Weekly HIGHLIGHTS

PPPL PRINCETON PLASMA PHYSICS LABORATORY

U.S. DEPARTMENT OF ENERGY

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

NSTX-U RECOVERY AND RESEARCH (J. MENARD)

Recovery:

A preliminary design review (PDR) was held on March 22 for the vessel/coil instrumentation.

The PPPL winding shop has completed winding the first layer of the prototype inner poloidal field coil. A successful manufacturing readiness review was held for an external vendor on March 13.

The NSTX-U recovery project met with its advisory board on March 22 and 23 at PPPL.

Research:

R. Perkins visited Tri Alpha Energy to discuss electron heating with high-harmonic fast wave power, antenna design, and strap-to-strap decoupling. He gave a seminar titled "Mitigating edge losses of high-harmonic fast-wave heating power on the National Spherical Torus Experiment."

M. Podestà visited DIII-D the week of March 19 to discuss analysis of DIII-D data and plans for modeling activities for the Joint Research Target (JRT)-18 Milestone. He also discussed with DIII-D collaborators ongoing work to validate the fast ion transport "kick model" implemented in TRANSP for neoclassical tearing mode (NTM) instabilities.

F. Poli's tutorial paper, "Integrated tokamak modeling: when physics informs engineering and physics planning," has been published online in the special issue of *Physics of Plasmas* with invited talks from the 2017 DPP meeting.

U.S. ITER FABRICATION (H. NEILSON)

Low-field-side reflectometer (LFSR): The U.S. LFSR team, including PPPL and General Atomics engineers, held a series of meetings with Central Team counterparts to discuss important strategies for routing diagnostic system equipment across safety barriers (wall penetrations) in the ITER complex. Microwave signal transmission data for several barrier options were presented. Design requirements for barriers, including fire and leak scenarios, were discussed and clarified with preferences communicated. These meetings provided the information needed for the project to converge on a safety barrier design strategy with which to proceed to the preliminary design review (PDR) schedule for June 2018.

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ITER & TOKAMAKS (R. Nazikian)

DIII-D (B. Grierson):

Research:

Z. Wang and N. Logan ran a half-day contingency experiment on March 20 and an additional 2-hour session on March 23 to verify the energetic particle contribution to neoclassical toroidal viscosity (NTV). In the experiments, a beam voltage scan is performed with matched beam power and torque and resonant/non-resonant magnetic perturbation are applied to study the NTV. The fraction of trapped fast ions is also varied by applying different beam combination.

F. Poli and M. Podestà traveled to DIII-D during the week of March 12 to participate in an experiment led by C. Collins (GA) on reducing fast ion transport by Alfvén eigenmodes (AE) in high qmin scenarios for the joint research target (JRT). Poli and Podestà participated in the preparation of this experiment with predictive time-dependent simulations of the discharge evolution and AE stability analysis. In-between shot TRANSP analysis was used during the day in support of the experiments (B. Grierson).

Operations:

The DIII-D powder dropper has been assembled and is waiting for the vacuum system to be completed for bench pump down, operational tests, and leak checking, in order to qualify for machine installation on April 10. The control system wiring is being installed and the PCS is being programmed, with the vacuum PLC programming to follow. This device will be used during the last week in April for impurity studies on DIII-D in conjunction with the impurity granular injector.

EAST Plasma-Materials Interactions (R. Maingi):

E. Gilson, R. Lunsford, and A. Nagy visited ASIPP in China to install a powder dropper on EAST. The equipment was removed from the shipping crate, reassembled in the laboratory and successfully tested. The equipment is being installed on EAST, with experiments anticipated in the summer of 2018. In addition, R. Maingi held a videoconference with the EAST team to establish experiment priorities, emphasizing the new capabilities (versatile powder dropper, granule dropper, and the next generation flowing liquid lithium limiter plate).

EAST/KSTAR Scenarios and Control (F. Poli):

F. Poli traveled to DIII-D during the week of March 19 to participate into the experiment led J. Huang (ASIPP) on development of high betap discharges. In-between-shot TRANSP analysis has been used during the day in support of the experiments. The EAST/DIII-D team, guided by J. Huang and A. Garofalo, demonstrated achievement of plasmas with high density, operating close to the global stability limit with internal transport barriers and magnetic shear reversal in the plasma core.

KSTAR (R. Maingi):

E. Gilson and A. Nagy visited KSTAR to meet with the KSTAR team on the future installation of a powder dropper for long-pulse wall conditioning. A presentation by Nagy outlined the installation, operation, and equipment details to the KSTAR team. The installation will be scheduled for the last week of June 2018.

