PPPL PRINCETON PLASMA PHYSICS LABORATORY
A Collaborative National Center for Fusion & Plasma Research
U.S. DEPARTMENT OF ENERGY
WEEKLY
October 12, 2015

Calendar of Events

WEDNESDAY, OCT. 14

PPPL Colloquium
4:15 p.m. ◆ MBG Auditorium
Atomic Tracings: The History of Radio Isotopes in Science and Medicine
Angela N.H. Creager, Princeton University

UPCOMING

TUESDAY, OCT. 20

Lab Management Review
8:30 a.m.

WEDNESDAY, OCT. 21

PPPL Colloquium
4:15 p.m. ◆ MBG Auditorium
Reconnection at the Dayside Magnetopause from MMS
Dr. James Burch, Southwest Research Institute

THURSDAY, OCT. 29

PPPL Benefits Fair
10 a.m.–2 p.m.

INSIDE

Laboratory Director Stewart Prager heralds start of new era with NSTX-U and looks to future projects in "State of the Laboratory" address

By Jeanne Jackson DeVoe

The completion of the $94 million National Spherical Torus-Upgrade (NSTX-U) will usher in a decade of research that will lead to vital results for the international and national fusion programs and could lead the way to a next-step fusion facility, PPPL Director Stewart Prager told staff members in his annual "State of the Laboratory" address on Oct. 5.

When research on the facility begins later this year, it will herald the start of a 10-year research program on the apple-shaped device called a "tokamak," Prager said. Some 300 researchers, two-thirds of them from outside the Laboratory, will conduct research on the device that will advance the effort to create clean, safe, and affordable fusion energy as a source of generating electricity.

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Technicians inspect the new NSTX-U center stack.

PPPL honors engineer Charles Neumeyer and physicist Rajesh Maingi

By John Greenwald and Raphael Rosen

PPPL presented its 2015 outstanding research awards to engineer Charles Neumeyer and physicist Rajesh Maingi following Stewart Prager's October 5 State of the Laboratory address. Neumeyer received the Kaul Foundation Prize "For the design analysis and overall management of the U.S. contributions to the steady state electric network (SSEN) that will supply power to ITER. This culminated in the successful delivery of the first major plant components to ITER, establishing procedures for all future shipments of ITER components." Maingi received the Distinguished Research Fellow Award "For seminal research and program leadership in tokamak boundary and divertor physics."

Neumeyer, team leader for the SSEN, will receive a $7,000 cash award as part of the Kaul Prize. Former PPPL Director Ronald Davidson endowed the prize by giving Princeton University a portion of the gift he received as the 1993 recipient of the Award for Excellence in Science, Education and Physics from the Kaul Foundation in Tampa, Florida.

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State of the Lab

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"A new era"

NSTX-U is currently "the most capable spherical tokamak in the world, soon to be joined by our sister facility in England, the MAST," Prager said. "It will be a research anchor for the Laboratory and guarantee the future of the Laboratory for at least a decade. It is truly a national facility. This is where we are. We're starting a new era."

Research on the experiment will lead to new discoveries in plasma physics that can be applied to ITER, the international fusion experiment in Cadarache, France, Prager said. NSTX-U research could advance the spherical tokamak as a candidate for a next-step fusion facility. It will also help researchers identify the best materials to serve as a boundary between the super-hot plasma in experiments and the tokamak walls.

"I just want to say congratulations and thank you to the entire NSTX-U project team for a momentous accomplishment," Prager said, as the crowd applauded loudly. "It's of overwhelming importance to the Laboratory and the future of fusion energy.

Prager also singled out the engineers and technicians who completed the project with technical excellence and without any injuries despite enormous hazards. "The entire safety record of this project was excellent," he said.

Broadening PPPL's research focus

A next challenge for the Laboratory, Prager said, is to broaden its research focus to include diverse topics, while at the same time contributing to and preparing for a world fusion program through ITER. The Laboratory's leadership needs to think "with a sense of urgency" about the U.S. fusion program 10 years into the future, and about PPPL's next research program, Prager said. At the same time, PPPL will implement a campus program to renew and improve its infrastructure. A $25 million plan of refurbishment is scheduled to begin next summer.

With the NSTX-U construction completed, PPPL leaders can begin crafting strategic plans for the near and long-term future. PPPL's leadership team held a strategic retreat on Oct. 1 and 2 to evolve PPPL's strategy and to "build consensus about the strategy," Prager said. The retreat included 55 staff members from all sectors of the Lab. The group tackled six topics: overarching strategic considerations, engineering, indirect operations, the magnetic fusion research program, research topic diversification; and diversity, inclusion, and workplace climate.

