PPPL U.S. DEPARTMENT OF ENERGY
PRINCETON PLASMA PHYSICS LABORATORY
WEEKLY
MONDAY, JANUARY 7, 2013

At PPPL THIS WEEK

WEDNESDAY, JANUARY 9

PPPL Colloquium
4:15 p.m. ◇ MBG Auditorium

The Environmental Footprint of Shale Gas Extraction and Hydraulic Fracturing
Robert Jackson, Duke University
Refreshments at 4 p.m. in the LSB Lobby

Click here for link

SATURDAY, JANUARY 12

Science on Saturday
9:30 a.m. ◇ MBG Auditorium

Visualizing the Atomic World
Udo D. Schwarz, Yale University

UPCOMING EVENTS

Jan. 21
Martin Luther King. Jr. Day

Director's Corner

Seeking staff feedback for an improved PPPL

By **STEWART PRAGER** — Director, Princeton Plasma Physics Laboratory

PPPL benefits from numerous external advisory and review committees that regularly provide critical outside perspectives on all aspects of the Lab. However, the greatest insight and most potent ideas for improvement are found right here at home. To tap directly into the pulse and brains of the Lab staff, I have initiated a series of meetings with small groups from the Lab – groups of about 15 people, all from the same department. So far I have covered about 20 percent of the Lab. My goal is to work my way through all of the staff throughout the spring.

The director's suggestion box, available on our local network, is an additional good vehicle for feedback and I benefit regularly from continuous informal discussions at the Lab. But I find the meetings (without managers present to encourage broad participation in discussions) to be a wonderful venue to discuss Lab improvements.

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SAFETY CHAMPIONS NEEDED

As part of a continuing effort by PPPL to strive for the safest work environment possible, the Lab is forming an employee-led "Safety Champions Committee." This group will serve as a focal point to engage workers, offer workers' perspectives on the implementation of the safety program, and provide an additional path to raise safety concerns to Laboratory management. The committee also will make recommendations and provide input on Laboratory ES&H policies and procedures. The Lab is looking for volunteers who are willing to serve on this Committee and help improve the safety culture at PPPL.
Mike Williams will serve as the ES&H Executive Board Safety Champion for this committee. Based on the response, an initial slate of members will be selected and the expectation is that membership will be rotated on at least an annual basis to accommodate staff interest. Please contact Adam Cohen, chair of the ES&H Executive Board, at acohen@pppl.gov by next Monday, Jan. 14, if interested.

Celebrating the 30th anniversary of TFTR's first plasma

By John Greenwald

'Twas the night before Christmas and all through the cell
Not a creature was stirring. Just the warning bell.
The diagnostics were hung on the tokamak with care
In hopes that first plasma soon would be there.

—From "Santa Claus Comes to Fusion" by Paul Reardon, project manager for the construction of TFTR

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The makeshift control room cheers the first plasma. Standing from left: Jim Sinnis, Dale Meade, Nelson Grace, unidentified, Sam Goldfarb, Harold Furth, Don Grove, Robert Woolley. Seated from left: Phil La Rue, Bruce Berlinger.

Director's corner

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The meetings offer a two-way flow of information: I receive input from staff but also provide feedback to questions raised on any topic. There is no planned agenda; we discuss whatever is on anyone's mind. Invariably, a large number of compelling ideas are raised, some brought to the meeting by participants, some arising spontaneously through discussion. Topics range over every facet of Lab activity, including (to date) salary policy, job appraisal practices, Lab celebrations, safety, Lab strategy, the future of the Lab, communications within the Lab, recruitment of early career staff, recruitment of undergraduate and graduate students, overtime policy, Lab policy for inclement weather, and more. The suggestions are abundant. Every suggestion and concern is being logged and considered carefully. We are assembling a master catalogue of all suggestions, with possible associated actions. As we implement the actions we will provide feedback to the staff on progress.

Thanks to all that have met with me to date. I look forward to upcoming meetings and especially, to implementing your suggestions.

