

PRINCETON PLASMA PHYSICS LABORATORY

WEEKLY highlights



The PPPL Highlights for the week ending February 22, 2013, are as follows:

Featured Highlight:

On February 20, PPPL was named the 2012 EPA WasteWise Program Federal Partner of the Year. Annually, the WasteWise program recognizes one Federal agency or facility that makes exceptional progress toward eliminating, recycling or diverting solid waste and other waste streams. PPPL's receipt of this prestigious award recognizes a sustained commitment to waste minimization that is championed by the Facilities and Site Services and Environmental Services Divisions and practiced by PPPL employees every day. Congratulations to all!

U.S. ITER FABRICATION (D. JOHNSON):

A Statement of Work for "Physics and Engineering Design Support and Diagnostic Hall Instrumentation Development for ITER Low-Field-Side Reflectometry (LFSR) Diagnostic System" was completed and is now in the PPPL approval cycle.

A progress meeting on the development of the ITER Motional Stark Effect Diagnostic was held to review modifications to the optical design of the viewing system housed in Equatorial Port Plug #3. Neutronics analysis of the associated viewing labyrinth was also reviewed. Based on this progress, it appears that this viewing concept will be able to view both the edge region of the ITER heating beam and the core region of the diagnostic neutral beam. The Conceptual Design Review for this system was tentatively scheduled for the last week in May.

NSTX (M. ONO):

The NSTX-U Program Advisory Committee (PAC) Meeting was held February 19-21 at PPPL. The PAC was charged with assessing the NSTX-U draft five year plan for 2014-2018. In particular, the PAC was charged with assessing plans with respect to how well it addresses the key physics issues needed to evaluate the potential of the ST to provide high-performance plasmas for use in a future fusion research facility, plans to investigate key tokamak physics issues for ITER, and plans to contribute to model validation and the development of predictive capability. Additional emphasis was placed on assessing the strength of planned NSTX-U contributions to boundary physics and plasma-material-interaction research, and comments on the plan presentations including logic and format were also requested. The PAC provided very valuable feedback on the five year plan content and presentations. The PAC-33 presentations and other info are available at: <http://nstx-u.pppl.gov/program/program-advisory-committee/pac-33>.

The paper "Plasma Facing Surface Composition During NSTX Li Experiments" by C.H. Skinner (PPPL), et al., was published on-line by Journal of Nuclear Materials, and can be found at <http://dx.doi.org/10.1016/j.jnucmat.2013.01.136>. The article describes laboratory studies of the chemical composition of lithium surfaces exposed to typical residual gases found in tokamaks. Solid lithium and a molybdenum alloy (TZM) coated with lithium were examined using X-ray photoelectron spectroscopy, temperature programmed desorption, and Auger electron spectroscopy both in ultrahigh vacuum conditions and after exposure to trace gases. It was found that lithium surfaces near room temperature were oxidized after exposure to 1–2 Langmuirs of oxygen or water vapor. The oxidation rate by carbon monoxide was four times less. Lithiated PFC surfaces in tokamaks will be oxidized in about 100 s depending on the tokamak vacuum conditions.

A paper, "2D Divertor Heat Flux Distribution Using a 3D Heat Conduction Solver in National Spherical Torus Experiment" by Kaifu Gan (ASIPP, China), et al, was published at Rev. Sci. Instrum. 84, 023505 (2013); doi: 10.1063/1.4792595 (<http://link.aip.org/link/?RSI/84/023505>). Kaifu was an exchange student to PPPL. This paper describes the recent implementation and improvement of a 3D heat conduction code (TACO), incorporating the effect of thin surface layer on divertor tiles, and its application to obtain the 2D heat flux profiles in NSTX. Results are found to be in good agreement with those from a standard 2D heat flux code (THEODOR). An example of toroidal asymmetry in heat flux during ELMs using the 2D data is also provided. Details of inversion techniques to obtain 2D heat flux profiles from the measured surface temperature including the treatment of surface layer effect are given in the appendices.

