



The PPPL Highlights for the week ending November 21, 2020, are as follows:

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

Recovery (J. Galayda):

Bus Supports — Water testing of the PF1B power cables continued. Water jackets of two cables failed at the fittings and PPPL worked with the vendor to correct the problem. The materials required for the PF extension and OH coax bus connection were inspected, and preparations were made for fabrication of the supports in conjunction with the work packages.

Coils — Preparations for machining the six production coils continued at PPPL. At Sigmaphi, paperwork for coil PF1B-S (spare) was assembled as it was packaged for shipping to PPPL on Nov. 20. Coil PF1A-S (spare) hydrostatic testing was completed and document review was in process.

Center Stack Casing (CSC) — The finish machining of the CSC in Camden continued with good progress. PPPL resumed QA oversight in Camden twice a week and engineering oversight full-time at Turtle Creek. At Turtle Creek, the bellows mockup welding continued, along with stud installation prototyping and organ pipe welding.

IVPS — Installation of the pump, electrical, and controls packages were approved for near-term installation.

Machine Core Structure (MCS) — Precision Boring in Michigan continued with fabrications; they operated at approximately 90% as their staff returned from their Covid issues. The capture and common flanges neared completion. In South Carolina, Carolina Fabricators' production of PF1A sling base parts continued, with 27 completed. G. J. Oliver continued work on the upper PF1C support, and the ceramic break flange was machined. The outer skirt forging arrived so fabrication could proceed. At PPPL, mockup activities were completed and lessons learned continued to be reviewed and incorporated into assembly procedures. PF1B lower slings welding was completed, and post-weld inspection and heat treating began. The PF1C support was dimensionally checked and moved into welding, cleaning, and testing.

Casing Lift Fixture and Case Stand Peer Review — A peer review was held Nov. 20 to review the center stack casing lift fixture and case stand design to ensure that positioning, lift, and assembly fixtures are available for NSTX-U reassembly. The review included the design of new fixtures, modification of existing fixtures for case lifting and the validation of existing fixtures to ensure QAPD, and the NSTX-U QAP compliance. The

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committee will reconvene for a review of updated drawings before issuing recommendations.

Research (S. Kaye):

NSTX-U researchers participated in the 62nd Annual Meeting of the APS Division of Plasma Physics, which was held virtually during the week Nov. 9-13. Researchers reported on results from both NSTX/NSTX-U as well as from collaborative activities in which they have been engaged during the NSTX-U Recovery. Eighteen researchers contributed oral talks, 30 contributed posters, and four invited talks comprised the set of these presentations. Z. Sun, N. Mandell, R. Lunsford and V. Duarte gave the invited talks.

The paper titled, “Microturbulence-mediated route for energetic ion transport and Alfvénic mode amplitude oscillations in tokamaks” by N. Gorelenkov and V. Duarte was published in *Physics Letters A*:

<https://doi.org/10.1016/j.physleta.2020.126944>. The work reports that micro-turbulence can be an essential element in explaining the saturation levels of Alfvén eigenmodes (AEs) observed in DIII-D. Although the direct effect of micro-turbulence on the transport of fast ions is small, turbulence acts to increase the effective stochasticity experienced by resonant fast ions with respect to the case of collisional pitch angle scattering alone. Such enhanced anomalous scattering acts to broaden the resonances and, therefore, to extend the phase-space range for the interaction between AEs and fast ions and also to increase the AE saturation level. Micro-turbulence can then become a mediator for energetic particle relaxation in tokamaks. The work reports simulation results from the recently developed Resonance-Broadened Quasilinear (RBQ) code, which uses a quasilinear framework self-consistently derived from first principles near marginal instability [Duarte et al, <https://doi.org/10.1063/1.5129260>]. The BRQ results are also benchmarked with those from the nonlinear kinetic code BOT.

ITER PROJECTS (H. NEILSON)

Upper Wide Angle Viewing — UWAV (M. Smith):

The UWAVS team met with the IO responsible officer (IO-TRO) and discussed the interface issues related to the in-vacuum components being installed in five upper ports having two different port plug design schemes. While four of the ports follow the generic IO design the fifth, namely UP17, a EUDA port, uses a very different DSM and shielding design. The EUDA developed their port integration scheme to match the UWAVS 2017 front end optical tube (FEOT) interfaces. In order to support the UP17



design schedule, the UWAVS interfaces in this port need to be frozen. It is agreed to use the UWAVS 2017 FEOT space claim and detailed design as the basis for installing the system into the UP17. Consequently, there will be two different design configurations for the UWAVS in-vacuum components.

