



The PPPL Highlights for the week ending November 11, 2017, are as follows:

NSTX-U (J. MENARD)

Recovery:

For the PF coils, the PPPL magnet team traveled to Nazareth, Pennsylvania, to meet with Everson Tesla to discuss prototype fabrication. For the polar region components, performed additional finite element analysis on the coil support slings, and redesigned the bolted capture feature on the PF1A and PF1B supports. For the passive plates, the Analysis Group is investigating the effects of magnetic damping and the potential reduction in EM load resulting from these effects.

The NSTX-U Recovery Project Plasma-Facing Component group conducted the first set of high-heat flux tests at the Applied Research Laboratory (ARL) located at Penn State University on Nov. 7. Candidate materials for high-heat flux regions of the NSTX-U were subjected to intense heating in a procedure to rank the materials based on destructive testing. Results will be reviewed at the PFC Preliminary Design Review (PDR) scheduled for Nov. 15.

Research:

S. Sabbagh attended the 22nd Workshop on MHD Stability Control at the University of Wisconsin-Madison and gave a talk entitled “Progress on Disruption Event Characterization and Forecasting in Tokamaks (DECAF).” The talk showed analysis of NSTX, NSTX-U, and KSTAR plasmas regarding disruption prediction and tool development, kinetic equilibrium reconstruction, and stability analysis in connection to the DECAF code.

The paper “Application of Townsend avalanche theory to tokamak startup by coaxial helicity injection,” by K.C. Hammond, R. Raman, and F.A. Volpe was published online in *Nuclear Fusion* [<https://doi.org/10.1088/1741-4326/aa8fa4>]. For many years, the basic experimental requirements to achieve a successful plasma breakdown in a tokamak have been derived using the Townsend avalanche theory. To date, the theory has primarily been applied to the conventional startup technique of generating a loop voltage with the central solenoid. This paper extends the theory to determine corresponding requirements for an alternate method, Coaxial Helicity Injection (CHI), which facilitates startup without a solenoid or loop voltage. The methodology used in this study is applicable to the design of CHI systems in larger tokamaks and STs, like a Fusion Nuclear Science



Facility. This study was carried out with funding from a DOE Office of Science Graduate Student Research (SCGSR) award, which permitted K. Hammond to work with the NSTX-U team on-site at PPPL for four months in the fall of 2016.

ITER & Tokamaks (R. NAZIKIAN)

DIII-D (B. Grierson)

At the State of the Laboratory Address, PPPL Interim Director R. Hawryluk awarded B. Grierson the Kaul Foundation Prize for Excellence in Plasma Physics Research and Technology Development for his “groundbreaking studies in deuterium charge exchange spectroscopy, leading to the first routine measurement of main ion flow in a fusion plasma.”

Research:

N. Logan presented a talk titled, “Optimizing 3D Field Coils in Tokamaks” at the 22nd Workshop on MHD Stability Control in Madison, Wisconsin. In the talk, he detailed an alternative approach to 3D field coil design in which physics models are used to determine the most important 3D spectra for controlling the physics of interest and then stellarator design tools are used to form 3D coils that can efficiently produce those fields. Using this approach, he was able to show outboard external fields can be optimized to efficiently perform the primary tasks many current tokamaks use internal coil arrays for. This has important implications for reactors, where the hostile neutron environment discourages internal coil designs.

ADVANCED PROJECTS (H. NEILSON)

Stellarators (D. Gates)

On Nov. 8, D. Gates presented a seminar titled, “Stellarator Research for Fusion Energy” to the Power and Energy chapter of the IEEE at Bell Labs in Crawford Hill, New Jersey. Gates was given a tour that included a stop at the famous radio antenna that first observed the cosmic microwave background in 1964 which led to a Nobel prize for Penzias and Wilson in 1978. He also toured laboratories working on high-speed fiber optic communications technology. The seminar was attended by about 30 members of the local chapter of the IEEE which was well received with a question-and-answer period extending for an hour after the talk.



Fusion Energy System Studies (C. Kessel)

C. Kessel participated in the International Conference on Fusion Reactor Materials in Aomori, Japan, where he presented a poster on the status of the ongoing liquid metal plasma facing component study, and gave an oral reporting on the materials challenges associated with the Fusion Nuclear Science Facility (FNSF). The liquid metal presentation described 1) liquid metal properties and behavior, 2) solid substrates and interactions with liquid metals, and 3) some integration issues associated with liquid metal systems. The FNSF topic focused on the importance of the complex in-service environment only accessible in an actual fusion device and the need to perform detailed material examinations on components in the FNSF to establish a database for larger power producing fusion devices. Near-term materials R&D activities were described, motivated by the FNSF study, including 1) helium thresholds for onset of degradation mechanisms, 2) aluminum additions to fusion-relevant steels to mitigate liquid metal corrosion, 3) first wall high-heat-flux design and material interface issues, and 4) vacuum vessel material development in the low irradiation dose regime while balancing tritium permeation and accident scenarios. These topics can be studied presently in available platforms. Kessel also had discussions with N. Yanagi on the US/JA Workshop and Y. Sakamoto and K. Tobita on interactions with the DEMO team at QST.

