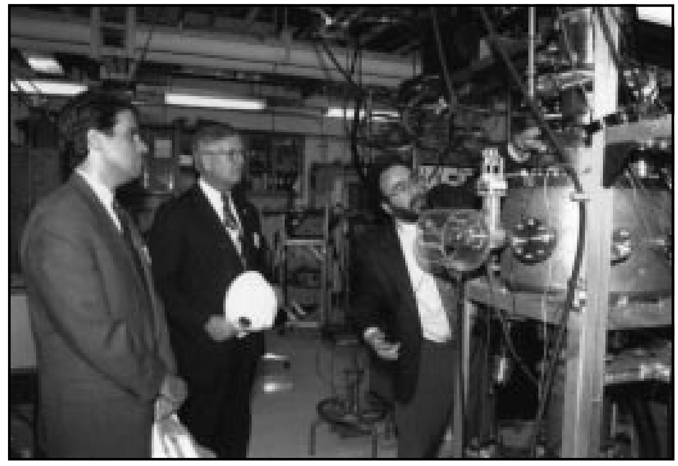
DOE PRINCETON PLASMA PHYSICS LABORATORY VOL. 2, NO. 1 • SPRING 1998

PPPL News

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

Lab Hosts Congressional Visitors

In the photo above, U.S. Representatives Rodney Frelinghuysen and Mike Pappas pledged their support for fusion funding during a January news conference at the Laboratory. During the conference, the Congressmen signed a letter to President Clinton urging him to fully fund the U.S. fusion research program in his annual budget. From left are Pappas, Frelinghuysen, Princeton University student Daniel Weitz, and PPPL Director Rob Goldston.



In November, PPPL Director Rob Goldston gave U.S. Representatives Michael Pappas and Curt Weldon a tour of PPPL. The Congressmen visited the Tokamak Fusion Test Reactor and the L-wing experiments, including the Magnetic Reconnection Experiment and the high-intensity hyperthermal atomic beam apparatus. Goldston (right) describes the apparatus to Pappas (left) and Weldon (middle).

Rob's Notes...

PPPL: Our Mission for the Future

The U.S. Department of Energy's Princeton Plasma Physics Laboratory (PPPL) is a Collaborative National Center for plasma and fusion science. The Laboratory's primary mission is to develop the scientific understanding and the key innovations which will lead to an attractive fusion energy source, including:

- Worldwide availability of inexhaustible fuel;
- No contribution to acid rain or global warming;
- Materials and by-products unsuitable for weapons;
- Radiological hazards thousands of times less than from fission;
- No runaway reaction possible;
- Cost comparable to other long-term energy options.

In the long run, perhaps one hundred years or so from now, experts estimate that a sustainable world energy economy will require three times *more* energy production than today – but with three times *less* carbon dioxide emission and with minimal other environmental impacts. At the 1998 meeting of the American Association for the Advancement of Science President Clinton expressed his confidence that fusion would help "grow the economy by restoring, not depleting, our planet." This is the fundamental theme of our research.

We must think globally, but we also must develop fusion for the sake of our own national energy security. While the nation possesses large reserves of coal, the environmental and ultimately economic cost of burning it may not be supportable. The U.S. is unacceptably dependent on other nations for the oil required to maintain our standard of living. The present tensions in the Middle East will seem minor compared to what we will face as reserves of oil and gas begin to run low in the next century. We will be more secure and prosperous in the future if we invest now in developing fusion and other clean energy sources.

Research at PPPL has given rise to new ideas on the magnetic confinement of plasmas – the hot ionized gases in which fusion reactions occur. PPPL's Tokamak Fusion Test Reactor (TFTR), which operated from 1982-1997, achieved world-record levels of fusion power and greatly enhanced our understanding of the science and technology required for practical fusion energy. The National Spherical Torus Experiment (NSTX), now under construction at PPPL — building on the insights from TFTR — is just the first of our new initiatives. Other exciting ones are now coming off the drawing boards. Together with the Oak Ridge National Laboratory and other institutions we are developing a proposal for a second "proof-of-principle" experiment, called the National Compact Stellarator Experiment, at about the same scale as NSTX. It combines results from TFTR with some of the earliest insights into plasma confinement by our founding director, Lyman Spitzer, Jr. We are also developing ideas for smaller experiments and planning a major initiative in computational plasma physics. An important element of our research involves collaborating on off-site experiments, both in the United States and abroad.

