

THIS WEEK

MONDAY, FEB. 20

Special seminar for all PPPL'ers
9 a.m. ♦ MBG Auditorium
PNNL National Security Overview
Tony Peurrung, associate laboratory
director of National Security at PNNL

**Final day to apply to present
at Princeton Research Day**
[See page 7 for more information.](#)

FEB. 24-25

**New Jersey Regional Middle
and High School Science Bowls**
[See page 6 for information](#)
[on how to volunteer](#)

UPCOMING

SATURDAY, MAR. 4

Science on Saturday
9:30 a.m. ♦ MBG Auditorium
[Eyes wide open and all hands
on deck: Challenges and
opportunities in responding to the
risks of climate change](#)
Elke Weber, Princeton University

WEDNESDAY, MAR. 8

PPPL Colloquium
4:15 p.m. ♦ MBG Auditorium
[The Breakthrough Starshot
Initiative: A Funded Interstellar
Flight Project](#)
Edward Turner, Princeton University

SATURDAY, MAR. 11

Princeton Research Day

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Vacuum Vessel DVVR focuses on the NSTX-U bakeout and other key issues

By Jeanne Jackson DeVoe

The National Spherical Torus Experiment-Upgrade (NSTX-U) wasn't able to reach specified temperatures for a bakeout during the last run because the high heat could have potentially damaged one of the smaller magnets embedded in the center stack.

That was one of the problems identified during a meeting of the review committee on the NSTX-U vacuum vessel and internal hardware last week.



Examining the ceramic break for the PF1C assembly in front of the center stack casing are from left to right: Roel Verhoeven, of the Culham Centre for Fusion Energy; Frank Malinowski, PPPL Quality Assurance engineer; Rui Viera, of MIT's Plasma Science and Fusion Center; and PPPL engineer Steve Raftopoulos.
(Photo by Jeanne Jackson DeVoe)

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Advanced fusion code led by PPPL will participate on three new supercomputers

By John Greenwald

U.S. Department of Energy (DOE) high-performance computer sites have selected a dynamic fusion code, led by PPPL physicist C.S. Chang, for optimization on three powerful new supercomputers. The PPPL-led code was one of only three codes out of more than 30 science and engineering programs selected to participate in Early Science programs on all three new supercomputers, which will serve as forerunners for even more powerful exascale machines that are to begin operating in the United States in the early 2020s.

The PPPL code, called XGC, simulates behavior of the ions, electrons and neutral atoms in the transport barrier region— or “pedestal” — between the ultra-hot core of the plasma that fuels fusion reactions and the cooler and turbulent outer edge of the plasma. The pedestal must be high and wide enough to prevent damage to the divertor plate that exhausts heat in doughnut-shaped tokamaks that house the fusion reactions. “How to create a high edge pedestal without damaging the divertor wall is the key question to be answered,” said Chang. “That is a prerequisite for achieving steady state fusion.”

[continued on page 4](#)

700 tons of crushed stone for C Site MG building basement

Workers have poured concrete footings for steel columns that will support a new concrete floor in the C Site-Motor Generator (MG) building, and have reinforced the basement floor by placing 700 tons of crushed stone.

Each of the three bays, located in the southwest, northwest and northeast corners, required nine truckloads of crushed stone with 28 men working on the floor to complete the task, according to Frank Karam, the Princeton University field engineer for PPPL's Infrastructure Operational Improvements (IOI) project.

Workers are using jackhammers in the Southeast corner to break up the concrete floor. The area used to contain an enclosure for electrical equipment for old experiments at PPPL that workers recently removed.

Once the concrete is removed, workers will erect concrete pillars in that area to support the structural concrete floor slab on the first floor of the MG building. The southeast corner will have concrete pillars because most of the heavy equipment being moved from the Research Storage and Assembly (RESA) building will be in that area.

The first floor of the MG building will house machine shops now located at the RESA building. The RESA building will then be converted into a modern storage warehouse.



