

## Calendar of Events

### MONDAY, MAR. 14

#### Pi Day Celebration

1:00-2:30 p.m. ♦ LSB Lobby  
Come enjoy a nice slice of pie à la mode and network with your colleagues!

### WEDNESDAY, MAR. 16

#### American Red Cross Blood Drive

8 a.m.-1 p.m. ♦ American Red Cross Bloodmobile, Lower End Parking Lot  
For an appointment or information, please contact Tricia Berran, 243-3200, or sign up online at [redcrossblood.org](http://redcrossblood.org). Enter Sponsor Code: PPPLPrinceton

#### PPPL Colloquium

4:15 p.m. ♦ MBG Auditorium  
[Fusion Rockets for Planetary Defense](#)

Dr. Glen Wurden, Los Alamos National Laboratory

### FRIDAY, MAR. 18

#### Young Women's Conference in STEM

9 a.m.-2 p.m. ♦ Frick Chemistry Laboratory, Princeton University

### SATURDAY, MAR. 19

#### Ronald E. Hatcher Science on Saturday Lecture Series

9:30 a.m. ♦ MBG Auditorium  
[Using Physics and Chemistry to Understand the Genome](#)

Professor Mary Jo Ondrechen, Northeastern University

## INSIDE

Pi Day Celebration 5

Colloquium 6

Performance Management 6

Science on Saturday 7

Young Women's Conference 7

Earth Day Photo Contest 8

Red Cross Blood Drive 9

Menu 9

## DOE's Ed Synakowski traces key discoveries in the quest for fusion energy

By Jeanne Jackson DeVoe

The path to creating sustainable fusion energy as a clean, abundant and affordable source of electric energy has been filled with "aha moments." These have led to a point in history when the international fusion experiment, ITER, is scheduled to produce more fusion energy than it uses when it is completed in 15 to 20 years, said Ed Synakowski, associate director of Science for Fusion Energy Sciences at the U.S. Department of Energy (DOE).



DOE's Associate Director of Science for Fusion Energy Sciences Ed Synakowski discusses the "aha" moments in the development of fusion energy at a March 5 Ronald E. Hatcher Science on Saturday lecture.

Speaking at a Ronald E. Hatcher Science on Saturday lecture on March 5 at PPPL, Synakowski traced the discoveries that have led to this moment as well as his own personal journey as a plasma physicist. Synakowski was a researcher on PPPL's Tokamak Fusion Test Reactor from 1988 until its closure in 1997. He was head of Research and deputy program director of the National Spherical Torus Experiment at PPPL from 1998 to 2005.

"Getting there, if you think about nuclear fusion, is going to take some moments of discovery, some 'aha' moments," Synakowski said in his talk, "Reimagining the Possible: Scientific Transformations Shaping the Path Towards Fusion Energy."

"We're taking the process that powers the sun and the stars and bringing it to earth for the benefit of mankind."

[continued on page 2](#)

## 50 middle-schoolers are wowed by science at PPPL's My Brother's Keeper program

By Jeanne Jackson DeVoe

Fifty seventh- and eighth-graders from John Witherspoon Middle School in Princeton came to PPPL for a half day on March 4 to become scientists – doing a variety of hands-on science activities, from building a motor to sampling ice cream frozen with liquid nitrogen in a cryogenics demonstration, to watching cool plasma demonstrations of lightning, static electricity and stars. They left wanting more.

The activities, organized by PPPL's Science Education staff, were designed to spark students' interest in STEM (science, technology, engineering, and mathematics). The program was one of many National Week at the Labs events taking place Feb. 29 to March 4 with more than 5,000 students at more than 50 laboratories across the country. The initiative was part of President Obama's My Brother's Keeper (MBK) program, which aims to support and inspire boys and young men of color to succeed in school and go on to college and successful careers. The MBK recently announced MBK STEM and entrepreneurship tracks to encourage young men in those areas. Princeton is one of the towns participating in the program.

