The PPPL Highlights for the week ending February 17, 2017 are as follows:

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

H. Neilson, R. Feder, E. Nassar and Y. Zhai attended the annual diagnostics all-hands meeting at the ITER offices in Cadarache, France. Representatives from all the Domestic Agencies (DAs) providing diagnostic systems to ITER attended. The purpose of this meeting was to work on solutions to design, interface and management issues and risks that affect all of the DAs. Optimization of the equatorial port plugs nuclear shielding performance continues to be one of the main topics of discussion. It was agreed by the meeting panel that an expert peer review of the IO equatorial port DSM "Modular Design" will be partly lead by the US ITER engineering team. The US equatorial port design will then be reviewed two months later in order to bring this topic to a close and allow for the equatorial port diagnostic systems designs to advance. Other topics discussed included design review documentation preparation and review, the use of Boron Carbide for nuclear shielding and the status of important remote handling structures. The PPPL team was very fortunate to be taken on an in-depth walking tour of the ITER construction site. Neilson, Feder, Nassar and Zhai were taken into the machine pit to see concrete works, into the massive assembly building to see the ITER machine assemble crane system and to generally experience the rapid progress of ITER construction.

**ITER Steady State Electrical Network (J. Dellas):**

RPC (Reactive Power Compensators); Ongoing preparation efforts continue for Release for Shipping approval for Lots #1 & 2. Each lot contains two sets of power factor correction capacitor banks for the ITER SSEN system.

UPS (Uninterruptible Power Supplies) & DC Distribution; Ongoing preparation efforts continue for Release for Manufacturing approval of these last two procurement contracts for the SSEN.

**ITER Diagnostics (R. Feder):**

Upper Wide Angle View VIS-IR Cameras (UWAVs): The General Atomic Upper Camera design effort is moving on to the Back End Optics Design. The kickoff coordination meeting was very productive. The mirror cleaning R&D is nearing completion and has successfully identified a methodology for remotely cleaning contaminated mirrors. PPPL is now reviewing General Atomic quote for performing the previously deferred optics Instrumentation and Control (I&C) work in order to bring the I&C effort forward to align with the Camera mechanical I&C PDR.
Upper Port Plugs 11 & 14: Weekly meeting held with DMS and IO team to resolve the integration issue. DMS team is looking into using a Feedthrough at the closure plate (CP) instead of Flange attached on the CP. This may resolve the clash with lifting lug at the CP and VisIR/UWAVs window; IO's report on Post First Plasma (PFP) interfaces has been reviewed by diagnostic system's engineer and comments have been shared with USITER. In IO's report most of the PFP interface sheet doesn't have a commitment date from IO, which imposes a risk of "changing interfaces" for PDR level design.

Electron Cyclotron Emission (ECE): New molybdenum heater was successfully tested as a part of a ECE hot source prototype assembly including housing, and silicone carbide emitter. The test showed ability of the heater to provide enough energy so emitting surface is at required 700C. The test was conducted by UT team in Austin. Progress was made in PPPL on defining cable arrangement and configuration.

Equatorial Port 09: CATIA modeling for conversion to neutronics analysis format remains in work, however, key components were finalized this week for the high priority analysis. Preliminary analysis steps can now begin in a few days.

ITER Analysis Team: The volumetric heating data from UP14 neutronics analysis were interpolated onto the UP14 thermal hydraulic model for cooling assessment of the in-port primary components. This is a necessary step to develop temperature distribution on the UP14 in-port components for structural integrity evaluation. Electromagnetic (EM) analysis of the UP11 with NAS system was also performed. EM loads are evaluated for input to the UP11 system load specification.

**NSTX-U RECOVERY PROJECT (R. HAWRYLUK):**

The fifth Design Verification and Validation Review (DVVR), reviewing the NSTX-U Vacuum Vessel and Internal Hardware was held this week. Comments and suggestions on the design, analysis and as-built documentation/operating history of the vacuum vessel structures, center stack casing including ceramic breaks and load paths, plasma facing components including neutral beam armor and passive plates, and instrumentation and protection systems were recorded during this three day review and will be incorporated into the Corrective Action Plan. The review committee at PPPL included external members Rui Viera, of MIT’s Plasma Science and Fusion Center; Roel Verhoeven, of the Culham Centre for Fusion Energy, and Dennis Youchison, of Oak Ridge National Laboratory; along with several participating by video conference: Kevin Freudenberg and Brad Nelson, of Oak Ridge National Laboratory; and Jeff Doody, Jim Irby, and Brian LaBombard, of MIT’s Plasma Science and Fusion Center, and Tom Todd, head of the Extent of Condition Committee, Michel Huguet formerly head of the ITER EDA site in Naka in Japan and Rem Haange formerly ITER Deputy Director-General and Head of the ITER Project Department. Also attending attending remotely was Josh King, program manager for Spherical Tokamak at the United States Department of Energy’s Fusion Energy Sciences (FES) program.

