New York City's Times Square. At the present time, small LEDs cannot compete economically with LCDs. Because of fabrication difficulties and cost, neither LEDs nor LCDs are economically viable for the size of screens required for entertainment and business presentation applications. These are the provinces of plasma displays, which involve relatively simple fabrication processes compared to the other flat panels.

Plasma Cells

Sony's Plasmatron display or Plasma Addressed Liquid Crystal is a large-scale LCD in which the intricate thin film transistor array has been replaced by plasma cells. Induced charges at the surface of a plasma cell set up an electric field that aligns the liquid crystals, allowing them to transmit light. White light, incident from the rear of the display, is filtered by the liquid crystal. Only one of the three primary colors — red, green, or blue — is allowed to pass through it to the front surface of the display. The strength of the field determines which primary color is admitted. Colors comprising the image are determined by mixing the primary colors from different cells.

In all other commercially available plasma displays, a plasma is created by energizing electrodes directly underneath the front glass plate of the display (see diagram)

From left are PPPL experimentalist Hyeon Park and PPPL theorist Hideo Okuda with students Carl Li and Jill Foley. The group is working on the plasma device similar to the Plasma Display Panel Cell, which is on the table.



Typical Plasma Display

where Xenon gas is mixed with a buffer gas (inert gases such as neon and helium) to optimize ultraviolet emission. When ultraviolet light emitted by the plasma strikes a phosphor, visible light is generated. The color of the light depends on the phosphor contained in a particular plasma cell.

The display screen is comprised of pixels, which are groups of three plasma cells, one for each of the primary colors. The color output of a pixel is determined by the combination of cells triggered and the intensity to which each cell is energized. The resolution of the image ultimately depends upon the number of pixels it contains. To meet a true HDTV condition, a screen must contain at least 1,200 pixels along a horizontal line of the screen and 900 in the vertical direction. An easy way to satisfy this condition is to make the screen larger with the present cell size. However, market analysts expect the demand to be greatest for flat screens measuring 40 inches or less. Consequently, a 50 percent reduction in the size of the pixels is necessary for manufacturers who wish to dominate the flat-panel TV market in the coming decades.

According to Park, "The clarity of state-of-the-art plasma displays is marginal. The electrical process is extremely inefficient. As a result, plasma displays are dimmer than conventional television sets. To meet the clarity requirements for true HDTV, a plasma display panel must sustain or improve the brightness in a smaller plasma cell, so that the gray scale and resolution can compete with HDTV based on cathode ray tubes and other techniques. As plasma physicists, we are not trained to fabricate complex TV sets, but we do have knowledge and ideas to improve the efficiency of plasma discharges allowing true plasma display panel HDTV at an affordable price."

Better Theoretical Understanding Needed

Park noted that there are many computational models available for plasmas used in displays, but none of these has been verified by direct measurement of plasma parameters. Futhermore, these models, which are based on plasma mobility and diffusion, may not be adequate for the kinds of discharges used in displays. A better theoretical understanding that can accurately predict performance is essential.

Park and Okuda believe that experimental and theoretical techniques developed for fusion research can be applied. But the challenge is substantial. Display plasmas

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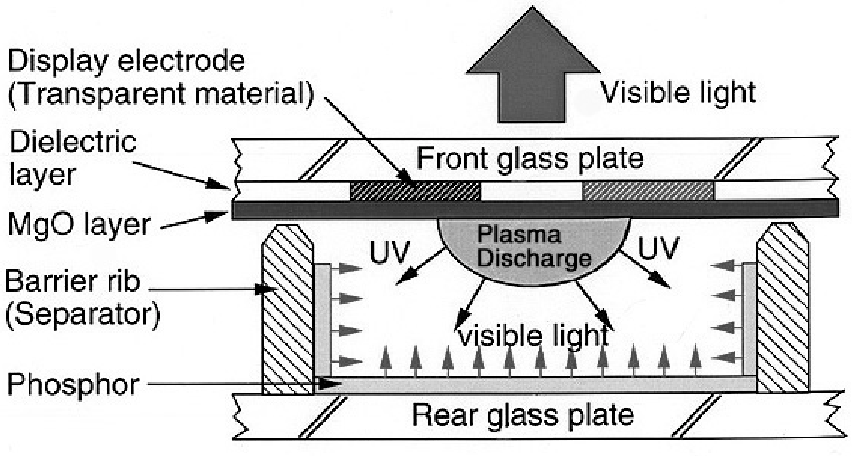


Cross-section of a plasma cell of a typical plasma display panel. MgO is magnesium oxide.

are not only miniscule, but also highly transient. Whereas the size of fusion plasmas may be measured in meters, those found in a display have dimensions of 200 microns or less. Fusion plasmas last a few seconds, while those in a display have about a one-microsecond lifetime.

