PPPL PRINCETON PLASMA PHYSICS LABORATORY
A Collaborative National Center for Fusion & Plasma Research
U.S. DEPARTMENT OF ENERGY
WEEKLY
January 15, 2018

THIS WEEK

MONDAY, JAN. 15

Martin Luther King Jr. Day
Laboratory Closed

TUESDAY, JAN. 16

Core Values Session
9:30 a.m. ◆ Room B318

WEDNESDAY, JAN. 17

Core Values Session
12:30 p.m. ◆ Room B318

THURSDAY, JAN. 18

Open Meeting to Discuss DOE Feedback on PPPL's Performance in FY 2017
1 p.m. ◆ MBG Auditorium

SATURDAY, JAN. 20

Science on Saturday
9:30 a.m. ◆ MBG Auditorium
Improbable Research and the Ig Nobel Prizes
Marc Abrahams, Editor, Annals of Improbable Research

UPCOMING

WEDNESDAY, JAN. 24

Colloquium
4:15 p.m. ◆ MBG Auditorium
Exoplanet Snapshots, from Precision Optics to Precise Astronomical Measurements
Laurent Pueyo, Space Telescope Science Institute

FRIDAY, JAN. 26

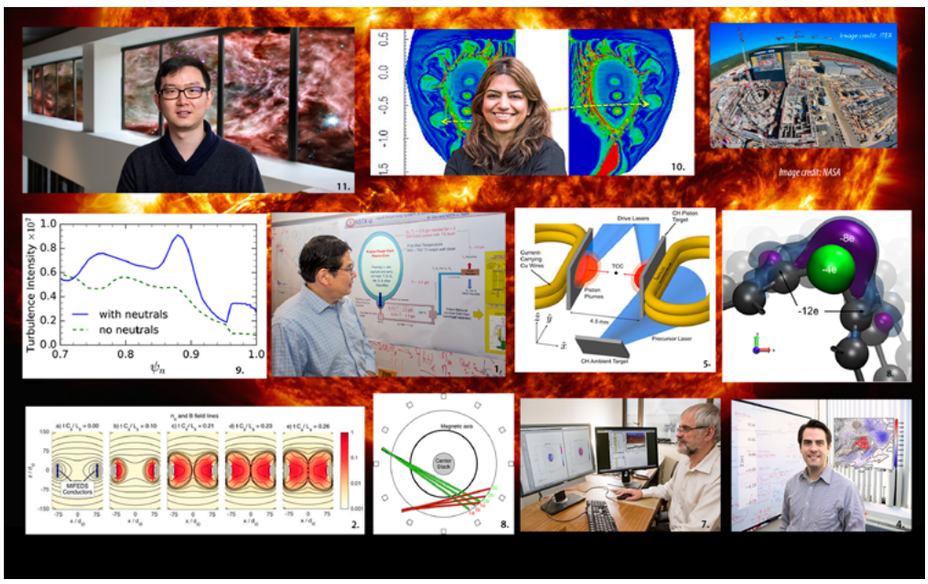
Celebration for employees
1:30 p.m. ◆ LSB Lobby

INSIDE

Ten stories in 2017 you may have missed, plus a bonus

By John Greenwald

Throughout 2017 researchers at PPPL have produced new insights into the science of fusion energy that powers the sun and stars and the physics of plasma, the hot, charged state of matter that consists of electrons and atomic nuclei, or ions, and makes up 99 percent of the visible universe. The research advances the development of fusion as a safe, clean and plentiful source of power, produced in doughnut-shaped facilities called tokamaks, and explores the diverse aspects and applications of plasma. The findings range from a breakthrough for stabilizing fusion plasmas to good news for the international ITER project going up in France to new thoughts about the chances of life on planets circling nearby stars. Here, in no particular order, are 10 not-to-be-missed PPPL stories — plus a bonus story — that appeared in 2017.



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NSTX-U Advisory Panel assesses research mission and praises corrective action plan as coil prototype production moves forward

By Jeanne Jackson DeVoe

The National Spherical Torus Experiment-Upgrade (NSTX-U) Research Program Advisory Committee (PAC) praised PPPL's corrective action plan for the facility after a two-day meeting last week.

