PPPL PRINCETON PLASMA PHYSICS LABORATORY
A Collaborative National Center for Fusion & Plasma Research
U.S. DEPARTMENT OF ENERGY
WEEKLY
September 18, 2017

THIS WEEK

WEDNESDAY, SEPT. 20

Colloquium
4:15 p.m. ◆ MBG Auditorium
The Interstellar Boundary Explorer (IBEX)
David McComas, Princeton University
Vice President for PPPL

UPCOMING

OCT. 23–NOV. 27

58th Annual Meeting of the APS Division of Plasma Physics
Milwaukee, Wisconsin

INSIDE

Former PPPL physicist Frank Cheng wins 2017 S. Chandrasekhar Prize

By John Greenwald

C.Z. "Frank" Cheng, a distinguished long-time former physicist at PPPL, has been named a recipient of the 2017 S. Chandrasekhar Prize of Plasma Physics. Cheng served as a PPPL staff member from 1975 to 2005, then directed the Plasma and Space Science Center at the National Cheng Kung University in Taiwan from 2006 to 2014. He currently is a Distinguished Research Fellow in the Physics Department at Lehigh University and a Visiting Chair professor at National Cheng Kung University.

C.Z. "Frank" Cheng *(Photo courtesy of National Cheng Kung University)*

The award, from the Division of Plasma Physics of the Association of Asia-Pacific Physical Societies, is named for Subrahmanyan Chandrasekhar, an Indian-American astrophysicist who received the Nobel Prize in 1983. As a 58-year member of the physics department at the University of Chicago, Chandrasekhar advised the 1954 doctoral thesis of Russell Kulsrud, now a professor emeritus of astronomical sciences at Princeton University.

Cheng cited his career at PPPL in discussing the award. "I am very much honored to receive this prize, in particular for the work on fusion and space plasmas that I did at PPPL," he said. "I greatly appreciate the excellent research opportunity with many outstanding PPPL scientists. I am pleased that we were able to achieve many seminal and fundamental scientific results. It was the most scientifically challenging and intellectually rewarding period of my research career."

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External Cost & Schedule review is crucial step before PPPL submits NSTX-U corrective action plans to Department of Energy

By Jeanne Jackson DeVoe

PPPL has completed a crucial review of cost and schedule for the National Spherical Torus Experiment-Upgrade (NSTX-U) Recovery Project. The review caps a year-long effort to analyze each NSTX-U system and to prepare a detailed corrective action plan that will enable the Recovery Project to move forward with the fabrication of new magnets and other improvements.

A committee of experts convened for a three-day cost and schedule review at PPPL Sept. 6 to 8 and generally gave high marks to the Recovery Team's plans to construct six new magnets and address other technical issues on the NSTX-U. However, the reviewers found the plans do not sufficiently take into account the cost and schedule consequences of recommendations by a separate Extent of Cause committee aimed at bolstering PPPL's policies and procedures.

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Work on Lyman Spitzer Building Annex wrapping up as IOI project continues

Work on the Lyman Spitzer Building Annex is reaching the final stages as workers finish painting walls, install carpeting, and install lights in the ceiling. Business Operations staff, now located in temporary trailers, as well as PPPL'ers now located in the Mod 6 trailer, could move in after work is completed this fall, according to Les Hill, the head of the IOI project. The Mod 6 trailer would then be demolished.

Contractors have installed heating, ventilation, and air conditioning (HVAC) systems in the Annex and new furniture will be installed when all of the construction work is completed. The architectural design called for the extensive use of glass partitions to allow for natural sunlight through all the office spaces. The 2nd and 3rd floors have "huddle rooms" and the first floor has a conference room. The LSB work includes the replacement of the HVAC system in the Annex basement, which is nearing completion.

Meanwhile, work is continuing in the C Site-Motor Generator (MG) Building, where workers are upgrading fire protection systems and installing a new HVAC system. The replacement of the roof, a chronic source of rainwater infiltration into the building, is nearing completion. Workers are also installing insulated walls. The heavily insulated walls and roof, along with the LED lighting system that has been installed, are important design features for improving energy efficiency long after construction is complete.

Work on the MG Building is expected to be substantially complete by the end of the year. The IOI project team is working on detailed plans for moving the fabrication and machine tools from RESA into the renovated MG Building.

