



The PPPL Highlights for the week ending March 21, 2014, are as follows:

U.S. ITER FABRICATION (D. JOHNSON):

The Release for Manufacture (RFM) was issued for the ITER HV Substation Transformer. Completion of several RFMs for other ITER Steady State Electric Network components are pending submission by subcontractors.

Following the Risk Workshop at the US ITER Project Office last week, significant changes were made to the diagnostics risk registry and the diagnostic uncertainty risk limits.

In a progress meeting held with IO experts, various aspects of the low-field-side reflectometer front-end design were discussed. These included the availability of 110 mm diameter bolted windows, clarification of the maximum duration for exposure to stray ECH radiation, thermal analysis for a revised front-end bistatic antenna pair, and the timing of the preliminary design review for this system.

IO experts and supporting subcontractors presented work to close out chits from the core imaging x-ray spectrometer conceptual design review held in June 2013. They also presented the latest CATIA design for this system, which will be the basis of the Procurement Arrangement with the US. The signoff of this Procurement Arrangement is expected in the next few months.

NSTX (M. ONO):

Ed Magee of the Lawrence Livermore National Laboratory visited PPPL during the past week. He discussed details regarding the installation of three extreme ultraviolet spectrometers with NSTX-U personnel. Interferences with support structures near the midplane port where the instruments are to be located might be resolvable by reorienting them and changing their distance to the vacuum vessel.

ITER & TOKAMAKS (R. HAWRYLUK):

DIII-D (R. Nazikian):

PPPL researchers participated in experiments and analysis of QH mode plasmas on DIII-D aimed at extending the QH regime to high densities. Sustainment of QH plasmas was obtained for up to 80% of the Greenwald density. The thermal energy confinement time was observed to

increase with density in the QH regime and the inferred ion and electron thermal diffusivities both reduce across the minor radius. Pedestal stability analysis, using the EPED model, have successfully reproduced the observed increase in pedestal height and width with increasing density.

A. Nagy has returned to being a chief operator on DIII-D. He is currently receiving refresher training in preparation for the start of plasma operations.

International Collaborations (R. Hawryluk):

A Flowing Liquid Lithium (FLiLi) test coupon has been delivered to ASIPP for planned testing and operations in the upcoming EAST run. L. Zakharov traveled to Hefei, China to participate in the installation of the component at EAST.

C-Mod (A. Diallo):

A paper titled “Observation of Edge Instability Limiting the Pedestal Growth in Tokamak Plasmas”, by A. Diallo *et al.*, appeared in Physical Review Letters 112,115001 (2014). The reports direct evidence of an instability limiting the pedestal between ELMs. This instability has been characterized experimentally using a suite of edge diagnostics on the Alcator C-Mod tokamak. The measurements clearly showed that the fluctuations have both a density and magnetic component with ion scale and propagating in the ion diamagnetic direction consistent with the kinetic ballooning mode (KBM). Theoretical calculations indicated that the edge pedestal is both ballooning and KBM unstable in agreement with measurements.

ADVANCED PROJECTS (H. NEILSON):

The Laboratory hosted three visitors from the Chinese Academy of Sciences Institute for Plasma Physics (ASIPP), Drs. Jinxing Zheng, Mingzhun Lei, and Zhongwei Wang. The visit was a step in building a long-term collaboration on engineering issues among PPPL, ASIPP, and the University of Science and Technology of China (USTC). The visitors met with a number of PPPL project leaders, worked with PPPL engineering staff to identify several collaborative tasks to be carried out at the home institutions over the next several months, and presented a seminar describing progress in the conceptual design for China's Fusion Engineering Test Reactor (CFETR). The CFETR is a fusion nuclear facility being considered as a next step in China's fusion program.

