

## At PPPL THIS WEEK

**TUESDAY, NOV. 11**
**Electronics Recycling Collection**  
7 - 10 a.m. ♦ Lower Parking Lot

**PPPL's America Recycles Day  
Celebration**  
10:30 a.m. to 1 p.m. ♦ LSB Lobby

**FRIDAY, NOV. 14**
**Open Enrollment for Princeton  
Healthcare Plans ends**

### UPCOMING EVENTS

**November 17-19**  
**Environmental Management  
Systems Audit**
**November 18**  
**20th Anniversary 10 Megawatts  
of Fusion Power in TFTR**  
1 p.m. ♦ Labwide celebration  
(Ice Cream and Cake served)

**2 p.m. ♦ Colloquium**  
"Achieving 10MW of Fusion Power in  
TFTR: a Retrospective"  
**Michael Bell, PPPL**
**November 19**  
**PPPL Colloquium**  
4:15 p.m. ♦ MBG Auditorium  
Antibiotic Resistance: A Global Challenge  
**Dr. Laxminarayan, Princeton Univ.**
**January 14, 2015**  
**PPPL's Records/Paper Shredding  
Event**  
9 a.m. - 4 p.m. ♦

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### Guest Corner

## To better serve PPPL, benefits services now housed on main campus


 By **Paulette Gangemi** - Director of Human Resources

Dear PPPL'ers:

I wanted to take this opportunity, as we head into a period of intense activity over benefits decisions, to clarify how you can best be served with your questions.

As you may already know, services that support the complex issue of benefits are a centralized function for all departments on the main campus of Princeton University. Knowing that, I truly believe we all will be better served by adopting that model and working directly with the team of highly trained, deeply experienced benefits experts located at Human Resources on Princeton's main campus. These individuals are easily reached via email, at: [benefits@princeton.edu](mailto:benefits@princeton.edu), or by telephone, at 609-258-3302. You will be provided with complete answers to all of your benefits questions. This arrangement is effective immediately.

I have recently restructured PPPL's Human Resources Department and instituted several promotions to better align our team so that it maintains its record of outstanding service to all of you, but also enables it to dynamically support the strategic mission and vision of the Laboratory. As part of these changes, we plan to bring on, in the near future, a Disability Administrator who will be responsible for managing leave processes here at the Lab. In addition, we are examining other new processes and systems to increase the Lab's effectiveness in achieving its goals.

Andrea Moten, our Associate Director, now has primary duties for talent acquisition, training and development, and diversity. Michael Gonzalez, our Senior HR Generalist, will work directly with Andrea, supporting these efforts. Jean Werneck, our Manager of Compensation and Organizational Development, will continue to oversee the compensation function, but also has embarked on the exciting task of investigating new approaches of enhancing our effectiveness. Sue Hill, our Senior HRIS/Training Specialist, is taking on greater responsibility for training programs. And Kate Harkness, our newest member, will be working both as our Executive Assistant and an HR Specialist. She will be managing the Plasma Hutch, special projects and events.

This is an exciting time for all of us to be engaged in the goal of developing fusion energy. I am honored and thrilled to play a part in supporting this great mission. In the coming months, I am asking for your support, patience and trust as we work to develop some new roles and relationships.

With thanks – PAULETTE GANGEMI

• APS PRESS RELEASES • APS PRESS RELEASES •

## PPPL researchers present cutting-edge results at APS Plasma Physics Conference

Some 135 researchers, graduate students, and staff members from PPPL joined 1,500 research scientists from around the world at the 56th annual meeting of the American Physical Society Division of Plasma Physics Conference from Oct. 27 to Oct. 31 in New Orleans. Topics in the sessions ranged from waves in plasma to the physics of ITER, the international physics experiment in Cadarache, France, to women in plasma physics. Dozens of PPPL scientists presented the results of their cutting-edge research into magnetic fusion and plasma science. There were about 100 invited speakers at the conference, more than a dozen of whom were from PPPL.

The press releases in this issue are condensed versions of press releases that were prepared by the APS with the assistance of the scientists quoted and with background material provided by John Greenwald and Jeanne Jackson DeVoe. The full text is available at the APS Virtual Pressroom 2014: <http://www.aps.org/units/dpp/meetings/vpr/2014/index.cfm>.

