Weekly HIGHLIGHTS

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

The PPPL Highlights for the week ending October 19, 2019, are as follows:

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

Recovery (J. Galayda):

Centralized Control System PDR — A preliminary design review (PDR) was held Oct. 18 to evaluate beginning designs for the NSTX-U Centralized Control System (CCS). The NSTX-U CCS receives status information directly from the Personnel Safety System (PSS), Safety Instrumented System (PSS-SIS), and Trapped Key System (TKS). The CCS interacts with the individual Basic Control Systems (BCSs) by providing permission for execution on the basic control systems. A successful PDR for the NSTX-U Personnel Safety System was held on May 8.

Center Stack Casing — Forgings of the center stack casing components began in Italy this week. The project will provide oversight of the final inspections in Italy early in November.

HTT/HTP — G. Oliver delivered the mandrels for the heat transfer tubing (HTT) tube bending, and they successfully passed inspection. Tube bending on this job scope will start in mid-October. Hollis Line continued fabrication of the heat transfer plate (HTP), and PPPL gave approval to begin tube welding this week.

Magnets — In France, Sigmaphi moved into the coil winding facility; the installation of the first winding line is nearing completion. The mandrel fabricated by a Sigmaphi subcontractor was defective, and they are working on the root cause analysis and path forward for manufacturing a new one. It is needed to begin winding the first PF1A coil. In parallel, Sigmaphi is pre-testing the winding line for operation. M. Kalish is on site to oversee the work and will be there next week for the manufacturing readiness review (MRR) scheduled for Oct. 23.

PF Coil Bus Work PDR-2 — A preliminary design review 2 (PDR-2) was held on Oct. 14 for the PF coil bus work. The first preliminary design review was completed on Feb. 28 for the inner PF bus work. This second PDR reviewed the design of the bakeout bus at the top and bottom of the vessel, the PF4 hard and flex bus and supports, the PF1B water-cooled power cable connection from the vessel to the PCTS, the TF extension connection field fit-up, and the OH coaxial hard bus field fit-up. Cost and schedule were also covered, as well as the manufacturing and installation of the bus, power cable, and supports.

Research (S. Kaye):

F. Poli traveled to Garching, Germany, to attend the ITPA-IOS meeting Oct. 14-17. This meeting was jointly held with the MHD Topical Group. Poli has reported on a joint activity for the modeling of the ITER current ramp-down phase. The results of this activity are now being used to prepare new joint experiments to inform ITER.

U.S. ITER FABRICATION (H. NEILSON)

The Laboratory's ITER diagnostics team submitted responses to questions raised by a U.S. ITER Project Office engineering team stemming from their review of the technical specifications for manufacturing development of the Low Field Side Reflectometer (LFSR) in-vessel assembly. The development plans, and the questions raised, concern the most critical manufacturing and inspection processes: deep-bore "gun" drilling, welding, weld inspection, and tolerancing. These issues illustrate the engineering challenges in implementing a proven tokamak diagnostic technique, microwave reflectometry in this case, in the environment of a burning plasma experiment. The heat loads experienced by the LFSR plasma-facing components require a dense network of cooling channels throughout the component volume; these channels are created by deep-bore drilling and sealed against leakage with welded plugs. The LFSR equipment will be enveloped by a conformal shield; tight tolerances are necessary to minimize gaps between components and shield that could allow neutron streaming, while at the same time providing robust structural support against disruption forces.

ITER & TOKAMAKS (R. NAZIKIAN)

DIII-D (B. Grierson)

Research:

Three talks were given by Q. Hu, S. Haskey, and B. Grierson at the ITPA PEP/TC joint group held in Hefei, China. Hu's talk, titled, "The role of resonant field penetration in the edge-localized-modes suppression and density pump-out in the DIII-D tokamak," showed that field penetration at both the foot and top of pedestal can account for both density pump-out and ELM suppression due to the enhanced parallel transport by magnetic island from TM1 model simulations. Haskey presented measurements of the ion isotope ratio using main-ion CER for mixed deuterium/hydrogen plasmas and validation on existing DIII-D discharges. The technique will be used in the DIII-D isotope campaign that will be executed after the APS meeting. Grierson presented conditions in

which the DIII-D H-mode pedestal electron density appears to be driven by a significant impurity ionization source with little fueling from recycling deuterium neutrals, confirmed by main-ion pedestal measurements. These observations motivate the measurements of and inclusion of lower impurity charge-states on pedestal fueling in the inter-ELM pedestal recovery.