C. Kessel participated in the US/Japan Workshop on Fusion Power Plants and Advanced Technologies, held at UCSD. Kessel presented the physics and systems analysis done for the ARIES-ACT study on the advanced and conservative tokamak power plant configurations. He also presented a preliminary discussion of the recently started FNSF study. The Japanese presenters showed a movement toward more conservative assumptions in their DEMO plans, under the influence of their Broader Approach EU collaborators. Their approach to the ITER follow-on still involves a large tokamak facility at about 8 m in major radius, although they indicate that they would prefer the plant not to exceed the ITER size. The stellarator DEMO activity appeared to continue most of its efforts as before, with less or no direct impact of the EU

influence. A detailed assembly and disassembly approach was presented for their helical reactor design. Following the Fukushima accident, safety aspects have risen to a very high priority in the Japanese design activities.

In the Laboratory's collaboration with the Wendelstein 7-X (W7-X) project at Germany's Max Planck Institute for Plasma Physics (IPP), PPPL and IPP design engineers have focused on integrating the U.S. x-ray imaging crystal spectrometer (XICS) with the W7-X facility. The crowded conditions close to the device constitutes the main challenge, and it is essential to finalize the interface soon so that work on both sides of the interface can move forward. An IPP design review will be held in early April to finalize details for the port cover being used for XICS. Upon successful completion of this review, PPPL will proceed to complete the XICS design and IPP will proceed with modifications to the port cover and pump-down of the cryostat.

THEORY (A. BHATTACHARJEE):

A. Hakim gave a talk at the Courant Institute at NYU on "Discontinuous Galerkin schemes for a class of Hamiltonian evolution equations with applications to plasma kinetic problems" (<http://math.nyu.edu/webapps/content/mfdd/seminars>) describing work performed in collaboration with G. Hammett and graduate student Eric Shi, to develop a new approach for the difficult problem of simulating edge turbulence. While there he had discussions with Harold Weitzner, Antoine Cerfon, and others, on these and other algorithmic topics.

W. Fox attended the Center for Magnetic Self-Organization Annual Meeting in Santa Fe, New Mexico and presented an invited talk on recent results from laboratory astrophysics experiments, titled "Astrophysical Weibel instability in counter-streaming laser-produced plasmas."

A paper titled "On the nature of kinetic electrostatic electron nonlinear (KEEN) waves", by I. Y. Dodin and N. J. Fisch, appeared in Phys. Plasmas 21, 034501 (2014). The paper reports an analytical theory for the so-called kinetic electrostatic electron nonlinear (KEEN) waves that were originally found in simulations by Afeyan et al [arXiv:1210.8105]. It is suggested that KEEN waves represent saturated states of the negative mass instability (NMI) reported recently by Dodin et al [Phys. Rev. Lett. 110, 215006 (2013)]. Due to the NMI, trapped electrons form macroparticles that produce field oscillations at harmonics of the bounce frequency. At large enough amplitude, these harmonics can phase-lock to the main wave and form stable nonlinear dissipationless structures that are nonstationary but otherwise similar to Bernstein-Greene-Kruskal modes. The theory explains why the formation of KEEN modes is sensitive to the excitation scenario and yields estimates that agree with the numerical results of Afeyan et al. It is also predicted that a new type of KEEN wave may be possible at even larger amplitudes of the driving field than those used in simulations so far.

A series of experiments for the DIII-D tokamak proposed by A. Reiman and a group of collaborators have been scheduled for May 12. The experiments will provide data for validation for a set of eleven codes presently being cross-benchmarked, allowing the codes to be validated simultaneously with the benchmarking. The collaborators on the proposal are: T. Evans, A. Turnbull, J. King, N. Ferraro, M. Lanctot, and F. Turco, all from GA.

ENGINEERING AND INFRASTRUCTURE (M. WILLIAMS):

NSTX Upgrade (R. Strykowski, E. Perry, L. Dudek, T. Stevenson):

Construction: The checkout and repair of magnetic sensor continues, as does the in-vessel installation of the sFLIP diagnostic and mounting studs for the VB diagnostic. The Vacuum Prep Lab continues to prepare and install TIVs, shutters and flanges on the vessel. The MPTS laser port at FG was enlarged this past weekend. Welding and leak checking of the centerstack casing tubes continues. The re-installation of TIV and shutter cables continues. Work continues on the gas injection system hardware in the gallery.

