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PPPL NEWS

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Menard Named NSTX Program Director

As the new Program Director for the National Spherical Torus Experiment (NSTX), Jon Menard is now spending the majority of his time helping to define the scientific research program for NSTX. Menard replaces ORNL's Martin Peng, who is taking broader responsibility for the coordination of U.S. and international spherical torus (ST) activities.

In his new post, Menard works closely with NSTX Project Director Masa Ono and with PPPL's Stan Kaye, who has been newly appointed as the NSTX Deputy Program Director.

"Martin [Peng] left big shoes to be filled, and Stan and I are sharing the tasks," said Menard, whose experience has been primarily as an NSTX physicist with research interests focusing on stability properties of ST plasmas, advanced operating scenarios in the ST, plasma startup, and plasma wave physics.

Ono's role as Project Director will remain working with engineers, technicians, and the national team of physicists to implement the facility capabilities and diagnostics that make the research program possible. "Clearly, the Program and Project Directors must work very closely together for NSTX to remain successful," Menard noted.

Jon Menard

His first task is to organize the five-year plan for NSTX, covering FY09 through FY13. "It's been an ongoing process beginning in early 2007, and we are focusing on how research on NSTX can contribute strongly to both ITER and future STs," he said. "We are also preparing to participate

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Lab Notes Creative Spirit at Annual Dinner for Inventors

Photo by Frank Wojciechowski

Inventors at the Patent Dinner are, from left, Eliot Feibush, Dick Majeski, John DeSandro, David Cylinder, Kenny Silber, Dana Mastrovito, Mike Zarnstorff, Charlie Gentile, David Gates, and Steve Langish.

They began as ideas — things that would have significance to stellarators and tokamaks, and for national security. Through creativity and development, they became inventions. On June 21 at the Patent Recognition Dinner, the Laboratory honored those responsible — 27 inventors — for inventions at PPPL during Fiscal Year 2006. The dinner was at Princeton University's Prospect House.

PPPL Tech Transfer Head Lewis Meixler, who served as master of ceremonies, thanked the inventors "for their ideas and inventions."

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Menard

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in a planning workshop with DIII-D and Alcator C-MOD in September. One desired outcome of this workshop is to find ways to better coordinate research among the three machines in order to make the U.S. fusion research program even more effective."

Beyond these responsibilities, his job entails working with the NSTX team to define research objectives and milestones, organizing meetings with the NSTX Program Advisory Committee, and interacting with DOE to report research progress and highlights.

"Jon brings a very broad understanding of toroidal physics, including ST's, tokamaks, and in particular ITER, so I have great confidence that under his leadership the NSTX program will make critically important contributions to the development of fusion science," said PPPL Director Rob Goldston. "Jon has also been central in developing the preliminary concept for a future long-pulse high-power fusion research facility [NHTX] at PPPL, so he will bring a strong understanding of how NSTX can contribute in that area."

Amid organizing the NSTX research program and analyzing experimental results from the last run campaign, Menard is also working on physics design activities for the proposed National High-power Advanced Torus Experiment (NHTX), and in particular on how NSTX research can support the R&D needs for next-step ST devices. "It's a lot of planning and thinking things through, especially in an environment where limited resources greatly have an impact on how much you can do," he said.

Menard described his new job as "a challenge I look forward to. I've worked with many members of the NSTX team from the research side, and last year represented the NSTX team at IAEA in China summarizing our research results. I really enjoy doing research, but I also increasingly appreciate the value of helping to create a productive research environment — an interesting coupling." The management, he added, "requires a lot of time and planning, and a different set of skills."

The new program director began his new job in June and is still settling in. "I'm learning more and more about the responsibilities I now have, and how to best implement the program. No year is the same as before, and shifts with changing budgets, people, and the needs of DOE," he said.

He emphasized that he doesn't plan to give up all the research aspects of his job, although these will decrease with his new role as NSTX Program Director. During the last NSTX run period, Menard ran five experimental proposals on NSTX and will present results from several of these experiments in an APS invited talk in November. During the next run he will likely have time for at most one experiment. "Any research I do will be done on weekends, at airports, on planes, during meetings, or while napping," said Menard, half-jokingly.

