

HOTLINE

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

Stellarator Vacuum Vessel Segment Arrives

On May 9, the first of three vacuum vessel parts for the National Compact Stellarator Experiment (NCSX) rolled into PPPL. Covered with a protective cloth, the metal hunk — weighing more than 6,000 pounds and filled with holes that made it resemble a silvery twist of Swiss cheese — arrived on a flatbed.

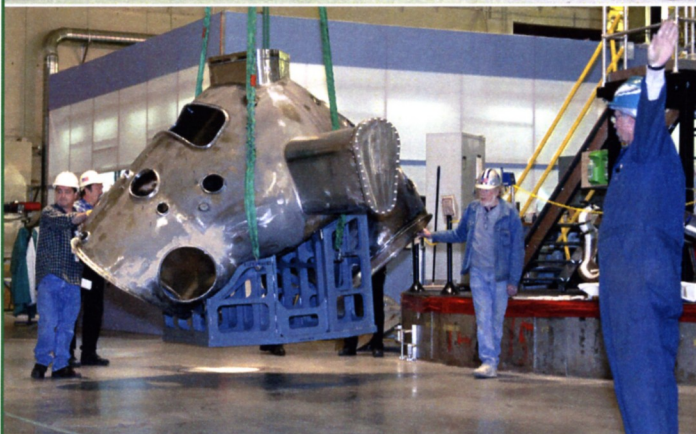
Some folks eagerly awaited the arrival. PPPL's Mike Viola watched from the LSB Lobby windows as the delivery entered the site. "I had great anticipation. The segment is a once-in-a-lifetime fabrication," Viola said. He was on a break from the Lehman Review for NCSX, and had arranged for the delivery to coincide with the meeting. "I wanted the review folks to see it."

Once the flatbed made it to the NCSX Coil Winding Facility at D-site, PPPL staff used a forklift, and then a crane and rigging to install the segment inside the facility. The team included Ed Bush, Red Delany, John Edwards, Manny Fernandez, Kris Gilton, Erik Perry, and Colin Phelps. Perry, the lift engineer for the job, said the team for the vessel arrival was ready with one intention: to do the job right. In less than an hour's time, the piece was in place and ready for measurements to ensure it was built to model.

Major Tool and Machine, Inc., of Indianapolis, manufactured the vessel segment, with its three largest diagnostic ports installed. Twenty-four additional port extensions will be installed at PPPL. It is made of Inconel 625, an alloy that is hard to form, but has high electrical resistivity to suppress electrical currents that could interfere with

plasma confinement. NCSX Project Head Hutch Neilson said, "Major Tool did an excellent job manufacturing this challenging part."

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Photos and collage by Elle Starkman

PPPL Hosts Annual Safety Forum for Staff



Shane Bush

PPPL staff filled the MBG Auditorium and Cafeteria on May 15 for the Lab's annual Safety Forum. Shane Bush, of the Idaho National Laboratory, presented a talk, "Celebrating the Human Side of Safety," and PPPL Environment, Safety & Health (ES&H) Division Head Jerry Levine gave a presentation about the Laboratory's safety performance. Jack Anderson, Head of the Lab's ES&H and Infrastructure

Department, and DOE's Steve Eckstrand offered remarks, and PPPL Director Rob Goldston presented safety awards to NCSX and NSTX staff.

Following the forum, all staff members were invited to discuss possible solutions to safety issues at several breakout sessions around the site. The issues had been raised in small group meetings prior to the forum. To view the forum presentations, summary presentations from the eight breakout sessions, and a video of the forum, go to the ES&H Executive Board web site at: http://www-local.pppl.gov/eshis/ESH_Exec_Bd.html.



PPPL's Jerry Levine discusses safety practices at PPPL during the annual Safety Forum held in the MBG Auditorium.

Goldston, who congratulated members of the NCSX and NSTX staffs for their safety records, repeated his mantra to PPPL'ers at the forum: "Let's keep working safely, safely, safely." ●

PPPL's Sharma Receives Grimm Prize

Princeton University graduate student Prateek Sharma is the recipient of the 2006 Ray Grimm Memorial Prize in Computational Physics. The award recognizes Sharma for his "outstanding research achievements, academic merit, and creativity."

