The PPPL Highlights for the week ending December 2, 2017, are as follows:

ITER & TOKAMAKS (R. NAZIKIAN)

R. Maingi presented the annual update on activities and proposals for the ITPA Pedestal and Edge Physics (PEP) topical group at the ITPA Coordinating Committee at the ITER Organization HQ, Nov. 7-9 in Cadarache, France. He also served as a member on the ITPA Coordinating Committee, representing NSTX-U, and presented the annual collection of international exchanges between the US and other countries on behalf of John Mandrekas at the IEA-CTP meeting.

DIII-D (B. Grierson)

Research:
S. Haskey has been selected to present an invited talk at the 2018 High-Temperature Plasma Diagnostics conference titled, “Active spectroscopy measurements of the deuterium temperature, rotation, and density from the core to scrape-off layer on the DIII-D Tokamak.” This work is based on the recent upgrade of the DIII-D main-ion charge exchange spectroscopy system under B. Grierson’s Early Career Award.

F. Laggner co-led with M. Shafer (ORNL) a DIII-D experiment titled, “Pedestal fueling variation in a closed divertor configuration.” The experiment was carried within the newly established DIII-D Core-Edge-Integration task force co-lead by B. Grierson (PPPL) and A. Jarvinen (LLNL). In the experiment, the deuterium fueling was varied by running plasmas heated by neutral-beam injection and electron cyclotron heating with deuterium pellet fueling and gas injection. Initial results indicate that when the nominal deuterium fueling rates are matched, the density increases more with pellet fueling than with gas puffing.

E. Kolemen worked with Z. Wang to implement a new controller to perform relay feedback control on the I-coils to detect and regulate the plasma response to an \( n=1 \) error field. During the machine startup, Q. Hu and F. Laggner tested and tuned the controller for several sensors and bias levels and successfully demonstrated the robust self-adjustment of the external drive to maintain constant plasma response. This controller has many applications, including core MHD stability threshold detection for disruption avoidance and edge RMP field control for edge-localized mode (ELM) suppression during changing plasma conditions.
A. Bortolon presented a physics validation review for a new diagnostic that could measure neutral density on DIII-D. The diagnostic consists of a set of pinhole cameras to provide measurements across the separatrix at multiple poloidal locations, utilizing the design of the Lyman-alpha system on Alcator C-MOD. The cameras are equipped with linear arrays of Si detectors (AXUV), allowing fast measurements of low light inputs. The diagnostic, developed in collaboration between PPPL and PSFC/MIT, can enable accurate model validation in areas spanning pedestal particle transport to divertor leakage.

*Operations:*
The neutral beam calorimeter plates (4) produced by PPPL have been delivered to DIII-D. This calorimeter set will be installed during the new NB210 Co/counter Off-Axis conversion scheduled to begin in May 2018. This calorimeter plate design uses gun-drilled coolant passages to eliminate systemic thermal expansion tube cracking that plagued the original design after 25 years of operation. This design also doubled the number of thermocouples for better beam thermal topography analysis and provides an internally serviceable cooling tube interface. Three of the four DIII-D neutral beams do not have water cooled calorimeters due to coolant tube leaks, which require overnight passive cooling to cycle back to room temperature. This new design will set the future refurbishment path.

**EAST Plasma Materials Interactions: (R. Maingi)**

The manuscript, “ELM elimination with Li powder injection in EAST discharges using the tungsten upper diverto,” by R. Maingi, J.S. Hu, Z. Sun, K. Tritz, G.Z. Zuo, W. Xu, M. Huang, X. Meng, J. Canik, A. Diallo, R. Lunsford, D. Mansfield, T. Osborne, X.Z. Gong, Y.F. Wang, and Y.Y. Li was accepted for publication in *Nuclear Fusion*. The paper reports the first successful use of lithium to eliminate edge-localized modes (ELMs) with tungsten divertor plasma-facing components in the EAST device. Lithium powder injected into the scrape-off layer of the tungsten upper divertor successfully eliminated ELMs for 3-5 seconds in EAST. The ELM elimination became progressively more effective in consecutive discharges at constant lithium delivery rates, and the divertor $D_{\alpha}$ baseline emission was reduced, both signatures of improved wall conditioning.

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

Preliminary analysis of tests carried out by PPPL’s G. Kramer and M. Gomez as well as General Atomics colleagues indicates that the Gaussian telescope, developed and fabricated by PPPL, performed well and appears to be an acceptable means of decoupling
the ITER Low Field Side Reflectometer (LFSR) waveguide transmission line at the vessel to accommodate vessel displacements. The analysis is ongoing. An initial alignment of the Gaussian telescope mirrors was conducted in the horizontal nominal position prior to beam scans and reflection tests. The beam profiles appeared Gaussian even at the extremes of Gaussian telescope displacement. Mode purity calculations confirmed this observation.