Menard joined the research staff at PPPL in 1999 after conducting post-doctoral research at PPPL. He received a bachelor's degree in nuclear engineering from the University of Wisconsin-Madison in 1992, and a master's and a Ph.D. in plasma physics from Princeton University, Department of Astrophysical Sciences, in 1994 and 1998, respectively.Among his honors, Menard received the 2006 Kaul Prize for Excellence in Plasma Physics Research and Technology Development and the 2002 Presidential Early Career Award for Scientists and Engineers. ●

Patent

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PPPL Deputy Director Rich Hawryluk presented the awards to the inventors, who represent the Lab's Research, Engineering and Technical staffs, as well as other institutions that work in collaboration with PPPL. He thanked everyone at the dinner, but, he said, "most especially the people who work day in and day out ...to create things that allow these dinners to continue." A complete listing of the honorees and their inventions is available in the July Hotline, which can be downloaded from the web at: **http://www.pppl.gov/polNewsletters.cfm** ●

Photo by Frank Wojciechowski

At the dinner, PPPL Deputy Director Rich Hawryluk presents PPPL engineer Charlie Gentile (right) a "check" marking the first royalty payment of $30,000 for The MINDS Team. MINDS — the Miniature Integrated Nuclear Detection System — can be used to scan moving vehicles, luggage, cargo vessels, and the like for specific nuclear signatures associated with materials employed in radiological weapons. Gentile led the PPPL team that developed the system.

Live From... the PPPL Control Room

At the NSTX Control Room, Princeton graduate student Dave Smith (left) and PPPL Science Education Program Head Andrew Zwicker respond to questions from participants in the "Live From ...PPPL" program on May 31. At left (facing computer) is PPPL physicist Ron Bell. Behind Zwicker is PPPL engineer Tim Stevenson and in the red shirt is PPPL's John Robinson.

Grad student Stephanie Diem fields questions from the students in Teterboro through video conference technology.

Without leaving their school in Teterboro, 60 Bergen County Technical High School physics students took a field trip to the National Spherical Torus Experiment (NSTX) Control Room on May 31. The students participated in "Live From... PPPL," a program created by PPPL Science Education Head Andrew Zwicker in partnership with the Liberty Science Center.

Virtual Field Trip

The students took a virtual field trip to the control room at PPPL through the innovative program. Using video conference technology, Nancy Butnick, Director of Online Education at Liberty Science Center, connected them with scientists, engineers, and support staff in the control room while fusion experiments were being performed. Students spoke directly to those involved in fusion research. A TV monitor in the control room showed PPPL participants the students in the school's auditorium while the students viewed the control room from a large screen in the school's auditorium. Those speaking from either end used a hand-held microphone.

"The 'Live From… PPPL' program is a unique opportunity to expand an innovative program," said Zwicker. "Students were able to learn about the design of the fusion reactor, observe the real-time run of a fusion experiment, analyze data sets, and discuss the applications of this work with scientists. They also found out about paths to careers in plasma physics and engineering."

Princeton University graduate students Dave Smith, Stephanie Diem, and Patrick Ross, NSTX physicist Steve Paul, NSTX engineer Tim Stevenson, and Zwicker answered questions from the students about plasma physics, heating fusion-grade plasmas, and NSTX operations. They also talked to the high school students about the experiments occurring that day.

The virtual field trip was part two of the program. A week earlier, Zwicker conducted a workshop at the school, guiding the students through hands-on demonstrations using plasma balls, fluorescent lights, and the PPPL interactive web site to teach the science behind plasma, the fourth state of matter.

