The PPPL Highlights for the week ending May 27, 2016 are as follows:

FEATURED HIGHLIGHT:

Ronald C. Davidson, a pioneering plasma physicist who directed the Laboratory from 1991 to 1996 during the path-breaking use of deuterium and tritium to fuel fusion reactions, passed away on May 19. He was 74.

“Ron was an anchor for the Laboratory both through his science and through his wisdom,” said PPPL Director Stewart Prager. “His prodigious contributions not just to PPPL’s science but also to plasma physics writ large are clear and widely known. Within the Laboratory, he was a mentor and a guide to people young and old. His impact within the Laboratory was enormous.” A memorial was held on May 26 and obituaries appeared in publications including the New York Times and the Boston Globe, and will appear later this week in the Toronto-based Globe and Mail in the province of Ontario where Davidson was born.

U.S. ITER FABRICATION (C. NEUMEYER):

In response to a congressional request, the DOE issued a report entitled “U.S. Participation in the ITER Project.” The report recommends that the U.S. remain a partner in the ITER project at least through FY 2018 and focus on efforts related to First Plasma. It also recommends that the situation be re-evaluated prior to the FY19 budget submittal to determine whether the recent progress in improving the management of the ITER Organization has been sustained. Numerous other recommendations are contained in the report, which is available at http://science.energy.gov/~/media/fes/pdf/DOE_US_Participation_in_the_ITER_Project_May_2016_Final.pdf.

Steady State Electric Network (SSEN):

Power Transformers: The Lot 3 transformers, consisting of 10 dry-type units (six @ 2.5MVA and four @ 1.6MVA) were delivered to the ITER site on May 24. This satisfies an ITER Council (IC) milestone. Factory Acceptance Testing (FAT) of the Lot 1 and Lot 2 transformers was completed and correction of punch-list items is underway. Target date to begin shipping the Lot 1 and Lot 2 oil-filled units (eight @ 35MVA and four @ 7MVA) is June 29.

6.6kV Switchgear: The Lot 2 Release for Shipping (RFS) documentation package was approved by the ITER Organization. A delivery planning meeting was convened with all involved parties,
leading to a revised shipping date of June 17 for the 48 cubicles in Lot 2 from the Schneider Electric factory in Manisa, Turkey. Fabrication of the remaining 110 cubicles in Lot 3 and 4 is nearing completion and the FAT will commence on June 15.

**Diagnostics:**

Project and Administrative Notes and Highlights: N. Sauthoff and Bill Cahill held discussions with Mike Walsh, the ITER diagnostics program manager, on scenarios for including Equatorial Port 9 and the tenant diagnostic systems TIP and ECE for First Plasma and early ITER operations. The PPPL team, over the next few weeks, will address several questions and study associated costs and risks. For example, the extent to which TIP and ECE diagnostics systems need to be deployed will be studied. Another important consideration is the location and use of a Port Plug Test Facility (PPTF). The PPPL team will look at costs and benefits of hosting the PPTF at Princeton versus sending the First Plasma EP9 Port Plug to another PPTF host.

R. Feder visited the U.S. ITER home office this week to discuss a variety of WBS 1.5.3 topics. Discussions were held on re-organizing the Diagnostic RGA project (DRGA) under the U.S. ITER Vacuum Group. Other meetings were held on Diagnostics I&C and Documentation and Quality Control.

Upper Port Wide Angle View Vis-IR Cameras (UWAVs): The UWAVs team held a three day face to face technical workshop this week at PPPL. Team members from General Atomics, TNO and ITER attended. Specific emphasis was upon the upcoming July Peer Review, which will be the first formal review of UWAVs preliminary design progress since the CDR.

Motional Stark Effect (MSE): This week the MSE team reviewed and discussed the EP01 Interface Requirements documentation from IDOM, the EUDA port integration subcontractor. Currently there are no significant difficulties and work has begun on implementing the MSE optical ray traces into the EP01 model. Some slight optical model updates are needed to accommodate window position tolerances, but nothing that adjusts the overall diagnostic design significantly. In general, the front end optics work in EP3 and EP1 is moving along nicely and we are just waiting on the finalization of the SOW updates to start focusing work on the mirror cleaning and mirror design R&D. There was significant discussion with IDOM about the high neutron environment in the EP01 interspace due to the Radial Neutron Camera system. They are going to work on acquiring a nuclear overview approximation so that we can start thinking of solutions for protecting the MSE fiber optic bundles and other equipment.

