

Calendar of Events

TUESDAY, APRIL 19

Earth Day Cleanup

10:30 a.m. ♦ Meet in lobby
Pizza lunch for volunteers!

WEDNESDAY, APRIL 20

Unicor Electronics Recycling

7:30-10 a.m. ♦ Upper parking lot

**Earth Week colloquium on
climate change**

4:15 p.m. ♦ MBG Auditorium

[Living with Climate Change:
The Road from Paris](#)

Dr. Dale Jamieson, New York University

THURSDAY, APRIL 21

Grounds Cleanup rain date

10:30 a.m. ♦ Meet in lobby

UPCOMING

TUESDAY, APRIL 26

Lunchtime walk on the D&R Canal

11:45 a.m. ♦ Meet in Lower
Parking Lot

(See page 5 for Earth Week events)

WEDNESDAY, APRIL 27

**Green Machine Awards and short
video, "The Story of Stuff"**

1 p.m. ♦ MBG Auditorium

Plants and snacks for audience
members.

PPPL Colloquium

4:15 p.m. ♦ MBG Auditorium

[Probing the Accelerating Universe
with the Dark Energy Survey](#)

Dr. Joshua Frieman, Fermilab and the
University of Chicago

MAY 11-12

PPPL Advisory Committee

INSIDE

Prospective Students Luncheon **4**

Earth Week **5**

Federal Bike Challenge **6**

Robotics Coaches Needed **7**

YWCA Volunteer Appreciation **7**

Colloquium **8**

Menu **8**

Hunting for Big Bang neutrinos that could provide fresh insight on the origin of the universe

Like "detecting a heartbeat in an arena" full of people

By John Greenwald

Big Bang neutrinos are believed to be everywhere in the universe but have never been seen. The expansion of the universe has stretched them and they are thought to be billions of times colder than neutrinos that stream from the sun. As the oldest known witnesses or "relics" of the early universe, they could shed new light on the birth of the cosmos if scientists could pin them down. That's a tall order since these ghostly particles can speed through planets as if they were empty space.

Now Princeton University physicist Chris Tully is readying a facility to detect these information-rich relics that appeared one second after the Big Bang, during the onset of the epoch that fused protons and neutrons to create all the light elements in the universe. Tully runs a prototype lab at PPPL that draws on the fact that neutrinos can be captured by tritium, a radioactive isotope of hydrogen, and provide a tiny boost of energy to the electrons emitted in tritium decay.



Princeton physicist Chris Tully in the PTOLEMY laboratory. Behind him are powerful superconducting magnets on either side of the vacuum chamber.

[continued on page 2](#)

Meeting explores high-tech methods to bridge 4,000-mile gap between U.S. and W7-X

By Jeanne Jackson DeVoe

With American collaborators at least 4,000 miles away from the Wendelstein 7-X stellarator (W7-X) in Greifswald, Germany, scientists and information technology experts from both sides of the pond are trying to make remote collaboration easier and more effective for scientists at PPPL and six other U.S. institutions collaborating on W7-X.

"We have to make our remote collaboration with the Wendelstein 7-X work in a way that does not require the whole team to live in Greifswald," said Hutch Neilson, head of advanced projects at PPPL and the coordinator of the U.S. collaboration. "Certainly people have to travel there and spend time there, but we have to develop a way to make remote collaboration as effective as possible."

[continued on page 3](#)

Big Bang neutrinos

continued from page 1

Precision never before achieved

The prototype aims to measure this tiny extra energy with a precision never before achieved. The task, which has been compared to detecting a specific heartbeat in a packed sports arena, will require the coldest and darkest conditions achievable to prevent disruption of the exquisitely sensitive instruments. If successful, the project could lead to a major new experiment at PPPL to confirm or reassess the standard model of the Big Bang and its aftermath.

“We hope to take enough data to measure the neutrino or at least produce the world’s most accurate measurement using calorimeter techniques by the end of 2017,” Tully said.