"Feedback from the students was extremely enthusiastic and the 60-minute program was expanded to 90 minutes due to the volume of questions asked by the students," said Zwicker, noting that the prototype program was part of an ongoing collaboration between the Liberty Science Center and PPPL. "A funding proposal will be written this summer to expand the program to bring real-time fusion research directly to museum visitors during NSTX operations in Fiscal Year 2008." ●

ITER Secondees Prepare for Life in France

By Cindy Ross Lundy, U.S. ITER Project at ORNL

Photo courtesy of ORNL

U.S. secondees assigned to the ITER site in Cadarache are, from left, Idaho National Lab's Ken Sowder, ORNL's Paul Holik, Savannah River Site's Dennis Baker, General Atomics' Remy Gallix, Los Alamos National Lab's Craig Taylor, ORNL's Gary Johnson, High Bridge Associates' Larry Lew, PPPL's Chang Jun and Jerry Sovka of Advanced Technologies.

The charms of living in a picturesque French village and experiencing European culture appear to outweigh any occasional frustrations caused by a more leisurely lifestyle for U.S. ITER scientists and engineers assigned to the international ITER project construction site in Cadarache.

Nine employees affiliated with the U.S. ITER Project have been assigned to the site in the South of France. They are secondees, employed by their home institutions and temporarily seconded to work in Cadarache with the ITER International Fusion Energy Organization. It will build the full-scale experimental device aimed at demonstrating the scientific and technological feasibility of fusion energy.

ITER – Latin for "the way" – involves a scientific collaboration between the United States, China, European Union, India, Japan, Korea and Russia. It is expected to be completed by 2016.

The U.S. ITER Project Office is hosted by Oak Ridge National Laboratory with partner labs PPPL and the Savannah River National Laboratory. The U.S. contributions to ITER project will be accomplished through a collaboration of DOE laboratories, universities and industry.

U.S. ITER "secondees" in Cadarache include Chang Jun of PPPL, a mechanical and electrical engineer. He is involved in computer analysis of the vacuum vessel and other structures and will be working on manufacturing control.

"I speak French and English, so I have adjusted here quite well," he said. "I'm on a very good team, and as a recent secondee, I am working to catch up on the details of the project."

He has two school-age children in Princeton and is working a schedule of three weeks in Cadarache and one week in New Jersey. "My biggest challenges have been the travel and being away from my family. I hope to bring them here as soon as possible to limit the travel time and be able to focus even more fully on our mission," he added.

Gary Johnson of ORNL works closely with Jun. Johnson is no stranger to European assignments, having worked on earlier stages of the ITER project in Germany during the 1990s. He is serving as deputy director general for the ITER tokamak, with responsibility for its design, procurement and construction. This includes the superconducting magnets, vessel systems, blanket and divertor systems, and assembly and remote handling.

Johnson said he enjoys working in an international environment. "Living in Southern France is also very nice. Cadarache is in a beautiful area."

Current professional challenges include helping to build the organization that will finish the design of the tokamak. It involves hiring candidates from all seven ITER parties. The process is time-consuming, he said, but adds that they are making real progress.

Johnson has found eating dinner in France to be a very different experience than in the United States. "Many restaurants don't even open until 7:30 p.m., and then the meal may take more than three hours. This has definitely been an adjustment."

Another secondee, Dennis Baker, spent the previous 34 years of his professional career supporting the Savannah River Site. He has experience in reactor operations support, safety analysis and safety basis development. He helped develop DOE's Magnetic Fusion Safety Standards and was seconded to ITER in the Safety Division in San Diego during the project's engineering design phase. In France, he is in the safety group developing and defending the ITER safety basis.

"This assignment has been an adventure," Baker said. "I have enjoyed the technical work and have already been given assignments with considerable significance. For example, I updated the general ITER confinement strategy and participated in presentations on it to the Safety Working Group of the Design Review Activity and the French Nuclear Regulatory

Spotlight

Name: Chang Jun

Position: Analysis Engineer at PPPL and Vacuum Vessel Analyst at ITER. Jun's mission is to verify and enhance designs by using computer analysis. His work covers mechanical stress analysis and electro-magnetic field analysis, and leads to building better fusion machines.

Quote: "During almost 10 years of service, I have grown to like PPPL more and more because its environment is very professional and the Lab has highly qualified scientists, engineers and staff. I can dive deeply into challenging problems and, through discussions with my colleagues, fly high to see the bigger picture.