Frank Karam, the Princeton University field engineer for PPPL's Infrastructure Operational Improvements (IOI) project, examines metal studs for offices in the Lyman Spitzer Building Annex. (Photo by Elle Starkman)

Work is also continuing in the Lyman Spitzer Building (LSB) Annex, where workers have erected metal studs for offices on all three floors.

The next step will be to install ductwork in the ceilings for heating, air conditioning and ventilation systems and to install insulation. 📸



A jackhammer was used to break up the concrete floor in one corner of the MG Building. (Photo by Elle Starkman)



Crushed stone has been laid out in the basement and footers are ready for steel pillars to support the cement slab floor on the first floor. (Photo by Elle Starkman)

PNNL “National Security Overview” Feb. 20 at 9 a.m.

All PPPL'ers are invited to attend a special PPPL seminar with Tony Peurrung, associate laboratory director of National Security on Feb. 20 at 9 a.m. in the MBG Auditorium who will discuss the “PNNL National Security Overview.”

Peurrung oversees the portfolio of national security programs at PNNL and provides scientific insights, tools and methods to deploy science and technology to clients in the U.S. departments of Energy, Homeland Security, and Defense, as well as the intelligence community and the National Security Administration.

DVVR

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Rich Hawryluk, head of the NSTX-U Recovery Team, said the design verification and validation review (DVVR) of the vacuum vessel was one of the most important reviews along with the magnets, which were reviewed two weeks ago. "This session will be probably almost as intensive as last week's meeting on the magnets," Hawryluk told the committee. "We have to get this right. The machine has to run reliably and the vacuum vessel and components in the vessel are critical elements to enable that."

The three-day session from Feb. 14 to Feb. 16 was the fifth of 12 Design Verification and Validation (DVVR) reviews of the components of the NSTX-U aimed at identifying any potential gaps in the design and construction of the machine as part of an overall extent of condition review of the device. The most important findings from the sessions will be reviewed in an extent of condition meeting in early March and will become part of a interim assessment that PPPL will submit to the DOE by the end of March.

The vacuum vessel is the main part of the machine in which the charged gas called a plasma is confined. Among other components, the review included the vessel itself, the umbrella dome, the ports that open into the vessel, the divertors at the top and bottom of the vessel, the supports for the three sets of small magnets and the poloidal field coils that were attached to the center stack or the vacuum vessel until being removed recently. The failure of one of those coils, the PF1A-upper coil, caused the shutdown of the experiment last summer.

350 degrees Centigrade too hot for coil

The PF1B coils are a set of twin coils that were embedded in the upper and lower part of the center stack. The PF1B upper coil was located right next to divertor tiles that must be heated to 350 degrees Centigrade during bakeout to remove water from the tiles. But heating the machine to 350 degrees would damage the PF1B magnet, one of three sets of magnets that shape the plasma.

As a result, the inboard divertor tiles were never heated to more than 220 degrees Centigrade during bakeout and did not reach the full 350 degrees, engineers told the review committee.

Engineer Peter Titus said one possible solution may be to redesign the PF1B coils with an additional layer of thermal protection so that they will be protected during a bakeout.

Another major issue with the vacuum vessel is the potential damage to tiles in the vacuum vessel, particularly in the divertor, from the intense heat of plasma experiments and from halo currents, a type of current that flows outside the



Engineer Marc Sibia was the responsible engineer for the vacuum vessel and internal hardware DVVR. (Photo by Elle Starkman)

confined plasma. Physicists have a better understanding of how the forces from currents and heating loads operate than they did when NSTX-U was first designed, Hawryluk said. And while the tiles were not damaged during recent operations, the heat and currents could potentially damage the tiles and halt operations in the future, he said.

New materials for tiles discussed

The interior tiles of the vacuum vessel are made of graphite. One potential solution would be to replace them with a carbon fiber composite that is stronger and is already used in the center stack casing, Hawryluk said. Another solution could be to find a different method of attaching the tiles to the vacuum vessel.


A third issue is the condition of another set of coils, the PF1C coils, which had a vacuum leak and may have been exposed to plasma during experiments. The coils were recently removed from the center stack. Engineers fixed the vacuum leak problem during operations but a better solution may be required, Hawryluk said. One possibility among several to address the plasma heat flux would be to add a thermal shield between the coils and the vacuum vessel.