TFTR first plasma

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Staffers at PPPL had more than the holidays to celebrate this past Christmas Eve. The date marked the 30th anniversary of a scientific milestone that saw the Laboratory's Tokamak Fusion Test Reactor (TFTR) produce its first plasma—the superhot, electrically charged gas that fuels fusion reactions as a potential source of clean and abundant energy. The dramatic 1982 event climaxed months of furious preparation to meet a year-end deadline and ushered in more than a decade of record-setting experiments on the big PPPL machine.

But that first step was hardly easy.

The historic day began on Dec. 23, 1982, and stretched into the early hours of Christmas Eve as glitches stalled progress. The day-and-night-long effort produced a stopped clock, a critical machine part tied together with rope, and a souvenir T-shirt that had to be replaced as the day wore on. "It was pretty crazy," recalled Rich Hawryluk, who headed a physics operations group during that time and is currently completing a two-year tour as Deputy Director-General of ITER, an international fusion experiment under construction in France. "Most of us had worked pretty much nonstop 16-hour days, seven days a week to get ready for the first plasma," said Hawryluk, "and by the time we finally made it we were all feeling weary and slightly punchy."

The balky 600-ton, 17-foot- high TFTR device behaved like a car that wouldn't start. "We had to go underneath the hood to find out the problem," Hawryluk said. The machine's power system created havoc when a copper component called a bus bar failed its preoperational tests. This was like warning lights coming on in a car, and forced some unanticipated maintenance. After due consideration, technicians replaced the bus bar with cables lashed together with rope—an ad hoc fix that was only possible because of the restrictions on machine capability at the time.

The Tokamak Fusion Test Reactor (TFTR) at PPPL in 1982.

Water leaks and complex interlocks

The faulty bus bar was just one source of electrical woe. Charles Neumeyer, who ran the power supply system, had to contend with frequent leaks in water-cooling lines plus an unreliable interlock system that controlled access to the TFTR test cell so that workers could fix problems. "Trying to get the interlocks armed and ready was very difficult because of the newness and complexity of the system," said Neumeyer, who now heads the Electrical Engineering Design Branch at PPPL and serves as team leader for the Steady State Electrical Network for ITER. "It took half an hour to restore the system to operating condition each time we used it."

Computers were another challenge, since the system that controlled TFTR experiments had not been fully installed. So the Laboratory created a makeshift command center near the TFTR test cell to augment the control room in the basement of the subsequently named "Lyman Spitzer Building" (LSB).

The 100 or so staffers trying to make plasma were unable to attend the annual holiday parties that PPPL departments were holding that day. "We started early in the morning and were pushing hard to make first plasma by noon so we could have lunch and join the parties,"

TFTR first plasma

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recalled physicist Dale Meade, who served as deputy to TFTR Project Head Don Grove. "But we just kept running into problems."

Meade wanted to present Grove with a T-shirt that read, "TFTR First Plasma Dec. 23 1982" once the plasma was made. He asked Sallie Connell, who worked in the budget office, to hunt up such a shirt. Connell, who has since married Meade and uses his last name, returned with the shirt only to find that the date needed changing since there still was no plasma. "I had to hurry back down to Trenton before the shop closed," she recalled. She made it in time and brought back a T-shirt with "Dec. 24" as the date.

Down in the LSB basement control room, Kenneth Young, who headed the TFTR diagnostic unit, found little to occupy him. The bank of computer monitors had few new data to report since there was no plasma to diagnose. "We got rather bored because there was little we could do. The few active diagnostics had all been thoroughly checked out," Young recalled. "I am sure that pizza was ordered in to keep us all going through the evening." Young passed time chatting with Ned Sauthoff, who was deputy division head for the central instrumentation, control and data acquisition system and now directs the ITER Project Office at the DOE's Oak Ridge National Laboratory.

Sauthoff had his own glitches to deal with. "Something was corrupting the computer program's automatic sequencing of programs," he recalled. This forced programmer Walt Stark to restart the sequence after each attempt to make plasma.

