



The PPPL Highlights for the week ending May 9, 2020, are as follows:

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

Recovery (J. Galayda):

Coils — Sigmaphi began work again at the fabrication facility in Plescop, France, along with PPPL oversight by the longstanding QA representative and a new French national engineer. The new French engineer was trained by the PPPL cognizant individual. After satisfactory completion of a manufacturing readiness review (MRR), Sigmaphi began the vacuum pressure impregnation (VPI) process for the PF1B coil on May 7. VPI of the PF1A coil will follow the PF1B VPI work. Winding of other coils resumed in parallel with this work.

Center Stack Casing (CSC) — Machining of the center stack casing tapered ends approached completion this week at the Holtec facility in Camden, New Jersey. In parallel, work on the diverter flange mockup continued at the Turtle Creek facility. The machining is almost completed and welding is set to begin.

CD-3B Independent Project Review (IPR) — The Project office met with the Federal Project Director and the chairman of the upcoming independent project review committee to discuss plans for the review, including logistics and areas of the project that should be emphasized.

U.S. ITER FABRICATION (H. NEILSON)

The Low Field Side Reflectometer (LFSR) design team presented details of the in-vessel antenna assembly design to a U.S. ITER review panel this week. The aim of the review was to assess readiness of the project for an ITER final design review (FDR) scheduled for June. The team presentations addressed the FDR scope, resolution of applicable chits from previous reviews, interface requirements, the technical design and associated analysis, the status of compliance with applicable system requirements, and the status of document approvals. Key documents were provided to the panel prior to the review. Review chair D. Rasmussen of U.S. ITER reported that the panel recognized that the content is comprehensive and that the team has largely demonstrated that the design meets the requirements. He noted, however, a number of outstanding documents still in need of U.S. ITER review, approval, and subsequent submission to the ITER Organization.

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Motional Stark Effect (MSE) diagnostic team members A. Cohen and B. Linn presented a preliminary analysis of mirror heat loading during high fusion power plasma operation. The analysis is a first step toward determining mirror cooling requirements. Mirror temperature is estimated to increase by approximately 200 degrees Celsius under combined nuclear and plasma radiation heating, while radiative cooling is estimated to reduce the heat load by ~3%. Issues requiring further investigation include concepts for mechanical support, mirror volume reduction to reduce nuclear heating, temperature ratcheting over multiple pulses, and materials options. In addition, PPPL engineer M. Messineo has updated the CAD model of the MSE optical elements integrated in Equatorial Port 03, for which the Laboratory has port integration responsibility. While formal subcontracting arrangements are still in progress, the Laboratory has effectively resumed its collaboration with Nova Photonics, its partner in the ITER MSE project.

ITER & TOKAMAKS (R. NAZIKIAN)

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

A periodic meeting of the domestic liquid metal PFC development program was held. J. Lore (ORNL) gave a presentation on the first-edge plasma and neutral gas simulations of an FNSF with the SOLPS-ITER code. This calculation represents the plasma response to liquid lithium plasma-facing components and provides critical input to the liquid lithium MHD calculations done separately. D. Andruczyk (University of Illinois at Urbana Champaign) also gave a brief update on experimental activities at UIUC.

Several papers from the 2019 PFMC conference related to the US-PRC PMI collaborative research program came out in the print version of *Physica Scripta*: “Improvement on the plasma performances via application of flowing lithium limiters in EAST tokamak,” by G. Zuo, J. Hu, R. Maingi, et al.; and “Overview of lithium injection and flowing liquid lithium results from the US-China collaboration on EAST,” by D. Andruczyk, J. Hu, R. Maingi, et al. The first paper describes three generations of flowing-liquid-lithium-limiter experiments on EAST; the third-generation limiter made of molybdenum was designed and constructed by PPPL and exposed in EAST in the summer of 2018. The second paper gives an overview of results from the US-PRC collaboration on PMI from 2016-2019.

