

Hotline

The Princeton Plasma Physics Laboratory is a United States Department of Energy Facility

NSTX Construction Marks Milestones

Assembly of National Spherical Torus Experiment to Begin in September



PPPL's Joe Bartzak guides the world's tallest ohmic-heating solenoid as it is lowered over the inner toroidal field coils of NSTX.

By Anthony De Meo

The delivery of the National Spherical Torus Experiment (NSTX) ohmic-heating (OH) solenoid on June 30 and its mating with the inner toroidal-field (TF) bundle on July 8 marked major milestones in the assembly of NSTX. According to Project Director Masa Ono, "The OH coil presented the most difficult and critical NSTX design and fabrication challenges, requiring a great deal of innovation. We are pleased that NSTX is the first spherical torus in its class to have successfully completed its OH assembly."

Fourteen feet in height, the NSTX OH solenoid is the tallest in the world. It will play a crucial role in the creation of the NSTX plasma, the generation of the plasma current, and the formation of the device's unique magnetic field geometry. NSTX will also have TF coils and poloidal-field (PF) coils, which play major roles in the creation of the magnetic fields that confine, stabilize, and shape the plasma.

NSTX is a compact machine, designed to produce a plasma resembling a sphere with a small hole running all the way through its middle. Consequently, the NSTX center column must have the smallest diameter possible. NSTX engineers successfully designed a uniquely thin (13-

Continued on page 8

Rutherford Honored for Career Contributions

Paul Rutherford, former Associate Director for Research at PPPL, is a recipient of the 1998 Distinguished Career Award from Fusion Power Associates (FPA).

The award recognizes Rutherford's many outstanding technical and leadership contributions to fusion energy development throughout his career. It further notes that in addition to his many seminal contributions to fusion theory, he has provided "insight and leadership on the key issues of



Paul Rutherford

fusion energy development and has provided a continuing link between plasma theory and engineering applications."

Rutherford received the citation on June 3 in Washington, D.C., during the FPA annual meeting. The awards are given annually to individuals who have made distinguished career contributions to fusion development. Rutherford said, "I am greatly honored by this award, particularly since it recognizes my efforts toward inte-

Continued on page 3

Menard Wins American Nuclear Society Award



Professor Gerald Kulcinski (left) of the University of Wisconsin presents PPPL's Jon Menard with the American Nuclear Society's FED citation for "Best Student Paper."

In recognition of his significant technical contribution in the area of fusion science and engineering, PPPL's Jon Menard garnered the "Best Student Paper" Award from the American Nuclear Society (ANS) Fusion Energy Division (FED) last month.

Menard, who is at PPPL through a postdoctoral research appointment, received the ANS FED Certificate of Accomplishment and a cash award during the 13th Topical Meeting on the Technology of Fusion Energy in Nashville.

The purpose of the Student Award is to recognize significant research accomplishment by a student in the area of fusion science and engineering. Selection is based on a letter of nomination and a journal quality paper resulting from the student's research. PPPL Deputy Head of Theory Steve Jardin nominated Menard for the latter's paper entitled, "Ideal MHD Stability Limits of Low

Aspect Ratio Tokamak Plasmas," which was published in *Nuclear Fusion*.

Jardin, Menard's thesis co-advisor, said, "It is very gratifying to see Jon recognized in this way. The paper that won him the award was not only an excellent piece of scholarship, but has done much to lay the physics foundation for NSTX [National Spherical Torus Experiment] and the next generation of spherical tokamaks. It is people like Jon who give us confidence that today's students will be capable of leading the quest towards the practical realization of fusion energy."

"It is very gratifying to see Jon recognized in this way. The paper that won him the award was not only an excellent piece of scholarship, but has done much to lay the physics foundation for NSTX and the next generation of spherical tokamaks."