A paper, "Characterization of the Spatial Structure of Turbulence Fluctuations During the Edge Localized Mode Cycle in the Pedestal Region" by A. Diallo (PPPL) et al., has been published in Physics of Plasmas 20, 012505 (2013). The focus of this work is to investigate the fluctuations limiting the pedestal width growth between ELMs. Using the beam emission spectroscopy and the correlation reflectometry systems, we show that fluctuations are of ion scale propagating in the ion diamagnetic drift direction at the pedestal top. These propagating spatial scales are found to be anisotropic and consistent with ion-scale microturbulence of the type ion temperature gradient and/or kinetic ballooning modes. This results represent a step toward testing the EPED hypothesis where KBM is postulated to limit the pedestal width.

ITER & TOKAMAKS (R. WILSON):

DIII-D (R. Nazikian):

PT_SOLVER implements the TGLF transport model in the predictive transport code PTRANSP. A series of validation exercises are being performed to demonstrate consistency between the PTRANSP-PT_SOLVER implementation of TGLF and TGYRO-TGLF over a range of discharge configurations and devices. TGLF transport fluxes are being compared for a range of geometries and ExB shear representations. Current investigations incorporate L- and H-mode discharges from DIII-D interpreted by TRANSP and ONETWO, as well as TFTR TRANSP analysis.

A. Nagy has begun designing a cross over network to allow for the simultaneous operation of the high power supplies (SPAs) and audio amplifiers for improved Resistive Wall Mode control using the internal I-coils on DIII-D. PPPL will provide the cross over network in the next two years, with design work to be completed in FY13. A Conceptual Design Review (CDR) is expected in a few months.

The redesign of the water manifold for gyrotron 8 is now complete. The new design provides improved hand valve access for operation, component removal and replacement.

ADVANCED PROJECTS (H. NEILSON):

Dr. Thomas Rummel, Wendelstein 7-X (W7-X) Magnet Division Head at Germany's Max Planck Institute for Plasma Physics (IPP) joined PPPL staff in visits to suppliers for the W7-X trim coil project. The team visited Applied Power Systems (APS) in Hicksville, New York, who are manufacturing the trim coil power supplies, and Everson Tesla, Inc. of Nazareth, Pennsylvania, who are completing the manufacture of the trim coils. The APS team reported that the majority of the power supply parts are now on hand; the cabinets are due to arrive in mid-March, and it is planned that assembly of the five units will begin thereafter. Additionally, tentative dates were set for the acceptance testing of the first supply. At ETI the fifth and final trim coil was inspected. The coil hydraulics system has been installed and tested, and final electrical testing has been completed. The coil is currently being packaged in preparation for shipment next week.

Drs. Keeman Kim and Kihak Im of Korea's National Fusion Research Institute (NFRI) visited PPPL this week for a two-day meeting to discuss progress in the NFRI-PPPL collaboration on K-DEMO, a next-step fusion facility being planned in Korea. Mr. Seong Hoon Yoon, a visitor from Korea's Ministry of Science and Technology, attended as an observer. The aim of the meeting was to establish a reference design point which will serve as the basis for analysis for the next several months. Dr. Kim presented the toroidal field geometry and radial build developed by the NFRI team. PPPL's C. Kessel presented system code analyses of candidate design points and Y. Zhai presented an assessment of superconductor options. The goal of setting a design point was achieved, near-term plans for configuration studies and analyses were established, and a date for the next teleconference meeting was adopted.

