The PPPL Highlights for the week ending January 27, 2017 are as follows:

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

ITER Steady State Electrical Network (J. Dellas):

6.6kV Switchgear; Final inspection reports received from IO. No issues were reported. Final Delivery Report for Lots 3 + 4 has been submitted for approval in IDM. The Transfer of Ownership of Warranty and Site Support acknowledgement letter for these lots has been uploaded to IDM. All tasks have now been completed and the CAS Credit Request is underway.

Power Transformers: All shipments have arrived at the ITER site. The IO has inspected the last shipping batch, which contains the accessories, and the preliminary inspection report is satisfactory. The supplier is reviewing a report on IO’s inspection of the contents of the weathered crates.

Reactive Power Compensators: Manufacturing at the Schneider Pringy, France, factory is ongoing. The FATs for the first two lots have been completed. A re-inspection of the second lot was held on December 19 to verify completion of the punch list items. A contract amendment has been executed which adjusts the VAT payments to the LSP pick-up milestones. Documentation towards achieving RFS approval for the first two shipping lots has started to be received from the supplier and review is underway.

UPS, DC Distribution; Regular coordination meetings for both contracts ongoing to facilitate preparation of Release for Manufacturing documentation packages. For UPS, testing will be required to be performed at two locations. The factory in Wettingen, Switzerland will perform some tests, and for the higher power testing, a facility in Montbonnet, France will be used (equipment to be shipped between locations by supplier). Documentation for obtaining RFM for the DC Distribution and UPS is being uploaded in iDOCS/IDM for approval.

LV Distribution & Sub-distribution Panels; Arrangement has been signed which transfers to IO-CT the responsibility to procure, on behalf of US ITER, along with UPS and DC Distribution batteries.

ITER Diagnostics (R. Feder):

Motional Stark Effect (MSE): Bill DeVan was at PPPL this week and went over the MSE P&ID. There was discussion on the addition of some new components for the shutter system. There was
discussion on what will be done for the front end calibration device, the polarizers will be hit with neutrons and heat and we will have to come up with a unique solution to accommodate the polarizers. Fabrication and welding of second dome is complete and installed for the mirror cleaning chamber. Modification to the second dome is in process.

ITER Analysis Team: Electromagnetic (EM) analysis of the UP14 with integrated in-vessel tenant systems has been completed and the PDR level analysis report is nearing completion. The heating and neutron flux data from UP14 neutronics analysis were extracted and will be reviewed after completion of the data post-processing. Results of the EM and neutronics analyses are used to update the load specification for the UP14 in preparation for the PDR.

CIXS: The CIXS internal detector and crystal still show to be a problem. There has been discussion this week on what to do with the internal components. What looks to be the best solution is to move the view outside the port plug, but to maintain the same viewing angle, use a graphite x-ray reflector to direct the x-rays out of the port plug. There has been discussions with Dectris on the analysis of the nuclear tested detector; we might be able to send it back to the company for post mortem analysis of the detector panel.

Upper Wide Angle View VIS-IR Cameras (UWAVs): The General Atomic Upper Camera design effort continues. The Reliability Availability Maintainability and Inspectability (RAMI) final report and files have been received. The mirror cleaning R&D effort is planning its final experiment. Discussions continue with GA about obtaining a quote for the optics I&C contract amendment in order to bring the I&C effort forward to align with the Camera I&C PDR.

Equatorial Port 09: P&ID sessions were hosted by Bill DeVan. The meetings provided opportunities for EP09 Port Integration to discuss issues and solutions to better synchronize design developments with various deliverable schematic documents. It was noted that software development is also highly dependent on these schematics, highlighting the value of keeping the processes in synch.

I&C Integration: Bill DeVan visited PPPL to conduct "P&IDs 101" training. The staff of port plug and diagnostic system engineers worked with Bill through a couple sessions to dig deeper into the P&ID, Single Line Diagrams and Cable Collection Spreadsheets. There is a lot of key design and integration information in these "I&C Infrastructure" documents. The training sessions were used to make sure project engineers are fluent in the "language" of these documents and that this information is folded into project cost and schedule estimates.

