



**The PPPL Highlights for the week ending September 1, 2018, are as follows:**

**NSTX-U RECOVERY AND RESEARCH (J. MENARD)**

*Recovery:*

Commissioning and Accelerator Safety Order — R. Camp and J. Malo of PPPL attended the 2018 DOE Accelerator Safety Workshop held Aug. 21-23 at the SLAC National Accelerator Laboratory. At this workshop, members of the accelerator community, both domestic and international, met to discuss safety issues, plans, and experiences, and to network with other safety professionals. Malo gave a talk on PPPL adapting and implementing the Accelerator Safety Order (DOE O 420.2C) to a magnetic fusion experiment. Camp gave a short talk on PPPL's mission and the NSTX-U Recovery process.

Magnets — Fabrication is complete for all four PF1A prototype coils. Evaluation criteria to procure and produce PF1 coils, a draft Selection Procurement Evaluation Board (SPEB), and draft Requests for Proposals (RFPs) were further developed this week. The Sigma Phi coil completed and passed all testing. The Tesla coil passed low-power electrical testing and hydrostatic tests, and coil sectioning is in preparation for turn-to-turn testing.

*Research:*

Collaborations — Y.-S. Hwang, Director of the Center for Advanced Research in Fusion Reactor Engineering, Seoul National University, Korea, visited PPPL Aug. 28-29. He discussed several spherical-tokamak-related physics and engineering issues with NSTX-U/PPPL researchers including S. Jardin, J. Menard, M. Ono, and J.-K. Park.

**U.S. ITER FABRICATION (H. NEILSON)**

The low field side reflectometer (LFSR) team has completed and submitted to the U.S. ITER project office (USIPO) document management team more than 90 percent of deliverable documents for the project's next milestone, a preliminary design review (PDR). The team has also entered more than 200 responses to the 260 system requirements in the project's design compliance matrix. These are key steps in the project's preparation for the PDR. The next step is a U.S. ITER design readiness review (DRR) scheduled for Sept. 11 at the U.S. ITER project office in Oak Ridge, Tennessee.

In preparation for the DRR, the LFSR team has posted a summary documentation package on its [dashboard](#). The material, which is designed to serve as advance reading for review panel members, includes a System Design Description document, drawings and diagrams, key analysis reports, and a summary of the design's compliance with



system requirements.

### **ITER & TOKAMAKS (R. NAZIKIAN)**

A. Nagy, the head PPPL engineer on DIII-D, successfully mentored four outstanding interns this summer. C. Sweetnam (a recent electrical engineering graduate from the University of California, San Diego) spent approximately 15 months working part-time on the neutral beam control system for DIII-D led by Nagy. P. Fisher, a Princeton University sophomore in mechanical engineering, spent the summer designing a toroidal field reversing switch for DIII-D and presented a successful conceptual design review before returning to Princeton. Fisher started interning with Nagy several years ago while he was a high school student in the San Diego area. A third intern, E. Wolfe, worked about 15 months with Nagy while doing a masters in physics at San Diego State University. He is returning to full-time studies in the fall. Everett contributed to the design, fabrication, calibration, and operation of a new impurity powder dropper developed by the PPPL team for fusion devices around the world. D. Mauzey, a mechanical engineering sophomore at Mira Mesa Community College, started working with Nagy two years ago, developing an improved injection mechanism for the Impurity Granular Injector. This resulted in a patent disclosure and installation of the device on DIII-D. Mauzey was also a major contributor to the powder dropper development with three units now installed around the world.

### **DIII-D (B. Grierson):**

S. Cowley, R. Hawryluk, and M. Zarnstorff traveled to General Atomics in San Diego, California, for a two-day visit. On the first day, they toured the manufacturing location of the ITER central solenoid at the Poway facility and held discussions with General Atomics management. On the second day, they met with the onsite PPPL/DIII-D collaboration and toured the DIII-D facility.

S. Haskey presented a talk titled, "Active Spectroscopy Measurements of Deuterium Temperature and Rotation from the Core to SOL on DIII-D," at the Friday Science Meeting, demonstrating recent advances and future plans for main-ion CER on DIII-D.

### **KSTAR Stability (S. Scott):**

S. Scott visited KSTAR this week to perform a beam-into-gas calibration of both the existing KSTAR MSE diagnostic and the new MSE background polychromator. The visit was extended into next week due to a torus vacuum issue. On Friday, a beam-into-gas calibration of the existing KSTAR-MSE diagnostic was performed. Despite an early delay associated with a poloidal field (PF) coil power supply, the calibration started on

Weekly

# HIGHLIGHTS



schedule, and approximately 30 shots were taken over the scheduled four hours of run time. Significantly, it was determined that a shot rep-rate of one shot per four minutes is sustainable even for large PF currents, which bodes well for future beam-into-gas calibrations. The PF currents were ramped during the shot, yielding five pitch angle measurements on each shot, further enhancing the efficiency of the calibration exercise. Calibration data was obtained over the desired range of 1.2-2.5 Tesla, including several shots at each toroidal field to explore the so-called “filter-offset,” i.e., moving the filter passband relative to the MSE spectrum to optimize performance. The calibration of the MSE background polychromator is scheduled for Monday.

## **International Long Pulse (F. Poli):**

A kick-off meeting was held with NFRI staff to discuss planning for the support of the KSTAR experimental campaign in 2018. KSTAR is now preparing for first plasma and will be running to the end of the calendar year. PPPL is engaged in supporting KSTAR research in several areas, including the analysis, understanding, and avoidance of energetic-particle-driven instabilities in high-beta plasmas. The discussions focused on the discharges that NFRI identified of most interest to the high-beta experimental campaign, including plasmas where beam-driven energetic particle instabilities are suppressed by central electron cyclotron heating. Regular follow-up meetings are planning to ensure effective coordination of the joint research.