The review committee at PPPL included external reviewers Rui Viera, of MIT's Plasma Science and Fusion Center; Roel Verhoeven, of the Culham Centre for Fusion Energy, and Dennis Youchison, of Oak Ridge National Laboratory. Participating by video conference were: Kevin Freudenberg and Brad Nelson, of Oak Ridge National Laboratory; Jeff Doody, Jim Irby, and Brian LaBombard, of MIT's Plasma Science and Fusion Center; Tom Todd, head of the Extent of Condition Committee; Michel Huguet, former head of the ITER EDA site in Naka in Japan; and Rem Haange, former head of ITER Deputy Director-General and Head of the ITER Project Department.

"I'm very impressed with the forensics work that was done and just the breadth of material that's been visible," Viera said at the end of the session.

Identifying solutions

When some members of the committee expressed concern about the number of issues coming out of the DVVRs, Hawryluk said he along with Charles Neumeyer, head of NSTX-U Recovery Project Engineering and Stefan Gerhardt, deputy head of NSTX-U Recovery Project Engineering, would have to categorize the chits and propose corrective actions. "In some cases it's very clear how to address them and in some cases there may be two or three alternatives for corrective actions," Hawryluk said. "We are working on that right now. Currently, it's a work in progress."

The next DVVR will be a one-day session on cooling systems scheduled Feb. 22, chaired by Valeria Riccardo, head of engineering. A DVVR on power systems will be Feb. 27 to 28, chaired by Neumeyer. The first extent of condition committee meeting will be March 6 to 9. 



Taking part in the DVVR discussion were from left to right: Rich Hawryluk, head of the NSTX-U Recovery Project, engineer Bill Blanchard, Valeria Riccardo, head of Engineering, engineers Tim Stevenson, Mike D'Agostino, and Joseph Petrella. (Photo by Elle Starkman)

Pre-exascale

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Among the team of nationwide experts developing this program are PPPL physicists Seung-Ho Ku, Robert Hager and Stephane Ethier.

Selection of the PPPL code could help ready it for exascale development. “Computer architecture is evolving rapidly and these new pre-exascale computers have features that are quite different from some of the earlier petascale supercomputers,” said Amitava Bhattacharjee, head of the Theory Department at PPPL. Petascale machines operate in petaflops, or one million billion (10^{15}) floating point operations per second.

Bhattacharjee heads a PPPL-led Exascale Computing Project that will integrate the XGC code with GENE, a code developed at the University of California, Los Angeles, to create the first simulation of a complete fusion plasma. Exascale supercomputers will perform exaflops, or a billion billion (10^{18}) floating point operations per second.

The three new pre-exascale supercomputers

Cori, now fully installed at the National Energy Research Scientific Computing Center (NERSC) at the Lawrence Berkeley National Laboratory. Cori, named for biochemist Gerty Cori, the first American woman to win a Nobel Prize in science, has a theoretical peak speed of 30 petaflops per second on scientific applications using Intel Xeon “Haswell” and Xeon Phi “Knights Landing” processor nodes.

Also selected to participate in Cori’s NERSC Exascale Science Applications Program (NESAP) is the PPPL-led M3D-CI, an extended magnetohydrodynamics (MHD) code focused on simulation of plasma disruptions led by physicist Stephen Jardin, with support from physicists Joshua Breslau, Nate Ferraro and Jin Chen.


Two more PPPL-led codes, in addition to the 20 that included XGC and M3D-CI that were previously selected, will



PPPL physicists working on development of XGC code for simulating the behavior of transport barrier particles. From left: Robert Hager, Seung-Ho Ku, team leader C.S. Chang, Stephane Ethier.


participate in the Cori NERSC program. These programs are GTC-P and GTS codes that model plasma turbulence in the plasma core and are headed by physicists William Tang and Stephane Ethier. Principal developer of the GTS code is PPPL physicist Weixing Wang. The GTC-P code is PPPL’s version of the GTC code led by the University of California, Irvine.