NSTX-U RECOVERY PROJECT (R. HAWRYLUK):

The second Design Validation and Verification Review (DVVR), reviewing the NSTX-U Integrated Project Design was held this week. Many good comments and suggestions (chits) were recorded, which are now be categorized into action items. Tom Todd, the chairman of the NSTX-U Extent of Condition Committee, attended this review and then spent another day at PPPL reviewing NSTX-U field activities. In addition, Ron Parker, Brian LaBombard, and Jim Irby were at the review and Rui Vieira and Michel Huguet participated remotely.
Progress continues on the development of NSTX-U System Design Descriptions (SDD’s), and drafts are being reviewed and updated. The focus is now on the upcoming heating systems (high harmonics fast wave (HHFW), electron cyclotron heating (ECH) and neutral beam) reviews, which will be held next week.

Procedures for the removal of the PF1BL coil were reviewed and approved, and fieldwork has begun. Impedance testing of the PF1AL and PF1CU coils is in progress. Recommissioning of the coil winding facility continued with the ongoing assembly of the brake skid, and the reconfiguration of the coil facility oven to support the in-house cleaning and priming of the PF coil conductor copper. The primer for that activity has been received.

Also this week, work in the Neutral Beam clean room / decon facility continues on the disassembly of the spare ion source with an internal water leak, and the completion of decontamination of a source last used on TFTR.

Voith Hydro Reps are on site, and continue scheduled maintenance of the NSTX-U Motor Generator Upper and Lower Guide Bearings.

R. Hawryluk chaired the KSTAR PAC meeting in Daejeon, Korea.

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

Daniel Den Hartog and Lisa Reusch from the University of Wisconsin visited PPPL to meet and discuss physics and diagnostic issues with several NSTX-U researchers. They met with Diallo and LeBlanc to discuss the progress of the pulse-burst laser system (PBLS) installation, schedule and milestones for PBLS implementation, and optimization of PBLS operation. Possible collaborations on MST to determine the effect of tearing mode island asymmetry on plasma stability, particularly density limits were also discussed. Luis Delgado-Aparicio discussed the planning for x-ray spectroscopy collaborations on MST and also discussed diagnostic implementation and possible scientific goals. Discussions were held with K. Tritz (JHU) regarding the use of ADAS for analysis of x-ray data and possible experimental validation of models for atomic parameters used in ADAS.

Jack Lovell (Durham University, CCFE) visited PPPL from January 16 - 27 to work with Matthew Reinke (ORNL) and Greg Tchilinguirian (PPPL) on furthering the development of the analyzer electronics for the resistive bolometry, planned for next NSTX-U operations. Lovell has worked with D-tAcq to develop an FPGA-based analyzer to replace existing analog electronics, dramatically reducing cost/channel and necessary rack space. Tests demonstrated quantitative comparison against conventional analyzers, and further improved the integration with MDSplus.

R. Maingi participated in the proto-MPEX Advisory Committee meeting in Oak Ridge, Tennessee, held January 23-24. The PAC was chaired by M. Wade, and the presenters clearly showed substantial progress in R&D over the past 12 months.

The paper “Investigation of instabilities and rotation alteration in high beta KSTAR plasmas” by Y.S. Park, S.A. Sabbagh, W.H. Ko, et al. has been recently published online. This paper covers
work that is part of joint high beta research efforts between NSTX-U and KSTAR. The paper contains significant results including the achievement of record normalized beta of the device up to 4.3 (60% above the ideal n = 1 no-wall limit), the use of non-resonant magnetic fields to alter the plasma rotation profile by neoclassical toroidal viscosity (NTV), creating profiles closer to those found in L-mode plasmas while maintaining high energy confinement. Analysis in steady-state shows the scaling of NTV with respect to the applied 3D field strength and plasma ion temperature, and tearing mode analysis of these plasmas.

