PRINCETON PLASMA PHYSICS LABORATORY
WEEKLY highlights

PPPL
U.S. DEPARTMENT OF ENERGY

The PPPL Highlights for the week ending February 5, 2016 are as follows:

U.S. ITER FABRICATION (C. NEUMEYER):

Steady State Electric Network (SSEN):

Manufacturing of the Power Transformers at the Schneider Electric factory in Çayirova, Turkey has commenced. A total of 22 transformers will be fabricated, consisting of 12 large oil-filled and 10 smaller dry-type units of various ratings. Last week the first in-process QC inspection took place and Factory Inspection Testing (FAT) of the dry-type units will take place during the last week in February.

For the remaining three SSEN procurements—Uninterruptible Power Supply (UPS) system, DC Distribution, and Low Voltage (LV) Distribution and Sub-distribution Panels procurements—a memo was issued that presents a revised cost estimate and optimized procurement strategy. A Project Change Request (PCR) will be submitted to U.S. ITER to authorize the recommended approach. The Low Voltage (LV) Distribution and Sub-distribution Panels procurement will be transferred to the ITER IO and the UPS and DC Distribution systems (minus the batteries) will be procured by PPPL. Technical specifications for the UPS and DC Distribution systems are in the final stages of preparation and will be submitted to U.S. ITER and ITER IO for approval this week. A Request for Proposal (RFP) for these final procurements will be issued in March.

Diagnostics:

Meeting on Diagnostic Electronics in Radiation Environments: A two-day meeting was organized by PBS 55 to review the status of loads, requirements and design strategies for diagnostic electronics in the harsh ITER radiation environment. Kurt Vetter, Bill De Van and N. Allen attended in person while R. Feder and M. Smith joined via web meeting. The main challenge is to optimally place electronics to satisfy diagnostic measurement requirements while protecting the components with adequate shielding and distance from the radiation sources. There is also a very stringent ITER policy on Rad Hard Electronics that adds a level of engineering controls that will be difficult to adhere to. The main impact on U.S. ITER scope is on the Upper Port Wide Angle View VIS-IR cameras. PPPL is developing an ATTILA modeling tool to design optimal UWAVs camera shielding.

EP11 Tenant Meeting: Van Graves and R. Feder attended the monthly Equatorial Port 11 tenants coordination meeting. EP11 is an RF-DA port plug slated for First Plasma installation. EP11 is also very crowded and has a challenging nuclear shielding and maintenance problem to work out. The U.S. is providing a Diagnostic RGA (DRGA) system and the Low Field Side

Reflectometer (LFSR) diagnostic for EP11 integration. An important outcome of this month's meeting is an action for the U.S. to consider relocating and simplifying the DRGA sampling pipe in the EP11 interspace and port cell. Currently, the DRGA gas sampling pipe starts at the EP11 closure plate and has to run through the EP11 Bio-Shield. The new proposal would eliminate the closure plate and interspace interface and relocate the DRGA sampling pipe to come off of the VUV diagnostic pipe in the EP11 Port Cell. Another important outcome of the EP11 tenant coordinating meeting was the acknowledgement between the U.S. and RF DA that the LFSR in-vacuum configuration is locked. Now the RF DA can move forward with the engineering design and analysis of EP11 DSM-1 and the DFW blocks.

Review of F4E/IDOM Electrical Feedthrough concept: One major challenge for port plug integration is how to pass electrical signals through the closure plate vacuum and confinement barrier. Any electrical feedthrough component concept needs to comply with stringent ITER vacuum and radiation safety requirements, minimize remote handling complexity, and work within the other complex port plug integration constraints. The EU-DA and partner sub-contract company IDOM have proposed a promising electrical feedthrough design that the U.S. EP9 integration team is considering. The team met this week to review the pros and cons of adopting the F4E concept for further study. It is important to pick a feedthrough design so that EP9 integration can proceed towards the next round of neutronics and EM analysis. The EP9 team is also considering offering analysis or prototype support to F4E and IDOM to help develop the feedthrough further.

