

## THIS WEEK

**WEDNESDAY, MARCH 29**
**PPPL Colloquium**

4:15 p.m. ♦ MBG Auditorium

**[The long and the short of collisions in strong magnetic fields](#)**

Daniel Dubin, University of California - San Diego

**THURSDAY, MARCH 30**
**PPPL Colloquium**

10:30 a.m. ♦ MBG Auditorium

**[The U.S. D.O.E. Exascale Computing Project - Goals and Challenges](#)**

Paul Messina, Argonne National Laboratory

## UPCOMING

**WEDNESDAY, APRIL 6**
**PPPL Colloquium**

4:15 p.m. ♦ MBG Auditorium

**[Pilot-wave hydrodynamics](#)**

John W. M. Bush, MIT

**APRIL 17-21**
**Earth Week at PPPL**
**THURSDAY, APRIL 27**
**Revealing War: A Conversation About Art and Journalism in the 21st Century**

5 p.m. ♦ 101 McCormick Hall, Princeton University

## INSIDE

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## PPPL prepares to build new PF1A coils

By Jeanne Jackson DeVoe

**P** PPL is preparing to build a new set of magnets – the PF1A poloidal field coils – and engineering staff is working on that and other projects critical to getting the National Spherical Torus Experiment-Upgrade (NSTX-U) operational, Rich Hawryluk, head of the NSTX-U Recovery Project, told the recovery team on March 22.

Hawryluk said the design, verification and validation reviews (DVVRs) to identify any gaps in the design and construction of major systems on the experiment are necessary and valuable. “First of all, there was a need for doing this,” Hawryluk said. “We had a history of unintended difficulties. We have to go through this to give ourselves, the university, and DOE assurance that we’re going to have a reliable machine coming out of this process.”

[continued on page 3](#)

## Century-old machine used in space race and fusion is getting a new home

By Larry Bernard



The vertical boring mill in the RESA building being readied for disassembly. The century-old machine was used to mill parts for NASA in the space race and then for fusion devices at PPPL. (Photo by Elle Starkman)

**T**he year was 1964, three years after President Kennedy launched the space race with the goal of putting a man on the moon by the end of the decade. The year spawned Gemini and then Apollo, which landed the first astronauts on the lunar surface.

A crucial component of the Apollo missions were the tiles that served as heat shields to protect space capsules and their inhabitants from the searing heat of reentry into Earth’s atmosphere. To create the tiles, NASA needed a large boring mill that could machine the parts to fit the contours of the capsules.

Thus began the modern chapter in the history of the century-old Sellers Vertical Boring Mill, once used to machine heat shields for Apollo’s Command Service Modules, and last used to machine parts of the vacuum vessel of PPPL’s tokamak, the National Spherical Torus Experiment (NSTX). Built around 1914 by the William Sellers and Co. in Philadelphia, the 100-ton, room-sized instrument made possible the safe reentry of the Apollo missions.

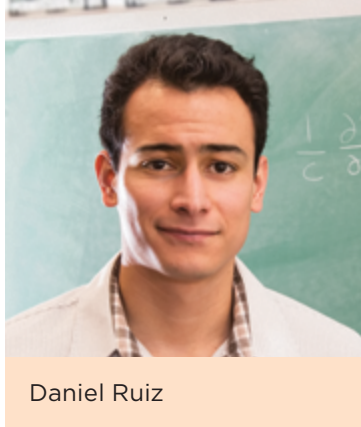
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## Daniel Ruiz wins Truman fellowship

By John Greenwald

**D**aniel Ruiz, a fifth-year graduate student in plasma physics at PPPL, has won a Harry S. Truman fellowship for post-doctoral work at Sandia National Laboratories. Ruiz, who graduates in August, is the second PPPL student to receive the coveted fellowship. Paul Schmit won it in 2012.


Ruiz, who recently published a series of papers on waves in modulated media and fundamental corrections to traditional geometrical optics, will use the three-year fellowship to study laser-plasma interactions in the Magnetized Liner Inertial Fusion (MagLIF) experiment on Sandia's Z machine. "The fellowship presents a wonderful opportunity," said



Daniel Ruiz

Ruiz. "It will allow me to pursue my own research interests and to collaborate closely with researchers of the Pulsed Power Sciences Center at Sandia."

