



The PPPL Highlights for the week ending August 14, 2015, are as follows:

FEATURED HIGHLIGHT (M. ONO):

After the completion of an integrated systems test procedure (ISTP), on August 10, 2015, in-shot 201085 NSTX-U achieved a 100kA test plasma satisfying the CD-4 key performance parameters (KPP) threshold of 50kA necessary for completion of the NSTX Upgrade Project. We also have preliminary EFIT equilibrium reconstructions that confirm the plasma current and plasma shape consistent with the camera images. This achieves an important first step toward resuming research operations and using the new capabilities of NSTX-U. We want to say a profound 'thank you' to all the engineering, technical, project management, operations, research, FES, PSO, and other staff members who helped achieve this important milestone. The dedication, hard work, and sacrifice of the NSTX-Upgrade team during the design, analysis, fabrication, assembly, and testing has led up to this occasion. It took over 250 people and 574,000 hours over the last 5+ years to bring this project to this culminating achievement!

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

Summer student Cara Bagley presented her summer work on the Self-Aligning Mirror Mechanism for the Gaussian telescope done in conjunction with A. Zolfaghari and M. Gomez. The team designed, tested, and prototyped (3D printed) this mechanism, which allows for a wave to maintain incidence when the target of interest is moving relative to the wave source. The motivation of the design was to maintain the alignment of reflectometry microwaves while allowing thermal expansion of the ITER vacuum vessel and also correct for build tolerances; however it can have many additional optical applications as well. Princeton University's Office of Technology Licensing is now filing a provisional patent application for this technology.

Researchers at General Atomics have constructed an ITER prototype two-color interferometer/polarimeter in the laboratory, utilizing a CO₂ laser at 1.59 micron wavelength and a quantum cascade laser at 5.33 microns. Presently the optics of this assembly are located on a single optical table. Part of the prototype is a state-of-the-art digital phase demodulator. After optimization and characterization of the noise in the measurements in this configuration, probe and reference beam lines will be extended to

travel along a recently completed optical relay system. The system is a full-scale mockup of the ITER relay geometry with features designed to simulate expected relative motions of components along the ITER beam paths. In the near future this full prototype will be used to experimentally validate and refine the real-time alignment strategy for the ITER TIP system.

A revised DRGA Load Spec draft was ready to be uploaded to IDM, but new comments from the Vacuum Vessel section were received prior to the submittal. These will be addressed before the revision is submitted. A maintenance plan for the DRGA was submitted to IDM in response to an FDR-1 chit and is under review. The DRGA LP12 Vacuum Piping Specification (22QLFE) has completed its iDOCS review and is awaiting approval. The specification for the heated aperture weldment is in progress and will likely be the next one submitted.

Equatorial Port 9 integration work is focusing on the complex cooling water piping network. For each DSM there are up to ten supply and return pipes carrying water to and from the DFW blocks, the DSM front end, and to diagnostic components requiring active cooling. All of this piping has to be as compact as possible while still allowing remote handling welding equipment access and pipe stress relief features. Compact piping is needed to maximize bulk nuclear shielding volume. The team is looking at pre-formed pipes similar to what is used in aerospace applications to avoid large bend radius requirements.

NSTX (M. ONO):

NSTX-U is in the Upgrade Project outage in FY 2015.

The NSTX-U team meeting was held on August 14. The NSTX-U team was updated on the ISTEP and CD-4 KPP plasma operations. An updated schedule toward research operation and the research program plan were also discussed. The meeting material is available on the web at:

http://nstx.pppl.gov/DragNDrop/NSTX_Meetings/Team_Meetings/2015/2015-08/.