[continued on page 3](#)

# Science on Saturday: Ed Synakowski

continued from page 1



Synakowski touched on the role of magnets in fusion energy in his Science on Saturday talk.

Under a fusion power roadmap developed by European scientists, the next step after ITER would be to build fusion power plants that could begin generating electricity as early as the middle of this century, Synakowski said. Fusion energy would supplement other green sources of electricity, such as wind and power, which have great potential but face the challenge not only of relying on the weather but of storing energy, Synakowski said. “Any robust clean energy infrastructure will benefit greatly from a mix that includes renewables as well as something like fusion,” he said. “You need something that’s clean and has the potential of stable, reliable electric power,” he said.

## Wendelstein 7-X a sign of progress

Another sign of progress on the road to fusion energy was the Feb. 3 celebration of the first hydrogen plasma at the Wendelstein 7-X stellarator in Greifswald, Germany, Synakowski said. He attended the event along with A.J. Stewart Smith, Princeton University’s vice-president for PPPL, and several PPPL researchers. Synakowski noted that PPPL leads the U.S. collaboration with W7-X scientists, which is vital because the U.S. does not have a stellarator on the same scale as W7-X.

Synakowski explored his own inspiration as a scientist, culminating in his current position with the Office of Fusion Energy Sciences, which supports research to develop the scientific basis for fusion energy, and serves as a leading steward of plasma science. The FES has a budget of over \$400 million and oversees research at national laboratories, universities, and in private industry. Synakowski was previously the Fusion Energy Program leader and the deputy division leader at large of the Physics Division at the Lawrence Livermore National Laboratory. An American Physical Society and Institute of Physics fellow, he has written more than 160 publications. He received a Ph.D. in physics from the University of Texas at Austin and a bachelor’s degree from Johns Hopkins University.

Synakowski said his own journey to joining the quest for fusion energy began as a child when he was fascinated by space. He recalled his feeling of elation as a boy when he was able to identify Saturn using his home telescope. “My career in the sciences has been an effort to capture that kind of moment because it’s so powerful and uplifting,” he said. “The field, I think, has had many such moments.”

Fusion energy is based on the same process that takes place in the sun, where gravity holds together the hot ionized gas called a plasma. Inside the plasma nuclei of hydrogen collide together often enough, and overcome the force keeping them apart, called the Coulomb force, to fuse together and create a burst of energy, Synakowski explained.

Fusion energy uses two isotopes of hydrogen: deuterium, which can be extracted from seawater, and tritium, a radioactive isotope that is not naturally available but can be produced in a fusion reactor. Unlike many other forms of energy, it takes a small amount of fuel to produce a large amount of energy, Synakowski said. A power plant that produces 1,000 megawatts of energy consumes 9,000 tons of coal a day and emits 30,000 tons of carbon dioxide, the most common greenhouse gas linked to climate change. A fusion power plant producing the same amount of energy would produce just four pounds of helium as a byproduct. And compared to the byproducts of nuclear plants, which remain radioactive for thousands of years, the small amount of radioactive material produced in fusion reactions would remain radioactive for tens of years, Synakowski said.

Synakowski noted that humankind’s energy consumption has increased over the centuries as people’s lifespan has increased. In the past 160 years, U.S. life expectancy has doubled from 40 to 80 years, Synakowski said. That has been partly due to the availability of energy, he said, and has caused political instability as the governments of developing countries strive to obtain a plentiful energy source that will improve their people’s quality of life. The increased lifespan has also required additional energy. Meanwhile, the source of energy has also evolved from wood to coal, to petroleum, natural gas and nuclear sources of electric power. “Energy drives a quality of life that isn’t going away,” he said.

## Lyman Spitzer and the first fusion energy device

Synakowski traced the roots of fusion energy to Princeton astrophysicist and PPPL founder Lyman Spitzer who led a classified program called “Project Matterhorn” in the 1950s and was the first to come up with the idea of creating fusion energy in a device he called a “stellarator.” Spitzer’s device had the same basic elements as modern fusion devices, Synakowski said. It used an ionized gas called a plasma for fuel and had magnets on the outside to create a magnetic field to contain the plasma and keep it away from the walls. Spitzer believed that if the plasma could be heated to 200 million degrees Centigrade, he could create a fusion reaction.