I also like the ITER project because it reflects world-wide cooperation, instead of world-wide competition. I applied for an ITER position because I wanted a new challenge, and to continue to develop myself. I received my Ph.D. in France, so if the U.S. is my foster father, France is my uncle. (My 'natural' father is Korea.) I will be back in several years to share my experiences with PPPL'ers."

Other interests: Jun plays tennis and ping-pong, and shares his family's enjoyment of music.

"I have enjoyed many ping-pong games with several PPPL'ers at the Lab. My family members are quite serious about music. My wife plays piano, our high school boy plays cello and drum, and our middle school daughter plays flute and piano. I was a choir conductor for many years, but nobody in our family recognizes my musical sense due to my maladroitness in instruments," Jun says. ●

Chang Jun at the Palais de Chaillot in Paris.

Agency in Paris. "I have also very much enjoyed working with people from other countries and experiencing the culture of the Region of Provence. I have joined a chorale at the Darius Milhaud National Conservatory of Music in Aix en Provence, which has afforded the opportunity to meet many new friends in the area," he added.

Baker said dealing with the bureaucracy long-distance has been a challenge – even though everyone does his or her best to help. "The whole international assignment thing is rather new to me and to my company at Savannah River. I'm also living away from family, and I'm working to get comfortable finding and eating in restaurants, etc. After work, I consider myself a hunter-gatherer, spending my evenings seeking out places to eat or feeling my way through grocery stores studying microwaveable dinners."

Secondee Ken Sowder has been employed by Idaho National Laboratory since 1991 and has provided quality assurance management support to various programs such as ITER, the National Spent Nuclear Fuel Program (Yucca Mountain) and the New Production Reactor Program.

As responsible officer and division head for ITER Quality Assurance, Sowder reports to the deputy director general for Safety and Security and represents ITER and INL on various American Society of Mechanical Engineers and American Society for Quality committees. "In this role, I have really enjoyed working with the many diverse and intelligent people from all over the world brought to this project to support its construction," he said. Living and working in a different culture and language have provided the greatest challenges, he added, along with dealing with relatively expensive living conditions.

Larry Lew has been a project controls engineer on various large-scale civil, nuclear, fossil and transportation construction projects in North America, Japan, Hong Kong and Europe. His ITER responsibilities include coordinating the Planning & Scheduling Working Group to define the scheduling standards and procedures for the international organization and project teams.

Lew has found much to enjoy in his assignment, including "all the challenges of working on a truly unique project with fascinating people from all parts of the world; daily life in a small village in Provence; and the sites and people of France."

He also is adjusting to marathon restaurant dinners. Additional challenges include ensuring a smooth transition to French life for his children and obtaining an ADSL (asymmetric digital subscriber line) connection, which required seven weeks.

Other U.S. secondees to Cadarache include Remy Gallix, mechanical engineer from General Atomics; Paul Holik, plant system engineer from ORNL; Jerry Sovka, site layout, buildings and assembly group leader from Advanced Technologies; and Craig Taylor, physicist from Los Alamos National Laboratory, who is working on design and integration of tritium exhaust processing. ●

PPPL Assists in the Development of Artificial Muscle

By Anthony R. DeMeo

PPPL collaborator Lenore Rasmussen has the gift of serendipity. Two disparate life experiences sparked the polymer chemist's interest in the development of electro-responsive "smart materials" — electrically-driven polymers that are strong and durable enough to act as artificial muscles in prosthetic devices and robotics. Her early experience identifying DNA proteins and an injury suffered by her cousin in a farm accident triggered her interest in the development of the materials. She brings to this work an extensive background in chemistry, biology, and biochemistry.

Rasmussen was using electrophoresis — the movement of suspended particles through a gel under the action of a strong electric field — to separate and identify protein molecules and DNA. "There are little wells in which you put your proteins or DNA samples. You turn on the electricity and watch how they migrate. Different proteins or DNA fragments will go through the gel at different speeds that depend on their molecular weights. The larger, heavier molecules will have a harder time getting through. One of the wells would contain known proteins for comparison. For DNA, the smaller fragments would move further and longer ones would end up closer to the starting point," explained Rasmussen. But, as fate would have it, one day she made a mistake formulating the gel. "I goofed up mixing stuff together and (as a result) the gel responded to the electricity by contracting — a Eureka moment," she said.

