



The PPPL Highlights for the week ending February 24, 2018, are as follows:

NSTX-U RECOVERY AND RESEARCH (J. MENARD)

Recovery

A Preliminary Design Review (PDR) for the Coil Cooling Water System Interlocks was held on February 22, 2018.

A Purchase Order for the Inner PF1 production coil conductor has been issued.

PPPL and two of the three external vendors have begun winding of the prototype PF1 coils. The third external vendor is expected to begin winding in the next week.

Research

The paper "Scenario Development during Commissioning Operations on the National Spherical Torus Experiment Upgrade," by D. Battaglia, et al. was published in Nuclear Fusion 58 (2018) 046010. This paper summarizes the rapid progress in developing L- and H-mode scenarios during the first operation of NSTX-U and describes progress on wall conditioning, inductive startup, error field correction, real-time control and diagnostics that enabled this development.

The paper "Plasma boundary shape control and real-time equilibrium reconstruction on NSTX-U," by D. Boyer et al. was published in Nuclear Fusion 58 (2018) 036016. This paper provides significant detail on new tools for real-time boundary control that accelerated progress in developing NSTX-U target scenarios.

E-H. Kim and N. Bertelli attended the KSTAR conference 2018 in Muju, Korea. Kim gave an oral presentation entitled "2D full-wave simulation of HHFW energy loss in the scrape-off layer of NSTX." Bertelli gave an invited oral presentation entitled "Research plan in support of the helicon wave modeling in KSTAR." R. Raman also attended the KSTAR 2018 Conference to give a talk on the Electromagnetic Particle Injection (EPI) concept, and to discuss the EPI concept with KSTAR personnel.

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U.S. ITER FABRICATION (H. NEILSON)

The Laboratory's ITER Diagnostics team hosted a visit by A. Gattuso and M. Smiley of General Atomics to discuss their joint work on the ITER low field side reflectometer (LFSR). In two days of meetings, the engineering team conducted a detailed review of the entire system design, as presented by PPPL designer M. Duco. Issues needing additional work in preparation for a planned preliminary design review (PDR) were identified, and responsibilities assigned. In addition, the team reviewed and updated presentation responsibilities for that review.

ITER & TOKAMAKS (R. Nazikian)

DIII-D (B. Grierson)

Research:

E. Kolemen et al. published "Initial development of the DIII-D snowflake divertor control," at Nuclear Fusion <https://doi.org/10.1088/1741-4326/aab0d3>. This article described the use of the snowflake divertor (SFD) magnetic geometry to reduce the peak heat flux on divertor surfaces. The SFD magnetic topology is unstable and requires complex magnetic control. The first realtime snowflake detection and control system on DIII-D is described. The control algorithm calculates the position of the two null points in realtime by locally expanding the Grad-Shafranov equation in the divertor region. A linear relation between variations in the poloidal field (PF) coil currents and changes in the null point locations is then analytically derived. This formulation enables simultaneous control of multiple PF coils to achieve a desired SFD configuration. It is shown that the control enabled various snowflake configurations in scenarios such as the double null advanced tokamak in DIII-D. The SFD resulted in a 2.5-times reduction in the peak heat flux for many energy confinement times (2–3 sec) without any adverse effect on the core plasma.

B. Grierson et. al. published "Orchestrating TRANSP Simulations for Interpretative and Predictive Tokamak Modeling with OMFIT," in Fusion Science and Technology <http://www.tandfonline.com/doi/full/10.1080/15361055.2017.1398585>. This article shows how TRANSP simulations are being used in the OMFIT workflow manager to enable a machine-independent means of experimental analysis, postdictive validation, and predictive time-dependent simulations on the DIII-D, NSTX, JET, and C-MOD tokamaks. By using OMFIT to orchestrate the steps for experimental data preparation, selection of operating mode, submission, postprocessing, and visualization, we have streamlined and standardized the usage of TRANSP.

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C-MOD (R. Nazikian):

A paper written by C. Kessel reporting experiments on Alcator C-Mod, to explore ELMy H-mode Helium discharges and their performance relative to D experiments, was accepted for publication in Nuclear Fusion. Helium discharges will be the primary focus of the phase between first plasma (2025) and DT operations (2035) in ITER, and they will be used to access as much plasma operation experience as possible without making neutrons and activating the hardware surrounding the plasma. For these experiments the L to H power threshold for He discharges ranged from similar to D at higher density to nearly 2 times higher at lower density. ELM frequencies were found to be similar for He and D. The He discharges show a net lower plasma stored energy, 75% of D. The net power to sustain the H-modes in He discharges was about 40% higher than that required to sustain similar D discharges. Tungsten laser-blow-off experiments showed that the ELMy and EDA H-modes in He avoided W buildup in the core, while infrequent ELM regimes showed W accumulation, with overall similar behavior in D. Based on this study, it will be important to have as large an auxiliary heating capacity as possible early in the ITER program to facilitate entry to H-mode, and to sustain H-modes in He.