As we travel down the road to fusion, we are also making exciting scientific discoveries about the plasmas which form the sun and the stars and which fill the space around the earth. Understanding this plasma is crucial, for example, for the comprehension of "space weather" which affects our communication satellites and astronauts. Our plasma measurement techniques are applied to understanding solar flares and astrophysical phenomena.

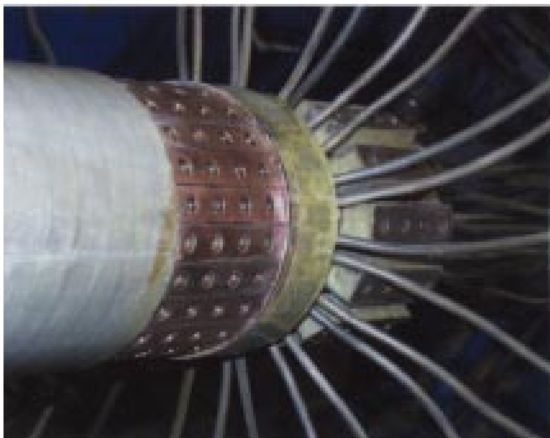
The science and technology of plasmas also have many applications here on earth. Our research provides important technological capabilities for society. Almost all computer chips are now processed with plasmas. Satellites are kept in their orbits using plasma thrusters. Plasmas are key to the latest high-efficiency flat-panel displays. The radio-frequency waves we use to heat plasmas can also be used to kill bacteria in milk. Here at PPPL, some of us are working on developing a new "cold pasteurization" process. Others are using lasers, originally developed to measure the characteristics of fusion plasmas, to monitor the properties of fibers, on the fly, as they are being made. Projects of this kind allow our research results to be applied in the near-term to help the national economy, while we continue our quest for a key new energy source for a sustainable world.

We hope you enjoy reading the *PPPL News*.

— Rob Goldston
PPPL Director

NSTX Moves Ahead

Construction of the National Spherical Torus Experiment Continues at PPPL



Photos by:
Tom Meighan and Elle Starkman

Construction of the National Spherical Torus Experiment (NSTX) is moving forward at PPPL. The experiment is a joint project among PPPL, Oak Ridge National Laboratory, Columbia University, and the University of Washington at Seattle, with PPPL having primary responsiblity for the project and coordination of its design. The experiment, expected to begin operation in 1999, will test the physics principles of spherical torus plasmas. Clockwise from bottom left: (1) Last fall, the Test Cell was cleared to make way for NSTX. (2) The lower half of the toroidal field (TF) center stack. The prong-like objects are cooling tubes that will be straightened out and then nested between the contact pads. (3) Representatives of the Department of Energy, PPPL, and Everson Electric look over the ohmic heating tension tube. From left are DOE's John Sauter, Everson Electric's Greg Naumovich, NSTX Project Director Masayuki Ono, DOE representative Jeff Hoy, and PPPL Procurement Head Rod Templon. (4) The NSTX Test Cell in its present state. The three cylinders at the back are high-voltage enclosures for the neutral beam line at right. (5) A mold at Everson Electric in Allentown, Pennsylvania, for the machine's TF center stack.

Team Develops Stellarator Concept

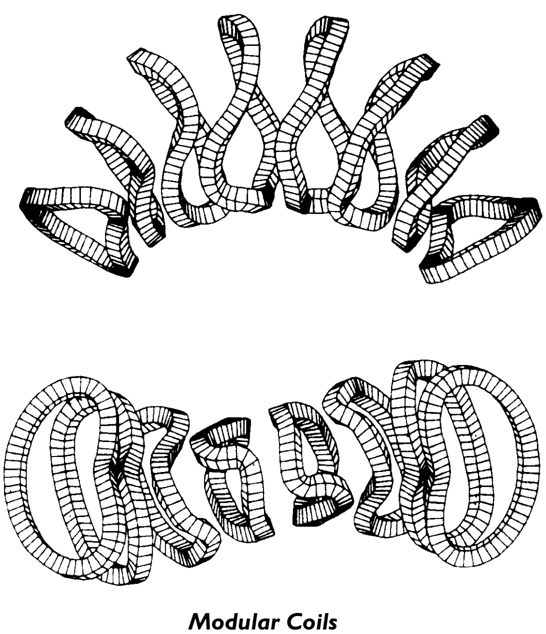
Later this year, a national stellarator experiment may be proposed for construction at PPPL. The project team, which is presently engaged in developing the conceptual design of a medium-sized, non-axisymmetric device, includes researchers from PPPL and many collaborating laboratories and universities in the U.S. and abroad. The stellarator configuration was presented during an international workshop on stellarator concept improvement at PPPL in January, and the machine's first plasma is proposed for 2002 or 2003. Below, Stellarator Project Leader Allan Reiman talks about the rebirth of interest in stellarators and their potential for advances in the development of fusion power.

