

THIS WEEK

OCT. 23-27

**59th Annual Meeting of the APS
Division of Plasma Physics**
Milwaukee, Wisconsin

TUESDAY, OCT. 24

Photo Clique meeting
12 p.m. ♦ PPPL Café
**Questions? Contact Elle at x2090
or estarkma@pppl.gov**

WEDNESDAY, OCT. 25

Council Café Lunch
12 p.m. ♦ Cafeteria
Valeria Riccardo,
Head of Engineering

THURSDAY, OCT. 26

**Open Enrollment 2018
Benefits Fair**
10 a.m.-2 p.m.
Vendors in LSB Lobby
Presentations in MBG Auditorium:
11 a.m.-12 p.m.
**Understanding Your
Social Security Benefits**
by Social Security Administration
representatives
12:30-1:30 p.m.
**Introducing the New Roth
Retirement Savings Option**
by TIAA representatives

UPCOMING

WEDNESDAY, NOV. 1

PPPL Colloquium
4:15 p.m. ♦ MBG Auditorium
**Machine Learning for Controlling
Complex Dynamic Systems**
J. Schneider, Carnegie Mellon University

WEDNESDAY, NOV. 15

America Recycles Day

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PPPL takes detailed look at 2-D structure of turbulence in tokamaks

By John Greenwald

A key hurdle for fusion researchers is understanding turbulence, the ripples and eddies that can cause the superhot plasma that fuels fusion reactions to leak heat and particles and keep fusion from taking place. Comprehending and reducing turbulence will facilitate the development of fusion as a safe, clean and abundant source of energy for generating electricity from power plants around the world.

At PPPL, scientists have assembled a large database of detailed measurements of the two dimensional (2-D) structure of edge plasma turbulence made visible by a diagnostic technique known as gas puff imaging. The two dimensions, measured inside a fusion device called a tokamak, represent the radial and vertical structure of the turbulence.

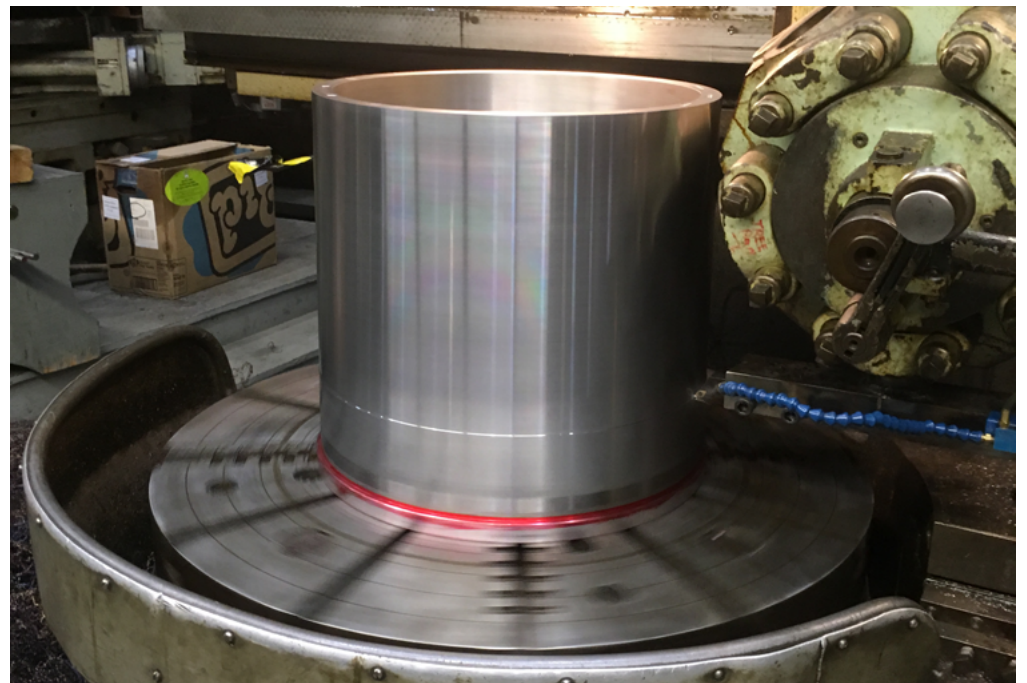
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Contracts awarded for prototype coils in planning NSTX-U recovery

By Jeanne Jackson DeVoe

PPPL has awarded contracts to two companies for each to build one prototype coil that will qualify the manufacturers of new magnets being designed as part of the planning process for the National Spherical Torus Experiment-Upgrade (NSTX-U) Recovery Project team.

The contracts were awarded to Tesla Engineering Ltd. in the United Kingdom and Sigmaphi in France. The Laboratory expects to sign a third contract with another company soon and plans to build a fourth prototype magnet itself, said Charles Neumeier, head of engineering for the Recovery team.



