The PPPL Highlights for the week ending September 15, 2018, are as follows:

**NSTX-U RECOVERY AND RESEARCH (J. MENARD)**

An NSTX-U team meeting was held on Sept. 14 to discuss results of the Director’s Review, go over recovery and research progress from the past six months, and discuss next steps for the coming fiscal year.

*Recovery:*

**Magnets** — Evaluation criteria have been developed for procuring the inner poloidal field coil. Sectioning of the Tesla coil was completed, and electrical tests of the coil have yielded good results. Turn-to-turn tests continue for the Tesla coil.

*Research:*

**Collaborations** — M. Podestà attended the ITPA Energetic Particles fall meeting in Lisbon, Portugal, Sept. 3-5. Status and plans of current joint activities were discussed, including plans for an EP-8 Joint Experiment titled, “Validation of neutral beam current drive modeling and projections to ITER” that is coordinated by Podestà. A new activity, to which NSTX-U is expected to contribute, was proposed to study the effects of 3D fields on energetic particle confinement.

**U.S. ITER FABRICATION (H. NEILSON)**

A U.S. ITER design readiness review for the Low-Field-Side Reflectometer (LFSR) project, held Sept. 11, found that the project is ready to proceed to a preliminary design review (PDR). Representing the project team, A. Basile, A. Gattuso (General Atomics), and H. Neilson presented an overview of the LFSR system design, status of PDR deliverables and design compliance documentation, and advances in technical maturity of the design. A review panel composed of U.S. ITER managers and technical leads, and chaired by Systems Engineering Manager H. Bailey, recommended moving forward with an ITER Organization PDR planned for early November. The panel also advised the LFSR team on priorities for preparatory work prior to that review.

**ITER & TOKAMAKS (R. NAZIKIAN)**

R. Maingi presented a webinar for the Burning Plasma Organization (BPO) titled, “Summary of FESAC Report on Transformative Enabling Capabilities for Efficient Advance Toward Fusion Energy.” The report identified five technology areas with transformative potential for accelerating toward fusion energy: advanced algorithms, high-temperature superconductors, advanced materials and manufacturing, tritium fuel
cycle control, and fast-flowing, liquid-metal plasma-facing components. The webinar had 53 ZOOM connections and more than 70 participants.

**DIII-D (B. Grierson):**

*Research:*

A. Bortolon and S. Haskey attended the EU-US TTF meeting in Seville, Spain. Haskey presented a talk titled, “Main-ion and impurity rotation, temperature, and density evolution across the L-H transition on DIII-D,” demonstrating the differences between impurity and main-ion rotation and temperature near the plasma boundary, and implications for turbulence and momentum transport studies. Bortolon presented a poster entitled “Observations of transient ELM stabilization during modulated neutral beam injection in DIII-D.” Bortolon reported a transient stabilization of type-I edge localized modes, showing that the likelihood of ELM occurrence lowers significantly during time intervals of counter-current neutral beam injection.

This week B. Grierson was named Deputy Group Leader of Pedestal and ELM Physics on DIII-D. The Pedestal and ELM Group is one of the three primary physics groups in the DIII-D Experimental Science Division (Burning Plasma Physics and Dynamics & Control being the other two groups). Grierson will retain his position co-leading the Core-Edge Integration Task Force, which provides synergy between Experimental Science and the Boundary and Plasma-Material Interaction Center.

N. Logan was named Leader of the 3D & Stability Physics group for the FY19-FY20 DIII-D experimental campaigns. In this role, he will be developing strategic goals and research plans for MHD physics studies on DIII-D.

A new article was published online by B. Grierson in the journal *Review of Scientific Instruments* titled, “Relative intensity calibration of the DIII-D charge-exchange recombination spectroscopy system using neutral beam injection into gas,” [https://doi.org/10.1063/1.5037333](https://doi.org/10.1063/1.5037333). This article presents an improved relative calibration for accurate impurity density profiles in DIII-D by using emission from xenon gas undergoing neutral-neutral collisional excitation from the heating beams.

*Operations:*

This week saw the culmination of a long effort over three years to upgrade the three neutral beam high-voltage control systems on DIII-D. The new state-of-the-art system replaces the outdated 40-year-old system with better reliability, improved timing resolution, and extra control features and interfaces. The upgrade did not go without a hitch. The first system proved much more challenging than anticipated. Over two years
of analysis and redesign was required to replace the old with the new. A key issue was to isolate some noisy electronic components from the components that do not tolerate noise well. This was accomplished using fiber optic communication between satellite systems to eliminate pickup. With the commissioning of two new systems, this now completes the PPPL role providing neutral beam high-voltage control systems for DIII-D.