Meeting to review MSE Project Cost and Schedule proposals from NOVA and PPPL Team: F. Levinton from Nova Photonics met with J. Klabacha, E. Nassar and R. Feder to review and lock in the cost and schedule plan for the MSE diagnostic project through 2018. Klabacha has worked with Levinton to develop an MS Project file that the team reviewed and approved. The next step is for Emil to enter the plan into Primavera for final cost analysis and submission to U.S. ITER as a PCR. The MSE project is in the early preliminary design phase with Nova Photonics setting up ZEMAX software optical ray-trace models of the EP1 and EP3 MSE optical systems.

NSTX-U (M. ONO):

A FY 2016 NSTX-U plasma operations update: The department has completed 2.33 run weeks and 241 plasma shots. The total operation targets are to be decided.

The NSTX-U Team Meeting was held on February 5 at Princeton Plasma Physics Laboratory. The NSTX-U team was updated on the on-going plasma operations and the plan. The research program items including the recent NSTX-U PAC meeting were also discussed. The meeting material is available on the web at:
http://nstx.pppl.gov/DragNDrop/NSTX_Meetings/Team_Meetings/2016/2016-02/.

Dr. Naoki Tamura of National Institute for Fusion Science, Japan visited NSTX-U for two weeks under the U.S.-Japan personnel exchange program. He collaborated on the physics of non-local transport including the analysis of the TFTR data with E. Fredrickson (PPPL).

Phil Ferguson (ORNL) and John Canik (ORNL) visited on February 3-4, meeting with a number of NSTX-U and laboratory staff to discuss the ORNL/PPPL collaboration, as well as tour the NSTX-U facility.

Felipe Bedoya has arrived from University of Illinois as part of the NSTX-U Materials Analysis Particle Probe (MAPP) collaboration to characterize the plasma-wall interaction. He replaced the Comstock electron analyzer and micro channel plate (part of the x-ray photoelectron spectroscopy system). The probe is being pumped down and will take measurements during the upcoming boronization and plasma campaign.

Zhen Sun from the Institute of Plasma Physics of the Chinese Academy of Sciences (ASIPP) visited PPPL. He has responsibility for lithium systems on the EAST tokamak in Hefei, China. They include a crucible-based lithium evaporator for coating plasma-facing components, and a dropper for introducing lithium particles into discharges. Dr. Sun is interested in collaborations with NSTX-U involving both technologies.

The electrical installation tasks for the lithium evaporators (LITERs) were completed with the attachment of cables between the electronics rack and the LITER probe drives during the past maintenance period. The Lithium Experts Committee (LitEC) has reviewed the procedures for filling the LITERs and installing them on NSTX-U. This completes the requirements for allowing current lithium-related procedures for NSTX-U to be performed.

The two-week maintenance period draws to a close with additional diagnostics shutters operational for SAMI, SSNPA, and BES. LoWeus/Zeus/MonaLisa diagnostics electrical and mechanical work made progress. Camera installation work at Bay J top took place; power was installed for the camera and SPRED. Argon dump system mechanical work took place also. An MGI meeting was held to organize and schedule planned work for the next few months to put this new system into service. The PF1CU coil case ventilation to dry trapped water was successful in reducing leakage current. Leakchecks and hydrostatic tests of the coil were successful. Water was restored to the coil. TF water fitting compliance modifications were started. The NBI 2A and 2B high voltage transmission lines were repaired and the systems returned to service. Gas Injection System testing and latency testing were performed. TMB is planned on the weekend to be followed by machine area scrubs.

