Weekly HIGHLIGHTS

The PPPL Highlights for the week ending May 19, 2018, are as follows:

NSTX-U RECOVERY AND RESEARCH (J. MENARD)

Recovery:

For the inner poloidal field (PF) coils, one of the prototype coil vendors is nearing completion of the vacuum pressure impregnation (VPI) process on its coil. The PPPL prototype coil has been placed in its VPI mold and is being prepared to be placed in the curing oven. Two other vendors are nearing completion of the winding process for their respective coils.

Research:

M. Jaworski visited the Dutch Institute for Fundamental Energy Research (DIFFER) and TU/Eindhoven of the Netherlands to deliver a seminar and serve as a thesis reader for Dr. G.G. van Eden's final defense titled, "Vapour Shielding of Liquid Metal Walls in Nuclear Fusion Devices." The seminar given by Jaworski at DIFFER was titled, "Plasma Facing Components for the NSTX-U Recovery Project and Applications of Liquid Technologies to Conventional Energy Sources."

U.S. ITER FABRICATION (H. NEILSON)

A report by engineer J. Klabacha titled, "EP11 LFSR Diagnostic Nuclear Heating Results," describes analysis performed by PPPL for the Low Field Side Reflectometer (LFSR) diagnostic using the neutronics software Attila. Nuclear heating from the plasma constitutes the dominant heat load on the in-port structures close to the plasma and is the major design driver in that region. The LFSR will be installed in ITER's equatorial port plug number 11, along with several other systems. The port plug is filled with shielding material, except for cavities in which diagnostics equipment and structures are installed. Since the nuclear heat loads to the LFSR equipment depend on the configuration of shielding and nearby equipment, a detailed analytical model of the entire port plug was constructed for the Attila analysis. The analysis calculates thermalization of the incident neutrons and gamma photon production within the shield module. It is found that gamma heating is the major contributor to the overall nuclear heating of the LFSR equipment. Peak heat loads of ~7.5 W/cm3 on the antenna tips and ~4.5 W/cm3 on the support block are calculated.

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ITER & TOKAMAKS (R. Nazikian)

DIII-D (B. Grierson)

Research:

B. Grierson has been selected as a U.S. Member in the ITPA Transport and Confinement topical group.

A paper written by A. Ashourvan with co-authors B. Grierson, S. Haskey, D. Battaglia, and T. Stoltzfus-Dueck titled, "Validation of the Kinetic-Turbulent-Neoclassical Theory for Edge Intrinsic Rotation in DIII-D," was recently accepted for publication in *Physics of Plasmas*.

DIII-D research by nine PPPL scientists was presented at the 2018 US Transport Task Force (TTF) meeting in San Diego, CA. F. Poli presented a plenary session talk titled, "Predict First," demonstrating successful use of predictive TRANSP for achieving stationary elevated qmin in DIII-D at high beta by tailoring the early electron cyclotron heating and current drive. T. Stoltzfus-Dueck presented a plenary session talk on validating models of momentum transport, describing successes and challenges for predicting the edge and core toroidal rotation on present devices for projection to ITER. B. Grierson presented live demonstrations of OMFIT physics modules in the "Transport Toolbox" session for tokamak database creation and processing, and gyrokinetic simulations with the GYRO and C-GYRO codes. Poster presentations on DIII-D research were given by A. Ashourvan, B. Grierson, W. Guttenfelder, S. Haskey, N. Logan, Y. Ren and W. Wang.

Operations:

A successful final design review (FDR) was held on May 16 for the calorimeter on the 150 neutral beam line. The FDR was presented by C. Ciummo, and only one chit was generated on calculation checking. RFQs will follow with award to vendor expected in July.

PPPL and General Atomics technicians have completed electronic components and wireways for neutral beam local control systems (LCS) numbers 5 and 6. The total wiring job of the LCS systems is approximately 20% complete and expected to be completed by June 15, 2018.

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ADVANCED PROJECTS (H. NEILSON)

Stellarators (D. Gates):

R. Lunsford made a presentation at a recent Wendelstein 7-X (W7-X) science meeting entitled, "Capabilities of a Probe Mounted Powder Injector." In the talk, Lunsford described the design and implementation of a compact, self-contained powder injector that can be mounted on the W7-X multi-purpose manipulator for experiments during the upcoming OP1.2b experimental campaign. Experiments using the powder injector will build on the research performed by PPPL staff at EAST, ASDEX, and DIII-D concerning the effects of particulate injection on plasma-wall conditions. Previous research has shown substantial benefit to wall conditions after the application of low-Z powders such as lithium, boron, and boron nitride. The presentation pointed out the advantages of such a system in contributing to the achievement of W7-X long pulse goals.

