

THIS WEEK

MONDAY, NOV. 20

**Celebrate PPPL's
Inventor Hall of Fame**
12:30 p.m. ♦ LSB Lobby
[See page 5 for details.](#)

WEDNESDAY, NOV. 22

Council Café Lunch
12 p.m. ♦ Cafeteria
Jerry Levine
Head of Environment, Safety & Health

NOV. 23-24

Happy Thanksgiving!
Laboratory closed

UPCOMING

MONDAY, NOV. 27

No Weekly

TUESDAY, NOV. 28

Open Forum with Terry Brog
3-4 p.m. ♦ B318
Please check your email for
registration information.

WEDNESDAY, NOV. 29

Council Café Lunch
11:30 a.m. ♦ Cafeteria
Jon Menard
Director of the NSTX-U
Recovery Project

NOV. 29-30

Core Values Workshops
B318
[See page x for details.](#)

THURSDAY, NOV. 30

United Way Bake-Off
[See page x for details.](#)

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PPPL physicist discovers that some plasma instabilities can extinguish themselves

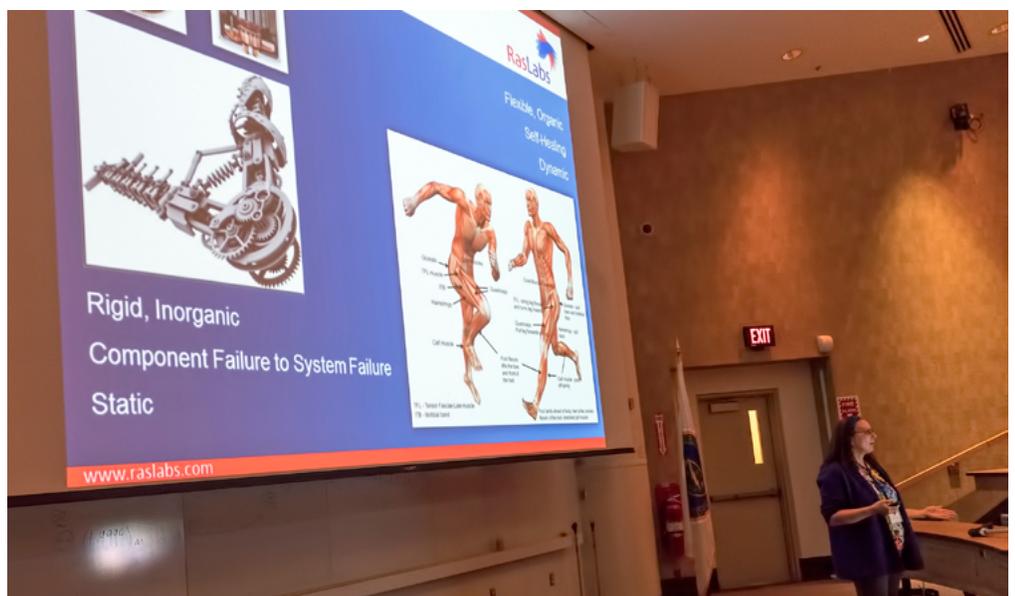
By Raphael Rosen

P PPL Physicist Fatima Ebrahimi has for the first time used advanced models to accurately simulate key characteristics of the cyclic behavior of edge-localized modes (ELMs), a particular type of plasma instability. The findings could help physicists more fully comprehend the behavior of plasma, the hot, charged gas that fuels fusion reactions in doughnut-shaped fusion facilities called tokamaks, and more reliably produce plasmas for fusion reactions. The findings could also provide insight into solar flares, the eruptions of enormous masses of plasma from the surface of the sun into space.

[continued on page 5](#)

Scientist recounts space odyssey of synthetic muscle material developed with help of PPPL scientists

By Jeanne Jackson DeVoe



Lenore Rasmussen discusses the synthetic muscle she developed with the help of PPPL at the Nov. 8 colloquium. (Photo by Elle Starkman)

When the synthetic muscle experiment that Lenore Rasmussen developed with the help of PPPL researchers rocketed off to the International Space Station (ISS) on April 14, 2015, she expected it would remain in space for 90 days.

