



**The PPPL Highlights for the week ending February 14, 2014, are as follows:**

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

PPPL diagnostic experts met with a representative of Virginia Diode, Inc. to discuss progress on a Phase 2 Small Business Innovative Research project for VDI to design and fabricate a 200-300 GHz radiometer front-end prototypical of the instrument needed for the ITER Electron Cyclotron Emission diagnostic. This prototype is scheduled for completion later this summer.

Topics discussed at the monthly TIP progress meeting included a new proposal of the ITER blanket group for the interface between the blankets and the outermost TIP retroreflector. Also discussed were design concepts for the TIP final turning mirrors, which need to be water-cooled and adjustable at least for initial alignment.

The Statement of Work for Diagnostic First Wall (DFW) Manufacturing Assessment and Evaluation was completed and circulated for PPPL sign-off. Deliverables for this effort include a manufacturing assessment and a budgetary cost estimate for an equatorial and an upper DFW panel, along with a proposal for prototype(s) which may be required to support the Final Design Review and to demonstrate manufacturing capabilities for these components.

### **NSTX (M. ONO):**

The NSTX-U Team Meeting was held on February 11. The presentations are available on [http://nstx.pppl.gov/DragNDrop/NSTX\\_Meetings/Team\\_Meetings/2014/02-11\\_2014/](http://nstx.pppl.gov/DragNDrop/NSTX_Meetings/Team_Meetings/2014/02-11_2014/). One important note is that the schedule for the in-vessel work continues through March 28 so please plan accordingly (see the Engineering Operation Update). Please also note that since we are not planning any vacuum vessel entry after the CD-4 in Mid-November, this period before March 28, 2014 maybe the only chance you have for the in-vessel access until the end of the FY 2015 research run (~ October, 2015). If you are expecting any in-vessel activities, which are not already on the NSTX-U work planning list, please contact M. Ono or other NSTX-U managers immediately.

Preparations for plasma operations in the NSTX-U configuration also continued with the ongoing preparations of the Field Coil Power Conversion (FCPC) rectifiers for upcoming power testing. This week the procedure was approved to install New I/O modules in rectifiers to upgrade the existing Hardwired Controlled System from electromagnetic relays to a programmable logic controller.

## **ITER & TOKAMAKS (R. HAWRYLUK):**

### **DIII-D (R. Nazikian)**

W. Solomon presented the FY14 research plan for the Dynamics and Control group to the DIII-D PAC. The plan included experiments aimed at addressing low torque ITER baseline stability issues, compatibility of QH-mode with radiative divertor and high-Z impurities, exploration of the upper limits of performance in the "steady-state hybrid", resolving issues of fast ion transport in the high  $q_{\min}$  scenario, and extension of high  $\beta_p$  experiments envisioned as a long pulse EAST steady state scenario.

A. Nagy worked with GA and PPPL engineering staff to scope out the cost and schedule for additional hardware tasks that PPPL will undertake in support of the DIII-D program based on increased FY14 funding. MOUs are currently being drafted on a range of projects including: lithium injector, gyrotron magnet current monitors, neutral beam control upgrades, long pulse neutral beam pole shields for one beam line and various diagnostic tasks.

M. Zarnstorff and R. Hawryluk attended the DIII-D PAC meeting as observers and had discussions with the PPPL staff. S. Gerhardt and D. Brennan participated in the DIII-D PAC meeting.

### **C-Mod (S. Scott):**

After several years of effort by PPPL and MIT physicists and engineers, significant progress has been realized in reducing the daily calibration drift of the C-Mod Motional Stark Effect polarimeter from ~6-8 degrees to near the desired value of 0.1 degrees. The response of the MSE system to a variety of thermal excursions was measured extensively by a robotic calibration system, which showed that the underlying problem is thermal stress-induced birefringence in the 11 MSE lenses due to the harsh thermal environment inside the tokamak and cryostat. System upgrades include (a) a gold-plated Inconel in-vessel radiation shield; (b) a novel "sausage" O-ring to thermally isolate the in-vessel lenses from their lens mount; (c) a water-heated copper sleeve that stabilizes the temperature of the MSE vacuum window; (d) a vast array of thermocouples to monitor the temperature environment of the diagnostic; and (e) improved control of the C-Mod vacuum vessel heaters. The residual drift will be compensated by a intershot calibration system that provides a four-angle calibration within 10 seconds of every C-Mod plasma shot. This system was recently upgraded taking into account the illumination uniformity requirements learned from the extensive tests using the robotic calibration system and evaluation of the effectiveness is underway.

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

In the Laboratory's collaboration with the Wendelstein 7-X (W7-X) project at Germany's Max Planck Institute for Plasma Physics (IPP), S. Lazerson is investigating the effects of applied  $n=1$  error fields, where  $n$  is the toroidal mode number. The divertor island positions are particularly sensitive to such perturbations due to a resonance condition at the edge of the plasma. Indeed the simulations show that the application of an  $n=1$  error field with amplitude of only 0.1 per cent of the main magnetic field causes significant poloidal displacement of the divertor islands relative

to their design positions. Due to the breaking of the device's 5-fold toroidal periodicity, the effects are different in each period. The risks are that heat loads to the ten divertor targets could become non-uniform, and that the regions of highest heat flux could shift away from the targets toward in-vessel components that cannot handle such loading, reducing the total power handling capability of the system. The U.S.-supplied trim coil system is designed to control such effects by canceling low-order error fields. At W7-X, the trim coils and power supplies are now installed and at PPPL, preparations to lead the commissioning of this equipment in May of this year are under way.