Cary Forest, a physics professor at the University of Wisconsin, said in the debriefing for the Advisory Committee that the vision for a high-field Spherical Torus Pilot Plant was "very important" and will provide a "great path for the U.S. to pursue."

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Max Everett, DOE's chief information officer, and other top officials visit PPPL

Max Everett, the U.S. Department of Energy's (DOE) chief information officer, along with his chief of staff, Mark Schreiber, and Gerry Hopkins, senior advisor and acting deputy chief information officer for architecture, engineering, technology and innovation, visited PPPL on Jan. 10 as part of a tour of the national laboratories.

The delegation met with members of the Lab Leadership Council before touring PPPL. The visitors heard a talk by Rich Hawryluk, PPPL's interim director and met with Pete Johnson, head of PPPL's Site Office and other Site Office officials, and with Chelle Reno, Princeton University assistant vice president for operations. He met with members of the IT department and records management and had lunch before touring the National Spherical Torus Experiment-Upgrade (NSTX-U) with tour guides Tim Stevenson and Greg Tchilinguirian and touring the Plasma Physics Lab Computer Center with Marc Cohen, acting head of the IT Department, and other IT team leads. Everett said he enjoyed the tour and particularly liked seeing the NSTX-U. "It's amazing just to see that and all the work that went into it," he said.

Max Everett, the DOE's chief information officer, front right, with his chief of staff Mark Schreiber, center, and Gerry Hopkins, senior advisor and acting deputy chief information officer for architecture, engineering technology and innovation, left. At back are from left: Chelle Reno, Princeton University assistant vice president for operations; Marc Cohen, PPPL's acting head of IT; Rich Hawryluk, PPPL's interim director; Pete Johnson, manager of the Princeton Site Office; Terry Brog, PPPL's deputy director for operations; and Sandy Rogan, deputy manager of the Site Office. *(Photo by Elle Starkman)*

Tour guide Tim Stevenson shows Max Everett, the DOE's chief information officer, the NSTX-U, as Greg Tchilinguirian, head of the Plant Instrumentation and Control Group, speaks to Gerry Hopkins, left, and Mark Schreiber. *(Photo by Jeanne Jackson DeVoe)*

Everett examines some panels in the Plasma Physics Lab Computer Center as Gerry Hopkins looks on. *(Photo by Jeanne Jackson DeVoe)*

Open Meeting to Discuss DOE Feedback on PPPL's Performance in FY 2017

Thursday, Jan. 18
1 p.m.
MBG Auditorium

Please come to an open meeting with Rich Hawryluk, PPPL's interim director, and Dave McComas, the Princeton University vice president for PPPL, to discuss DOE feedback on PPPL's performance in FY 2017.