By Patti Wieser

In a way, designing stellarator experiments during con temporary times is similar to navigating a ship in the late Middle Ages. Both — whether charting new territory in fusion research or crossing the ocean — pose difficulties without the proper navigational tools. And only with new inventions and technology are the hurdles overcome.

"Until the compass was invented, people pretty much sailed ships along the shoreline. They couldn't go very far from the shore without getting lost at sea. With the invention of the compass, they were able to cross the ocean," said PPPL Stellarator Project Leader Allan Reiman.

Just as the invention of the compass allowed sailors to venture across the ocean without getting lost, the recent development of sophisticated computer programs gives scientists the tools to design, investigate, and conduct research on a broader range of devices such as stellarators.



Modular Coils

"Once researchers give up the guiding principle of axisymmetry and begin research with non-axisymmetric devices they find themselves a little bit at sea. So they need something to guide them — some compass or navigational tool. In recent years, larger computers have become available, and we've developed sophisticated computer programs that provide such a tool. And now we're beginning to see that there's no fundamental reason why axisymmetric devices are better than non-axisymmetric devices."

The term stellarator refers to a large class of toroidal devices that are non-axisymmetric. A non-axisymmetric device is one in which the magnetic field changes as one follows it around the torus (in contrast to an axisymmetric device, where the field does not change). A non-axisymmetric magnetic field can be produced from an axisymmetric one by giving it a twist. Some stellarators have modular magnetic coils that look like deformed toroidal field coils. Another example of a stellarator is the heliac model in the Lobby, which is similar to one being built in Spain and to a smaller one in Australia.

Lyman Spitzer founded the Laboratory with a stellarator experiment in the 1950s, but it presented problems which researchers could not solve because they lacked the necessary computational tools. And while some level of interest in stellarators continued at PPPL over the years, tokamaks became the favored fusion device during the last two decades.

"Until recently, people focused on axisymmetric machines such as tokamaks. An axisymmetric magnetic field has basically the same shape as an automobile tire in the sense that if you rotate it, it looks pretty much the same. This simplifies things conceptually and allows you to understand more easily what's going on," explained Reiman.

A potential advantage to a stellarator is more flexibility. "Once you allow the magnetic field to become three dimensional, there is more flexibility in terms of controlling the properties of the magnetic field and being able to do things that you couldn't do in axisymmetric devices," Reiman said. For instance, in a stellarator, researchers have more control over the shape and pitch of the field lines than in a tokamak.

Another advantage the stellarator has over a tokamak is that it doesn't have disruptions, said the project leader. Also, you don't need to drive a plasma current.

"In principle, you can sustain a stellarator plasma indefinitely. In practice, however, you have limitations unless you have such things as superconducting coils," he said.

In addition, researchers can get a better test of their codes than before. "So you have these computer codes that tell you how to design your machine and in some sense they embody the present state of knowledge in plasma physics," said Reiman. "The codes tell you to go off in a certain direction and twist the coils in a certain way. You then can test the physics basis for following that direction. That leads to advances in plasma science that benefit the whole magnetic fusion program."

There are about ten medium-sized to large stellarators in the world. The stellarator being proposed for construction at PPPL would be medium-sized — about as large as the Princeton Beta Experiment-Modification (PBX-M). It would be the third — and largest — stellarator in the U.S. Larger stellarators — comparable in size to the Tokamak Fusion Test Reactor (TFTR) — include the soon to be completed LHD in Japan and the planned W7-X in Germany. Both are in the $500 million to billion dollar range.

The stellarator at PPPL would use many existing facilities such as power supplies, machine components, heating systems, and diagnostics. One possibility is to convert PBX-M to a stellarator. "That would have a lot of advantages including the ability to reuse the coils, vacuum vessel, and diagnostics. We are presently looking into the various options," noted Reiman. If PBX-M is reused, the project would need some additional coils inside the vacuum vessel to produce the non-axisymmetric field. "The main new component would be the coils. We're asking our computer programs to come up with an optimal shape," said the project leader.

In addition to equipment and experimental space, PPPL has another important stellarator resource — its staff. "We have a number of people with expertise in stellarators. In addition to current staff, John Johnson, who is retired, maintains an interest. He's now in Japan as a visiting professor at the stellarator lab there for three months. We are always happy to get his input," Reiman said.