Electron Cyclotron Emission (ECE): The latest round of EP9 Diagnostic Shield Module (DSM) design modifications are introduced for updates to ECE equipment design. A push rod design for shutter mirror actuation with a “catcher” fixture is introduced. Preparations are underway for mechanical and magnetic testing of the piezo motor, which will come to PPPL by the end of June. Drawings of test fixture are in preparation in the design group.

Diagnostic RGA (DRGA): Steady progress continues on the DRGA prototype system testing. Magnetic field effects testing has been reconfigured to test an MV2 QMS instrument after the ITMS instrument testing was concluded.
Upper Port 11 and 14 Integration and DSM Engineering: Tenant’s models are being incorporated into the new Preliminary Design Review UP#14 model for Neutronics analysis. This will be the final iteration on neutronics until after the PDR in 2017. A meeting was held with IO’s Remote Handling(RH) team for Diagnostics. RH agreed on setting up the UP#14 specific model of Hot Cell Facility for Maintenance. We will use this model to do Remote Handling Compatibility Assessment (RHCA) study, which is one of the key deliverable documents for the PDR.

Equatorial Port 9 Integration and DSM Engineering: DSM design for the ECE system progressed with further design/modeling of weight-reduced structure and shield material distribution. Resulting shielding capabilities will be internally reviewed soon. DSM3 for the TIP diagnostic was reviewed internally and assumptions for mirror selection were discussed. DSM design and mirror integration will move forward based on selection of an earlier “baseline” design. The TIP/DSM integration is also incorporating further weight saving approaches.

Toroidal Interferometer and Polarimeter (TIP): Severe attenuation of the quantum cascade laser intensity was observed in recent tests of the laboratory prototype interferometer at GA. This was recently traced to an offset in the operating wavelength from that specified. This offset placed the operating wavelength at the foot of an absorption line in water vapor. Adjusting the laser within its tunable range confirmed the expected wavelength dependence of this effect. On ITER, a wavelength far from any absorption lines will be chosen to avoid this problem.

Core Imaging X-Ray Spectrometer (CIXS): Magnetic Field Testing—power supply commissioning is completed. Fabrication of brackets and other parts for testing has been completed. Procedure has been completed and signed. Detector IT setup is completed. Hardware is currently being installed into test magnet. Tests planned for June 2 and 3. Nuclear testing meetings scheduled for next week to discuss dates of testing at Indiana University.

NSTX-U (M. ONO):

A FY2016 NSTX-U plasma operations update: The department has completed 8.95 run weeks and 940 plasma shots. The total operation target is 18 run weeks.

A paper “Evaluation of thermal helium beam and line-ratio fast diagnostic on the National Spherical Torus Experiment-Upgrade” by J. M. Munoz Burgos (Johns Hopkins University) et al. was published in Physics of Plasmas 23 053302 (2016), and is available online at http://scitation.aip.org/content/aip/journal/pop/23/5/10.1063/1.4948554. The abstract reads: “Synthetic evaluation of a helium line-ratio diagnostic based on a gas-puff system for characterization of the SOL, and Edge regions of NSTX-U plasmas has been accomplished for the THB diagnostic currently in operation on RFX-mod. It has been proposed to install this diagnostic on NSTX-U. The purpose of the synthetic analysis is to evaluate the application of this diagnostic for high temporal resolution (~4us) measurements of electron temperatures and densities. This diagnostic makes use of the 667.8, 706.5, and 728.1 nm lines of helium, and it is concluded that the expected signal level of the THB system on NSTX-U should exceed the detection limit, thus making this diagnostic a viable option for high temporal resolution characterization of SOL and edge plasmas.”
A paper “Parallel electron force balance and the L-H transition” by T. Stoltzfus-Dueck (PPPL), PoP 23 054505 (2016) was published online at http://scitation.aip.org/content/aip/journal/pop/23/5/10.1063/1.4951015. The abstract reads: “In one popular model for the L-H transition, the energy in turbulent fluctuations is directly depleted via Reynolds-stress-induced energy transfer to the zonal flows. Experimental attempts to validate this model have used energy balance between zonal flows and nonzonal (turbulent) ExB velocities, concluding that the mechanism was viable. However, in a recently accepted article, T. Stoltzfus-Dueck demonstrated that parallel electron force balance couples the nonzonal velocities with the free energy carried by the electron density fluctuations, replenishing the turbulent ExB energy until the sum of the two turbulent free energies is exhausted. Since that sum is typically two orders of magnitude larger than the energy in turbulent ExB flows alone, the Reynolds-stress-induced energy-transfer mechanism is likely to be much too weak to explain the rapid turbulence suppression at the L-H transition.”