—Steve Jardin

Menard came to PPPL in 1992 as a Princeton University graduate student in plasma physics after receiving a bachelor's degree in nuclear engineering from the University of Wisconsin at Madison. Last month, he received a Ph.D. in plasma physics from Princeton. He is presently involved in studying high-harmonic fast wave heating physics and MHD stability issues for the NSTX and the Current Drive Experiment-Upgrade. Among his honors, Menard received the Princeton University Honorific Fellowship in 1996 and the U.S. Department of Energy Magnetic Fusion Science Fellowship in 1993. ●

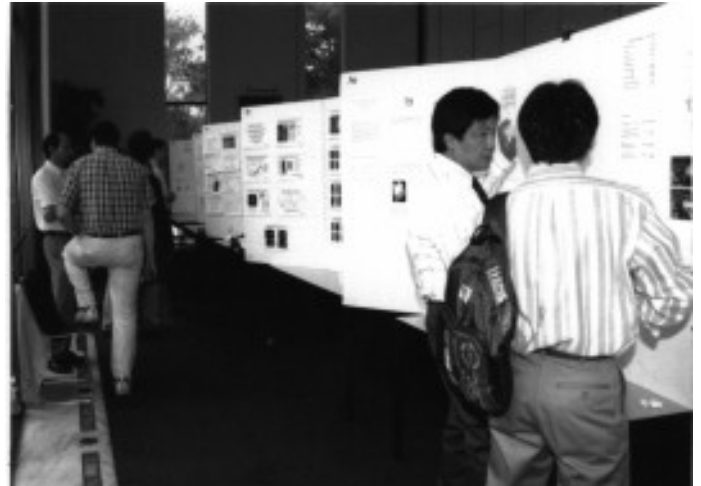
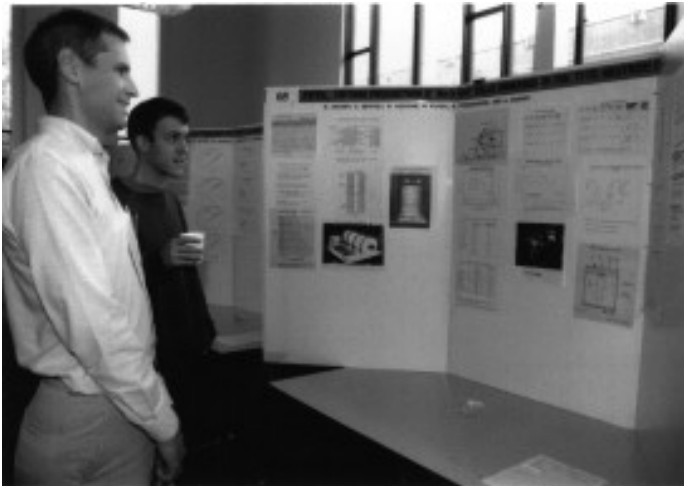
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High Temperature Plasma Diagnostics Conference Attracts Researchers from Around the World



The 12th Topical Conference on High Temperature Plasma Diagnostics at Princeton University drew 250 participants — including a record 45 undergraduate and graduate students — from 18 countries. PPPL's Bob Kaita and Dave Johnson, along with James Knauer, of the University of Rochester, served as co-chairs of the four-day conference in June. The meeting, held at the Woodrow Wilson School and McCosh Hall, is a major international event, and this one was among the best attended in the series. There were presentations by plasma physicists and

engineers in a wide variety of areas, including magnetic fusion, inertial confinement fusion, plasma processing, and space plasma physics. The papers will be archived in a special issue of the *Review of Scientific Instruments* this January. Above is one of the seven sessions of contributed posters in Richardson Hall at the Woodrow Wilson School. At left, PPPL research physicist Douglas Darrow (left) and Princeton graduate student Tobin Munsat review a poster from a PPPL team. At right, conference participants discuss other posters displayed. ●

Rutherford

Continued from page 1

grating fusion science and technology through international pooling of resources.”

Rutherford, who joined the staff of PPPL in 1965, served as Head of the Theoretical Division from 1974 to 1980 and Associate Director for Research from 1980 to 1995 before retiring. Since 1992, he has served as Chair of the International Thermonuclear Experimental Reactor (ITER) Technical Advisory Committee, which provides advice to the ITER Council on all technical aspects of the ITER design and associated research and development program. He served on the predecessor committee during the ITER Conceptual Design Activities.

Rutherford received a bachelor's and a Ph.D. in theoretical physics from Cambridge University. In addition to his duties at PPPL, he served as lecturer with the rank of professor at Princeton University's Department of Astrophysical Sciences and co-taught, with present PPPL

Director Rob Goldston, an undergraduate course in plasma physics. This course formed the basis for a textbook, “Introduction to Plasma Physics,” co-authored with Goldston and published in 1995.