The state-of-the-art system, set up by PPPL engineer Charles Gentile and other Laboratory staff, consists of a pair of superconducting magnets joined to opposite ends of a 5-foot vacuum chamber, with the second magnet connected to a calorimeter that measures electron energy. Tully names the project PTOLEMY after the second century Egyptian astronomer of Greek descent and as an acronym for “Princeton Tritium Observatory for Light, Early-universe Massive-neutrino Yield.” Support comes from grants of \$400,000 from the Simons Foundation in New York City and \$330,000 from the John Templeton Foundation in Pennsylvania.

Hunt begins this summer

The hunt for Big Bang neutrinos will begin this summer after several years of preparation. Soon to arrive is a key ingredient: 1/100th of a microgram of tritium loaded onto a postage stamp-sized sheet of graphene, a layer of carbon just a single atom thick. This arrangement will produce a clean spectrum of tritium decay when it arrives from Savannah River National Laboratory under a Cooperative Research and Development Agreement approved by the DOE. PPPL will handle this tritium safely in accordance with its DOE-approved Radiation Protection Program. The Laboratory used higher quantities of tritium as a fuel, with the hydrogen isotope deuterium, for fusion experiments conducted on its Tokamak Fusion Test Reactor from 1993 to 1997.

Researchers will position the tritium-loaded graphene inside the first superconducting magnet, whose field strength is similar to the MRI systems that hospitals and clinics use. This field will guide electrons from the tritium decay into the neighboring vacuum chamber. Low-energy electrons will be filtered as they travel through a series of electrodes placed within the vacuum chamber as the magnetic field first dips in strength and then rises again as the electrons enter the second magnet, leaving only the highest-energy electrons for the calorimeter to analyze.

Most accurate instrument of its kind

The calorimeter will be the most accurate instrument of its kind in the world. It will be hooked to a dilution refrigerator set at 10-to-50 milli-Kelvins, a temperature more than 50 times colder than deep space and a small fraction of a degree above absolute zero. The extreme cold will keep the calorimeter poised between a superconducting state – one in which electrons can flow without resistance – and a non-superconducting state that provides resistance. When an electron with neutrino-supplied extra energy comes along, the calorimeter would signal it by rapidly becoming resistive.

This dilution refrigerator could make PPPL one of the hottest as well as coldest spots in the solar system on days when the National Spherical Torus Experiment-Upgrade (NSTX-U), the Laboratory’s recently completed flagship facility, is running. The NSTX-U routinely conducts experiments at or above the 15 million degree Celsius core of the sun as it investigates fusion reactions as the energy for generating electricity.

Pave the way for a much larger experiment

The PTOLEMY project will have a major goal: to demonstrate the ability to measure the mass of Big Bang neutrinos and thus pave the way for a much larger experiment, one that would explore the decay from 100 grams of tritium.

The large new experiment would test the theory that predicts that some 330 Big Bang neutrinos per cubic centimeter exist throughout the universe. The enlarged PTOLEMY will count the number of electrons that neutrinos have bumped up in energy to determine whether this prediction is correct. Confirming it would validate current thought about the evolution of the cosmos since the Big Bang, while refuting it could overturn the model and lead to fresh insights.

The expanded experiment could have other far-reaching effects. It might detect so-called sterile neutrinos, hypothetical Big Bang particles that have no positive or negative charge and could be the source of invisible dark matter, which scientists say makes up 20 percent of the mass of the universe.

Besides hunting for neutrinos, the area in which PTOLEMY sits houses equipment useful for furthering the central collaborative mission of the fusion energy lab. For example, developers of ITER, the international tokamak under construction in France, will test a diagnostic device on a powerful magnet next to the site. Work on PTOLEMY itself will attract graduate students and summer interns. Tully notes such opportunities as he looks ahead. “My dream is to prove that measuring neutrino mass can work,” he says, “and to have a beautiful picture of a major new facility that engineers can build.”



View of the dilution refrigerator that will lower temperature to a small fraction of a degree above absolute zero when connected.

W7-X remote collaboration

continued from page 1

Neilson and other PPPL scientists met with Stephan Bosch, head of the Operations Division of the Max Planck Institute for Plasma Physics (IPP) and Andreas Werner, Head of Control, Data Access and Communication at IPP, April 5 and 6 at PPPL. Joining the meeting were Stacia Zelik, PPPL's chief information officer; and Paul Henderson, head of Systems and Network Engineering, and others. Several U.S. collaborators participated remotely via Zoom videoconferencing. Neilson said the approach is that U.S. collaborators are part of "one team," and any solutions must work for all of them.

