Weekly HIGHLIGHTS

PPPL PRINCETON PLASMA PHYSICS LABORATORY

U.S. DEPARTMENT OF ENERGY

The PPPL Highlights for the week ending July 27, 2019, are as follows:

NSTX-U RECOVERY (R. HAWRYLUK) AND RESEARCH (S. KAYE)

Recovery (R. Hawryluk):

TF Bundle — Tensile testing is now underway based on a back-up program that uses samples prepared at PPPL, quadrant-to-quadrant testing at the PPPL Material Test Lab, and turn-to-turn testing at Composite Technology Development (CTD) in Colorado. For the PPPL tests, an elevated temperature test chamber was fabricated so that tests could be performed at 40C. Static tests are complete and cyclic tests are underway. The contract with CTD has been revised to stop prior work and to add the testing of PPPL samples.

The first five PPPL samples for static testing were shipped to CTD. Static short beam shear (SBS), turn-to-turn, and quadrant-to-quadrant sample testing was completed at the Element Materials Technology lab in California and cyclic testing is underway. The high fidelity and delamination analyses are being refined. The FEA model for analysis of the effect of delamination on the external load path is running cases to determine the boundary of maximum allowable delamination. Once the remaining material test data becomes available the calculations will be finalized prior to the Stage 2 review scheduled for August 7-8.

Director's Review — The final report from the director's review was submitted by the review team. This review and corresponding report help support preparations for the upcoming IPR.

Magnets — M. Kalish is in France at Sigma Phi, and the team continues to work through fabrication questions and fine details. Sigma Phi has ordered all critical path components to build winding lines. The company is preparing to assemble components at their main facility in order to expedite the establishment of the winding line in their new building, where winding will begin in early October.

Center Stack Casing — M. Viola, C. Pagano, and T. Young visited the Holtec Turtle Creek facility near Pittsburgh on a site visit of the facility where elements of the CSC will be fabricated. The team toured the facility and met with the fabrication team from OR/Holtec to discuss several details of the fabrication, validate current status, and resolve any questions for the upcoming MRR. ORT/Holtec continues to purchase materials (forgings, etc.) for the CSC fabrication. The PPPL team continues to review ORT/Holtec fabrication procedures, provide further information to augment specifications, and work through the weekly action list.

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Research (S. Kaye):

A number of NSTX-U researchers attended the APS-DPP-sponsored Community Planning Process (CPP) Workshop on Magnetic Fusion Energy and Fusion Materials and Technology held in Madison, WI, July 22-26. Among those chosen to speak in plenary sessions were:

D. Battaglia (PPPL) — "The NSTX-U Facility in the 2020s: Advancing the Physics Basis for Configuration Optimization Toward a Compact Fusion Pilot Plant"

R. Goldston (PPPL) — "Development of a Liquid Lithium Divertor for a Compact Fusion Power Plant"

T. Gray (ORNL) — "Strategy for Advancing the Technical Readiness of Liquid-Metal Plasma-Facing Components"

M. Ono (PPPL) — "Integrated RF Program to Develop Fusion-Reactor-Relevant Actuators"

R. Raman (U. Washington) — "Demonstration of solenoid-free start-up of low-inductance plasma for advanced ST or tokamak scenarios using transient coaxial helicity injection"

S. Sabbagh (Columbia University) — "A National Initiative for Disruption Elimination in Tokamaks"

J. Menard — "Development of Mission Need and Preliminary Design of a Sustained High-Power-Density Tokamak Facility"

Other participants included F. Poli, M. Podesta, A. Diallo, R. Maingi, R. Smith (U Wisc.), N. Gorelenkov, and A. Kaye. Co-chairs and members of the program committee for the CPP effort include N. Ferraro (PPPL), W. Guttenfelder (PPPL), and M. Reinke (ORNL).

S. Sabbagh, J. Berkery, and Y-S Park gave presentations at the 46th European Physical Society Conference on Plasma Physics in Milan, Italy covering multi-device disruption prediction and avoidance research and related physics support. The talks were titled "Progress on Disruption Event Characterization and Forecasting in Tokamaks and Supporting Physics Analysis," "Equilibrium and Stability Calculations of MAST Spherical Torus Plasmas in Preparation for MAST-U," and "Analysis of MHD stability and active mode control on KSTAR for disruption prediction and avoidance," respectively.

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U.S. ITER FABRICATION (H. NEILSON)

The Laboratory's ITER Diagnostics design team has updated its detailed schedule for a final design review of the Low Field Side Reflectometer (LFSR) in-vessel antenna assembly in early 2020. The update included an assessment of document deliverables, providing input to a comprehensive time and resource plan.

Details and status of an LFSR in-vessel design tolerance strategy were shared with ITER Central Team colleagues during an informal peer review. The approach was acknowledged and several productive ideas were shared for next steps. Continued discussions with UKAEA's remote handling (RH) consultants RACE contributed further to closing on a design decision to meet, or seek exception to, a requirement to integrate attaching hardware as captive to primary components.

ADVANCED PROJECTS (D. GATES)

Stellarators (D. Gates)

S. Lazerson presented a white paper entitled, "International stellarator research in support of a low-capital-cost pilot plant" at the American Physical Society's Division of Plasma Physics Community Planning Process meeting in Madison, WI. The white paper highlighted the success of the US-W7-X collaboration and argued that scaling the investment in this activity will provide timely results for the development of a low-capital-cost power plant. The initiative was well received and discussions about how to integrate this with a development of a mid-scale stellarator at Wisconsin University were conducted.