An unplugged command-post clock

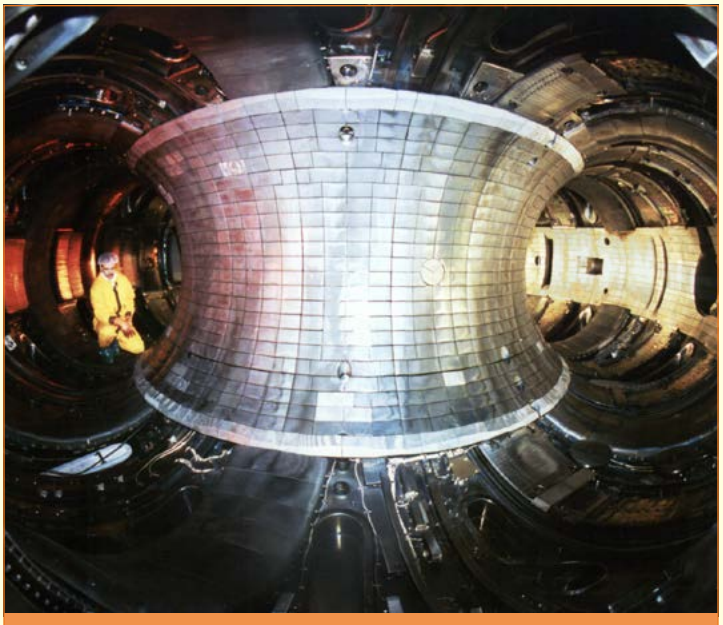
As time dragged on, PPPL Director Harold Furth decided to halt work at midnight to keep staffers from getting too tired. But Grove and Meade, who were in the makeshift command center with Furth, persuaded him to extend the deadline to 2 a.m.—yet still there was no plasma. So at 1:55 Meade ducked under a bank of control panels and unplugged the clock's cord from the wall. When Furth glanced at the clock an hour later, he seemed surprised that it was still before 2. Pulling out his pocket watch, he saw that the time was actually 3 in the morning and mouthed something inaudible when he realized what had happened.

The delay worked, however, since all TFTR systems were now ready to go. At 3:06 a.m. on Christmas Eve, then-smoker Charles Neumeyer, with a walkie talkie in one hand and a cigarette in the other, announced the countdown "5 — 4 — 3 — 2 — 1 — 0," and pushed the button to initiate the first plasma.

The big moment lasted some 50 milliseconds as an electric current pulsed through the hydrogen gas in TFTR, stripping electrons from the hydrogen atoms and turning the gas into plasma. Cheers broke out in both control rooms as bright wavy lines displayed the current and its voltage on computer screens. In the LSB basement, Kenneth Young witnessed the plasma itself as a flash of white light that a camera that looked inside TFTR beamed to a control room screen. "There was a terrific cheer," said Young, "and a feeling of huge relief that we had done it."

Among those celebrating the achievement was Nelson Grace, the DOE's on-site area manager. His presence was vital since he needed to certify that the Laboratory had kept its commitment to DOE to produce a TFTR plasma by the end of that year. "Achieving first plasma allowed the Department of Energy to complete the construction phase of TFTR and move on," recalled Milt Johnson, the Chief of the Engineering and Construction Branch in the DOE's area office at PPPL.

The weary workers could now finally party. Champagne greeted them in the LSB lobby, Don Grove got his T-shirt and Kenneth Young presented Harold Furth with the computer tape of the first plasma data, which now resides in the Computer Division's tape vault at the Laboratory. "We all celebrated in the lobby and then dragged ourselves into our cars and went home in the wee hours of the morning," Rich Hawryluk recalled. There still would be much to do, because "Santa Claus was arriving 24 hours later and many of us had relatives to entertain."



A view of the inside of the TFTR vacuum vessel.

