Weekly HIGHLIGHTS

The PPPL Highlights for the week ending December 9, 2017, are as follows:

NSTX-U RECOVERY AND RESEARCH (J. MENARD)

Recovery:

A preliminary design review (PDR) for the Center Stack Cooling Tube/Heat Transfer Plate (HTP) was completed on Nov. 30. A PDR for the High-Temperature Helium System (HTHS) Feed-throughs was completed on Dec. 1. For the PF coils, the automated Co-winding and Inspection System has been installed and tested. The development of the operating procedure and training for the system is underway. A PDR for the inner PF coils is scheduled for Dec. 14.

Research:

On Nov. 27, J. Menard gave an NSTX-U physics meeting presentation on preparation for the next NSTX-U PAC-39 meeting to be held Jan. 9-10, 2018.

On Nov. 28, D. Kim gave an NSTX-U/I&T physics meeting presentation entitled, "ORBIT modeling of fast particle redistribution induced by sawtooth instability." Initial tests on NSTX-U show that introducing energy selectivity for sawtooth (ST)-induced fast ion redistribution improves the agreement between experimental and simulated quantities (e.g., neutron rate). Thus, it is expected that a proper description of the fast particle redistribution due to ST can improve the modeling of the ST instability and interpretation of experiments using a transport code.

S. Sabbagh gave the presentation, "Automated Identification of MHD Mode Bifurcation and Locking in Tokamaks," at PPPL on Nov. 30. The talk reviewed a new, portable code capability that automatically analyzes MHD magnetic spectrograms for further use in computer-generated disruption event characterization and forecasting. Analysis of NSTX/-U plasmas with various MHD activity was shown. This talk was given as part of a collection of presentations by Columbia University researchers reviewing a wide array of analyses comprising international collaboration research on KSTAR.

On Dec. 5, D. Boyer presented, "Preliminary results of modeling neutral beam injection on NSTX-U using neural networks." Predictive real-time control applications, along with scenario development optimization studies and between-shot analysis, require models of actuators and plasma response that can be evaluated quickly while maintaining relatively high fidelity. In this work, data produced by NUBEAM during interpretive TRANSP runs for the shots in the 2016 NSTX-U campaign is used to train a neural network model of the heating, current drive, torque, and other effects of beam injection. The resulting

model reproduces the NUBEAM results well, with an execution time measured in microseconds, as opposed to seconds or minutes.

A group from NSTX-U visited the Brookhaven National Laboratory from Dec. 4-5 to learn how their user facilities are operated, with the goal of improving NSTX-U operation as a DOE Office of Science user facility. The group consisted of B. Stratton, J. Menard, S. Gerhardt, M. Jaworski, G. Tchilinguirian, and M. Ono. They visited the STAR detector at the Relativistic Heavy Ion Collider, the Accelerator Test Facility, the National Synchrotron Light Source II, and the Center for Functional Nanomaterials. In addition to touring these facilities, discussions were held with representatives of the facilities to address specific questions on a number of topics including the experimental proposal process, the structure and functions of the user group, user training, and best practices. Similar visits to user facilities at Argonne National Laboratory and Oak Ridge National Laboratory are planned for Jan. 2018.

U.S. ITER FABRICATION (H. NEILSON)

Low-field-side reflectometer: In response to proposed project nuclear safety requirements, the design team is investigating solutions to increase the space envelope for personnel access. We found that with a reconfiguration of the interspace support structure, we can increase the personnel access envelope width from about 600 to 710 millimeters. The need for further modifications is being assessed, in concert with ITER's Central Team staff.

Motional Stark Effect (MSE): Work on mirror-cleaning research and development at Nova Photonics continues according to a recently adopted work plan. Technicians remove surface contamination by bombarding the surface with ions from a glow discharge, in a process known as sputtering. The MSE mirror-cleaning program uniquely incorporates the capability to electrically bias the mirror. Recently, the Nova team reported measurements of plasma density profiles across the mirror surface using a newly constructed Langmuir probe. The team made measurements both with and without an applied magnetic field, and both on and away from the mirror surface. They are investigating the cleaning performance and operating conditions in both helium and neon.

Weekly HIGHLIGHTS

ADVANCED PROJECTS (H. NEILSON)

Stellarators (D. Gates)

This week, S. Lazerson led experiments on Wendelstein 7-X (W7-X) to explore divertor heat load symmetry using the U.S. supplied trim coil system. These studies exhibited a change in the error field with reversals of the main magnetic field direction. The results of those experiments were used to determine a trim coil setting that then allowed for a record 75 megajoules of injected energy throughput and multiple 25-second discharges throughout the week. Additionally these settings were used to achieve over 1 megajoule of stored energy in a record setting shot for the device. This week's experiments, as well as a highly successful OP1.2a experimental campaign on W7-X, concluded on Dec. 7.