Returning to his analogy, Reiman said, "It was only after they started using the compass in the late Middle Ages that they really learned how it worked. When Columbus sailed to America and got close to the Caribbean, he discovered that his compass no longer pointed toward the North Star. There was a major panic on the ship. And it was only with time that people discovered that the north magnetic pole was not the same thing as the north pole of the earth. With this knowledge, they improved the use of the compass for navigation. That's analogous to how we use our computer programs to help us design a stellarator. We know that we can rely on our computer programs only up to a point, and then we have to do an experiment and see what is really going to happen." ●

The PPPL stellarator team includes (from left): Larry Grisham, Irving Zatz, Martha Redi, Mike Zarnstorff, Rob Goldston, George Sheffield, Hutch Neilson, Allan Reiman, John Schmidt, Harry Mynick, Don Monticello, Morrell Chance, Bob Simmons, Gerd Schilling, Guo-Yong Fu, Harold Furth, and Long-Poe Ku. Not pictured are Art Brooks, Neil Pomphrey, and Gregory Rewoldt.

PPPL Rated Outstanding

Outstanding. That's what the U.S. Department of Energy (DOE) rates PPPL for the Laboratory's operations in fiscal year 1997.

In a report released earlier this month, the DOE gave the Laboratory the highest rating — outstanding — for its scientific and operational accomplishments. The federal agency cited the Laboratory for providing new insights into physical sciences and for constructing and operating leading edge experiments on schedule, within budget, and in a safe and environmentally sound manner. In addition, PPPL was noted for aggressively expanding its role in collaborating with other domestic and foreign fusion programs, as well as for theoretical and computational work, and efforts in technology transfer, public outreach, and education.

"This highest citation from the Department of Energy, which recognizes our first year under the new performance-based contract, is the result of the efforts and dedication of our extraordinary staff," said PPPL Director Rob Goldston. "It is also a great credit to the leadership of former Director Ron Davidson and former Interim Director John Schmidt during fiscal year 1997."

Difficult Challenges

N. Anne Davies, Associate Director for Fusion Energy Sciences for the DOE's Office of Energy Research, commended the Laboratory for successfully dealing with difficult challenges during the past year, including a change in top management, downsizing, and the closing of the record-setting Tokamak Fusion Test Reactor.

"Despite these circumstances, PPPL has maintained a balanced, well-qualified staff who, under their new director and deputy director, are highly motivated and dedicated to sustaining their institution's strong record of scientific and operational accomplishments," said Davies.

She further cited PPPL for "making the transition from a tokamak-dominated research program to one more focused on innovative concepts, consistent with and fully supportive of DOE's strategic goals for a restructured fusion energy sciences program."

Said DOE Princeton Group Manager Jerry Faul, "This rating is the highest that could be earned ... I express my appreciation to all of the Laboratory staff who contributed to this successful year."●

PPPL Collaborates with Agriculture Department in Development of Pasteurization Process

Researchers Are Investigating Use of Radio Frequency and Microwave Heating for Pasteurization

A small group of researchers at PPPL — including physicist Randy Wilson, engineers Elmer Fredd and Chris Brunkhorst, and technician Dave Ciotti — is focusing its attention on an innovative pasteurization process through a collaboration with the Agriculture Department.

Last fall, PPPL and the U.S. Department of Agriculture (USDA) signed an interagency agreement to jointly develop new pasteurization methods that use radio frequency (RF) waves and microwave heating. These heating techniques — also used to warm plasma in a fusion device — are being tested for pasteurizing raw liquid foods such as eggs, fruit juices, and milk.