He was awarded the Grimm graduate fellowship "in recognition of his novel numerical methods for simulating the dynamics of low-density astrophysical plasmas, and on the basis of strong letters of recommendation." He works on numerical simulations of collisionless accretion flows around black holes.

The prize honors an advanced student in computational physics and includes an award of \$5,000. It was established in 1985 in memory of Ray Grimm, a talented and popular scientist and teacher. "It feels good to receive a fellowship that recognizes computational effort. Numerical simulations are the basis for many advances in physical understanding, but

are not always given their due credit," said Sharma. He is receiving a Ph.D. in astrophysical sciences, program in plasma physics, this summer. Upon graduation, Sharma is joining the Astronomy Department at the University of California, Berkeley, as a postdoctoral research fellow. Before



Prateek Sharma

coming to Princeton University in 2001, he received a bachelor's degree in engineering-physics at the Indian Institute of Technology in Bombay. In 2003, Sharma received the first Thomas H. Stix '54 Plasma Physics Prize. ●

Hotline

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The HOTLINE is issued by the Princeton Plasma Physics Laboratory, a research facility supported by the United States Department of Energy. It is primarily an internal publication. Correspondence and requests to reprint material should be directed to the Editor, PPPL HOTLINE, P.O. Box 451, Princeton, NJ 08543; Interoffice correspondence should be addressed to MS-38, LSB Bldg., C-Site; fax 609-243-2751; telephone 609-243-2757; e-mail pwieser@pppl.gov.

PPPL Collaboration Yields Fusion Advance

By Anthony R. DeMeo

In two back-to-back articles published in the May 19th issue of *Physical Review Letters*, PPPL physicists, along with colleagues from the Netherlands and California, report a major advance in understanding the so called “sawtooth” instability — one of the most important and familiar plasma phenomenon. Their work may lead to the ability to control and manipulate the instability, substantially benefiting the performance of future fusion reactors such as ITER.

“The sawtooth instability has been the subject of more than 30 years of research,” said PPPL physicist Hyeon Park, who is the lead author on both *Phys Rev* papers, one reporting experimental results and the other reporting the impact of these results on sawtooth theory.

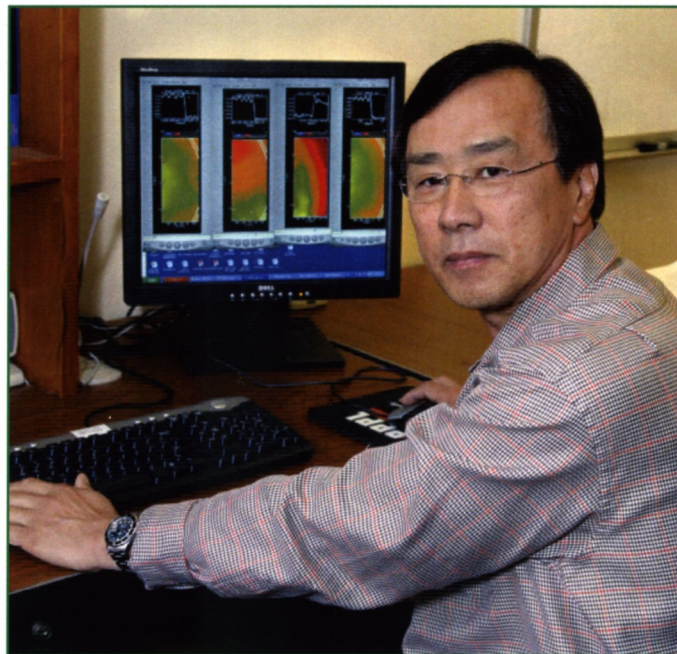
“This instability, originally discovered on PPPL’s Symmetric Tokamak in 1974, derives its name from the pattern of the X-ray signal coming from the core of the plasma. The repetitive up and down (sawtooth) pattern of the X-ray signal is due to the relatively slow build up and rapid collapse of the central plasma pressure at regular intervals, which is the essence of the sawtooth oscillation,” Park said. The recent experimental work was performed on the TEXTOR device, a tokamak located at the Forschungszentrum in Julich, Germany.