ITER & TOKAMAKS (R. HAWRYLUK):

DIII-D (R. Nazikian):

The Impurity Granule Injector (IGI) was used to assess the effect of different impurity types (lithium, carbon, boron carbide) on ELM triggering capabilities. The ELM frequency was successfully increased more than 10 times the natural ELM frequency, resulting in density pumpout. Deuterium pellet fueling was used to demonstrate the ability to refuel the plasma with enhanced ELM frequency. A. Bortolon led the experiment and operated the IGI with A. Nagy, R. Lunsford, R. Maingi, and D. Mansfield all participated on-site.

Successful experiments were lead by G. Kramer to study the effects on the Alfven eigenmode spectrum when the radius of q_min is moved from 0.3 to 0.6 of the minor radius. The large

radius of q_min was achieved by fast current ramp (8 MA/s) and early beam injection. Weak Reverse Shear Alfven Eigenmode (RSAE) activity was observed when the radius of q_min was increased, consistent with theoretical predictions. The AE activity was further manipulated by varying the beam voltage, the heating mix (NBI vs. ECH), heating time, and the current ramp rate. The results will be compared to quasi-linear model estimates of the losses in the different plasma and heating conditions.

In preparation for a physics experiment on the snowflake divertor configuration, two control sessions were run to test and develop improvements to the snowflake control algorithm. Control upgrades were necessary, as the experiment required that the snowflake be formed at a smaller major radius than in previous experiments in order to image the outer strike point. The upgraded control was successful in moving the snowflake centroid inward and thus the strike point became visible. Internal improvements in the PCS, such as a new inversion algorithm and better data sharing with real time EFIT, were successfully tested. Changes in DIII-D's power supplies required adaptation of the previous controller and this development was completed. Further development time is needed to achieve steady simultaneous control of the snowflake centroid position, the X-point separation distance, and the angle of the line between X-points, while also scanning the separation distance.

S. Haskey has implemented an Er module as part of the new OMFIT profiles analysis package. Measurements from the vertical impurity CER system are now corrected for the toroidal velocity component before being used with impurity pressure and toroidal rotation profiles to calculate Er. The pressure, poloidal rotation, and toroidal rotation contributions to the Er profile are plotted individually as a function of time allowing better understanding of the role of the various terms throughout the evolution of a discharge.

International (W. Solomon):

W. Solomon and Chris Holcomb (LLNL) participated remotely on EAST experiments, together with a team of GA scientists on-site at EAST (Andrea Garofalo, M. Lanctot and N. Eidietis), aimed at investigating steady-state operation with an ITER-like divertor at high poloidal beta. Scans of the electron density were performed at the fully non-inductive operating point (characterized by zero loop voltage) to vary the lower hybrid heating and current drive profile as well as investigate the impact of the resulting variation in the q-profile on performance.

ADVANCED PROJECTS (H. NEILSON):

S. Lazerson, N. Pablant, and H. Neilson attended the Wendelstein 7-X (W7-X) First Hydrogen Plasma Celebration at the Max Planck Institute for Plasma Physics in Greifswald, Germany. In all, nine researchers represented the U.S. team at the event, with participants from Los Alamos National Laboratory, Oak Ridge National Laboratory, the University of Wisconsin, Auburn University, and Princeton Plasma Physics Laboratory. Princeton’s A.J. S. Smith greeted German Chancellor Angela Merkel on behalf of the U.S. team during the Chancellor’s visit to the W7-X control room. Pablant and Lazerson are currently leading experiments on W7-X, studying impurity transport (Pablant) and application of trim coils to symmetrize limiter heat loading (Lazerson).

D. Gates served on the U.S. IAEA Fusion Energy Conference paper selection committee, which met in Germantown, Maryland on February 1-2. The U.S. committee considers which abstracts to promote as oral presentations at the international selection committee meeting in Vienna in April. It also makes suggestions to the authors on ways to improve the submissions. Gates served on the experimental subcommittee.

BEST PRACTICES & EXTERNAL AFFAIRS (J. DELOOPER):

Science Education (A. Zwicker):

More than 280 individuals attended the Science on Saturday lecture on Plastic Electronics given by L. Loo of Princeton University.

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