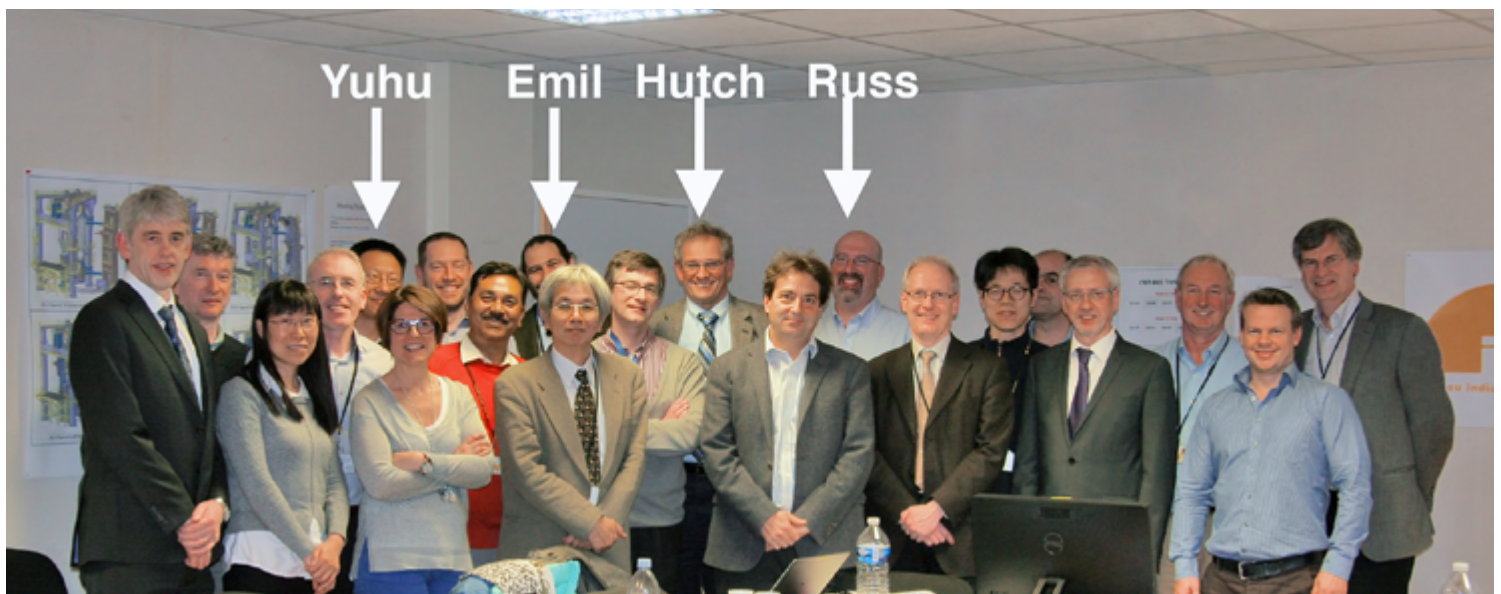
Summit, to be operational at the Oak Ridge Leadership Computing Facility (OLCF) at Oak Ridge National Laboratory in 2018. Summit features a hybrid architecture consisting of IBM Power 9 processors and multiple NVIDIA Volta graphic processing units and will be capable of performing up to at least 200 petaflops for a wide range of applications. The facility’s Center for Accelerated Application Readiness (CAAR) program has selected 13 projects that will participate in the program to optimize their applications codes and demonstrate the effectiveness of their applications on Summit.

Aurora, scheduled to be deployed in 2018 at the Argonne Leadership Computing Facility (ALCF) at Argonne National Laboratory, will be comprised of third generation Intel Xeon Phi “Knights Hill” many-core processors. Ten projects have been selected for the ALCF Early Science Program, which is expected to be capable of performing up to 200 petaflops on a wide range of scientific applications. 