Two-dimensional pictures

The intensity of microwaves emitted by the plasma is a measure of plasma temperature. PPPL physicists and their colleagues from the FOM-Institute for Plasma Physics Rijnhuizen in the Netherlands and from the University of California, Davis, developed a new microwave camera with high space and time resolution, and the ability to take two-dimensional pictures. The sawtooth instability causes the temperature and pressure at the center of the plasma to collapse rapidly. Images taken on TEXTOR demonstrated that during the sawtooth collapse, heat from the center of the plasma flows outward via a small perturbation (disturbance) in the confining magnetic field.

The two-dimensional pictures of the perturbation of the magnetic field make it possible to compare experimental results directly with predictions from various theoretical models. In fact, one model has already been discarded on the basis of the results, and the limitations of two other models, which describe only part of the sawtooth evolution, became clear. Theoreticians can now use the results to adjust their existing models or develop new ones. Physicists hope this will lead eventually to a complete understanding and control of the sawtooth instability.

Park explained the importance of this understanding for burning plasma devices such as ITER. “The sawtooth



Hyeon Park

instability will cause helium produced in the deuterium-tritium fusion reactions to be exhausted from the center of the plasma to its edge. The helium ash will hold 20 percent of the fusion energy produced, and in a burning plasma device, this energy will be the predominant source of plasma heating,” he said.

Park added that once it has imparted its energy to the bulk plasma, the helium must be swept out to the edge of the plasma and removed. “Otherwise it will build up, cool the plasma, and the fusion reaction will stop. However, if the sawtooth instability is not properly controlled, the helium will be swept out prematurely. So it would really be great if we had a ‘knob’ on the fusion reactor to turn the instability on and off and to regulate its amplitude and frequency,” he said.

Intense Microwave Beam

Interestingly, using an extremely intense microwave beam (1 million watts), the Dutch team was able to heat the TEXTOR plasma very locally. Depending on where the heating took place, they found that the frequency of the sawtooth instability could be varied. This should make it possible to regulate the exhaust of the helium ash from the center of the plasma, thereby preventing a large reduction of the plasma temperature and pressure at the core.

In addition to its importance in developing a magnetic fusion reactor, understanding the sawtooth oscillation will be highly beneficial for solar and interstellar physics, which both involve magnetically-confined plasma phenomena. ●

PPPL Staff to the Rescue

When PPPL's Mike Viola and Erik Perry arrived, they found a modular office on its side, basically intact. The cab of the tractor-trailer hauling the modular unit had jumped the median and was face-down on the southbound side of Route 1 just off Forrestal Campus. "I talked to the truck driver, who was shaken, but unhurt," recalled Viola.

Viola and Perry were among PPPL staff who responded to the May 18 accident, which happened shortly after lunch. Laboratory personnel from the Engineering Department, Environmental Services, and Materiel Services groups assisted PPPL's Emergency Services Unit (ESU), New Jersey State Police, the Plainsboro Township Police and Fire Departments, and the Middlesex County Hazardous Materials Unit in responding to the single-vehicle accident. The driver had reportedly lost control of the vehicle when another vehicle was passing. No one was injured and no other vehicles were affected. The trailer and modular unit blocked the entire northbound lane in front of the Forrestal Campus and closed off traffic in both directions for several hours. The tractor straddled the Jersey barrier with its ruptured fuel tank hanging into the southbound lane, leaking about 275 gallons of diesel fuel onto the roadway. The PPPL Hazmat team swung into action to assist with the containment and cleanup of the fuel spill. "The first priority was to control the hazard of the spilled diesel fuel," said ESU Captain Dave Neuman, who along with ESU's Darren Thompson and Sean Donohue joined PPPL's Hazmat team to control and clean up the spill. "The second was to safely move the office trailer and get the roadway opened up."