THEORY (A. BHATTACHARJEE):

Discovery of new modes of intense beam propagation in alternating-gradient accelerators. High-intensity charged particle beams have a wide range of applications ranging from basic scientific research in high energy and nuclear physics and ion-beam-driven high energy density matter to practical applications such as heavy ion fusion energy and medical accelerators. To accelerate and transport high-intensity beams, it is critical to understand in what modes the beams can propagate through an alternating-gradient focusing channel. Up to now, the only known class of exactly soluble modes of intense beam propagation including self-electric and self-magnetic field effects is the Kapchinskij-Vladimirskij (KV) distribution discovered in 1959. Recent research at Princeton University's Plasma Physics Laboratory reveals that there exists a much larger class of self-consistent modes of intense beam propagation in alternating-gradient accelerator

systems [[Phys. Rev. Lett. 110, 064803 \(2013\)](#)]. For each of the classical KV solutions, the beam propagation dynamics is specified by two free parameters, i.e., two emittances in the transverse plane. For the newly discovered class of beam modes, which include the classical KV solutions as a sub-class, each mode is specified by ten free parameters. Because the space domain of free parameters has been extended from two-dimensional to ten-dimensional, the new propagation modes that have been discovered enable a large increase in flexibility in the amount of beam control and steering capability. For example, the new modes allow the beam to tumble (rotate) in the transverse plane perpendicular to the propagation direction, which can be utilized as a beam smoothing technique for accelerator applications where smooth illumination is required, such as in the case of heavy ion fusion and medical accelerators. Theoretically, the new modes have been discovered by generalizing the one-dimensional Courant-Snyder theory for charged particles in an alternating-gradient focusing lattice and the associated one-dimensional envelope equation (also known as the Milne-Pinney equation) to a higher-dimensional, non-Abelian space. In particular, the one-dimensional Courant-Snyder invariant (also known as the Lewis invariant in quantum mechanics) is generalized to higher dimensions, and the new class of solutions of the nonlinear Vlasov-Maxwell equations is constructed after applying the Cholesky decomposition technique. [H. Qin and R. C. Davidson, Phys. Rev. Lett. 110, 064803 (2013)]

J. Johnson participated in the STORM kick-off meeting in Brussels, Belgium February 20-21. STORM is a FP7 project involving seven partners from EU and USA to understand turbulence, intermittency, and nonlinearity in Heliospheric plasmas.

W. Tang was invited to serve on the Advisory Board for the DOE-ASCR SciDAC-3 Institute: "Scalable Data Management, Analysis, and Visualization Institute" (SDAV) led by Arie Shoshani of LBNL and attended its initial meeting on February 20. He also participated in the associated SDAV All Hands Meeting February 20-22 in San Francisco, California.

COMPUTATIONAL PLASMA PHYSICS GROUP (S. JARDIN):

A. Kritz, T. Rafiq, and A. Pankin from Lehigh University visited PPPL February 15 to discuss their experience with PTRANSP and to learn to use the new solver in TRANSP, PT_SOLVER.

S. Ethier attended the annual NERSC Users Group meeting held in Oakland, California, on February 12-15. The first day was dedicated to the business meeting, during which the NERSC staff present the status and plans for the supercomputer center, and seek feedback from the user community on how to best support and enhance scientific discovery through high performance computation and storage. The second day took place at LBNL and focused on trends in HPC, as well as scientific and HPC accomplishments by NERSC users. The final two days were dedicated to training, for both beginners and experienced users, with a focus on NERSC's new Cray XC30 supercomputer, Edison. Documents for the presentations can be found at <https://www.nersc.gov/users/NUG/annual-meetings/2013/>.

ENGINEERING AND INFRASTRUCTURE (M. WILLIAMS):

NSTX Upgrade (R. Strykowski, E. Perry, L. Dudek, T. Stevenson):

Construction: The bay L nozzle has been set on the vessel and has been aligned. Machining of two outer TF coils to repair flag/coil joints is underway. Installation of cable trays continues on the east and west sides of NSTX. Ground bus for the category 3 racks is also being installed. The welding of the SW vessel leg mount has been completed. Scaffolding and platforms on the north and south sides of NSTX are being reconfigured to accommodate re-installation of TF coils. The umbrella stiffeners are being re-machined and installation on the machine has started.

Center Stack Upgrade: TF Conductors - The TF Quadrant mold was closed up and received an acceptable vacuum rate of rise test on February 21. It has been moved into the VPI oven where it will be connected to the epoxy system. VPI of the first NSTXU TF Bundle quadrant is on track for the beginning of next week.