Ruiz has broken new ground in the study of waves in plasmas since arriving at PPPL in 2012. "He's taught me a lot," said physicist Ilya Dodin, Ruiz's thesis adviser and co-author of the recent papers. "Daniel has done exceptional Ph.D. research. When he finishes his thesis, I will recommend it as a fundamental textbook for anyone interested in modern wave theory and its plasma applications."

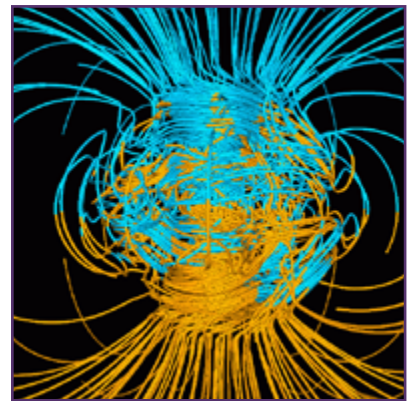
Ruiz, originally from Colorado, was an undergraduate at Tecnológico de Monterrey in Monterrey, Mexico, where he was a member of the varsity swim team. He also attended École Polytechnique in Palaiseau, France and received his M.S. in Nuclear Reactor Physics and Engineering from the National Institute of Nuclear Science and Technology (INSTN) in Saclay, France. 

# COLLOQUIUM

## The long and the short of collisions in strong magnetic fields

**Daniel Dubin**

University of California - San Diego



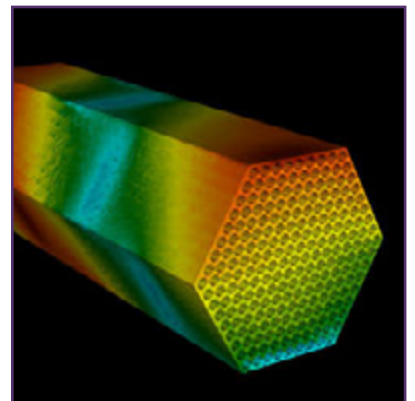
**Wednesday, March 29**

4:15 p.m., M.B.G Auditorium, Lyman Spitzer Building

## The U.S. D.O.E. Exascale Computing Project - Goals and Challenges

**Paul Messina**

Argonne National Laboratory



**Thursday, March 30**

10:30 a.m., M.B.G Auditorium, Lyman Spitzer Building

# PF1A

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The NSTX-U Recovery Project leaders will submit an interim corrective action report to the U.S. Department of Energy (DOE) this week that outlines plans to address issues intended to ensure the NSTX-U will operate reliably. The interim report will focus on the first five of 12 DVVRs, along with recommendations of an external extent of condition (EOC) review committee.

Hawryluk acknowledged that engineers and other staff members have worked extremely hard to prepare for the DVVRs. PPPL has had nine DVVRs out of 12 that started in January and will continue through April. The ninth DVVR on vacuum and fueling was March 23 to 24 and a DVVR on bakeout is scheduled March 30. "This has been a difficult process – an enormous amount of work – but we know more today in a comprehensive sense than we did going into it," Hawryluk said.

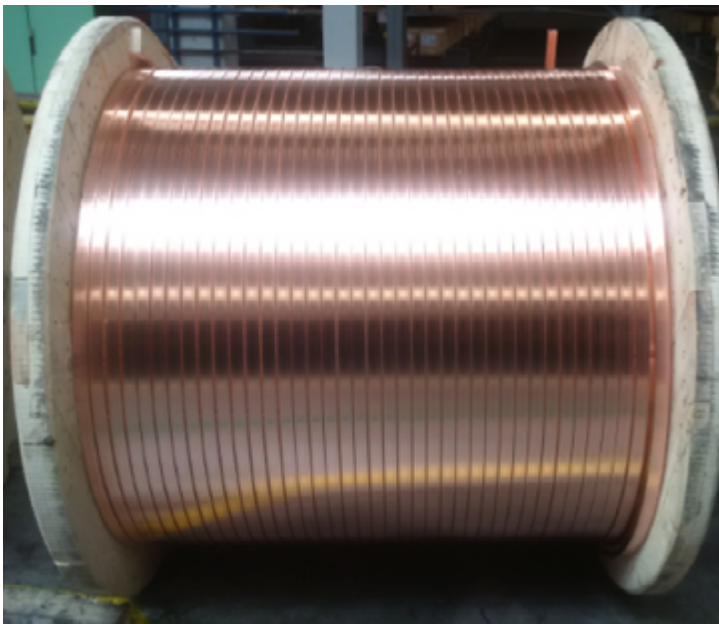
Hawryluk said Recovery Project leaders will develop a detailed cost and schedule after the DVVRs and a second EOC meeting are completed. Those details will be part of a final corrective action plan that is due to be submitted to the DOE by the end of May.

