Weekly HIGHLIGHTS

PPPL PRINCETON PLASMA PHYSICS LABORATORY
U.S. DEPARTMENT OF ENERGY

The PPPL Highlights for the week ending August 18, 2018, are as follows:

NSTX-U RECOVERY AND RESEARCH (J. MENARD)

Recovery:

NSTX-U Project — A successful NSTX-U Project preliminary design review (PDR) was conducted August 15-16. There were seven external reviewers and additional internal reviewers that contributed input, and there were many talks provided over the two days. The talks on Day 1 focused on issues including global, analyses, magnets, the center stack casing, polar regions, plasma-facing components, passive plates, and systems engineering. The talks on Day 2 focused on issues including bakeout, CAD integration, diagnostics and instrumentation, interspace pumping, the PF1B power loop, and test cell shielding. One of the final talks of the review pertained to the assembly of the NSTX-U machine. This talk integrated many sub-assemblies that had previously been discussed during the review. The afternoon of the second day provided three breakout session: vacuum vessel/systems engineering, PFCs/magnets, and shielding/instrumentation/assembly. These breakout sessions allowed time for both detailed discussion and questions-and-answer sessions, and provided discovery based on the talks.

Magnets — The Tesla prototype coil shipped last week. This is the last of the four prototype coils, which means prototype coil evaluation is nearly complete. The Sigma Phi coil successfully completed initial electrical testing and is being prepped for sectioning, internal inspection, and turn-to-turn electrical testing.

NTC Shielding — A successful PDR was conducted on August 14 for the test cell oxygen monitoring and radiation annunciation jobs. This PDR covered the expansion of the existing radiation monitoring system to bring it into compliance with DOE regulations. The review also covered plans for the installation of a new oxygen deficiency monitoring system with a siren alert in the test cell, and alarm indicators at test cell entrances.

Polar Region — The polar region group completed an In-718 weld specimen tensile test that screened for fatigue life specimens and heat treatment optimization. This work supports the design, analysis, and validation of the PF1A/B coil support slings.

U.S. ITER FABRICATION (H. NEILSON)

The Low-Field-Side Reflectometer (LFSR) design team continues its preparations for a preliminary design review (PDR) later this year. The team has made steady progress under team lead A. Zolfaghari in preparing over 100 deliverable documents, including both drawings and written reports. The majority have already been uploaded to the U.S.

ITER document management system, iDocs, and are in various stages of review. In addition, the team is developing its Design Compliance Matrix (DCM), an ITER tool that provides the mapping between the LFSR system requirements, of which there about 260, and the reference documents (analysis reports, R&D reports, drawings, etc.) which justify the design's compliance with the requirements. A. Basile leads the DCM development activity. Recently, U.S. ITER Diagnostics Team Lead H. Neilson visited the Project Office at ORNL to review the status of PDR preparations with U.S. ITER management. Plans for a PDR readiness review in early September were finalized.

ITER & TOKAMAKS (R. NAZIKIAN)

DIII-D (B. Grierson):

Research:

Two papers by S. Haskey that focus on main-ion transport physics have been published online. The first paper, titled, "Active spectroscopy measurements of the deuterium temperature, rotation, and density from the core to scrape-off layer on the DIII-D tokamak" was published in *Review of Scientific Instruments* (doi). It advances the diagnostic technique of main-ion charge-exchange recombination spectroscopy to the plasma edge, demonstrating the capability to directly measure the main-ion temperature, density and toroidal velocity in the pedestal region. The second paper, titled, "Main ion and impurity edge profile evolution across the L- to H-mode transition on DIII-D" was published in *Plasma Physics and Controlled Fusion* (doi). The paper reports research involving using this diagnostic to reveal that main-ion rotation evolves smoothly in time and space across the L-H transition, while the carbon impurity velocity develops a non-monotonic feature in the pedestal. The neoclassical code NEO is applied to these conditions and partially explains the feature in the impurity rotation, although diverges very near the separatrix where finite orbit effects are expected to play a role.

Operations:

A conceptual design review was held for the toroidal field reversing switch (TF switch) by P. Fischer, a Princeton University second-year student intern under A. Nagy. The review was successful, and the design is continuing with the manufacturer (Staubli) and the PPPL design team. The new onsite PPPL junior engineer T. Raines will continue to the development of the TF switch at DIII-D. A preliminary design review (PDR) is scheduled for September.