The paper “Midplane Neutral Density Profiles in the National Spherical Torus Experiment” by D. P. Stotler (PPPL) et al. was published in Phys. Plasmas 22, 082506 (2015). Atomic and density data in the outer midplane of NSTX are inferred from tangential camera data via a forward modeling procedure using the DEGAS 2 Monte Carlo neutral transport code. Simulations of 12 time slices in seven NSTX discharges produce molecular densities near the vacuum vessel wall of 2 to $8 \cdot 10^{17} \text{ m}^{-3}$ and atomic densities ranging from 1 to $7 \cdot 10^{16} \text{ m}^{-3}$; neither has a clear correlation with other parameters. The sensitivity of the simulated camera image and neutral densities to uncertainties in the data input to the model were assessed. The simulated camera image is sensitive to the plasma profiles and virtually nothing else. The neutral densities at the vessel wall depend most strongly on the spatial distribution of the source; simulations with a localized neutral source yield densities within a factor of two of the baseline,

uniform source, and case. The uncertainties in the neutral densities associated with other model inputs and assumptions are < 50%.

The following two experimental machine proposals (XMPs) were successfully carried out this week (D. Battaglia, PPPL): XMP-100 “Demonstration Plasma for CD4” was completed on Monday, August 10. This XMP demonstrated plasma operation on NSTX-U and satisfied the CD-4 KPP milestone of achieving a plasma discharge with a plasma current greater than 50 kA. In total, 11 plasma attempts were made, with the maximum plasma current increasing with each discharge. The final discharge of the day achieved a maximum plasma current of 109 kA in about 25ms. Magnetic equilibrium reconstructions using the upgraded magnetic measurements were in excellent agreement with camera images of the plasma boundary and the vacuum compensated plasma current measurement. XMP-131 “Increase the CD-4 Plasma Current” was run in the two days following XMP-100. Sixteen plasma shots were taken with the maximum plasma current improving to 140kA and the duration of the discharge increasing to 45ms. The XMP improved the vertical centering of the plasma at breakdown, the growth of the plasma following breakdown, and documented the impact of gas fueling on the initial plasma current ramp rate. Initial spectroscopy measurements indicated that carbon and oxygen were the dominate impurities, with very little nitrogen. This is expected with a good vacuum quality and unbaked carbon first-wall tiles.

The NSTX-U CD-4 Plasma was achieved on August 10 with 100kA discharge. A machine proposal, XMP-131, to adjust the up/down bias on the plasma via the PF3 coils was then performed, successfully increasing the plasma current to 140kA. Phase 2 of coil integrated system testing has now started with initial 500A test shots on PF-2U/L, PF-1aU/L, and PF-4. Coil protection test strips are now being performed per the Integrated System Pest Procedure (ISTP-001). Coil polarity/magnetic diagnostic continue in parallel with the ISTP. Preparations of the Multi-Pulse Thompson Scattering (MPTS) diagnostic lasers for the upcoming Rayleigh/Raman scattering calibration also continued this week.

Access to the NSTX-U Test Cell is expected to be available this coming week. Access must be arranged through work permits approved by the D-Site Shift Supervisors.

ITER & TOKAMAKS (R. HAWRYLUK):

DIII-D:

B. Grierson completed an upgrade to the TRANSP predictive transport solver PT_SOLVER to the most recent release of the GLF23 transport model. The update standardizes the interface between the two turbulent transport models GLF23 and TGLF, where both codes accept input gradients with respect to normalized minor radius and output gyro-Bohm normalized fluxes. A benchmark was performed between PT_SOLVER and TGYRO to verify the update.

S. Haskey worked with Rick Moyer (UCSD) and Mike Van Zeeland (GA) on an initial

test of synchronous imaging for measuring the EHO in QH-mode plasmas. The phase locking to EHO worked well, enabling an intensified camera image to capture various phases of the mode. Technical issues related to the alignment of the focal plane to the mode tangency radius and performance of the intensifier are being addressed.

The second version of the LGI dropper was fabricated and returned from the GA machine shop this week. After some drop tests it appears that the tighter tolerance on the guide tube has been met. A. Nagy, M. Vorenkamp, and Will Brown are in the process of assembling the system for integrated testing.