Based on discussions at the retreat, "it was clear that everybody in the Laboratory is rowing in the same direction, everyone is on the same page" about the future of the Laboratory, Prager said. "There's a strong feeling that the Laboratory can do more for the nation," Prager said, "a strong sense that we should diversify topically. We need to think broadly."

Future of magnetic fusion

Retreat participants also discussed the future of magnetic fusion, including everything from small programs in the near-term to major facilities that could start 10 years from now. They focused on the need for national planning for significant experimental programs within the context of the international fusion program. "We now want to develop major scientific activities to follow the NSTX-Upgrade or to run parallel with it," he said.

With the completion of NSTX-U construction, another topic at the retreat was to reassess the missions of the Engineering Department, which could include operations, analysis/design, fabrication, and engineering research. Participants at the retreat discussed whether the skill mix of the staff is appropriately balanced between those four missions, Prager said. The topic will probably be pursued further at an engineering retreat.

Participants also looked at the Laboratory's indirect (non-research) operations. They examined whether "we have all the needed functions" and whether there are areas in which indirect operations could be more efficient, Prager said. They agreed that both indirect and direct staff must work together on finding answers to that question. Participants also discussed the need for strong communications between direct and indirect staff.

Prager emphasized that the areas he discussed were "just early impressions," and encouraged staff members to give

Stewart Prager delivers his annual State of the Laboratory address in the MBG Auditorium.

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State of the Lab

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their feedback on these topics. He said staff would receive more information about the retreat once the information has been compiled.

Looking at PPPL's funding, Prager said he did not know how much PPPL would receive in fiscal year 2016, which began Oct. 1, as we await passage of the fiscal year 2016 budget. However, he said the last two years have been fairly stable, with $100 million in fiscal year 2015 and $101 million in funding in fiscal year 2014, up from $86 million in 2013.

PPPL's strategy is aligned with the DOE's Fusion Energy Sciences Program's emphasis on burning plasma science, (science aimed at a self-sustaining plasma such as the one that will be produced on the ITER experiment), and discovery science (research that may or may not be directly related to fusion research).

A possible breakthrough solution

One promising direction for the Laboratory in burning plasma science is research into utilizing liquid metals as a kind of protective wall between the plasma, which is heated to temperatures hotter than the sun, and the tokamak wall. "Liquid metal is a possible breakthrough solution," Prager said. "If you surround the plasma by a liquid, it doesn't break, it is self-healing, and it can carry heat out if it's flowing."

The topic would be "a perfect research topic" for both the United States and the Laboratory, Prager said. "It is a potential solution to the plasma-material interface challenge but one with its own large science and engineering challenges," he said. PPPL's Lithium Tokamak Experiment (LTX) and the surface science laboratory have both done important research in this area, he said. A lithium boundary could be tested in NSTX-U. One possible future research project is a full torus with flowing lithium, he said.

PPPL researchers working on the LTX have recently shown that the lithium boundary improves the plasma energy confinement, Prager said. PPPL plans to expand the capabilities of the LTX in the future by adding a neutral beam for core fueling and heating.

Prager noted that lithium is hazardous, but a recent DOE review gave high marks to the Laboratory for its safe handling of the material.

Computational research increasingly important

Another strategic research area, computational research, has become increasingly important in fusion energy research, Prager said. Researchers use sophisticated computer models along with NSTX-U measurements to shed light on disruptions that can interrupt fusion experiments. They also focus on turbulence in the complex edge region, an important research area in fusion energy research. "We're learning more and more that to some extent the edge is the dog that wags the tail of the whole tokamak," Prager said.

Prager noted that the TRANSP code, which was developed at PPPL, is being used as a research tool in fusion facilities worldwide. In fact, scientists at a recent user-group meeting called for PPPL researchers to enhance the capabilities of the TRANSP code.

PPPL researchers are also focusing on stellarators that could sustain a plasma in steady-state, in keeping with the FES long-pulse research goal. PPPL is leading a team of researchers from U.S. laboratories who collaborate on the Wendelstein 7-X stellarator that is ready to open in Germany, Prager said. PPPL engineers oversaw the construction of magnetic trim coils and physicists installed an X-ray spectrometer on the device.

