



The PPPL Highlights for the week ending September 28, 2019 are as follows:

### **NSTX-U RECOVERY (J. GALAYDA) AND RESEARCH (S. KAYE)**

#### **Recovery (J. Galayda):**

**Center Stack Casing, HTT Precision Coil Bending** — PPPL successfully finished the test bend of the precision Inconel625 heat transfer tube for the NSTX-U vertical divertor cooling. The precision coil winding method worked well.

**Magnets** — Work continued on preparation for coil winding at Sigmaphi. The manufacturing readiness review date is forecast for mid-October. PPPL is working closely with Sigmaphi on the delivery schedule.

**Shorted Turn Protection PDR** — A preliminary design review (PDR) was held Sept. 20 for this scope. During an NSTX-U design verification and validation review (DVVR), a chit was created to evaluate the possibility of an additional, real-time protection system that would work with the digital coil protection system (DCPS) to continuously monitor coil voltages and currents. This additional protection system would flag changes in behavior that would indicate failures inside a coil, and would be used to detect arcing at the coil terminals. This PDR was held to review preliminary designs following from the presented at a conceptual design review held on May 2.

**Institutional Staff Augmentation Blanket Ordering Agreements (BOA)** — Eighteen BOAs were issued by PPPL's procurement team that will streamline the acquisition of personnel resources.

#### **Research (S. Kaye):**

N. Nishino, Professor of Graduate School of Engineering at Hiroshima University, completed his two-week visit to NSTX-U/PPPL under the US-Japan Personnel Exchange Program. He worked with F. Scotti (LLNL), S. Sabbagh (Columbia University), S. Zweben and M. Ono (PPPL) on the analyses of the NSTX and NSTX-U fast visible camera data.

### **U.S. ITER FABRICATION (H. NEILSON)**

Detailed design of the ITER Low Field Side Reflectometer in-vessel antenna assembly continues to progress toward a design "freeze" in the next few weeks. Interfaces with the enclosing shield module, including geometry, water connections and supply rate, and aperture specifications through the first wall and vacuum closure plate, have been finalized. With the highly loaded front-end antenna assembly design now fixed, attention has shifted to the waveguide feed assemblies and their attachments to the

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shield module structure. Preparations for electromagnetic and neutronic analyses of the assembly have begun with the creation by the LFSR team of analytical models based on the CAD models of this complex system. These analyses must include the details of the surrounding structures and neighboring diagnostics in order to generate valid loads for structural analysis of the assembly.

## ADVANCED PROJECTS (D. GATES)

### Stellarators (D. Gates):

PPPL's responsibilities in the national Fusion Energy Systems Studies (FESS) program focus on magnet design analysis supporting the program's current study of high magnetic field options for a fusion nuclear science facility (FNSF). This week, the Laboratory's FESS team, led by P. Titus and Y. Zhai, presented a plan for a preliminary assessment of the potential of high-critical-temperature superconductors (HTS) to enable design improvements over the reference FNSF design. Zhai presented a plan to develop conductor and winding pack designs for the toroidal field magnet and central solenoid, addressing cooling, thermal stability, and quench issues. Titus described the structure concepts available to support a high-field magnet system. The team will integrate conductor, winding pack, and structure solutions into the reference FNSF radial build to quantify potential benefits compared to low temperature (LTS) designs. In the course of the FNSF study, the team will identify HTS-specific technical issues not present in LTS designs and will propose solutions.

On Sept. 27, K. Hammond presented a contributed talk at the ISHW titled, "Drift effects on W7-X edge heat and particle fluxes." The talk described the results of a series of experiments on the Wendelstein 7-X (W7-X) device in Greifswald, Germany, designed to determine the impact of particle drifts in the edge plasma on the distribution of heat and particles on the plasma-facing components. Particle drifts were shown to cause systematic differences in the heat flux patterns on components on the upper side of plasma with respect to components on the lower side. A specific flow pattern was proposed to explain the asymmetries in low-density plasmas, but further analysis will be required to understand the results at higher densities.

N. Pablant gave an invited talk at the International Stellarator Heliotron Workshop (ISHW) in Madison, Wisconsin, on Sept. 24. The presentation, titled "Validation of Neoclassical Ambipolar Radial Electric Fields in Wendelstein 7-X," described measurements of the radial electric field as provided by the X-Ray Imaging Spectrometer (installed by PPPL on the W7-X stellarator) and showed comparisons of predictions from neoclassical theory. This comparison provides a convincing argument that current neoclassical theory provides an accurate description of particle and energy

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transport in W7-X. This invited talk also provided an overview of efforts by a range of scientists at W7-X to measure radial electric field from additional diagnostics.