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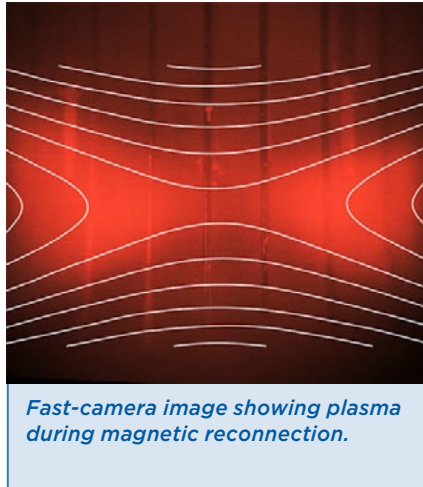
## How magnetic reconnection goes “Boom!”

*MRX research reveals how magnetic energy turns into explosive particle energy*

Paper by: M. Yamada, J. Yoo

**M**agnetic reconnection, in which the magnetic field lines in plasma snap apart and violently reconnect, creates massive eruptions of plasma from the sun. But how reconnection transforms magnetic energy into explosive particle energy has been a major mystery.

Now research conducted on the Magnetic Reconnection Experiment (MRX) at PPPL has taken a key step toward identifying how the transformation takes place, and measuring experimentally the amount of magnetic energy that turns into particle energy.



Fast-camera image showing plasma during magnetic reconnection.



Masaaki Yamada



Jongsoo Yoo

The investigation showed that reconnection in a prototypical reconnection layer converts about 50 percent of the magnetic energy, with one-third of the conversion heating the electrons and two-thirds accelerating the ions in the plasma.

“This is a major milestone for our research,” said Masaaki Yamada, the principal investigator for the MRX. “We can now see the entire picture of how much of the energy goes to the electrons and how much to the ions in a prototypical reconnection layer.” ■

## What a Difference a Magnetic Field Makes

*Experiments on MRX confirm the lack of symmetry in converging space plasmas*

Paper by: J. Yoo

**S**pacecraft observing magnetic reconnection have noted a fundamental gap between most theoretical studies of the phenomenon and what happens in space. While the studies assume that the converging plasmas share symmetrical characteristics such as temperature, density and magnetic strength, observations have shown that this is hardly the case.

PPPL researchers have now found the disparity in plasma density in experiments conducted on the MRX. The work, done in collaboration with the Space Science Cen-

ter at the University of New Hampshire, marks the first laboratory confirmation of the disparity and deepens understanding of the mechanisms involved.

Data from the MRX findings could help to inform a four-satellite mission—the Magnetospheric Multiscale Mission, or MMS—that NASA plans to launch next year to study reconnection in the magnetosphere. The probes could produce a better understanding of geomagnetic storms and lead to advanced warning of the disturbances and an improved ability to cope with them. ■



Jongsoo Yoo

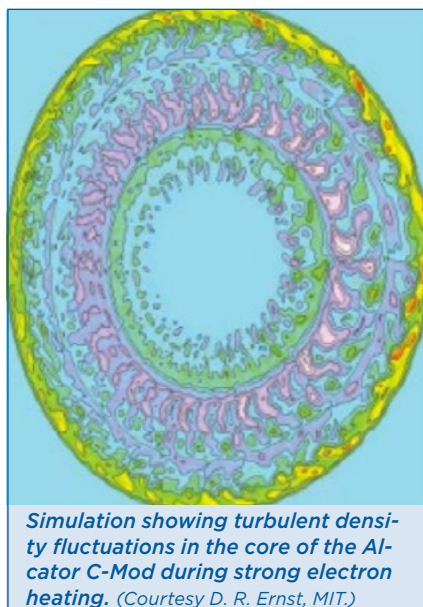
## Using radio waves to control density in fusion plasma

*Experiments show how heating electrons in the center of hot fusion plasma can increase turbulence, reducing the density in the inner core*

Paper by: D. Ernst, K. Burrell, W. Guttenfelder, T. Rhodes, A. Dimits

**R**ecent fusion experiments on the DIII-D tokamak at General Atomics in San Diego and the Alcator C-Mod tokamak at the Massachusetts Institute of Technology show that beaming microwaves into the center of the plasma can be used to control the density in the center of the plasma. The experiments and analysis were conducted by a team of researchers as part of a National Fusion Science Campaign.