Results from the X-ray imaging crystal spectrometer (XICS) diagnostic system on W7-X, which was designed and installed by PPPL in collaboration with the Max Planck Institute for Plasma Physics (IPP), have led to the selection of IPP's Dr. A. Langenberg as an invited speaker at the upcoming High Temperature Plasma Diagnostics conference (HTPD-2018). Langenberg and PPPL's N. Pablant have collaborated closely to develop and install the XICS diagnostic and accompanying analysis software, and to operate it throughout the recently completed OP1.2a experimental campaign. This invitation to Langenberg recognizes the scientific importance of this powerful diagnostic system and demonstrates the benefits achievable through international collaborations on diagnostic development and physics analysis.

During a recent visit to Japan's National Institute for Fusion Science (NIFS), site of the Large Helical Device stellarator, H. Neilson met with staff to discuss opportunities for increased collaboration by U.S. fusion scientists. Already several such collaborations are active, some of them involving joint research on LHD and Germany's Wendelstein 7-X (W7-X), the world's two leading stellarator facilities. Of particular interest to PPPL, there is agreement on the desirability of installing an X-ray imaging crystal spectrometer (XICS) on LHD in order to strengthen an ongoing collaboration between NIFS and PPPL on core heat and impurity transport. There is a recognized need for further study in the topics of core heat transport, particularly in the case of ERCH heated plasmas, as well as core impurity transport, both of which would benefit from XICS measurements on LHD. Additionally, these measurements would enable a more complete set of joint W7-X/LHD joint experiments.

Weekly HIGHLIGHTS

THEORY (A. BHATTACHARJEE)

COMPUTATIONAL PLASMA PHYSICS GROUP (S. Kaye, S. Jardin)

J. Sachdev attended the AToM SciDAC Meeting, which was held during the week of Nov. 28 at General Atomics in San Diego. The objective of this project is to develop an integrated framework for Whole Device Modeling (WDM) of tokamaks. Specific topics discussed included the need for scrape-off layer and free-boundary equilibrium solvers that meet the requirements of a reduced WDM. As part of this project, the plasma state developed for TRANSP and IPS will be upgraded. TRANSP will also be used to benchmark the workflows produced by this effort. J. Breslau is working on developing a stand-alone ISOLVER equilibrium solver module, which will be uploaded to the NTCC module library. He has identified the minimum subset of TRANSP executables, libraries and device description files to be able to run the ISOLVER scripts without requiring an entire TRANSP build. M. Gorelenkova is working on an IDS to NUBEAM translator in order to install NUBEAM as a Kepler component on the IMAS system at ITER. NUBEAM has been run and benchmarked successfully within the IMAS framework installed at PPPL. She has also changed the implementation of CQL3D in TRANSP so that the module can be run in MPI as either a subroutine or sub-process. This step is an important one in developing a more modular framework for TRANSP. Both Josh and Marina reported this work remotely at the JET TRANSP User's meeting on Dec. 4. J. Carlsson has written a bash script to configure all the environment variables needed to build and run TRANSP. This will make it easier for developers to build TRANSP on a new system and to run different versions of TRANSP on the same machine. X. Yuan is continuing his work on developing a deep learning network with an algorithm that can address discontinuities in TGLF fluxes; this approach could help facilitate predictive TRANSP runs based on the TGLF transport model.

SITE PROTECTION (F. WHITE)

SPD Personnel conducted "Official Use Only" training for PPPL staff and an Occurrence Reporting & Processing Systems (ORPS) progress meeting. SPD Personnel participated in two Technical Resources Committee (TRC) meetings, and members of the Emergency Services Unit (ESU) participated in Confined Space Training conducted by the Mercer County Fire Academy.

Weekly HIGHLIGHTS

COMMUNICATIONS & PUBLIC OUTREACH (A. ZWICKER)

COMMUNICATIONS (L. BERNARD)

The Office of Communications posted a press release to the PPPL website about two teams at PPPL that together have won more than 210 million core hours on two of the most powerful supercomputers in the nation. Physicist C.S. Chang and his team were awarded more than 160 million core hours on Titan, the U.S.'s most powerful supercomputer, located at the Oak Ridge Leadership Computing Facility. They were also awarded 61.5 million core hours on Theta, a supercomputer at the Argonne Leadership Computing Facility. In addition, 50 million core hours on Titan were awarded to PPPL Theory head A. Bhattacharjee and his team. The story was also posted on the *Newswise* and *EurekAlert!* press release distribution services.

DIRECTOR'S OFFICE (R. HAWRYLUK)

On December 6, the VP's Office and the Director's Office hosted a visit by Department of Energy Under Secretary for Science, Paul Dabbar, Dr. Steve Binkley, Deputy Director for Science Programs, and Ms. Kristen Ellis, Chief of Staff for Under Secretary for Science.

On December 6, Dr. Hagen Zimer of TRUMPF Photonics Inc., presented a colloquium entitled, "High Power Laser Activities at TRUMPF."

This report is also available on the following web site:

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