

Weekly

HIGHLIGHTS



The PPPL Highlights for the week ending August 1, 2020, are as follows:

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

Recovery (J. Galayda):

Upper Primary Passive Plate Bracket Drilled Holes Solution Peer Review — A peer review was held on July 30 to review the technical solution for the enlarged holes drilled in the wrong location per the post-FDR bracket design modification. The peer review also covered the ECN and NCR required to document the new in-field condition and the analysis validation of the post-FDR design solution. The holes were drilled in the wrong location for the five upper primary passive plates for the passive plate bracket bolt subassembly.

Coils — Low-power electrical testing was successfully completed at PPPL on the second coil (PF1A Lower) fabricated by Sigmaphi. Coil fabrication continued in France and coils PF1C#1 and PF1A#2 were shipped to PPPL on July 30. PF1B#2 winding was completed and the coil was prepared for vacuum pressure impregnation (VPI), which will be conducted on Aug. 25. PF1C#2 metrology was completed and the paperwork will be reviewed while Sigmaphi is on vacation for the next two weeks. Coil PF1C#2 will be shipped when Sigmaphi returns from vacation. In addition, the order for spare coils was approved by the DOE, and the order was placed this week.

Center Stack Casing (CSC) — Machining continued in Camden, New Jersey, on the center stack casing. The machining of the center stack casing was done during two shifts and weekends at the Holtec facility in Camden. The spiral groove for the heat transfer tube was started on both ends and the ID of each end underwent final machining. This phase of machining will continue through Aug. 6, when the CSC will be shipped to Turtle Creek to attach the collar pieces on each end. The CSC will then be returned to Camden in early August for more machining.

Machine Core Structure (MCS) — Many fabrication activities continued at the three facilities currently making sling parts. Precision Boring in Michigan shipped all Lower PF1B sling component parts to PPPL, where they underwent the final stages of QC inspection. In addition, fabrication continued of the PF1A and PF1B capture and common flanges and PF1C capping flanges for the sling supports. In South Carolina, Carolina Fabricators first articles and production of PF1A sling parts continued with partial shipment expected the week of Aug. 3. G.J. Oliver finished radiograph inspection and resumed final machining of the welded parts of the PF1C supports. The preload parts at Magnaplate were coated and are in Receiving at PPPL. Additional procurement activities to award contracts for the remaining MCS components are neared completion.

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Interspace Vacuum Pumping System (IVPS) — On-site activities to install power to the vacuum pump and perform mechanical installations of the vacuum system components will resume in early August.

Research (S. Kaye):

The paper, “Enhanced pedestal H-mode at low edge ion collisionality on NSTX,” has been published online by *Physics of Plasmas* as part of the special edition for invited presentations at the 2019 APS DPP meeting: <https://doi.org/10.1063/5.0011614>. The authors are D. Battaglia, W. Guttenfelder, R. Bell, A. Diallo, N. Ferraro, E. Fredrickson, S. Gerhardt, S. Kaye, R. Maingi, and D. Smith. The paper provides new insight into the mechanisms responsible for the enhanced pedestal (EP) regime on NSTX where the global energy confinement improves concurrently with a reduction in the particle confinement compared to similar H-mode regimes. EP H-mode is an attractive wide-pedestal ELM-free H-mode regime for NSTX-U and future compact devices. The paper demonstrates that EP H-mode is realized due to a positive feedback between the neoclassical ion energy flux and particle transport driven by MHD edge modes such as the kinetic ballooning and saturated kink-peeling modes. The positive feedback occurs at low-ion collisionality where the edge ion temperature gradient rises rapidly with a small decrease in the edge density.

S. Sabbagh gave a presentation entitled, “Progress on Tokamak Disruption Event Characterization and Forecasting Research and Expansion to Real-Time Application” to the first IAEA Technical Meeting on Plasma Disruptions and their Mitigation run by the IAEA (Vienna) July 20-23.

ITER PROJECTS (H. NEILSON)

Low Field Side Reflectometer — LFSR (S. Shirey):

The manufacturing development for LFSR has entered a new phase with the authorization by PPPL for manufacturing partner General Atomics to begin preparing samples for welding development. This step is critical to begin developing plug welding process parameters for a Test Antenna Block Assembly (TABAs) that will prototype weld configurations for LFSR in-vessel assembly. The first in a new series of PPPL-GA manufacturing coordination meetings identified specific welding process and inspection questions for the ITER Central Team, raising awareness of the challenges of inspecting the gun drilled water channels within the antenna and looking into features of the in-vessel periscopes that could improve manufacturability.



