



The PPPL Highlights for the week ending July 14, 2018, are as follows:

NSTX-U RECOVERY AND RESEARCH (J. MENARD)

Recovery:

Magnets — PPPL finished testing the PPPL PF-1A prototype coil, which passed all acceptance tests. Following completion of these tests, the prototype coil testing notable outcome report was completed by the coil testing team and submitted to the DOE.

Sigma Phi (France) completed the vacuum pressure impregnation (VPI) process and removed the coil from the VPI mold. The coil's external surfaces showed no evidence of voids. The Tesla Engineering (UK) coil was installed in its VPI mold, and will undergo an oven and vacuum VPI trial run.

CTD Inc. finished insulation tests and delivered the final report for the inner poloidal field (PF) coil. Lutava finished production of the conductor and shipped it to ICAS-Tratos, the company awarded the grit blasting and priming contract for the conductor. PPPL is sending legacy PF1A and PF1C conductor to ICAS-Tratos for grit blasting and priming trial runs.

Plasma-Facing Components — Updated electromagnetic simulations have been performed on center-stack first wall (CSFW) tiles. The simulations indicate that the maximum pin force is 16% higher than previous estimates. Qualification of the existing design through static and fatigue tests will start in an effort to reflect this updated analysis. Analysis of the high-heat-flux Langmuir probe design was completed. The analysis indicates that surface temperatures track with the tile temperature and that internal stresses are within the allowable values for R6510. Tensile loading tests of the graphite samples under consideration for the project have been completed and indicate their performance is on par with the data sheet values.

Research:

Visiting Scholars — K. Iwasaki, a graduate student from the University of Tokyo, Japan, completed his summer visit to NSTX-U under the Princeton University-University of Tokyo Student Exchange Program. During his visit, he worked on magnetic diagnostics that included the diamagnetic loop and Rogowski coil. He was advised by the NSTX-U/PPPL staff including M. Bell, R. Ellis, and M. Ono.

U.S. ITER FABRICATION (H. NEILSON)

The Low-Field-Side Reflectometer (LFSR) design team is investigating improvements to facilitate remote maintenance of in-vessel antenna-to-waveguide joints, responding to feedback from the ITER central team's remote handling unit. The capability is necessary in order to replace aging or defective radioactive antenna components during



maintenance operations. A chain-type clamp design, resembling a bicycle chain, with a self-engaging clamp to secure the ends, shows promise. A special tool would be provided to guide the chain around the industry standard “KF” joint during installation, and to link the chain ends with a single nut that would be tightened with a standard remotely operated nut driver as the last step. It should be noted that this study exemplifies the many ways in which ITER engineers are advancing the technology of plasma diagnostics for application to fusion nuclear devices.

ITER & TOKAMAKS (R. Nazikian)

DIII-D (B. Grierson):

Research:

N. Logan and J.-K. Park presented seminars on the plasma response to nonaxisymmetric fields at the Institute of Plasma Physics, Czech Academy of Sciences this week. The seminars were attended by physicists and graduate students working on the COMPASS tokamak. Interest in the work has led to plans for close collaboration, with IPP researchers to analyze and optimize COMPASS experiments. In addition, COMPASS will provide error field correction data to the ITPA MDC-19 database effort being led by Logan and Park.

The paper by M. Knolker, et al., titled, “Investigation of the role of pedestal pressure and collisionality on type-I ELM divertor heat loads in DIII-D,” has been published online in the journal *Nuclear Fusion* (<https://doi.org/10.1088/1741-4326/aace92>).

The paper by R. Nazikian, et al., titled “Grassy-ELM regime with edge-resonant magnetic perturbations in fully noninductive plasmas in the DIII-D tokamak,” has been accepted for publication in the journal *Nuclear Fusion*.

International PMI (R. Maingi):

On July 12, A. Bortolon gave a remote seminar at National Institute for Fusion Science (NIFS, Japan, site of the LHD stellarator) on observations of improved wall conditions by injection of solid boron dust in ASDEX-Upgrade and DIII-D. In both machines, boron injection with the newly installed impurity powder dropper (IPD) appears to reduce impurity sources and wall fueling, similar to that obtained with standard, gaseous boronization procedures. The new technique might have important applications for wall conditioning for long-pulse tokamaks and stellarators. The seminar was intended to illustrate the principal technical aspects of the IPD and the potential research avenues it enables in the fields of plasma-wall interaction and impurity transport, aiming toward a possible future collaboration with LHD.



R. Maingi, E. Gilson, K. Tritz (JHU) and J. Canik (ORNL) traveled to Hefei to participate in ELM-control experiments on EAST. Planning of upcoming experiments next week and finalization of manuscripts from past experiments dominated the week's activities.

ADVANCED PROJECTS (H. NEILSON)

Stellarators (D. Gates):

A recent invited paper, presented by A. Langenberg of the Max Planck Institute for Plasma Physics, reported on results from a series of impurity injection experiments led by PPPL's N. Pablant and conducted during the first W7-X divertor campaign (Op1.2a). The paper, "Impurity Transport Studies at Wendelstein 7-X by Means of X-ray Imaging Spectrometer Measurements," was presented at the 45th European Physical Society Conference on Plasma Physics, held July 2-6 in Prague. Pablant is a co-author on the paper, which has been submitted to the journal *Plasma Physics and Controlled Fusion*. This is the third invited paper resulting from the X-ray imaging crystal spectrometer diagnostic collaboration at W7-X, and highlights the mutual benefits of this U.S.-supplied instrument and the ongoing collaboration.