ITER & TOKAMAKS (R. NAZIKIAN):

KSTAR:

D. Boyer and D. Mueller traveled to S. Korea to participate in the annual KSTAR collaboration conference and to hold discussions with NFRI and GA researchers on ideas for improving the plasma control system and planning for next step control experiments on KSTAR. Dan Boyer presented a poster on “Vertical stability and control improvements on NSTX-U and potential for application to KSTAR” Dennis Mueller presented a poster on Improvements to the fast vertical control system on KSTAR. A KSTAR experimental proposal on vertical control was developed by Dennis Mueller in preparation for the next KSTAR experimental campaign. The proposal includes testing of the digital signal filters, better control during current ramp-up, compensation for applied loop voltage and use of more hardware differences of voltage and flux loop signals. J. Park also attended the KSTAR conference and gave a plenary talk entitled "Experimental validation of predicted ELM suppression windows in KSTAR RMP coil configuration space". This talk introduced physics concepts and the methods used to find effective 3D fields coupling to edge resonant surfaces, and the experiments that validated the predictions. The experimental results substantiated recent findings on the importance of plasma response in RMP coupling, and also provides a strong and reliable basis for the systematic optimization of 3D fields for RMP ELM control in future experiments.

EAST:

R. Maingi hosted a video-conference to discuss new data and analysis from the collaborative lithium experiments in EAST in December 2017, and to discuss SOFE conference abstracts and draft paper preparation. The participants were J.S. Hu, R. Maingi, D. Mansfield, K. Tritz, W. Xu, S. Zhen, G.Z. Zuo.

R. Maingi hosted the bi-weekly PI US-ASIPP PMI collaboration conf. call, with participants from JHU, LANL, MIT, ORNL, PPPL, UI-UC, and UT-K. Good progress is being made on analysis of EAST data from the December 2016 set of experiments, and abstracts for upcoming conferences are being prepared. PPPL staff are planning to attend the 2nd EAST General Planning Meeting scheduled for March 13-14.

C-MOD:

This week a body of equipment loaned over the years by PPPL to the PSFC for Motional Stark Effect and Gas Puff Imaging diagnostics was returned to PPPL. Ownership of other components
of these two diagnostics, particularly those engineered for the specific C-Mod environment that have limited prospects for use elsewhere will be transferred from PPPL to MIT in the coming weeks. Return of PPPL-owned components of the curved x-ray crystal spectrometer (‘HIREX’) will follow a final calibration currently scheduled for the week of January 30.

**DIII-D:**

Y. Ren, G. Kramer, and A. Diallo traveled to DIII-D to support the ECE-I system commissioning and data analysis. During this visit, they participated in meetings with the computer group to evaluate data storage options in order to increase the data accessibility of ECEI for the whole DIII-D research team. A plan is being developed by the computer division together with S. Haskey and Kramer to streamline the ECEI data access. Diallo and Ren worked with UC Davis graduate student Ming Chen on analysis of the coherent EHO mode structure in DIII-D.

Y. Ren gave a Friday science meeting presentation titled “Recent Progress in Understanding Electron Thermal Transport in NSTX and NSTX-U”. He also presented an NSTX/DIII-D campaign experiment proposal entitled “Study of collisionality dependence of ion- and electron-scale turbulence in advanced inductive hybrid scenario with ST-relevant q95 on DIII-D”. A. Diallo also held meetings with UCLA scientists to prepare for an upcoming experiment titled “Identify inter ELM pedestal saturating instabilities for type-I ELMs”.