ADVANCED PROJECTS (H. NEILSON):

During a recent trip to the Wendelstein 7-X (W7-X) facility in Griefswald, Germany, N. Pablant completed the initial integration of the acquisition system software for the X-Ray Imaging Crystal Spectrometer (XICS) with the W7-X CoDaC and MDSplus systems. The acquisition software is currently being developed by Pablant and graduate student S. Massidda of Auburn University. This was an important step in preparing the XICS diagnostic for operation at the start of the first W7-X experimental campaign scheduled for this fall. A full acquisition test sequence was completed which included reading of the W7-X timing packets and MDSplus settings, a complete test of the diagnostic sequence timing, and writing complete XICS data sets into MDSplus. With this successful test of the XICS diagnostic, both hardware and acquisition systems are essentially ready for operation with the exception of a few remaining IPP interface tasks.

D. Gates has been appointed to the Physics Evaluation Group of the Natural Sciences and Engineering Research Council of Canada (NSERC). The group reviews applications for physics grants under the NSERC's Discovery Grants program.

THEORY (A. BHATTACHARJEE):

On August 12, Ralf Kleiber (Max Planck Institute for Plasma Physics) gave a theory seminar on gyrokinetic simulations for tokamaks and stellarators: "Present status of the EUTERPE code: Particle-in-cell methods are an efficient way of simulating the gyrokinetic equation especially in complicated three-dimensional configurations such as stellarators because they are relatively easy to implement and show a good scaling behaviour on parallel machines". The code EUTERPE is a global (full radius and full flux surface) gyrokinetic particle-in-cell code which is able to simulate up to three kinetic species for three-dimensional equilibria. It solves the field equations for the electrostatic and parallel vector potentials and can be used for linear and nonlinear simulations. We will report on recent extensions by hybrid models of varying complexity and a new electromagnetic formulation. Both developments strongly facilitate electromagnetic simulations and simulations of modes interacting with fast particles. Applications results for various Alfvén waves destabilized by fast particles and ITG instabilities in Wendelstein 7-X and LHD with and without a neoclassical electric field will be

presented.

COMPUTATIONAL PLASMA PHYSICS GROUP (S. JARDIN):

Six summer students mentored by E. Feibush presented their work at the Science Education poster session on August 12.

Michael Knyszek (SULI), Matthew Lotocki (SULI), and Zachary Kaplan (HS Science Intern) completed High Performance Visualization of $f(x,y,t)$ Data. Their GPU-PyCUDA implementation runs 15,000 times faster than the original CPU-based serial version. They developed a Numpy vector operation that accelerates serial computing of a six million-element data set from three minutes to one second. Automated multi-core processing provides a speed-up factor by the number of cores.

Matthew Parsons (SULI, Drexel co-op) presented his work on Preparation for a Statistical Study of Plasma Disruptions in JET. He is applying machine-learning techniques to classify disruptive vs. non-disruptive states in plasma parameters acquired from shots on JET. His implementation of cross-validation routines is 100 times faster than prior work. Over 50 GB of signal data from JET has been analyzed.

Hadar Lazar (SULI) presented Effects of Impurities and Incidence Angle on the Secondary Electron Emission of Ni(110). She worked on the high-resolution electron energy loss spectrometry chamber in the PPPL Surface Science and Technology Laboratory. She collected data showing how sample temperature affects contamination due to continuous desorption. Angle of incidence increases primary electron path near sample surface region.

Brandon May (HS Science Intern) worked on Data Visualization and 3-D Modeling Techniques Using NetCDF and VTK Formats. He developed time-step visualizations of data acquired from secondary electron emissions. Additionally, he developed a program for compressing visualization data files so they are 3.5 times smaller and display 12 times faster in VisIt.

PLASMA SCIENCE AND TECHNOLOGY (P. EFTHIMION):

Several PS&T Department members participated in a Frontiers of Plasma Science Workshops virtual town hall meeting on Plasma Self-Organization on August 12; I. Kaganovich organized the workshop. The workshops are sponsored by the DOE Office of Fusion Energy Sciences to identify the grand scientific challenges in plasma science. Invited talks given by PPPL staff were Y. Raitses on "Plasma Sources for Nanomaterials and Nanodevices" and M. Yamada on "Major Scientific Challenges and Opportunities in Understanding Magnetic Reconnection and Related Explosive Phenomena in Self-Organizing Plasmas".