Okuda is developing a computational code which will provide a realistic model that can predict the brightness of the ultraviolet light produced by the plasma. To do this, he must determine the density and energy distributions of the Xenon ions and the electrons comprising the plasma. Each cell contains a few million electrons in a plasma pulse of one-microsecond duration. Okuda's calculations require the development of a kinetic model to compute the energy distribution in a transient plasma — one that never has time to reach steady state. Okuda is developing a technique that can handle this by clamping many particles into super-particles, thereby reducing computational time considerably. "With this method, as the size of the plasma display cell becomes smaller, it actually becomes easier to model the device on a computer," Okuda said.

Tests of Okuda's theories will require precise, direct measurements of electron density in a one-microsecond plasma measuring 200 micrometers — a formidable task. Most of the conventional direct diagnostic methods cannot be applied. Fortunately, Park has invented a new interferometric technique, which has a potential to make the necessary measurements. Park employs a visible-light laser, rather than longer-wavelength (microwave or far-infrared lasers) conventionally used for the range of plasma density expected in a plasma display cell. The short-pulse, continuous-wave visible laser not only allows measurements to be made on the tiny cells of a plasma display, but provides adequate spatial resolution, because the visible beam can be focused to a spot much smaller than cell size. Park's method, in principle, has the potential to determine both the electron density and temperature of the plasma cell.

Plasma displays are the most vivid example of what plasmas can do for people and society in addition to producing fusion energy. "At this point, a plasma TV is as expensive as a new car, and therefore limited to those who can afford it. Since plasma technology is evolving fast, plasma displays will eventually become a mainstream product for consumers not interested in deciding between a new car and a new television. Therefore, long-term research on the fundamentals of a plasma display cell for true HDTV is inevitable in order to make a quantum jump from the current generation of plasma display cells. It is fitting that PPPL, one of the world's leading centers for plasma science and technology, plays a prominent role in the development of this highly visible application," said Park.●

FPA Recognizes Stix and Williams

The Fusion Power Associates (FPA) Board of Directors recently honored PPPL's Thomas Stix and Michael Williams. Stix, Professor Emeritus of Astrophysical Sciences at Princeton University and former Associate Director for Academic Affairs at PPPL, received the FPA's 1999 Distinguished Career Award. Williams, Head of PPPL's Engineering and Technical Infrastructure Department, received the group's 1999 Excellence in Fusion Engineering Award.

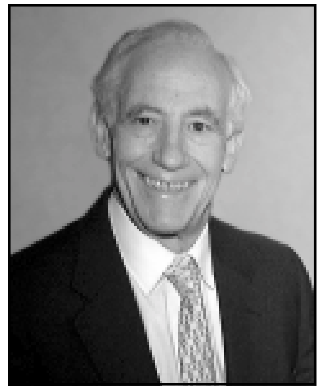
PPPL Director Rob Goldston said of the award recipients, "Tom Stix administered the Princeton University Graduate Program in Plasma Physics when I came as a student in 1972, and Mike Williams was the chief engineer under my thesis advisor, Harold Eubank. So I have a strong basis for saying that the contributions of these two gentlemen to the field of fusion science and engineering have been pivotal to the success of our Laboratory."

Stix, cited by the FPA for "outstanding accomplishments throughout a distinguished career," is one of the pioneers of the U.S. fusion program. He received a Ph.D. in physics from Princeton University in 1953 and has spent his career working on plasma physics and fusion at PPPL since that time. In 1962, he became Professor of Astrophysical Sciences at Princeton University. Before retiring from PPPL in 1996, he held many positions at the Laboratory, including Co-head of the Experimental Division, Associate Director for Academic Affairs, and Head of the Basic Plasma Physics Group. He has served on numerous advisory committees over the years and is a Fellow of the American Physical Society. He is best known for his outstanding original contributions to the physics of plasma waves. His 1962 text, "The Theory of Plasma Waves," is one of the classics of the fusion field.