Diagnostic Residual Gas Analyzer — DRGA (C. Klepper, ORNL):

Design work on the DRGA has resumed under the leadership of T. Biewer and C. Klepper of ORNL. Immediate priorities are to close the final design of the interface with the vacuum vessel and to supply temporary hardware that will be used to seal the vacuum vessel before the full DRGA system becomes available. Final design closure requires resolution of numerous chits that were raised at a 2015 final design review. Resolution plans are being developed in a series of meetings between Klepper and the Central Team Responsible Officer.

Toroidal Interferometer Polarimeter — TIP (M.-A. De Loosz):

The TIP team is reviewing and revising various design features that have been affected by changes in interfacing systems. CAD models revealed a misalignment between the laser beam tubes crossing the gallery and those exiting the penetrations from the diagnostics hall. A solution that would avoid impacting the placement of laser tables in the diagnostic hall, which is fixed by laser safety considerations, is now under review. The design of in-vessel mirrors that form the optical path is also in review. The mechanical design, including cooling, must be adapted to a new standardized shield module design that was adopted by the project in 2018. Design solutions developed for another laser diagnostic are being evaluated for applicability to TIP.

Electron Cyclotron Emission — ECE (G. Paraiso):

The ECE team continues its work on the redesign of the shutter-mirrors for both radial and oblique views. Mirror mounting redesign for adapting to the new shield module structure has also started. Design concepts are being coordinated with the U.S. design teams for TIP and Equatorial Port 9, which have close interfaces with ECE. The ECE system includes an ex-vessel compliant seal which interfaces with ECE components for which ITER-India is responsible. A proposed modification for the compliant seal was presented by the PPPL team at a project meeting including U.S., ITER-India, and Central Team participants. The design is now under review by the other participants.

ITER & TOKAMAKS (R. NAZIKIAN)

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

A collaborative paper titled, "Effect of lithium coating on long pulse high performance plasma discharges in EAST," by W. Xu, J. Hu, Z. Sun, R. Maingi, L. Zhang, et al., was published in *Plasma Physics and Controlled Fusion*: <https://doi.org/10.1088/1361-6587/ab9b3a>. The paper documents the reduction of other edge and core impurities by lithium powder injection on EAST. Powder injection is compared with pre-discharge



evaporative coatings, and the role of lithium wall conditioning on helping to achieve the 101-second-long H-mode pulse is explained.

ADVANCED PROJECTS (D. GATES)

Stellarators (D. Gates):

The Laboratory is partnering with Oak Ridge National Laboratory in a project to deliver a Continuous Pellet Fueling System (CPFS) for Wendelstein 7-X. On July 28, the project passed an important milestone with a successful preliminary design review (PDR). The ORNL-PPPL project team presented a mature design for a technologically advanced system that will continuously deliver pellets up to 3 millimeters in diameter of cryogenic hydrogen or deuterium at 100-millisecond intervals, or even more frequently for smaller pellets. Importantly, it was shown that the system can be used as a tool for density feedback control, which is expected to be the focus of physics research during the next phase of operation. At the PDR, PPPL's instrumentation and controls team of G. Tchlinguirian, B. Smith, and P. Sichta described design solutions for integrating the new injector with the W7-X control system, including human-machine interface and safety systems. Fabrication Group leader M. Safabakhsh described the design of the support stand, explaining its integration with the injector and with the W7-X infrastructure. The review panel, chaired by PPPL's T. Stevenson, found the design to be sound and ready to move to final design.

OFFICE OF ACADEMIC AFFAIRS (N. FISCH)

J. Schwartz, a graduate student in the Program in Plasma Physics, successfully defended his thesis, "Experimental and Modeling Studies for the Development of the Lithium Vapor-box Divertor," and passed his FPOE on July 24. His thesis advisor was R. Goldston. He will be working as a postdoctoral researcher with E. Kolemen and J. Jenkins at Princeton, performing techno-economic studies on fusion power plant concepts.