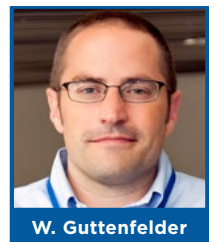
The new experiments reveal that turbulent density fluctuations in the inner core intensify when most of the heat goes to electrons instead of plasma ions, as would happen in the center of a self-sustaining fusion reaction. Supercomputer simulations closely re-



Simulation showing turbulent density fluctuations in the core of the Alcator C-Mod during strong electron heating. (Courtesy D. R. Ernst, MIT)

produce the experiments, showing that the electrons become more turbulent as they are more strongly heated, and this transports both particles and heat out of the plasma.

“As we approached conditions where mainly the electrons are heated, pure trapped electrons begin to dominate,” said Walter Guttenfelder, who did the supercomputer simulations for the DIII-D experiments along with Andris Dimits of Lawrence Livermore National Laboratory. Guttenfelder was a co-leader of the experiments and simulations with Keith Burrell of General Atomics and Terry Rhodes of UCLA. Darin Ernst of MIT led the overall research. ■



W. Guttenfelder

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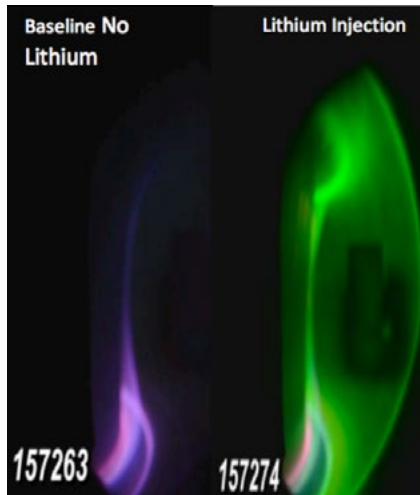
## Calming the Plasma Edge: The Tail that Wags the Dog

*Lithium injections show promise for optimizing the performance of fusion plasmas*

Paper by: G.L. Jackson, R. Maingi, T. Osborne, Z. Yan, D. Mansfield, S.L. Allen

Experiments on the DIII-D tokamak fusion reactor that General Atomics operates for the U.S. Department of Energy have demonstrated the ability of lithium injections to transiently double the temperature and pressure at the edge of the plasma and delay the onset of instabilities and other transients. Researchers conducted the experiments using a lithium-injection device developed at PPPL.

Lithium can play an important role in controlling the edge region and hence the evolution of the entire plasma. In the present work, lithium diminished the frequency of instabilities known as “edge localized modes” (ELMs), which



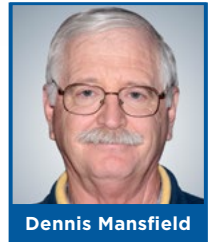
Comparison of visible light from a reference no-Li discharge and one with Li injection in DIII-D.

have associated heat pulses that can damage the section of the vessel wall used to exhaust heat in fusion devices.

The tailored injections produced ELM-free periods of up to 0.35 seconds, while reference discharges without lithium showed no ELM-free periods above 0.03 seconds. The lithium rapidly increased the width of the pedestal region—the edge of the plasma where temperature drops off sharply — by up to 100 percent and raised the electron pressure and total pressure in the edge by up to 100 percent and 60 percent, respectively. These dramatic effects produced a 60 percent increase in total energy-confinement time. ■



Rajesh Maingi



Dennis Mansfield

## Scratching the surface of a material mystery

*Scientists shed new light on how lithium conditions the volatile edge of fusion plasmas*

Paper by: A. Capece

For fusion energy to fuel future power plants, scientists must find ways to control the interactions that take place between the volatile edge of fusion plasma and the physical walls that surround it in fusion facilities. Such interactions can profoundly affect conditions at the superhot core of the plasma in ways that include kicking up impurities that cool down the core and halt fusion reactions. Among the puzzles is how temperature affects the ability of lithium to absorb and retain the deuterium particles that stray from the fuel that creates fusion reactions.

Answers are now emerging from a new surface-science laboratory at PPPL that can probe lithium coatings that are just three atoms thick. The experiments showed that



Lithium-coated molybdenum heated to high temperature during a PPPL experiment.

the ability of ultrathin lithium films to retain deuterium drops as the temperature of the molybdenum substrate rises—a result that provides insight into how lithium affects the performance of tokamaks.

Experiments further showed that exposing the lithium to oxygen improved deuterium retention at temperatures below about 400 degrees Kelvin. But without exposure to oxygen, lithium films could retain deuterium at higher temperatures as a result of lithium-deuterium bonding during a PPPL experiment.