But then an unmanned SpaceX Falcon 9 rocket headed for the ISS that would have retrieved the experiment exploded in June of that year. The synthetic muscle experiment remained on the ISS for more than a year, returning to Earth on May 11, 2016.

Rasmussen, a synthetic polymer chemist and founder of RAS Labs in Quincy, Massachusetts, recounted her odyssey and PPPL's role in helping develop and test the material before and after its space journey during a Nov. 8 colloquium at PPPL.

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Green is supreme at PPPL's America Recycles Day celebration

PPPL celebrated America Recycles Day with a recycled art contest, a sorting game, and displays. Many employees won prizes when they got “caught green-handed” for bringing reusable mugs, containers or lunch boxes to the cafeteria. Numerous employees recycled their home electronics in the Unicor home electronics recycling drive. Many also contributed clothing to the Trenton Rescue Mission clothing drive, which ends today.

Winners of the America Recycles Day Art Contest received gift certificates to the Plasma Hutch. Angela Powell won first prize for her 2017 “Shipping Fashion Design,” Mark Hughes won second prize for “Reclaimed Pallet Wood American Flag,” Emily Hughes won third place for her “Ship in a Bottle,” and Nelson Neal won fourth place for his “Neck Tie & Handkerchief with Paper Clip.”



Kyron Jones and Margaret Kevin-King, the head of Building and Grounds, with some of the home electronics donated by staff on America Recycles Day. (Photo by Elle Starkman)



The recycled art created by staff, including Angela Powell's recycled dress and Mark Hughes' American flag on a reclaimed pallet. (Photo by Elle Starkman)



Stanley Reece decides where to place a plastic top in a sorting game with Leanna Sullivan. PPPLers learned that plastics labeled 1 through 7 are recyclable, except for plastics labeled 6, which are trash. (Photo by Elle Starkman)



Leo Konkel sorts plastic in a recyclable sorting game as Leanna Sullivan looks on. (Photo by Elle Starkman)



Alana Coleman signs a recycling pledge as Mark Hughes staffs the America Recycles Day table. (Photo by Elle Starkman)



Some members of PPPL's Green Team, which helped organize the America Recycles Day event. From left, Jeanne Jackson DeVoe, Leanna Sullivan, Virginia Finley, Mark Hughes, Ana Marie Datuin, Marisol Ovalles, and Margaret Kevin-King. Not pictured: Chris Roames, Kyron Jones, Rob Sheneman, Kate Morrison, and Ed Jenkins. (Photo by Elle Starkman)



Angela Powell shows off her dress and a recycled bag. (Photo by Elle Starkman)

PPPL'ers get caught green-handed



Richard Owusu got caught green-handed with his reusable coffee cup. (Photo by Mark Hughes)



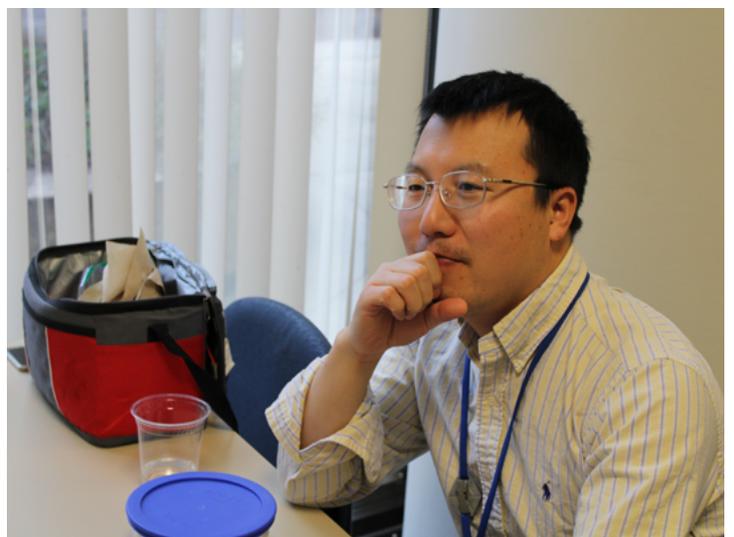
Kate Morrison also won. (Photo by Jeanne Jackson DeVoe)