PPPL’ers take part in ITER diagnostics meeting in France

Four PPPL staff members joined representatives of the ITER Central Team and all seven Domestic Agencies at ITER headquarters earlier this month to discuss progress and issues in ITER diagnostic and port plug activities. The Laboratory team consisted of physicist Hutch Neilson, head of the ITER Fabrication Department; engineer Russ Feder, leader of the design and construction of U.S. diagnostics for ITER; engineer Yuhu Zhai, leader of port plug analysis; and Emil Nassar, project control officer for the diagnostics work. The five-day

meeting prepared an action plan for issues raised during the sessions by Feder and others. PPPL staffers also toured the ITER construction site and Neilson met with ITER Director General Bernard Bigot. “As one who has only recently become involved in the ITER project, I found this week-long session to be a valuable learning experience about the project itself and particularly the challenges in the diagnostic area, where PPPL has responsibility,” Neilson said of the event. 



Live radio show features Scientific American's Mike Lemonick in "The Science of Memory" discussion at Princeton University

PPPL's Brian Kraus, a Princeton University graduate student and host of "These Vibes Are Too Cosmic," on WPRB (103.3) along with Stevie Bergman, will host a live radio show on "The Science of Memory." The talk features Mike Lemonick, opinion editor at Scientific American, and Sabine Kastner, Princeton University professor of neuroscience, with performances by PLOrk, the Princeton Laptop Orchestra. The event is on Friday, Feb. 24 from 7:30 to 8:45 p.m. in Taplin Auditorium at Princeton University's Fine Hall. It is free and open to the public.

The event is sponsored by Princeton University's Council on Science and Technology and the Department of Music.

American Red Cross Blood Drive

Wednesday, March 15 from 8 a.m. to 1 p.m.

Appointments are preferred. Please call the OMO at ext. 3200 or go to redcrossblood.org and enter sponsor code PPPLPrinceton.

You can make a difference! Your blood donation matters!

Thank you!

—American Red Cross, Occupational Medicine Office and Human Resources

Newly revised moving policy

PPPL has begun implementing a newly revised moving allowance policy that defines the relocation expenses that will be reimbursed or paid by PPPL to eligible new hires or existing employees transferring to a new location.

The policy was developed by Business Operations and Human Resources and was approved by the DOE Site Office.

The new policy is available at http://hr.pppl.gov/PPM/Employment%20PPM/PDF/PPM_Employment_Moving.pdf.

Science Bowl Volunteers Needed: Feb. 24 and 25

We still need lots of help with the Science Bowl on Friday, Feb. 24 and Saturday, Feb. 25, when PPPL will host 48 teams of middle and high school students for the New Jersey Regional Middle and High School Science Bowls.

We need moderators, science/rules judges, time/score keepers, lunch attendants etc. Lunch will be provided for competition day volunteers.

Please sign up here:

[Technical: moderator, science judge](#)

[Non-technical: time/score keeper, administrative](#)

Please contact Deedee Ortiz at dortiz@pppl.gov or ext. 2785 to sign up or for more information.

Staff, Family & Friends Ski & Snowboard Trip

Join your co-workers, families and friends for a fun day of skiing and riding at Shawnee Mountain! Just a 90-minute drive from Princeton. Shawnee is a great place for novice skiers and riders, offering a “Best Value” package of lift ticket, equipment rental and lessons for only \$65.

NOTE: We need a minimum of 15 participants to get the discounted group rates shown below.

TRIP DETAILS - SATURDAY, MARCH 4, 2017

- Mountain is open from 8:00 am to 10:00 p.m.
- Lift Ticket: \$38.00/person
- Lunch Voucher: \$9.00/person (includes a choice of hot sandwich or salad, soft drink and French fries)
- Ski/Board Rental: \$25.00/person
- Helmet Rental: \$9.00/person
- “Best Value” Ski or Snowboard Package: \$65.00/person

(\$90 value: all-mountain lift ticket, rental & group lesson — lesson times throughout the day)

QUESTIONS:

Contact Rob Sheneman (x3392 or rsheneman@pppl.gov)

Two-step reservation process:

- 1. Complete the online reservation form using the link below:
<https://goo.gl/oNNnWY>
- 2. Make your payment in cash or check to Rob Sheneman by 4 p.m. March 1. (x3392, MOD VI, Room 111)

Information on carpooling and how to pick up your lift tickets and vouchers will be distributed by email after you make your reservation.