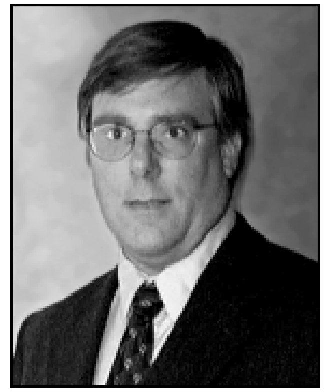
In presenting the award to Stix, Fusion Power Associates President Stephen O. Dean, stated, "In addition to his many technical contributions, Tom is also known and respected among his colleagues for his objectivity in judging the work of others and his interest in the human aspects of our field, including the training of students and the plight of less fortunate scientists in other countries."

Stix is the sixth person from PPPL to receive the FPA's Distinguished Career Award since it was created in 1987. Former Directors Melvin B. Gottlieb, Harold Furth, and Lyman Spitzer, Jr., former Deputy Director for Technical Operations Don Grove, and former Associate Director for Research Paul Rutherford are past recipients of the award.

Williams, who was honored by the FPA for "very important contributions to fusion engineering and in



Thomas Stix



Michael Williams

recognition of impressive leadership qualities," is Deputy Director of the NSTX Project. He came to PPPL in 1976 after graduating magna cum laude from Rutgers University with a bachelor's degree in electrical engineering. At PPPL, he led several project teams and served as the Deputy Project Head of the Tokamak Fusion Test Reactor from 1992 until the project was closed down in 1997. Williams has been Head of the PPPL Engineering and Technical Infrastructure Department since 1991, where he is responsible for managing all technical engineering facilities, environmental engineering, and computing resources at the Laboratory. Williams is the recipient of PPPL's 1999 Kaul Foundation Prize for Excellence in Plasma Physics and Technology Development and of the 1993 Fusion Technology Award from the Institute of Electrical and Electronic Engineers-Nuclear and Plasma Sciences Section's Standing Committee on Fusion Technology.

Outstanding Technical Accomplishment

The FPA Excellence in Fusion Engineering Awards were established in 1987 in memory of Professor David J. Rose of the Massachusetts Institute of Technology, a pioneer in the field of fusion engineering. The awards are presented to individuals relatively early in their careers who have shown both outstanding technical accomplishment and potential to become exceptionally influential leaders in the fusion field. Past PPPL recipients of the engineering award include Charles Kessel, Wayne Reiersen, and Michael A. Ulrickson.

FPA President Stephen O. Dean presented the group's awards to this year's recipients in October during the FPA's 20th Anniversary Meeting and Symposium in Washington, D.C. This year, J. Bryan Taylor and Masaji Yoshikawa joined Stix in receiving FPA Distinguished Career Awards. P. F. Peterson joined Williams in garnering the FPA Excellence in Engineering Award. ●

Three Garner PPPL's 1999 Kaul Prize

The Laboratory Recognizes Physicists Lin and Ono and Engineer Williams

By Patti Wieser

Three researchers at PPPL are the 1999 recipients of the Kaul Foundation Prize for Excellence in Plasma Physics and Technology Development. The honorees are physicists Zhihong Lin and Masayuki Ono and engineer Michael Williams. The trio accepted the awards during a ceremony and reception at the Laboratory in October.

Ono and Williams were cited "for their work leading to the construction of the National Spherical Torus Experiment (NSTX) facility ahead of schedule and within budget." NSTX began operating a year ago. Ono is the Project Director for NSTX, as well as the Head of the NSTX Department, and Williams is Deputy Director of the Project, as well as Head of PPPL's Engineering and Technical Infrastructure Department.

Lin was honored "for performing advanced simulations with unprecedented realism and resolution leading to results demonstrating the positive impact of modern massively parallel computers and for outstanding contributions to understanding the physics of sheared zonal flows." Lin, a research physicist in PPPL's Theory Department, is involved in computer simulations relating to fusion research.

"It is a delight to be able to recognize an experimental physicist, an engineer, and a theoretical physicist this year. Their accomplishments in bringing NSTX on line within budget and ahead of schedule, and in advancing the state of the art in computational modeling using massively parallel processors are truly outstanding."