Showing off their reusable lunch containers are, from left: Eugene Evans, Andy Alt, and Jeff Lestz. (Photo by Jeanne Jackson DeVoe)



Maria Huber, left, and Penny Neuman with their reusable cups. (Photo by Jeanne Jackson DeVoe)



Danny Cai won for bringing a lunchbag and reusable lunch container. (Photo by Jeanne Jackson DeVoe)

PPPL hosts FIRST LEGO League robotics teams

PPPL hosted two FIRST LEGO League robotics teams on Nov. 8. The groups toured PPPL, viewed demonstrations in the Science Education Lab and presented their projects to organizers Kevin Lamb and Atiba Brereton. Other volunteers were Laura Zhang, Oak Nelson, and Valentin Skoutnev. 📷



Laura Zhang and Oak Nelson show students how a Tesla coil lights up a fluorescent bulb. (Photo by Elle Starkman)



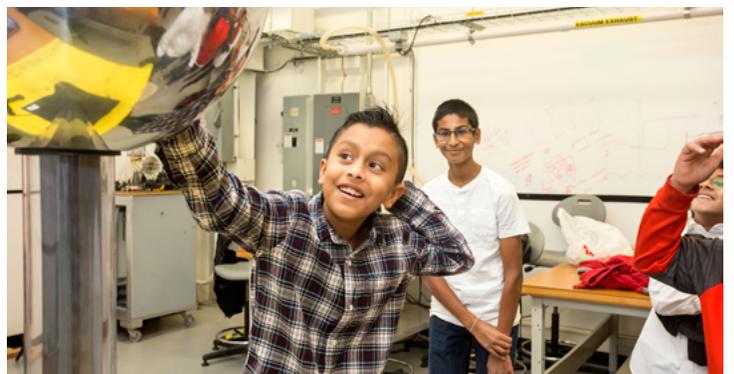
Atiba Brereton, right, and Kevin Lamb, center, give students a tour of the NSTX-U Test Cell. (Photo by Elle Starkman)



Kevin Lamb with students in the NSTX-U test cell. (Photo by Elle Starkman)



Students watch as Valentin Skoutnev shows them an electromagnet demonstration. (Photo by Elle Starkman)



A student tries out the Van de Graaff generator. (Photo by Elle Starkman)



Laura Zhang, right, and the students peer through spectroscopes at a fluorescent bulb. (Photo by Elle Starkman)

Celebrate PPPL's Inventor Hall of Fame

Come celebrate PPPL's Inventor Hall of Fame, Monday, Nov. 20, at 12:30 p.m. in the LSB Lobby. Cake and coffee will be served.

Learn, anytime, anywhere with Lynda.com online training

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Go to [Lynda.princeton.edu](https://lynda.princeton.edu).

Edge-localized modes

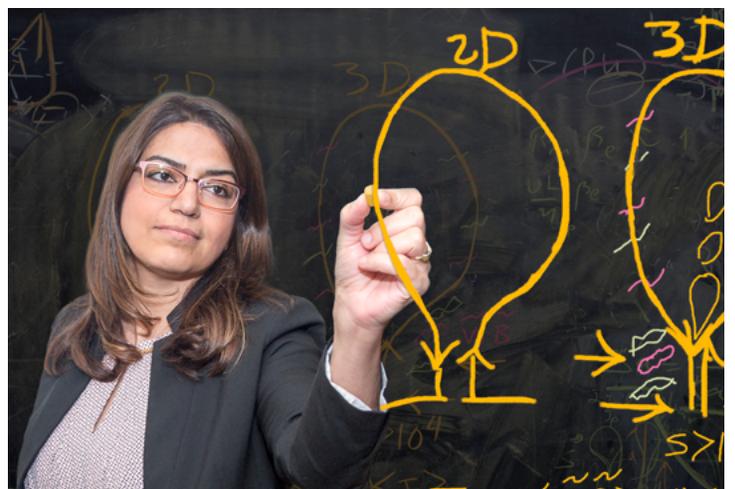
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Ebrahimi, who reported the work in May in a paper titled, "Nonlinear reconnecting edge localized modes in current-carrying plasmas" in the journal *Physics of Plasmas*, achieved the results through nonlinear simulation of the instability. "This research both reproduces and explains the burst-like, or quasi-periodic, behavior of ELMS," said Ebrahimi. "If it occurs in large tokamaks in the future, these bursts could damage some of the machine's internal components. Understanding them could help scientists prevent that damage."