**Reservation deadline:
Wednesday, March 1 by 4 p.m.**

This event is not sponsored by PPPL nor financially supported by DOE contract funds.

Application opens for presenters at 2017 Princeton Research Day

Applications are being accepted through Feb. 20 for non-faculty researchers at Princeton University, such as undergraduates, graduate students and postdoctoral researchers, to present at the second annual 2017 Princeton Research Day on May 11.

The application is available at <https://researchday.princeton.edu>.

[The link to the Research Day website is available here.](#)

[The link to the application is available here.](#)

Business Operations issues important highlights for General Guidelines for Subcontractor Travel

Business Operations has developed a document summarizing the Guidelines for Subcontractor Travel. The document is a high-level, quick reference tool highlighting the subcontract travel requirements with the intent of communicating the key facts quickly and succinctly. [The guidelines are available on the Travel and Conference Services website.](#) The important highlights document does not replace the General Guidelines for Subcontractor Travel incorporated into PPPL Subcontracts, and should only be used as a quick reference tool. Specific questions regarding travel under subcontracts should be directed to the Procurement Division and/or the Travel Office.

Volunteers wanted for Mercer Science and Engineering Fair

Organizers of the Mercer Science and Engineering Fair are looking for scientists and engineers to volunteer as judges of fourth to twelfth-grade science projects during the fair in March at Rider University.

Students from Mercer County schools show off their original science projects at the fair from March 12 to March 15. Judging takes place March 12 to 13. Additional information about the fair is available at <https://mercersec.org/about/msef>.

To volunteer, go to <http://mercersec.org/help/BecomeAJudge> or contact volunteers Kevin Lamb, klamb@pppl.gov or Hans Schneider, hschneid@pppl.gov.

Ronald E. Hatcher Science on Saturday LECTURE SERIES

Feb. 25

**NO SCIENCE ON SATURDAY LECTURE—
Department of Energy’s 2017 New Jersey
Regional High School Science Bowl**

Mar. 4

**Eyes wide open and all hands on deck: Challenges and
opportunities in responding to the risks of climate change**
Elke Weber, Princeton University

Mar. 11

Science Invigorating Architecture
Forrest Meggers, Princeton University

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

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 February 20	Tuesday February 21	Wednesday February 22	Thursday February 23	Friday February 24
COMMAND PERFORMANCE Chef's Feature	Chicken Cacciatore	Vegetarian Chili over Rice with Cornbread	Pork Carnitas Burrito with Beans	Beef Barbacoa	Curry Chicken over Basmati Rice with Naan Bread
Early Riser	Belgian Waffle Sticks	Greek Egg White Omelet with Spinach, Tomato, Peppers & Feta Cheese	Hash and Eggs	Omelette Florentine with Spinach, Tomato & Mozzarella	Breakfast Tacos
Country Kettle	Chipotle Chicken	Pasta Fagioli	Turkey Wild Rice	Tomato Lentil	Spinach and White Bean with Sausage
Deli Special	Smoked Turkey Baguette	Liverwurst with Bacon and Onion	Prosciutto, Pesto, Roasted Peppers & Arugula on Ciabatta	Tomato & Fresh Mozz on Ciabatta with Basil, Red Onion & Arugula	Maple-Roasted Vegetable Wrap
Grill Special	Italian Grilled Cheese	Buffalo Chicken Steak Sandwich with Fries	Tuna Melt on Rye served with Onion Rings	Chicken Zen Sandwich	Falafel Sandwich
Panini	Popcorn Shrimp Wrap	French Dip with Swiss Cheese, Caramelized Onion & Horseradish Cream served with Potato Wedges	Southwest Turkey, Peppers & Cheddar with Jalapeno Ranch Spread	Crab Cake on a Kaiser with Lettuce & Tomato	Turkey French Dip with Swiss Cheese

MENU SUBJECT TO CHANGE WITHOUT NOTICE

HEART HEALTHY

VEGETARIAN OPTION

WEEKLY

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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/>.