At the same time, Michael Zarnstorff, PPPL's deputy director for research, has been leading an effort this year to improve remote collaborations at PPPL as part of PPPL's Campus Plan. Work is beginning to install audiovisual equipment in conference rooms, including a designated remote collaboration room with multiple large screens and enhanced communication equipment.

The remote collaboration tools will include videoconferencing tools, tools for rapid data access, better communications tools, and web-based tools, Zarnstorff said. "We are also looking at ways we can improve the NSTX-U collaborator experience that also apply to W7-X and there I think we'll be learning together," Zarnstorff said. "We're trying to have them cross-inform each other, so we want to make it easier for NSTX-U users to participate even when they're home," Zarnstorff said. "We think this can be really helpful for enabling collaborators at universities, in particular."

Plans call for a remote collaboration space next to the National Spherical Torus Experiment-Upgrade (NSTX-U) Control Room, to improve communication that could be used with NSTX-U collaborators and collaborations outside the Laboratory.

"It will be very beneficial for all of us at PPPL who collaborate whether on W7-X or on EAST, DIII D, or any of the off-site experiments where we collaborate" Neilson said.

A perfect opportunity

This is a perfect opportunity to establish the parameters of remote collaboration with W7-X, Neilson said, because the experiment has a one-year outage to install a divertor and other equipment after operating from December through March.



Hutch Neilson, left, shows off the control room to scientists from the Max Planck Institute for Plasma Physics (IPP) during a tour of PPPL. At center is Stephan Bosch, head of the Operations Division of the Max Planck Institute for Plasma Physics (IPP) and Andreas Werner, Head of Control, Data Access and Communication at IPP.

Bosch agreed. "Many of the people in Greifswald never had an experience when the machine was operating," he said. "It's like building a ship but now we have to sail." Bosch said the meeting was productive, and he particularly enjoyed spending so much time at the Laboratory; he was a post-doc at PPPL in 1987 working on TFTR. "So it's like coming home."

The challenge is to improve remote collaborations for American scientists at seven institutions, including PPPL, who are collaborating with scientists in Greifswald. If a phone or video meeting were scheduled at 9 a.m. in Greifswald, it would be 3 a.m. for scientists at PPPL, MIT in Cambridge, and Auburn University in Alabama. Scientists at the University of Wisconsin and Xantho Technologies, LLC, in Wisconsin, and at Oak Ridge National Laboratory in Tennessee would have to wake up at 2 a.m., while scientists at Los Alamos National Laboratory in New Mexico, would be meeting at 1 a.m. As PPPL scientist Novimir Pablant, who collaborates with the W7-X, put it at the meeting: "I might join the meeting in my pajamas from my kitchen."

PPPL has a lot of experience with remote collaborations through its work with numerous fusion facilities around the world, including JET in the United Kingdom, JT-60 and LHD in Japan, EAST in China, and KSTAR in South Korea, Neilson said. One difference between those experiments and W7-X is that W7-X eventually will have 30-minute plasmas that will produce a stream of data rather than a burst of data from "shots" that are a few seconds long. As a consequence, data from the W7-X will be packaged in multiple time segments.

[continued on page 4](#)



Scientists at PPPL use a large screen in the "Vis Wall Room" to speak to PPPL physicist Novimir Pablant at the Wendelstein 7-X in Greifswald, Germany.

W7-X remote collaboration

continued from page 3

A model for international partners

Neilson was coauthor, along with Rich Hawryluk, head of ITER and Tokamaks; Stanley Kaye, deputy program director for NSTX-U; and Zarnstorff, of a white paper on remote collaborations submitted to the U.S. Department of Energy in March. The paper recommends PPPL develop a “model for technical communications” that “enables any U.S. researcher to participate in W7-X from anywhere in the world.”

“The W7-X collaboration provides an opportunity for the U.S. community to develop and refine a modern model for working with international partners effectively,” the authors wrote.