ADVANCED PROJECTS (H. NEILSON)

Stellarators (D. Gates)

H. Neilson visited Japan’s National Institute for Fusion Science (NIFS) for a series of discussions on topics for stellarator collaboration. A highlight of the visit was a tour of the Large Helical Device (LHD) pellet injection system, which ingeniously combines a 20-pellet burst system with a continuous repeating pneumatic injector. The responsible officer, R. Sakamoto, provided detailed design documentation, including overall system diagrams and specification data for all of the most important components. The discussions were held in the context of a collaboration, involving ORNL, NIFS, Germany’s Max Planck Institute for Plasma Physics, and PPPL to provide a continuous pellet fueling system for the Wendelstein 7-X (W7-X) stellarator to meet fueling requirements similar to those of LHD. The information provided and work plans agreed upon during the NIFS visit will expedite design work on the W7-X system.

System Studies (C. Kessel)

C. Kessel participated in the kickoff meeting for the Advanced Tokamak Modeling (AToM) project, which is led by General Atomics. Kessel presented work on integrated modeling performed for ITER, ARIES-Act, FNSF, and K-Demo as examples of how a future device physics basis is developed. The work included systems analysis identification of an operating point, plasma equilibria, time-dependent simulations with TSC, peeling-ballooning analysis, heating and current drive analysis, ideal MHD analysis, transport, 2D scrape-off layer/neutral analysis, and fast particle stability analysis. The engagement with AToM is intended to provide a path to improve these studies both in physics scope and physics fidelity. Simultaneously, these future devices are good examples that could drive new thrusts in the integrated modeling area. TSC and the need for free-boundary equilibria and evolution capability was clearly raised, identifying a weakening area in US integrated modeling. In addition to TSC, PPPL tools such as JSOLver were also identified as potentially attractive to examine plasma equilibria with self-consistent bootstrap current solutions. The multi-institutional activity
has significant goals that address physics, physics integration, validation, as well as flexible, modern and structured approaches to manage these simulations.

**THEORY (A. BHATTACHARJEE)**

The paper titled, “Magnetic flux pumping in 3D nonlinear magnetohydrodynamic simulations,” by I. Krebs, S.C. Jardin, S. Günter, *et al.* has been published [Phys. Plasmas 24, 102511 (2017)]. This paper describes how a self-regulating magnetic flux pumping mechanism in tokamaks that maintains the core safety factor at q≈1 — thus preventing sawteeth — is analyzed in nonlinear 3D magnetohydrodynamic simulations using the M3D-C1 code.

The paper titled, “Plasmoid Instability in Forming Current Sheets,” by L. Comisso, M. Lingam, Y.-M. Huang, and A. Bhattacharjee has been published in [The Astrophysical Journal 850, 142 (2017)].


A. Moten, PPPL’s Interim Human Resources Director, gave a “Preventing Sexual Harassment” refresher training seminar for the Theory Department. The presentation reminded all that PPPL management takes these issues very seriously.

**SITE PROTECTION (F. WHITE)**

SPD personnel: conducted “Official Use Only” Training for PPPL staff; attended a severe weather planning meeting on main campus; conducted an emergency preparedness “Protective Actions” risk assessment meeting with PPPL personnel; conducted building evacuation drill at PPPL

GEN-006 and the ORPS Initial Notification Report has been updated on the PPPL website

The following Emergency Planning Implementing Procedures (EPIP) have been completed:

- Emergency Facilities & Equipment
- Protective Actions
- Readiness Assurance
● Off-Site Response
● Emergency Medical Support

The following were also completed:

● Emergency Readiness Assurance Plan (ERAP)
● Continuity Readiness Assurance Report (CRAR)

Engine 66 responded to Princeton Township for five (5) mutual aid assignments

COMMUNICATIONS & PUBLIC OUTREACH (A. ZWICKER)

COMMUNICATIONS (L. BERNARD)

During the past two weeks, the Office of Communications has posted three press releases to the PPPL website. One focused on new results by C. Dong suggesting that the number of habitable exoplanets could be lower than expected because the stellar wind would deplete each planet’s atmosphere and cause surface water to dry up. Another news release documented how a new high-resolution spectrometer was recently delivered to the National Ignition Facility at Lawrence Livermore National Laboratory. The device was built by physicist L. Gao, Head of the Plasma Science & Technology Department P. Efthimion, principal research physicist K. Hill, and graduate student B. Kraus. A third story noted that principal research physicist D. Gates was recently named editor-in-chief of Plasma, a new online journal. These stories were also posted to the EurekAlert! and Newswise press release distribution services.

DIRECTOR’S OFFICE (R. HAWRYLUK)

From Nov. 27-30, R. Hawryluk was in China participating in the Experimental Advanced Superconducting Tokamak (EAST) International Advisory Committee meeting and the 10th Anniversary Celebration of the Chinese ITER Domestic Agency.

This report is also available on the following web site:

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