PPPL has also made significant contributions to ITER, which will be the focus of international fusion research. "I think in 2080 when we look back at the century, ITER will be viewed as a landmark experiment of the century," Prager said. PPPL is responsible for the U.S. contribution to diagnostics, and delivered a $33 million steady-state electric network, which will power all of ITER's non-pulsed operations, Prager said. "It was delivered with great technical success and also on time and on schedule," he said.

Stellarators could play important role

Looking ahead to PPPL's long-term future, Prager said stellarators could play an important role. "Stellarators are crucial for fusion, an innovative research opportunity for the United States and a possible major component of the Laboratory's future," he said.

He noted that a PPPL study group is identifying possible future stellarator paths and developing new ideas on how to optimize the design and simplify magnet shapes. A next step would be to enlarge the study to a national effort, Prager said.

Another concept for a future project at PPPL would be a tokamak that would be surrounded by a liquid-metal wall. "A challenge now is to develop the most compelling future for the major U.S. effort on plasma material interface," Prager said.

And while a pilot plant or nuclear science facility "is not currently on the table," Prager said it's important that researchers explore the scope of such projects. "We continue to advance our understanding to possible aggressive next steps, in concert with other U.S. fusion groups," he said.

Next generation of MRX

One example of "discovery science" at PPPL is research on the Magnetic Reconnection Experiment (MRX) into magnetic reconnection, the mysterious process responsible for solar flares, geomagnetic storms, and other phenomena throughout the universe. The next generation reconnection experiment, the Facility for Laboratory Reconnection Experiments (FLARE), is under construction and will be completed by late 2016.

PPPL has begun research into plasma synthesis of nanomaterials. That project is funded by the DOE's Basic Energy Sciences (BES), establishing a BES/FES partnership, Prager said. A new expanded lab for plasma nanotechnology is being refurbished.

Prager said the Laboratory is renewing its emphasis on the importance of developing ideas that can lead to new projects. PPPL is allocating $3 million in Laboratory Directed Research and Development (LDRD) funds. Scientists and engineers are encouraged to exploit the LDRD and other opportunities to develop new ideas.

"To conclude, the start of NSTX-U signifies a new research opportunity," Prager said. "And looking forward to the future, through the creativity of all of you we're developing new fusion opportunities for the near-term and long-term, small-scale and large-scale."

Kaul Foundation and Distinguished Research Fellow Awards

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Charles Neumeyer

Rajesh Maingi

The honor for Maingi, division head of boundary physics research and plasma-facing components, includes a $5,000 cash award supported by the U.S. Department of Energy. The recognition is part of the Laboratory's Distinguished Research and Engineering Fellow Program, which honors members of the scientific and engineering staffs for their accomplishments.

Charles Neumeyer

Winning the Kaul Award surprised engineer Neumeyer, who noted that it is typically given for highly technical work. "What my team and I have been doing is pretty ordinary," he said. While that may be true, Neumeyer's work has paved the way for the delivery of virtually all components for the construction of ITER, the international tokamak being built in France to showcase fusion power. What he's done has been "pioneering" said Mike Williams, associate director of engineering and infrastructure, who retired last month. "It's quite an achievement."

Neumeyer is purchasing some $33 million of transformers and other electrical equipment for ITER's steady state electrical network, a substation and distribution network that will power all the complex plant's electrical loads, except for the pulsed loads that will power the heating, current and magnetic fields inside the giant tokamak. This work requires intense paperwork every step of the way, from specifying contractor requirements to transferring ownership of what PPPL has bought to the ITER Organization.

Neumeyer delivered ITER's first major shipment, a 90-ton transformer made by Korea's Hyundai Heavy Industries, to the project in January. Completion of the job, and the reams of paperwork that Neumeyer and his team put together to accomplish it, showed ITER's seven partners—countries with more than half the world's population—how such work could be done.

Neumeyer arrived at PPPL in 1976 as an employee of EBASCO — now a division of AECOM — to work on power supplies for the Tokamak Fusion Test Reactor. He became a Lab employee in 1983, went back to EBASCO in 1991, and rejoined PPPL in 1995 to stay. His jobs since returning have included responsibility as project engineer for all activities in the design, manufacturing and commissioning of the National Spherical Tokamak (NSTX), and establishment of all design details for the upgrade.

For ITER, Neumeyer and his team have now purchased 12 of the 16 electrical groups that PPPL is providing for the SSEN, whose 120 megawatts will be enough to run a small city. The team has done this on time, at a cost well below budget, by carefully selecting the most efficient contractors from around the world. "I'm really happy that the contracts we have placed are going to the best companies to do the work," Neumeyer said. "By issuing one contract at a time, rather than handing everything to one company, we've been able to pick and choose the best qualified manufacturers at the most competitive pricing."

