



**The PPPL Highlights for the week ending December 14, 2019, are as follows:**

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

**Recovery (J. Galayda):**

**Coils** — M. Kalish was at Sigmaphi in France this week actively completing the review of the winding procedures and providing oversight for the winding lines. The first winding line and clean room are complete, tested, and ready for the installation of the repaired PF1A mandrel that arrived on Dec. 12 from the repair facility. The second winding line was assembled and in testing. The PF1B mandrel has passed inspection in China and has been shipped to Sigmaphi. It has been received by French customs. Earliest possible delivery of PF1B to Sigmaphi is Dec. 16.

**NSTX-U Test Cell** — The BOA subcontractor completed forming and concrete placement for the test cell labyrinth wall. Formwork has been removed and final finishing is complete. After verification of the 28-day compressive strength tests, the wall will be ready for placement of the roof blocks.

**HTT/HTP** — Hollis Line continues to fabricate the many parts required for the heat transfer plate (HTP). S. Sheckman (Engineering) and M. Ramos (QA) visited the factory in New Hampshire on Dec. 11 and delivered the heat transfer tubing (HTT) and inspected numerous completed parts. The HTP is on track for a Jan. 2020 delivery.

**PF1A Sling Assembly Modification Peer Review** — A peer review was held Dec. 11 to review the design of the new belt and buckle as part of the machine core structure assembly since the final design review (FDR) held on Aug. 5 and 6, 2019. The design modification does not require any changes to the PF1A sling.

**Shorted Turn Protection System Voltage Measurement Peer Review** — A peer review was held for the voltage measurement shorted turn protection system on Dec. 12. During an NSTX-U design validation and verification review (DVVR), a chit was created to examine the possibility for an additional real-time protection system in addition to the digital coil protection system (DCPS). This shorted-turn-protection (STP) would continuously monitor coil voltages and currents, and flag changes in behavior that might indicate failures (shorted turns) inside a coil. This peer review reviewed the voltage measurement design, testing of the STP system using the existing DCPS autotester, and FCPC test results for the shorted turn protection system presented at the Sept. 20 preliminary design review (PDR).



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

G. Verdoolaege (Ghent University, Belgium) is visiting PPPL for two weeks to work with S. Kaye on finalizing the draft paper on the updated International H-mode database, and to work with A. Diallo on ELM research.

R. Maingi attended the ITPA Coordinating Committee and IEA Co-Operation on Tokamak Programmes meetings in Cadarache, France, during the week of Dec. 9.

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

The Laboratory's ITER Diagnostics team has begun the documentation phase of its preparations for a final design review (FDR) of the Low Field Side Reflectometer in-vessel antenna assembly. More than 40 component fabrication and assembly drawings are planned. The team, including partner General Atomics, has developed a plan for document naming and production. Agreements have been reached with the U.S. ITER project office regarding drawing standards, requirements, and review procedures. Also, criteria for reporting drawing completion status have been adopted. In addition to drawings, more than 25 reports documenting the design basis as well as plans for manufacture and installation will be delivered for the FDR. The complete list of planned FDR deliverables was compiled by the team's document coordinator, P. Serai, and submitted to the ITER Organization for approval.

A key focus of the FDR will be an assessment of design compliance with 100 or more system requirements. A design compliance matrix will be delivered, providing the link between each requirement and at least one document or drawing that demonstrates compliance. This week the team met and agreed on each team member's responsibility for addressing compliance, ensuring that all applicable requirements will be addressed.

### **ITER & TOKAMAKS (R. NAZIKIAN)**

#### **DIII-D (B. Grierson)**

##### *Research:*

The paper titled, "The density dependence of edge-localized-mode suppression and pump-out by resonant magnetic perturbations in the DIII-D tokamak," by Q. Hu, R. Nazikian, et al. was published online in *Physics of Plasmas* as a letter, and it was selected as an editor's pick: <https://doi.org/10.1063/1.5134767>. This letter presented a comprehensive understanding of density pump-out and ELM suppression caused by 3D field due to magnetic island formation at both the top and foot of pedestal.

