

Calendar of Events

WEDNESDAY, MAR. 2

PPPL Colloquium

4:15 p.m. ♦ MBG Auditorium
[History, Applications, Numerical Values and Problems with the Calculation of EROI - Energy Return on \(Energy\) Investment](#)

Professor Charles Hall, State University of NY College of Environmental Science and Forestry

FRIDAY, MAR. 4

My Brother's Keeper

9:30 a.m.-12:30 p.m. ♦ MBG Auditorium and Science Ed. Lab

SATURDAY, MAR. 5

Ronald E. Hatcher Science on Saturday Lecture Series

9:30 a.m. ♦ MBG Auditorium
[Reimagining the Possible: Scientific Transformations Shaping the Path Towards Fusion Energy](#)

Ed Synakowski, DOE

UPCOMING

SATURDAY, MAR. 12

Ronald E. Hatcher Science on Saturday Lecture Series

9:30 a.m. ♦ MBG Auditorium
[Taking the Universe's Baby Picture](#)

Professor David Spergel, Princeton University

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.
Enter Sponsor Code: PPPLPrinceton

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PPPL inventors win award for device that creates medical isotope vital for diagnosing diseases

By Jeanne Jackson DeVoe

Charles Gentile, an engineer at PPPL, and fellow inventors George Ascione and Adam Cohen won third prize at Princeton University Keller Center's 11th Annual Innovation Forum on Feb. 24 for their invention of an on-demand method to create a badly needed isotope used routinely in medical imaging for diagnosis.

The invention could help solve a worldwide shortage of a radioactive element that is crucial in medical scanning devices used to diagnose diseases such as heart disease and breast cancer. And it does so without the use of uranium. The refrigerator-sized device can produce Technetium-99m (Tc-99m), the substance used in most medical diagnostic procedures, in a hospital or doctor's office. This could make the substance more available to third-world countries, Gentile said. And unlike the production of Tc-99m in nuclear reactors, there is no danger of nuclear proliferation associated with the device because it does not use uranium.

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West Windsor-Plainsboro South High School & William Annin Middle School win N.J. Regional Science Bowl at PPPL

Top science whizzes will go to national contest in Washington, D.C.

By Jeanne Jackson DeVoe

The West Windsor-Plainsboro South High School Science Bowl team is going to Washington, D.C., for the second consecutive year after emerging undefeated in 12 rounds of challenging science and mathematics questions at the New Jersey Regional Science Bowl at PPPL on Feb. 20.



Millburn High School, Team B at right, played against the undefeated West Windsor-Plainsboro South team in Round 12 of the New Jersey Regional Science Bowl at the U.S. Department of Energy's Princeton Plasma Physics Laboratory on Feb. 20.

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DOE Associate Director for Fusion Energy Sciences Ed Synakowski to discuss fusion energy at PPPL's Ronald E. Hatcher Science on Saturday Lecture March 5

Ed Synakowski, associate director for Fusion Energy Sciences at the U.S. Department of Energy, will discuss the path to the development of fusion energy at PPPL's Ronald E. Hatcher Science on Saturday lecture on March 5

The title of Synakowski's lecture is, "Reimagining the Possible: Scientific Transformations Shaping the Path Towards Fusion Energy."

Synakowski worked at PPPL from 1988 through 2005 and was head of Research and deputy program director of the National Spherical Torus Experiment at PPPL. From 2006 to 2009, Synakowski was the Fusion Energy Program (FEP) leader and the deputy division leader-at-large of the Physics Division at Lawrence Livermore National Laboratory. He joined DOE's Office of Science (SC) in 2009. SC's Fusion Energy Sciences program office, which Synakowski leads, supports research to develop the scientific basis for fusion energy and supports plasma science more broadly as well. It oversees research at national laboratories, universities, and private industries.