S. Lazerson conducted flux surface measurements on the W7-X experiment to assess the impact of electromagnetic loads on coil deformation. Lazerson and collaborators worked to measure the location of the flux surfaces just radially inside the 5/5 divertor island chain of W7-X. This was done for multiple rotational transform profiles. This data will then be used to determine magnetic field configurations that compensate the deformation of the superconducting coils due to electromagnetic forces.

D. Gates participated as a member of the thesis committee for Q. Teng, a graduate student in Princeton University's Program in Plasma Physics. Teng presented a defense of his thesis entitled, "A Thermo-Resistive Tearing Mode Model of the Density Limit in Tokamaks." The semi-analytic model developed in the work is able to quantitatively recreate the empirical Greenwald limit that is observed in all tokamaks with a phenomenologically correct model. The work was a quantitative extension of theories that had been previously developed by several authors including Gates, who co-advised Teng, along with R. White and N. Ferraro of the PPPL Theory Department.

THEORY (A. BHATTACHARJEE)

N. Fisch attended the EPS meeting in Prague, where on July 5 he presented a poster titled, "Threshold Effect In Tearing Mode Stabilization," co-authored by A. Reiman. The poster is based on the recent arXiv submission here: <https://arxiv.org/abs/1806.09260>. This work overturns the general assumption within the field that local deposition of radio-frequency power and radio-frequency current drive are unaffected by an island. That assumption suggests that the current required to stabilize the island increases as its

width increases, with the result of directing attention to the stabilization of small islands. However, due to the presence of the island, the presenters identify a powerful current condensation effect, with a threshold width above which there is a decrease in the required current, and a second threshold at which the condensation effect is dramatically enhanced, which efficiently stabilizes larger islands. An important consequence is reducing the difficulty of aiming accurately the radio-frequency power deposition to align radially with the island center.

C. Liu presented his work on kinetic instabilities associated with runaway electrons at the EPS meeting in Prague. In this work, he shows that whistler waves can be driven by the anisotropic distribution of runaway electrons, which can cause “fan instabilities.” The instabilities can be reflected through ECE diagnostic and can cause an increase of threshold electric field for runaway electron growth. The work attracted a lot of attention at the meeting, and future collaborations with scientists from COMPASS, FTU and ASDEX tokamaks are discussed.

The paper titled, “Role of kinetic instability in runaway electron avalanche and elevated critical electric fields” by C. Liu, E. Hirvijoki *et al.*, Phys. Rev. Lett. **120**, 265001 (2018), was published. The abstract and a link can be found on the Theory Department website at <https://theory.pppl.gov/news/seminars.php?scid=4&n=publications>

I. Kaganovich gave an invited talk at the ESP meeting in Prague titled, “Fundamental Study of Synthesis of Carbon and Boron Nitride Nanostructures in Atmospheric Pressure Arc Discharges.” The abstract and a copy of the presentation can be found on the Theory Department website here: <https://theory.pppl.gov/news/seminars.php?scid=3&n=invited-talks>

B. Sturdevant attended the 2018 SIAM Annual Meeting, July 9-13 in Portland, Oregon, and presented a poster titled, “An Equation-free Multi-scale Time Integration Approach to Fusion Plasma Simulation.”

ACADEMIC AFFAIRS (N. FISCH)

Q. Teng successfully earned his Ph.D. on July 11 by presenting his thesis project titled, “A Thermo-Resistive Tearing Mode Model of the Density Limit in Tokamaks.” His committee members were A. Bhattacharjee, N. Ferraro, D. Gates, S. Jardin (Chair), and R. White. His advisers were Ferraro, Gates, and White.

SCIENCE EDUCATION (A. ZWICKER)

From June 29 to July 1, the Science Education department hosted the Minority Serving Institution Faculty Workshop. Nine faculty members participated in the workshop, which was led by A. Dominguez, J. Williams of Wittenberg College, and J. Lopez of Seton Hall University. Its objective is to encourage faculty members to incorporate plasma physics



into their curricula, establish possible collaborations, and attract students from underrepresented communities into the field.

COMMUNICATIONS (L. BERNARD)

The Office of Communications posted two press releases to the PPPL website. The first announced the publication of the 2018 issue of *Quest*, PPPL's annual research magazine, which can be found online here: <https://www.pppl.gov/quest>. The second press release described that a diagnostic built at PPPL and installed on Wendelstein 7-X stellarator in Germany helped confirm W7-X's recent world record. Both stories were posted on the *Newswise* press release distribution service.

In June, approximately 230 people visited PPPL. On June 1, two Princeton University reunion tours were led by A. Brereton, B. Kraus, D. Battaglia, D. Gates, R. Camp, and J. Schwartz; on June 5, a group from New Brunswick High School was led by A. Dominguez; on June 8, a group of Princeton University communications staff was led by C. Gentile, M. Cropper, and N. Allen; on June 13, a group of students associated with the Princeton University Department of Mechanical and Aerospace Engineering was led by R. Camp; on June 14, a tour group of Hutchins Scholars students from the Lawrenceville School was led by H. Schneider; on June 15, a public tour was led by M. Ono and D. Cai; on June 19, a group of researchers associated with the PSI conference was led by D. Gates with help from J. Yoo and P. Hughes; on June 20, a tour group of veterans in the Warrior-Scholar Project was led by R. Kaita; on June 21, a tour group from Montclair State University was led by M. Cropper, N. Allen, and A. Brereton; and on June 26, a group from the DOE's Office of Scientific and Technical Information was led by C. Gentile.

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