A winding mandrel was machined at the RESA building at PPPL.
(Photo by Richard Burke)

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PPPL hosts Princeton University Freshman Families tours

PPPL hosted three tours for Princeton University's Freshman Families Weekend. About 30 visitors each joined two tours on Friday, Sept. 13 with tour guides Ray Camp, Devon Battaglia, Atiba Brereton, Kevin Lamb, Jessica Guttenfelder, and Erik Gilson. Some 100 visitors joined the tour on Saturday, Sept. 14, on a tour hosted by Raphael Rosen, with tour guides Lamb, Brereton, Brian Kraus, and Arturo Dominguez.



Ray Camp speaks to visitors in front of the model stellarator from the 1958 Atoms for Peace Conference. (Photo by Elle Starkman)



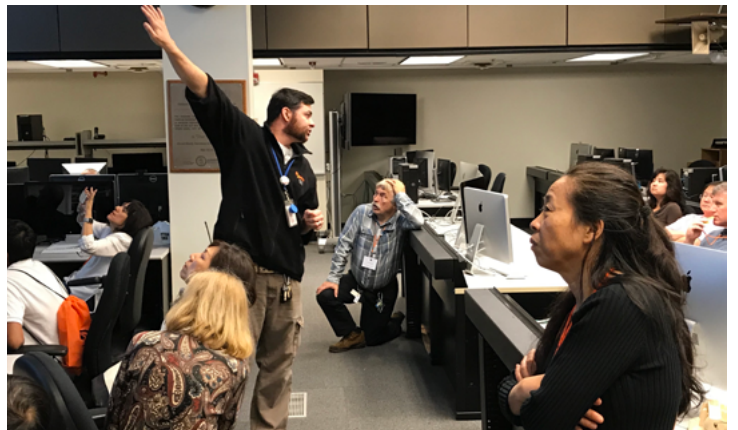
Tour guide Jessica Guttenfelder speaks to visitors on an Oct. 13 tour. (Photo by Elle Starkman)



Guttenfelder, far left, in the NSTX-U test cell. (Photo by Elle Starkman)



Guttenfelder, far right, shows visitors the NSTX-U center stack. (Photo by Elle Starkman)



Tour guide Kevin Lamb with visitors in the NSTX-U Control Room on the Oct. 14 tour. (Photo by Raphael Rosen)



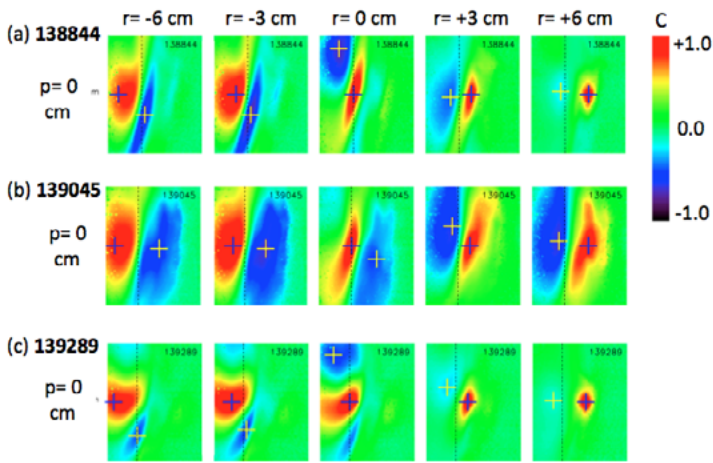
Visitors look up at the NSTX-U test cell on the Oct. 14 tour. (Photo by Raphael Rosen)



Tour guide Atiba Brereton, far right, shows visitors the NSTX-U test cell on Oct. 14. (Photo by Raphael Rosen)

Turbulence

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Correlation analysis of three plasma discharges on NSTX for each of five different radial locations near the plasma edge. The red regions marked with a blue cross have high positive correlation around the origin point, while the blue regions marked with a yellow cross have high negative correlation. (Images courtesy of Stewart Zweben)

Step toward fuller understanding

“This study is an incremental step toward a fuller understanding of turbulence,” said physicist Stewart Zweben, lead author of the research published in the journal *Physics of Plasmas*. “It could help us understand how turbulence functions as the main cause of leakage of plasma confinement.”

Fusion occurs naturally in space, merging the light elements in plasma to release the energy that powers the sun and stars. On Earth, researchers create fusion in facilities like tokamaks, which control the hot plasma with magnetic fields. But turbulence frequently causes heat to leak from its magnetic confinement.

PPPL scientists have now delved beyond previously published characterizations of turbulence and analyzed the data to focus on the 2-D spatial correlations within the turbulence. This correlation provides clues to the origin of the turbulent behavior that causes heat and particle leakage, and will serve as an additional basis for testing computer simulations of turbulence against empirical evidence.

