PPPL
U.S. DEPARTMENT OF ENERGY

PRINCETON PLASMA PHYSICS LABORATORY WEEKLY

MONDAY, JANUARY 9, 2012

At PPPL THIS WEEK

MONDAY, JANUARY 9

PPPL Colloquium
4:15 p.m. ◆ M.B. Gottlieb Auditorium

Conflict Between Economic Growth and Environmental Protection

Dr. Bryan Czech
(Center for the Advancement of the Steady State of the Economy)

CLICK HERE FOR ABSTRACT

TUESDAY, JANUARY 10

Theory Seminar
10:45 a.m. ◆ T-169

Gyro-Center Shift as Explanation for the Various Anomalies in Magnetized Plasmas

K.C. Lee (UC Davis/PPPL)

THURSDAY, JANUARY 12

GFDL Events and Seminars
2 p.m. - 3 p.m. ◆ GFDL
Smagorinsky Seminar Room

Ecological Stoichiometry, Biogeochemical Cycling and Aquatic Food Webs: The View Beyond Carbon

Pat Glibert (UMCES)

www.gfdl.noaa.gov/events

FRIDAY, JANUARY 13

DIII-D Science Meeting
1 p.m. - 2:30 p.m. ◆ B-233

SATURDAY, JANUARY 14

Science on Saturday
9:30 a.m. ◆ M.B. Gottlieb Auditorium

What is the Universe Expanding Into? And Other Perfectly Reasonable Questions

David Goldberg (Drexel University)

PPPL to Launch Major Upgrade of Key Fusion Energy Test Facility

NSTX-U Project Will Produce Most Powerful Spherical Torus in The World

By John Greenwald

PPPL is getting an earlier-than-expected start on a $94 million project as the next stage of its mission to chart an attractive course for the development of nuclear fusion as a clean, safe and abundant fuel for generating electricity.

The project will upgrade the major test facility at PPPL, the National Spherical Torus Experiment (NSTX), over the next 30 months, with completion slated for 2014. The work will enhance the position of NSTX as the world's most powerful spherical torus — or tokamak — a device that controls the superheated and electrically charged gases called plasmas that create fusion power.

The overhaul "will be a huge boost to all NSTX science missions," said Stewart Prager, director of PPPL, which is managed by Princeton University for the DOE Office of Science and has been a leader in fusion research for 60 years. Experiments done on the upgrade, he said, "will establish the physics basis to determine whether the NSTX design is suitable for a 'U.S. fusion nuclear science facility' — a possible next major research facility that would operate with fusion fuel."

Construction has been cleared by DOE officials to start immediately, six months ahead of schedule. Plans originally had called for the work to begin after the conclusion of a series of experiments on the NSTX tokamak. But when technical difficul-

continued on page 2

Award-Winning Journalist Joins PPPL's Communications Team

By Kitta MacPherson

Photo by William Greenwald

John Greenwald

John Greenwald, an award-winning explanatory journalist who has written extensively about business and science, has joined PPPL's Communications team as its Science Writer.

John has spent much of his career as a senior writer at *Time* magazine where he wrote more than two dozen cover stories, including ones on the Chernobyl nuclear disaster and militant Iran. Among many topics, he wrote about herbal medicine, neuroscience, and the nuclear power industry. He was part of a team of *Time* magazine writers and correspondents whose work earned the John Hancock Award for Excellence in Business and Financial Journalism. Colleagues who have worked with John speak highly of his abilities, describing him as "outstanding," "the consummate professional," and noting that when writing his stories, which often involve highly complex topics, "he gets it right." He also is described as being "strong with abstract stuff" and exhibiting "a quiet strength."

John started his career as a reporter at The Minneapolis Star where he ultimately became the business editor. While there, his section was named the best in Minnesota by the Associated Press.