**International Long Pulse (F. Poli):**

A major component of the Fusion Flight Simulator project for KSTAR is enabling a robust and flexible approach to steering TRANSP simulations using external processes. This will enable, for example, actuator trajectories to be communicated to TRANSP from control algorithm prototyping environments, like Simulink. Building from an initial file-based communication method developed previously, D. Boyer and X. Yuan have defined the requirements for TCP/IP-based external steering of TRANSP. An initial demonstration of the new approach to communication between TRANSP and external processes has been developed, and the implementation of other necessary functionalities is ongoing.

The KSTAR Coil Monitoring System will demonstrate real-time calculation of machine critical parameters, like coil forces and peak fields. This will enable monitoring and eventually active avoidance of machine limits to avoid tripping protection systems. An initial project plan and high-level requirements document for the Coil Monitoring System on KSTAR has been prepared for internal review, which explains the hardware implementation and the calculations to be done in both an offline calculator and a real-time algorithm.

A conference call was held on Sept. 13 between PPPL and NFRI to discuss mitigation and suppression of Alfvénic modes with electron cyclotron heating and current drive, aiming at selecting discharges that can be used for analysis and for improvement of MHD and Alfvénic stability in high q-min KSTAR plasmas.

**ADVANCED PROJECTS (H. Neilson)**

**Stellarators (D. Gates):**

S. Lazerson made a presentation titled, “Rapid Profile Fitting for W7-X,” at the weekly W7-X science meeting. This presentation covered the development of the WAPID_FIT code, which uses precomputed VMEC equilibria to calculate profiles fits to Thomson scattering, interferometer, and X-ray imaging crystal spectrometer (XICS) data. This tool allows researchers to quickly invert experimental data using precomputed lookup tables based on fixed boundary equilibria. The equilibria were carefully matched to the vacuum last closed flux surface for a variety of magnetic configurations in W7-X. These
equilibria were developed in collaboration with C. Nuhrenberg and J. Geiger (IPP-Greifswald). Diagnostic models for the Thomson system were developed in collaboration with S. Bozhenkov (IPP-Greifswald). The diagnostic model for the XICS was developed by N. Pablant (PPPL) and P. Traverso (Auburn Univ.). The lookup tables are based on inversion routines from STELLOPT. This tool is currently being used to provide initial profiles for bootstrap current predictions and for modeling of NBI injection and fast-ion losses in W7-X.

System Studies (C. Kessel):

P. Titus, T. Brown, H. Neilson, D. Gates, R, Nazikian, and C. Kessel participated in a videoconference with S. Korea’s National Fusion Research Institute (NFRI) and discussed joint work on the K-DEMO design study. Brown reviewed progress on configuration issues and proposed new work topics for the next cycle: an advanced winding scheme with low-temperature superconductors to increase current density, liquid-metal divertor, and design analysis. Titus presented stress analysis of the central solenoid (CS) and other poloidal field coils, indicating forces were too high in the CS, but that better definition of the stress allowable might make this easier to meet. His proposals for the next cycle included a structural modification for the divertor coils (PF1-4), structural solutions for the CS, error fields and impacts on divertor heat loads, disruption simulations, VDE effects, and blanket fluid dynamics. Kessel presented the plasma and coil simulations of the ramp-up, showing that the ramp-up time had to drop to 60 seconds, along with 10 megawatts of heating, to meet the force constraints. Limitations imposed by db/dt in superconductors may also become an important constraint. Nazikian proposed using a KSTAR flight simulator (to be developed) in TRANSP to model K-DEMO scenarios. The NFRI team will review proposed tasks for the next cycle and prioritize them as well as suggest their own.

THEORY (S. HUDSON)

W. Wang participated the first Chengdu Theory Festival Aug. 20-31 in Chengdu, China (http://www.swip.ac.cn/ctf/). The festival, organized by the Southwestern Institute of Physics, aims to promote advanced research dialogue and education at the cutting edge of research in theoretical fusion plasma physics and related fields. Wang gave two lectures, each 1.5 hours long, on the topics of plasma intrinsic rotation and self-driven current generation in magnetic fusion. The lectures ranged from basic physics to advanced research, including phenomenology and basic observations about intrinsic rotation; toroidal momentum transport, turbulent residual stress and symmetry breaking physics; plasma heat engine paradigm for flow generation; underlying physics related to Rice-scaling; physics validation and first-principles-based model prediction;
machine-size scaling of intrinsic rotation; underlying physics related to intrinsic rotation reversal; and turbulence effect on plasma self-driven current generation.