ELMs occur around the outer edge of high-confinement, or H-mode, plasmas due to strong edge currents. Ebrahimi used a computer simulation code known as NIMROD to show how ELMs go through a repeated cycle in which they form, develop, and vanish.

The model demonstrates that ELMs can form when a steep gradient of current exists at the plasma edge. The gradient develops when the plasma moves suddenly up or down, creating a bump in the current and forming an edge current sheet. The instability then forms a current-carrying filament that moves around the tokamak, producing electrical fields that interfere with the currents that caused the ELMs to form. With the original currents disrupted, the ELM dies. "In a way," Ebrahimi said, "an ELM eliminates its own source — erases the bump on the edge current — by its own motion."

Ebrahimi's findings are consistent with observations of cyclic behavior of ELMs in tokamaks around the world. These include Pegasus, a small spherical device at the University of Wisconsin; the Mega Ampere Spherical Tokamak (MAST)



Fatima Ebrahimi (Photo by Elle Starkman)

in the United Kingdom; and the National Spherical Torus Experiment (NSTX), the flagship facility at PPPL before its recent upgrade. The research could also improve understanding of solar eruptions, which are accompanied by filamentary structures similar to those produced by ELMs. Her next step will involve investigating the impact of differences in plasma pressure on the cyclic behavior of ELMs.

This research was funded by the DOE's Office of Science. Computer simulations were performed at the National Energy Research Scientific Computing Center (NERSC), a DOE Office of Science User Facility at Lawrence Berkeley National Laboratory. 

Synthetic muscle

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“My experiment went around the planet for more than a year, finally returning on SpaceX-8,” Rasmussen said. “We didn’t know what to expect because this was not what we planned for.”

Rasmussen’s Synthetic Muscle™ is a robust gel-like material called an electroactive polymer that can potentially mimic human movement by expanding and contracting to simulate the movement of muscles in humans. That ability would make it very useful to create robots that could withstand deep space conditions. It could also be used to develop better prosthetic limbs.

Rasmussen began working with PPPL in 2007 just four years after she started her company. Early on, she solved a crucial problem: getting the gel, which can be as soft as jelly or as hard as rubber, to adhere to the metal electrode. Rasmussen ultimately solved the problem by treating the metal with plasma, which made the gel adhere better to the metal.

Testing for space conditions

PPPL scientists helped her test the material for space conditions in the months before the launch, Rasmussen said. Working with lead engineer Charles Gentile, together with George Ascione, head of the Health Physics Division, and others, Rasmussen exposed several different formulations of the material to more than 300,000 RADs of gamma radiation, the equivalent of a trip to Mars and back. There were no significant changes in the strength, electroactivity or hardness of the materials.

Rasmussen then designed an experiment in which 28 samples of her material had various substances. These including Vitamin E BHT, and BHA, which are a powerful free radical inhibitors, and various coatings, such as a Mylar® coating, a 3-ply coating from US Natick Labs’ Meals Ready to Eat (MRE) Program used to protect food for long term storage, a gold-polymer Danfloss® coating, and just the electroactive polymer itself (no additives, no coatings) as the control. The samples got similarly positive results. Rasmussen and her team then picked the ones with the best results for the ISS experiment.

PPPL and the Princeton University Gas and fluid Dynamics Lab helped Rasmussen with packaging her samples by building four aluminum cages to hold the samples, with each of the 32 samples held in place inside the bolted and glued down cage assemblies. Gentile and other PPPL staff members, along with Rasmussen and her staff, signed the back of the metal cages that went into space. Rasmussen kept an identical set of 32 ground control samples back on Earth.

Finally, Rasmussen recalled, the material was ready to take off, and Rasmussen went to Cape Canaveral, along with her then 12-year-old son, Carl, and her mother. After the first liftoff was scrubbed due to an oncoming storm, the Falcon 9 rocket carrying the Dragon spacecraft blasted off on April 14.