Goldston said, “Paul Rutherford's recognition as an international scientific leader comes of course in large measure from his great skill at scientific analysis, but it comes equally from his ability to motivate groups of people with disparate interests to work together very effectively, and from his clear and constant dedication to the success of fusion. Paul always sees the best in people, and encourages them to live up to what he sees. He most certainly deserves this award many times over.”

Rutherford, the author of more than 80 research papers, received the Department of Energy's coveted E.O. Lawrence Award in 1983 for his contributions to the toroidal reactor concept. His research interests have included a variety of topics in tokamak theory, especially resistive instabilities and processes of anomalous cross-field transport. ●

PPPL Honors Inventors at Annual Patent Dinner

The Laboratory honored twenty-two inventors for Fiscal Year 1997 during the sixteenth annual Patent Recognition Dinner on June 16 at Princeton University's Prospect House. Patent Committee member Lewis Meixler delivered remarks at the dinner, and PPPL Director Rob Goldston presented the awards to the honorees. Congratulations, inventors!

Committee on Inventions

The Committee on Inventions includes Peter Bonanos, C.Z. Cheng, Sam Cohen, Phil Efthimion, Terry Greenberg, Rich Hawryluk, Steve Jardin, Henry Kugel, Lewis Meixler, Carol Phillips, Ken Young, and Stewart Zweben. ●



The inventors at the dinner included (from left) Don Weissenburger, Joseph Cecchi, Charles Skinner, Nathaniel Fisch, Robert Woolley, Samuel Cohen, Gennady Shvets, Tobin Munsat, Jan Wioncek, Enoch Durbin, Szymon Suckewer, and Hironori Takahashi.

Patents Issued in Fiscal Year 1997

Apparatus and Process for Producing High Density Axially Extended Plasmas

Joseph Cecchi and James Stevens

Patents Applied for in Fiscal Year 1997

Traveling Spark Ignition (TSI) System

Szymon Suckewer and Enoch Durbin

Inventions Disclosed in Fiscal Year 1997

Spectroscopic Method to Measure Electric Fields in a Plasma

Michael Zarnstorff

Non-Optical Imaging and Structure Determination of Random Variable Targets

Raffi Nazikian

The Conducting Shell Stellarator

George Sheffield

Live Parallels

*John DeSandro, Jan Wioncek,
Joseph Vannozzi, and William Zimmer*

Magnetic Field Sensors Using Thick Film Printed Circuit Technology

Hironori Takahashi

Efficient Tritium Removal by Heating with Continuous Wave Lasers

Charles Skinner

Magnetic Nozzle to Promote Plasma Recombination

Samuel Cohen, Jaeyoung Park, and Tobin Munsat

Pulse Shaping in Short-Pulse FEL Oscillators Using Multiple Resonators

Gennady Shvets and Jonathan Wurtele

A Molecular Sieve Binder for Tritiated Water Which Prevents Hydrogen Gas Formation

R. Thomas Walters

Spark Version 2.0

Donald Weissenburger and James Bialek

Thick Flowing Liquid Lithium First Wall for Toroidal Magnetic Confinement DT Fusion Reactors

Robert Woolley

Method to Produce Electrical Power Within the Lithium Blanket Region of a Magnetically Confined DT Fusion Reactor

Robert Woolley

PPPL Garneres Best Poster Design Award

PPPL garnered the “Best Poster Design” Award last month during the U.S. Department of Energy (DOE) Pollution Prevention Conference XIV in Seattle. The Lab was one of two awarded out of forty-three DOE laboratories and contractors who submitted posters in two categories. The categories included Best Poster Design and Most Innovative Pollution Prevention Solution.

“Not only did Margaret King and Tom McGeachen do a great job organizing the pollution prevention awareness events, but they also submitted a winning poster! I was very impressed with their enthusiasm and effort, which made the entire event a success,” said PPPL Deputy Director Richard Hawryluk.

The winning PPPL poster was a 4-foot by 6-foot collage and display table depicting the Lab’s pollution prevention awareness efforts during Earth Week. The activities included a lecture series, a poster contest for area students, and activities for 125 visiting students.