N. Bertelli, J. Hosea, and G. Taylor of PPPL participated in the US-Japan RF Physics Workshop held in Toyama, Japan May 18 – 20. This allowed them to gain knowledge of recent developments in ICRF, EC, EBW, and LH research in Japan and the U.S. This helps to inform planning of fast wave experiments on NSTX-U and guide the development and design of the 28 GHz EC/EBW heating system on NSTX-U to support non-inductive plasma start-up. It provides them with valuable access to Japanese RF researchers currently working on ICRF, EBW, EC, and LH heating and current drive. There were 21 presentations at the workshop covering the topics of EC/EBW, IC/LH, HHFW, Helicon and theory/modeling. Many contacts were made, especially with the Japanese coordinator of the meeting Professor Shin Kubo of NIFS. G. Taylor and J. Hosea were chairmen of two sessions of the workshop and G. Taylor presented the summary of all presentations at the end of the workshop. There was in-depth coverage of the presented research. This gave all of the participants a very good overview of much of the RF research that is ongoing in Japan and the U.S. Also, this workshop serves to foster valuable collaborations between the two research programs in many RF areas.

W. Guttenfelder (PPPL) gave a talk to the Cranbury Presbyterian Senior Breakfast club on May 26 titled “Containing a star on earth: PPPL and the promise of fusion energy.” The talk provided an introduction to plasmas, nuclear fusion, and research taking place at PPPL with a focus on the NSTX-U project.

C. Myers (PPPL) was interviewed by Gizmodo on May 20, following the NSTX-U dedication ceremony. An article incorporating the interview was published by Gizmodo on May 27. The story can be viewed here: http://gizmodo.com/the-real-problem-with-fusion-energy-1777994830.

The Granule Injector has now been interlocked to the NSTX-U TVPS and its TIV has been exercised. In addition, the Granule Injector preoperative test procedure has been successfully completed and the system is now fully commissioned. It has been initially loaded with 300 and 500 micron carbon spheres and 500 micron boron carbide granules, and is ready to support operations when NSTX-U operations recommence.

NSTX-U is in a maintenance period to address a deformation discovered on a connecting flag on a PF1A coil lead, and to continue several previously scheduled test cell installations. All coil leads/flex bus have since been evaluated, and it has been determined that additional bracing for
the PF1A upper and lower water cooled flex bus is required. Similar bracing will be implemented for the PF1B and PF1C coil circuits before those systems are brought into service.

**ITER & TOKAMAKS (R. HAWRYLUK):**

**DIII-D (R. Nazikian):**

New capabilities for integrated modeling and “predict first” initiative have matured in OMFIT, with users now being able to submit predictive TRANSP runs using GLF23, MMM, and TGLF models from the OMFIT TRANSP module. B. Grierson and L. Cui have successfully implemented this capability in OMFIT. The predictive TRANSP solver “PT_SOLVER” is also available as a standalone module for single time slice analysis for predictions of Te, Ti, density and momentum transport. These new features were demonstrated by B. Grierson at the TRANSP developers meeting on May 27.