Studying 20 discharges of plasma

The paper studied 20 discharges of plasma chosen as a representative sample of those created in PPPL’s National Spherical Torus Experiment (NSTX) prior to its recent upgrade. In each of these discharges, a gas puff illuminated

the turbulence near the edge of the plasma, where turbulence is of special interest. The puffs, a source of neutral atoms that glow in response to density changes within a well-defined region, allowed researchers to see fluctuations in the density of the turbulence. A fast camera recorded the resulting light at the rate of 400,000 frames per second over an image frame size of 64 pixels wide by 80 pixels high.

Zweben and co-authors performed computational analysis of the data from the camera, determining the correlations between different regions of the frames as the turbulent eddies moved through them. “We’re observing the patterns of the spatial structure,” Zweben said. “You can compare it to the structure of clouds drifting by. Some large clouds can be massed together or there can be a break with just plain sky.”


Detailed view of turbulence

The correlations provide a detailed view of the nature of plasma turbulence. “Simple things about turbulence like its size and time scale have long been known,” said PPPL physicist Daren Stotler, a coauthor of the paper. “These simulations take a deep dive into another level to look at how turbulence in one part of the plasma varies with respect to turbulence in another part.”

In the resulting graphics, a blue cross indicates the point of focus for a calculation; the red and yellow areas around the cross are regions in which the turbulence is evolving similarly to the turbulence at the focal point. Farther away, researchers found regions in which the turbulence is changing opposite to the changes at the focal point. These farther-away regions are shown as shades of blue in the graphics, with the yellow cross indicating the point with the most negative correlation.

For example, if the red and yellow images were a region of high density turbulence, the blue images indicated low density. “The density increase must come from somewhere,” said Zweben. “Maybe from the blue regions.”

Going forward, knowledge of these correlations could be used to predict the behavior of turbulence in magnetically confined plasma. Success of the effort could deepen understanding of a fundamental cause of the loss of heat from fusion reactions.

Also contributing to this study were Filippo Scotti of the Lawrence Livermore National Laboratory and J. R. Myra of Lodestar Research Corporation. Support for this work comes from the DOE Office of Science. 

**Make an
appointment for
your flu shot**

Protect yourself from influenza and avoid spreading the illness to others by getting a flu shot.

Please call the OMO at ext. 3200 to schedule an appointment.

Coils

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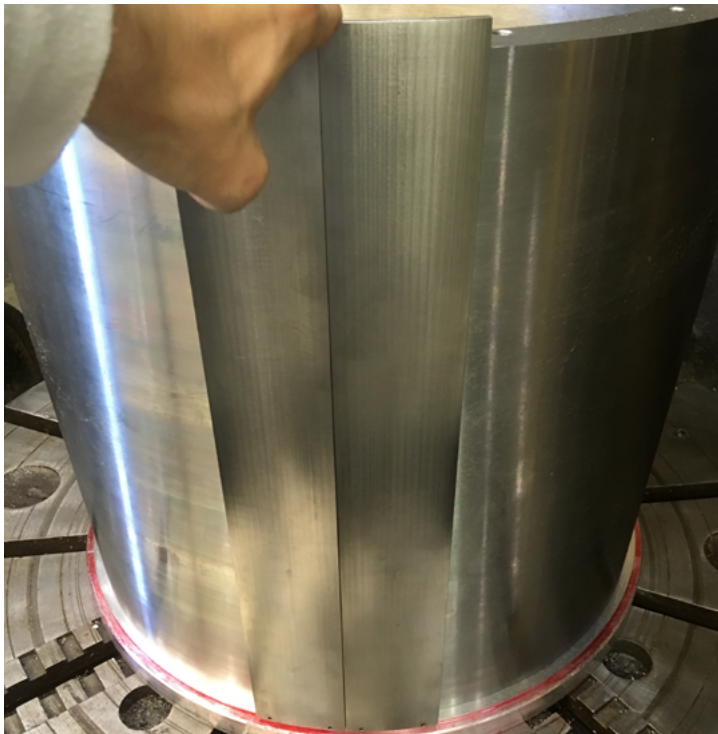
“The idea is to get the suppliers to qualify themselves to receive a contract to produce production coils,” Neumeyer said.

The prototype magnets will test a new design for three sets of magnets called inner poloidal field (PF) coils that nestle together next to the top and bottom of the center stack. One of those magnets, the PF1-A upper magnet, failed in the summer of 2016 and led to an extensive analysis of each system of the machine and to the redesign of the magnets.

Mandrel-less coils

The new coil will not contain an inner metal spool called a mandrel. This will produce more reliable results when engineers perform extensive electrical tests on the coils since the metal spool is itself conductive and could mask results. The redesigned coils also eliminate certain features such as joggles and brazed joints to minimize the risk during manufacturing, Neumeyer said.

The prototype design is similar to the new design concept planned for the PF1-A coil, which is the most complicated of the three inner PF coils, Neumeyer said.