The winning collage featured images of the students’ posters, as well as photos of the young visitors at the Lab, guest speakers, and Lobby exhibits. King, Buildings and Grounds Supervisor, and McGeachen, Pollution Prevention Waste Minimization Coordinator, jointly organized the pollution prevention awareness events in April and then designed and assembled the collage. PPPL’s Environmental Restoration/Waste Management and Maintenance and Operations groups assisted them in both efforts. King and McGeachen accepted the award on behalf of the Lab. Said King, “I was excited when we won the award for best poster design. I truly believe that the focus

on children’s involvement, and educating our children about science and the environment were keys to PPPL winning this award. Thanks go to the volunteers, the Science Education Program, the Director’s Advisory Committee on Women, and all those who supported and played a role in the 1998 Earth Week events at PPPL,” said King.

Added McGeachen, “It took several hours to compile all the materials and come up with a design, and then a couple of additional hours assembling the collage and display at the conference. We appreciate all the help we received from the Lab personnel, especially from PPPL’s photographer, Elle Starkman, who provided most of the photos for the collage.”

The winning entry created by McGeachen and King will temporarily be displayed in the Lobby this summer. In addition, the design citation is on the awards wall near the reception area of the Lobby.

The annual DOE conference, this year titled, “Return on Innovation: Investing in our Future,” brings industry, military, and pollution prevention experts together to exchange information on innovative pollution prevention achievements.

McGeachen said of the conference, “I benefited from the technical and plenary sessions, the poster displays and exhibits, and the opportunity to share PPPL’s pollution prevention and waste minimization and recycling efforts with our DOE colleagues. The keynote speakers were excellent, providing new concepts and ideas to apply at the Lab.”

Innovative and Inspiring

King described the conference as “innovative and inspiring.”

“The message brought forth by all the speakers touched the very core of why we should be concerned about our environment. Pollution destroys human life and creates a mastery of affliction on nature. It should be our mission to prevent pollution at all levels,” she explained.

She added that both individuals and teams should set goals for a cleaner environment. “We have to invest in our future. Pollution prevention should not be looked on as another government policy or mandate, it should be treated as a means to reduce cost, reduce waste, and reuse our resources. After all, the forest replenishes itself with no cost at all. All of us must take responsibility for how we treat our planet Earth. When we start to realize that we need it to sustain life, then we can begin to respect and understand the importance of our Earth,” King added. ●



Staff present the Lab’s “Best Poster Design” Award to Deputy Director Rich Hawryluk. From left are J.W. Anderson, Carl Potensky, Hawryluk, Margaret King, Tom McGeachen, and Scott Larson.

Maintenance and Operations Group Celebrates Two Years without a Lost-Time Accident



On May 22, the Maintenance and Operations staff celebrated a milestone — two years without a lost time accident. The occasion was marked with an outdoor barbecue for the entire group, organized by the electrical shop. PPPL Director Rob Goldston, Deputy Director Rich Hawryluk, and Environmental, Safety, and Health and Infrastructure Support Head J.W. Anderson congratulated the group and noted that the office consolidation and the NSTX Groundbreaking and Spitzer Building Dedication projects were completed without any accidents. In the photo at right, Goldston (right) presents a commemorative plaque to Maintenance and Operations Manager Rich Gallagher. In the photo at left are the staff honored for their efforts. Congratulations for a SAFE job well done!

FIRST Teams Honored by State Assembly

PPPL Team is Among Those Recognized

At ceremonies marked by a robot roaming the halls of the State House, the New Jersey State Assembly passed a resolution honoring the 20 New Jersey teams — including the PPPL-Hopewell Valley Central High School team — that participated in the 1998 FIRST Competition.

FIRST — For Inspiration and Recognition of Science and Technology — is a national engineering contest that immerses high school students in the world of engineering. This is the second year the Lab's Science Education Program sponsored the PPPL/Hopewell Valley team.

Through FIRST, a group of high school students teams up with staff from an area business or university to create a robot for a competition. This year, students and teachers from Hopewell Valley Central High School and a few PPPL engineers, including Bill Blanchard, created "Spike," a robot they took to Rutgers University to participate in the Johnson & Johnson Mid-Atlantic Regional FIRST competition. Blanchard spent more than 100 hours this winter working with the students to design, construct, and test their robot, giving the teens an inside look at the engineering profession. ●

Teachers Come to PPPL



In June, PPPL hosted the A+ for Kids Teacher Network's "Science, Mathematics, and Technology Institute" for 35 area teachers. Middle school teachers worked with trainers to create a comprehensive water quality program to use with their students, as well as to incorporate environmental and pollution information into their curriculum. High school teachers explored biology and chemistry concepts using the TI-83 graphics calculator and the calculator-based laboratory system. ●

Spreading the Fusion Word through Community Outreach

Photo by James Morgan



Two area teachers conduct experiments with magnets during a workshop, "Magnetism," this spring hosted by the Lab's Science Education Program. The workshop, one of three held recently at the Ben Franklin Elementary School in Lawrenceville, is part of PPPL's "Science Over Supper" series in which area teachers team up with PPPL scientists to explore the science concepts they teach in their classes. The workshop was led by PPPL's Andrew Post Zwicker.