Walls are going up in the C Site-MG Building.
(Photo by Elle Starkman)

The third floor of the LSB Annex.
(Photo by Elle Starkman)

Walls on the second floor of the LSB Annex.
(Photo by Elle Starkman)

A new stairway in the C Site-MG Building.
(Photo by Elle Starkman)

Help solve the case of the disappearing flatware

Please return any forks, knives, and spoons you have in your office or work area to the cafeteria and put the utensils in the proper container in the cafeteria. Thank you!

Team led by graduate student at PPPL produces unique simulation of magnetic reconnection

By John Greenwald

Jonathan Ng, a Princeton University graduate student at PPPL, has for the first time applied a fluid simulation to the space plasma process behind solar flares and space storms. The model could lead to improved forecasts of space weather that can shut down cell phone service and damage power grids, as well as to better understanding of the hot, charged plasma gas that fuels fusion reactions.

The new simulation captures the physics of magnetic reconnection, the breaking apart and snapping together of the magnetic field lines in plasma that occurs throughout the universe. The simulations approximate kinetic effects in a fluid code, which treats plasma as a flowing liquid, to create a more detailed picture of the reconnection process.

Previous simulations used fluid codes to produce simplified descriptions of reconnection that takes place in the vastness of space, where widely separated plasma particles rarely collide. However, this collisionless environment gives rise to kinetic effects on plasma behavior that fluid models cannot normally capture.

Jonathan Ng and Ammar Hakim
(Photo by Elle Starkman)

Estimation of kinetic behavior

The new simulation estimates kinetic behavior. "This is the first application of this particular fluid model in studying reconnection physics in space plasmas," said Ng, lead author of the findings reported in August in the journal *Physics of Plasmas*.

Ng and coauthors approximated kinetic effects with a series of fluid equations based on plasma density, momentum and pressure. They concluded the process through a mathematical technique called "closure" that enabled them to describe the kinetic mixing of particles from non-local, or large-scale, regions. The type of closure involved was originally developed by PPPL physicist Greg Hammett and the late Rip Perkins in the context of fusion plasmas, making its application to the space plasma environment an example of fruitful cross-fertilization.

The completed results agreed better with kinetic models as compared with simulations produced by traditional fluid codes. The new simulations could extend understanding of reconnection to whole regions of space such as the magnetosphere, the magnetic field that surrounds the Earth, and provide a more comprehensive view of the universal process.

Coauthoring the paper were physicists Ammar Hakim of PPPL and Amitava Bhattacharjee, head of the Theory Department at PPPL and a professor of astrophysical sciences at Princeton University, together with physicists Adam Stanier and William Daughton of Los Alamos National Laboratory. Support for this work comes from the DOE Office of Science, the National Science Foundation and NASA. Computation was performed at the National Energy Research Scientific Computer Center, a DOE Office of Science User Facility, and the University of New Hampshire.

Northern lights illuminating the sky *(Photo courtesy of NASA)*

Frank Cheng award

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Cheng made important contributions in both fusion and space plasma physics. He initially worked as a post-doc along with Wei-li Lee, also a post-doc at the time and now a senior scientist, simulating micro-instabilities in tokamak plasmas. He went on to achievements that included theoretical discovery of a major type of Alvén wave instability, and invention of a widely used method for solving Vlasov-Maxwell equations that describe the dynamics of plasmas. Among the computer codes he developed was the international standard for calculating the stability of a type of Alfvén wave in tokamaks and a program for modeling data from the magnetosphere, the magnetic field that surrounds the Earth.

PPPL physicists recognized Cheng for his reception of new ideas. "I learned from him to be open-minded but nevertheless persistent in making my own point," said Nikolai Gorelenkov. As a visiting researcher from Russia in 1993 and 1995, Gorelenkov worked closely with Cheng, who headed the theoretical group on energetic particles at the time. "His interests were broad," recalled Gorelenkov, who joined PPPL in 1999. "Cheng organized the group in the Theory Department that studies the magnetosphere."

On leaving PPPL, Cheng established experimental capabilities in space physics instrumentation and basic laboratory plasma experiments at the Plasma and Space Center at the National Cheng Kung University. The center has conducted many international experiments and attracted a wide range of students.