ENGINEERING AND INFRASTRUCTURE (M. WILLIAMS):

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

With the completion of the last KPP (see NSTX-U report), this project is complete.

Fabrication and Operations Division (L. Dudek):

A successful design review was held for the PF1B bakeout heating system. A tabletop assembly of the system was performed to work out some of the layout issues. All of the equipment required for the system will be on-site by the end of Friday. Bake-out of the Nb₃Sn SC test coil was completed. Preparations are being made for a bag mold type VPI of the coil. Began discussions with outside vendors regarding fabrication of replacement parts for the NSTX NBIS grid modules. Machine Technicians are supporting NSTX Operations. Preparations are underway for a mini vent of NSTX in about a week so that several items can be installed on the vacuum vessel. The installation of a new water jet cutter continues in the RESA building.

Facilities and Site Services (M. Donohue):

Engineering Services: The department performed a walk-through inspection with subcontractor VFA of the D-Site mechanical equipment rooms and other areas, including elevators and rooftop heating and ventilation units to continue the site condition assessment. Bailey refrigeration is on-site to perform repairs and annual maintenance on the Central Plant Chillers starting with Chiller 701. Patriot Roofing was on-site to install fall protection anchors at the D Site Pump House roof. Construction submittals for CMG enclosures were reviewed. Based on the most recent quarterly inspection of cafeteria equipment, the Princeton Technical Representative has approved the repair of the Merco Warmer, Cleveland Steamer, and the Panini Grill. The Princeton Technical Representative is working with Business Computing (B101) to schedule their relocation to B116 and is working on the replacement of two awnings on-site.

Fire Protection: The documentation required for the ratification for Gosline Fire Protection was completed. Security instruments and facilities assisted the troubleshoot sump pump 5 and 7 at the D site transformer yard. We are working on the CMG demo and new work drawings for Master Fire. We are also working with Simplex for the replacement Graphics Communication Center.

Maintenance: The renewal activities in the A116 office suite are complete. New parts for the CS Elevator Modernization project were received and USA Hoist resumed work. The new jack cylinder and piston has been installed and the car was recaptured and lowered. Work will continue over the next few weeks to install new controls, doors, and cab. Energy staff attended the DOE Energy Exchange this week in Phoenix, Arizona. Staff members from all federal agencies gathered at the conference to exchange ideas and lessons learned, as well as attend 10 training sessions on various topics ranging from energy efficiency technologies, energy project financing, and strategies to optimize

building performance.

Material services: Eighteen crates of NSTX-U coil fabrication parts were delivered to the warehouse to be placed in Equipment Held for Future Projects. A new employee recently accepted a position within Material Services, Warehouse Operations.

BUSINESS OPERATIONS (K. FISCHER):

Accounting:

The Accounting Division submitted the improper payments and recapture data report to DOE HQ. In addition, PPPL completed and submitted the required risk assessment which included consideration of OMB required risk factors as they relate to PPPL payment activities.

Budget Office:

NASA provided \$60,000 for first-year funding of the research proposal titled “Understanding the Occurrence of High-M Waves in the Magnetosphere and Its Relationship to Solar Wind Conditions”. The work will be performed in collaboration with UCLA. The Principle Investigator for this effort is J. Johnson.

Amendment 5 to the Strategic Partnership Project Agreement with UCLA (“Micro-Engineered Material Surfaces for Electric Propulsion and Pulsed Power”), which adds fifth-year funding and work scope, was submitted to the DOE Princeton Site Office for approval. The amount of funding to be provided for the final year of the project is \$135,000. The Principal investigator for this effort is Y. Raitses.

DOE approved a new Laboratory Directed Research and Development (LDRD) project for FY2015 titled "Construction of Nb3Sn Superconducting Magnets at PPPL". With this additional project, the total FY2015 LDRD funding allocated to date is \$2.7 million against the \$3.0 million ceiling approved by the DOE.

Strategic Business Planning & Analysis:

The Business System Upgrade Project continued with Huron Consulting documenting the future state business process flows for many of PPPL's functional areas. The goal of this phase of the project is to determine how well PeopleSoft 9.2 fits with the Laboratory requirements and also to determine the current business processes that will drive system modifications or re-engineering.

