Weekly HIGHLIGHTS

PPPL PRINCETON PLASMA PHYSICS LABORATORY

U.S. DEPARTMENT OF ENERGY

The PPPL Highlights for the week ending March 3, 2018, are as follows:

NSTX-U RECOVERY AND RESEARCH (J. MENARD)

Recovery:

A preliminary design review (PDR) for the PF1B bipolar circuit was completed on Feb. 27.

For polar region scope, a new design for the PF1A and PF1B pre-load mechanisms has been developed. The first polar region PDR is scheduled for late March and is an important prerequisite for the inner PF coil FDR. Work continues on the design of the production inner PF1 coils and on the fabrication of the prototype PF1 coils by PPPL and three external vendors.

The installation procedure for the TVPS backing pump was approved and the chiller that will support the pump has been ordered.

PPPL staff supported high heat flux testing and development at the Penn State Applied Research Lab. The trip, sponsored by Oak Ridge National Laboratory (ORNL), improved the operation and control of the e-beam system and demonstrated large-area control of the applied heat fluxes mimicking an Eich-function heat flux profile. Simultaneously evaluated was one of two candidate PFC diagnostic schemes using commercial, off-the-shelf thermocouples. The experiments were led by T. Gray (ORNL) and supported by D. Youchison (ORNL), G. Smalley, B. Ellis, N. Allen, K. Lamb, and M. Jaworski (PPPL). A preliminary report of the experiments was delivered to the PFC team on Feb. 28. A statement of work and associated requisition were completed to obtain material property certifications of three candidate PFC materials. Material samples were delivered to the laboratory and will be shipped for testing as soon as a contract for testing is procured.

Research:

D. Mueller, D. Boyer, K. Erickson and E. Gilson from PPPL attended the KSTAR Conference in Muju, South Korea. Mueller gave an invited talk on vertical stabilization on KSTAR; Boyer gave a talk on real-time forecasting and feedback-control algorithm design enabled by TRANSP; Erickson gave a talk on PPPL real-time advances applicable to KSTAR; and Gilson gave a talk on powder droppers as a versatile tool for wall conditioning and impurity delivery. They also participated in talks concerning the PPPL-KSTAR collaboration as well as private discussion with KSTAR researchers regarding future experiments. R. Nazikian gave a plenary talk and presented a talk for J-K Park. The Columbia University/PPPL/MIT international collaboration on the KSTAR device was also represented at the 2018 KSTAR Conference by S. Sabbagh, S. Scott, and J.H. Ahn, who presented a total of three talks (two invited) and two poster presentations.

O. Izacard of Princeton University (working on NSTX edge/pedestal simulations and analysis) has been named Plasma Physics and Controlled Fusion Reviewer of the Year for 2017.

S. Kaye participated in the National Academy of Sciences Panel Study on Burning Plasma, which met at General Atomics, La Jolla, California, Feb. 26-28. The purpose of the meeting was to gather information and discuss proceeding forward toward completing the panel's final report.

U.S. ITER FABRICATION (H. NEILSON)

In preparation for a June 2018 preliminary design review (PDR), the low field side reflectometer team continues to make progress in completing analyses and documentation supporting the design. PPPL engineer W. Wang recently completed an analysis of cooling water flow through the plasma-facing support block cover plate, with special attention to the potential for deformation due to high fluid pressure. The results showed that structural ribs of sufficient thickness could provide adequate stiffness, a solution that avoids the need for brazing and the attendant manufacturing and inspection risks. A perimeter weld is sufficient to secure the plate to the block. Neutronics analysis by engineer J. Klabacha is nearing completion, and a preliminary assessment of nuclear heating loads from these analyses is already in progress.

ITER & TOKAMAKS (R. NAZIKIAN)

R. Nazikian gave a plenary talk on edge-localized-mode (ELM) control at the KSTAR conference in Tejeon, South Korea. D. Mueller gave an invited talk on plasma control at the same meeting. Fifteen PPPL staff attended the meeting to discuss various aspects of research relevant to the KSTAR program. Discussions were held on the scientific challenges and opportunities for future collaboration on KSTAR.