THEORY (S. HUDSON)

On July 22, A. Kleiner gave a remote talk in the PedELM meeting at General Atomics titled, "Modeling of peeling-ballooning modes in low-aspect ratio tokamaks beyond ideal-MHD."

A collaborative team including researchers from the Albert Einstein Institute (Potsdam, Germany), I. Dodin (PPPL), and D. Ruiz (Sandia) published a paper titled "Gravitational spin Hall effect of light" in *Physical Review D*:

<https://doi.org/10.1103/PhysRevD.102.024075>. The paper reports the first comprehensive theory of the deviation of vacuum geometrical-optics rays from null



geodesics in curved spacetime. This deviation is caused by polarization effects that Ruiz earlier studied at Princeton as a graduate student with Dodin as his PhD advisor.

Many Theory Department members attended the Virtual IAEA Technical Meeting on Disruptions July 20-23. The meeting was hosted by the ITER group and was to be held in Saint-Paul-lez-Durance, France. However, in response to the COVID-19 outbreak the meeting organizers changed the format to a virtual meeting. S. Jardin presented an invited talk titled, "Vessel forces from a vertical displacement event in ITER." The following Theory Department members also gave oral presentations: C. Clauser, "C-pellet simulations in NSTX-U with M3D-C1;" A. Reiman, "Magnetic island suppression and disruption avoidance via RF current condensation;" and C. Zhao, "Simulation of MHD instabilities with runaway electron current using M3D-C1." This year's meeting was hosted by the ITER Group in place of the Theory and Simulation of Disruptions Workshop (TSDW) which has been at PPPL every year since 2012. Theory Department Head A. Bhattacharjee served on this year's organizing committee. In 2021, PPPL will be host for the 8th Workshop on the Theory and Simulation of Disruptions, followed by another Technical Meeting on Disruptions hosted by the ITER group in 2022.

ENGINEERING (V. RICCARDO)

A report titled, "5G-Enabled Energy Innovation" was published by a working group established by the Office of Science to recommend research areas and opportunities for the DOE. This report will be used to develop strategies for the application of advanced wireless technology to enable research across the complex. G. Tchilinguirian, of PPPL's Engineering department, helped develop the workshop, organize the conference, and co-author the report. A copy of the report is available here:

<https://www.osti.gov/biblio/1606538>

COMMUNICATIONS & PUBLIC OUTREACH (A. ZWICKER)

Science Education (A. Dominguez):

The Science Education Department ran the 4th annual Undergraduate Workshop in Plasma Physics July 27-30. We hosted remotely 12 participants from undergraduate institutions from all over the country. A. Dominguez and graduate student L. Zhang led the workshop. The workshop focused on electrodynamics, vector calculus, computational methods, and an intro to plasmas and had a mission of getting students excited about plasmas and interested in applying for plasma internships and graduate school.



Communications (L. Bernard):

The Office of Communications posted three press releases to the PPPL website this week. The first reported that M. Simeni Simeni, an early-career physicist with a strong background in plasma physics, has been appointed to a fellowship that honors pioneering physicist Robert A. Ellis Jr. and is aimed at encouraging more diversity in plasma physics research at PPPL. The second reports that exploration of the processes behind supernova shockwaves has won W. Fox the John Dawson Award for Excellence in Plasma Physics Research. The honor, awarded by the American Physical Society, recognizes “a recent outstanding achievement in plasma physics research.” The third describes the first results of the extensively upgraded Lithium Tokamak Experiment-Beta (LTX- β), demonstrating that the major enhancements operate as designed and improve the performance of the hot, charged plasma that will fuel future fusion reactors.

L. Bernard participated remotely in the U.S. Department of Energy Office of Public Affairs monthly meeting on July 28.

DIRECTOR’S OFFICE (S. COWLEY)

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

C. Ferguson participated virtually in the APS-U - Welcome/Overview & Status meeting, July 27-29.

On July 28, C. Ferguson participated in the weekly National Laboratory Chief Operating Officers (NLCOO) conference call.

On July 28, S. Cowley participated in the virtual celebration of the ITER launch of the official Start of Assembly, paving the way to a new fusion era.

J. Menard participated remotely in the ITER Final Design Review (FDR) of the Plasma Control System (PCS) for First Plasma operation, held July 28-31.

On July 29, S. Cowley participated in the virtual 2020 Undergraduate Workshop in Plasma Physics.

This report is also available on the following web site:

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