Photo by Dianne Nunes



PPPL's James Morgan demonstrates the electromagnetic arm wrestling machine to a visitor at Future Fest in May in Washington, D.C. PPPL participated in the annual outdoor street festival, which included science and education displays.

Photo by James Morgan



PPPL Science Education Program Head Diane Carroll (left) watches as Gov. Christie Whitman takes on the electromagnetic arm wrestling machine during a science and technology conference at Princeton University's Center for Photonics and Optoelectronics Materials. PPPL joined other local educational and business institutions in offering exhibits at the June conference. In addition to Carroll, PPPL's John DeLooper, James Morgan, and Andrew Post Zwicker gave hands-on science demonstrations and distributed information about the Laboratory during the event.

Photo by James Morgan



PPPL's Dianne Nunes demonstrates a plasma ball at the Future Fest. Other PPPL staff at the event included Dianne Carroll, John DeLooper, James Morgan, and Chris Ritter.

NSTX

Continued from page 1

inch diameter) center column, enclosing the OH solenoid. The inner legs of the TF coils run vertically through the solenoid.

Though they must be thin and assembled without a large, massive support structure, NSTX's OH and inner TF coils will have to withstand high stress generated by the 7-tesla OH magnetic field. To achieve the required strength, the NSTX solenoid winding consists of the longest, continuous water-cooled copper conductor of any magnetic fusion device. Special insulation material was also required. To fit together properly, both the OH solenoid winding and the inner legs of the TF coils were manufactured with a radial accuracy of less than a hundredth of an inch, maintained over the entire height of the center column.

Challenges Successfully Met

These challenges were successfully met by the OH solenoid design team, led by John Citrolo, and the manufacturing team, led by Jim Chrzanowski. Fabrication of both the OH solenoid and the TF coils was performed by Everson Electric Company of Bethlehem, Pennsylvania. The PF coils were manufactured by Magnetic Enterprises International of Oakland, California. On July 8, the OH solenoid was slipped over the inner leg of TF coils to form the NSTX center column.

The second half of 1998 will be a busy time for NSTX staff. Within a three-month period beginning in September, major machine components will be assembled on the support structure in the Test Cell. The vacuum vessel, which is being fabricated by Process Systems International of Massachusetts, will be delivered in August. It will reside in the RESA building for about six weeks of preparation, including the attachment of the four smallest PF coils. The larger PF coils will be attached to the vacuum vessel after it arrives in the Test Cell.

In early September, the center column will be brought to the Test Cell where it will be prepped for about one



At top is the OH solenoid supported by a bridge crane in the RESA Building as it is slowly lowered over the inner legs of the TF coils. Above are (from left) PPPL visitor Nobuhiro Nishino, of Hiroshima University; NSTX Project Director Masayuki Ono; Everson Electric Company Vice President Greg Naumovisch; NSTX Program Manager Martin Peng; and PPPL's Jim Chrzanowski. Above right, PPPL's Joe Bartzak assists as the OH coil is lowered over the center stack TF coil bundle.



month prior to its attachment to the vacuum vessel. In TFTR and other tokamaks, the vacuum chambers are separate from the center columns. To save space, the outer surface of the NSTX center stack will serve as the inner wall of the vacuum vessel. Preparation of the center column will therefore include the attachment of protective carbon tiles and various diagnostic sensors.

By early November, the center column will be inserted into the center hole of the vacuum vessel. Following the installation of the remaining PF coils, the outer sections of NSTX's 12 TF coils will be attached to their inner legs.

Researchers expect that the entire NSTX device will be assembled before the end of December. Integrated systems testing will follow in January, 1999. Subsystems will be tested individually and then linked together and tested again in a building block process, until the entire NSTX device is tested at first plasma.

"The plan is aggressive. If all goes well, we could beat our schedule which calls for first plasma in April, 1999," noted Dr. Ono. ●