PPPL teams with South Korea on forerunner of commercial fusion power station

By John Greenwald

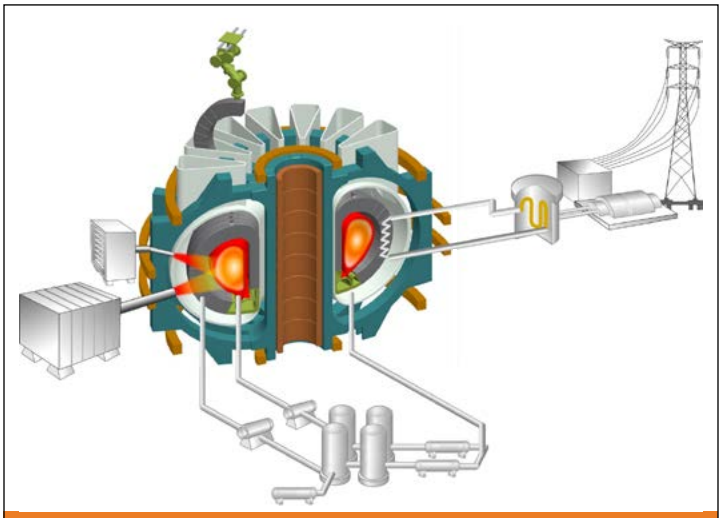
PPPL has joined forces with researchers in South Korea to develop a conceptual design for a pioneering fusion facility in that Asian nation. The proposed device, called K-DEMO, could be completed in the mid-to-late 2030s as the final step before construction of a commercial fusion power plant that would produce clean and abundant energy for generating electricity.

The full K-DEMO project requires approval by the South Korean government. South Korea's National Fusion Research Institute (NFRI) will fund PPPL's initial collaboration, which will run for six months, beginning in January, and could be extended.

The cooperative agreement stands to enhance the development of fusion energy in both the United States and South Korea. PPPL will explore cutting-edge designs and technologies that could benefit the U.S. fusion program, and South Korea will gain access to the Laboratory's deep experience in designing and engineering fusion facilities. These include the National Spherical Torus Experiment (NSTX), PPPL's leading fusion experiment, which is undergoing a major upgrade.

The K-DEMO collaboration will be "a mutual win for everyone," said George "Hutch" Neilson, head of advanced projects at PPPL, who will oversee the Laboratory's role in the cooperative design effort. Working with Neilson and NFRI, will be PPPL engineers Tom Brown, Charles Kessel and Peter Titus, together with fellow members of the Laboratory's mechanical engineering division.

PPPL has a history of cooperating with South Korea on fusion projects. The Laboratory helped design that country's major fusion facility, called KSTAR, in the 1990s and participates in experiments on the advanced machine. Both KSTAR and NSTX produce strong magnetic fields in circular devices called tokamaks to control the hot, electrically charged plasma gas that fuels fusion reactions.



Schematic sketch of the proposed K-DEMO fusion facility. (Courtesy of South Korea's National Fusion Research Institute).

The K-DEMO collaboration will be "a mutual win for everyone," said Hutch Neilson, head of advanced projects at PPPL. Neilson will oversee the Laboratory's role in the cooperative design effort.

New agreement

The new collaborative agreement caps some six months of planning that included a pair of visits to PPPL by leaders of the South Korean fusion program. Plans call for the Laboratory to provide engineering analysis of K-DEMO design concepts, including the size and shape of the K-DEMO tokamak and the strength of the magnetic fields that will create and control the plasma. "We all share the same vision to deliver a possible DEMO design," said Dr. Gyung-Su Lee, a research fellow at NFRI. "We will share our expertise so that the outcome will benefit not just K-DEMO, but a next-step U.S. fusion facility as well."

K-DEMO will be comparable in size to ITER, a seven-story tokamak that the European Union, the United States, South Korea and four other nations are building in Cadarache, France. ITER is to produce 500 million watts of fusion power for 500 seconds by the late 2020s to showcase the feasibility of fusion energy. K-DEMO, by contrast, is to produce some 1 billion watts of power for several weeks on end. "K-DEMO should be just a small step away from a commercial plant in technology and performance," said Neilson.

K-DEMO will be a two-stage project. The first stage, called K-DEMO 1, will develop components for the second stage, K-DEMO 2, to use to produce fusion energy and generate electricity. Construction of a commercial fusion generating station would follow completion of the overall K-DEMO project.