DIII-D (B. Grierson)

Research:

A. Bortolon led an experiment on DIII-D to mitigate ELMs by high-frequency pacing with frozen deuterium pellets. The goal of the experiment was to study the triggering of ELMs in low pedestal collisionality plasmas close to ITER conditions. While collisionality plays an important role in ELM stability, previous demonstrations of ELM mitigation in DIII-D by were obtained in conditions of high collisionality, due to the cooling effect inherent to fueling pellets. During the experiment, the ELM triggering

efficiency was low, possibly due to the higher electron temperature at low collisionality, causing faster pellet ablation.

S. Haskey attended the 2018 KSTAR conference in Muju, South Korea, and gave an oral presentation titled, "Differences between main-ion and impurity toroidal rotation, temperature, and density across the L- to H-mode transition in DIII-D." The talk included some of the most recent results from the DIII-D edge main ion charge exchange system including D+ temperatures which are half the commonly measured C6+ temperatures near the separatrix, and the rapid increase of the co-Ip D+ toroidal rotation near the separatrix which is not present in the impurity measurements.

A. Ashourvan presented a seminar at the University of California at San Diego on Feb. 27. In this talk, he presented results on the experimental investigation of a model for edge momentum transport [T. Stoltzfus-Dueck, *Phys. Rev. Lett.* 108, 065002 (2012)] based on a comprehensive database of low-torque discharges in the DIII-D tokamak.

ADVANCED PROJECTS (H. NEILSON)

Stellarators (D. Gates):

Colleagues at Germany's Max Planck Institute for Plasma Physics (IPP) reported that a pair of U.S.-provided divertor "scraper" elements was successfully installed in the Wendelstein 7-X stellarator device. The scrapers are special-purpose plasma-facing components that were designed by a team of Oak Ridge National Laboratory (ORNL) and PPPL scientists and engineers to test a solution for reducing divertor target overheating risks under certain long-pulse plasma operating scenarios. The fabrication effort was led by PPPL and the units were delivered to IPP in 2017. The scrapers are equipped with instrumentation that will allow an ORNL-led physics team to measure the scrapers' effects on plasma heat and particle flows in the edge region and make comparisons with physics and engineering models used in the design.

The Laboratory is fabricating an X-ray wavelength calibration system for the X-ray imaging crystal spectrometer (XICS) now operating on Wendelstein 7-X. All solid modeling (CAD) is now complete, and generation of final manufacturing drawings is in progress. Purchasing of long-lead-time hardware has begun with the placement of an order for a compact X-ray tube system with a cadmium anode. A prototype cadmium anode tube was developed by Proto Manufacturing of Taylor, MI for this purpose, and has undergone extensive testing by PPPL in collaboration with MIT's Plasma Science and Fusion Center. This system will be able to produce line emission at 3.95 angstroms that can be used as a wavelength reference for calibration of plasma flow velocities on W7-X.

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THEORY (A. BHATTACHARJEE):

The paper "Study of the likelihood of Alfvénic mode bifurcation in NSTX and predictions for ITER baseline scenarios," by V. Duarte, N. Gorelenkov, M. Schneller, E. Fredrickson, M. Pedesta and H. Berk, was accepted for publication in Nuclear Fusion. A link to the article is here:
https://theory.pppl.gov/news/seminars.php?scid=4&n=publications

A Research and Review Seminar titled "Plasmoid Instability Mediated Current Sheet Disruption and Onset of Fast Reconnection," was presented by Y-M Huang. The abstract and a copy of the presentation are available at:
https://theory.pppl.gov/news/seminars.php?scid=2&n=rr-seminars

COMMUNICATIONS (L. BERNARD)

The Office of Communications posted two press releases to the PPPL website. One reports that using computer simulations and theoretical analysis, PPPL physicists Y-M Huang, A. Bhattacharjee, and L. Comisso demonstrated that a phenomenon known as the plasmoid instability creates bubbles within plasma that can lead to magnetic reconnection when certain conditions are met. The other focuses on the recent New Jersey Regional Science Bowl competition that took place at PPPL on Feb. 23 and 24. Both stories were also posted on the *Newswise* and *EurekAlert!* press release distribution services.

DIRECTOR'S OFFICE (R. HAWRYLUK)

On Feb. 28, Professor M. Evans from the MIT physics department presented a colloquium entitled, "Gravitational Waves: Discoveries and Future Detectors."

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