The PPPL Highlights for the week ending April 28, 2017 are as follows:

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

Steady State Electrical Network (J. Dellas):

The Laboratory continues to make progress toward completion of United States equipment deliveries for the Steady-State Electrical Network (SSEN). All remaining equipment deliverables are now in manufacture or beyond. Last week, the first two Reactive Power Compensator lots were shipped, en route to the ITER project site. For the remaining two lots, the shipping release approval process has been started. In addition, an on-site inspection report for power transformers that were delivered last year was received. Completion of this step enables the project to now proceed toward final transfer of ownership to the ITER Organization.

Diagnostics (R. Feder):

In the course of developing designs for ITER diagnostic systems, the Laboratory and its subcontractors contribute to the advancement of fusion diagnostic technology. Examples from the electron cyclotron emission (ECE) diagnostic project include a compliant gas seal design for ECE waveguides. A new window design from the ITER Central Team has been adapted for the ECE aperture and compliant gas seal attachment. A supplier for elastic bellows suitable for fusion applications has been identified and contacted. The University of Texas at Austin team continues their efforts to document another ECE technology advance, namely an in-situ calibration hot source, in preparation for a May peer review.

PPPL’s port integration team was represented by engineers N. Dean and Y. Zhai at an Expert Review for a new diagnostic shield module (DSM) design being developed by the ITER Central Team. The review, which was held at the ITER site at St. Paul-lez-Durance, France, focused primarily on the requirements for the two first plasma diagnostics port. Dean and Zhai also attended a technical training course on the development of the Load Specification and Structural Integrity Reports, two reports which are critical deliverables for diagnostic and port plug preliminary design reviews planned for 2018.

NSTX-U RECOVERY PROJECT (R. HAWRYLUK):

A meeting was held to discuss issues related to the NSTX-U radiation field and its impact on electronics. G. Ascione presented a summary of radiation effects on electronics. S. Doskoczynski presented the results of a survey of electronics racks in the NSTX-U Test Cell. The next step in
this work is to quantify the radiation field expected at full NSTX-U performance, and to begin discussions with the US ITER I&C team at ORNL that is addressing similar issues but at much higher levels that will exist at ITER.

The PF1AU Coil Failure Root Cause Analysis team of L. Hill, F. Malinowski, I. Zatz, and experts from the firm of McCallum-Turner have completed their planned first round of interviews with members of the NSTX-U Project Team, and are now conducting secondary interviews in parallel with analyzing data and developing timelines. The team is working towards a final report in mid-May.

Removal, inspection and silver plating of the TF, OH and CHI bus under the machine is in progress has started, and the installation and alignment of the FIReTIPS diagnostic wave guides is nearing completion.

Recommissioning of the coil winding facility also continued with the trial wrapping of sections of copper conductor to go out for testing by Clinton Instruments Company.

Grit blasting of the first spool of inner PF coil conductor was completed this week by the vendor.

Work continues in the Neutral Beam Clean Room on the assembly of a second spare ion source. An ion source has successfully passed all pre-operational testing, and has been declared our first spare source for the next run period.

The new Pulse Burst Laser System Stand has been moved into the Multi-pulse Thomson Scattering (MPTS) diagnostic room, and is being configured for University of Wisconsin and PPPL testing.

Scott Davis, the DOE Accelerator Safety Program Manager, visited PPPL this week and provided helpful advice on the PPPL implementation of the Accelerator Safety Order, O 420.2C.

**NSTX-U RESEARCH (J. MENARD):**

The paper "Stabilizing effects of enhanced resistivity due to lithium-conditioning on low-n edge localized modes in NSTX" by D. Banerjee, P. Zhu and R. Maingi was published in Phys. Plasmas 24 (2017) 054501. The abstract reads "The stabilizing effects of enhanced edge resistivity on edge-localized instabilities in high confinement discharges due to lithium-conditioning in the National Spherical Torus Experiment are identified for the first time. Linear stability analysis of the experimentally constrained equilibrium suggests that the change in the equilibrium plasma density and pressure profiles alone due to lithium-conditioning may be insufficient for a complete suppression of low toroidal mode number peeling-ballooning modes. The enhanced resistivity due to the increased effective electric charge number Zeff after lithium-conditioning provides additional stabilization of the edge localized modes. Notably, this stabilizing effect by enhanced edge resistivity becomes evident only in two-fluid magnetohydrodynamic simulations."

From April 3-14, Ian Waters, an NSTX-U University collaborator from University of Wisconsin-Madison (group O. Schmitz), traveled to the Culham Centre for Fusion Energy to participate in
the MAST-U research forum. Proposals on neutral fueling and exhaust and its optimization by means of 3-D fields were presented and well received. The trip also included work with CCFE collaborators on 3D modeling of Scrape Off Layer flows in MAST in preparation for the upcoming Sherwood Fusion Theory Conference and an oral contribution at the conference of the European Physics Society this year.