— Rob Goldston

"It is a delight to be able to recognize an experimental physicist, an engineer, and a theoretical physicist this year. Their accomplishments in bringing NSTX on line within budget and ahead of schedule, and in advancing the state of the art in computational modeling using massively parallel processors are truly outstanding," said PPPL Director Rob Goldston. Goldston and Princeton University Research Board Chair Will Happer presented the citations to the Kaul Prize recipients.

The Kaul Prize is awarded by Princeton University to recognize a recent outstanding technical achievement in plasma physics or technology development by a full-time, regular employee of PPPL. It includes a cash award of $2,000 for each of the honorees. Nominations for the award are submitted to the Prize Selection Committee, which includes the Princeton University Provost, the Chair of the Princeton University Research Board, the PPPL Director, PPPL Deputy Director, and PPPL Chief Scientist.

Former PPPL Director Ronald C. Davidson created the prize by directing that $40,000 of the $100,000 gift he received as the 1993 recipient of the Award for Excellence in science, education, and physics from the Kaul Foundation be given to Princeton University to endow the Kaul Foundation Prize for Excellence. Last year, the Kaul Foundation gave $60,000 to PPPL to supplement the endowment for the Laboratory's Kaul Prize. This is the third time the prize has been given.

Lin

Lin received a bachelor's degree in physics from Beijing University in Beijing, China in 1989. He came to PPPL in 1990 as a graduate student and joined the research staff in 1997 after receiving a Ph.D. in plasma physics from Princeton University in 1996.

Lin said, "This is really an award for the whole Theory Department in recognizing its groundbreaking work on the promising frontiers of advanced scientific computing. The excellent progress in this area of research has benefited from many key contributions from both inside and outside PPPL."

Ono

Ono came to PPPL as a graduate student in 1973 after receiving a bachelor's degree in physics from the California Institute of Technology. In 1978, he received a Ph.D. in plasma physics from Princeton University and joined the research staff at PPPL. Since 1978, he has led a number of research project teams at the Laboratory, including those for the Advanced Concept Torus-I, the

From left are PPPL Director Rob Goldston with 1999 Kaul Prize recipients Zhihong Lin, Michael Williams, and Masayuki Ono, and Princeton University Research Board Chair Will Happer. Goldston and Happer presented the citations for the Kaul Foundation Prize for Excellence in Plasma Physics and Technology Development to the recipients during a ceremony at PPPL in October.

Current Drive Experiment, and the Current Drive Experiment-Upgrade. Ono, a faculty member of the Princeton University Astrophysical Sciences Program, is the author of more than 170 scientific papers and is a 1995 PPPL Distinguished Research Fellow.

Ono said, "I am very happy and honored to receive the Kaul Prize on behalf of the NSTX Project Team for accomplishing the NSTX Construction Project within budget and ahead of schedule. The facility is running very well thanks to the excellent engineering and physics operating team. The performance of the device actually exceeded my own expectations! Mike and I had a great time 'cheerleading' the NSTX Project effort, but the success was truly due to the giant team work where a large number of people at all levels — from the Department of Energy and the DOE's Office of Fusion Energy Science to PPPL management and staff — contributed tirelessly in a synergistic fashion. Essentially, we received much help from every part of the Laboratory, as well as from external institutions that are collaborating on the project. I am grateful to be given this opportunity to serve as the Director of this great team."

Williams

Williams came to PPPL in 1976 after graduating magna cum laude from Rutgers University with a bachelor's degree in electrical engineering. At PPPL, he led several project teams, served as the Deputy Project Head of the Tokamak Fusion Test Reactor from 1992 until the project was closed down in 1997, and has been Head of the PPPL Engineering and Technical Infrastructure Department since 1991. Williams is the recipient of the 1999 Excellence in Fusion Engineering Award from Fusion Power Associates and of the 1993 Fusion Technology Award from the Institute of Electrical and Electronic Engineers-Nuclear and Plasma Sciences Section's Standing Committee on Fusion Technology.