## PF1A designed for easier manufacturing

Meanwhile, PPPL engineers unveiled a preliminary redesign for the PF1A coils focused on making the coils easier to manufacture and avoiding potential problems identified in the failed PF1A coil. Plans also call for a new testing protocol that includes building a full power test stand at PPPL to test the PF1A and other inner PF coils, if needed.

The new design for the PF1A coils was the subject of a preliminary design review on March 17. The coils would replace the PF1A upper and lower coils, two magnets that are used to shape the plasma. The PF1A upper coil failed last summer, forcing the shutdown of the NSTX-U. Its twin was designed and manufactured identically.

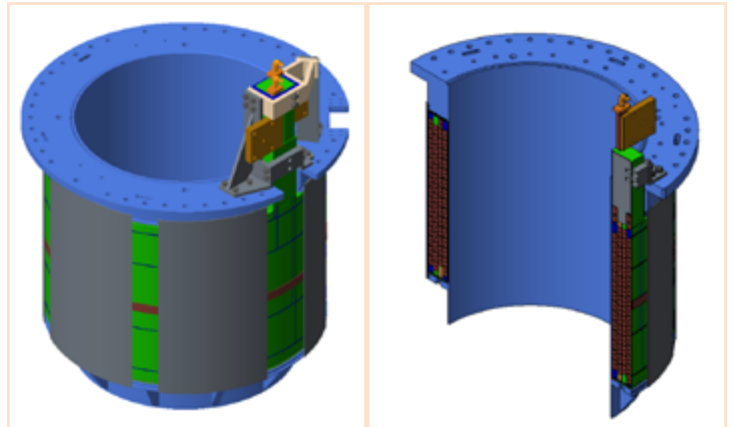
"What we're really pushing is to get the most reliable, easiest to build coil possible," said Mike Kalish, the engineer in charge of the PF1A design.



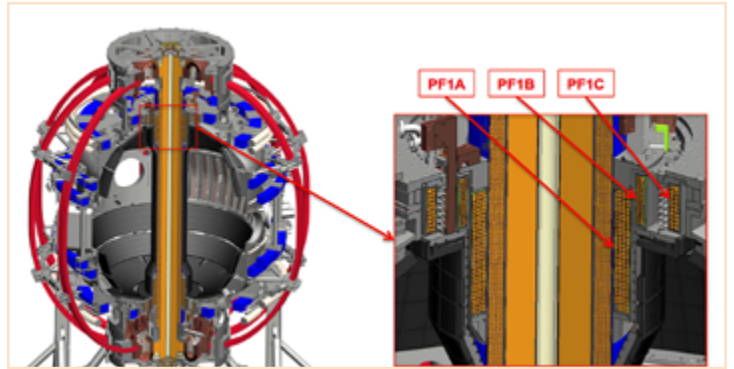
One of four spools of copper that will be used for the PF1A coils. (Photo by Mike Kalish)

## On-site test stand

Engineers are designing a test stand on the first floor of the FCPC (Field Coil Power Conversion) building, located on D Site behind the NSTX-U test cell, that would test the electrical, thermal and mechanical performance of the PF1A coils by pulsing a current through the coils. The test stand could also be used to test the other inner coils, the PF1B and PF1C coils.



An illustration of the redesigned PF1A coil. (Image by John Mitchell)



An illustration shows the location of the PF1A upper coil nestled next to the center stack. (Image by John Mitchell)

Once the PF1A design is approved sometime over the next month or so, the plan is to build a PF1A prototype at PPPL at a coil winding apparatus that is almost


complete at the C Site test cell. The prototype would be tested before the PF1A upper and lower coils are built.

Although a forensic analysis of the failed coil never pinpointed the exact cause of the coil failure, engineers believe certain design features made it more difficult to manufacture. For example, the new design uses a softer continuous piece of copper that is easier to bend than the copper used in the PF1A upper. Having one continuous piece of copper eliminates the need to braze pieces of copper together.

## Joggles replaced

Another major change is to replace sharp bends in the PF1A coils called "joggles" that provided transitions between coil layers and replacing them with a spiral design that transitions smoothly between layers. "It's essentially getting rid of stairs and putting in a ramp," explained Steve Raftopoulos, the responsible engineer for magnets on the NSTX-U Recovery Project. He said the coil would be easier and faster to manufacture without the joggles. "It's easier to make, which should make it a more reliably-made coil," Raftopoulos said. However, without joggles there are fewer turns in the coil. Since the magnetic field is proportional to the magnetic current and the number of turns, the magnetic field produced by the coil would be slightly less powerful unless the current was increased.