Armed with these findings, scientists will be better able to determine how to use lithium to enhance the performance of fusion plasmas. ■



Angela Capece

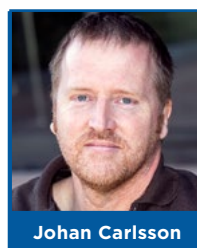
## Putting Plasma to Work Upgrading the U.S. Power Grid

*PPPL lends GE a hand in developing an advanced power-conversion switch*

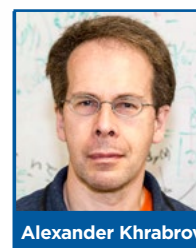
Paper by: J. Carlsson, A. Khrabrov, I.Kaganovich, T. Summerer

When researchers at General Electric sought help in designing a plasma-based power switch, they turned to PPPL. The proposed switch, which GE is developing under contract with the DOE's Advanced Re-

search Projects Agency-Energy, could contribute to a more advanced and reliable electric grid and help lower utility bills.



Johan Carlsson



Alexander Khrabrov



Igor Kaganovich

continued from page 3

The switch would consist of a plasma-filled tube that turns current on and off in systems that convert the direct current coming from long-distance power lines to the alternating current that lights homes and businesses; such systems are used to reverse the process as well.

To assist GE, PPPL used a pair of computer codes to model the properties of plasma under different magnetic con-



Laboratory test of a liquid-metal cathode (Courtesy of General Electric.)

figurations and gas pressures. GE also studied PPPL's use of liquid lithium, which the laboratory employs to prevent damage to the divertor that exhausts heat in a fusion facility.

The information could help GE develop a method for protecting the liquid-metal cathode — the negative terminal inside the tube — from damage from the ions carrying the current flowing through the plasma. ■

## Laser experiments mimic cosmic explosions

*Scientists bring plasma tsunamis into the lab*

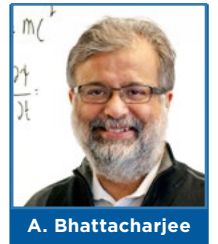
Researchers are finding ways to understand some of the mysteries of space without leaving earth. Using high-intensity lasers at the University of Rochester's OMEGA EP Facility focused on targets smaller than a pencil's eraser, they conducted experiments to create colliding jets of plasma knotted by plasma filaments and self-generated magnetic fields. In two related experiments, researchers used powerful lasers to recreate a tiny laboratory version of what happens at the beginning of solar flares and stellar

explosions, creating something like a gigantic plasma tsunami in space.

Much of what happens in those situations is related to magnetic reconnection, which can accelerate particles to high energy and is the force driving solar flares towards earth. ■



William Fox



A. Bhattacharjee

## Laboratory experiment aims to identify how tsunamis of plasma called "shock waves" form in space

Paper by: **W. Fox, G. Fiskel (LLE), A. Bhattacharjee**

In the first experiment, William Fox, a researcher at the U.S. Department of Energy's Princeton Plasma Physics Laboratory, and his colleague Gennady Fiskel, of the University of Rochester, got an unexpected result when they used lasers in the Laboratory to recreate a tiny version of a gigantic plasma tsunami called a "shock wave." The shock wave is a thin area found at the boundary between a supernova and the colder material around it that has a turbulent magnetic field that sweeps up plasma into a steep tsunami-like wave of plasma.



Hubble Telescope photo of an exploding star.

Fox and Fiskel used two very powerful lasers to zap two tiny pieces of plastic in a vacuum chamber to 10 million

degrees and create two colliding plumes of extremely hot plasma. The researchers found something they had not anticipated that had not previously been seen in the laboratory: When the two plasmas merged they broke into clumps of long thin filaments due to a process called the "Weibel instability." This instability could be causing the turbulent magnetic fields that form the shock waves in space.

Their research could shed light on the origin of primordial magnetic fields that formed when galaxies were created and

could help researchers understand how cosmic rays are accelerated to high energies. ■

## Magnetic reconnection in the laboratory

Paper by: **G. Fiskel (LLE), W. Fox, A. Bhattacharjee**

Many plasmas in space already contain a strong magnetic field, so colliding plasmas there behave somewhat differently. Gennady Fiskel, of the University of Rochester, and William Fox continued their previous research by adding a magnetic field by pulsing current through very small wires. They then created the two colliding plumes of plasma as they did in an earlier experiment. When the two plasmas collided the effect compressed and stretched the magnetic field and a tremendous amount of energy accumulated in the field like a stretched rubber band. As the magnetic field lines pushed close together, the long lines broke apart and reformed like a slingshot, propel-

ling the plasma and releasing the energy into the plasma, thereby accelerating the plasma and heating it.