### **COMPUTATIONAL PLASMA PHYSICS GROUP (S. JARDIN):**

A 3d Monte Carlo halo model has been developed and implemented in the TRANSP/NUBEAM code. Proper treatment of halo neutrals is crucial for the accurate simulation of Neutral Particles Analyzer (NPA) horizontal and vertical scan measurement. The most effective NPA diagnostics employ sightlines that intersect the footprint of neutral beam injectors well inside the plasma to measure fast ion distributions ranging from thermal to supra-thermal via the charge exchange process that generates escaping neutrals. At this intersection, the contributions of injected and halo neutrals are larger than the "wall" neutrals that are localized near the plasma boundary. The charge-exchange cross section for halo neutrals is larger than that for primary beam neutrals and the spatial profile is broader which changes the NPA signal temporal evolution. We have added to the code a feature called "beam in box"—a bounded 3d gridded Cartesian domain aligned with each beam. Each neutral beam has its own box that represents the 3d "box" and gathers neutral density for the neutral beam itself,  $E_b$ ,  $E_b/2$ ,  $E_b/3$  - lab. frame energy components, 3d fast neutral densities due to charge exchange of partially slowed down fast ions in the beam halo region, and, 3d thermal neutral densities due to the charge exchange deposition and fast neutral recapture source. This new feature allows greatly improved TRANSP-based NPA simulations as halo neutrals largely remain near the beam footprint.

### **ENGINEERING AND INFRASTRUCTURE (M. WILLIAMS):**

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

Construction: In-vessel inspection and cable terminations continue, as does the installation of vacuum vessel insulation. Work continues on the new RWM coils for bays J-A and the PF4/5 clamps for bays L and B. The new port cover for bay E has been installed and the cooling tubes on the centerstack casing for the inboard divertor have been welded and have passed leak check. Piping for four other tubes on the centerstack casing are being reworked. Electricians are installing thermocouple runs under NSTX.

CS Upgrade: OH Coil layer 2 is about 20% wound, the first pair of layer 2 inline braze joints were completed this week. Second shift winding operations was restarted this week. A plan to rework the PF1B Upper coil was developed by Everson and approved by PPPL. Everson this week began the rework and believe they have found and cleared the short. They are now insulating the area so a repeat hipot test can be performed to verify the rework. Once the verification test is complete they will implement a permanent insulation repair and retest the coil. The PF1B lower coil was meggered at PPPL and is being prepped for the flux loop

installation. The rework of the OH mold in the Tech Shop was completed. Kickoff meeting for the fabrication of the PCHERS passive plates was held with Major Tool. Major Tool made a few requests for some minor changes that will simplify the manufacturing process. The drawings are being revised to reflect the changes.

NBI Upgrade: Progress on DI water manifold fabrication and installation was put on hold to perform other repairs. The NBI Armor shine through tile bakeout has been completed. RGA results will be evaluated. The Bay H port cover lift fixture preparation has been completed; calculations are being checked. Subcontractor triax terminations progressed and assembly was completed. Epoxy pours have started and testing is planned for next week. Mod/Reg controls work and preparation continues. Water skid maintenance is in progress. VV RWM coil fit-up continues for the Bay JK area. The two TVPS duct pieces were attached to the NBI duct to evaluate fit and leakcheck the joints, but rework will be required. NB Controls is on hold awaiting resources.

ITER Property Transfer documentation, revision 1, for SSEN was submitted on February 12 to ITER Organization per their review and recommendations. Loan P12-05 with Nova Photonics and Loan P10-02 with LLNL were submitted to DOE for approval last week.

#### **BEST PRACTICES & EXTERNAL AFFAIRS (J. DELOOPER):**

Professor Colin Adams from Williams College presented the Science on Saturday lecture to more than 200 individuals (weather affected the turnout) on “Blown Away: what Knot to do When Sailing By Sir Randolph Bacon III”

A. Zwicker was the keynote speaker at the Innovation Magazine launch party on the campus of Princeton University. His talk was titled, "Innovative Science Communication for the Non-Scientist."

The Department of Energy twitter feed highlighted the Remote Control Glow Discharge Experiment in the Science Education Laboratory (<https://twitter.com/ENERGY/status/434364040022732800>). Users can control a DC glow discharge from any computer with an Internet connection and see a live video stream as they change the plasma parameters. This is part of ongoing work to provide real-time plasma physics experiments to students of all ages anywhere in the world. The link is: <https://pppl.princeton.edu/ww.pppl.gov-RGDX>

#### **DIRECTOR'S OFFICE (C. AUSTIN):**

A. Cohen and M. Viola travelled to Jefferson Laboratory on February 10-14 to participate in a Laboratory Operations Board meeting.

February 11-13, M. Zarnstorff and R. Hawryluk attended a DIII-D PAC meeting in San Diego, California.

A delegation from Tsinghua University in Beijing visited PPPL on February 11 as part of a four-day visit to Princeton University, arranged by the Vice Provost for International Initiatives. The group had lunch with PPPL Director S. Prager, physicists G.Y. Fu and W. Wang, and J. DeLooper, head of Best Practices and Outreach. DeLooper then led a tour of PPPL that included the NSTX-U Control Room, NSTX Coil winding, QUASAR, and a stop at the model of one of the first stellarators,

On February 12, Professor Gaspar Bakos presented a colloquium entitled, "Extrasolar Planets with Small Telescopes".

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