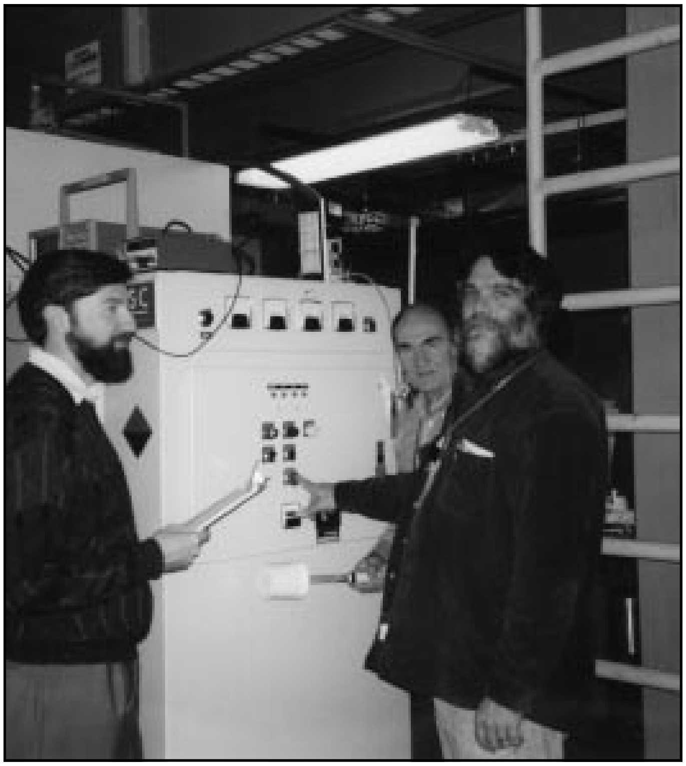
"This is another example of applying our fusion and plasma science capabilities to an area that benefits the U.S. public," said PPPL Technology Transfer Head Lewis Meixler.

The $120,000 agreement between the two federally funded agencies came about after researchers at the USDA's Eastern Regional Research Center (ERRC) in Philadelphia evaluated RF radiation while exploring improved methods for pasteurization. Initial results and subsequent evaluation of micro-organisms introduced into liquid foods indicate that RF radiation is a potentially effective means for pasteurization.

RF Advantages

RF waves offer advantages over the traditional pasteurization method of directly heating raw liquid foods. The direct method often heats foods unevenly, possibly resulting in incomplete pasteurization in lower temperature regions and in denaturing foods in overheated regions. Using radio frequency waves in the appropriate wavelength may allow pasteurization without heating liquid foods to temperatures that cause food deterioration.

The ERRC is collaborating with PPPL because of the Lab's extensive experience in the application of RF and microwave radiation to the study of plasmas. The Labo-



Next to the radio frequency oven that will be used in the pasteurization experiments are members of the PPPL team, including (from left), Chris Brunkhorst, Elmer Fredd, and Dave Ciotti. Not pictured is Randy Wilson.

ratory has particular expertise in optimizing the absorption of RF and microwave energy into a receiving medium. Experience includes the measuring of RF parameters, instrumentation, the design and fabrication of antennas, and the safe handling of these components.

The four-person PPPL team is working with Mike Kozempel, who is the USDA's Principal Investigator on the project. The PPPL team is assisting the ERRC researchers in improving the operation of their RF power source, as well as providing the expertise to enable the measurement of power deposited, power launched, and launch efficiency. In addition, the PPPL group is concentrating on optimizing the equipment's RF launch configuration.

The ERRC's radio frequency oven is presently at PPPL for testing and modifications. The machine is expected to be returned to the ERRC sometime this summer, where the pasteurization experiments will take place.

The agreement between ERRC and the Princeton Plasma Physics Laboratory supports a memorandum of understanding between Secretary of Agriculture Dan Glickman and former Energy Secretary Hazel O'Leary to use one federal agency's technologies to benefit research at other federal agencies. ●

PPPL Funded for Textile Research

By Anthony R. DeMeo

The U.S. Department of Energy's Princeton Plasma Physics Laboratory (PPPL) will receive $700,000 in fiscal year 1998 under a recently established Cooperative Research and Development Agreement (CRADA) between the Laboratory and the Princeton Textile Research Institute. The agreement is part of the American Textile Partnership (AMTEX) — a government-industry consortium which includes many of the nation's leading textile and apparel manufacturers. Under the terms of the CRADA, Laboratory staff will develop state-of-the-art optical techniques for the on-line characterization of synthetic fibers during production.

"The AMTEX Partnership provides PPPL scientists with the opportunity to apply technology developed in magnetic fusion research to help solve a significant industrial problem in the near-term. We are pleased to join our colleagues from other DOE-supported laboratories participating in AMTEX," noted PPPL Director Rob Goldston.

PPPL's Dennis Mansfield is the Principal Investigator on the CRADA. He will be joined by Phil Efthimion and Stewart Zweben, who will act in administrative capacities, and Hideo Okuda, who will be involved in theoretical and numerical work on the project.