Upon receiving the prize, Williams said, "The success of NSTX was the result of a lot of hard work by a number of people. The schedule was tight and the budget was lean, but the team managed to overcome all the typical construction and startup obstacles, making steady progress one day at a time. We are lucky to have had the support of such a talented and dedicated staff." ●

DOE Pulse

Science and Technology Highlights from the DOE National Laboratories

The U. S. Department of Energy's (DOE's) National Laboratories house world-class facilities where more than 30,000 scientists and engineers perform cutting-edge research spanning DOE's science, energy, national security, and environmental quality missions. Interested in the latest achievements of the National Laboratories? Then visit the DOE Pulse at: http://www.ornl.gov/news/pulse/. DOE Pulse is distributed twice each month. Each issue includes research highlights, updates on collaborations among laboratories, and profiles of individual researchers.

On the Road...with PPPL's Bob Budny

When European and Asian scientists analyze data from experiments on tokamak fusion machines, they often call upon American collaborators for assistance.

One of these collaborators is PPPL physicist Robert Budny. Budny is presently analyzing data from the Joint European Torus (JET) in England. "JET is a very interesting opportunity for us because it is one of the largest fusion experiments in the world and the researchers there have done an extensive deuterium-tritium (D-T) campaign. The Tokamak Fusion Test Reactor, which operated at PPPL from 1982 to 1997, is the only other fusion machine to do experiments using D-T as the fuel, so there is a natural affinity between TFTR and JET," says Budny, adding that another similarity between JET and TFTR is both produce high-temperature plasmas.

Budny, who has collaborated on tokamak research around the globe, shares his special expertise in code analysis that he has culled from years of experience on TFTR. "I model tokamak plasmas to understand what makes them tick. I use a computer code that inputs many different measurements, and calculates various quantities that we cannot measure. This allows us to check the consistency of the data, for instance to see if quantities that physics tells us must be conserved actually are. If not, this tells us that there may be a problem with the data, so the measuring system needs to be checked. Also, the results from the code are used as a bridge between the experimental data and theories," he explains.

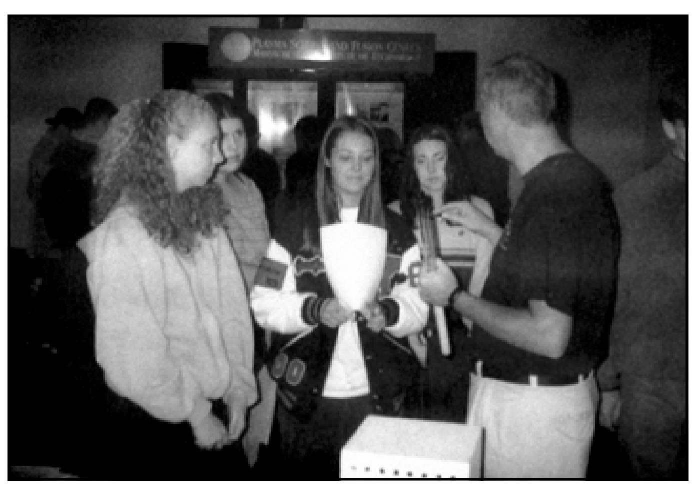
For the past two years, Budny has made six trips to England annually, spending three weeks at a stretch there. "I go to JET, talk to people, get data, and bring it back to PPPL, where I run the analysis. When I get the results, I send them back to England for use in publications and further analysis," he says, relying on e-mail and telephone calls for communication between his visits.

Robert Budny

Budny has also spent considerable time in France analyzing data from the Tore-Supra tokamak, as well as in Japan working with researchers on the JT-60U fusion machine, and with scientists at the TEXTOR tokamak in Jülich, Germany. In addition, while at PPPL he has worked with various foreign visitors. "I set up operations for a Chinese researcher to do simulations of the HL-2A tokamak in China," says Budny, who eventually co-authored a paper with the visitor.

Budny is one of several collaborators from PPPL. The DOE funds the collaborative efforts. ●

PPPL Science Exhibit is a Big Draw in Seattle



PPPL's John DeLooper (right) discusses science with visitors at the Plasma Sciences Expo during the American Physical Society-Division of Plasma Physics (APS-DPP) meeting held last November in Seattle. The Expo, which featured presentations, hands-on displays, and exhibits, as well as a chance to talk to fusion scientists, was conducted by the APS-DPP and coincided with the organization's annual conference on plasma physics. ●

Experimental Balloon Tested at PPPL's High Bay

In December, it looked as if you could embark on a trip "around the world in 180 days" at the motor generator high bay area of PPPL's D-site.