Synakowski served on the Council of the U.S. Burning Plasma Organization and was a member of the Executive Committee of the Division of Plasma Physics for the American Physical Society. He has served on numerous committees reviewing the activities of the international fusion experiment ITER, and he chaired the U.S. Transport Task Force from 2000 to 2002. He has won several awards, including sharing the APS Award for Excellence in Plasma Physics in 2001 and receiving Princeton University's Kaul Foundation Prize for Excellence in Plasma Physics Research and Technology Development

in 2000. He is a fellow of the APS and of the Institute of Physics and the author of more than 150 refereed publications. Synakowski received his doctorate in physics from The University of Texas at Austin and his bachelor's degree with honors from Johns Hopkins University, where he was awarded the Donald Kerr Memorial Medal for Excellence in Physics.



Ed Synakowski

Science on Saturday lectures begin at 9:30 a.m. but visitors should plan to arrive early because seats fill up quickly. The doors open at 8:15 a.m. with refreshments for early birds.

On March 12, David Spergel, a theoretical astrophysicist at Princeton University, will discuss "Taking the Universe's Baby Picture."

The lecture series will conclude with a special added lecture on March 19 by Mary Jo Ondrechen, of Northeastern University, who will discuss, "Using Physics and Chemistry to Understand the Genome." Ondrechen's lecture was originally scheduled for Jan. 23 but was canceled due to a snowstorm.

You can watch the lecture series live from home here: https://mediacentral.princeton.edu/id/1_rqmmkznx. You can tweet questions from @PPPLSciEd or #scionsat.

If Science on Saturday is canceled due to inclement weather or other emergency, a message will be left on the Science on Saturday Hotline at (609) 243-2121. 📞

Ronald E. Hatcher Science on Saturday LECTURE SERIES

Mar. 5

Reimagining the Possible: Scientific Transformations Shaping the Path Towards Fusion Energy

Dr. Edmund Synakowski, Department of Energy, Office of Science

Mar. 12

Taking the Universe's Baby Picture

David Spergel, Princeton University

Mar. 19

Using Physics and Chemistry to Understand the Genome

Mary Jo Ondrechen, Northeastern University

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

Innovation forum

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Charles Gentile presents to judges seated in the front row at the 11th Annual Innovation Forum at the Andlinger Center for Energy and the Environment on Feb. 24.

The award gives Gentile, the head of the Tritium Systems Group at PPPL, and Ascione, the head of the Health Physics Division, \$5,000 to help develop their invention. The third inventor was Cohen, the Deputy Undersecretary for Science and Energy at the U.S. Department of Energy, who formerly was deputy director for operations at PPPL when he worked on the technology.

“I’m really happy,” Gentile said after receiving the award. “They know we’re onto something and we’re going to have a positive impact.”



George Ascione, one of the co-inventors, and Gentile, show off their third-place award.

Recently awarded a patent

Ascione said he and Gentile are looking forward to receiving a patent. The inventors recently learned through Princeton’s Office of Technology Licensing that the device has received a patent and they expect the patent to issue any day. “It’s a great thing,” Ascione added. “This is really a payoff for all the hard work we put in.”

Princeton University’s Keller Center, which hosted the event along with the Office of Technology Licensing, invited Gentile and six other inventors to present their inventions at

the Innovation Forum, held at Princeton’s Andlinger Center for Energy and the Environment’s Maeder Hall, before a panel of judges made up of entrepreneurs and venture capitalists. The judges decided this year to award not one but two third-place prizes along with the first and second-place prizes. “The judges really fell in love with many of the inventions,” said Cornelia Huellstrunk, the executive director of the Keller Center.

Jen-Tang Lu, a Princeton University Ph.D. candidate in electrical engineering, won first place for his invention to enhance ultrasound imaging. Jake Herb, a chemistry Ph.D. candidate, won second place for his method of producing low-cost green electrolytes for magnesium-ion batteries. The other third place prize winner was Gilad Arwatz, a postdoctoral researcher in mechanical and aerospace engineering, for a nano-wire that provides a faster, cheaper and more compact device to measure temperature, velocity and humidity.

Gentile said his invention would help fill a need for Tc-99m, which is used in two-thirds of medical diagnostic procedures around the world and is part of a multi-billion dollar radioisotope industry. A worldwide shortage of the material is developing due to nuclear reactors being shut down. A facility in Chalk River, Ontario, Canada, which is one of the main producers of the substance, is slated to shut down this year, Gentile said.