The new PF1A design is also intended to make it easier to perform the vacuum pressure impregnation, or VPI process, which is used to seal and insulate coils, Kalish said. The process backfills the copper in the coil, which is wrapped in fiberglass and kapton tape, with an epoxy resin. It is then cured at 170 degrees Centigrade, or about the same temperature at which you bake a cake. The new design adds an extra layer of insulation to allow more space for the epoxy to infiltrate the coil during the VPI.

This feature addresses an issue identified by a forensic analysis of the failed coil, which found there were "numerous unwetted areas indicative of a lack of epoxy impregnation," according to a report on the forensic investigation. 

## PPPL hosts EU counterparts for ITER diagnostics



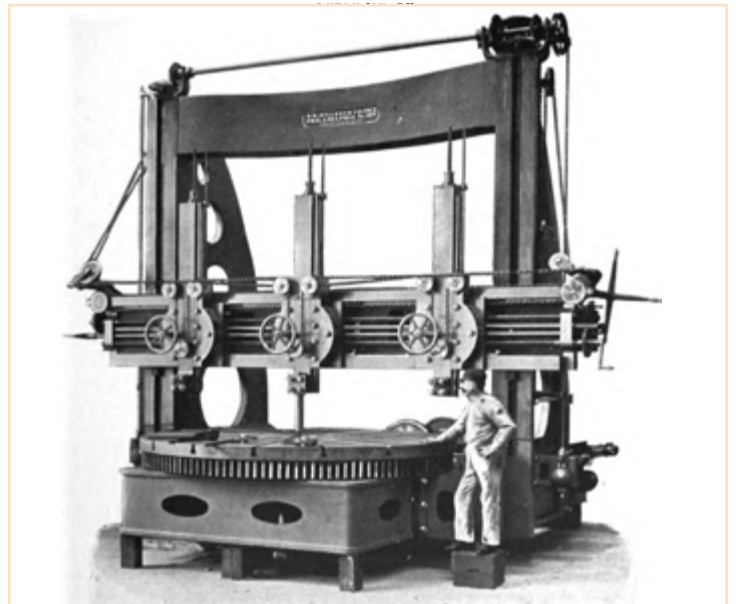
PPPL's ITER diagnostics team working on diagnostic interfaces for US ITER met at PPPL on March 16 with their counterparts from Spain for the European Union's Fusion 4 Energy.

## Vertical boring mill

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The machine now sits in the Research Storage and Assembly (RESA) building at PPPL, where A&A Machinery Moving is dismantling and shipping it to a company in Utah that will use it to manufacture turbines for hydroelectric generators. "We got it off a government excess list in the 1970s," said Larry Dudek, head of the PPPL Fabrication, Operations and Maintenance Division. "So it cost us nothing to buy – just transport."

While PPPL sold the machine for a token amount, the new owner will spend another \$1.5 million or so for the disassembly and transportation of the unit and the cost of modernizing it. But that's a bargain, since a 100-ton boring mill would cost about \$7 million today. "They don't make them like that anymore," said Rick Rainey, head of the Material Services Division at PPPL. The unit includes a 50-ton table that measures 16 feet in diameter and a 25-foot tall bridge that allows the machining of very large components.




A page from the Sellers illustrated catalogue in the early 1900s show a smaller, 12-foot boring mill. PPPL's version is a larger model.



The sellers Boring Mill prior to disassembly in the RESA building. (Photo by Elle Starkman)

AVCO Corp. bought the machine from the U.S. Navy in the 1960s to produce the Apollo heat shields. PPPL acquired it in the 1970s to machine parts for various experimental vacuum vessels, including the Poloidal Divertor Experiment and the Spheromak, and later to machine large parts for the construction of the Tokamak Fusion Test Reactor. In the 1990's PPPL used it to machine coil mounts and vacuum vessel flange surfaces for NSTX.

In the RESA building, the enormous machine has to make way for a warehouse as part of the Infrastructure Operational Improvements project. "It's a huge machine," Dudek said. "There really are only a few things we could use it for, maybe once a decade. It's very that rare we would need it."

Disassembly of the machine began March 6 and, piece-by-piece, is being removed. The machine is expected to be gone by April. 