The experiment showed that the reconnection process happens faster than theorists had previously predicted. This could help shed light on solar flares and coronal mass ejections, which also happen extremely quickly. Coronal mass ejections can trigger geomagnetic storms that can interfere with satellites and wreak havoc with cellphone service.

The laser technique the scientists are using is new in the area of high energy density plasma and allows scientists to control the magnetic field to manipulate it in various ways. ■

## PPPL's Science Education team is a hit at APS Plasma Sciences Expo

PPPL's Science Education Team gave hands-on plasma demonstrations at the APS Plasma Sciences Expo in New Orleans during six-hour sessions on Oct. 30 and 31. They showed off the Van de Graaff generator, the plasma speaker, a turbulence in a flowing bubble demonstration and other experiments. In all, more than 1,600 people attended the free events for school groups and the general public sponsored by the American Physical Society's Division of Plasma Physics and the U.S. Department of Energy. (See the APS press release on the Expo at <http://www.aps.org/units/dpp/meetings/vpr/2014/upload/miller.pdf>).

John DeLooper, head of Best Practices and Outreach, along with Andrew Zwicker, head of Science Education, Arturo Dominguez, a postdoctoral fellow in Science Education, and Deedee Ortiz, a program administrator, were joined by several PPPL volunteers at the Expo. They include: Daren Stotler, John Roszell, Robert Kaita, Yuan Shi, Jacob Schwartz, Jonathan Squire, Seth Davidovits, Charles Skinner, Samuel Lazerzon, Ammar Hakim, Michael Zarnstorff and Erik Gilson.



Andrew Zwicker, left, demonstrates a plasma ball to young visitors at the APS Plasma Sciences Expo.



John DeLooper, left, shows off the flowing bubble demonstration to students at the APS Plasma Sciences Expo that took place during the APS Division of Plasma Physics Conference.

# 20<sup>th</sup> ANNIVERSARY 10 MEGAWATTS OF FUSION POWER IN TFTR

Tuesday, November 18  
2014



**1 p.m.**  
Labwide Celebration!  
Ice cream/cake served

**2 p.m.**  
Colloquium  
Presented by Michael Bell

## Come to America Recycles Day Nov. 11

Come to PPPL's America Recycles Day celebration on Tuesday, Nov. 11 from 10:30 a.m. to 2 p.m. in the LSB Lobby. Activities include:

- 7 a.m. to 10 a.m.: Electronics recycling in lower parking lot.
- 1:45 a.m. & 12:30 p.m.: Recycled Fashion Show. Vote on the best dresses!
- All day: Recycled designs & Inventions. Vote on the best!
- A new game to toss recycled items into buckets. Win prizes!
- Win a thermal lunchbox by signing the America Recycles Day pledge.
- Recycle discarded office supplies in the Terra Cycle box (all November).





## Exchange Rates

For reimbursement of travel expenses paid with foreign currency, all receipts showing the amount actually paid should be submitted with the travel voucher. Foreign currency receipts must include the type of expense, the U.S. dollar equivalent and the conversion rate used, and whenever possible, supply supporting documentation for that rate (e.g., currency exchange receipt, credit card bill, etc.). If you are submitting documents for an actual currency exchange transaction, use the same conversion rate for all transactions paid with foreign cash. For transactions that are paid with a credit or debit card, please ensure you provide a copy of the statement to show the actual rates charged or you may use the OANDA published rates.

If you do not provide the exchange rate in supporting documentation, Accounting will use the OANDA published rates to check that the rate you are requesting is reasonable. If the rate used and the published rate vary by 5 percent, Accounting will notify the traveler that the OANDA rate will be used unless there is an adequate explanation or additional supporting documentation is submitted.

## SPD • TIP • OF • THE • WEEK

### Winter Weather Information

The beautiful fall season is well under way, which means that winter, snow and sleet cannot be far behind. In fact, this past Sunday, PPPL sports fans who watched football got a nice preview of the coming winter weather as the pre-game updates for the a game in Foxborough, Mass., showcased lots of snow, frigid temperatures, and howling winds!