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The winners of the Innovation Forum from left to right: Jake Herb, Jen-Tang Lu, Gentile, and Gilad Arwatz.

PPPL graduate students help create Princeton University Art Museum exhibition exploring art and physics

By Raphael Rosen

When you think of a physicist, what comes to mind? Perhaps a figure in a white lab coat tinkering with complex machinery. Or maybe a wild-haired theoretician scribbling equations on a chalkboard. And you might believe that the world of physics is entirely consumed with numbers and devices, with no connection to the non-scientific world.

If so, you would be mistaken. In fact, physics has a deep relationship with art. Both artists and physicists are interested in symmetry and patterns, and both claim that beauty is an integral component of their work. Though they appear different at first glance, physics and art turn out to have many connections.

This winter, a group of past and present PPPL graduate students collaborated on a new exhibition at the Princeton University Art Museum that explores those connections. The exhibition, called “Fluid Motions: A Conversation Between Art and Physics,” features 27 images from the museum’s collection, including photographs by Ansel Adams, Brett Weston, and Henry Troup. It is on view in the museum’s Works on Paper Study Room on weekends through March 6.

“Fluid Motions” was organized by Veronica White, the Andrew W. Mellon Curatorial Assistant for Academic Programs. She also happens to be the daughter of Roscoe White, a long-time PPPL theoretical physicist. The exhibition began as a series of conversations in early 2015 between White and three PPPL



Graduate student Vinicius Njaim Duarte (Photo courtesy David Pfefferle)

graduate students: Vinicius Njaim Duarte, Joshua Burby, and Jonathan Squire. Burby and Squire are now postdocs at New York University and the California Institute of Technology, respectively. “We discussed a range of topics, including symmetry, balance, movement, and beauty,” White said. “We then discussed pattern formation in both art and physics and out of that grew the idea to create this installation.”

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Brett Weston, American, 1911–1993. *Dunes, Oceano, Calif.*, 1937. Gelatin silver print, 18.2 x 22.3 cm. (7 3/16 x 8 3/4 in.). Gift of David H. McAlpin, Class of 1920 (x1971–339). ©Estate of the artist

Innovation forum

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Doctors inject Tc-99 m to diagnose conditions ranging from brain tumors to heart disease. The isotope emits gamma rays that scanning devices can easily trace. Since the substance has a half-life of six hours, the radiation exposure to patients is kept to a minimum. But the half-life also makes it difficult to ship to third-world countries that are more than six hours away from the reactors that produce the substance. Gentile said he hopes that hospitals and medical centers in these areas would be able to use the device to produce Tc-99m themselves. Gentile told the judges that he could

produce a prototype of the refrigerator-sized device within a year. "We would like to get this material to many places where people now can't access it," he said.

Laurie Bagley, head of Technology Transfer at PPPL, said she was happy to see the invention recognized. "The technology is potentially life-changing for those who would now have access to this medical isotope," she said. 

Art and physics

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White chose photographs from the museum's collection and the graduate students helped write the descriptive text. "I wanted to recreate the experience of our conversations, which mixed perspectives from both the physics and art history worlds," she said.

The installation shows that physics and art share many of the same concerns. "There are a lot of elements in this exhibit related to daily life at PPPL, including symmetry, turbulence, chaos, pattern formation, and oscillatory behavior, among others," said Duarte, a fourth-year graduate student in plasma physics. "Physics is a kind of art," continued Duarte. "It involves a great deal of beauty and aesthetic satisfaction."

Duarte studies the interaction between energetic particles and plasma waves in research guided by Nikolai Gorelenkov, a theoretical physicist at PPPL. While helping create the installation, Duarte was struck by parallels between some of the photos and his own research. "Henry Troup's 1990 series "Wind, Water and Sand" particularly captures some phenomena of my research, such as shear flows, instabilities, self-organization and turbulence," he said.