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

A. Diallo and Z. Sun presented talks at the ITPA Pedestal group meeting in Hefei, China, Oct. 14-16. Diallo presented "ELM suppression with B injection in EAST," and Sun presented "Full ELM pacing by lithium pacing injection basing on ELM-absent H-mode on EAST." In addition, J. Hu (ASIPP) presented collaborative work from the US-PRC collaboration on plasma-materials interactions led by PPPL: "Lithium injection for ELM control on EAST."

The paper by R. Lunsford, et al entitled, "Active conditioning of ASDEX Upgrade tungsten plasma-facing components and discharge enhancement through boron and boron nitride particulate injection," was published in the journal *Nuclear Fusion*. In this paper, Impurity Powder Dropper (IPD) experiments are described whereby boron-containing powders are injected into ASDEX Upgrade H-mode discharges. Globally, the BN injection improved energy confinement by 10%-20%, associated with improvements in pedestal performance similar to gaseous N injection. Following conditioning discharges with B powder injection, three low gas-fueling discharges with magnetic perturbations for ELM suppression were successfully conducted. These first results suggest that the application of B containing powders can be used to both improve plasma performance in real-time, and to improve overall wall conditions for subsequent discharges. The paper can be found here: https://dx.doi.org/10.1088/1741-4326/ab4095

ITER-JET (M. Podestà, F. Poli):

F. Poli, N. Bertelli, and M. Podestà held a videoconference with colleagues from IPP Garching to discuss plans for validation of EP physics and NBI+RF synergy within the ongoing PPPL/JET-EU collaboration. Two discharges from ASDEX-Upgrade were selected for a detailed assessment of RF models in TRANSP and their validation against experimental data.

ADVANCED PROJECTS (D. GATES)

A new project has been launched with the approval by DOE Fusion Energy Sciences of funding of a collaboration with the Compass Upgrade (Compass-U) project at the Czech Republic's Institute of Plasma Physics (IPP), Czech Academy of Sciences in Prague. The Laboratory's work will initially focus on engineering analysis of certain critical Compass-U design issues, relying on PPPL's unique experience and capabilities in copper magnet machine designs, as well as Laboratory experience designing for high-temperature operation conditions similar to those planned for Compass-U. The Laboratory's work will be carried out by an engineering team under the leadership of Analysis Group leader P. Titus.

Stellarators (D. Gates):

The first talk of a newly organized Stellarator Seminar Series was held on Oct. 10 at PPPL. This first seminar was given by C. Zhu: "Identification of important coil deviations to avoid error fields using the Hessian matrix method." The series is a new set of talks with the goal of facilitating better communication and collaboration between the experimental, engineering, and theory groups working on stellarators at PPPL. This series will be held every other week during Fall 2019 and Spring 2020 and is being organized by N. Pablant.

COMMUNICATIONS & PUBLIC OUTREACH (A. ZWICKER)

Communications (L. Bernard):

The Office of Communications posted four news stories to the PPPL website. One focused on research by W. Wang showing that turbulence may have more of an effect on a fusion plasma's bootstrap current than previously thought. Another focused on the new DOE program Innovation Network for Fusion Energy (INFUSE), which will facilitate public-private partnerships. A third described the career of B. Ellis, who was recently named PPPL's chief engineer. The fourth story explained research by A. Ashourvan and others showing that enhanced turbulence in the edge of a fusion plasma may improve the thermal insulation needed to achieve fusion energy. These stories were also posted to the *Newswise* and *EurekAlert* press release distribution services.

Weekly HIGHLIGHTS

PPPL PRINCETON PLASMA PHYSICS LABORATORY

U.S. DEPARTMENT OF ENERGY

DIRECTOR'S OFFICE (S. COWLEY)

S. Cowley participated in the International Fusion Energy Cooperation Center meeting and the EAST International Advisory Committee (IAC) meeting Oct. 13-14. Both meetings were held in Hefei, China.

S. Cowley also participated in the National Laboratory Directors Council Fall Retreat and Diversity and Inclusion Workshop, which was held in Albuquerque, New Mexico, on Oct. 16.

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