Electron Cyclotron Emission — ECE (G. Paraiso):

The ECE team completed an update of its front-end optics layout, consisting of fixed mirrors, a movable shutter-mirror, and hot calibration sources. The models and layout drawings have been shared for review by Central Team and India DA participants in the project. Also, the team has made significant progress in its redesign of the push-rod shutter mechanism and its integration into the new DSM. A concept for the shutter/hot source mounting design has been modeled and shared with the port integrator for initial feedback. The team continues to improve the design and to complete the push-rod actuation design. Finally, the team has completed a review of the system requirements document and is currently reviewing interface sheets.

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

Welding development continued this week with a completed test block ready for grinding, sectioning, and inspection. An expected amount of distortion was visible and plans are underway to understand the distortion and how the final ABA machining can accommodate it. Manufacturing readiness planning also took a step forward in a meeting with the IO responsible officer, A. Sirinelli, in understanding the IO's expectations and overall process.

ITER & TOKAMAKS (R. NAZIKIAN)

DIII-D (B. Grierson):

Operations:

The paper titled, "Toroidal Field Reversing Switch" by T. Raines has been published online in *IEEE Transactions on Plasma Science*: <http://doi.org/10.1109/TPS.2020.3036029>. The present DIII-D field-reversing procedure requires approximately four hours of labor performed between run days to reconfigure the bus work, thus requiring separate run days to complete experimental scans that require studies in both field directions. This typically results in different wall conditions which complicate the results. The proposed switch will complete the reversal process in approximately four or five minutes between shots so wall conditions are not a factor, and easily fits within the 10-120-minute DIII-D shot cycle.

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International PMI and Liquid Metal PFC Concept Development (R. Maingi & A. Diallo):

R. Lunsford presented, “Continuing development of controlled particulate impurity injection techniques in fusion research devices” at the virtual Technology of Fusion Energy (TOFE) conference. The presentation summarized the history of the PPPL dropper program and provided updates on the current state of the world research program. ELM pacing experiments at EAST and DIII-D as well as powder conditioning and ELM suppression efforts at ASDEX-Upgrade, DIII-D, EAST, K-STAR and LHD were presented. In addition, a brief overview of the recent W7-X powder injection experiments and an outline of the PPPL IPD upcoming research program was discussed.

A. Khodak gave an oral presentation at the virtual Technology of Fusion Energy (TOFE) meeting titled, “Numerical modeling for flowing liquid lithium in 3D printed divertor heat shields.” The concept of a porous wall with liquid lithium at the surface and flowing underneath the surface in a coolant channel was presented. Heat fluxes of 10 MW/m² can be exhausted by this concept while maintaining surface temperature below 450 degrees Celsius with a flow speed of about 8 m/s.

R. Maingi hosted a periodic meeting of the domestic liquid metal PFC development program. D. Andruczyk (UIUC) presented UIUC collaborative work on MAGNUM-PSI with liquid lithium targets and Neon gas seeding, as well as preparations for liquid metal corrosion and wetting R&D in test stands.

ADVANCED PROJECTS (D. GATES)

Stellarators (D. Gates):

A. Chambliss will be giving an invited talk this week as part of PPPL’s Stellarator Seminar Series. She will be presenting the results from her sensitivity studies on the MUSE tabletop stellarator, which include computation of the shape gradient of normal field error for dipole position as well as preliminary results from the application of the Hessian matrix method to normal field error. This work is the first instance in which the shape gradient and Hessian matrix methods have been applied to a permanent magnet stellarator.

THEORY (S. HUDSON)

E. Feibush presented, “Scientific Visualization with VisIt” in a mini-course sponsored by PICSciE, the Princeton Institute for Computational Science and Engineering. The course was presented remotely. The presentation featured techniques for exploring and communicating data either generated by simulations or acquired from experiments. Attendees completed interactive exercises for displaying data on a 3D-compute grid.



VisIt's built-in Python scripting interface was described to automate visualization workflows.

M. Churchill attended the Supercomputing 2020 conference and presented an invited talk titled, "Machine learning for science with a deadline: a focus on the scientist."

R. Kube gave a talk at the 2020 International Workshops on Urgent and Interactive HPC. Accompanying the talk, the paper titled, "Near Real-Time Analysis of Big Fusion Data on HPC Systems" (R. Kube, R. Churchill, J. Choi, J. Wang, M. Choi, C.-S. Chang, S. Klasky) was published in *Proceedings of UrgentHPC 2020: The 2020 International Workshops on Urgent and Interactive HPC*:
DOI: 10.1109/UrgentHPC51945.2020.00012. He also participated in the workshop's

panel discussion that explored challenges and developments needed to further establish use of high-performance computing in interactive research settings.