Science and art have been intertwined for centuries, said White. "Think of Leonardo da Vinci, with his interests in anatomy and vortices," she said. "In a lot of ways, he was more skilled at drawing a complicated concept than at explaining the concept using words, so his sketches became a kind of scientific investigation."

White added that the close relationship between science and art can be widely seen. "For example, Monet's outdoor paintings reflected a keen sense of observation," she said. "In his writings you can sense his angst that he can't paint quickly enough to capture the fleeting light effects that he's noticing."

After the installation has closed, an electronic version will continue to be available on the art museum's website at <http://artmuseum.princeton.edu/object-package/fluid-motions-conversation-between-art-and-physics/64943>. As for whether there might be more installations like this one, White simply noted that "there certainly could be opportunities to do something again in the future." 

COLLOQUIUM

History, Applications, Numerical Values and Problems with the Calculation of EROI - Energy Return on (Energy) Investment



Professor Charles Hall

State University of NY College of Environmental Science and Forestry

Wednesday, Mar. 2

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

Science Bowl

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The team defeated the Millburn High School Team in the final contest to win the Science Bowl. Millburn High School came in second, while Princeton High School came in third.

“I’m really in shock! It hasn’t hit me yet that we’re going to nationals,” said Jamie You, a senior on the West Windsor-Plainsboro team.



Carol Ann Austin was a timekeeper/scorekeeper, while Andrew Zwicker was the moderator and Angelica Ottaviano, a spring SULI intern, at center, was the science judge during the final rounds of the Middle School Science Bowl in the MBG Auditorium. Laurie Bagley, at left, volunteered as a moderator through most of the day.



The William Annin team focuses on a question during the Science Bowl contest on Friday.



The Princeton Charter School, left, competes against the John Witherspoon Middle School, right.



The West Windsor-Plainsboro South Science Bowl team members show off their trophy and banner following their win against Millburn High School in Round 12 of the U.S. Department of Energy’s New Jersey Regional Science Bowl at PPPL on Feb. 20.



The William Annin Middle School Team members from Basking Ridge hold their banner and trophy after winning the Middle School competition against Princeton Charter School. The team was undefeated in 11 rounds at the Feb. 19 competition at PPPL.



Science judge Yuhu Zhai, left, and moderator Arturo Dominguez, consult about an answer at the Middle School Science Bowl.

William Annin Middle School in Basking Ridge, New Jersey, won the Middle School Science Bowl on Feb. 19 in which 16 middle school teams from the area competed. Princeton Charter School placed second and John Witherspoon Middle School in Princeton was third.

The winning teams will get an all-expenses paid trip to the U.S. Department of Energy’s National Science Bowl® (NSB) April 28 to May 2 in Washington, D.C. They will compete with 69 other high school and 49 other middle school regional teams. DOE’s Office of Science manages the NSB, and sponsors the Finals competition. More information is available on the NSB website: <http://www.science.energy.gov/wdts/nsb/>.

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Science Bowl

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Deedee Ortiz, Science Education's program administrator, organized the Science Bowl.

The contest brought 32 high school teams to PPPL from as far away as Brooklyn and Wilmington, Delaware, to compete in the Science Bowl. The team members consult with each other and hit a flashing red buzzer when they have the answer to one of up to 25 questions in general science, earth science, physical science, math and technology. They play up to 13 rounds in the high school contest and 11 rounds in the middle school contest in a double-elimination format.

Deedee Ortiz, the program administrator of PPPL's Science Education Department, who organized the event, said the competitors make the event a success. "They come in excited, focused and ready to win," she said. "They keep that great energy buzzing and I think that we all feed off of that energy and enjoy the day as much as they do."



The Millburn High School Team came in second.



The Princeton Charter School Team poses with their trophy.



Princeton Charter School team members consult about the answer to a question. The team came in second in the middle school contest.

"I have to tell you how amazing it is to see 16 teams come from all over the state to compete," said Andrew Zwicker, head of Science Education at PPPL. "I'm so proud of every team."

William Annin Team Captain Kaivalya Hariharan said he was happy the hard work of practicing several hours a week since August paid off. "It's amazing," he said. "We'll put some more work into it and maybe we'll win!"