The winding mandrel is tapered so that it can easily be removed after the coil is constructed.
(Photo by Richard Burke)



A technician examines the winding mandrel.
(Photo by Richard Burke)

The first prototype coil that is completed will be tested on a newly-built test stand at PPPL and will undergo extensive electrical tests and be cut into pieces to examine whether they were built to the exact design specifications. The results of the tests will determine which manufacturers will be considered to build the production coils.

Meanwhile, the design for the three sets of coils, the PF1-As, Bs, and Cs, is continuing, and a preliminary design review is scheduled in November.

PPPL has already constructed a winding mandrel on which the prototype manufactured here will be built. The winding mandrel has removable flanges and is tapered so that it can be extracted from the coil, said Steve Raftopoulos, head of magnets for the Recovery team.

Testing the VPI process

Engineers plan to test the vacuum pressure impregnation (VPI) process in which epoxy is injected into a vacuum-sealed mold and then heated to meld the epoxy and the fiberglass and kapton tape together. This process will be tested on a small, straight bundle of coils that has been assembled in the C-Site high bay inside a large oven.

The Laboratory plans to have an engineer on site at each of the manufacturing companies during production, as well as a quality assurance staff person for much of it. The plans, specifications and quality assurance requirements will apply equally to PPPL and the companies, Neumeyer said. “These people will serve as our eyes and ears in the factory to find anything that seems inconsistent with our specifications or anything else,” he said. “This will hopefully prevent any problems with the manufacture of the coils.” [📷](#)

**America
Recycles Day
Clothing Drive
begins Oct. 23**

Please donate your gently used clothing to the Trenton Rescue Mission from Oct. 23 through Nov. 21. Bins are located in the LSB lobby and lower parking lot entrance.

Explore Life through the Lens *with Photo Clique*

The Photo Clique's first meeting will be Tuesday, Oct. 24 at 12 p.m. in the café.

This photo club is open to all regardless of experience and imaging product preference.



Questions? Contact Elle Starkman at x2090 or estarkma@pppl.gov

Open Enrollment 2018 Benefits Fair

Vendors in the LSB lobby

Presentations in the MBG Auditorium:

11 a.m.-12 p.m.

“Understanding Your
Social Security Benefits”

*by Social Security Administration
representatives*

12:30-1:30 p.m.

“Introducing the New Roth
Retirement Savings Option”

by TIAA representatives

Thursday, Oct. 26

10 a.m.-2 p.m.

Open Enrollment ends Friday, Nov. 10

**Unicor electronics
recycling collection
is Nov. 15**

Please bring your home electronics for recycling to the Warehouse by the roll-up door across from the firehouse from 7:30 a.m. to 10 a.m.

Council Café Lunch

This Week:
Valeria Riccardo,
 Head of Engineering



Wednesday, Oct. 25
 12 p.m., PPPL Café

Next Week: David Carle

BROCK
NICK PETTI
 Chef Manager



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 Oct. 23	Tuesday Oct. 24	Wednesday Oct. 25	Thursday Oct. 26	Friday Oct. 27
COMMAND PERFORMANCE Chef's Feature	Beef and Bean Burrito with Yellow Rice	Buffalo Chicken Mac and Cheese	Sushi Day	Jerk Seasoned Pork Chops with Pineapple Rice and Mango Salsa	Bourbon Chicken over Rice
Early Riser	Blueberry Pancakes	Fried Bologna and Egg Sandwich	Tater Tot Breakfast Bake	Ham, Egg & Cheese French Toast	Biscuits and Sausage Gravy
Country Kettle	Chef's Choice	Chef's Choice	Pumpkin Bisque	Chef's Choice	Chef's Choice
Deli Special	Italian Hero	Cobb Salad Wrap	Lemon-Rosemary Turkey Sandwich	American Hoagie with Ham, Bologna, and American Cheese	Italian Tuna Salad Wrap
Grill Special	Grilled Pork and Long Hots	Chorizo Quesadilla	Grilled Fish Cake Sandwich	Grilled Margherita Sandwich	Pepperoni Roll
Panini	Cheddar Crab Melt	Chicken Breast, Mozzarella Cheese, Spinach and Tomato Pesto on Ciabatta Bread	Sushi Day	Corned Beef Reuben	NY Street Dog— 2 Sabrett Hot Dogs with Sauerkraut, Red Onions & Mustard served with Fries

MENU SUBJECT TO CHANGE WITHOUT NOTICE

HEART HEALTHY

VEGETARIAN OPTION

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The PPPL WEEKLY is published by the [PPPL Office of Communications](#) on Mondays throughout most of the year and biweekly during the summer, except for holidays.

DEADLINE for calendar item submissions is noon on WEDNESDAY. Other stories should be submitted no later than noon on TUESDAY.

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