THEORY (A. BHATTACHARJEE)

A theory seminar titled, “A fast integral equation based solver for the computation of Taylor states in toroidal geometries,” was presented by A. Cerfon from the Courant Institute at New York University. The abstract and slides are available on the Theory Department website:

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

Computational Plasma Physics Group (S. Jardin, S. Kaye)

E. Feibush presented “Visualization in Research” at the Princeton University Research Computing Day on Nov. 7. He described scientific visualizations of simulations from PPPL, the Princeton Institute for Computational Science and Engineering (PICSciE), and the Geophysical Fluid Dynamics Laboratory (GFDL). Emphasis was on applying visualization techniques based on the dimensionality of the application data and incorporating visualization into the workflow. Time-dependent processes were illustrated with animated sequences. Feibush also co-chaired the Research Computing Visualization Contest and its awards ceremony.

Weekly

HIGHLIGHTS



Y. Petrov from CompX visited PPPL Nov. 6-10 to work with M. Gorelenkova, X. Yuan and F. Poli. Petrov has extended the use of GENRAY/CQL3D to cases where multiple Fokker Planck species are present in the plasma. This addresses HHFW heating in the presence of neutral beams fast ions, which is relevant for NSTX and NSTX-U, and IC heating with minority heating when the thermal background plasmas is expected to deviate from Maxwellian distribution. The preliminary tests are currently ongoing, and the interface will be available to users when the implementation has been successfully executed on selected user cases. In addition, the robustness of CQL3D in TRANSP has been improved by making a more efficient usage of the memory allocation and of the compilation of libraries. Tests for robustness and compatibility with the system are undergoing to compare the use of CQL3D both as a subprocess and as a subroutine in TRANSP. (F. Poli)

ENGINEERING & INFRASTRUCTURE (V. RICCARDO)

N. Greenough was named a Distinguished Engineering Fellow for his creation of new methods of heating and diagnosing plasmas with radio frequencies. He received the award from R. Hawryluk, interim director, at the State of the Laboratory address.

I&C Group:

The I&C group has developed device support for its Reconfigurable Timing Unit (RTU) from MDSplus. A Python program was written that reads data from the MDSplus tree and uses the Experimental Physics and Industrial Control System (EPICS) to configure the hardware, making it possible to integrate it with the NSTX-U shot cycle.

ENVIRONMENT, SAFETY & HEALTH (J. LEVINE)

Auditors from DQS-UL conducted an assessment of PPPL's Environmental Management System (EMS) to measure the Lab's transition to the 2015 version of ISO-14001. Three auditors visited all areas of the Laboratory, met with senior management and representatives of Princeton and the U.S. Department of Energy, and interviewed dozens of employees and contractors.

The audit identified eight best practices, seven opportunities for improvement, and five minor non-conformances to the standard's requirements. The auditors recommended certification of our EMS to the ISO-14001:2015 standard upon resolution of the non-conformances. Completion of this audit is a major milestone toward the re-certification of our EMS to the new ISO-14001 standard, which is a Notable Outcome in the Laboratory's FY 2018 PEMP goals.



COMMUNICATIONS & PUBLIC OUTREACH (A. ZWICKER)

A. Dominguez visited Howard University and the University of Maryland Eastern-Shore to present a seminar on the status of fusion energy research and options for interested undergraduate students to participate in research at PPPL. The visits are part of an ongoing effort to recruit underrepresented populations to PPPL and to the U.S. DOE Laboratories through support from the DOE Office of Workforce Development for Teachers and Students.

COMMUNICATIONS (L. BERNARD)

The Office of Communications posted two press releases to the PPPL website. One described work by PPPL physicist D. Mueller and a team of U.S. and Korean researchers that has sharply improved the stability of the elongated plasma in KSTAR, setting an example for how to address similar issues in other superconducting devices such as ITER. The other press release focused on research by PPPL physicist W. Fox showing that plasmas created by lasers could provide insight into plasmas found in outer space. Both stories were also posted on the *Newswise* and *EurekAlert!* press release distribution services.

DIRECTOR'S OFFICE (R. HAWRYLUK)

On Nov. 7, Interim Director R. Hawryluk presented the annual State of the Laboratory address to all staff. M. Kevin-King for the Organizational Diagnosis team presented the core values. Hawryluk provided an update on PPPL's mission, research initiatives, the status of the NSTX-U recovery, improvement of laboratory operations, budget information, and announced award recipients.

On Nov. 8, L. Rasmussen, of Ras Labs, presented a colloquium entitled, "Ras Labs-CASIS-ISS NL Synthetic Muscle™ Experiment Returned to Earth: Resistance to Radiation."

On Nov. 8-9, a meeting of the bi-annual PPPL Advisory Committee was held. The purpose of the PPPL Advisory Committee is to provide an outside independent review of PPPL science and operations, and the committee then provides PPPL management with feedback and recommendations.

This report is also available on the following web site:

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