But the stellarator was not the only type of fusion experiment in the world. The British created a device called a “pinch” and the Russians invented a doughnut-shaped device called a “tokamak.” The Russians announced they had achieved an electron temperature of up to 20 million degrees Centigrade in the plasmas in their fusion experiments and the results convinced many researchers around the world that the tokamak was a better way to confine the plasma to create fusion energy. After the stellarator produced disappointing results in the 1950s and 1960s, many laboratories worldwide, including the Princeton Plasma Physics Laboratory, which received its current name in 1961, followed the example of the Russians.

Synakowski was a researcher at PPPL during some of the “aha” moments at PPPL’s Tokamak Fusion Test Reactor (TFTR), which operated from 1982 to 1997 and was then the biggest tokamak in the U.S. and the third biggest in the world. Synakowski showed the audience a picture of himself, along with Mike Zarnstorff, now PPPL’s deputy director of research, Richard Hawryluk, now the head of ITER and

[continued on page 5](#)

# My Brother's Keeper

continued from page 1

Seventh-grader Delmos White gave the morning's activities rave reviews. "It was awesome," he said. "I like how we did experiments."

The middle-schoolers heard a recorded greeting from U.S. Energy Secretary Ernest Moniz and then broke up into three rotating groups for science activities. One group spent an hour in the Science Education Laboratory learning to build circuits, motors and electromagnets. Another took part in a cryogenics demonstration, while a third group participated in hands-on plasma activities. Plainsboro Deputy Mayor Neil Lewis attended the event.

"I'm so proud that PPPL could be part of President Obama's initiative through the local Princeton My Brother's Keeper program and through National Laboratories Week," said Head of Science Education Andrew Zwicker. "We know that middle school is a critical time to get students interested in science and engineering careers and the best way to do that is with the hands-on program we're doing here today."

The group building electronics seemed to delight in making first a light bulb and then an LED light up with their circuits. They later made copper wire spin around with their electromagnets.



John Witherspoon students successfully light their LED using only one wire and two batteries.

"It was fantastic," said Science Education Program Leader Shannon Greco, one of the organizers, who led the workshop with Senior Program Leader Arturo Dominguez. "They were really engaged. We planned these activities with high-schoolers in mind and some of the middle-schoolers did it faster than the high-schoolers!"

[continued on page 4](#)



PPPL's Head of Science Education Andrew Zwicker mixes ice cream frozen with liquid nitrogen.



The ice cream frozen with liquid nitrogen is ready to be served.



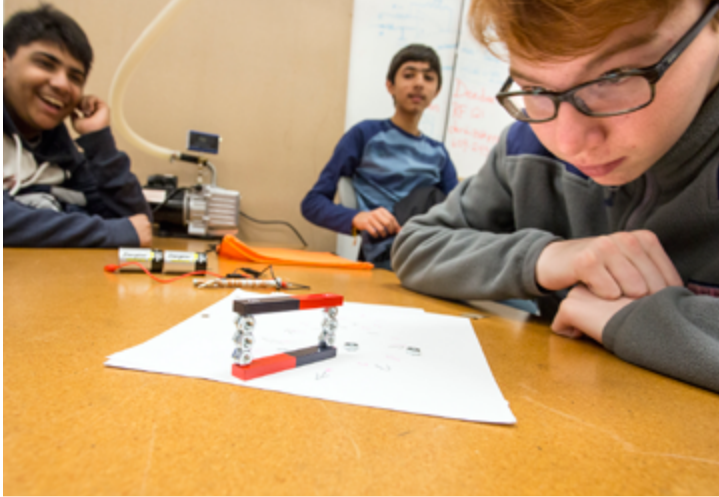
PPPL Program Leader Shannon Greco works with students on the circuit to light the LED.