continued on page 3 ►

NSTX Upgrade

continued from page 1

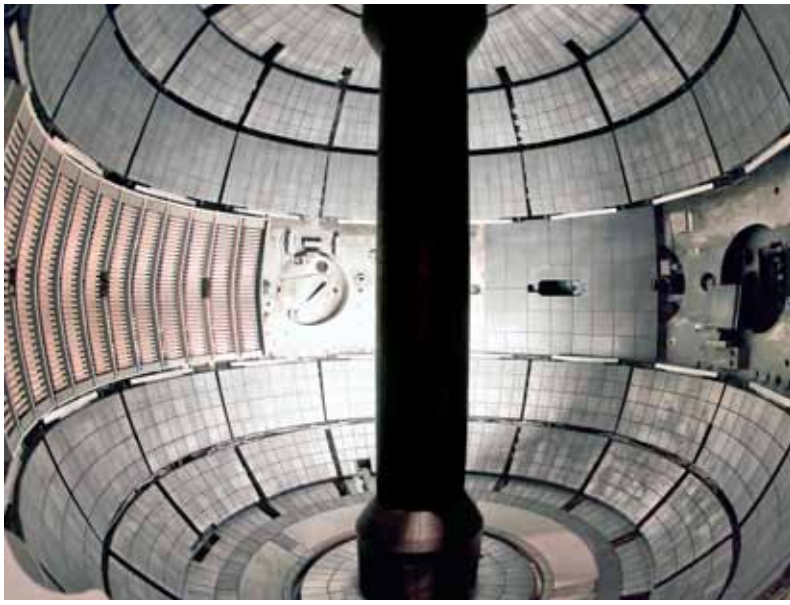
ties delayed the start of the experiments, PPPL managers decided to move directly to the upgrade rather than spend an undetermined amount of time addressing the technical issue. Specifically, a short that damaged a key piece of magnetic equipment would have been expensive and time-consuming to replace.

Work on the upgrade has brought excitement to the technicians and engineers at the Laboratory. "We're building something that's one of a kind, that hasn't been built before," said Michael Williams, associate director for engineering and infrastructure at PPPL.

Fusion takes place when the atomic nuclei in plasmas combine at extremely high temperatures and release a burst of energy. Such reactions drive the sun and the stars. But sustaining fusion in the laboratory has proven quite difficult because plasmas that leak from the confinement can halt the reaction. Controlling the plasma is thus a basic goal of fusion research.

PPPL physicists will use the NSTX upgrade to assess the role of the compact reactor for the future development of fusion power. The spherical torus confines its plasma in the shape of a cored apple, unlike bulkier conventional tokamaks that produce doughnut-shaped plasmas and can be more costly to construct.

PPPL scientists are eager to explore mysteries that have puzzled them for years. A key issue is whether the NSTX reactor can maintain its record-high level of a measure called "beta" — the ratio of the pressure of a plasma to the strength of the magnetic field that confines it — as the plasma grows hotter. The higher the beta, the more cost-effective the confinement.



Inside the vacuum vessel of the NSTX fusion machine, shown with the center column.

The NSTX upgrade will furnish new tools for probing such issues. The overhaul "will provide ample research opportunities for five to 10 years' worth of work at least," said Michael Zarnstorff, deputy director for research at PPPL. "The whole NSTX group is quite excited by the opportunities and the leadership position that it will be in."

The makeover will boost the principal capabilities of the NSTX reactor, which began operating in 1999. The device puts high-voltage current into an isotope — or form — of

continued on page 3

NSTX UPGRADE FACTS

- **The $94 million upgrade will make the NSTX reactor the most powerful spherical torus, or tokamak, in the world when the work is completed in 2014. The spherical design confines superheated plasmas in the shape of a cored apple, compared with the donut-shaped plasmas that bulkier conventional tokamaks create. The spherical geometry requires less high-cost magnetism to maintain.**
- **The NSTX reactor has already set world records for creating and controlling plasmas under laboratory conditions. This achievement is measured by a value called "beta," which gives the ratio of the pressure of a plasma to the strength of the magnetic field that confines it. The NSTX beta has been found to be some three times higher than the best ratio for conventional tokamaks. The higher the beta, the more cost-effective the reactor.**
- **The enhancements will double the temperature range at the core of the plasma to at least 20-60 million degrees Celsius, as compared with the 10 million degree temperature at the core of the sun.**
- **The upgrade will double the strength of the reactor's magnetic field to 1 tesla, or 20,000 times the strength of the Earth's magnetic field and more than 200 times the strength of a refrigerator magnet.**
- **The NSTX reactor's current will double to 2 million amperes as a result of the upgrade. A 100-watt light bulb draws 1 amp of current.**
- **Strategies developed for taming the intensely hot plasma particles that strike the wall of the upgrade could serve as a model for the international experiment ITER, a major conventional tokamak that is under construction in the south of France.**
- **Scientists will use the upgrade to determine the suitability of the NSTX design for a "U.S. fusion nuclear science facility" that would develop components for a commercial fusion power plant.**
- **Planners hope to have a commercial fusion reactor in operation by 2050. It would use the heat produced by fusion to generate electricity.**