Ten stories of 2017

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1. **Improving fusion power plants.** Future facilities that produce fusion energy must operate in a steady state, or constant, manner 24 hours a day. At PPPL, physicist Masayuki Ono, in collaboration with research centers in the United States and Japan, has proposed an innovative solution to the steady state problem. His design calls for loops of liquid lithium to clean and recycle tritium, a key fusion fuel ingredient, while protecting tokamak components that exhaust waste heat, and cleaning dust and other impurities from the tokamak — all at the same time.
2. **Bringing solar eruptions down to Earth.** Using lasers, researchers led by PPPL physicist Will Fox have created conditions on Earth that mimic astrophysical behavior. The lasers generate plasmas that shed light on cosmic bursts of subatomic particles that give rise to solar eruptions and solar flares and accelerate cosmic rays to near the speed of light. Subsequent computer simulations have agreed well with the breakthrough laboratory experiments.
3. **Good news for ITER.** New findings led by C.S. Chang, of PPPL, show that ITER, the international fusion experiment under construction in France, should be able to withstand the enormous heat load that will strike the divertor plates that exhaust waste heat from the facility. Results of the two-year collaboration with seven U.S. and European institutions found that the load, which will be comparable to the heat that spacecraft experience when re-entering the Earth's atmosphere, will be wide enough for the divertor to tolerate. Previous estimates drawn from existing tokamaks had suggested that the heat could be so narrow and concentrated as to the damage the divertor.
4. **The blob that ate the tokamak.** Like bubbles that rise in boiling water, blobs that percolate in the plasma inside fusion devices known as tokamaks can cause heat to escape from the devices. PPPL scientists led by Michael Churchill performed computer simulations that have produced a fuller and more fundamental picture of the behavior of blobs, providing new insight into how to control them.
5. **Shock waves of the new.** Supersonic shock waves propel astrophysical processes such as supernova particles to velocities that approach the speed of light. Scientists led by Derek Schaeffer, of PPPL, and Princeton have for the first time reproduced such shocks in a laboratory setting, enabling study of the puzzling processes with greater flexibility and control than can be done in space.
6. **Growing microscopic particles that are stronger than steel.** Research at the PPPL Laboratory for Plasma Nanosynthesis develops new insight into the use of plasma to synthesize nanomaterials — particles such as carbon nanotubes that are measured in billionths of a meter, are found in everything from swimwear to electrodes and have a tensile strength, or resistance to breaking when stretched, that is stronger than steel. PPPL collaborations with physicists at Princeton University and the State University of New York at Stony Brook have now uncovered a method for speeding the growth of nanoparticles — a step toward understanding, predicting and controlling the synthesis of plasma to produce the prized material.
7. **Stabilizing next-generation fusion plasmas.** In a potentially major advance, physicists at PPPL and the DIII-D National Fusion Facility that General Atomics operates for the DOE have discovered a way to reduce the loss of heat and particles from fusion plasmas. A combination of PPPL modeling led by physicist Gerrit Kramer and DIII-D experiments has found that broadening the electric current in the center of plasma could reduce the loss of crucial elements called alpha particles that heat the plasma and sustain fusion reactions.
8. **A quick and easy way to shut down plasma instabilities.** A wave-like disturbance that commonly occurs in fusion plasmas can halt fusion reactions and damage the walls of tokamaks that house the fusion process. PPPL physicist Eric Fredrickson recently found that such disturbances can be suppressed on the National Spherical Torus Experiment-Upgrade at

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Ten stories of 2017

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the Laboratory with particles from a second neutral beam injector installed in the upgrade — a remarkably simple solution. The results validated predictions of a computer code developed by PPPL physicist Elena Belova and marked good news for the future of fusion.

9. **The impact of recycling on plasma turbulence.** Researchers have long wondered how atoms recycled from the walls of tokamaks that house fusion reactions affect turbulence, the random fluctuation of plasma that can cause heat and particle loss. In the first basic-physics attempt to study the impact, PPPL physicist Daren Stotler, working under PPPL's C.S. Chang, used an extreme-scale computer code to model how the recycled neutral atoms tend to increase turbulence in detail that had never before been possible. Further research could improve understanding of the likely performance of plasma in the huge ITER tokamak, where recycling may differ from what is observed in current tokamaks.

10. **Self-extinguishing troublesome bursts in fusion plasmas.** Instabilities called Edge Localized Modes (ELMs) frequently arise in highly confined fusion plasma and could damage tokamak components and halt fusion reactions. PPPL physicist Fatima Ebrahimi has for the first time used advanced models to simulate the cyclic behavior of these instabilities, creating insight into how to curtail or prevent them in future tokamaks. The simulations agree with observations of the cyclic behavior of ELMs in tokamaks around the world.

And now, a bonus story you should not miss from 2017:

11. **Life on exoplanets.** Astrophysicist Chuanfei Dong of PPPL and Princeton University has led collaborative research that casts doubt about the chances of life on planets that orbit stars beyond the solar system. The space physicists noted that the stellar wind that blows from stars could deplete the atmosphere of such planets over hundreds of millions of years, eliminating liquid water that is vital for life as we know it.

Council Café Lunch

This Week:

Les Hill, head of the IOI project and the Integrated Corrective Action Plan

Wednesday, Jan. 17
12 p.m., PPPL Café

Next: Mike Zarnstorff

Submit your questions for Plasma 101 Lunch & Learn

Please submit your questions about fusion energy, plasma, or any of the research we do here in the box in the LSB lobby.

Sample questions:
What is plasma?
How is what we do different from "nuclear power?"
Why don't we have fusion energy on the grid yet?