Regarding test cell work, preparations are underway to begin silver-plating of the TF Bus connecting surfaces. Installation of the OH Coil Pre-Heater system and diagnostic equipment
such as FIRETIPS waveguides and components of the new Pulse Burst Laser System (PBLS) continued.

Re-commissioning of the coil winding facility also continued with the completion of the assembly and alignments of the tensioning skid. Spools of coil conductor copper are being leak checked and hydrostatically tested, and the coil bake-out oven extension has been installed and is ready for painting and insulation.

The commissioning of a PF inner coil test stand in the Field Coil Power Conversion Building continues.

PPPL Motor Generator Technicians have completed D-MG#1 bearing surface inspection/measurements. This data has been reviewed by Andritz Engineering (formerly GE Canada), and found to be acceptable.

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

D. Battaglia travelled to the Culham Centre for Fusion Energy (CCFE) in the United Kingdom to initiate collaboration activities between NSTX-U and MAST-U emphasizing plasma control, scenario development, and MAST-U first-plasma preparation. Battaglia gave a presentation to the MAST-U team on the status of NSTX-U activities and proposed areas of collaboration, including possible development of common tools for scenario modeling and plasma control development.

S. Sabbagh and S. Kaye attended the first of two ITER Research Plan Workshops as United States representatives on the review committee. The aim of the workshop was to develop an analysis of the ITER experimental program within the staged approach, leading from first plasma through full DT operation and towards long pulse/steady-state fusion power production. Sabbagh participated in the Working Group on the commissioning of the plasma control system through all operational phases and including MHD control and disruption mitigation. Kaye participated in the Working Group developing the research plan for the Long-pulse, steady-state program, which will be carried out after the Q=10 demonstration.

J. Park presented “Plasma response analysis on resonant field coupling by HFS coils in COMPASS” to the ITER Organization (IO) and the COMPASS Research Team. The analyses are currently being used to guide high field side (HFS) coil configurations and currents for COMPASS experiments to test HFS field effects on locking and L-H transition. This collaboration was motivated by the increasing concerns of HFS error fields in ITER and from NSTX-U results from the FY2016 research campaign where potential HFS error fields from toroidal field coil misalignment have been identified.

The paper “Fusion nuclear science facilities and pilot plants based on the spherical tokamak” by J.E. Menard, T. Brown, L. El-Guebaly, and 29 additional co-authors was selected to be included in the Nuclear Fusion journal annual Highlights collection for 2016. Publications in the Highlights collection are selected when they have generated particular interest in the community and with the referees during 2016.
ITER & TOKAMAKS (R. NAZIKIAN):

DIII-D:

The recent Nuclear Fusion article by A. Bortolon titled "High frequency pacing of edge localized modes by injection of lithium granules in DIII-D H-mode discharges" has been selected by the editorial board to appear on the journal's annual Highlights Collection. The collection is dedicated to articles that, over the course of the year have generated strong interest in the fusion community and are of the highest technical quality. The selection of this paper reflects on the quality of our research on DIII-D and on the impact of our impurity ELM pacing research on ITER physics.

B. Grierson led a DIII-D experiment in the Rotation Thrust focusing on momentum transport in low torque electron heated plasmas. On DIII-D, ITER target plasmas at low beam torque have a tendency to undergo a rotation collapse and eventually encounter a 2/1 tearing mode. The experiment aimed to understand the role of MHD and turbulent Reynold's stress in the rotation profile collapse. Good data was obtained for detailed analysis. Between-shot TRANSP and TGLF analysis by L. Cui (PPPL) was used to identify the radial location of the largest turbulent growth rate for the aiming of fluctuation diagnostics.

L. Cui and A. Ashourvan visited PPPL for the week of February 13. Cui and Ashourvan presented talks at the PPPL monthly research meeting on "Energy Confinement Recovery in DIII-D Plasmas with Resonant Magnetic Perturbations" and "Validation of turbulence-neoclassical theory for edge intrinsic rotation in low torque DIII-D plasmas".