Said Mansfield, "There will be an enormous economic benefit, if we can monitor and control the characteristics of synthetic fibers such as nylon and dacron online during the manufacturing process. Substantial time and money will be saved by eliminating the need to stop production to remove samples for off-line laboratory

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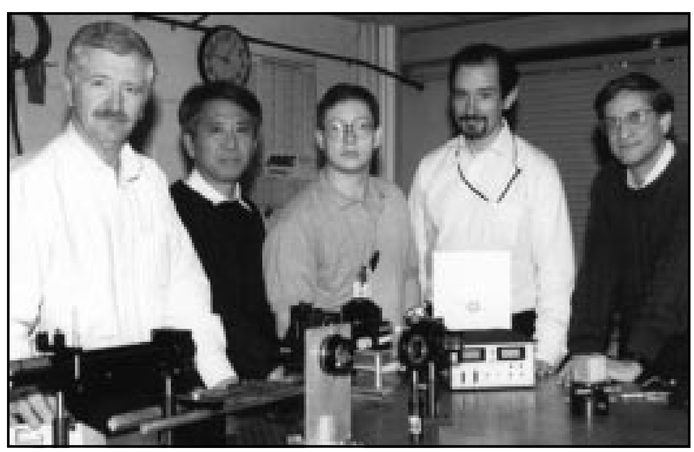

PPPL staff involved in the AMTEX project are (from left) Dennis Mansfield, Hideo Okuda, Mark Cropper, Phil Efthimion, and Stewart Zweben. The laser device is on the table in front of Efthimion. Not pictured is Lewis Meixler.

AMTEX

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analysis." PPPL scientists also expect to expand significantly the number of fiber properties that can be measured.

On-line measurement of the physical and chemical properties of textile fibers will allow process adjustments to be made immediately — a substantial advantage. It is anticipated that vastly improved process reproducibility, efficiency, and quality control will result, eliminating the over-production presently needed to insure an adequate supply of fiber with consistent characteristics.

For years, PPPL scientists have used sophisticated lasers operating in the infrared, visible, and ultraviolet wavelength ranges to study the properties of hot ionized gases — high-temperature plasmas in which fusion reactions occur. The PPPL staff will now apply these well-developed research tools to help textile manufacturers.

Specifically, laser light will be scattered from textiles during and immediately following solidification of the extruded fibers, as well as during the drawing process. During these processes, the fibers are moving at speeds up to 30 miles per hour. The light scattered from fibers under these conditions contains important information about the physical and chemical make-up of the polymer under investigation.

Mansfield noted, "Whatever instrument comes out of this work will have to function in the difficult environment of a factory floor; it will, therefore, have to be robust. In this regard, making delicate measurements on a factory floor presents many of the same challenges that arise in the environment of a fusion device. We hope to be able to exploit the revolutions which are currently taking place in the fields of laser physics, modern optics, and computer science to meet these challenges."●

Science Over Supper

Throwing light on the subject, local teacher Doris Gross (left) works with PPPL scientist Andrew Post Zwicker to understand the principles of electrical circuits. The workshop, held recently at the Patton J. Hill Elementary School in Trenton, was titled "Wire That House! — Understanding the Basics of Electricity." As part of PPPL's "Science Over Supper" series, area teachers are teaming up with PPPL scientists to explore the science concepts they teach in their classes. Besides electricity, topics cover geology, plate tectonics, earthquakes, energy, magnetism, and the solar system. A second series, organized by PPPL's Science Education Program staff, is being planned for this spring.

PPPL Receives Donation

In photo at right PPPL Deputy Director Richard Hawryluk (left) accepts a $1,000 donation from Robert F. Kelley, Vice President of the Division of Environment, Safety, and Communications for Formosa Plastics Corporation, U.S.A. The donation is for the Laboratory's research and science education efforts.

Managers Gain Diversity Insight through Workshop

By Patti Wieser

"He's from there? Hm. I didn't know they had physicists in that area of the country."

"He has a college degree and is applying for a secretarial position. Something's not right."

"Do you think someone from that culture can handle a management position? Those people are always so non-confrontational. What if she has to tell a staff member that he or she isn't doing a good job?"

Such stereotypically spiked perceptions could be first impressions managers have of potential employees or promotional candidates. And if the adage "first impressions are the most important" is believed, employment decisions will be affected.

Through a Diversity Awareness program offered to PPPL Council members and senior managers in January, participants worked to break through assumptions, judgments, and stereotyping while demystifying diversity and recognizing its advantages. "This workshop let people know what diversity is and what it isn't," said PPPL Diversity Leader Pamela Lucas.

Diversity includes physical, cultural, and institutional differences, including race and gender, religion and demographic background, as well as management style and communication modes. Diversity is **not** a new name for affirmative action or a special program to disenfranchise white males. Nor is it a fast track project for women and minorities. Diversity awareness is recognizing and valuing the skills and abilities of all employees, and seeing the worth of alternative perspectives.

