



The PPPL Highlights for the week ending November 10, 2018, are as follows:

NSTX-U RECOVERY AND RESEARCH (J. MENARD)

Recovery:

Central Instruments & Controls — Installation of the course wave division multiplexing equipment in the data acquisition room (DARM) and NSTX-U test cell began this week. The three-month test period for the equipment will begin next week.

Magnets — The updated magnet work authorization form (WAF) with the basis of estimate (BOE) was completed this week. The vendor qualification was approved for the improved glass tape, and an order was placed. Final modifications are being made to the drawings, and the specification is ready for final review. The processing for the first conductor at ICAS Tratos is scheduled for Nov. 19 and PPPL staff is on location at Tratos. The corona testing on the ETI prototype coil section was successfully completed and showed no degradation of the insulation system after aging. The magnets team is proceeding with limited tests of other coil samples. A meeting was held to review the results of the composite shear strength testing, and it was determined that the behavior was elastic for the small thermal shear strain. Fatigue testing is planned for the sample to verify insulation integrity. The water fitting test samples were completed; the torque was tested; and the samples were tested with hydraulics and then cut open and examined. All results were good. The WAF was updated last week for the PF Bus Task.

Research:

Collaborations — W. Guttenfelder presented a seminar titled, “Containing A Star On Earth: The Promise Of Fusion Energy,” to the Portland State University Department of Physics on Nov. 5 while attending the APS-DPP meeting. The seminar was arranged as part of the developing U.S. Fusion Outreach Team that was recently established by the U.S. Burning Plasma Organization. People interested in contributing to fusion outreach activities are encouraged to join the US Fusion Outreach Team.

Conferences — Researchers gave 34 presentations related to NSTX/NSTX-U results and/or collaborations at the APS-DPP meeting held in Portland, Oregon, including: D. Battaglia: “Enhanced Pedestal H-mode Regime on NSTX;” N. Bertelli: “The impact of the edge density fluctuations on the electron cyclotron wave propagation in tokamaks;” D. Boyer: “Accelerated predictive models based on TRANSP for scenario optimization and control of NSTX-U” and “NubeamNet: Accelerated predictive modeling of NSTX-U beam deposition for optimization and control;” Z. Chen: “X-divertor study with SOLPS-ITER;” V. Gajaraj: Accelerated predictive modeling of the current profile evolution on NSTX-U

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using neural networks;” G. Giesbrecht: “Modeling Photodetector Circuits for BES Systems;” T. Gray: “Heat Flux Testing of Prototype NSTX-U Plasma Facing Components;” A. Hakim: “Continuum Gyrokinetic Simulations of Turbulence in Model Tokamak Scrape-Off Layers Geometry;”

Also, K. Hammond: “Application of transient CHI plasma start-up to future ST and AT devices;” M. Jaworski: “Status of the NSTX-U Recovery Project Plasma-Facing Components;” S.M. Kaye: “Analysis of the Updated ITPA Global H-Mode Confinement Database;” E.H. Kim: “High harmonic fast wave propagation in the scrape-off layer of NSTX and NSTX-U;” S.H. Ku: “Fully implicit particle-in-cell simulation of gyrokinetic electromagnetic modes in XGC1 without the cancellation issue;” J. Kunimune: “Optimization and application of neural network models for accelerated predictive modeling of NSTX-U;” J. Lestz: “Multi-beam effects on compressional Alfvén eigenmode stability;” T. Looby: “Heat Flux Model Validation Utilizing Machine Learning and Sub-surface Thermocouples for NSTX-U Plasma Facing Components;” N.C. Luhman, “Simultaneous High-k Scattering and Microwave Imaging Reflectometry on NSTX-U;” J. Menard: “Status and Plans for the NSTX-U Recovery Project;” M. Ono: “Solenoid-free Start-up Modeling of 2nd Harmonic Electron Cyclotron Heating and Current Drive;” S. Munaretto: “Assessment of equilibrium field coil misalignments on the divertor footprints in NSTX-U;” J.K. Park: “New aspects of error fields from high field side in tokamaks;” S. Pereira: “Development of a Motorized Telescope for Pulse-Burst Laser System;”