EAST:

L. Cui presented a talk at the DIIID-EAST Task Force meeting titled "Effect of current evolution during Ip ramp-up on Internal Transport Barrier formation". The current diffusion simulation by TRANSP confirms that the bottom of the internal transport barrier is associated with the location of the shear reversal radius. Further simulations will explore a possible avenue for full non-inductive scenarios that can be extended to long pulse on EAST.

ADVANCED PROJECTS (H. NEILSON):

Stellarators (D. Gates):

S. Lazerson and N. Pablant completed submission of experimental proposals for the 2017-2018 W7-X experimental campaign (Op1.2). Dr. Pablant submitted four proposals on core transport and neoclassical confinement, including one W7-X -- LHD joint experiment, along with five proposals relating to impurity transport and recycling, and two proposals on diagnostic techniques. Dr. Lazerson submitted five proposals on the topics of divertor heat loads, error field and the effect of the magnetic field perturbations on fast ion confinement. Both Samuel and Novimir were also co-authors on numerous other proposals that have been submitted.
Novimir completed a second week of experiments at MIT-PSFC relating to the development of a wavelength calibration system for XICS diagnostics. These experiments provided important data sets on four possible wavelength calibration techniques that have been considered. The results of these tests will be invaluable in the design of the final calibration system and will allow us to move towards the development of a detailed system design.

D. Gates travelled to Ottawa, Canada from February 12-15 to participate in the Competition Week of the Physics Review Board of the Canadian National Science and Engineering Research Council. The Physics Review Board meets annually to review all the physics proposals for Canada. Each proposal is then discussed amongst a sub-committee of six people (five scientists and one NSERC member). The process occurs over a three-day window. Dr. Gates reviewed a total of twenty-six proposals.

**System Studies (C. Kessel):**

C. Kessel gave a wrap up presentation to the FES staff on the Fusion Nuclear Science Facility (FNSF), highlighting the importance of the facility's program to advance a range of technical issues, thereby creating the required basis for subsequent electricity producing fusion devices. Several important technical highlights from the study were discussed, including tritium behavior simulations, the importance of hot cell capability, liquid metal breeder analysis, and pre-FNSF R&D topics. The study successfully addressed the questions of why such a facility is needed, and what it must accomplish to advance fusion energy development.

C. Kessel, M. Jaworski, R. Majeski, E. Kolemen, and M. Hvasta participated in the FESS liquid metal plasma facing component study kick-off meeting held at DOE Headquarters, Germantown, MD. The three day meeting reviewed the previous ALPS/APEX study, liquid metals and their flows, substrate materials, the loading environment, safety and tritium issues, the FNSF configuration, liquid metal hardware designs, and free-surface liquid metal modeling. The meeting also had participation from UCLA, INL, SRNL, LANL, LLNL, ORNL, MIT, University of Wisconsin, and University of Illinois, along with several consultants, and FES personnel. The study will examine a LM FW and a LM divertor in the existing FNSF design, and follow this with a re-design to generate a LM-FNSF. The goals for the study are to clarify critical Research and Development areas that can rapidly advance and validate LM PFC concepts.

**THEORY (A. BHATTACHARJEE):**

Y. Shi presented the Thesis Proposal Presentation on February 17 on the topic of “Laser Pulse Processing Using Magnetized Plasmas”. The committee consisted of I. Dodin (chair), N. Fisch, H. Qin, A. Reiman, and J. Mikhailova, and the Advisors are N. Fisch and H. Qin. The abstract reads: “Powerful laser pulses of high intensity, high frequency, and short duration are demanded in many applications such as inertial confinement fusion and single molecule imaging. This thesis proposes new techniques, using parametric interactions in magnetized plasma, to produce powerful laser pulses beyond what is possible using current techniques. Our theoretical model and simulation results have indicated that using the upper-hybrid wave, we can compress pump lasers of lower intensity or higher frequency to achieve higher output pulse intensity than previously possible. In this proposed research, we will continue to explore laser pulse
compression using, instead, the Bernstein waves. In addition to pulse compression, we will also explore the possibility of converting laser frequency using the cyclotron waves in magnetized plasma. By analytically deriving and solving nonlinear wave equations, we will use our closed-form results to determine plasma parameters and magnetic field that are optimum for processing high-intensity and high frequency lasers pulses. Our analytical results, together with our numerical validations, will put forth the pathway towards the next generation powerful lasers.”

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