NSTX-U corrective action plan

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Further, Forest said the committee was impressed with PPPL's corrective action plan for the recovery project. The committee praised NSTX-U researchers for continuing to carry out world-leading research during the recovery outage, and noted that NSTX-U will make world-leading contributions to ST research in areas such as non-inductive scenarios when operations resume in 2020.

The positive feedback from the PAC, which met Jan. 9 to 10 at PPPL, was good news in advance of the U.S. Department of Energy's (DOE) capability assessment review planned for later this month or early February that will assess NSTX-U's mission, the cost and schedule of the Recovery Project, and the Lab's capability of implementing the Recovery Project.

"From their (the DOE's) perspective we spent a lot of money on the NSTX-U project and now we're spending a lot of money on the Recovery Project and they legitimately want to know whether they're getting what they're paying for," said Russ Feder, the project manager for the Recovery Project. "We have a very strong engineering staff, so there's nothing we're doing that we haven't done before. Everyone on the management staff is working to get this right."

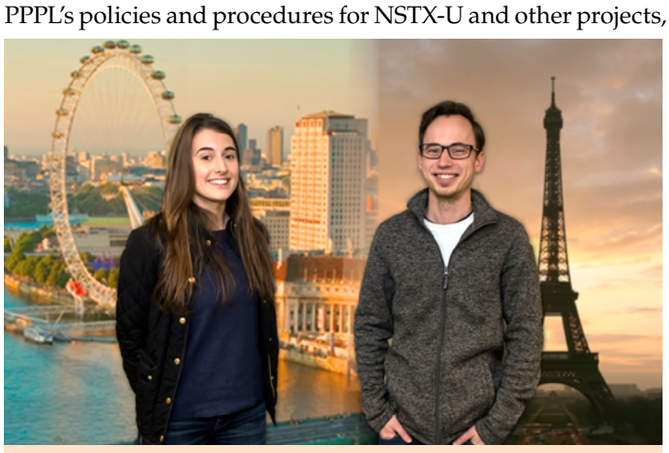
Meanwhile, the Recovery Project is holding two or three design reviews per week to ensure that each element of the project is carefully assessed through preliminary and final design reviews. These reviews will all be part of preparing for a baseline assessment by the end of April.

"The staff is working full bore," said Feder. "The poloidal field coils, the magnets that are used to shape the plasma in experiments, continue to be a central focus of the Recovery Project." The failure of one of the coils, the PF1-A upper coil, caused the shut down of the machine in the summer of 2016. The DOE has given PPPL a notable outcome of completing the final design reviews for the PF1-A upper coil, as well as a twin, the PF1-A lower coil, and two sets of similar magnets that nestle together against the center stack: the PF1-B and PF1-C upper and lower coils.

The Recovery project must build and test at least one "production coil" for each type of coil that will be used in the actual machine to meet a second notable outcome with a deadline of Sept. 30.

In support of these activities, PPPL is hiring a chief engineer who will work under Valeria Riccardo, head of engineering, and will oversee all engineering projects. In addition, PPPL is hiring a systems engineer who will make sure that all the requirements for a project are flowing down to everyone involved in the project, Feder said.

Terry Brog, deputy director for operations, announced last week that Les Hill, who headed the Extent of Cause review of PPPL's policies and procedures for NSTX-U and other projects, will head the Integrated Corrective Action Plan (ICAP) effort that came out of the review. He will be assisted by Norm Nilsen, an experienced project manager who has worked at nuclear power plants. He began work last week as a deputy project manager for ICAP and other projects.



Engineer Carmela Ciummo is in England supervising the manufacture of a production coil and Richard Burke is heading for France in February. (Image by Elle Starkman)

Physicist Mario Podesta presents to the Advisory Committee. *(Photo by Elle Starkman)*

Physicist Michael Jaworski gives a presentation to the Advisory Committee. *(Photo by Elle Starkman)*

The Recovery Project is moving ahead with plans to build four separate prototype coils at four separate facilities, including PPPL. Each of the facilities must meet strict new guidelines for manufacturing the coils, including the requirement of a clean room. Each will also be supervised by a PPPL engineer and closely supervised by a responsible engineer. The prototype coils and the final production coils will be built without an inner mandrel, meaning that the final coils will not be wound on an inner spool. This will make it easier to perform electrical tests on the coils.