ADVANCED PROJECTS (D. GATES)

Stellarators (D. Gates)

A talk entitled, “Characterization of boron particulate injection into W7-X discharges,” was remotely presented by R. Lunsford to the W7-X Impurity Transport Task Force. The talk described the Probe-Mounted Powder Injector (PMPI) experiments performed

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during W7-X Operational Period 1.2b and described the injection series, the rapid toroidal entrainment of impurities and the observed effects upon the plasma. The report also described an unexpected transient performance boost to the discharge provided by the boron carbide injections. This result coupled with elevated stored energy observed by W7-X staff during the injection of cryogenic pellet trains was identified as a strong collaborative future experiment and a possible focus for further research.

A paper by C. Zhu, M. Zarnstorff, D. Gates, and A. Brooks entitled, “Designing stellarators using perpendicular permanent magnets,” has been accepted by *Nuclear Fusion*: <https://iopscience.iop.org/article/10.1088/1741-4326/ab9006>. The paper describes a fast method to design perpendicular permanent magnets for optimized stellarators. By using this method, scientists could reproduce the NCSX equilibrium using perpendicular permanent magnets together with simple planar coils. The demonstration in the paper shows that adopting permanent magnets has the ability to significantly reduce the coil complexity of stellarators.

THEORY (S. HUDSON)

A paper titled, “Linear beam stability in periodic focusing systems: Krein signature and band structure,” by M. Chung, Y.-L. Cheon, and H. Qin was recently published in *Nuclear Instruments and Methods in Physics A*: <https://www.sciencedirect.com/science/article/pii/S016890022030262X?via%3Dihub>. The paper developed a new theoretical approach using Krein signature for analyzing the envelope instabilities in high-intensity charged particle beams.

E. Feibush attended the 2020 DOE Computer Graphics Forum. Originally planned for Santa Fe, New Mexico, the conference was conducted as an on-line video meeting. Feibush presented the PPPL Site Report describing our scientific visualization accomplishments and resources. His presentation included developments in augmented reality for combining physics simulations with CAD models. The movie showing simulations and analysis for NSTX-U was well received. Presentations from the other DOE laboratories covered applications of and enhancements to visualization software tools, such as Paraview and VisIt. It was also an opportunity to see the latest developments in scientific visualization from Intel and Nvidia.



C. Liu made a presentation at the virtual CTTS meeting entitled, “A new energetic particle module in M3D-C1 with GPU acceleration.” The talk is posted here:

https://ctts.pppl.gov/Sherwood2020/Chang_Liu.pdf

C. Smiet gave a talk at the Magnetic Topology Webinar in Glasgow University entitled, “The alternating-hyperbolic sawtooth.”

ENGINEERING (V. RICCARDO)

A brochure was published highlighting the work done by the DOE in analyzing research directions that will be impacted and enhanced by advanced wireless technology like 5G. A member of the PPPL engineering department participated in planning and running this conference, which was held in Chicago in March 2020, along with others from DOE labs, industry and academia. The brochure is available here:

<https://www.osti.gov/biblio/1606539>

A more comprehensive report is currently being written with contributions from PPPL, which will set research thrusts and help develop research funding opportunities for DOE labs and industry and academic partners.

COMMUNICATIONS & PUBLIC OUTREACH (A. ZWICKER)

Communications (L. Bernard):

The Office of Communications posted two news stories to the PPPL website. One reported that more than 100 PPPL parents and children attended PPPL’s Take Your Daughters and Sons to Work (at Home) Day on April 23 to watch plasma experiments and find out about science experiments they can do at home. The other reported that D. Graves, a professor at the University of California, Berkeley, since 1986, will become PPPL’s first associate laboratory director for Low-Temperature Plasma-Surface Interactions, effective June 1. Both stories were posted to the *Newswise* and *EurekaAlert* 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.

On May 7, J. Menard hosted the PPPL FY2022 Budget Planning Meeting with DOE Fusion Energy Sciences.

On May 8, J. Menard participated in the National Virtual Biotechnology Laboratory (NVBL) working group call.



On May 8, S. Cowley participated in the weekly National Laboratory Director's Council COVID-19 Coordination conference call.

This report is also available on the following web site:

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