The ESU team had its equipment ready and used a Holmatro power wedge to pry the trailer up enough to allow forklift forks under the modular unit. "I was impressed with the way all the agencies involved worked together and I was proud to be part of the Lab's effort. Once it was determined there were no injuries, we prioritized what needed to be done," Neuman said.

The PPPL Tech Shop rigging crew used a 15-ton forklift to gently pry the unit up a bit more to allow cribbing to be placed. Then slings were pushed under it and PPPL's 35-ton Grove crane lifted the unit up and to the side of the road. The PPPL group had decided to use the crane when Viola learned the gross load weight was 26,000 pounds. The crane load indicator showed that the modular unit actually weighed only 16,000 pounds. Viola had used calculations for the slings and positioned them to spread the load. "We had 50 feet of sling on each of the two basket configurations," he said. The lift was safely and successfully executed and U.S. Route 1 reopened before rush hour. "To have a major accident on an artery like the Route 1 corridor controlled, cleaned up, and reopened to traffic for the evening rush hour was a great accomplishment and a credit to all involved," said Neuman.

Perry also lauded staff involved. In an e-mail, he wrote, "Thanks for the prompt and very professional response ...Your skills and ability to handle the situation safely and efficiently were praised by the local police, fire departments, the Middlesex County Hazmat unit, the Mercer County Emergency Operations Center and especially the N.J. DOT."

Added Viola, "Everyone from PPPL was cooperative and watched out for everybody's safety. The groups came together and were calm, and everyone had good ideas for dealing with the accident. We talked about the plan before the lift. It was definitely a team effort." ●



Photo by Dietmar Krause



Photos by Rob Sheneman and Elle Starkman.

Lab Strives to Save Energy and Reduce Costs

Concerned about burgeoning energy costs and possessing an eye for “green,” PPPL continues its efforts to conserve energy and cut back on energy-related spending. The challenge is on, with natural gas and fuel oil costs affected by the Katrina disaster, and a 75 percent increase in PPPL’s electricity rate since deregulation in 2003.

In response to Katrina, the Lab set a goal to reduce energy usage by 5 percent during the last heating season, which ran from November of 2005 through April of 2006. PPPL exceeded these energy reduction goals by taking the following actions, which resulted in an estimated savings of \$122,000!

- Issued progress reports about PPPL’s energy conservation to staff via e-mails, asking for its support in energy reduction efforts.
- Identified additional areas in which lighting could be controlled by the Building Automation System and added control of these lighting circuits to the system.

- Reduced the boiler plant main header pressure and reused 90 percent of the steam generated by the boilers.
- Installed additional energy-efficient lighting systems.
- Brought a new energy efficient and air-cooled air compressor on line in January of 2006, which conserves electrical energy and drinking water.
- Replaced the computer servers in the NSTX Control Room area with energy-efficient computer servers in the Computer Center.
- In the winter, maintained a temperature of 70 degrees Fahrenheit in non-experimental areas during regular working hours and 55 degrees Fahrenheit during off hours. In the summer, maintained a temperature of 75 degrees Fahrenheit in non-experimental areas during regular working hours and 84 degrees Fahrenheit during off hours. ●

– Provided by Tom McGeachen

Energy Savings Talk Slated

Homeowners in New Jersey can expect a 14 percent increase in electricity costs beginning this month. To find out how you can conserve energy at home and save money, come to the “Save Energy and Save \$\$\$ at Home” brown-bag lunch presentation by Tom McGeachen on Wednesday, June 28, at 11:45 a.m. in the Training Room. Check out these websites before you attend: <http://www.energystar.gov/> and <http://www.njcleanenergy.com/>. ●

Vacuum Vessel Arrives

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With its arrival at PPPL, our Field Period Assembly activities can now get under way.”

The next two segments will be delivered this summer. During final assembly in the NCSX Test Cell, the three segments will be welded together to make a 25,000-pound chamber that looks like a hollow French cruller with only three twists. The completed vessel will have a total of 84 ports, which will provide access for plasma heating and diagnostic devices.