Also, J. Riquezes: “Rotating MHD analysis for disruption event characterization and forecasting;” J. Ruiz Ruiz: “Validation of novel hybrid scale ETG simulations in NSTX via comparisons of simulated turbulence with a new high-k scattering synthetic diagnostic;” D.A. Russell: “Reduced model (nSOLT) simulations of neutral-plasma interaction in the edge and SOL: verification, equilibrium profiles and turbulent momentum transport;” S. Sabbagh: “Disruption Event Characterization and Forecasting in Tokamaks;” H. Schamis: “Fundamental surface interactions of vacuum-level contaminants with lithium coatings on plasma-facing materials;” H. Schamis: “Deuterium irradiation studies of lithium and boron coatings on graphite samples from NSTX-U;” F. Scotti, “Characterization of deuterium neutral density profiles in the National Spherical Torus Experiment Upgrade;” E. Startsev: “Recent Progress in EM-GTS code;” T. Stoltzfus-Dueck: “Velocimetry and the aperture problem for 2D incompressible flows;” J. William: “Disruptivity and Density Limits in MAST and other Tokamaks;” B. Woods: “Machine learning driven correlation studies: Alfvénic and sub-Alfvénic frequency chirping at NSTX.”



U.S. ITER FABRICATION (H. NEILSON)

The preliminary design review of the ITER Low Field Side Reflectometer (LFSR) took place Nov. 7-8 at the ITER site in St. Paul-lez-Durance, France. Attending from PPPL were project leader A. Zolfaghari, along with A. Basile, G. Kramer, M. Sibilia, and H. Neilson. D. Loesser participated as a member of the review committee. Remote presentations were made by J. Klabacha, E. Nassar, and W. Wang. Together with partner General Atomics, the PPPL-led team made 24 presentations during the two-day meeting, covering the designs of in-vessel and ex-vessel equipment in the tokamak building and the design of microwave and control instrumentation in the diagnostic building. The physics analyses, engineering analyses, and laboratory testing that supports the design and justifies compliance with more than 280 requirements were presented and discussed in detail. In addition, the team presented plans for assembly, installation, commissioning, operation, and maintenance of the equipment. Committee deliberations and formulation of conclusions and recommendations will take place over the next 2 to 3 weeks; the review will close with a report and de-briefing by the chair on Nov. 29.

Work on the image detection and processing design for the Upper Wide Angle Viewing (UWAV) diagnostic continues under a contract with Bertin Technologies. The current status of the design was assessed, and key remaining issues identified, in a Nov. 6 meeting led by project leader F. Hoffman, and including participants from PPPL, Bertin, and the ITER Diagnostics Division.

ITER & TOKAMAKS (R. NAZIKIAN)

KSTAR Control (D. Boyer, K. Erickson):

D. Boyer and X. Yuan demonstrated closed loop feedback control using the Simulink-TRANSP communication capability that has recently been developed at PPPL. Specifically, control of the TRANSP predicted normalized beta was demonstrated through the manipulation of neutral beam power via a control algorithm running in Simulink. The ability to test and tune control algorithms using predictive TRANSP simulations will facilitate the design and validation of more sophisticated control algorithms and enable improved experimental planning. The demonstration of closed loop control represents a major milestone towards the completion of the FY19 Notable Outcome.

K. Erickson began porting the NSTX-U and DIII-D versions of the Isoflux shape control algorithms to KSTAR. This work makes use of the PCS code generator capabilities to greatly simplify the code (a reduction from approximately 10,000 lines of code to around 3,000 lines has already been achieved), improving maintainability and making

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future code development easier. By standardizing the code as much as possible across the three devices (NSTX-U, DIII-D and KSTAR), the sharing of algorithms and new developments will be facilitated. Work on documenting the KSTAR shape control algorithms (D. Boyer, J. Barr [GA], K. Erickson) is being done in parallel and will provide references for both operators and developers. Offline testing of the updated code will begin once porting and documentation are complete.

DIII-D Research (B. Grierson):

Ten members of the PPPL DIII-D collaboration presented results at the 2018 APS-DPP meeting in Portland, Oregon. There were four invited talks on DIII-D research from PPPL: E. Kolemen on real-time plasma stability analysis for the control of stable tokamak operation; N. Logan on rotation and rotational shear induced by multimodal plasma response; Z. Wang on validating the multi-modal nature of the plasma response and detection of the damping rate of multiple stable $n=1$ modes, and B. Grierson on using main-ion toroidal rotation measurements to gain insight on the structure and magnitude of residual stress in low torque plasmas.

In oral sessions, Q. Hu showed the role of multiple edge-locked modes on fast heat transport during the thermal quench, and S. Haskey showed main-ion measurements in the pedestal and the breakdown of local neoclassical theory in predicting main ion rotation from impurity measurements.

A. Bortolon gave a poster presentation on the use of impurity powder droppers for wall conditioning; A. Ashourvan presented a poster on CGYRO modeling of wide pedestal grassy ELM regimes; R. Hager presented results of particle pump-out by RMP fields using M3D-C1 and neoclassical XGC simulations and W. Guttenfelder showed how the electron temperature pedestal tracking the ETG critical gradient based on CGYRO simulations in DIII-D pedestals.

