



**The PPPL Highlights for the week ending January 9, 2021, are as follows:**

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

**Recovery (J. Galayda):**

**Bus Supports** — The water-cooled power cables were all returned to the vendor for repair. The materials required for the PF extension and OH coax bus connection were inspected and prepared for fabrication of the supports in conjunction with the work packages.

**Coils** — Preparations for machining the six production coils continued at PPPL. The new rotary table was installed and will be commissioned next week.

**Center Stack Casing (CSC)** — The finish machining of the CSC continued in Camden, New Jersey. At Turtle Creek, an issue with distortion of the diverter flange was found during the bellows mockup welding. PPPL Engineering was engaged with Holtec in developing fixtures and methods to minimize this distortion. A new mockup at Holtec was in progress and analytic work continued at PPPL to resolve the distortion issue.

**IVPS** — Installation of the pump and electrical and controls was completed.

**Machine Core Structure (MCS)** — Precision Boring in Michigan continued with fabrications. The capture flanges were completed and the common flanges neared completion; both were in inspection. PPPL requested enlargement of several flange holes to improve clearances. Fixture plates fabrication neared completion and spare PF1B coil components were fabricated. In South Carolina, Carolina Fabricators continued production of PF1A sling base parts with all Phase 2 machining complete. Drilling of the base plates will be completed via contract modification in the near term. G. J. Oliver continued machining the outer skirt support. The PF1C upper support was received at PPPL. The ceramic break flange will be shipped next week. At PPPL, assembly procedures were in review for PF1A and PF1b coil assemblies. PF1B lower slings welding was completed and post-weld inspection and heat treating began. Upper PF-1B sling welding began, as did preparations to weld the PF1A slings. The PF1CL support was dimensionally checked and moved into welding, cleaning, and testing.

**T-MOD of Signals for the Centralized Control System Work Peer Review** — A peer review was held Dec. 22 to review the proposed T-MOD implementation to accommodate the planned Centralized Control System installation. The charge to the committee and chair was to assess whether the proposed solution provided adequate protection for NSTX-U personnel while enabling Recovery Project work scope.



**Personnel Safety System Installation** — This work is ongoing during the second shift.

**Survey** — This work is ongoing during the second shift.

### **ITER PROJECTS (H. NEILSON)**

#### **Low Field Side Reflectometer — LFSR (A. Zolfaghari, S. Shirey):**

Manufacturing partner General Atomics (GA) has made considerable progress on the LFSR antenna support bushing expansion process as well as the welding study. Multiple installed bushings have been cross sectioned for inspection of the mechanical interface between the CuCrZr bushing and the 316 stainless steel housing. A welded sample of the front antenna cap with its intricate water channels was welded and cross sectioned as well. Observations from the final welded cross sections provide input to adjust the welding parameters for less heat and adding chill blocks at appropriate locations.

In December, GA submitted the first of multiple Inspection Plans (IP) and Manufacturing Work Instructions (MWI) that will guide the manufacturing of both the Test Antenna Block Assembly (TABAs) as well as the ITER in-vessel deliverables. These documents are currently under internal review and will be submitted during the manufacturing readiness review process.

#### **Toroidal Interferometer Polarimeter — TIP (M.-A. De Loos):**

The TIP Captive Component team has begun designing the newly revised overhead support system for TIP-ECE beam lines and waveguides. Two concepts are proposed: adapting the design developed by IO for another diagnostic, the erosion monitor, as well as a circular vertical support conceptualized by PPPL designer M. Duco. Duco is evaluating the two concepts for structural response under load in order to efficiently rationalize designs across TIP and LFSR captive supports.

#### **Electron Cyclotron Emission — ECE (G. Paraiso):**

In its continued focus on shutter actuation design, the ECE team is developing plans for design partner University of Texas at Austin (UTA) to perform the design and prototyping of an electromagnetic actuator, with input and support from PPPL. This assignment takes advantage of expertise in electromagnetics within UTA's Center for Engineering Mechanics.

The PPPL team is nearing completion of an initial review of the project's interface sheets and preparing comments for IO consideration. Likewise, the team is completing a review of an updated List of Deliverables (LoD), preparing it for an informal review by the IO

Weekly

# HIGHLIGHTS



responsible officer for feedback and agreement before sending the LoD through the formal approval process.