Later, while she was a grad student at Purdue pursuing a degree in biophysics, one of her cousins was spreading hay on a land reclamation project. He slipped and his leg got caught in the hay spreader. His foot was not detached, but much of the muscle and circulation in the calf of his leg were damaged. Initially doctors were not sure he would keep the leg. If gangrene set in, he would have to have it amputated. "I was the scientist and biologist in the family, so they asked if I could go and look at prosthetics to see what was out there in case he needed one. While I really liked what I saw for legs, I really hated what I saw for arms and hands. As it turns out, my cousin's leg healed. He had a lot of recovery and still has a slight limp. But I kept thinking about my experience with the gels in DNA analysis and the need for better prosthetics. So I went on to Virginia Tech partly to get the background in polymer chemistry that I would need to develop artificial muscles," said Rasmussen.

Currently, prosthetics for the arm and hand are not functional unless they utilize three-pronged metal devices that are controlled mechanically. Rasmussen wondered

PPPL's Lew Meixler collaborates with Lenore Rasmussen on the plasma treatment of electrodes for smart materials project at PPPL.

if a prosthetic limb could respond directly to a neural impulse, and whether they could be made more attractive and highly functional. In 2003 she established Ras Labs, LLC, a small, for-profit, innovative research and development laboratory devoted to projects that utilize polymer chemistry, biochemistry, biology and engineering.

Rasmussen envisions artificial muscles, or actuators, that are comprised of an electro-responsive polymer gel (the smart material) containing embedded electrodes, all encased in a flexible coating that acts as a kind of skin. The smart material is cross-linked, meaning that a side bond has been formed between polymer chains to increase strength and toughness. The embedded electrodes serve a dual role: providing the electric stimulus, much like a nerve, and attaching the smart material to a lever, like a tendon attaches muscle tissue to bone. The thin elastomeric coating also serves as a moisture barrier, preventing evaporation and leakage of the electrolyte solution in the polymer, and allowing the actuators to be fully operational anywhere. When the electrodes are energized with direct current, the smart material contracts or expands, depending on the formulation. It then relaxes when the current is turned off, acting much like real muscle tissue responding to a neural impulse from the brain. The goal is for both the electro-responsive smart material and the embedded electrodes to move as a unit, analogous to muscles and nerves moving together.

Rasmussen tested a variety of polymers and found that poly(hydroxyethylmethacrylic acid) — poly(methacrylic acid) cross-linked network gels respond quickly to electricity and have all the other needed properties. But one

challenge remained: after repeated cycles, the polymer detached often from the electrodes. However, from her former affiliation with Virginia Tech and with Johnson & Johnson's Ethicon division, Rasmussen recalled that J&J performed plasma sterilization of its medical needles, and then coated them with polymers that allow them to slide more quickly into the patients, reducing discomfort. Plasma treatment not only sterilizes metal, but also improves the adherence of the polymer.

A potential solution was at hand. A colleague put Rasmussen in touch with Lew Meixler, PPPL's Head of Applications Research and Technology Transfer. She met Meixler at a grant-writing seminar at which he presented information on cooperative research opportunities for small businesses at federal labs. Rasmussen's discussions with Meixler resulted in the establishment of a Cooperative Research and Development (CRADA) Agreement last December between PPPL and Ras Labs. The CRADA, with PPPL participants Meixler and Yevgeny Raitses, revolves around PPPL's plasma sterilization equipment, an excellent apparatus in which to treat metal samples with plasma. Different ions are being studied to find a suitable metal and plasma combination that solves the detachment problem.