AUG (Maingi):

A. Bortolon and R. Lunsford visited IPP Garching for one week, to support the ongoing collaboration on the multi-impurity powder dropper (IPD). During the visit, the powder dropper was upgraded with a new powder flow-meter, implementing a more robust design for finer and more effective measurements of the flow rate. The newly installed flow-meter was commissioned with BN powder test drops delivering outstanding performance (more than three times the light throughput). A local technician (V. Brack) has been trained to correctly calibrate and safely operate the system, to allow the dropper to be utilized throughout the upcoming campaign, without the need of PPPL personnel on site. An operation manual was drafted and delivered to the IPP group, including the descriptions of the different elements of the system, calibration and alignment procedures, as well as the reference calibration curves for the materials in use.

Progress was made in data analysis from the B and BN injection experiments conducted in October 2017, in preparation of the contributions to the upcoming PSI and IAEA conferences. An interesting observation emerged during this visit is that BN powder injection was able to sustain good confinement with better efficiency than N₂ gas injection. In particular, the production of ammonia, an critical issue for tritium retention in ITER scale devices, was found more than an order of magnitude smaller than in similar discharges with N₂ injection.



ADVANCED PROJECTS (H. NEILSON)

Stellarators (D. Gates):

A review article entitled, “Stellarator Research Opportunities: A Report of the National Stellarator Coordinating Committee” (NSCC), also known as the STELLCON report, was published online this week in the *Journal of Fusion Energy*. The report outlines important research topics for stellarators and also describes a timeline for a re-invigorated stellarator research program for the U.S. The report is the product of a process which was initiated in February 2016 with a workshop held at MIT, called STELLCON, that was organized by the NSCC. The NSCC coordinates community activities for U.S. stellarator research and is chaired by PPPL physicist D. Gates. The report was developed as an input to the ongoing National Academy of Sciences panel on U.S. burning plasma strategy.

System Studies (C. Kessel):

The Laboratory hosted a video conference with collaborators at South Korea’s National Fusion Research Institute (NFRI) to discuss progress on their joint work on South Korea’s demonstration power plant concept study, K-DEMO. The detailed analysis of a vertical plasma disruption coupled to finite element analysis model, with ferromagnetic treatment of the reduced activation martensitic (RAFM) steel, was reported by S. Kwon from NFRI, highlighting the multiple conducting structures in the design and a scaled ITER disruption model for the plasma. PPPL’s P. Titus reported an alternative disruption analysis with a different approach to the plasma evolution, and modeling of multiple conductor components in the core. D. Mikkelsen reported vertical launch electron cyclotron heating, finding that the very restrictive conditions for high current drive efficiency by this method indicated that midplane launching was more robust and flexible. T. Brown described his detailed development of vertical maintenance, concentrating on how the sector parts are moved and where they are transported, showing a model for a structure over the tokamak with individual cranes for each vertical port. This work continues as part of a yearly activity aimed at collaborating on the K-DEMO design.



THEORY (A. BHATTACHARJEE):

A heliophysics seminar titled, “Magnetic Reconnection in MHD and Kinetic Turbulence,” was presented by N. Loureiro of MIT. The abstract is available on the Theory website:

<https://theory.pppl.gov/news/seminars.php?scid=9&n=helio-physics-seminars>

A Theory Seminar titled “Parametric Instability, Inverse Cascade, and the 1/f Range of Solar-Wind Turbulence,” was given by B. Chandran, of the University of New Hampshire. The abstract and a copy of the presentation are available on

<https://theory.pppl.gov/news/seminars.php?scid=1&n=research-seminars>

The article, “Magnetohydrodynamic Turbulence in the Plasmoid-Mediated Regime,” by L. Comisso, Y.-M. Huang, M. Lingam, E. Hirvijoki, and A. Bhattacharjee was published in *The Astrophysical Journal* **854**, 103 (2018). The abstract and link can be found on

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

COMMUNICATIONS & PUBLIC OUTREACH (A. ZWICKER)

The New Jersey Regional Science Bowl sponsored by the U.S. Department of Energy was held Feb. 23 and 24 at PPPL. Two teams, one from middle school, one from high school, will represent new Jersey in the national Science Bowl tournament in Washington, D.C. Princeton Charter School won the middle school contest, and West Windsor-Plainsboro North High School narrowly won the high school competition.

COMMUNICATIONS (L. BERNARD)

L. Bernard attended a meeting of the National Laboratory Chief Communications Officers (NLCCO) and U.S. Department of Energy Office of Science public affairs and communications staff to discuss communications activities Feb. 15-19 in Austin, Texas, coinciding with the annual meeting of the American Association for the Advancement of Science.

DIRECTOR’S OFFICE (R. HAWRYLUK)

A Laboratory Management Review (LMR) meeting was held on Feb. 21. The Director’s Office made presentations and discussed their observations with the participants in the meeting.

This report is also available on the following web site:



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