The scientists said better tools would also make it easier for off-site scientists to collaborate on PPPL’s NSTX-U. Most importantly, they said, remote tools will help U.S. laboratories and institutions collaborate on experiments at ITER, the international fusion experiment in Cadarache, France. “While our immediate goal is to enable us to be effective on W7-X, we are looking at it with ITER in mind,” Neilson said.

The goal, the scientists said in the paper, is to develop a distributed network for remote collaboration in which the host’s computer, whether it’s at NSTX-U or W7-X, links to a large number of collaborators through the Internet rather than directly through the host’s computer. US researchers collaborating with European facilities have the advantage of using the DOE’s Energy Sciences Network (ESnet), which recently extended into Europe.

Access to data is scientists’ top priority

Neilson recently surveyed U.S. collaborators on W7-X to ask what issues would be most important to them for remote collaborations. Top priorities, the scientists said, are having convenient and fast access to data and being able to spend time on-site. Other issues: having access to good meeting tools, such as Zoom, and having an on-site team that could help them when there is a problem.

Neilson said a lot of information, such as changes in meeting times or changes in status can get lost when collaborators are not present. “If you’re all on site working together there’s an enormous amount of information being transferred,” he said. “If you put 4,000 miles between you and rely on only emails, that information transfer goes down by an order of magnitude.”

Some of those problems could be solved by giving remote collaborators access to an online log book that would let them see what happened the day before or what is currently happening. Other problems might be solved by having task force leaders at the site who could improve communication between scientists at W7-X and those in the United States.

PPPL has the expertise to lead the remote collaboration effort, Neilson said. “There are some things we’re trying to implement that are equivalent to what we can already do,” Neilson said. “We’re just trying to do it better, faster, and more conveniently, and we’re trying to implement some brand new capabilities.”

Prospective students tour PPPL



Nat Fisch, director of the Princeton Program in Plasma Physics, standing, talks to students at a luncheon for prospective graduate students touring PPPL on April 8.

Lots of ways to go green during PPPL's Earth Week celebrations

There's still time to sign up for PPPL's annual grounds cleanup on April 19 at 10:30 a.m. Help keep PPPL green and enjoy a pizza lunch. [Please go here to sign up!](#)

Among many upcoming sustainable events celebrating Earth Week throughout April will be a lunchtime walk along the Delaware and Raritan Canal on April 26 at noon. Meet in the Lower Parking Lot at 11:45 a.m. [Sign up here.](#)

Audience members attending the Green Machine Awards on April 27 at 1 p.m. will see the short video "The Story of Stuff," and will receive succulent office plant giveaways. There will also be soft pretzels and "dirt cups" (chocolate pudding and gummy worms) desserts.

PPPL's Environmental Services Division has an [Earth Week website](#) with details about all the Earth Week events.

April 18 to 22: Celebrate Earth Week

- **Tuesday, April 19, 10:30 a.m.**—Meet in the LSB Lobby for the annual grounds cleanup.
- **Wednesday, April 20, 7:30 to 10 a.m.**—Unicor Home Electronics Collection, Lower Park Lot, [A list of acceptable items is available here.](#)
- **Wednesday, April 20, 4:15 p.m.**—Earth Week Colloquium, MBG Auditorium: Dale Jamieson, of New York University, discusses "Living with Climate Change: The Road from Paris."
- **Thursday, April 21, 10:30 a.m.**—Grounds cleanup rain date

April 22 to 26: The celebration continues

- **Tuesday, April 26 at 11:45**—Meet in Lower Parking Lot for the D&R Canal Walk. [Sign up here.](#)
- **April 27, 1 p.m., MBG Auditorium**—Green Machine Awards and video.



PPPL volunteers clean up on a beautiful spring day in 2014.

Join a PPPL bike team to compete in the Federal Bike Challenge next month

May brings flowers and sunshine and a chance for PPPL'ers to leave their cars at home and bike to work, to the grocery store, or anywhere else they can think of as PPPL once again joins the Federal Bike Challenge in honor of National Bike Month!



[You can register for a PPPL team here.](#) You will be assigned to one of four Bike Month Challenge teams and your team captain will contact you with registration information.

Then all you have to do is log your cycling miles during May for all your bike rides at home and to work.

There will be a breakfast meeting on May 3 for anyone who has registered or who wants more information. Stay tuned for more details.