Lenore Rasmussen (Photo by Elle Starkman)

Rasmussen said one of the highlights for her was watching video and seeing photos of her experiment in space. Astronaut Scott Kelly took a photo of a sample floating in space.

A harsh environment

The 13 months aboard the ISS meant the experiment was exposed to 75 times more radiation than that found on Earth, as well as hard and soft x-rays, Rasmussen said. That made her realize that “space for us gentle living things is a very harsh environment.”

Rasmussen tested the returned samples in her laboratory and at PPPL and Princeton University using a variety of tools including a scanning electron microscope at Princeton.

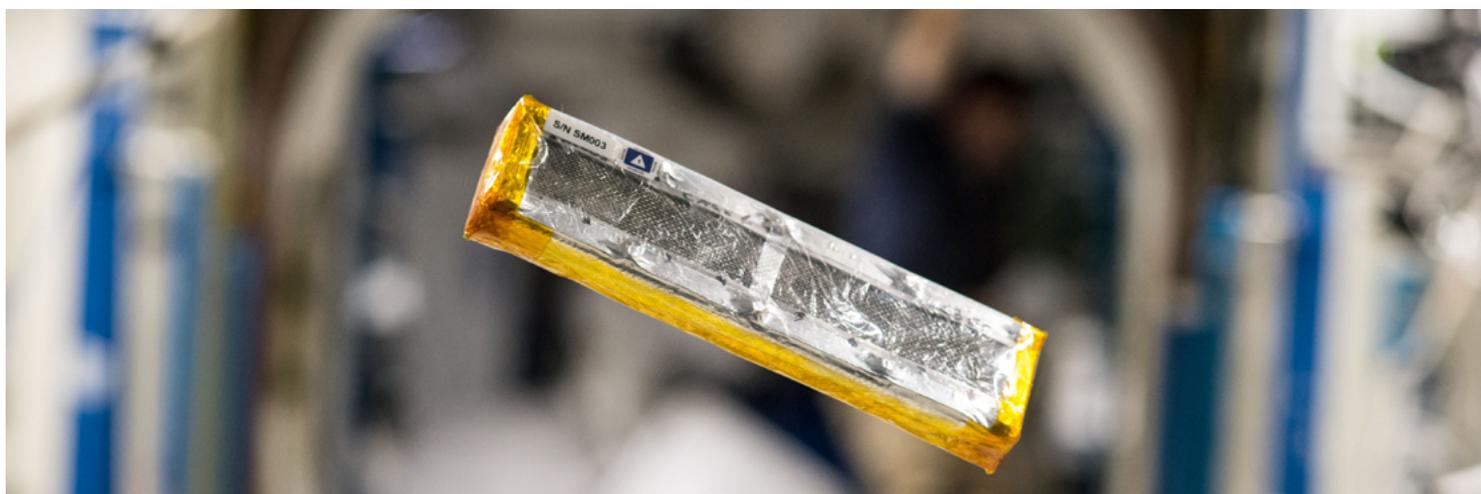
The materials were much harder when they returned to Earth but once they were rehydrated, most of the materials returned to their gel-like state, and retained their electroactivity and their integrity, Rasmussen said. The materials yellowed and there were some changes in acidity but they generally withstood the year on the space station very well, she said.

Potential for space exploration

“This was a wonderful experiment showing the potential for this to be used in space exploration,” Rasmussen said. “You could also use these as we move to smart materials and robotics for human retrieval in war zones.” This would be especially beneficial for areas with any nuclear fallout.

The material is being explored as a self-adjusting prosthetic liner to make prosthetics fit more comfortably, Rasmussen said. She is also working on other possible uses such as high-comfort perfect-fit earbuds .

“This has been a wonderful journey from developing this material to it flying on the space station,” Rasmussen said. “I want to thank the audience for your time today and for PPPL’s support and collaboration. This is an amazing site here.” 📍



A photo taken by Astronaut Scott Kelly of a sample of the synthetic muscle experiment floating in the ISS. (Photo courtesy of NASA)

Open Forum with Terry Brog

Terry Brog, deputy director for operations, will host the next open forum on Tuesday, Nov. 28, from 3 to 4 p.m. in room B318.