TF Lead Extensions: Test sample material was received and is being machined into test samples for Electron Beam weld qualifications.

OH preparations: The OH winding tension station fabrication continued in the Tech Shop.

Procurements: Full TF mold's lower half has been welded at the vendor. Machining on the lower half and full welding of the upper half started this week. OH mold procurement has started - pre-bid meeting was held February 20.

PF1 coils - bids received, evaluation and award by March 1.

NBI Upgrade: Calorimeter drives were installed and tested. Water line leakcheck testing is in progress. A large B container was loaded for rad shipment. Rad laundry was also dispositioned. Armor backing plate brazing will resume after the oven pump repairs. Preparations for HVE relocations are in progress. Procurement packages for power system cable and tray and for deionized water piping are progressing; drawings for these packages are nearing completion and checking. Fabrication and leakchecking of LHe cryo line continues in the NB shop. LHe cryogenics line installation and welding on the TFTR Test Cell South wall continues. Fabrication continues on the central spool section for the NBI duct and other flanges in the Tech Shop. Cable tray installation for BL controls and instrumentation awaits additional parts which are on order. BL cable removals continued in the NTC. TVPS turbomolecular pumps arrived. Duct fabrications continue including rectangular flange welding.

Office of Project Management (T. Stevenson):

The monthly Project Status Review Board meeting was held February 12, with active jobs reporting on progress and plans. System engineer training with the online package is in progress. Follow up with system engineers to review Preventive Maintenance lists is planned. Several key work planning additions have been requested for a version WP 6.1 to address immediate concerns for Lithium work and MSDS, Lithium Review Committee, and Davis Bacon determinations. The need for a much larger revision has been identified in association with various JONs. Requirements for this expansion are being gathered for IT project planning purposes. Testing for WP email notifications will be repeated after it was discovered that the downstream link for email generated by the WP system had been broken. Development of the COG/RLM update online supplemental training package continues. This package will be an addendum to the existing online COG/RLM package from 2012. New COGs will need both

packages for their introductory training. The Lessons Learned report for AFCI procurements has resulted in several Corrective Actions assigned to OPM. These CAs were reviewed and discussed at the Actions and Assessment meeting this week and will require revisions to various ENG procedures. The EVMS self assessment report was promulgated and posted.

Facilities and Site Services (M. Viola):

Engineering Services: Facilities met with representatives from Seimens to discuss their demand flow system for reducing energy use in pumping and chiller operations. A presentation was made and further evaluation is planned. A final statement of work for the ESU Project has been sent to Safety and QC for review. A final estimate for the job is complete. Quotes were received and a recommendation for the award of the Central Plant Chiller Overhaul, Tube Cleaning, Eddy Current Testing and Maintenance project was made. The plan is to start with Unit 701 in March. Reviewed Projects in OPEX category to determine the priorities for limited spending.

Fire Protection: Effort continues on items from the Fire Protection Audit. Three items were closed last week and other proposals for closure of items continue through the system. Resumes were reviewed for the Fire Protection engineer position.

Telecom: Verizon visited and a plan was developed for re-feeding the phone system and Booth 6 services to prepare for SLI construction. The Telecommunications Office provided input for a new Lab Procedure GEN-XXX; for the purchase of Tablet Personal Computers, Related Software (Apps) and Telecommunications Network Services. The Tablet PCs being purchased for use with a telecommunications network (such as Verizon Wireless or AT&T Wireless) or WiFi will now require the approval from the Telecommunications Officer and IT management.

Energy: Water use has been higher than normal for a few weeks and suddenly dropped February 21. It is important to know the source to determine if it is accidental or operational and if it should be deducted from our sewer bill. Please contact Ana Pinto with any relevant information.