D. Schaeffer organized two outreach and networking events during the meeting for the DPP LGBT+ community.

The Theory Department had 44 members attend the 62nd Annual Meeting of the APS Division of Plasma Physics virtual conference. There were three invited talks, 15 external seminars and 17 poster presentations.

M. Churchill attended the APS-DPP 2020 conference and presented a talk titled, "Accelerating Kinetic Simulations of the Tokamak Edge Utilizing Encoder-Decoder Neural Networks to Solve the Nonlinear Fokker-Planck Collision Operator."

D. Schaeffer presented two talks at the 2020 APS-DPP meeting. One was titled, "Kinetic Simulations of Piston-Driven Collisionless Shock Formation in Magnetized Laboratory Plasmas" and one titled, "Magnetic Reconnection in Highly Extended Current Sheets at the NIF."

H. Qin gave an invited talk titled, "Structure-Preserving, Geometric, Particle-in-Cell Algorithms for Tokamaks" at the 62nd Annual Meeting of the APS Division of Plasma Physics. The talk introduced the basic techniques of the algorithms and reviewed the recent advance in this active research field.

E. Belova presented a poster at the APS-DPP conference titled, "Global Alfvén eigenmode (GAE) simulations for NSTX(-U) and DIII-D."

C. Smiet presented a talk titled, "Topological bifurcations of the magnetic axis and the alternating-hyperbolic sawtooth."



C. Clauser presented a contributed oral talk at the APS-DPP titled, “M3D-C1 modelling of C-pellet disruption mitigation in NSTX-U.”

A. Kliener presented a contributed talk at the APS-DPP meeting entitled, “Effect of resistivity on peeling-ballooning modes in low-aspect-ratio tokamaks.”

I. Kaganovich of the Princeton Plasma Physics Laboratory, M. Shneider of Princeton University, and M. Keidar of The George Washington University organized a mini-conference on the latest results in developing plasma-based applications to ameliorate COVID-19 during the virtual 62nd Annual Meeting of the APS Division of Plasma Physics.

Y. Shi, a graduate student, won the 2020 Marshall N. Rosenbluth Outstanding Doctoral Thesis Award.

W. Fox is part of a team that won the Dawson Excellence in Plasma Physics Award.

E. Belova was elected APS Fellow in 2020.

HUMAN RESOURCES (J. VANNOY)

Equity, Diversity and Inclusion (B. Harrison):

Recently, PPPL became an employer member of The National GEM Consortium. GEM is a network of leading corporations, government laboratories, top universities, and top research institutions that enables qualified students from underrepresented communities to pursue graduate education in applied science and engineering. This week, A. Dominguez, B. Ellis, and B. Grierson participated in the two-day GEM Fellowship Application Review. To learn more about GEM, please log onto their website at www.gemfellowship.org.

COMMUNICATIONS & PUBLIC OUTREACH (A. ZWICKER)

Communications (L. Bernard):

The Office of Communications posted one press release to the PPPL website that reported on PPPL’s participation in and contributions to the 62nd annual meeting of the American Physical Society-Division of Plasma Physics.

C. Cane participated remotely in the Department of Energy headquarters Public Affairs and National Laboratories Social Media meeting on Nov. 18.

L. Bernard participated remotely in the Nov. 17 Department of Energy’s headquarters Public Affairs meeting with National Laboratories’ communications officers.



L. Bernard participated remotely in the Nov. 19 National Laboratory Chief Communications Officers (NLCCO) meeting.

DIRECTOR'S OFFICE (S. COWLEY)

Laboratory leadership virtually hosted the Department of Energy/Princeton University Independent Review of the Re-baseline Proposal Facility for Laboratory Reconnection Experiments (FLARE) Nov. 16-17.

S. Cowley and C. Ferguson participated in the annual America Recycles Day event on Nov. 17.

J. Menard and M. Zarnstorff participated in the 2020 American Nuclear Society (ANS) virtual winter meeting, as well as the Technology of Fusion Energy (TOFE) 2020 meeting, which was embedded in the ANS meeting. J. Menard gave an oral presentation entitled, "Configuration Studies for a Fusion Pilot Plant Innovation Integration eXperiment."

Greg Brittles, Senior HTS Magnet Engineer of Tokamak Energy, presented a virtual colloquium on Nov. 18. titled, "HTS magnet development at Tokamak Energy — a discussion of challenges and solutions."

A virtual PPPL all-hands meeting was hosted by laboratory leadership on Nov. 20.

On Nov. 20, J. Menard participated in the monthly National Laboratory Chief Research Officer (NLCRO) conference call and the biweekly National Virtual Biotechnology Laboratory (NVBL) working group call.

This report is also available on the following web site:

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