To date, tests conducted at PPPL are encouraging, resulting in improved bond strengths. Stainless steel and titanium metals are being treated with plasma comprised of ions of nitrogen, helium, or hydrogen. Titanium in particular is suitable for use within the body. Oxygen ions derived from synthetic air (for safety) are also used. Ions are driven onto the surface of a 0.5-inch by 1.5-inch metal foil by a 40-volt electric potential for 12 hours. Following treatment, a polymer coating is sandwiched between two pieces of treated foil. The composite is sent to the University of Pennsylvania or to the Princeton Textile Research Institute, which have the capability of performing adhesion tests on the small samples that fit into PPPL's apparatus. A standardized testing apparatus controls the speed and strain with which the composite is peeled apart. Future tests will be conducted with actual wire electrodes treated in the PPPL apparatus.

In addition to identifying a suitable plasma treatment for metals, the tests at PPPL should provide insight into the mechanism responsible for improved adhesion of the polymer. Preliminary studies have shown that the plasma ions rough up the metal surface on a molecular scale and make the surface super clean by removing any oils that might be present. "Right after the peel test we check to see where the break has occurred. If necessary, we use electron microscopy to view the surfaces. If the polymer comes off the metal cleanly, the interface is the problem. If there are patches of the polymer remaining on the metal, then the failure was in the polymer itself — or there could be other things going on," Rasmussen said.

Whatever is learned from the PPPL plasma treatments, Rasmussen will continue her quest for electro-responsive smart materials that can have a profound impact on prosthetics and robotics, with excellent control, dexterity, and durability. If she is successful, a lot of folks may benefit.

"This collaborative effort with Ras Labs is a good example of how a DOE Lab can advance the research of a small business startup. PPPL is helping to improve the metal-polymer interface by plasma treating the actuator electrodes. We hope it will lead to superior electro-responsive actuators that will benefit disabled people," Meixler said. ●

Success and Pie a la Mode Mark Year's End of NSTX Ops

The Lab threw a pie-and-ice cream party for staff on June 29 to toast this year's successful NSTX operations. In an invitation to staff, PPPL Director Rob Goldston said, "NSTX has had great success over a wide gamut of its scientific goals, so this is a fine time to celebrate."

At the bash, NSTX Run Coordinator David Gates thanked all the teams who contributed to the operations, which included twelve and a half weeks and 40 experiments. Others offering brief remarks were Goldston, PPPL's Hutch Neilson, and Princeton University's Stewart Smith. ●

Photo by John Bennevich

David Gates addressing the staff (blue shirt) with PPPL Director Rob Goldston at right.

Colleagues and Friends Pay Tribute to PPPL's Davidson

Colleagues, friends, and family from near and far came to PPPL June 11 and 12 to honor Princeton University Professor and former PPPL Director Ronald C. Davidson. The Laboratory hosted the "Symposium on Recent Advances in Plasma Physics" in honor of Davidson's 40 years of plasma physics research and graduate education. The program included scientific talks by researchers from many laboratories, institutions, and universities. During the opening, Rep. Rush Holt offered congratulatory remarks to Davidson and Princeton University Dean of the Faculty David Dobkin presented the welcome. The event included two days of technical talks and a banquet at Frist. ●

Far left, U.S. Rep. Rush Holt (NJ-12) congratulates Princeton University Professor Ronald C. Davidson (right) on 40 years of contributions to plasma physics research and graduate education during a symposium held in Davidson's honor at PPPL. Left, Davidson (left) with UCSD's Fred Driscoll at the Symposium. Driscoll was one of the presenters.

Chuan S. Liu, of the University of Maryland, presents to Davidson an embroidered silk cloth from Taiwan, with beautiful images of many children.

At right, Ron Davidson (left) with Rep. Rush Holt.

Symposium photos by Elle Starkman and John Bennevich

Above, Davidson and his family listen to remarks at the Symposium. From left are Davidson, his wife, Jean, son, Ron Jr., daughter Cyndy Premru, niece Arlene Steele, and nephew Rob Davidson.

Top right, PPPL's Nathaniel Fisch, Chair of the Symposium Committee, offers opening remarks. Right, Princeton University Dean of the Faculty David Dobkin welcomes attendees at the Symposium.

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