An article was published by A. Ashourvan and P. Diamond in Physics Plasmas, titled "On the Emergence of Macroscopic Transport Barriers from Staircase Structures”. This article sets forth the mechanism by which mesoscale staircase structures condense to form macroscopic states of enhanced confinement. Density, vorticity, and turbulent potential enstrophy are the variables for this model. Formation of the staircase structures is due to inhomogeneous mixing of (generalized) potential vorticity (PV). Such mixing results in the local sharpening of density and vorticity gradients. When PV gradients steepen, the density staircase structure develops into a lattice of mesoscale “jumps” and “steps,” which are, respectively, regions of local gradient steepening and flattening. The jumps then merge and migrate in radius, leading to the emergence of a new macroscale profile structure. This model sets forth conditions where a region of enhanced confinement or a region with strong turbulence can form at the plasma edge similar to L-mode and H-mode conditions.

**ADVANCED PROJECTS (H. NEILSON):**

**Stellarators (D. Gates):**

R. Lunsford and D. Gates visited the Max Planck Institute in Greifswald, Germany from January 23-25, to discuss the installation of a powder dropper on W7-X. The powder dropper has been used on numerous fusion devices including NSTX-U, DIII-D, and EAST in China. Lunsford presented "Real-Time wall conditioning for long pulse operation and edge impurity transport studies" which described the PPPL designed dropper apparatus and attached control system. There was significant interest from both the impurity transport and wall conditioning groups to explore how the powder dropper concept could be utilized in upcoming experimental campaigns. Lunsford and Gates also met with Professor Dr. Melzer (Greifswald University) who expressed interest in exploring academic collaboration. All participants from PPPL and IPP
agreed that the implementation of a powder dropper on W7X filled a unique scientific niche and was worth pursuing further.

S. Lazerson conducted a tutorial on the STELLOPT code in the Computer Resource Center. The tutorial went over how to access STELLOPT on the PPPL cluster using module commands, how to use the VMEC2STEL script to generate the STELLOPT input file, and how to run the code. Demonstrations of the code highlighted both the Differential Evolution and Levenberg-Marquardt optimization algorithms.

THEORY (A. BHATTACHARJEE):

J. Schwartz presented a Thesis Proposal Presentation on January 25 in the Theory Conference Room. The thesis committee consists of B. Kaita (chair), C. Skinner and D. Stotler; with advisors M. Jaworski and R. Goldston. The thesis title is “Mass and energy flow in the lithium vapor box divertor”. The abstract reads: “A reactor-scale tokamak is expected to have a much higher scrape-off-layer and divertor heat flux than present machines, and solid tungsten divertors with attached plasma will not scale to such a device without >90% volumetrically radiated power. ITER is planned to be operated in partially detached conditions, but detachment fronts can be unstable to traveling up the divertor leg toward the core, often leading to a MARFE and disruption. The lithium vapor box divertor is a new divertor concept that envisions stable detachment and volumetric radiation of SOL power. A chamber with walls coated with liquid lithium at several hundred C creates a dense Li vapor on which the plasma radiates, recombines, and cools. Additional chambers with cooler liquid lithium walls condense the vapor that escapes from the first chamber to prevent it from reaching the main plasma. This thesis will explore the Li vapor box concept on a test stand. An experiment will measure neutral vapor transport and heat transport in the box with and without plasma, to test how much Li might leak into the main chamber and whether the vapor can redistribute the plasma power to the box walls.”

COMMUNICATIONS & PUBLIC OUTREACH (A. ZWICKER):

Communications (L. Bernard):

R. Rosen posted a story on January 27 about I. Kaganovich's research into the physics of plasma etching of silicon chips, which power cell phones, computers, and a range of electronic devices. He sent the news release to several distribution services.

DIRECTOR'S OFFICE (S. ZELICK):

On January 25, Dr. Charles Kessel, Princeton Plasma Physics Laboratory presented a colloquium entitled, "What is the Fusion Nuclear Science Facility, What Does it Do, Why do We Need It... The Critical First Step Toward Power Plants".

On January 27, T. Brog traveled to General Atomics - he was provided with a tour of the facility, and met with General Atomics senior leadership and PPPL staff.
This report is also available on the following web site:
http://www.pppl.gov/publication-type/weekly-highlights