DIII-D Operations and Control (A. Nagy, K. Erickson):

The calorimeter for the 150-degree, tiltable, off-axis neutral beam has been shipped to General Atomics and will arrive next week. Upon arrival, the calorimeter will be subject to quality control inspection and then will be stored till needed. This calorimeter will not be installed during the long torus opening.

A requisition has been placed for the DIII-D helicon system high-power waveguide switching network. This network includes the waveguide transmission lines and dummy loads.

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International PMI (R. Maingi):

Z. Sun presented a remote talk titled, “ELM elimination via lithium granule gravitational injection in EAST,” at the ITPA Pedestal and Edge Physics group meeting, held at the ITER site in France Oct. 29-31. The talk presented the first set of observations showing that dropped lithium granules also condition the plasma-facing components at least as effectively as lithium powder, and also eliminate ELMs. As with lithium powder injection, a progressive conditioning effect was observed.

ADVANCED PROJECTS (D. GATES)

Stellarators (D. Gates):

S. Lazerson presented a talk, “The role of perturbative fields in Wendelstein 7-X,” at the 2018 APS Division of Plasma Physics meeting held in Portland, Oregon, Nov. 5-9. The talk reviewed Lazerson's work to correct error fields in W7-X using the U.S. Trim Coil system and how additional coils are being used for divertor control. Lazerson also served as chair for tutorial session on tokamak power plant design given by R. Buttery of General Atomics.

D. Gates presented a poster entitled, “Stellarator research opportunities.” The talk covered the material in a recently published paper with the same title. He also chaired a review session covering a summary of recent results from W7-X.

THEORY (S. HUDSON)

An article titled, “Projection-operator methods for classical transport in magnetized plasmas. Part 1. Linear response, the Braginskii equations and fluctuating hydrodynamics,” by J. Krommes has been selected by the editorial board of the *Journal of Plasma Physics* as one of the featured articles from the 2018 Issue 4. This article now appears on the front page of the journal's website:

<https://www.cambridge.org/core/journals/journal-of-plasma-physics>

Many members of the theory department attended the 60th Annual Meeting of the APS Division of Plasma Physics, Nov. 5–9 in Portland, Oregon. Theory department members presented 19 posters and two invited talks. N. Gorelenkov's talk was titled, “Quasi-linear resonance broadened model for fast ion relaxation in the presence of Alfvénic instabilities.” In it, he discussed using a realistic quasi-linear model to find the energetic particle distribution function relaxed in the presence of Alfvénic instabilities. Y. Zhou's talk was titled, “Current singularity formation in line-tied magnetic fields: the Parker Problem.” His talk focused on the problem of coronal heating and whether, in ideal magnetohydrodynamical situations, genuine current singularities can emerge from a smooth 3D line-tied magnetic field. Zhou and others developed a novel variational



integrator for ideal MHD by discretizing Newcomb's ideal MHD Lagrangian on a moving mesh using discrete exterior calculus.

Computational Plasma Physics Group (S. Jardin):

F. Poli presented on behalf of the TRANSP development group a poster on the status and plans for development of TRANSP at the 60th Annual Meeting of the APS Division of Plasma Physics, Nov. 5–9 in Portland, Oregon. A users meeting was held to present updates on recent developments and gather feedback.

SITE PROTECTION (M. COHEN)

Site Protection Division staff participated in a knowledge exchange meeting with the Lawrence Berkeley National Laboratory concerning the Safeguards and Security Program. Engine 66 responded to four mutual aid assignments in Princeton Township and Plainsboro Township.

COMMUNICATIONS & PUBLIC OUTREACH (A. ZWICKER)

C. Gentile and R. Maingi hosted a group of Plainsboro middle school students and parent advisors participating in a science competition. The students have identified edible packaging as a means to reduce/eliminate the plastic waste generated on space stations during meal consumption. A French company provided samples of innovative cellophane-style packaging, which the students shrink wrapped around snack items to obviate other packaging and prevent crumb formation while eating. PPPL scientists advised them on the project and their upcoming final competitive presentation, which will take place next week.

Communications (L. Bernard):

The Office of Communications posted one press release to the PPPL website. It focused on research by D. St-Onge and M. Kunz about new findings indicating that plasma turbulence may be responsible for the intensification of cosmic magnetic fields. The story was also posted to the *Newswise* and *EurekAlert* press release distribution services.

DIRECTOR'S OFFICE (S. COWLEY)

Nov. 5-8, S. Cowley and M. Zarnstorff attended a meeting of the American Physical Society, held in Portland, Oregon.

This report is also available on the following web site:

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