About 50 PPPL volunteers served as moderators, science judges, and timekeepers during the two days of competition.

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Team members from John Witherspoon Middle School in Princeton puzzle over an answer. The team came in third in the middle school Science Bowl.



Rea Rustagi, a 10th grader on the Somerset County Vocational School team in Bridgewater, is trying out for "teen Jeopardy" next month.

Science Bowl

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The John Witherspoon Middle School team members, who came in third, pose with their trophy.



The Highland Park High School Team reacts as their team moves ahead the Princeton High School team by two points in overtime.



The third-place Princeton High School team.



The West Windsor-Plainsboro South team buzzes in an answer as they compete against Millburn High School in Round 12 of the New Jersey Regional Science Bowl at PPPL on Feb. 20. The team won the contest for the second consecutive year in a row.

One of the most exciting moments of the contest came early in the day in Round 4 in a match between Princeton High School and Highland Park. With one more bonus question to go for Highland Park and zero seconds left, the score was 102 Princeton to 94 Highland Park. But the Highland Park team answered the question correctly and pulled ahead to win the round 104 to 102. "That was intense!" said Nicholas Heuh, one of the members of the Highland Park team. Princeton later defeated Highland Park and went on to the 11th round of the contest.

Rea Rustagi, a 10th grader at Somerset County Vocational School in Bridgewater, was among the high school contestants. She is auditioning for TV's "Jeopardy" for a segment of "Teen Jeopardy" next month after making it through an online quiz. "These questions are way harder," Rustagi said. "I was nervous in the beginning and then as time went on I was having fun. If you take yourself too seriously you're not going to enjoy the experience."

Photos by Elle Starkman.



Naila Firdaus was a timekeeper/scorekeeper for both science bowls.



Shannon Greco was the science judge and Leland Ellison was the moderator, with Margaret Kevin-King serving as timekeeper/scorekeeper during a round between the Princeton Charter School, at front, and John Witherspoon Middle School in Princeton.

Widow of one of the first Project Matterhorn employees tours PPPL

By Jeanne Jackson DeVoe

Laura Kruskal, the widow of Martin Kruskal, a pioneering mathematician and physicist who was one of the first researchers to work on Project Matterhorn with PPPL founder Lyman Spitzer, toured the Laboratory on Feb. 23 along with several members of the Women's College Club of Princeton.

"It's serendipity that I should be here for this because this is the 10th anniversary of Martin's death," Kruskal said. "It's just accidental that I should be here where he began his career."

Kruskal said she had many wonderful memories of socializing with Lyman and Doreen Spitzer and of entertaining physicists like Enrico Fermi and James Tuck.

Physicist Walter Guttenfelder showed the group plasma demonstrations and physicist Greg Hammett gave a brief talk about some of Martin Kruskal's contributions in physics. Hammett took Kruskal's course on "asymptotic methods" in 1981. "It opened my eyes to how to think about complicated equations and gave a powerful bag of tricks for understanding their behavior in various limits," he said.



Laura Kruskal, the widow of Martin Kruskal, listens to a presentation on her husband in the MBG Auditorium during a visit to PPPL on Feb. 23.



Physicists Walter Guttenfelder, front, and Greg Hammett speak to members of the Women's College Club of Princeton, including Kruskal, before giving them a tour of the Laboratory.

Hammett noted that Kruskal was the third employee (badge number 4) hired by Lyman Spitzer to work at the secret government program in plasma physics and fusion energy known as Project Matterhorn, which began in 1951. Project Matterhorn was declassified in 1958 and renamed the Princeton Plasma Physics Laboratory in 1961.




Hammett chats with Kruskal and other members of the Women's College Club of Princeton.

Hammett said that many of Kruskal's theories are taught in graduate courses in plasma physics at Princeton University and around the world. Kruskal and his collaborators developed some key theories in the 1950s and 1960s, including a stability theory, which identified the Kruskal-Shafranov Instability, and an adiabatic theory, which describes how well particles can be confined in imperfect magnetic fields, Hammett said. Kruskal also co-discovered nonlinear waves known as Bernstein-Greene-Kruskal waves, and developed a diagram that analyzes complicated equations known as the Kruskal-Newton Diagram. "There were several areas where he was incredibly critical in developing deeper understanding," Hammett said.