# My Brother's Keeper

continued from page 3

Greco said she explained to the students making the electromagnets that the center stack of PPPL's National Spherical Torus Experiment-Upgrade is also an electromagnet. "I said, 'This is exactly what we do at the Laboratory all the time.' "

The cryogenics demonstration was also a big hit. Zwicker and engineer Ray Camp showed the group how they could



A student has some fun with a magnet during the workshop.

flash freeze hot dogs to make them as hard as stone. And making and eating ice cream using liquid nitrogen in what looked like an experiment by a mad scientist was one of the most popular things to do. "I loved the ice cream," said eighth-grader Luis Munoz. "It was pretty good!"

Students lined up to make their hair stand on end when they touched the Van de Graaff generator, one of many plasma activities. They watched how a Tesla coil lit up a fluorescent tube. They particularly enjoyed watching marshmallows expand and then shrink in a vacuum chamber.

Princeton Public Schools Science Supervisor Eddie Cohen said the activities were "highly engaging. The students were excited to show their ideas and observations about experiments they've never seen before," he said. "So I think the wow factor is very large here!"

Greco said she would like to see more activities in partnership with Princeton and other schools nearby PPPL. "We have that much more opportunity to really change the trajectory of their careers when there's something this accessible to them," she said.

Seventh-grader Delmost White, for one, sounded like he would welcome that opportunity. "It was amazing!" he said. "I want to come back a million times!" 📍



PPPL's Ankita Jariwala uses a Tesla coil to light up a blue fluorescent bulb.



PPPL Science Education Program Leader Arturo Dominguez helps students create a motor.



Students have fun with a magnet.

## Science on Saturday: Ed Synakowski

continued from page 2


Tokamaks at PPPL; and several other scientists in the control room of TFTR on Dec. 9, 1993. That's when the facility achieved a world-record 6.3 million watts of fusion power with a 50-50 mix of deuterium and tritium. In June of 1994, TFTR would generate headlines worldwide when it produced 10.7 million watts of fusion power, Synakowski said.

Meanwhile, the development of computers over the decades made it possible for physicists to more accurately predict experimental results, Synakowski said. That has made theoretical physics and computing essential to fusion research. For example, there was widespread concern based on work by theorists in the early 1970s that certain "drift instabilities" in fusion experiments would cool the plasma and prevent tokamaks from reaching the conditions necessary for fusion to occur. Later in the 1970s, theorists used new analyses and some of the first computational plasma physics studies to show that the picture was much less bleak than originally thought. Experiments at PPPL were central to helping to settle the question. Research on the Princeton Large Torus found there was no evidence of a universal instability, and that temperatures close to those required for a reactor could be generated efficiently. This kind of theory-experiment comparison has evolved over the decades, and now theoretical physicists like PPPL's C.S. Chang use complex computer simulations to predict fluctuations in the plasma that can inhibit fusion reactions, Synakowski said. "These simulations are used to inform research in a way previously unimagined," he said.

Synakowski credited Zarnstorff with another "aha" moment in which Zarnstorff identified a phenomenon called a "bootstrap current." The plasma generates the bootstrap current itself, thus reducing the need for more power to produce the plasma current necessary to heat and confine the plasma.



A member of the crowd asks a question.

Such discoveries have propelled fusion research forward and have captured his imagination and that of other scientists like him, Synakowski. But Synakowski said he has not only been drawn by the science of fusion energy but also by the pure beauty of plasma found in phenomenon like the Northern Lights, which he saw several years ago. And most of all, he has been captivated by the potential of fusion energy to change the world. "I feel most fortunate to have been a part of this journey, to be able to witness it, to be able to work in this field and to allow it to stimulate additional moments of discovery for me," he said. "I can't think of another field of science that is more compelling, both for the beauty of it and the practical import of it." 

# $\pi$ Day Celebration

## Celebrate Pi Day and Einstein's Birthday!

**Monday, 3.14, from 1:00 to 2:30 p.m.**  
**Enjoy pi(e) and ice cream in the Lobby!**

Come enjoy a nice slice of pie à la mode  
and network with your colleagues!