THEORY (S. HUDSON)

D. Schaeffer helped organize and lead the first APS Division of Plasma Physics Community Planning Process (DPP-CPP) workshop in the topical area of High-Energy-Density Physics (HEDP) on July 16-17 in Washington, D.C. The DPP-CPP is a strategic planning process with the goals of identifying scientific and technological opportunities in the fields of plasma physics and fusion energy science, and making consensus recommendations for a strategy to address these opportunities to the DOE Office of Fusion Energy Science Advisory Committee (FESAC). The workshop solicited feedback from the HEDP community, which will be incorporated into a long-term strategic vision for FES.

M. Churchill attended the Deep Learning for Science school (dl4sci.lbl.gov) at Lawrence Berkeley National Lab, where experts from industry and academia gave several lectures on intro and cutting-edge techniques in deep learning. He presented a poster entitled, "Deep convolutional neural networks for long time-series classification."

N. Gorelenkov attended the SciDAC 4 Annual Meeting last week in Rockville, MD. He presented a poster titled, "V&V for RBQ and Progress towards its 2D version" for PPPL SciDAC 4.

S. Ethier and W. Tang represented PPPL at the DOE CSGF Annual Program Review held in Arlington, VA. The Department of Energy Computational Science Graduate Fellowship (http://www.krellinst.org/csgf/) program provides outstanding benefits and opportunities to students pursuing doctoral degrees in fields of study that use high-performance computing to solve complex science and engineering problems. As part of the program, CSGF fellows are required to complete a practicum project in one of the many DOE labs, giving them practical work experiences while strengthening collaborative ties between the national academic community and DOE laboratories. The annual conference gives the students an opportunity to meet with the laboratory representatives to discuss their practicum. A poster session held by the DOE labs also gives them an overview of the science and activities taking place at the laboratories.

OFFICE OF ACADEMIC AFFAIRS (N. Fisch)

D. St-Onge, a graduate student in the Program in Plasma Physics, successfully defended his thesis, "Fluctuation Dynamo in Collisionless and Weakly Collisional Magnetized Plasmas," and passed his FPOE on July 19. His thesis advisor was M. Kunz. He will be starting a postdoctoral appointment at the University of Oxford in August.

N. Fisch attended the European Physical Society (EPS) meeting, in Milan, Italy, July 8-12, where he gave a poster, co-authored by A. Reiman, on, "Some Issues in Realizing the RF Current Condensation Effect". On July 15, N. Fisch visited the Associazione Euratom-ENEA sulla Fusione, Frascati, where he gave a seminar titled, "Current Drive, Current Condensation, and Alpha Channeling."

On July 19, *Nature Communications* published an article titled, "Determining the rotation direction in pulsars," by R. Gueroult, J-M Rax, Y. Shi, and N. Fisch: https://www.nature.com/articles/s41467-019-11243-4. Gueroult was a research physicist at PPPL before heading off to Toulouse. Rax, currently at Ecole Polytechnique, was formerly a postdoc at PPPL. Shi, now at LLNL, is a recent graduate of our Program in Plasma Physics.

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COMMUNICATIONS & PUBLIC OUTREACH (A. ZWICKER)

Communications (L. Bernard):

The Office of Communications posted three press releases to the PPPL website. The first notes that R. Maingi has been named to co-lead a national program to unify research on liquid metal components for future tokamaks. Maingi will coordinate the three-year project in conjunction with Oak Ridge National Laboratory and the University of Illinois at Urbana-Champaign. The second explains how new research by M. Podesta and others into updating TRANSP could help predict the leakage of fusion particles from a tokamak's magnetic fields, and possibly help scientists prevent those leakages. The third notes the Princeton University construction of a CubeSat as a testbed for a microthruster with unique capabilities being developed at PPPL. All stories were also posted to the *Newswise* and *EurekAlert* press release distribution services.

DIRECTOR'S OFFICE (S. COWLEY)

J. Menard and M. Zarnstorff participated in the Magnetic Fusion Energy and Fusion Materials and Technology workshop at the University of Wisconsin, Madison, July 22-26. This workshop included presentations by advocacy groups on proposed FES initiatives, breakout sessions by expert groups for discussing and evaluating these proposals, and forums on cross-cutting issues that affect all topical areas within FES.

J. Menard participated in the National Laboratory Chief Research Officers (NLCRO) meeting, held at DOE headquarters in Washington, D.C. on July 23.

S. Cowley participated in the National Laboratory Directors Council (NLDC) meeting during Laboratory Day on the Hill, held in Washington, D.C, on July 23-24.

C. Ferguson attended the National Laboratory Chief Operations Officers (NLCOO) working meeting, which was held on July 25 at DOE headquarters in Washington, D.C.

Alan Stone, from the DOE Office of Science (High-Energy Physics), visited PPPL on Aug. 25. The visit was hosted by R. Hawryluk, who provided Stone with an overview of PPPL and gave him a tour. A. Zwicker and J. Vannoy discussed diversity and inclusion, workforce development, and talent acquisition at PPPL. Mr. Stone also toured PPPL facilities.

This report is also available on the following web site:

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