BUSINESS OPERATIONS (E. WINKLER):

T. Gillars participated in a conference call conducted by the DOE Office of Financial Risk, Policy and Controls. The purpose of this training was to provide Laboratory internal controls points-of-contact with an overview of the Financial Management Assurance (FMA) Tool. This program is part of an integrated process to comply with OMB Circular A-123, which, among other things, requires the testing of key internal controls annually.

T. Bleach attended a meeting with representatives from the DOE Princeton Site Office, Princeton University's Office of Audit and Compliance and the Baker Tilly, PLLC accounting firm. The purpose of the meeting was to brief DOE on the schedule and scope of the cost allowability audits to be conducted in FY2013.

ENVIRONMENT, SAFETY, HEALTH & SECURITY (J. LEVINE):

A management safety walkthrough of the D-Site Mockup Building and Mechanical Equipment Room was held on February 20. Action items were assigned for follow up to correct a number of issues that were found in these areas.

Emergency Services Engine 66 responded to one mutual aid assignment in Plainsboro and one mutual aid assignment in Princeton.

PPPL Counterintelligence Officer P. Moskal visited the Laboratory February 20-21.

ESU Driver/Operator S. Galie provided classroom and practical Fire Extinguisher Training on February 20 for four students (three employees and one subcontractor).

SPD received the DOE draft report, "PPPL Physical Protection System Risk Assessment." This draft report summarizes the results of a DOE Office of Science led effort to conduct a physical protection system assessment of PPPL. The assessment was held in November 2012.

SPD reviewed and provided comments for the latest version of the PPPL Nuclear Material Control and Accountability Plan (Rev. 8).

The Systems and Networking Division completed installation of all 18 outdoor wireless access points and they are all online. This Wi-Fi capability is necessary for full implementation of the Night Owl Asset Tracking Program at PPPL. Funding for this project was provided by the DOE Office of Safety, Security and Infrastructure. Wireless service is now available in the outdoor areas at PPPL. The standard networks ("pppl-wpa" and "ltu") are broadcast throughout the campus, with "pppl-guest" network also available at the front entry area of the LSB. Feedback on signal strength in specific areas should be provided to the Systems and Networking Division.

SPD participated in the pre-job briefing for the first VPI of a TF quadrant on Friday, February 22. The VPI procedure, emergency response procedure, JHA and schedule were discussed.

OFFICE OF COMMUNICATIONS: (K. MACPHERSON):

C. Cane attended the DOE Web Council meeting on February 14. Ian Kalin, Director of the DOE's Energy Data Initiative stressed the importance of the Web Council showing leadership among other government agencies. He reported he is spearheading an initiative called energy.gov/Data which will effectively aggregate all of the DOE datasets across all the various DOE headquarters and site offices and National Laboratories. Lynn Davis, Program Liaison at DOE's Office of Scientific and Technical Information, explained the launch of the National Library of Energy (a new website, which uses Drupal) with a live demo/tutorial using a Webinar tool that allowed remote sites like PPPL to view on-line the presentation and website interface. The premise of the new website tool is that citizens don't need to know the DOE structure to get the data they want and need; just a simple search will search across DOE entities. Cane also posted stories to Facebook and Twitter. In addition, he consulted with the Theory department on best uses of the Lab website's Drupal system.

G. Czechowicz met with Site Protection on Feb. 20 to consult on a new visual identity for the group. He designed new fact maps and produced material for press kits for Fusion Day.

J. Jackson DeVoe and G. Czechowicz produced and designed the PPPL Weekly which contained stories, including a profile of PPPL CIO S. Baumgartner and a presentation on fusion given by H. Neilson at the annual meeting of the American Association for the Advancement of Science (AAAS).

J. Jackson DeVoe issued a press advisory on the upcoming Science Bowls to regional media. J. Greenwald worked with H. Qin and R. Davidson to prepare a PPPL Highlight for a DOE website. The highlight featured PPPL's discovery of new modes for propagating high-intensity charged particle beams. J. Greenwald's profile of Mike Zarnstorff appeared in the February/March issue of Innovation magazine.