How We Perceive Other People

Information Services Head Anthony De Meo said, "I expected the program to be about employment quotas, but it was really about how we perceive other people. We were warned not to be fooled by first impressions or preconceived notions of individuals or cultural groups." He added that greater communication among different groups is critical.

Computer Head Dori Barnes said the program instructor offered a refreshing approach. "No one was made to feel bad about harboring an inkling of a prejudice about someone or something. The instructor's philosophy was realistic — we all have natural biases or make assumptions based on perceptions. The trick is how to focus our awareness of differences on their positive aspects and to respect others and understand how differences can be valuable to us and the organization," she said.

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Diversity trainer Ricardo H. Correia (standing) leads a group of PPPL senior managers during a diversity awareness workshop at the Laboratory.

Diversity

Continued from page 9

The workshop, conducted by Centaur Consulting President Ricardo H. Correia, focused on raising the level of awareness about diversity issues. According to material from the Connecticut-based Centaur, diversity allows people to recognize and appreciate the benefits of diverse experiences and perspectives. The concept encompasses three main elements: respecting all people simply because they are people; being aware that due to the uniqueness of each person's experiences, he or she will bring a different and valuable perspective; and understanding how those perspectives are a business asset and a necessary commodity.

Participant Steve Jardin commented, "I think the main point was that people with different backgrounds see problems and events from different perspectives, and may see solutions or improvements that others miss. We are a very diverse society, and it is constructive to view this diversity as an advantage."

Doug McCune called the training "entertaining and thought provoking." "The gist was to remind us to question our assumptions especially as these affect our relationships with others. This is a good thing to do on a continuing basis," said McCune.

He said the training reminded him of something he read not long ago by a Microsoft manager about the process of building an effective software development team. One of the manager's cardinal rules was "Don't flip the BOZO bit!" Explained McCune, "What he meant was just because somebody on the team once gave you some bad information or a false lead, that is not enough reason to set BOZO=TRUE in regard to this person, and to never again listen to anything he or she says."

McCune said everybody agrees that making snap judgements based on ill-informed prejudice can be destructive to the set of relationships that forms our institution. He added that diversity training is good, but more important factors are the examples provided by the Laboratory's leadership and the work environment they foster.

"Snap judgements occur frequently when people are pressured to produce beyond their capabilities. Overcoming prejudice requires energy and thought. If one feels 'I've got to keep moving, I don't have time to think about this,' then one is going to cut corners. This includes making snap judgements based on prejudice, sacrificing the long-term health of the Laboratory as an institution based on human relationships in the interest of some short-term consideration," he said.

Lucas noted the workshop generated a lot of discussion among participants, and was successful in heightening the awareness of PPPL's senior managers about diversity issues.

"It is important that department and division managers are involved in this training because we need support from the top for diversity efforts. This day reinforced the Lab's leadership commitment to diversity and we hope this is just the beginning in a long process of continuing diversity efforts," she said.●

Women of Color Dinner Draws Crowd

Princeton University's fifth annual Dinner in Celebration of Women of Color was a hit. The March 5 dinner and evening of entertainment drew several PPPL'ers, as well as Princeton University staff and friends. Above is the group from the Laboratory, including, from left, Teresa Greenberg (back to camera), Mary Ann Brown, Sue Murphy-LaMarche, co-organizer Pamela Lucas, Arlene White, Linda Harmon, and James Morgan. The Director's Minority Advisory Committee and Director's Advisory Committee on Women at the Laboratory contributed to the event.

PPPL's Interactive Website Wins Awards

It's "Cool." It's a "Hot Spot." It's a "Best of the Web." It's PPPL's interactive, educational website, called IPPEX, that allows users to operate their own fusion experiments and analyze data from real experiments conducted by physicists. The site recently won five awards.

The Internet Plasma Physics Educational eXperience (IPPEX) website was cited for its excellence last fall on five websites, including those of *New Scientist* magazine and the Exploratorium museum. IPPEX is a fully interactive educational experience that teaches users about plasma physics and fusion energy at a pre-college level (see website address at end).

One of Ten Cool Sites

IPPEX was selected for the Hot Spots section of *New Scientist* Planet Science website. Hot Spots is Planet Science's pick of science and technology-related sites on the web. In addition, the Exploratorium, a museum of science, art, and human perception in San Francisco, chose IPPEX as one of the "Ten Cool Sites" for the month of September, 1997. Each month, the Exploratorium picks the best websites in science, art, and education. Sites are submitted by visitors to the Exploratorium homepages or suggested by its staff and are selected based upon content, design, and the overall experience of visiting them.