— John Greenwald

NSTX Upgrade

continued from page 2

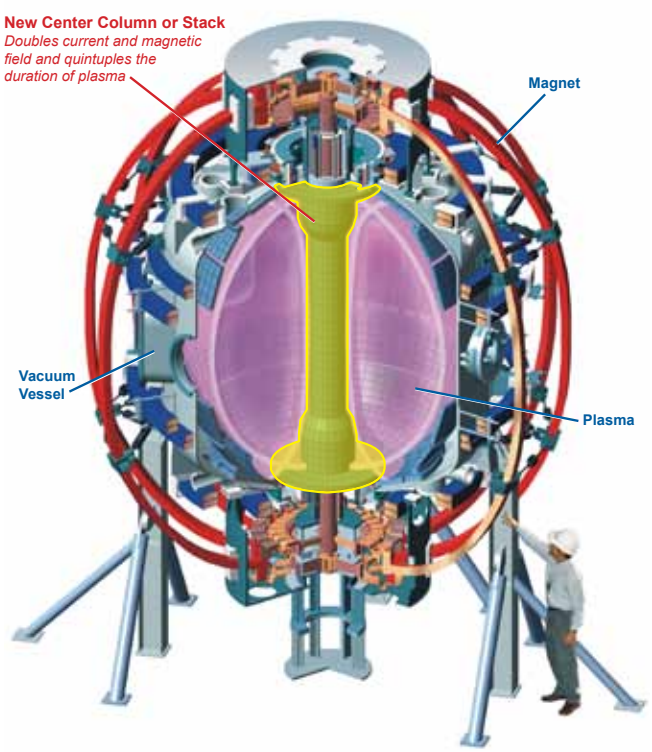
hydrogen gas to make the intensely hot plasma that is confined inside the reactor's magnetic field. The upgrade will double the field strength to one tesla — or 20,000 times the strength of the Earth's magnetic field. The electric current flowing in the plasma will also double and reach 2 million amperes. By contrast, a 100-watt light bulb draws one ampere of current.

Achieving these increases calls for widening a column at the center of the reactor that puts current in the plasma and helps to complete the magnetic field. Widening the center column also will increase the electric pulse that drives the plasma current from one second to five seconds, giving researchers more time to study the plasma.

The enhancements will help double the temperature at the core of the plasma to at least 20 million degrees Celsius, or twice the approximately 10-million-degree Celsius core of the sun. New heating also will come from installation of a second device called a "neutral beam injector" to go with the one currently on the machine.

The increased power will enable PPPL scientists to tackle these major questions:

- Can the compact device continue to effectively contain plasma when the temperature rises, which could make the confinement more difficult? Greater heat will reduce the rate at which plasma particles collide with one another — a phenomenon called "collisionality" that could further hinder the confinement. If the upgrade can effectively control the hotter plasma, "that means we could achieve high fusion power in a pretty compact machine, and that could make machines cheaper in the future," said Jon Menard, program head for NSTX.
- Can the researchers find new ways to start and sustain the electric current that creates the plasma? New methods are essential because future reactors will operate under conditions that would damage the spherical tokamak reactor's solenoid — a coil that winds around the center column and delivers the current. PPPL scientists have been testing alternatives. Eliminating the solenoid "is extremely important," said Masa Ono, project head for NSTX. "If we can demonstrate that, we will have a very solid basis to design the next-step machine."



- Can the upgrade tame hot plasma particles that escape the confinement and reach the reactor walls? This "power flux" can damage interior surfaces, drive impurities back into the plasma and shut down the reaction. Researchers have coated parts of the present NSTX torus with lithium, a metal that turns liquid when struck by stray particles and sponges up the impurities. But "the power flux that we expect in the upgrade will be very high compared to what we handle today," Ono said. "That is something we need to find attractive solutions for."

How PPPL scientists handle the increased flux could serve as a model for ITER, a major conventional test reactor that a consortium of countries including the United States is building in the south of France. ITER aims to produce a sustained fusion reaction — or "burning plasma" — by the late 2020s that will put out more energy than is needed to create it — a basic requirement for future commercial reactors.

The NSTX upgrade could also serve as the gateway to a next-generation spherical torus that would produce a burning plasma to complement the output of ITER. Such a spherical torus would be roughly twice as powerful as the NSTX upgrade, said Zarnstorff, and would be used to test components for a commercial fusion reactor. Planners hope to have a commercial reactor in operation by 2050. ■

Greenwald Joins PPPL's Comms Team

continued from page 1

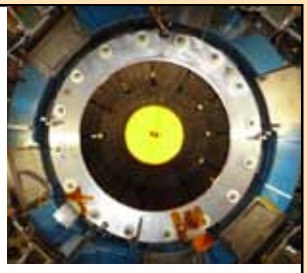
Most recently, he served as the editor of NJBIZ, a weekly statewide business newspaper, managing a staff of 11. The publication won more than two dozen state and national awards during his tenure. He also has written on a wide variety of subjects in articles that have appeared in *Fortune* magazine, politico.com, Knowledge@Wharton, and elsewhere.