CS Upgrade: The OH layer 3 winding started this week. The remaining PF1 coil fabrication schedule at Everson has been slipping for various reasons including difficulty in braze qualifications and machining issues with the casings. A renegotiated schedule now gets us all the coils by the end of June, which will minimize any schedule impact. A trip to Everson is scheduled for March 24 to review the schedule with Everson to ensure it doesn't slip further. Major Tool reported they have solved the E-beam welding issues on the PCHERS passive plate and will be sending us the weld process qualification paperwork for approval. The Outer TF lead finger supports bids were reviewed and a vendor was selected for award. The award meeting is set for March 24. The drawings for the outer TF finger mounting plates were completed. A request for quotation was sent out to Carolina Fabrications. Another batch of 600 CS PFT Tiles were sent out to Solar for bakeout cleaning. They are scheduled to be cleaned the week of March 24.

NBI Upgrade: Spool sections for small ports on the Bay H cover are complete and will be welded onto the port cover. HVE water lines installation started. Transmission line relocation is on hold awaiting completion of the HVE lines due to access restrictions in the area. Pipe connections to the pumps have started and Mod/Reg controls work and preparation continues. The bending of magnet cabling on BL2 is complete. NBPS water skid maintenance is in progress; the contract has been approved for maintenance to complete. VV RWM coil fit-up continues for the Bay JK area. The NBI/TVPS duct was fit up and checked on VV and BL2 TIV mating flanges. Rework is required to re-align the clocking of the bolt holes on the circular flange to account for differences in BL, VV, and build tolerances and reworking is in progress. TVPS flange rework is also required due to leaks on the sealing flanges. New flanges have been ordered. The duct supports were lifted into position and await the rework and installation of the duct for final attachment to the floor. NB Controls work on interconnecting wiring on racks in the gallery has resumed.

BUSINESS OPERATIONS (K. FISCHER):

PPPL submitted a proposal titled "Laboratory Study of Magnetohydrodynamic and Hydrodynamic Instabilities in Rotating Flows Relevant to Astrophysical Disks" to NASA. The Principal Investigator is H. Ji. The total budget request for the three-year period of performance is \$415,200.

OFFICE OF COMMUNICATIONS: (K. MACPHERSON):

C. Cane participated in the Culham Center for Fusion Energy (CCFE) #Askfusion Twitter tweet-up on March 18, and the Young Women's Conference (YWC) on March 21, and also the Princeton Area Developers and Website Administrators Network (PADAWAN) meeting on March 21.

BEST PRACTICES & EXTERNAL AFFAIRS (J. DELOOPER):

PPPL hosted the Annual Young Women's Conference at Princeton University's Frick Chemistry building on April 21. Approximately 385 young women and 40 chaperones attended from 43 different schools; 65 exhibitors show cased their field to the attendees, and over 55 employees from PPPL and main campus volunteered at the event.

A. Zwicker lectured via video-conference to graduate students in an Energy Policy class at Bard College in Annandale on Hudson, NY. The topic was "Fusion Energy, A Status Update."

Zwicker answered questions on fusion and plasma physics, via video-conference, from teachers attending the Nebraska section of the American Association of Physics Teachers annual meeting.

DIRECTOR'S OFFICE (C. AUSTIN):

March 12-13, S. Prager, M. Zarnstorff and A. Cohen traveled to Crystal City, Virginia to participate in the DOE National Laboratories Ideas Summit. The summit provided a prime opportunity for senior leadership at DOE headquarters and the Laboratories to work in partnership to address the nation's most pressing energy challenges.

A. Cohen participated in Fusion Day, held on March 13 in Washington DC. Fusion Day is an event to promote fusion science with representatives in Washington.

A. Cohen attended an Operations Committee Meeting at Brookhaven National Laboratory on March 19-20.

PUBLICATIONS:

Diallo, A.; *et al.*, "Observation of Edge Instability Limiting the Pedestal Growth in Tokamak Plasmas," Physical Review Letters 112,115001 (2014)

Dodin, I.Y., and Fisch, N.J., "On the nature of kinetic electrostatic electron nonlinear (KEEN) waves," Phys. Plasmas 21, 034501 (2014)

This report is also available on the following web site:

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