K-DEMO could thus set the pace for global efforts to achieve commercial fusion energy. Countries including China, Japan and India are contemplating their own demonstration facilities as gateways to commercial fusion power stations that could operate by mid-century.

PPPL Holiday Party

Above, PPPL'ers catch up with friends and enjoy their luncheon at the annual holiday party in the LSB Lobby on Dec. 21.

Lining up for the feast: From left to right: Mark Cropper, John Edwards, Robert Walker and Chris Brunkhorst.

The King was in the building: Elvis, aka Andrew Zwicker, gets some laughs in the skit.

Coworkers enjoy the holiday fare: From left, Teodora Todorova, Floribeth Chacon and Nelson Neal.

A moment to relax: From left to right: Marina Gorelenkova, Andrea Moten and Carol Ann Austin.

Bill Slavin and Michael Gonzalez as special agents Prager and Cohen are on a mission in the annual skit.

2013 Science on Saturday

Princeton University Plasma Physics Laboratory Lecture Series

JANUARY 5	**THE LARGE HADRON COLLIDER: BIG SCIENCE FOR BIG QUESTIONS** by Prof. James Olsen, Department of Physics, Princeton University
JANUARY 12	**VISUALIZING THE ATOMIC WORLD** by Prof. Udo D. Schwarz, Dept. of Mechanical Engineering and Materials Science and Department of Chemical and Environmental Engineering, Yale University
JANUARY 19	**OUTER SPACE!** by Joshua E. G. Peek, Hubble Fellow, Department of Astronomy, Columbia University
JANUARY 26	**DISASTROUS EQUATIONS: THE ROLE OF MATHEMATICS IN UNDERSTANDING TSUNAMI** by J. Douglas Wright, Associate Professor, Department of Mathematics, Drexel University
FEBRUARY 2	**FROM 0 TO C IN 60 MINUTES: A CRASH COURSE IN EINSTEIN** by Prof. R. Shankar, John Randolph Huffman Professor of Physics, Department of Physics, Yale University
FEBRUARY 9	**FINDING A NEEDLE IN A (GENOMIC) HAYSTACK OR HOW CAN COMPUTERS HELP CURE CANCER** by Prof. Olga G. Troyanskaya, Lewis-Sigler Institute for Integrative Genomics and Department of Computer Science, Princeton University
FEBRUARY 16	**FROM ROBOT SOCCER TO AUTOMOTIVE SAFETY: AN OPTICAL TOUR** by Prof. R. Andrew Hicks, Department of Mathematics, Drexel University
FEBRUARY 23	**NO LECTURE — DOE'S NJ HIGH SCHOOL SCIENCE BOWL®**
MARCH 2	**LIGHT AND NANOTECHNOLOGY — ENGINEERING AND SO MUCH MORE** by Prof. Claire Gmachl, Department of Electrical Engineering, Princeton University
MARCH 9	**A SHORT HISTORY OF LENGTH** by Prof. Joel Langer, Department of Mathematics, Case Western Reserve University
MARCH 16	**A ROBOT'S VIEW OF OUR OCEAN PLANET** by Josh Kohut, Assistant Professor of Oceanography, Center for Coastal Physical Oceanography, Rutgers University

Talks will be held in the Auditorium of the Princeton Plasma Physics Laboratory, James Forrestal Campus, U.S. Route 1 North in Plainsboro, NJ
FOR ADDITIONAL INFORMATION PLEASE VISIT OUR WEBSITE AT: www.pppl.gov

SCIENCE ON SATURDAY is a series of talks geared toward high school students but open to all. Students, teachers, parents, and community members are welcome. There is no fee for the program.

TIME: Doors open at 8:15 a.m. Lectures begin promptly at 9:30 a.m. and usually last one hour followed by a moderated question-and-answer session which typically ends by 11:15 a.m.

REGISTRATION: Register on site prior to each session. No preregistrations accepted. Seating is on a first-come first-served basis.

CANCELLATIONS: If it becomes necessary to cancel a session due to inclement weather, laboratory or national emergency, a message will be left on the Science-on-Saturday Hotline at (609) 243-2121.