A. Nagy made progress in developing a regular granule delivery system for the Impurity Granule Injector (IGI). An initial design based on a tube with a clocking gate was eliminated based on poor test results. However, another dropper technique was successfully tested. The method, based on a concept developed by D. Mansfield, uses a piezoelectric vibrator table with a V-groove to hold the granules. Carbon granule spheres are loaded at one end of the V-groove with an aperture dams between the loading point and the end of the “diving board.” The piezo frequency and amplitude is tuned to allow a steady stream of granules through the aperture dam. As the granules travel down the V-groove, they interact with each other so as to produce a highly regular rate of granule delivery at the end of the groove, called the diving board. With some tuning it was possible to achieve a consistent drop rate for the granules. This technique has the potential to solve many of the difficulties with the original dropper design including galling and clogging while providing a regular granule drop rate. The single granule drop goal is scheduled to be integrated with this vibration board. The rapid progress in the prototype development benefited from the active involvement of a new student intern P. Fisher.

I. Zatz is working with A. Nagy to complete the MOUs with GA for the supply of additional Pole Shields, a beam calorimeter, and a collimator for the 210 beam.

**ADVANCED PROJECTS (H. NEILSON):**

Wendelstein 7-X (W7-X) collaborators H. Neilson, N. Pablant, and S. Lazerson participated, along with numerous other U.S. collaborators, in a workshop to conduct a team-wide review of the first operational phase of W7-X, OP1.1, and to begin the planning for the next phase, OP1.2. The meeting was organized by the Max Planck Institute for Plasma Physics and held 23-26 May in Greifswald, Germany. Lazerson presented a talk entitled “Error field studies in W7-X,” in which confirmation of the source of the n/m=1/2 error fields in W7-X was presented. This allows estimation of the n/m=1/1 field error which will be critical to island divertor operation. An overview of planned U.S. contributions to OP1.2 was also presented by S. Lazerson on behalf of D. Gates, who was unable to attend. N. Pablant co-authored a presentation on profile data and power balance results from OP1.1, and H. Neilson summarized requirements and joint plans for improving remote collaboration capabilities for OP1.2. Overall, the workshop was a
useful exercise in information dissemination and assessment of the first operational campaign. It provided a means to extract additional value out of the first operational campaign in terms of lessons learned and planning of priorities for improving the overall operation for the next campaign.

A joint IPP-PPPL action plan for improving the effectiveness of remote participation was adopted at a meeting held on April 6-7 at PPPL. It was agreed that the work would be carried out as a joint IPP-PPPL project in the framework of the U.S.-IPP W7-X collaboration agreement, following the project management model that has been developed through a series of successful joint W7-X projects. A project kickoff meeting was held on May 27, attended by PPPL and IPP information technology teams, connecting via Zoom. The author participated from the IPP side and chaired the meeting, while PPPL’s Chief Information Officer, S. Zelick, organized PPPL’s participation in the project. It was agreed that a simple project execution plan would be developed to document agreements between the two parties on scope, deliverables, schedules, and division of responsibilities, and that project meetings will be conducted every two weeks.

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

Health Physics:

The PPPL Environmental, Analytical, and Radiological Laboratory (PEARL) received a Certificate of Achievement from testing laboratory ERA in recognition of the quality of our proficiency testing for 2016. The PEARL was recognized as a Laboratory of Excellence for demonstration of superior quality in achieving 100% acceptable data in evaluation of radiological standards for Gamma Emitters and Tritium. The study associated with this certificate included 62 participating analytical laboratories.

COMMUNICATIONS & MEDIA RELATIONS (L. BERNARD):

Media:

Several news outlets covered the dedication of NSTX-U on May 20. Some of the stories are here:

Philadelphia Business Journal—Princeton Plasma Physics Laboratory’s $94M upgrade to world’s most powerful fusion experiment—

NJTV News—Princeton Plasma Physics Lab Studies Energy Source—

CBS3 Philadelphia—

Princeton Packet—(centraljersey.com)

WHYY Philadelphia (Newsworks, NPR affiliate)—

Trenton Times (NJ.com)—
rad.html

**DIRECTOR’S OFFICE (C. AUSTIN):**

On May 25, Dr. Dennis Mah, ProCure Proton Therapy Center, presented a colloquium entitled, “Proton Therapy for Cancer: Current Status, Promise and Challenges.”

This report is also available on the following web site:
http://www.pppl.gov/publication-type/weekly-highlights