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

A management safety walkthrough of the D-Site NSTX South High Bay and Gallery was

conducted on August 12.

INFORMATION TECHNOLOGY (S. ZELICK):

Networking:

ESnet upgraded PPPL's connection to the Internet which will now utilize two distinct yet redundant 10Gb paths—one to Vienna, Virginia, and one to New York. PPPL's traffic, which had been routing exclusively through Vienna, will now utilize the shortest path to its destination, either through Vienna or NYC. This will optimize transmission times to offsite locations (note that NYC is the jump-off point for transatlantic traffic, notably to GEANT, the network upon which ITER resides).

Business Computing:

C.Venkatraman released the new version of Web NPT reports on August 11.

N. Firdaus released a new General Accounting portal with functionality to process uncosted obligations and journal vouchers (JV). This portal will be enhanced to support GL to Project Analysis, MARS to STARS processing, and Payroll Distribution.

Cyber Security:

We responded to a major DOE cyber security data call for cost estimates and project planning estimates for implementation of multi-factor authentication for all privileged and standard users.

PPPL submitted requisitions for cyber security system upgrades including web security system and 10Gbit network tap.

A response was completed to a minor reportable cyber security incident related to a user clicking on a phishing email and exposing sensitive personal information.

OFFICE OF COMMUNICATIONS (C. CANE):

J.J. DeVoe and K. Palmer with the help of J. Greenwald prepared the August 10 PPPL Weekly with a story on a new model of the “density limit” by Raphael Rosen, a story on Science Education programs by J.J. DeVoe, and an “I am the Lab” profile of Virginia Finley. E. Starkman and J.J. DeVoe provided photos.

J.J. DeVoe sat in on a phone interview on August 5 of J. Menard by Alex Pashley, of RTCC Climate News, who is writing an article about Tokamak Energy (a small spin-off from Culham Labs that is pushing tokamaks with high magnetic fields).

J.J. DeVoe and R. Rosen met with the tour advisory group to plan a tour guide meeting and training planned for August 27 at 10 a.m., in the MBG Auditorium.

J.J. DeVoe and R. Rosen attended a DOE digital update meeting via teleconference on August 5.

J.J. DeVoe covered the achievement of CD-4 on NSTX-U for the PPPL Weekly on August 10.

R. Rosen hosted a tour by Arturo Dominguez of 18 interns from Interra on August 5. The group visited the NSTX-U Control Room, QUASAR, and Science Education.

R. Rosen hosted an open public tour given by L. Ellison for about 20 people on August 14. The group visited the NSTX-U Control Room, QUASAR, and the Science Education Lab.

R. Rosen hosted a tour given by J. DeLooper for ten children and adults in a Boy Scout Troop from Brick Township on August 10. The group visited the NSTX-U Control Room, QUASAR and Science Education Lab.

BEST PRACTICES & EXTERNAL AFFAIRS (J. DELOOPER):

Site Protection Division (F. White):

Engine 66 responded to the area of Receiving and Material Control Offices for an odor of gas. The investigation of the odor was unfounded. The incident was cleared.

Engine 66 responded to Plainsboro for one mutual aid assignment and to Princeton for one mutual aid assignment.

Members of the Site Protection Division (SPD) participated in a PAAA Screening to address findings from a Radiological Protection Audit.

Education (A. Zwicker):

On August 12, the Science Education department hosted its annual Summer Programs Student Poster Session. Approximately 35 posters were on display as students presented their summer work. PPPL staff visited the posters and spoke with students about their projects; government officials were also in attendance and presented certificates and official resolutions to students residing in their districts. The Science Education department also hosted a celebratory BBQ for the students in appreciation of all of their hard work.

PUBLICATIONS:

Stotler, D.P.; et al. “Midplane Neutral Density Profiles in the National Spherical Torus Experiment” was published in Phys. Plasmas 22, 082506 (2015).

This report is also available on the following web site:

<https://sites.google.com/a/pppl.gov/pppl-weekly-highlights/>