PPPL PRINCETON PLASMA PHYSICS LABORATORY

U.S. DEPARTMENT OF ENERGY

Presently, PPPL, a federal facility, is taking heightened security measures. Upon arrival, all adult visitors must show a government-issued photo ID. This could include a passport or a driver's license. Non-U.S. citizens must show a photo ID, plus provide the following information: citizenship, date of birth, and place of birth. For the welfare of both our staff and visitors, PPPL security staff retain the right to inspect vehicles and personal packages such as briefcases, satchels, bookbags, and purses.

PPPL GIVES

Thank you to everyone who contributed to this year's food drive! PPPL collected 356 pounds of food and personal hygiene items for the Mercer Street Friends Food Bank in December!

*Thank you to all the PPPL'ers who contributed **$31,562** to the PPPL and Princeton University United Way as of Dec. 21. Your contributions will help numerous organizations in Mercer County.*

Although the drive is over, you can still send in your contributions, so keep those donations coming!

2013 Science on Saturday

Princeton University Plasma Physics Laboratory Lecture Series

Visualizing the Atomic World

UDO D. SCHWARZ
Yale University

Saturday, January 12, 2013
9:30 a.m. • M.B.G. Auditorium

COLLOQUIUM

The Environmental Footprint of Shale Gas Extraction and Hydraulic Fracturing

ROBERT JACKSON
Duke University

Wednesday, January 9

4:15 p.m. (Coffee/Tea at 4 p.m.)
M.B. Gottlieb Auditorium, Lyman Spitzer Building

Brock PPPL Café Menu

BREAKFAST ..... 7 a.m. • 10 a.m.
CONTINENTAL BREAKFAST..... 10 a.m. • 11:30 a.m.
LUNCH ..... 11:30 a.m. • 1:30 p.m.
SNACK SERVICE ..... until 2:30 p.m.

COMMAND PERFORMANCE CHEF'S FEATURE	MONDAY JAN. 7	TUESDAY JAN. 8	WEDNESDAY JAN. 9	THURSDAY JAN. 10	FRIDAY JAN. 11
					
	3 CHEESE LASAGNA	ARROZ CON POLLO	CHICKEN PARMESAN W/ PASTA MARINARA	BEEF TACOS	VEAL AND PEPPERS OVER PASTA
EARLY RISER	Bacon, Tomato & Onion Omelet	Blueberry Pancakes	Potato Knish with 2 Eggs Any Style	Breakfast Pita Pizza	Broccoli, Cheddar & Bacon Wrap
COUNTRY KETTLE	Cream of Broccoli with Cheddar	Black Bean With Bacon & Cilantro	Cream of Cauliflower	Roasted Corn, Pepper & Tomato Chowder	Chicken & Sausage Gumbo
GRILLE SPECIAL	Meatball Parm Torpedo Served with Fries	Bacon, Mushroom & Cheddar Cheesesteak with Onion Rings	Peppers & Egg Torpedo with Potatoes	Texas Tommy Hot Dog with Bacon & Cheddar, Onion Rings	Veggie Burger with Guacamole & Salsa with Chips
DELI SPECIAL	Turkey, Bacon & Cheddar Wrap	Classic Ham & Cheese Hoagie	Chicken Caesar Salad Wrap	Salami, Capicola, Provolone, Roasted Peppers, Pesto Torpedo	New Orleans Muffuletta
PANINI	Chipolte Pork & Avocado Wrap	Portabella, Provolone, Roast Peppers, Provolone Ciabatta	Chicken, Spinach, Feta & Kalamata Olive Ciabatta	Grilled Cheddar, Apple & Spinach On Multigrain Roll	Vegetarian Quesadilla with Veggie Sticks

MENU SUBJECT TO CHANGE WITHOUT NOTICE

CLICK HERE FOR A PRINTABLE WEEKLY MENU

WEEKLY

Editor: **Jeanne Jackson DeVoe** ◆ Layout and graphic design: **Gregory J. Czechowicz**
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