M. Podesta, D. Battaglia, W. Guttenfelder, V.Duarte, F. Scotti and F. Poli traveled to attend the US/EU TTF workshop in Williamsburg, Virginia, on April 25-28. Plenary talks were given by the NSTX-U team in three sessions. Battaglia gave one in the Pedestal structure and dynamics session, entitled "Bifurcation to Enhanced Pedestal H-mode on NSTX-U. Duarte gave one in the session Transport induced by Energetic particle instabilities entitled "quasilinear relaxation formalism for energetic particle interaction with Alfvénic modes". Shawn Tang (UCLA) also gave a plenary talk in this session, entitled "Parametric investigation of compressional and global Alfvén eigenmode instability and effect on thermal confinement in NSTX-U". Poli gave one in the session Transport predictions for experimental planning and real control systems entitled "the role of integrated modeling in the development of more robust control algorithms (for NTMs)". Scotti (LLNL) gave a presentation in the Working group Pedestal and scrape-off layer entitled "Scrape-off layer and near-separatrix intermittent filaments in the NSTX and NSTX-U divertor". In addition, five posters were presented on NSTX-U simulations and experiments. Guttenfelder reported on "Transport and turbulence validation using NSTX and NSTX-U L-mode", S. Zweben on "2-D turbulence cross-correlation functions in the edge of NSTX", Podesta on "fast ion transport by counter-propagating TAEs destabilized by off-axis co-NBI". Tariq Rafiq (Lehigh University) presented simulations of "Unstable Microtearing Modes in High Collisionality NSTX Discharge" and Juan Ruiz Ruiz (Massachusetts Institute of Technology) reported on the development of "A Synthetic Diagnostic for Studying Electron Scale Turbulence at NSTX and NSTX-U". Podesta chaired the Energetic Particle plenary session and Working group, and Podesta and Poli participated in the Executive Committee meeting.

The paper “A review of radiative detachment studies in tokamak advanced magnetic divertor configurations” by V. A. Soukhanovskii has been published in the Plasma Physics and Controlled Fusion journal Special Issue dedicated to reviewing divertor plasma detachment in magnetic fusion devices in Plasma Phys. Control. Fusion 59 (2017) 064005. The present vision for a plasma–material interface in the tokamak is an axisymmetric poloidal magnetic X-point divertor. Four tasks are accomplished by the standard poloidal X-point divertor: plasma power exhaust; particle control (D/ T and He pumping); reduction of impurity production (source); and impurity screening by the divertor scrape-off layer. A low-temperature, low heat flux divertor operating regime called radiative detachment is viewed as the main option that addresses these tasks for present and future tokamaks. Advanced magnetic divertor configuration has the capability to modify divertor parallel and cross-field transport, radiative and dissipative losses, and detachment front stability. Advanced magnetic divertor configurations are divided into four categories based on their salient qualitative features: (1) multiple standard X-point divertors; (2) divertors with higher order nulls; (3) divertors with multiple X-points; and (4) long poloidal leg divertors (and also with multiple X-points). The paper reviews experiments and modeling in the area of radiative detachment in the advanced magnetic divertor configurations.
ADVANCED PROJECTS (H. NEILSON):

Stellarators (D. Gates):

On April 27, D. Gates presented a webinar entitled “Needs for Stellarator Research in Fusion Energy Development”. The webinar was part of a regular series of electronically broadcasted presentations sponsored by the US Burning Plasma Organization (USBPO). The talk summarized the contents of a soon to be finalized report developed by the National Stellarator Coordinating Committee (NSCC). The report was generated as the final product of a workshop called “Stellcon” that was held at MIT in February of 2016, the purpose of which was to discuss new opportunities in stellarator research. The webinar was the culmination of a sixteen-month process to develop a consensus among the nations stellarator researchers on the most exciting new ideas for the future of fusion energy in the stellarator area. The webinar was well attended with fifty-two separate electronic connections to the meeting and estimated sixty-seventy listeners. Dr. Gates was very grateful for the support of the USBPO leadership in arranging and publicizing the presentation.

THEORY (A. BHATTACHARJEE):

E. Belova attended the West Lake International Symposium on Energetic Particle Physics and Microturbulence, held April 23-26 in Hangzhou, China, and gave an invited presentation titled “Nonlinear simulations of beam-driven compressional Alfven eigenmodes in NSTX”.

On April 27, S. Ku (PPPL) presented a theory seminar on “Gyrokinetic simulation of a fast L-H bifurcation dynamics in a realistic diverted tokamak edge geometry”. The abstract reads: “Despite its critical importance in the fusion program and over 30 years of H-mode operation, there has been no fundamental understanding at the kinetic level on how the H-mode bifurcation occurs. We report the first observation of an edge transport barrier formation event in an electrostatic gyrokinetic simulation carried out in a realistic C-Mod like diverted tokamak edge geometry under strong forcing by a high rate of heat deposition. The results show that the synergistic action between two multiscale dynamics, the turbulent Reynolds-stress driven and the neoclassical X-point orbit loss drive sheared E×B flows, works together to quench turbulent transport and form a transport barrier just inside the last closed magnetic flux surface. The synergism helps reconcile experimental reports of the key role of turbulent stress in the bifurcation with some other experimental observations that ascribe the bifurcation to X-point orbit loss/neoclassical effects. The synergism could also explain other experimental observations that identified a strong correlation between the L-H transition and the orbit loss driven E×B shearing rate. The synergism is consistent with the general experimental observation that the L-H bifurcation is more difficult with the VB-drift away from the single-null X-point, in which the X-point orbit-loss effect is weaker.

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