# COLLOQUIUM

## Fusion Rockets for Planetary Defense



**Dr. Glen Wurden**  
Los Alamos National Laboratory

**Wednesday, Mar. 16**  
4:15 p.m., M.B.G Auditorium, Lyman Spitzer Building

## Performance Management Toolkit for Supervisors

A new [Performance Management Toolkit](#) for supervisors is available on the [PPPL Human Resources page](#). The toolkit contains links to procedures, job aids, communication templates, and documentation tools for the following performance management actions:

- Coaching for Improvement
- Performance Improvement Plans (PIPs)
- Progressive Discipline

Please take some time to review the new toolkit and become familiar with its contents. Please direct any questions you have to Director of Human Resources Paulette Gangemi.

Thank you.

*Paulette Gangemi, Director of Human Resources*

[Pgangemi@pppl.gov](mailto:Pgangemi@pppl.gov)

Ext. 2224

Ronald E. Hatcher

## Science on Saturday LECTURE SERIES

### Using Physics and Chemistry to Understand the Genome

**Professor Mary Jo Ondrechen**  
Northeastern University



**Saturday, Mar. 19**

9:30 a.m., M.B.G Auditorium, Lyman Spitzer Building

## Volunteer for PPPL's Young Women's Conference March 18!



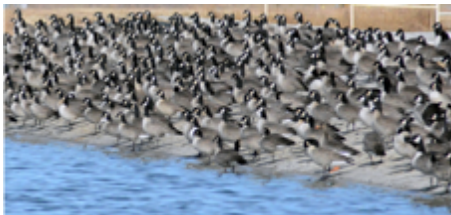
PPPL's 15th Annual Young Women's Conference in Science, Technology, Engineering, and Mathematics on March 18 from 9 a.m. to 2 p.m. at Princeton University's Frick Chemistry Laboratory will have more young women than ever—with 568 registered attendees. Dozens of volunteers are needed to help out with registration or lunch, lead groups, help out with exhibits, and numerous other tasks. Please go to <http://goo.gl/forms/OQBsvkL6jn> to fill out a registration form and pick your preferred job or jobs. There will be a shuttle early in the morning on March 18 to pick up volunteers and to transport volunteers back to PPPL. Lunch will be provided.

Please contact organizer Deedee Ortiz, [dortiz@pppl.gov](mailto:dortiz@pppl.gov), ext. 2785 with any questions. Thank you!

# Earth Day Photo Contest



**Alternative Power**



**Community**



**Conservation**



**Energy Efficiency**



**Climate Change Adaptation**

**\*Note:** All images are category winners from 2015 except climate change adaptation which is a new category for 2016.

## U.S. Department of Energy Earth Day 2016 Photo Contest

### CALLING ALL PHOTOGRAPHERS

**Professionals, amateurs, and shutterbugs!**

We invite all DOE employees and DOE contractors to share images of ways we save the planet.

One winner will be selected from each of the following five categories:

1. Conservation
2. Community
3. Alternative Power
4. Energy Efficiency
5. Climate Change Adaptation & Resilience

#### Entry Procedures and Requirements:

- Submit photographs via email to Diane Burnes at [dburnes@pec1.net](mailto:dburnes@pec1.net) by 4 pm ET March 31, 2016
  - jpg or .tiff images preferred
  - Maximum of one photograph per category
  - Files must not exceed 15MB
  - Please size photographs to no larger than 8"X10"
- Note the category in which you are submitting the photo
- Title each photograph in the file name and the email
- Include your contact information in the email

#### Where to View:

A broad selection of the submitted photographs will be featured at DOE Headquarters from April 18 thru April 28. The five winning photos will also be displayed on the DOE website.

#### Judging:

The 2016 DOE Earth Day Planning Committee will determine a winning photograph from each of the five categories (noted above).