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

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

#### *Research:*

The impurity powder dropper was successfully utilized to actively modulate the concentration of carbon in DIII-D hydrogen plasma experiments in preparation of the initial non-nuclear phase of ITER operation. One of the observations made during hydrogen operation is that the carbon content is lower than in deuterium. During DIII-D collaborative experiments, supported by F. Effenberg and A. Bortolon, controlled injection of spherical vitreous carbon granules was used to increase carbon concentration, and therefore the plasma effective charge  $Z_{eff}$ , to levels similar to corresponding plasmas generated with deuterium main ion species. This will allow discriminating the effect of different main ion species (H vs D) from the effect from dilution by impurities, and so enabling more robust conclusions and extrapolation to ITER conditions.

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

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

PPPL researchers F. Nespoli, E. Gilson, and R. Lunsford participated in remote Impurity Powder Dropper experiments on the Large Helical Device at the National Institute of Fusion Sciences in Japan in collaboration with local research staff. The series was a follow-on to a successful set of experiments in December where certain applications of powder were observed to generate enhanced core electron temperatures. The experiments, conducted during the Jan. 5 run day, expanded the parameter space in order to observe under what conditions the elevated temperatures could be measured. The series of experiments also supported observations of boron-assisted wall recycling effects through monitoring of real-time boron-hydrogen isotope interactions.

The development of the PPPL virtual engineering analysis workflow processes continues in the DOE Advanced Research Projects Agency-Energy (ARPA-E) permanent magnet (PM) stellarator program. Meetings regarding the Ansys Minerva Analysis Tool Architecture and Design Implementation took place on Jan. 7 and 8. The Permanent Magnet Field (No TF) data analysis comparison from physics to engineering found significant reduction in error between the expected physics results versus engineering



results with more analysis underway. The Preliminary Structural Analysis Model Development and Load Mapping was completed and analysis underway.

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

M. Churchill presented an invited talk at the High-Temperature Plasma Diagnostics (HTPD) 2020 conference entitled, “Deep convolutional neural networks for multi-scale time-series classification and application to tokamak disruption prediction using the Electron Cyclotron Emission imaging (ECEi) diagnostic on DIII-D.”

D. Schaeffer attended the virtual High-Temperature Plasma Diagnostics meeting and presented a poster titled, “Measurements of electron temperature in HED plasmas using gated X-ray imaging.”

R. Kube attended the High-Temperature Plasma Diagnostics meeting and presented a poster titled, “DELTA — The adaptable near-real-time data analysis framework.”

A paper titled, “Physics of ExB discharges relevant to plasma propulsion and similar technologies” by I. Kaganovich, A. Smolyakov, Y. Raitses, E. Ahedo, et al. was published as a featured open-access article in *Physics of Plasmas*:

<https://doi.org/10.1063/5.0010135>

A paper by F. Ebrahimi entitled, “An Alfvénic reconnecting plasmoid thruster” was published in the *Journal of Plasma Physics* on Dec. 21:

<https://doi.org/10.1017/S0022377820001476>. A new concept for space propulsion based on the formation of fast reconnecting axisymmetric plasmoids via helicity injection was proposed.

An article by R. White entitled, “Alpha particle channeling in ITER” was published in *Physics of Plasmas* on Jan. 8: <https://doi.org/10.1063/5.0033497>.

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

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

The Office of Communications posted three press releases to the PPPL website. The first reported that H. Qin and A. Diallo received the Lab’s outstanding research awards for 2020 for their work in plasma physics to push forward advancements in fusion energy. The second provided an overview of the new Princeton Collaborative Low-Temperature Plasma Research Facility. The joint venture of PPPL and Princeton University provides access to world-class diagnostics, computational tools, and expertise in plasma physics



for characterizing low-temperature plasmas — a rapidly expanding source of innovation in fields ranging from electronics to health care to space exploration. The third reports that the annual Science on Saturday lecture series will resume in a virtual format on Jan. 9. These stories were also posted to the *EurekAlert* and *Newswise* press release distribution services.

L. Bernard participated in the U.S. Department of Energy Office of Science (SC) Communications and Public Affairs meeting with the SC national laboratory communications officers on Jan. 7.

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

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