**Computational Plasma Physics Group (S. Jardin):**

**TRANSP (F. Poli)**

New support for running TRANSP for MAST and MAST-U has been completed by S. Henderson (CCFE, Culham) and made publicly available through the OMFIT workflow manager this week. Working together with scientists at UKAEA, PPPL, and GA, users can now run TRANSP for MAST through OMFIT with data preparation occurring either locally on the Freia computers or also at PPPL on the portal computers. The workflow leverages the existing OMFIT TRANSP module, which has been built through international collaboration, where scientists prepare, execute and view TRANSP runs for C-Mod, DIII-D, JET, MAST, and NSTX with one common interface.

**ENGINEERING (V. RICCARDO)**

Document Management System contractors have begun working on-site with PPPL’s IT and Engineering departments to accelerate the delivery of the new system. The documents-type form development and database installation is underway. Weekly testing of the development “sprints” will be performed.

The first session of Engineering procedure (ENG) training was held on Sept. 13. The second session is planned for Sept. 18. Slides and possibly the video will be made available for off-line training.

**Control and Data Acquisition (CODAC):**

The DIII-D Neutral Beam High Voltage Stability analysis effort resumed with a meeting with J. Dellas and A. Nagy discussing future work. A new PPPL engineer who is an expert in high-power electronics analysis is expected to be hired in Jan. 2019 and would be assigned this job. Meanwhile, Nagy and Dellas will collect data outlined from a peer review held in Aug. on the system operational parameter. A cost and schedule plus SOW will be compiled in the coming months. This will restart and commit to find a much needed solution for neutral beam power droop during operations.

**COMMUNICATIONS & PUBLIC OUTREACH (A. ZWICKER)**

**Communications (L. BERNARD)**

The Office of Communications posted five press releases to the PPPL website. One story focused on J.-K. Park’s research into finding the magnetic distortions that can be applied
to tokamak plasmas to best reduce edge-localized modes. Another story memorialized the life and career of PPPL physicist J. Hosea. A third story explained research by J. Carlsson into the origin of spoke-like structures that form within the plasma inside Hall thrusters, plasma propulsion devices that help maneuver satellites in space. A fourth story noted that N. Fisch was recently given the Fusion Power Associates’ Distinguished Career Award. The award recognizes Fisch, whose research has opened new paths in the study of controlled fusion energy and plasma science, for his “many years of dedication to plasma science and its application in many fields, and to advancing the prospects for fusion power.” The fifth story focuses on C. Zhu, a postdoctoral researcher at PPPL, who has won the 2018 CAI Shidong Award for plasma physics in China. His research describes a computer code that Zhu developed with the help of PPPL physicists that takes a novel approach to designing the complex magnetic coils that confine plasma in stellarators. All stories were also posted to the Newswise and EurekAlert! press release distribution services.

DIRECTOR’S OFFICE (S. COWLEY)

On Sept. 13, PPPL Lab Director Steve Cowley presented a colloquium entitled, “Explosive Instability and Fusion Performance.”

The proposal for the FLARE experiment was reviewed on Sept. 13-14. The charge for the review committee is to conduct an assessment of the plans and cost estimates to install the FLARE device, previously constructed and operated at Princeton University, at PPPL for operation as a research experiment.

PPPL hosted the Northeast Regional Meeting for the Federal Laboratory Consortium (FLC) for Technology Transfer on Sept. 12-13. Participants included technology transfer professionals from DOD, DOE, DHS, and DOT labs and affiliates: ARDEC, AFRL, FAA, Griffiss Institute, MIT-Lincoln Lab, NAVAIR, NUWC, PPPL, TSL, and the Volpe Center. The meeting included technology transfer best practices as well as invited speakers, including A. Zwicker.

PPPL received the FLC Northeast Regional Industry/Non-Federal Government/University Award with Princeton Satellite Systems for the successful transfer and ongoing partnership with S. Cohen’s Princeton Field Reversed Configuration (PFRC) technology. The award press release can be viewed here: FLC Award Announcement - PPPL/PSS.

This report is also available on the following web site:
http://www.pppl.gov/publication-type/weekly-highlights