Weekly

# HIGHLIGHTS



Q. Hu travelled to PPPL this week and gave a talk in the NSTX-U / Magnetic Fusion Science meeting titled, “Modeling the scaling law of EF threshold by using TM1 code,” to introduce recent prediction for EF scaling under single-fluid and two-fluid conditions. Hu gave another talk in the Theory seminar titled, “Wide q95 windows for edge-localized-mode suppression by resonant magnetic perturbations in the DIII-D tokamak,” to introduce the recent predictive understanding of the access to q95 windows of ELM suppression.

A. Bortolon and F. Laggner traveled to PPPL to advance collaborations on inter-ELM pedestal-localized instabilities and fast-ion/neutrals effects. They introduced their recent work with two presentations at the PPPL monthly research meeting. Laggner presented, “How LLAMA quantifies edge neutral density profiles in DIII-D.” This presentation was focused on the diagnostic concept of the LLAMA (the Lyman Alpha Measurement Apparatus). A collaborative effort with MIT PSFC and the PPPL engineering department allowed the establishment of this new capability of measuring off-midplane neutral density profiles at the inboard and outboard side of DIII-D.

Bortolon presented, “Reconditioning the first wall of a fusion machine by sprinkling the plasma with boron powder,” which summarized the results of the recent invited talk at the 2019 APS-DPP meeting, showing that introducing boron powder into DIII-D plasmas was found to have similar properties of the standard glow discharge boronization technique.

## **International PMI and FES LM PFC Development Program (R. Maingi):**

Z. Sun traveled to EAST in Hefei, China, to continue collaborative impurity injection experiments. Testing of the impurity injections techniques onsite at EAST continued, along with planning for upcoming experiments.

## **ADVANCED PROJECTS (D. GATES)**

### **Stellarators (D. Gates):**

C. Zhu attended the SIAM Conference on Analysis of Partial Differential Equations at La Quinta, California, Dec. 11-14. He gave a talk entitled, “Topology optimization of permanent magnets for stellarators to confine plasmas.” In his talk, he introduced the recent progress on developing numerical optimization methods for designing permanent magnets for stellarators.

Zhu also submitted a manuscript entitled, “Designing stellarators using perpendicular permanent magnets,” to *Nuclear Fusion* (also available at <http://arxiv.org/abs/1912.05144>). The manuscript describes a fast method to design



perpendicular permanent magnets for optimized stellarators. Using this method, scientists could reproduce the NCSX equilibrium using perpendicular permanent magnets together with simple planar coils. The demonstration in the manuscript shows that adopting permanent magnets has the ability to significantly reduce the coil complexity of stellarators.

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

E. Feibush presented, "Scientific Visualization with VisIt," in a mini-course sponsored by PICSciE, the Princeton Institute for Computational Science and Engineering. The presentation emphasized techniques for exploring and communicating data generated by simulations and acquired from experiments. Princeton's remote visualization capability, based on the TurboVNC client-server architecture, was also described. Attendees completed several in-class exercises using workstations in the Princeton University Digital Learning Laboratory. Teaching assistants were K. Florendo, K. Qiang, and J. Yan.

P. Perdikaris from the University of Pennsylvania visited and gave a seminar at the machine learning lunch group entitled, "Physics-informed neural networks: algorithms, applications and some open questions."

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

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

The Office of Communications posted two press releases to the PPPL website this week. The first focused on the passing of James Wilson Clark, PPPL's first deputy director for administrative operations. The second focused on research by E. Belova and E. Fredrickson into how the second neutral beam on NSTX-U prevented heat loss. These stories were also posted to the *Newswise* distribution service.

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

S. Cowley participated in the National Laboratory Directors Committee (NLDC) meeting in Washington, D.C., Dec. 11-12. J. Menard participated in the National Laboratory Chief Research Officer (NLCRO) meeting in Washington, D.C., Dec. 11-12.

**This report is also available on the following web site:**

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