Winners will be announced April 28, 2016, and will be notified via email. Their photographs will receive special recognition that day and will be featured on the DOE website.

#### Questions:

Eric Bradley, 202-586-7301 or [eric.bradley@hq.doe.gov](mailto:eric.bradley@hq.doe.gov)  
Diane Burnes, 240-686-3059 or [dburnes@pec1.net](mailto:dburnes@pec1.net)



# American Red Cross Blood Drive

**Wednesday,  
March 16**

**8 a.m.-1 p.m.**

**American Red Cross Bloodmobile  
Lower End Parking Lot**

Appointments are preferred.  
For an appointment or information,  
please call:

**Tricia Berran  
609-243-3200**

Or sign up at [redcrossblood.org](http://redcrossblood.org)  
Enter Sponsor Code: PPPLPrinceton

**BROCK**

**MARK GAZO  
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 14	Tuesday March 15	Wednesday March 16	Thursday March 17	Friday March 18
<b>COMMAND PERFORMANCE Chef's Feature</b>	<b>Crunchy Potato Chip Chicken</b> served with Macaroni & Cheese	<b>Glazed Tofu</b> with Bok Choy served with Vegetable Fried Rice	<b>COMMAND PERFORMANCE Create Your Own Burrito Bar</b>	<b>Corned Beef &amp; Cabbage</b> with Boiled Potatoes & Soda Bread	<b>LUNCH &amp; A MOVIE RATATOUILLE</b> over Rice with Italian Sausage
Early Riser	<b>Vegetable Breakfast Burrito</b>	<b>Scrapple</b> with 2 Eggs any Style & Potatoes	<b>Linzer French Toast</b>	<b>Ham, Egg &amp; Cheddar Croissant</b>	<b>Spaghetti</b> with Bacon & Eggs
Country Kettle	<b>Chicken Noodle</b>	<b>Tomato Tortellini Bisque</b>	<b>Corn Chowder</b> with Bacon, Cheddar & Potato	<b>Black Bean Cilantro</b>	<b>Matzo Ball Soup</b>
Grille Special	<b>BURGERLICIOUS As Gouda As It Gets Burger</b> Grilled Beef Burger smothered with smoked gouda, caramelized onions, and garlic-roasted wild mushrooms topped with Applewood bacon jam on a grilled brioche roll (Available All Week)	<b>Potato Skins</b> stuffed with Bacon, Broccoli, Cheddar Cheese & Sour Cream	<b>Poached Salmon &amp; Watercress Salad</b>	<b>Sausage Coddle</b> on a Torpedo Roll	<b>Baltimore Beef Bad Boy</b>
Deli Special	<b>Egg Salad Wrap</b> with Avocado	<b>Veggie Burger</b> served with Soybean Hummus & Pita Chips	<b>Salami &amp; Fontina Panini</b> with Tomato & Banana Peppers	<b>Corned Beef</b> , Swiss Cheese, Cole Slaw & Russian Dressing on Pumpnickel	<b>Italian Hoagie Cut from a 6-Footer!!</b>
Panini	<b>The Cubano</b> - Roast Pork, Ham, Swiss, Pickles & Dijonnaise on a Ciabatta	<b>Grilled Salmon</b> with Citrus Spinach Salad	<b>Breaded Chicken Cutlet</b> on Ciabatta Bread with Ham, Salami, Provolone & Marinated Roasted Peppers	<b>Beef Irish Stout Stew</b> served with Soda Bread	<b>Flank Steak Quesadilla</b>

MENU SUBJECT TO CHANGE WITHOUT NOTICE

VEGETARIAN OPTION

**WEEKLY**

Editor: **Jeanne Jackson DeVoe** ♦ Layout and graphic design: **Kyle Palmer**  
Photography: **Elle Starkman** ♦ Science Editor: **John Greenwald** ♦ Webmaster: **Chris Cane**

The PPPL WEEKLY is published by the [PPPL Office of Communications](http://www.pppl.gov/communications) on Mondays throughout the year 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/>.