## NASA aerospace engineer discusses travel to Mars



NASA aerospace engineer Aprille Ericsson in a March 22 colloquium, "Let's go to Mars," in which she discussed what it would take to send manned missions to Mars. (Photo by Elle Starkman)



Aprille Ericsson, second from left, a former professor at Howard University, with her former student, engineer Atiba Brereton, far right, along with engineer Charlie Gentile and engineer Nicole Allen, who introduced Ericsson at the colloquium. (Photo by Elle Starkman)

# Nominate your green colleagues or teams for Green Machine Awards

Please submit your nominations now for Green Machine Awards honoring PPPL employees or teams that have helped contribute to making PPPL green by the Wednesday April 5 deadline. Complete the online nomination form or email Virginia Finley ([vfinley@pppl.gov](mailto:vfinley@pppl.gov)).

Please submit award nominations for PPPL employees or employee teams that have contributed to PPPL's environmental performance during the past year by:

- Reducing greenhouse gas emissions
- Saving energy
- Saving water
- Reusing equipment or material
- Recycling materials or equipment
- Reducing the use of toxic or hazardous materials
- Sustainable acquisition (purchasing recycled content, energy efficient, bio-based, and other "green" products)
- Reducing or eliminating pollution
- Other actions that help protect public health or the environment.

**Nominations should include:**

- Nominee name(s)
- PPPL work group
- Description of the actions taken
- Estimated cost savings or environmental benefit

**Self-nominations will be accepted.**

**Please contact Virginia Finley ([vfinley@pppl.gov](mailto:vfinley@pppl.gov)) or Leanna Meyer ([lmeyer@pppl.gov](mailto:lmeyer@pppl.gov)) if you have questions or would like information about past Green Machine awards.**

**Note:** While the PPPL Green Machine Awards recognize environmentally sustainable practices at work, we would also like to hear about what you're doing at home. If you've made an effort to "green your home" and would like to share your experience during Earth Day, please complete the applicable section of the online nomination form.

# PPPL Children's Art Poster Contest for Earth Day

The Green Team is sponsoring an art poster contest for PPPL staff members' children and grandchildren, from kindergarten through eighth grade, in honor of Earth Day.

Children can submit 11-by-17-inch art on white drawing paper in any medium by April 10. Winners will receive a special prize and their drawings will be displayed in the LSB lobby on April 19.

Please contact Virginia Finley, [vfinley@pppl.gov](mailto:vfinley@pppl.gov), ext. 2746, for more information or to pick up paper.

**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 March 27	Tuesday March 28	Wednesday March 29	Thursday March 30	Friday March 31
COMMAND PERFORMANCE <b>Chef's Feature</b>	<b>Chicken Cacciatore</b>	<b>Farfalle Alla Romano</b> with Garlic Bread	<b>Pork Carnitas Burrito</b> with Beans	<b>Beef Barbacoa</b>	<b>Curried Seafood</b> over Basmati Rice with Naan Bread
Early Riser	<b>Belgian Waffle Sticks</b>	<b>Huevos Rancheros</b>	<b>Frittata Lorraine</b>	<b>Omelet Florentine</b> with Spinach, Tomato & Mozzarella	<b>Breakfast Tacos</b>
Country Kettle	<b>Chipotle Chicken</b>	<b>Pasta e Fagioli</b>	<b>Turkey Wild Rice</b>	<b>Tomato Lentil</b>	<b>Spinach and White Bean</b> with Sausage
Deli Special	<b>Smoked Turkey Baguette</b>	<b>Greek Tuna Salad</b> with Pita Chips over Lettuce	<b>Southwest Turkey,</b> Peppers & Cheddar with Jalapeño Ranch Spread	<b>Tomato &amp; Fresh Mozz</b> on Ciabatta with Basil, Red Onion & Arugula	<b>Maple-Roasted Vegetable Wrap</b>
Grill Special	<b>Italian Grilled Cheese</b>	<b>Buffalo Chicken Steak Sandwich</b> with Fries	<b>Pizza Burger</b>	<b>Chicken Zen Sandwich</b>	<b>Falafel Sandwich</b>
Panini	<b>Buffalo Shrimp Wrap</b>	<b>Italian Beef</b> with Spinach and Provolone	<b>Kielbasa</b> with Sauerkraut	<b>Crab Cake</b> on a Kaiser with Lettuce & Tomato	<b>California Turkey Wrap</b>

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