John received an undergraduate degree in English from the University of California at Berkeley and holds master's degrees from Harvard University and the University of California. At PPPL, John will work with the research staff to develop news stories for press releases. He also will write news features and backgrounders for external and internal audiences, serve as a media liaison for the Laboratory, and develop content for digital media.

He lives with his family in Princeton Junction.

What Is It?

And the Answer is...



HANS SCHNEIDER was the first to correctly identify what this photo shows — a view from under the National Spherical Torus Experiment (NSTX), looking through the vacuum vessel, toward the NSTX test cell ceiling (yellow) through an opening made after the center column was removed. Within a minute of receiving Schneider's answer by email, we received a second correct response from Craig Jacobson. Both will receive a free cup of coffee from the PPPL Cafeteria.

And graduate student Jessica Baumgaertel receives a free cup of joe, too, for noticing that the blue magnetic coils had a connection to the Magnetic Reconnection Experiment (MRX). The coils were previously housed on MRX, and were later installed on NSTX.

Congratulations to all three winners, thanks to everyone who submitted guesses, and a special thanks to NSTX technician Scott Gifford for taking the stunning photo.

Office of Communications Printed Materials Have Moved

PPPL Fact Sheets from the Office of Communications are now available in Room B-343. They were previously in B-375. Please feel free to take materials as needed for outreach.

COLLOQUIUM

CONFLICT BETWEEN ECONOMIC GROWTH AND ENVIRONMENTAL PROTECTION

DR. BRYAN CZECH

Center for the Advancement of the Steady State of the Economy

Monday, January 9

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

What Is The Universe Expanding Into? And Other Perfectly Reasonable Questions

DAVID GOLDBERG
Drexel University

Saturday, January 14, 2012
9:30 a.m.
M.B. Gottlieb Auditorium, Lyman Spitzer Building

Brock PPPL CAFÉ MENU

	MONDAY, JAN. 9	TUESDAY, JAN. 10	WEDNESDAY, JAN 11	THURSDAY, JAN. 12	FRIDAY, JAN. 13
COMMAND PERFORMANCE CHEF'S FEATURE	 Rigatoni Siciliana	 *Create Your Own...* Crispy Taco Bar	 Pulled Pork BBQ w/ Mashed Potatoes	 Arroz Con Pollo	 Santa Fe Chicken
EARLY RISER	The Belly Buster Hoagie	Steak, Egg and Cheese Quesadilla	Cranberry Pancakes	Pork Roll, Egg and Cheese	Vegetable and Potato Frittata
COUNTRY KETTLE	Beef Barley	Cream Of Broccoli	Turkey Chili	Pumpkin Bisque	7 Bean
GRILLE SPECIAL	Italian Hot Dog with Onion Rings or Fries	Double Turkey Cheeseburger and Fries	Crispy Chicken Tender Ranch Sandwich w/ Fries	Trenton Cheeseburger w/ Fries	Mushroom, Onion and Pepper Quesadilla
DELI SPECIAL	Turkey, Roasted Peppers, Provolone Cheese	Mozzarella, Tomato, and Basil Pesto	Napoli Grilled Vegetable Sandwich	Waldorf Chicken Salad Wrap	Bruschetta Chicken and Provolone Wrap
PANINI	Grilled Chicken, Pepper Jack, Onions and Peppers	Crispy BBQ Chicken Sandwich	The Mediterranean	3 Cheese and Ham Griller	Chicken Parmesan

MENU SUBJECT TO CHANGE WITHOUT NOTICE

CLICK HERE FOR A PRINTABLE WEEKLY MENU

WEEKLY

Editor: **Patti Wieser** ◆ Copy Editor /Graphic Design: **Gregory Czechowicz**
Photography: **Elle Starkman** ◆ Web: **Chris Cane**

PPPL WEEKLY is published by the PPPL Office of Communications on Mondays throughout the year except for holidays.
Deadline for calendar item submissions is noon on Thursday. Other stories should be submitted no later than noon on Wednesday.
Send to: pwieser@pppl.gov ◆ Comments: commteam@pppl.gov ◆ **PPPL WEEKLY** is archived on the web at: **http://www.pppl.gov/ppplweekly.cfm**