NCSX is under construction as the centerpiece of the U.S. effort to develop the physics and determine the attractiveness of the compact stellarator as the basis for a fusion power reactor. NCSX is being built at PPPL in partnership with Oak Ridge National Laboratory. The experiment is scheduled to begin operations in 2009. ●

Guess What This is and Win a Prize



If you can identify what this is or how it was used at PPPL, you may get a chance to win a PPPL T-shirt. Long-time employees — dig into your memory banks. PPPL newcomers — ask around. Send your guesses to pwieser@pppl.gov by July 1. Those who guess correctly will be entered in a drawing. Hint: It is still on site, but hasn't been used for decades!

Works of Artsy PPPL'ers Exhibited at University



At the reception for the opening of this year's Art of Science exhibition at Princeton University are, from left, PPPL's Andrew Post-Zwicker, Michael Burin, and Elle Starkman, whose works are included.

The work of four PPPL artists and a “sculpture” from the Lab made it into the University’s second annual “Art of Science” exhibition on display in the Friend Center.

The juried show, highlighted by three winning student entries, features prints, videos, poetry, paintings, and sculptures — 55 works in all — produced in the course of scientific or technical research by faculty, staff and students in more than a dozen different departments. Works by PPPL’s Michael Burin, Charles Skinner, Elle Starkman, and Andrew Post-Zwicker are included. Last year, Starkman and Post-Zwicker took first place for their joint entry, “Plasma Table.”

“It was a pleasant surprise to win last year, especially since it was the first competition. I didn’t expect to win again this year, but I was happy that two of my collaborative entries were selected for the exhibition,” said Starkman, PPPL’s photographer.

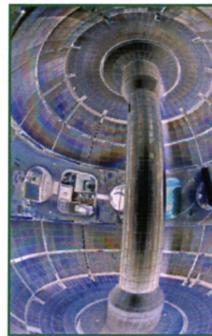
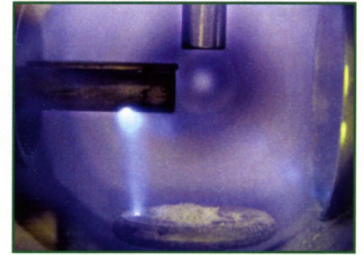
The exhibited works — which include six videos, one sculpture, one poem, three canvases and 44 digital prints — were selected from more than 150 submissions.

One of the most unusual pieces in the exhibit — a solicited work that was not entered into the competition — is a 3-ton “sculpture” that was found in a scrap heap at PPPL. The sculpture is a prototype of a winding form for an electromagnetic coil for the National Compact Stellarator Experiment (NCSX), an experimental fusion device being built at the Lab. Exhibition organizers noted that the shape of the winding form is a kind of mirror image to a sculpture by the famous artist Henry Moore near West College on the Princeton campus.

“When I saw it at the scrap yard over at PPPL it seemed to serendipitously reflect upon the University’s Henry Moore sculpture, ‘Oval with Points,’ so I thought it would be perfect for the Art of Science show,” said Andrew Moore, a



The pieces by PPPL staff in the show are: above, Fjord Wake by Michael J. Burin; at right, Jumpstart by Elle Starkman and Andrew Post-Zwicker; below, Interior Vacuum Vessel, NSTX, by Elle Starkman and Charles Skinner.



photographer and filmmaker who is a lecturer in the Program in Visual Arts and one of the exhibition’s organizers. “It fits with the whole theme of the exhibit — that science has this incredible aesthetic component to it.”

Moore spotted it outside the TFTR Building on D-site while touring PPPL with Post-Zwicker, who was instrumental in getting the piece to main campus, where it is at an entrance to the Friend

Center. “It was a beautiful thing to see on campus. The sculpture shows the wonderful aesthetics of one of our technological achievements,” said Post-Zwicker.

The exhibition opened May 10 and is expected to be on display from 9 a.m. to 6 p.m. weekdays for a year. A virtual gallery, which includes captions describing the work of the researchers who created the images, is available online at <http://www.princeton.edu/artofscience/>. ●



Andrew Post-Zwicker poses next to the PPPL sculpture outside the Friend Center.