At one end stood a gigantic balloon — eight-and-a-half meters in diameter — made of 36 nylon panels and inflated with helium for testing.

The balloon, fabricated at Princeton University, will eventually be transported to Italy for the new Borexino Solar Neutrino Experiment at the Laboratori Nazionali del Gran Sasso. The Princeton University Nuclear Physics Group has a major role in the development of this experiment, which is designed to detect low-energy solar neutrinos, in real time, using 300 tons of liquid scintillator in an unsegmented detector. Neutrinos are elusive, subatomic particles.

Members of the borexino team brought the balloon to PPPL to test it for leaks, measure distortion, and check out its geometry.The Borexino experiment involves about 100 collaborators from several institutions. Researchers are from three countries, the U.S., Germany, and Italy. Ernst de Haas, a former PPPL'er on the project team, suggested D-site for testing the balloon because of the large, open space available there.

"They needed a place that had a crane and was free from any wind," noted PPPL's Gene Baker.

Said Princeton University graduate student Laura Cadonati, "The main goal of Borexino is to measure the flux of neutrinos from the electron-capture decay of 7Be in the Sun. This is one of the thermonuclear fusion reactions that produce the Sun's energy." The number of these neutrinos emanating from the Sun is lower than expected. Scientists are attempting to understand why.

"The balloon will be filled with a liquid scintillator at the project site in Italy. It will be the first of its kind able to detect low-energy solar neutrinos in real-time," said Allan Nelson, a member of the Princeton team.

Cadonati noted that the liquid scintillator being used in Borexino is pseudocumene, a benzene-like organic liquid, doped with fluorescent compounds. "This mixture produces light when hit by a particle such as a neutrino; this light is then detected by an array of photomultiplier tubes," she said.

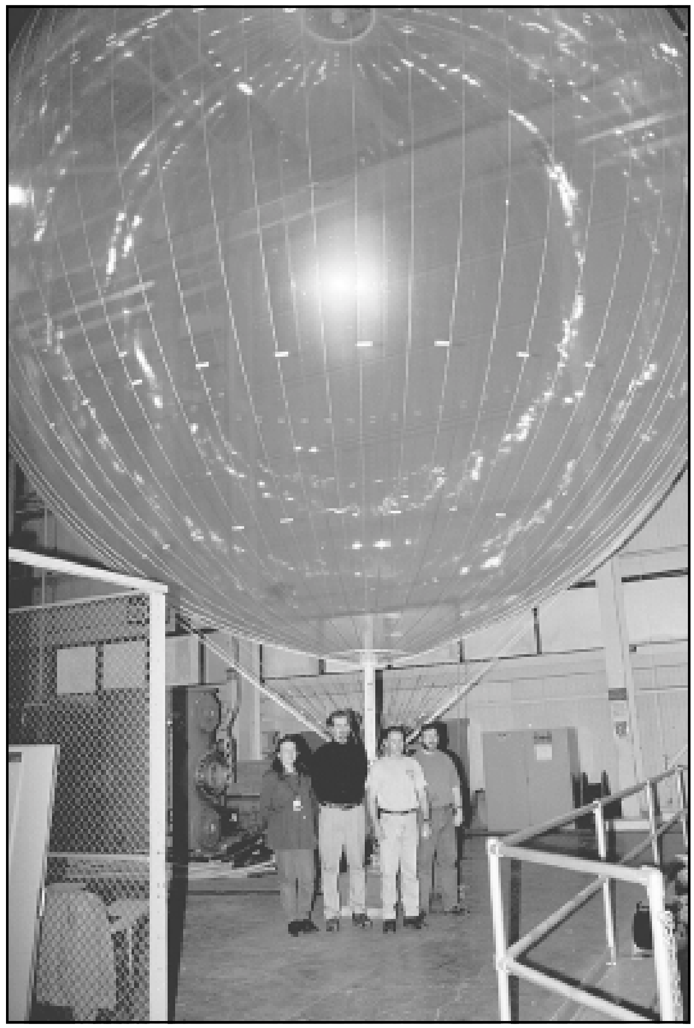
The balloon will go inside a larger balloon that will be placed into a stainless steel sphere. Pointing to the balloon at D-site, Princeton University Physics Professor Tom Shutt said, "This will be the center of the experiment."