International PMI (R. Maingi):

R. Maingi, Z. Sun, R. Lunsford, K. Tritz (Johns Hopkins University), and D. Andruczyk (University of Illinois at Urbana-Champaign) co-led remotely the flowing-liquid-lithium limiter experiment on August 14 on the EAST device via the PPPL remote control room. The third-generation limiter was constructed entirely out of molybdenum by PPPL. Final attachment of the limiter to the distributor and collector was done at ASIPP. Extensive testing of the heaters used to control the surface temperature was performed at UIUC. The limiter was inserted into EAST discharges with up to seven megawatts of auxiliary heating power, including both radio-frequency- and neutral-beam-heated H-mode plasmas. The results will be reported by R. Maingi in an oral presentation at the 2018 IAEA Fusion Energy Conference. The leaders of the experiment on the ASIPP side were J.S. Hu and G.Z. Zuo.

A follow-up ZOOM discussion on joint US and Chinese participation in COMPASS experiments was held on August 16. The discussion focused on the near-term liquid metal capillary porous system experiments in COMPASS planned for March 2019 and Oct-Dec. 2019. The next step is to identify specific areas of collaborative interest from the US and Chinese side for participation on the COMPASS program. Attendees from the US/PRC side were as follows: D. Andruczyk (UIUC), J. Canik (ORNL), A. Diallo (PPPL), E. Gilson (PPPL), T. Gray (ORNL), J.S. Hu (ASIPP – China), E. Kolemen (PU/PPPL), J. Lore (ORNL), R. Maingi (PPPL), F. Scotti (LLNL), Z. Sun (PPPL), K. Tritz (JHU), K. Woller (MIT), and G. Zuo (ASIPP – China). There were also five attendees from the COMPASS team, led by R. Dejarnac, including M. Hron, V. Weinzettl, P. Vondracek, and J. Cavalier.

KSTAR Stability (S. Scott): A comprehensive evaluation of the wavelength passbands required for the upcoming beam-into-gas calibration of the KSTAR MSE background polychromator is complete. The beam-into-gas calibration is scheduled for Aug 30-31. It was decided to extend the toroidal field range of the beam-into-gas calibration down to 1.2 tesla to support high-beta disruption experiments for the upcoming KSTAR run campaign. Operational testing of the shot sequence for the beam-into-gas calibration has begun using the GUI, which controls the MSE background polychromator system, which will determine the allowable shot rep rate.

ADVANCED PROJECTS (H. NEILSON)

Stellarators (D. Gates):

The Probe-Mounted Powder Injector (PMPI), originally fabricated by PPPL's A. Nagy and D. Mauzey at General Atomics, was shipped to PPPL this week for integrated system testing. The testing will take place this coming week using the control system developed

at PPPL by R. Lunsford. The final design review will be held on Monday next week and, pending a successful review and successful integrated testing, the plan is to ship the completed assembly next week to the Max Planck Institute for Plasma Physics in Greifswald, Germany for use in experiments on Wendelstein 7-X (W7-X) at the end of September. The PMPI will be used to inject boron carbide powder as the first step in a plan to develop a steady-state in situ boronization technique for use during long pulse (~30 mins) operation.

ACADEMICS (Fisch)

Y. Shi successfully earned his Ph.D. on August 16 by presenting his thesis project titled, "Plasma Physics in Strong-Field Regimes." His committee members were I. Dodin (Chair), N. Fisch, J. Mikhailova, H. Qin, and A. Reiman. His advisers were N. Fisch and H. Qin.

ENGINEERING (V. RICCARDO)

During the week ending on August 10, ENG-006 / 010 / 033 / 057 / 060 were reissued; ENG-061 / 062 / 063 / 064 were added; and ES-DRFT-01 was reissued. Training sessions for responsible engineers on ENG-063 (system breakdown and categorization) were held on August 13 and 17. A training package covering most of the ENG procedures in their most up-to-date condition has been developed for September, and two pilot session were held on July 25 and August 7. The templates and form for the new and reissued procedures are available on the Engineering Forms & Templates website.

COMMUNICATIONS (L. BERNARD)

The Office of Communications posted two press releases to the PPPL website. One focused on a collaboration between PPPL and General Electric to develop a new switch that will convert high-voltage DC current to high-voltage AC current for consumers more efficiently, enabling reduced-cost transmission of long-distance power. The other chronicled the recent poster session for the high school summer internship program. Both stories were also posted to the *Newswise* and *EurekAlert!* press release distribution services.

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