None of this would have been possible without teamwork, Neumeyer added. He offered special thanks to engineer John Dellas; planning and control officer Skip Schoen; quality assurance specialist Frank Malinowski; shipping logistics coordinator Barry Jedic, and document control specialist Kathleen Lukazik. "We all work together," he said.

Rajesh Maingi

Maingi is known throughout the world as an expert on the physics of the plasma edge and for program leadership. When the U.S. Department of Energy management in Fusion Energy Sciences under the Office of Science sponsored a nationwide community strategic planning activity and workshop on Plasma Materials Interactions, Maingi was chosen to chair the entire process, and hosted the workshop held at PPPL in May.

Yet he is modest about his achievements and renown. "I had no idea I had been nominated" for this award, he recalls. "I'm very, very happy to have been selected. There are many talented, smart, and wonderful people here, and any of them could have won this award. So if you're actually selected, it's a huge honor."

Results of Maingi's research are highly valued. "Rajesh has made many important contributions to boundary physics on NSTX and has many great research results yet to come on NSTX-U," said Jon Menard, program director for NSTX-U. "For example, his work on understanding the impact of lithium wall coatings on tokamak plasma performance is helping to spread lithium research to other devices around the world. Rajesh is very highly deserving of this Distinguished Research Fellow Award."

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Kaul Foundation and Distinguished Research Fellow Awards

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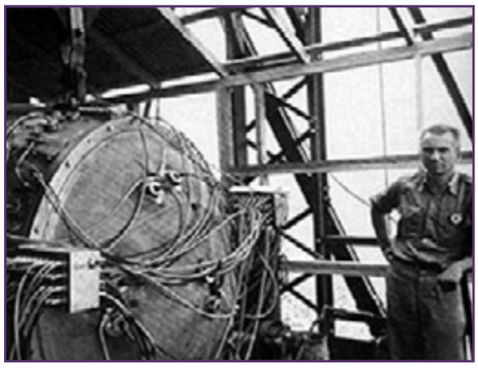
Maingi joined the PPPL staff in 2012, but that wasn't the first time he had stepped on to the Laboratory's campus. From 1999 to 2012 he was on long-term assignment to the NSTX from Oak Ridge National Laboratory. Understanding the behavior of the edge of fusion plasma is important because the plasma is so much hotter than the surrounding materials that uncontrolled interactions can damage the tokamak's walls.

Maingi's research includes what happens when plasma interacts with lithium. Conducting experiments on a suite of international fusion machines — NSTX-U, DIII-D in San Diego, EAST in Hefei, China, and ASDEX-U in Garching, Germany — Maingi studies the behavior of components coated with lithium, the characteristics of surfaces made up of liquid lithium, and the effects of lithium aerosol sprayed directly into plasmas. Physicists have learned that lithium improves a tokamak's performance, and that lithium particles will not shut down fusion reactions as quickly as other impurities will.

Maingi first got interested in fusion as a high school senior in 1983. In fact, while working on a senior research project he consulted physics papers written by PPPL scientists. He never expected, though, that his career would bring him to the institution that housed those very researchers. "I never thought I'd end up at the same place!" he recalls.

COLLOQUIUM

Atomic Tracings:
The History of Radioisotopes in Science and Medicine



Dr. Angela N. H. Creager
Princeton University

Wednesday, Oct. 14
4:15 p.m. (coffee/tea at 4 p.m.), M.B.G Auditorium, Lyman Spitzer Building

Open Enrollment begins Oct. 19

Open Enrollment for benefits will begin
Monday, Oct. 19, and ends Friday, Nov. 13.

PPPL will hold its annual Benefits Fair on
Oct. 29 from 10 a.m. to 2 p.m.