System Studies (C. Kessel):

C. Kessel and P. Titus participated in the 5th IAEA DEMO Programme Workshop held in Daejeon, S. Korea, the week of May 5. The main topics of the meeting were facility maintenance, plasma control, and magnets. Titus presented the toroidal field and poloidal field coil mechanical solutions for the U.S. Fusion Nuclear Science Facility (FNSF) design and S. Korea's K-DEMO design, which have radial and vertical maintenance schemes, respectively. Research shows that the maintenance scheme strongly impacts magnet size, geometry, and structural support. In addition, pursuing radial, or vertical with a large opening, pushes the coil solutions in similar directions. Titus' analysis showed that the feasibility of radial maintenance is not compromised by magnet over-turning forces as some have argued. Titus also addressed the appropriate magnet design criteria for the long term (steady-state operation) as the number of cycles drops to low values, compared to ITER with large numbers of cycles.

Kessel presented the status of the present systems study on liquid metal plasma-facing components as a special topic. He reported some examples in each of the main thrusts including liquid metal properties, solid substrates, liquid metal concepts, and integration issues. In addition, strategies to create an R&D plan were presented, noting how the concepts applied to the FNSF create prototypical parameters to target, and how the liquid metal properties motivated experiments to do, both leading to the identification of experimental platforms to perform the work (e.g. FLiT, LMX, QTOR at UCLA). All the presentations will be posted at the IAEA web site.

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THEORY (A. BHATTACHARJEE):

On May 10, C. Smiet, a long-term visitor from Leiden University, presented a poster at the Princeton Research Day on Princeton's main campus. The poster was titled, "On the topology of magnetic surfaces in decaying plasma knots." Understanding the structure of a magnetic field — most importantly, its linking and knotting — is an important problem in plasma physics. We simulate the time evolution of the very knotted class of fields known as plasma torus knots, and show that reconnection gives rise to ordered magnetic surfaces that contain zero lines and that are not toroidal.

W. Lee and R. White presented a poster titled, "Theoretical Calculations for the Radial Electric Field at DIIID Pedestal," at the 2018 Transport Task Force meeting last week in San Diego, where the comparisons between the the theory and the experimental measurements were given.

From April 30 to May 11, M. Gorelenkova hosted Z. Stancar, a Ph.D. student at Jožef Stefan Institute in Slovenia. Ziga's work involves (i) developing the plasma neutron source generator for the JET tokamak by using TRANSP-coupled NBI and ICRH heating, (ii) estimate the propagation of diagnostics uncertainties through TRANSP simulations with perturbed input diagnostics data, to (iii) study the possibility of TRANSP simulation of the advanced three-ion component plasma ICRH heating scenario based on a JET benchmark plasma discharge, and to (iv) extend the use of the plasma neutron source generator to ITER-relevant plasmas using TRANSP predictive simulation.

There were two Theory seminars. The first, "Design of a new quasi-axisymmetric stellarator equilibrium," was presented by S. Henneberg of IPP Greifswald. The second, "Bringing the GBS plasma turbulent simulation code from limited to diverted configurations," was presented by P. Paruta, from the École Polytechnique Fédérale de Lausanne. The abstracts and copies of the presentations are available at https://theory.pppl.gov/news/seminars.php?scid=1&n=research-seminars

Office of Academic Affairs (N. Fisch):

On May 11, N. Fisch gave a MIT PFSC (Plasma Fusion Science Center) seminar titled, "Unusual Effects in Rotating Plasma." Fisch discussed how these unusual effects might be exploited in a variety of plasma devices, including Hall thrusters, plasma mass filters, and fusion devices.

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COMMUNICATIONS (L. BERNARD)

The Office of Communications posted two press releases to the PPPL website. One focused on the naming of S. Cowley as the next PPPL director. Cowley starts at PPPL in July. The second focused on the Young Women's Conference in STEM, which takes place on the Princeton University campus on May 21. Hosted by PPPL, the conference engages more than 750 seventh- to tenth-grade girls in hands-on activities about STEM. The girls will have the opportunity to meet mentors and to get excited about STEM fields. Both stories were posted to the *Newswise* and *EurekAlert!* press release distribution services.

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