The Chandrasekhar Prize will be presented the week of Sept. 18 during the first Asia-Pacific Conference on Plasma Physics in Chengdu, Sichuan, China. Also receiving a Chandrasekhar prize at the conference will be physicist Lou-Chuang Lee, a pioneer in space plasma physics at the Academia Sinica in Taiwan.

PPPL hosts ITPA meeting on the physics of energetic particles

Physicists tackled topics ranging from the development of fast-ion detectors for ITER to joint experiments on energetic particles during the 19th annual meeting of the Energetic Particle Physics Topical Group of the International Tokamak Physics Activity (ITPA), which PPPL hosted Sept. 11-12. The meeting, attended by 34 scientists from around the world, was part of ITPA activities designed to provide a framework for internationally coordinated research relevant to the design and operation of ITER and fusion energy in general.

The PPPL sessions focused on energetic alpha particles—or helium nuclei—that fusion reactions create; these will provide the main heating power for ITER. Members of the topical group are conducting experiments and producing theoretical knowledge that will enable recommendations to ITER in a number of areas. Among these are the impact of energetic particle instabilities on plasma heating and first-wall material; neutral beam injection heating and current drive; and runaway electrons. Results of experiments organized at the meeting will be used to optimize the performance of ITER and other future fusion reactors.

Members of the 19th annual meeting of the Energetic Particle Physics Topical Group of the International Tokamak Physics Activity (ITPA). Physicist Eric Fredrickson, third from right, chaired local organizing with assistance from physicist Mario Podesta, first on left. *(Photo by Raphael Rosen)*

Cost & Schedule review

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The Cost & Schedule Review was part of an Extent of Condition review addressing any potential gaps in NSTX-U's technology that could fail when the machine reaches full physics and engineering parameters. The Recovery Project began work after a failed magnet caused the shutdown of the device in July of 2016. PPPL is required to submit a corrective plan to the U.S. Department of Energy by the end of this month detailing how the Recovery team will address both the hardware issues (the Extent of Condition) and underlying policies and procedures (the Extent of Cause).

Rich Hawryluk, PPPL's new interim director, who headed the Recovery Project for the past year, said the final cost and schedule estimates will be made available to the Laboratory when they are complete. "This was a pivotal step," Hawryluk said. "We now have a good understanding of what's required to go forward."

Charles Neumeyer, head of engineering for the Recovery Project, said he views the review team's feedback as largely positive. "Overall, I'm pleased with the result," he said. "I think the committee provided some valuable guidance and I'm grateful to our team for working so hard to pull it together."

Bob Iotti, the Cost & Review chair, left, and Ruben Fair, of Jefferson National Laboratory listen to a presentation. *(Photo by Elle Starkman)*

The last piece of puzzle

Hawryluk said completing the cost and schedule will allow the next phase of the Recovery Project to begin. "This is the last piece of the puzzle that we need to move forward," Hawryluk told the reviewers. "I know this is a big effort on your part. It has been a big effort on our part to get to this stage."

The Recovery Project plans call for three industrial suppliers to fabricate prototype magnets to qualify themselves to manufacture the production magnets that will replace the existing set of six inner poloidal field (PF) coils. The production coils will replace not only the failed magnet, PF1-A upper, located near the top of the center stack but also its twin, the PF 1-A lower magnet, along with two sets of magnets that were manufactured similarly and are considered unreliable: the PF1-B coils and the PF1-C coils. These new coils are among several improvements deemed essential to making the NSTX-U operate reliably.

Neumeyer said plans are all aimed at the original goals for the NSTX-U to double the magnetic field strength and plasma current and quintuple the length of plasma pulses. "We will have the capability to deliver the original performance defined for the NSTX-U project," he said.

A draft report by the Cost and Schedule Committee, which was made up of mostly external reviewers headed by Bob Iotti, the former chair of the ITER Council, said it "highly commends" the approach used by the Recovery Team in developing the cost estimates. It also singled out the "very rigorous process" analyzing each system of the NSTX-U in the design, verification and validation reviews (DVVRs). The team said the process "provides high confidence that the scope of the work is unlikely to miss important elements."