Astrophysicists from Japan's National Institutes of Natural Sciences (NINS) and the National Astronomical Observatory of Japan (NAOJ) visited PPPL last week. The group was in Princeton for the annual management meeting of the NAOJ-Princeton University collaboration for research on NAOJ's Subaru telescope on Mauna Kea, Hawaii. Members also met with Princeton President Christopher L. Eisgruber, Provost David S. Lee, Dean for Research Pablo G. Debenedetti, and A. J. Stewart Smith, Princeton vice president for PPPL, to discuss activities in the ongoing collaboration between Princeton and NINS. At PPPL, Director Stewart Prager described the Laboratory to the group, which then toured the National Spherical Torus Experiment-Upgrade and viewed the unfinished Quasar stellarator. Pictured in rear row from left: Masaaki Yamada of PPPL; Hideyuki Kobayashi, vice director of NAOJ; Junichi Watanabe, vice director of NAOJ; Hiroshi Karoji, senior visiting fellow in the Department of Astrophysical Sciences; Masa Ono of PPPL and Takumi Komatsu, NINS administrator. Front row: Stewart Prager; Katsuhiko Sato, president of NINS; A. J. Stewart Smith, and Masahiko Hayashi, director general of NAOJ.

John DeLooper last week hosted leaders from Ames National Laboratory in Ames, Iowa, who are visiting national laboratories to learn about their best practices for managing environment, safety health and conduct of operations. In addition to DeLooper, the group met with Tim Stevenson, Al von Halle, Jerry Levine, Bill Slavin, Dorothy Strauss, and Jim Graham, and toured the National Spherical Torus Experiment-Upgrade. Shown from left: John DeLooper; Tom Lograsso, deputy director of Ames Laboratory; Adam Schwartz, director of Ames Laboratory, and Sean Whalen, Environment, Safety Health & Assurance manager of Ames Laboratory.

Flu Vaccines Are Here!

Influenza is a contagious disease caused by a virus. It can be spread by coughing, sneezing or nasal secretions.

By getting the flu vaccine, you can protect yourself from Influenza and may also avoid spreading this illness to others.

Please call the OMO at extension 3200 to make an appointment.

Thank you.

—The OMO Staff

BROCK

MARK GAZO
Chef Manager

Café at PPPL

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.

	Monday October 12	Tuesday October 13	Wednesday October 14	Thursday October 15	Friday October 16
COMMAND PERFORMANCE **Chef's Feature**	**Turkey Shepherd's Pie**	**Baked Vegetable Mac & Cheese** served with Stewed Tomatoes	COMMAND PERFORMANCE **Create Your Own Gumbo Bar**	**Grilled Marinated Flank Steak** with Chipotle Butter served with Soft Polenta & Roasted Peppers & Onions	**Fish & Chips**
Early Riser	**Pumpkin Pancakes** with Homemade Turkey Sausage	**Corned Beef Hash & 2 Eggs** any Style	**Cream Chipped Beef over Biscuits** served with 2 Eggs any Style	**Mushroom Cheese Omelet** served with Home Fries	**Cranberry Apple Pancakes**
Country Kettle	**Potato Leek**	**French Onion**	**Tomato Bisque with Rice**	**Split Pea with Ham**	**Pumpkin Soup**
Grille Special	**Chili Cheese Fries**	**BLT on French Bread**	**Crispy Tilapia Sandwich** with Pineapple Slaw	**Rosemary Chicken Breast** on a Kaiser Roll with Sundried Tomatoes & Goat Cheese	**Grilled 3 Cheese** with Tomato
Deli Special	**Vegetarian Chickpea Sandwich** on Multigrain Bread	**Pastrami, Turkey, Swiss Cheese, Coleslaw & Russian Dressing** on Rye	**Ham Salad** on a Croissant with Lettuce & Tomato	**Krabby Kake Sandwich** on a Kaiser Roll	**Chicken Cacciatore Sub**
Panini	**Spinach Salad** with Chicken, Bacon, Hard-Cooked Egg, Tomato, Red Onion, Cucumber & Sweet & Sour Dressing	**Popcorn Chicken & Mashed Potato Bowl** topped with Seasoned Corn & Country Gravy	**Chicken Salad** with Walnuts, Apples & Raisins on a Wheat Roll	**Scrambled Eggs, Peppers, Onions & Potatoes** on a Torpedo Roll	**Roast Beef** with Spinach, Caramelized Onions, Artichoke Hearts, Swiss Cheese & Horseradish Wrap

MENU SUBJECT TO CHANGE WITHOUT NOTICE

VEGETARIAN OPTION

WEEKLY Editor: **Jeanne Jackson DeVoe** ◇ Layout and graphic design: **Kyle Palmer**
Photography: **Elle Starkman** ◇ Science Editor: **John Greenwald** ◇ Webmaster: **Chris Cane**

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Comments: commteam@pppl.gov ◇ **PPPL WEEKLY** is archived on the web at: http://w3.pppl.gov/communications/weekly/.