C. Zhu presented a poster at the ISHW on Sept. 24 titled, "Identification of Dangerous Error Fields in Stellarators Using Hessian Matrix Method." The poster described the results of a recent paper by the same name that investigates the important types of error fields in stellarator coils.

D. Gates presented a poster at the ISHW on Sept. 26 titled, "Preliminary plans for a permanent magnet stellarator." The poster described design activities that have been carried out in order to make a cost estimate for a proposal that hopes to build such a device at PPPL.

D. Gates attended the meeting of the Executive Council of the International Energy Agency Stellarator/Heliotron Technical Collaboration Program (<https://www.iea.org/tcp/sh/>), held Sept. 24 in conjunction with the ISHW in Madison, Wisconsin. As a result of this discussion, Gates has been named as the Chair of the International Program Committee for the next ISHW to be held in Warsaw, Poland. Gates also gave a summary presentation describing the activities of the previous CWGM meeting, which was held in Berlin in March.

As a satellite to the ISHW conference, the 20th CWGM mini-workshop was held in Madison, Wisconsin, on September 24. As the CWGM Impurity Task Force leader, Pablant provided a presentation on the progress of joint tasks within the impurity TF. Progress has been made in all topics within the impurity group and strong robust collaboration between international groups has been successfully formed. Gates also attended as a member of the International Program Committee of the CWGM.

Zhu attended a meeting of the Simons *Hidden Symmetries* workshop held in Chicago on Sept. 28 in conjunction with ISHW. Progress in the *Hidden Symmetries* activity was discussed.

## **THEORY (S. HUDSON)**

V. Duarte gave a Theory seminar on Sept. 19 titled, "First-principle formulation of resonance-broadened quasilinear theory near an instability threshold."

S. Hudson visited the Fermi National Accelerator Laboratory (Fermilab) and Argonne National Laboratory as part of the Oppenheimer Science Energy Leadership Program (OSELP). The Oppenheimer cohort met with laboratory leadership and toured the facilities.



## **PLASMA SCIENCE & TECHNOLOGY (P. EFTHIMION)**

Representatives from PPPL attended the International Electric Propulsion Conference (IEPC) in Vienna, Austria, Sept. 16-20. The IEPC is the premier international meeting of the electric propulsion community. PPPL staff I. Kaganovich, Y. Raiteses and Princeton University students A. Powis and J. Simmonds attended the conferences.

Raiteses presented two papers describing thruster research at PPPL in collaboration with Saskatchewan. Kaganovich presented a paper on basic plasma physics effects in electric propulsion devices (accumulation of cold electrons and soliton formation in plume). Simmonds presented two papers on the topic of his thesis, "In micro plasma thruster and cancelation of nano satellites for mapping magnetic reconnection," (co-authored with Y. Raiteses and M. Yamada). Powis presented research from his recent publication on the scaling of the plasma spoke frequency within a Penning discharge. He also shared lessons learned from PPPL High Performance Computing experts on developing robust and scalable kinetic codes for modeling plasma discharges, such as a Hall thruster. Emphasis was made on the importance of code validation and verification, with Powis recently being involved in a collaborative international benchmark of seven codes. A publication of this work was recently accepted by the *Journal of Plasma Sources Science and Technology*.

The authors, including Powis and Kaganovich, were presented with the award for best poster at the IEPC. The award was presented at a dinner within the City Hall of Vienna, a grand venue, which demonstrated the importance of this technology to both the European and international plasma communities.

## **ENGINEERING (V. RICCARDO)**

On Sept. 17, G. Tchilinguirian attended a meeting at DOE headquarters in Washington, D.C. to discuss opportunities to use 5G wireless technology to benefit the DOE's scientific mission. He gave a brief presentation about PPPL and presented some ideas solicited from different areas of the Lab. The 5G working group will continue to build on this initial meeting with roundtable discussions and workshops in the upcoming fiscal year.



## **COMMUNICATIONS & PUBLIC OUTREACH (A. ZWICKER)**

### **Communications (L. Bernard):**

The Office of Communications posted one story to the PPPL website. It focused on former Science Undergraduate Laboratory Internship (SULI) intern Barbara Garcia, a senior at Manhattanville College in Purchase, New York, majoring in physics and mathematics. She was one of three students who came to the SULI program after attending the 2018 Undergraduate Plasma Workshop at PPPL. The workshop teaches undergraduate students about plasma physics and fusion energy and is aimed at encouraging Hispanic, black, Native American, and female undergraduates to pursue STEM careers. The story was also posted to the *Newswise* press release distribution service.

### **DIRECTOR'S OFFICE (S. COWLEY)**

M. Zarnstorff attended the International Stellarator/Heliotron Workshop in Madison, Wisconsin, Sept. 22-27.

S. Cowley attended a Royal Society policy briefing on nuclear cogeneration on Sept. 25, in London, United Kingdom.

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