PPPL's teams will compete with nearly 300 other federal facilities. Some 2,600 participants logged almost 280,000 miles in last year's Challenge. The 40 members of PPPL's five Bike Challenge teams finished in the top 20 percent of all teams, logging a total of 765 trips and 5,555 miles. Those bike trips avoided 4,889 pounds of carbon emissions. Bike team members also got fit, burning a total of 272,221 calories!

The new rider who logs the most miles will win a prize and there will be a celebration in early June to recognize the top riders and all the members of the PPPL team.



Some members of last year's PPPL Bike Challenge team take a lunchtime ride last year.

Robotics coaches needed for all-girls robotics teams

PPPL's Science Education team is looking for volunteer coaches for a new all-girls FIRST Lego League Robotics team (ages 9 to 13) and the new FIRST Tech Challenge Team (ages 13 to 18) being organized in collaboration with the YWCA-Princeton.

The teams will meet throughout the fall semester and there are lots of events throughout the spring and summer to engage everyone. The program welcomes volunteers with all kinds of skills. This includes not only those with engineering, robotics, and building skills, but also volunteers with the ability to mentor students and help build leadership, teamwork, research, and social engagement skills. Coaching the teams is a rewarding experience that is, as one of the teams' founders put it, "the hardest fun you'll ever have!"

**Please call Shannon Greco ASAP to volunteer:
sgreco@pppl.gov, 609-243-2208.**

Robotics at Princeton YWCA event honoring volunteers



PPPL's Atiba Brereton gives a Lego Mindstorm robot demonstration at a YWCA Princeton volunteer appreciation event on April 7. Brereton coached one of two all-girls robotics teams, which Shannon Greco helped establish. Greco also attended the luncheon. (Photo by Shannon Greco).

COLLOQUIUM

Living with Climate Change: The Road from Paris



Dr. Dale Jamieson
New York University

Wednesday, April 20
4:15 p.m., M.B.G Auditorium, Lyman Spitzer Building

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 April 18	Tuesday April 19	Wednesday April 20	Thursday April 21	Friday April 22
COMMAND PERFORMANCE Chef's Feature	Ota-Ya Sushi	Vegetable Tikka Masala over Rice with Naan	Chicken, Sausage, Potatoes, Peppers, Onions & Marsala Wine served with Garlic Breadstick	Carved Roasted Pork Loin served with Potato Salad and Corn on the Cob	LUNCH AND A MOVIE - "EAT, PRAY, LOVE" Rigatoni Bolognese served with Tomato Bruschetta & Tiramisu Dessert
Early Riser	Eggs Benedict with Avocado	Grilled Cheese with Ham & Egg	Chicken Cheesesteak Omelet with Home Fries	Cranberry-Walnut Pancakes	Sausage Gravy & Grits served with 2 Eggs Any Style
Country Kettle	Vegetable Barley	Chicken Rice	Lentil	White Bean Escarole	New England Clam Chowder
Grille Special	BURGERLICIOUS Use it or Blues it Buffalo Turkey Burger Grilled Turkey burger with melted bleu cheese crumbles, sliced celery, shredded lettuce, tomato, red onion and fiery buffalo sauce on a grilled brioche roll (Available All Week)	Bratwurst & Sauerkraut on a Torpedo with German Potato Salad	Tuna Melt on Rye with Swiss Cheese & Tomato	Chicken Breast on French Bread with Broccoli Rabe & Aged Provolone Cheese	Greek Gyro
Deli Special	Grilled Portobello Mushroom with Red Onion, Red Pepper & Provolone on Wheat Roll	Open-Faced Sloppy Joe	Peppered Ham & Muenster Cheese on Pumpernickel Bread	Curry Tuna Fish Salad on Sourdough Bread	Grilled Jerk Chicken with Grilled Pineapple, Peppers & Onion on a Kaiser Roll
Panini	Turkey, Ham, Salami, Pepperoni, Provolone, Cheddar & Banana Peppers on Sourdough	Seafood Salad Quesadilla with Cheddar & Avocado served with Corn Relish	Smoked Chicken Quesadilla with Peppers, Onions & Jack Cheese	Falafel on a Pita with Tzaziki Sauce	Chicken Sliders served with Macaroni Salad

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/>.