The best way to deal with hazardous weather is to be prepared beforehand. This [link](#) from the National Weather Service's Office of Climate, Water, and Weather Services provides a succinct background on how weather gets forecast; what constitutes wind chill; the difference between an advisory, a watch and a warning; and how severe weather preparation affects safety. Watch for more winter tips to come.

## Switch to CrashPlan PROe to protect files in a crash

Protect your files by switching to CrashPlan PROe, PPPL's new backup system, by Dec. 1! The new cloud-based system allows users to back up their computers from anywhere with an active Internet connection. The web interface included with the system allows users to access their data from any system with a modern web browser, a particularly useful feature if your computer crashes. The Help Desk can easily install the system remotely on computers. (Call ext. 2275 or submit a ticket.) Once installed, users can view their data on their smart devices by downloading the mobile app.




### Holiday Dinner Dance Party

YOU'RE INVITED

### Holiday Dinner Dance Party

**When:**  
Saturday, December 20<sup>th</sup>  
6-10 PM  
**Price is \$55 per person**  
**If attending, please RSVP**  
**by November 14 to**  
**Rosemarie Fuchs,**  
**Marianne Tyrrell, or Dana**  
**Eckstein. Payment to be**  
**received by December 5<sup>th</sup>.**

**Where:**  
**The Stone Terrace by**  
**John Henry's**  
**2275 Kuser Road**  
**Hamilton, NJ 08690**  
**Convenient to Rt. 195 & 295**



**Elegant Dinner Menu**  
*Family Style Salad Course*  
Stone Terrace Salad  
*Family Style Pasta Course*  
Stone Terrace Pasta  
*Main Entree Choices: Select One*  
• Pariko Crusted Chicken Rollatini Stuffed with Asiago Cheese & Grilled Mushrooms Topped with Port Wine Gravy  
• Macadamia Crusted Grouper Topped with Seasonal Buerae Blanc  
• Vegetarian - Eggplant Parmigiana  
*Side: Roasted Potatoes & Chef's Vegetable Selection*  
*Family Style Dessert*  
Mini Pastries  
Fresh Brewed Regular & Decaffeinated Coffee & Tea Selections  
*Cash Bar*







~ DINNER ~ DANCING ~ MUSIC DJ ~ FUN ~

This event is not sponsored by PPPL.

# BROCK Café Menu

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.  
— MARK GAZO, *Chef Manager*

COMMAND PERFORMANCE  
CHEF'S FEATURE

	MON. 10 NOV.	TUE. 11 NOV.	WED. 12 NOV.	THU. 13 NOV.	FRI. 14 NOV.
					
<b>EARLY RISER</b>	Homemade Coffee Cake served with a 12 oz. Cup of Coffee	Multigrain Pumpkin French Toast with Caramelized Bananas	Eggs in Purgatory	Cornmeal Pancakes	Breakfast Tacos
<b>COUNTRY KETTLE</b>	Moroccan Chickpea & Eggplant Stew	French Onion Soup	Lentil Soup	Minestrone	Stuffed Pepper Soup
<b>GRILLE SPECIAL</b>	Philadelphia Eagles Cheesesteak with Fries 	Pork Roll with Swiss Cheese, Torpedo served with Fries	Fish Cake Sandwich	Open-Faced Portobello Mushroom on Flat Bread	French Bread Chicken Steak Hoagie
<b>DELI SPECIAL</b>	Fresh Mozzarella, Tomato, Eggplant & Basil Torpedo	Hot Roast Beef with BBQ Sauce on an Onion Roll	BLT with Avocado, Ham & Chipotle Mayo	Tuna Salad Club Sandwich	Turkey French Dip with Provolone Cheese & Fries
<b>PANINI</b>	Carolina Panthers Pulled Pork Sandwich	Open-Faced Ciabatta Crab Bread	Buffalo Chicken Pizza Panini served with a Side Salad	Broccoli & Cheddar Cheese Stromboli	Chicken Tacos

MENU SUBJECT TO CHANGE WITHOUT NOTICE       VEGETARIAN OPTION      [CLICK HERE FOR A PRINTABLE WEEKLY MENU](#)

## WEEKLY

Editor: **Jeanne Jackson DeVoe** ♦ Layout and graphic design: **Gregory J. Czechowicz**  
Photography: **Elle Starkman** ♦ Science Editor: **John Greenwald** ♦ Webmaster: **Chris Cane**

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