K. MacPherson and J. DeVoe worked with Josephine Halvorson, an art professor at Princeton University, who will be bringing a painting class to PPPL periodically, to work out the arrangements. MacPherson assisted the Trenton Times in scheduling a photographer to visit PPPL. She is also assisting Dan Clery, a writer, with information for his book.

E. Starkman shot, edited and produced a video of a centrifuge experiment with the assistance of J. Greenwald. She is developing a photo gallery for the production of a PPPL magazine. She also is working with the author Dan Clery to provide both historic and current photos for his book. She also photographed multiple subjects including: the middle school and high school Science Bowls; speakers for and visitors to Science on Saturday; and some group shots.

BEST PRACTICES & EXTERNAL AFFAIRS (J. DELOOPER):

On February 22, PPPL hosted the 2013 NJ Regional Middle School Science Bowl where 16 middle schools from the state of NJ participated. Bridgewater-Raritan Middle School won first place in the competition and will travel to Washington, D.C at the end of April to represent New Jersey at the National Science Bowl.; JDroids Science Club, of Wayne, New Jersey came in at a close second place and Thomas Grover Middle School came in at third place. A special thank you to all of our volunteers at the 2013 NJ Regional Middle School Science Bowl: K. Lukazik, A. Cohen, C. Austin, J. Hare, S. Shaw, D. Strauss, S. DePasquale, M. Pueyo, J. Parker, E. Shi, S. Burrows, L. Harmon, M. Kevin-King, B. Reed, B. Sarfaty, J. Jones, B. Herskowitz, J. DeLooper, A. Zwicker, A. Dominguez, A. Merali, E. Feibush, S. Green, A. Morgado, C. Armstrong, D. Anderson, N. Neal, T. Todorova and C. Greenstein.

On February 23, PPPL hosted the 2013 NJ Regional High School Science bowl, where 31 high schools from New Jersey and surrounding areas of Pennsylvania, participated. West Windsor-Plainsboro High School South, won first place and will travel to Washington, D.C. at the end of April to represent New Jersey at the National Science Bowl. Bergen County Academies won second place and State College Area High School, of State College PA, took third place. Thank you to all of our outstanding volunteers at the 2013 NJ Regional High School Science Bowl: I. Zatz, E. Feibush, B. Lyons, A. Zwicker, A. Dominguez, S. Baumgartner, P. LaMarche, K. MacPherson, K. Baumgartner (BMS), B. Faber, S. DePasquale, J. Hare, J. Lacenere, E. Shi, J. Smith, A. Cohen, J. Parker, M. Zarnstorff, M. DelCorso, (Merck), B. Blanchard, T. Abrams, L.

Ellison, A. Diallo, D. Boyle, J. DeLooper, K. Lukazik, J. Jackson-Devoe, B. Herskowitz, S. Green, N. Neal, D. Anderson, T. Todorova, A. Morgado, C. Armstrong, C. Greenstein, Max, Matt, Joey, Chris and Keliann.

A. Zwicker and P. Mala Murthy of the Department of Molecular Biology and Neuroscience Institute gave an informal research presentation over dinner to students at Rockefeller College at Princeton University. Professor Murthy talked about her work in understanding how the brain mediates acoustic communication in flies and Andrew talked about the physics of plasma speakers.

The following papers were published:

PPPL-4852

Particle Control and Plasma Performance in the Lithium Tokamak Experiment (LTX)

Authors: Richard Majeski, et. al.

Submitted to: Physics of Plasmas, (December 2012)

PPPL-4853

Guiding Center Equations for Ideal Magnetohydrodynamic Modes

Authors: Roscoe B. White

Submitted to: Physics of Plasmas (February 2013)

DIRECTOR'S OFFICE (B. SOBEL):

On February 21, Professor Roy B. Torbert, University of New Hampshire, presented a colloquium entitled "The Magnetospheric Multi-Scale Mission Investigation of Magnetic Reconnection".

This report is also available on the following web site:

<http://www.pppl.gov/polWeeklyHightsExternal.cfm>