The balloon tested at PPPL is a prototype. It or a new balloon is expected to go to Italy for futher tests sometime before the spring.

A special thanks goes to everyone at PPPL who assisted with the effort by lending tools, giving the team training on equipment, and conducting safety checks. PPPL staff who assisted with the effort are: Mounir Awad, Gene Baker, Larry Dudek, Chris Gilton, Bob Horner, Jerry Levine, Colin McFarlane, Lewis Meixler, Bob Parsells, Bill Slavin, and Mike Viola.

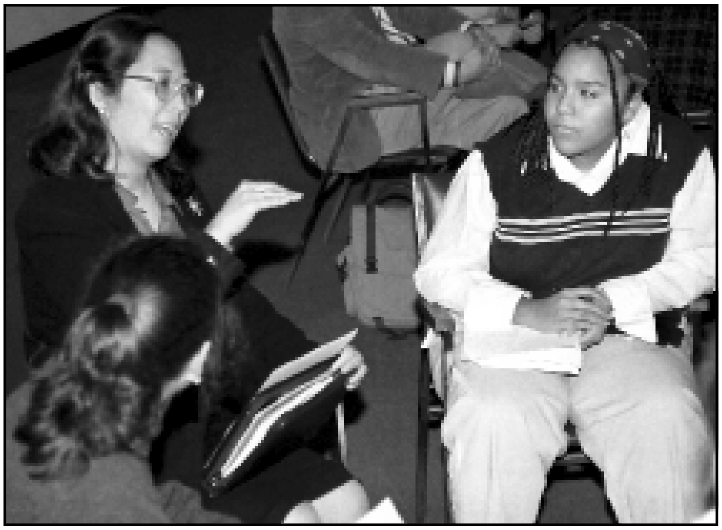
Borexino Group

The Borexino Group at Princeton University includes Jay Benziger, Frank Calaprice, Laura Cadonati, Mark Chen, Tom Shutt, Ernst de Haas, Richard Fernholz, Richard Ford, Cristiano Galbiati, Beth Harding, Aldo Ianni, Steve Kidner, Paul LaMarche (project manager), Fred Loeser, Allan Nelson, Andrea Pocar, James Semler, Andrew Sonnenschein, and Charles Sule. ●



From left are Laura Cadonati, Princeton University graduate student; Tom Shutt, Princeton University physics professor; Allan Nelson, technical staff member at Princeton University; and Richard Fernholz, Princeton University engineer.

PPPL Women Discuss Their Careers with Students



In January, PPPL's Andrew Post-Zwicker hosted a group of students from The Foxcroft School, an all-girls high school in Middleburg, Virginia. The day-long visit included a tour of experimental areas, hands-on experiments in plasma physics, and a small-group discussion with PPPL women about careers in science and engineering. The discussion was led by Science Education Program Acting Head Pamela Lucas and facilitated by Environmental Compliance Head Virginia Finley and NSTX software engineer Gretchen Zimmer. At left, Finley (middle) talks with the young visitors about how and when she made her career choice of environmental studies.

PPPL's "Green Machines" Awarded

Several PPPL'ers were named "Green Machines" for their recycling efforts during a presentation in the Auditorium for America Recycles Day (ARD) in November. From left are honorees Penny Neuman, Lisa Carlucci, Dolores Lawson, Jeff Makiel, Dianne Nunes, Mike Byrne, and Rich Gallagher, who accepted on behalf of Jules Nemeth. Award recipients not pictured are Erik Perry, Larry Sutton, Keith Rule, Sandy Schmidt, and Jules Nemeth. The ARD activities at the Laboratory also included presentations about the Laboratory's recycling efforts, area exhibitors, and a nation-wide Environmental Protection Agency satellite broadcast, "Buying Recycled: The Real Story about Cost, Availability, and Quality." The goal of ARD is to increase the purchase of recycled content products and recycling throughout America. "The Lab has greatly improved in recycling and buying recycled products during the last two years. We look forward to Earth Day 2000 in April," said PPPL's Tom McGeachen. McGeachen and PPPL's Margaret Kevin-King organized the ARD activities.