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

### **Stellarators (D. Gates):**

A successful final design review of a novel X-ray wavelength calibration system for the Wendelstein 7-X (W7-X) X-ray imaging crystal spectrometer (XICS) was completed recently. The development and design of this system has been a collaboration between Ph.D. student J. Kring and Prof. D. Maurer of Auburn University; N. Pablant, L. Delgado-Aparicio, and D. Gates of PPPL; and J. Rice of the Massachusetts Institute of Technology. The solid modeling, production of fabrication drawings, and response to CDR chits was led by Kring and reported at the review. When completed, the system will allow for an absolute wavelength calibration for the XICS system, which in turn allows for absolute plasma flow measurements to be made. This ability to make absolute flow measurement provides two advantages: 1) perpendicular velocity profiles will be made with higher accuracy, and 2) parallel flow velocity profiles will be available for the first time at W7-X. These measurements will allow the radial electric field, which plays a critical role in the investigation of core transport and neoclassical optimization on W7-X, to be inferred.

Weekly

# HIGHLIGHTS



## System Studies (C. Kessel):

C. Kessel participated in the Fusion Prototypic Neutron Source Workshop held in Gaithersburg, Maryland. Kessel presented the materials and components requirements of the Fusion Nuclear Science Facility (FNSF) as background to the needs for fusion neutron material testing before pursuing a FNSF. The presentation included possible timeframes that reflected how the FNSF program would require qualified fusion core components (blankets, divertors, launchers, etc.) at different phases. Presentations were made on international activities, the status of fusion nuclear materials science, fission reactor and ion beam exposure, post-irradiation material characterization, fusion safety and licensing, and specific facility proposals. The primary output was a series of basic first-cut parameters for a neutron source facility in the U.S. — ten displacements per atom (dpa) per year, helium-to-dpa ratio of 10, dpa, > 50 cc high flux volume, 20% max flux variation, and temperature control with maximum of three temperature zones. Future activities will concentrate on the potential platforms for such a facility.

C. Kessel, M. Jaworski, A. Khodak, E. Kolemen, and H. Neilson participated in the Fusion Energy System Studies (FESS) Liquid-Metal Plasma-Facing Component (LM-PFC) face-to-face meeting in Germantown, Maryland. Kessel presented various aspects of the LM-PFCs, along with end-of-project targets for the study group. Kolemen described several upgrade possibilities for the LMX experiment at PPPL; there was some discussion about these possibilities, which include retaining galistan and studying LM-MHD fluid behavior versus upgrading to higher temperatures, as well as creating an enclosure and pursuing tin, lithium, or tin-lithium experiments. Khodak presented his continuing work on using the ANSYS CFX-MHD package to examine divertor LM flow solutions. Jaworski presented his progress on describing the capillary LM system and the governing equations that will lead to design choices. The project will end in Dec. 2018 and several papers will be presented at the ANS Technology of Fusion Energy conference in Nov.

## THEORY (S. HUDSON)

On Aug. 20, W. W. Lee gave a talk at the weekly NSTX-U / Magnetic Fusion Science Meeting. The talk was titled, "Finite Larmor Radius Effects at the H-Mode Pedestal," and included comparisons of the methodologies used for the experimental measurements and the theory predictions.

H. Zhu, Y. Zhou, and I. Dodin published a paper titled, "On the Rayleigh-Kuo criterion for the tertiary instability of zonal flows" [Phys. Plasmas **25**, 082121 (2018)]. This paper reports the stability conditions for intense zonal flows (ZFs) and the growth rate of the corresponding "tertiary" instability (TI) within the generalized Hasegawa-Mima plasma



model. The full abstract and a link to the paper are available here:

<https://theory.pppl.gov/news/seminars.php?scid=4&n=publications>

#### **ENGINEERING (V. RICCARDO)**

Document Management System servers have been setup at PPPL. Onbase software is currently being installed by the vendor. The design document is under review with acceptance tests being developed.

#### **SITE PROTECTION (M. COHEN)**

The Emergency Services Unit completed training on rapid extrication procedures from a vehicle. Ambulance 166 responded to four and Engine 66 responded to three mutual aid assignments in Plainsboro Township.

#### **COMMUNICATIONS & PUBLIC OUTREACH (A. ZWICKER)**

##### **Communications (L. BERNARD)**

The Office of Communications posted two press releases to the PPPL website. One focused on a joint PPPL/Princeton University project led by W. Tang that will use the new Aurora supercomputer at the Argonne Leadership Computing Facility to explore how deep-learning techniques can be used to predict and ultimately prevent plasma disruptions in ITER. The PPPL/Princeton deep-learning software is called the “Fusion Recurrent Neural Network (FRNN),” composed of neural nets that allow a user to train a computer to detect items or events of interest. The software seeks to speedily predict when disruptions will break out in large-scale tokamak plasmas, and to do so in time for effective control methods to be deployed.

The other press release focused on the recent PPPL drive to benefit local children by collecting school supplies for the Trenton Board of Education, which distributed them to school children in need through its Back to School Extravaganza on Friday, Aug. 24.

Both stories were also posted to the *Newswise* and *EurekaAlert!* press release distribution service.

**This report is also available on the following web site:**

<http://www.pppl.gov/publication-type/weekly-highlights>