# Weekly HIGHLIGHTS

PPPL PRINCETON PLASMA PHYSICS LABORATORY
U.S. DEPARTMENT OF ENERGY

**The PPPL Highlights for the week ending April 11, 2020, are as follows:**

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

**Recovery (J. Galayda):**

**Recovery Project CDE-3B Director's Review —** A successful director's review was held April 6-9. The review committee, chaired by K. Robinson, gave affirmative answers to all charge questions. Robinson stated that the project team convincingly demonstrated that it is ready for approval of CDE-3B. Robinson also commented that the logistics of the online review, including separate chat rooms for committee closed sessions, were handled in an exemplary manner. The committee pointed out COVID-9 considerations will affect project work planning and control, and that the project should not plan on a return to pre-COVID-9 routine during installation.

**Center Stack Casing (CSC) —** The center stack casing final machining continued at the Holtec facility in Camden, New Jersey, and machining is expected to continue through next week. In addition, the bellows flange mockup machining continued at the Turtle Creek facility in Pennsylvania. The mockup is being performed to understand and minimize any distortion resulting from the welding process.

**Poloidal Field Coils —** Manufacturer Sigmaphi has stopped production and the firm's workforce is off-duty. A restart is targeted for April 15. PPPL's QA/observer engineer is still in place awaiting re-start of work.

**Research (S. Kaye):**

Mirroring of ST40 data in support of a collaboration with NSTX-U was completed this week by the Plant Instrumentation and Control engineering group. ST40 data has been transferred to a local NSTX-U data server and will be automatically synchronized each night with ST40's data servers. Intraday data is also available, but at a lower transfer speed until it is synchronized with our local server.

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

The ITER Diagnostics team is resuming its design work on the Motional Stark Effect (MSE) system. The MSE is an optical diagnostic that relies on a system of mirrors inside the port to relay light from the plasma to ex-vessel optics and a fiber transmission system. The team has re-established ownership of the CAD models and has undertaken a study to determine requirements for cooling of the mirrors, which are subject to heating from fusion neutrons and plasma radiation. PPPL engineers A. Cohen and B. Linn are leading the study.

The team is also resuming work on the Toroidal Interferometer Polarimeter (TIP) diagnostic. Team leader M.-A. de Looz and Senior Scientist D. Johnson have developed a Statement of Work for re-engagement of the project's design partner and issued it for internal review.

The preliminary design phase of the Low Field Side Reflectometer (LFSR) was formally closed this week. A report documenting closure of all Category 1 chits and approval of all deliverable documents from the Nov. 2018 preliminary design review (PDR) was approved by the ITER Organization.

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

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

*Research:*

The paper titled, "Real-time pedestal optimization and ELM control with 3D fields and gas flows on DIII-D," by F. Laggner, et al. (D. Eldon, A. Nelson, C. Paz-Soldan, A. Bortolon, T. Evans, M. Fenstermacher, B. Grierson, Q. Hu, D. Humphreys, A. Hyatt, R. Nazikian, O. Meneghini, P. Snyder, E. Unterberg, E. Kolemen, and the DIII-D team) has been accepted for publication by *Nuclear Fusion*. Three new control schemes allowing pedestal optimization and ELM control by magnetic perturbations were implemented into the DIII-D plasma control system (PCS) and successfully deployed in experiments. Pedestal control allows the exploration of core-edge integrated plasma scenarios in present-day tokamaks. With respect to ITER, the need for an advanced control system is highlighted to keep the applied 3D fields close to the ELM suppression threshold at all times, enabling high fusion energy gain.

*Operations:*

D. Mauzey created a new design of an expanded LLAMA calibration stand meeting the expanded calibration requirements. The vessel consists of two distinct chambers connected through a custom-designed DC break using Makrolon (a vacuum-compatible polycarbonate plastic) obviating the need for a long, small-bore, ceramic/bellows assembly. A 5kV standoff is expected, which enables the substantial noise reduction essential for the LLAMA photometric calibration. This new design calibration stand provides the flexibility to accomplish the calibration of the LLAMA diagnostic in a vacuum environment replicating the diagnostic geometry, as well as other VUV spectroscopy tasks, such as the on-site calibration of the reference light source and the spectroscopic characterization and acceptance of optical components.

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

S. Smolentsev (UCLA) presented a liquid metal MHD seminar titled, "International Liquid Metal MHD code-to-code comparison." As part of the ongoing international effort on Verification and Validation of MHD Codes for Fusion Liquid Metal Applications [Fusion Eng. Des., 100, 65 (2015)] a group of experts in computational MHD from several institutions in the U.S. and Europe recently performed a code-to-code comparison for the selected reference case of a mixed-convection, buoyancy-opposed MHD flow of eutectic alloy PbLi in a thin-wall conducting square duct. The current status of computational LM MHD was summarized, and then comparison results for the test problem were presented for the following codes: HYMAG, COMSOL, ANSYS CFX, ANSYS FLUENT, and OpenFOAM. All of these codes agreed quantitatively (within a few percent) with many high-level observable quantities. A few differences in predicted flow patterns, notably the advent of flow-reversed flow, was found in the non-ANSYS codes. The comparison report was accepted as an article in *Fusion Science and Technology*.

**ADVANCED PROJECTS (D. GATES)**

**Stellarators (D. Gates)**

On April 7, PPPL was awarded $3 million by ARPA-E to build a section of permanent magnets for quasi-axisymmetric stellarators. The principal investigator for the project, which was funded under the ARPA-E BETHE solicitation, is D. Gates. This award concludes a six-month pre-conceptual proposal development activity that included a team of several engineers and two physicists. PPPL will team with SABR Enterprises, a small company located in Massachusetts. SABR has extensive experience building permanent magnet assemblies for research. The project will take three years with a planned start date in the July 2020 timeframe. The proposal concept is based on a recent paper authored by P. Helander, the Head of Theory at IPP Greifswald, that was published in *Physical Review Letters* on March 5. The idea sprang from conversations with PPPL scientists during a long-term visit by Helander to PPPL.

Thanks to the collaboration between PPPL (F. Nespoli) and NIFS (G. Kawamura), the EMC3-EIRENE code is now operational on the Tiger cluster at Princeton University. EMC3-EIRENE simulations will support the interpretation of the LHD experiments employing the PPPL designed-and-built Impurity Powder Dropper.

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**TRANSP (F. POLI)**

This week, the TRANSP development team launched TRANSPHub, a GitHub-based interface for users to ask questions and report problems. This tool will help users support each other and let the TRANSP development team communicate progress on user requests and new features and capabilities under development. Access to the TRANSPHub is granted upon request to the TRANSP development team.

**OFFICE OF ACADEMIC AFFAIRS (N. FISCH)**

J. Lestz, a graduate student in the Program in Plasma Physics, successfully defended his thesis, "Theory and Simulations of Compressional and Global Alfven Eigenmode Stability in Spherical Tokamaks," and passed his FPOE on April 1. His thesis advisors were E. Belova and N. Gorelenkov. He will be starting a postdoctoral appointment at the University of California-Irvine, stationed at General Atomics.

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

**Communications (L. Bernard):**

The Office of Communications posted one press release to the PPPL website. It focuses on research by D. Brennan and others showing that all the layers matter when trying to stabilize a fusion plasma, and that the outer layers strongly couple to the inner layers. The story was also posted to the *Newswise* and *EurekAlert* press release distribution services.

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

Laboratory leadership has been communicating ongoing updates to staff regarding the COVID-19 virus and PPPL.

**This report is also available on the following web site:**
**http://www.pppl.gov/publication-type/weekly-highlights**