Valeria Riccardo, head of engineering, gives a presentation to the committee. To her left are Dennis Youchison and Steve Hartman, of Oak Ridge National Laboratory. *(Photo by Elle Starkman)*

The review team praised the Recovery project team saying that it "is technically strong and has done a very good job understanding the technical basis of systems and infrastructure at PPPL." The review team also praised the collaboration of physicists and design engineers in preparing a feasible engineering design for the NSTX-U that can still meet the appropriate physics requirements.

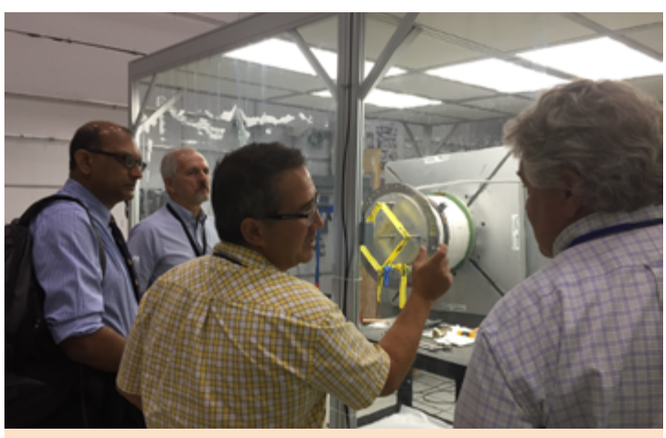
Integrating Extent of Cause

However, the report stated that the cost and schedule did not integrate the Extent of Cause recommendations in the areas of quality assurance, engineering design, procurement, documentation, and fabrication oversight, among others. The Extent of Cause recommendations, not yet finalized, are anticipated to require a graded approach that aligns the design review process with the risk to the project if a given system or component fails.

The review team said implementing the recommendations could affect the schedule. For example, the Extent of Cause review team recommended new procedures for engineering design reviews that would likely change how the Recovery Team conducts design reviews. Valeria Riccardo, PPPL's head of engineering, is rewriting those procedures.

The review team also stated that the schedule should be more detailed and should include each step of the process that will be used first to fabricate prototype coils and then to fabricate the coils.

Neumeyer said the Recovery Team has tried to anticipate some of those requirements. For example, the Recovery Project has already instituted increased requirements for PPPL quality assurance staff and engineers to be on site when the magnets are fabricated both at PPPL and offsite.



Members of the committee Ruben Fair, second from left, and Wayne Reiersen, US ITER, tour PPPL's coil winding facility with Steve Raftopoulos, center, and Larry Dudek, far left. *(Photo by Jeanne Jackson DeVoe)*

COLLOQUIUM

The Interstellar Boundary Explorer (IBEX)

David McComas
Princeton University Vice President for PPPL

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

BROCK

NICK PETTI
Chef Manager

Café at PPPL

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 Sept. 18	Tuesday Sept. 19	Wednesday Sept. 20	Thursday Sept. 21	Friday Sept. 22
COMMAND PERFORMANCE **Chef's Feature**	**Beef and Bean Burrito** with Yellow Rice	**Buffalo Chicken Mac and Cheese**	**Jerk-seasoned Pork Chops** with Pineapple Rice and Mango Salsa	**Flatbread Pizza** with Tossed Salad	**Bourbon Chicken** over Rice
Early Riser	**Blueberry Pancakes**	**Fried Bologna and Egg Sandwich**	**Tater Tot Breakfast Bake**	**Ham, Egg & Cheese French Toast**	**Bacon, Spinach & Mozzarella Quesadilla** with Cilantro Cream
Country Kettle	**Chef's Choice**	**Chef's Choice**	**Chef's Choice**	**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	**Cheddar & Bacon-Wrapped Hot Dog**	**Chorizo Quesadilla**	**Grilled Fish Cake Sandwich**	**Grilled Margherita Sandwich**	**Pepperoni Roll**
Panini	**Cheddar Crab Melt**	**Chicken Breast,** Mozzarella, Spinach and Tomato Pesto on Ciabatta Bread	**Hot Roast Beef** with Cheese and Horseradish Jus	**Corned Beef Reuben Sliders**	**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

WEEKLY

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