Please check your email for registration information.

Please
contribute to
United Way
through Nov. 30

Princeton University
matches up to 15
percent of employee
donations

Register your future scientist for the Young Women's Conference

Registration is now open for you to register your seventh to tenth-grade future scientist for the 2018 Young Women's Conference in Science, Technology, Engineering, and Mathematics, March 22, 2018, at Princeton University.

The all-day conference for seventh through tenth graders will include lectures, hands-on activities and science demonstrations. Registration is open to the daughters and relatives of PPPL staff and to school groups on a first-come-first-served basis. While registration is closed to the public, it is open for up to 50 PPPL employee relatives.

[More information is available here.](#)
[Click here for a registration form.](#)

Council Café Lunch

This Week:

Jerry Levine, Head of
Environment, Safety & Health



Wednesday, Nov. 22
12 p.m., PPPL Café

Next Week:

Jon Menard, Director of the
NSTX-U Recovery Project



Wednesday, Nov. 29
11:30 a.m., PPPL Café

Dec. 6: Charles Neumeyer

Submit your questions for Plasma 101 Lunch & Learn

101 Lunch & Learns for staff start in December. Please submit your questions about fusion energy, plasma, or any of the science 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?

United Way closes with PPPL Department Bake-off Contest

PPPL is sponsoring a PPPL Department Bake Sale and Contest to raise money for United Way on Thursday, Nov. 30. The event will take place at 11:30 a.m. in the LSB lobby. Raffle tickets for the United Way Preferred Parking spots will be given out at the event and the winning tickets will be selected at the conclusion of the bake sale.

Please bring your home-baked or store bought cookies, cakes, and other goodies to the LSB Lobby at 11 a.m. Creativity is encouraged!

Each department will have a table in the LSB lobby presenting their baked goods. Cast your vote for the winning team by purchasing their tasty creations! The winning department will receive the coveted PPPL Bake off trophy and earn bragging rights for their efforts! Will Business Operations retain their champion status or will they have to pass on the trophy?

Sign up by having a representative from each department contact Ricardo Marquez at rmarquez@pppl.gov, ext. 2221 no later than Nov. 27.

The Princeton University United Way Campaign takes place Nov. 1 to Nov. 30. Employees can give a one-time contribution or donate a certain dollar amount from their paychecks. They can opt for donations to specific causes or initiatives or a non-profit agency of their choice. More information is available at <https://community.princeton.edu/uw>

Core Values Workshops

Come discuss how to put our core values into action.

Wednesday, Nov. 29

12:30–1:30 p.m.

Thursday, Nov. 30

9:30–10:30 a.m.

Room B318





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 Nov. 20	Tuesday Nov. 21	Wednesday Nov. 22	Thursday Nov. 23	Friday Nov. 24
COMMAND PERFORMANCE Chef's Feature	Chicken Marsala over Egg Noodles	Roast Turkey with Stuffing, Gravy, Green Beans and Pie	Assorted Sushi		
Early Riser	Western Omelette	Huevos Rancheros	Frittata Lorraine		
Country Kettle	Vegetable	Beef Barley	Chicken and Mushroom		
Deli Special	Smoked Turkey Baguette	Greek Tuna Salad with Pita Chips over Lettuce	Tomato & Fresh Mozz on Ciabatta with Roasted Garlic Hummus		
Grill Special	Italian Grilled Cheese	Buffalo Chicken Steak Sandwich with Fries	Assorted Sushi		
Panini	Buffalo Shrimp Wrap	Italian Grinder			

	Monday Nov. 27	Tuesday Nov. 28	Wednesday Nov. 29	Thursday Nov. 30	Friday Dec. 1
COMMAND PERFORMANCE Chef's Feature	Beef and Bean Burrito with Yellow Rice	Chicken Parmesan with Pasta Marinara	Power Bowl	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	Taco Cheesesteak	Chorizo Quesadilla	Grilled Fish Cake Sandwich	Grilled Margherita Sandwich	Knuckle Sandwich
Panini	Cheddar Crab Melt	Roast Beef, Mozzarella, Spinach and Tomato Pesto on Ciabatta Bread	Meatball Parmigiana Hero	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/>.