Kruskal's research with Norman Zabusky also described the soliton, a unique form of nonlinear wave that could be very useful for undersea optical cables that carry internet traffic, Hammett said.

While most scientists count themselves lucky if they have 100 citations, some of Kruskal's papers have more than 2,000, Hammett said.

Laura Kruskal still lives in the couple's house in Princeton. She is a well-known origami expert who still teaches classes in origami. The couple have three children and five grandchildren and Kruskal's first great-grandchild was born last summer. 

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 next month at Rider University.

Students from Mercer County schools show off their original science projects at the fair from March 12 to March 15. Judging for the elementary division (grades 4 to 5) and the junior division (grades 6 to 8) takes place Sunday, March 12. Judging for the senior division takes place March 12 and March 13. Additional information about the fair is available at <https://mercersec.org/about/msef>.

To volunteer, create an account online and check off judge to volunteer at <https://mercersec.org/help/BecomeAJudge>.

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 February 29	Tuesday March 1	Wednesday March 2	Thursday March 3	Friday March 4
COMMAND PERFORMANCE Chef's Feature	Chicken Marsala with Mushrooms served with Mashed Potatoes & Gravy	Ziti with Wild Mushrooms, Ricotta Cheese, Mozzarella & Marinara Sauce	COMMAND PERFORMANCE Mac & Cheese Bar Choose from a variety of ingredients to top your Mac & Cheese	Meatloaf with Smashed Cilantro Potatoes, Roasted Carrots & Gravy	Lemon Pepper Salmon served with Risotto and Garlic Sautéed Broccoli Rabe
Early Riser	Chicken & Cheddar Omelet served with Hash Browns	Tex Mex Scrambled Eggs with Shredded Beef, Pepper Jack & Tomato in a Corn Tortilla	Sausage Hash Brown Bake	Egg McMuffin with Ham served with Hash Browns	Sausage Gravy & Biscuits served with 2 Eggs any style
Country Kettle	Kielbasa Soup	Vegetable Chili	Chicken Rice	Minestrone	Crab Bisque
Grille Special	BURGERLICIOUS BBQ Beef in a Blanket Grilled Beef Burger with Cheddar Cheese, Bacon Blanket, Crispy Onion Straws, Dill Pickle Chips and Chipotle BBQ Sauce on a Brioche Roll (Available All Week)	Corned Beef Reuben on Rye	Fish Taco with Pickled Slaw, Cilantro, Chipotle Sour Cream	Grilled Texas Toast with Prosciutto, Chicken, Swiss Cheese & Dijonnaise	Vegetarian Quesadilla
Deli Special	Egg Salad & Provolone with Arugula & Tomato on French Bread	Veggie Burger on a Wheat Roll served with Soy Bean Hummus & Pita Chips	Italian Hoagie with Prosciutto, Capicola, Fresh Mozzarella, Lettuce, Tomato & Marinated Red Peppers	Salad Nicoise-Grilled Tuna with Herbed Potatoes, Kalamata Olives, Cherry Tomatoes, Green Beans & Hard-Cooked Egg	Turkey, Blue Cheese, Avocado, Bacon, Lettuce & Tomato on a Kaiser Roll
Panini	Pork Roll & American Cheese on a Kaiser Roll served with Disco Fries (Gravy & Cheese)	Grilled Salmon with Spinach & Roasted Peppers on a Soft Roll	Ham, Smoked Turkey, Pastrami, American Cheese, Pesto, Onion & Tomato on Focaccia Bread	Eggplant Parmesan Sub	Chipotle Roast Beef with Blue Cheese, Onion, & Tomato on Ciabatta Bread

MENU SUBJECT TO CHANGE WITHOUT NOTICE

VEGETARIAN OPTION

WEEKLY

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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 ♦ PPPL WEEKLY is archived on the web at: <http://w3.pppl.gov/communications/weekly/>.