The *"Virtual Tokamak,"* an IPPEX section created by PPPL's Daren Stotler, was chosen as one of the top 25 percent web applets by JARS, the JAVA Review Service. JAVA is a programming language invented by Sun Microsystems for writing programs that can be downloaded through the Internet and immediately run on a local computer. Applets are small JAVA programs that allow web pages to include functions such as animations, calculators, or almost anything a regular computer program could do safely.

"We are excited we were able to develop a way for students to interact with real scientists, doing real experiments in a way that is meaningful and helpful to the students."

—Andrew Post Zwicker

WWW Associates, an Internet development company whose customers include Hewlett-Packard and Lucent Technologies, voted IPPEX one of the top 10 science sites on the web. Finally, the Yahooligans Directory on the Internet cited IPPEX as its only "cool" physics site under Top Science and Oddities: Physics.

"We are excited we were able to develop a way for students to interact with real scientists, doing real experiments in a way that is meaningful and helpful to the students," said IPPEX Project Manager Andrew Post Zwicker. "Our goal is to interest them in science and deepen their understanding of basic concepts."

Besides being noted at various websites, IPPEX has had an impact on students from as nearby as the Bronx to as faraway as Italy. IPPEX was featured in the Thirteen/WNET program, "The Internet in Action — Real Time and Remote Visits," where 10th graders at the Bronx High School of Science used it in their physics classes.

And, IPPEX helped create a new plasma physicist when an Italian undergraduate who had finished the TFTR data analysis section wrote expressing a desire to pursue graduate studies in fusion energy, but did not have any contacts in the field. Post Zwicker introduced him to an Italian colleague who arranged an interview for him. He starts his graduate work this fall.

In addition to Post Zwicker, the IPPEX development team at PPPL includes members of the Science Education Program, physicists Steve Scott and Daren Stotler, Engineering and Technical Infrastructure Head Mike Williams, Computer Division Head Dori Barnes, and software engineer Bill Davis. The new look was created by Da Jin Wang, a 1997 high school summer research student from Union City, NJ. The site includes a section of data analysis from the Tokamak Fusion Test Reactor (TFTR) at PPPL; the "Virtual Tokamak" and Magnetic Drift JAVA applets; interactive units on relevant physics topics; and "Ask a Scientist," in which students from all over the world ask questions on plasma physics and fusion energy.

Teaching Tool

IPPEX gives teachers a tool to use while teaching a subject that is difficult to demonstrate and explain, allowing students to interact with the site, visualize difficult concepts, and analyze actual data from a fusion experiment. It is funded by the New Jersey Networking Infrastructure in Education at the Stevens Institute of Technology through a grant from the National Science Foundation. The address for IPPEX is:

http://ippex.pppl.gov/ippex/

Princeton University Wins $305,000 DOE Grant to Advance Study of Inertial Confinement Fusion

The Department of Energy (DOE) announced this month the award of a multi-year research grant, valued at $305,000, to Princeton University to carry out experimental studies of high energy plasmas and how they interact with laser pulses. The research will support DOE's advanced studies of inertial confinement fusion.

PPPL's Nathaniel Fisch will lead the Princeton team examining how electrons are transported and magnetic fields are generated when a very short laser pulse collides with a pre-heated, pre-compressed plasma. This study of plasma effects during "fast ignition" of fusion reactions will help scientists understand and model ultraintense laser/matter interactions.

Other Grants

Thirteen other research grants, with a total worth of $5.2 million over three years, were awarded in a new research effort in high-energy-density science as part of the department's Inertial Confinement Fusion program. Initial funding of $2 Million has been appropriated for the current fiscal year (1998). Average funding for a winning proposal is about $143,000/year for two- and three-year programs of work. The 14 grants will support the work of professors and students at 16 universities, as well as researchers from one private company, in 11 states and the District of Columbia. At least 10 post doctoral associates and 13 graduate students will receive support from the grants.

Nathaniel Fisch

"The work that will come out of these grants will add to our basic knowledge of physics, and help to train future scientists and engineers," said Dr. Victor H. Reis, Assistant Secretary of Energy for Defense Programs. "Both of those goals are compatible with our long term plan to maintain the safety and reliability of the nation's nuclear stockpile without further nuclear testing." ●

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