ADVANCED PROJECTS (H. NEILSON)

Stellarators (D. Gates):

Laboratory physicists S. Lazerson and N. Pablant have led key planning activities in preparation for the upcoming Wendelstein 7-X experimental campaign, known as OP1.2b. Lazerson continues to lead the Task Force on Scenario Integration, while Pablant has led the development of nine experimental proposals on energy and impurity transport within the Task Force on Core Transport and Plasma Stability, and the subgroup on Impurity Transport. These nine proposals address physics issues that are central to the understanding of stellarators and W7-X in particular. They include “Investigation of core transport with off-axis heating,” “Investigation of core transport in high-density helium plasmas heated with second harmonic O-mode ECH,” “Investigation of core transport with neutral beam heating,” “Role of electric field on high-Z impurity control,” “Effect of magnetic configuration on impurity transport,” “Effect of helical ripple on impurity transport,” “Recycling of high-Z impurities,” “Impurity transport in hydrogen and helium plasmas — comparison to LHD,” and “Investigation of forward and reverse transitions from ion-root to electron-root.”

D. Gates made a presentation, “Recent advances in stellarator optimization,” at the US-Japan Joint Institute for Fusion Theory Workshop on “Progress on advanced optimization concept and modeling in stellarator-heliotrons.” The workshop was held in Kyoto, Japan from March 22-23 at the Uji Campus of Kyoto University. The talk described the results and current activities of an ongoing LDRD-funded study that seeks to understand the relationship between plasma shaping and stellarator coil complexity. The workshop was a

kickoff for a proposed collaboration on design optimization between the US and Japan. It was agreed that further discussions on a collaborative optimization activity would occur during future meetings between Y. Suzuki and Gates. Several of the US researchers that attended the meeting are also working optimization and a multi-institution collaboration was viewed as potentially beneficial.

System Studies (C. Kessel):

The Fusion Energy Systems Study team held a face-to-face meeting at DOE Fusion Energy Sciences office in Germantown, MD, this week. The main purpose was to review progress in the team's study of liquid metal plasma facing components (PFC) in fusion systems. Areas covered included liquid metals and their behavior, solid substrates, design concepts, and integration issues. National team leader C. Kessel reported project status and began to identify specific R&D items and possible platforms for doing the research, primarily in the area of liquid metals behavior. Several PPPL researchers reported on their work supporting the study. M. Jaworksi reported on his development of the capillary concept for the first wall or divertor. A. Khodak reported his 3D simulations of flowing liquid metal in the divertor with ANSYS CFX-MHD. M. Hvasta reported on cold trap approaches for removing impurities and tritium from lithium. E. Kolemen reported progress on FLIT and modeling of liquid metals. R. Majeski discussed some aspects of liquid metal PFCs. Apart from the PPPL presentation, highlights included modeling of the tritium fueling/exhaust loop by Savannah River National Laboratory, LM corrosion experiments performed at Oak Ridge National Laboratory, simulations of flowing first wall and "tub" divertor concepts from UCLA, lithium divertor simulations from Lawrence Livermore National Laboratory, and some early discussions of the liquid metal embrittlement phenomena associated with rapid failures. The project is moving into solid substrates characterization more strongly, along with a strong push on design concepts development within the fusion nuclear science facility (FNSF) device envelope. Concepts are needed to understand the prototypical characteristics of the systems, which points towards needed experimental capability.

COMMUNICATIONS AND PUBLIC OUTREACH (A. ZWICKER)

COMMUNICATIONS (L. BERNARD)

The Office of Communications posted one press release to the PPPL website. The story focused on former PPPL physicist Clayton Myers, who helped build a database of information gathered from five tokamaks around the world. Myers and other researchers used the database to determine that halo current rotation could damage the walls in ITER. The story was also posted to the *Newswise* press release distribution service.

L. Bernard attended the NLCCO (National Laboratories Chief Communications Officers) meeting in Washington, DC, on March 19, and met with representatives from the U.S. Department of Energy Public Affairs staff from Headquarters and public affairs staff from program areas including the Office of Science, the National Nuclear Security Administration, and Office of Nuclear Energy.

DIRECTOR'S OFFICE (R. HAWRYLUK)

From March 20-21, T. Brog attended the NLCOO Campus Planning Workshop in Newport News, VA. On March 22, M. Zarnstorff attended the Basic Energy Sciences Advisory Committee meeting (BESAC) in Washington, D.C. From March 22-23, an NSTX-U recovery advisory board meeting was held at PPPL to review the status of the project and their near-term plans.

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