On Jan. 5, engineers Michael Kalish and Carmela Ciummo traveled to England to meet with representatives from Tesla Engineering Ltd., which will start manufacturing the prototype coil soon. Kalish returned early last week but Ciummo will remain in England while the coil is being manufactured over the next few months. Another early career engineer, Richard Burke, will go to France in February to oversee work at Sigmaphi for a few months. Douglas Downing will do similar work at Everson Tesla Inc. in Pennsylvania, while Mike Viola is supervising PPPL's production work. Quality assurance staff will also oversee work at the three plants and the PPPL facility.

Another notable outcome requires PPPL to have at least one prototype magnet completed, do extensive electrical testing on the magnet, cut it into sections to test the effects, and submit a report to the DOE by July 15.

PPPL has also assembled a bundle of conductor, which engineers have dubbed "the VPI log," to test the vacuum impregnation (VPI) process in which epoxy is injected into a vacuum-sealed mold and heated to meld the epoxy, fiberglass and Kapton tape together. The VPI has been completed and the "log" underwent electrical tests to see if the insulation material breaks down under high voltage, and thus far the insulation has met project requirements.

PPPL has also begun winding the Kapton and fiberglass together in the coil winding facility in the C Site High Bay.

Ronald E. Hatcher

Science on Saturday LECTURE SERIES

Jan. 20	**Improbable Research and the Ig Nobel Prizes** **Marc Abrahams,** Editor, Annals of Improbable Research
Jan. 27	**Astrophysical Plasmas** **Amitava Bhattacharjee,** PPPL
Feb. 3	**Synthetic Muscle for Deep Space Travel** **Lenore Rasmussen,** Ras Labs

Saturdays at 9:30 a.m., MBG Auditorium

Peek behind the scenes of PPPL's research experiments

Tuesday, Jan. 23
2 p.m.

PPPL employees are invited to get a behind-the-scenes look at PPPL's experiments on the first monthly in-depth tour of PPPL's research facilities.

Sign up here or contact Deedee Ortiz, dortiz@pppl.gov, ext. 2785.

Celebration for employees

Friday, Jan. 26
1:30 p.m.
LSB Lobby

Come have some cake and coffee and bid farewell to the employees taking a voluntary separation from the laboratory.

Core Values Sessions

Come to an Information Session on Living RISE at PPPL

Tuesday, Jan. 16
9:30–10:30 a.m.

Wednesday, Jan. 17
12:30–1:30 p.m.

Room B318

Light refreshments will be served

BROCK

NICK PETTI
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 Jan. 15	Tuesday Jan. 16	Wednesday Jan. 17	Thursday Jan. 18	Friday Jan. 19
COMMAND PERFORMANCE **Chef's Feature**	Martin Luther King Jr. Day Laboratory Closed	**Pasta** with Clam Sauce and Garlic Bread	**Roast Beef Au Jus** with Mashed Potatoes	**Chicken Pot Pie**	**Baked Macaroni and Cheese** with Stewed Tomatoes
Early Riser		**Mexican Breakfast Burrito**	**Scrapple and Eggs**	**Cinnamon-Raisin Pancakes** with Homemade Apple Compote	**French Toast Sticks**
Country Kettle		**Vegetable**	**Chicken Noodle**	**Tomato Soup**	**Chili Bean**
Deli Special		**Smoked Salmon and Herb Cream Cheese Bagel**	**Cajun Egg Salad Wrap**	**Turkey Sloppy Joe**	**Spicy Crab wrap**
Grill Special		**Burgerlicious Old Macdonald Burger**	**Bacon, Arugula, and Fried Green Tomatoes**	**Ham and Cheese Pizza Roll**	**Greek Chicken Cheesesteak**
Panini		**Fried Flounder Hero** with Cajun Remoulade	**Pastrami and Swiss** on Marble Rye	**Chipotle Roast Beef Melt**	**Breaded Chicken Cutlet** with Ham, Swiss Cheese, Lettuce & Honey Mustard Ciabatta

MENU SUBJECT TO CHANGE WITHOUT NOTICE

HEART HEALTHY

VEGETARIAN OPTION

WEEKLY

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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/.