

PRINCETON PLASMA PHYSICS LABORATORY

**WEEKLY** highlights



**The PPPL Highlights for the week ending January 31, 2014, are as follows:**

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

Analysis results were reviewed for the divertor RGA sampling tube. Review of various load thermal and seismic cases resulted in changes to the support design.

Progress on documents associated with the remaining two procurement arrangements for U.S. diagnostics were reviewed.

In a monthly meeting with the IO Diagnostics Group, we discussed the need to make the Monthly Procurement Arrangement Reports more useful for both parties.

Also discussed was a need to define a yet to be specified interface with the HVAC system controlling the temperature of the interspace and port cell. The PPPL team needs to know how effective the thermal blanket, that insulates the port plug closure plate, needs to be.

**NSTX (M. ONO):**

The article titled, "The effects of increasing lithium deposition on the power exhaust channel in NSTX" by T.K. Gray (ORNL) *et al.*, has recently been published in Nuclear Fusion. The paper documents reduced divertor surface temperature and heat flux in the NSTX divertor with the application of sufficient lithium coverage. While the mechanism for the heat flux reduction is not yet understood, a relative increase in SOL electron density and radiation were measured in conjunction with the heat flux reduction. Future work is focused on SOLPS modeling of the lithiated discharges to better understand the mechanism responsible for the reduction in divertor heat flux.

Preparations for plasma operations in the NSTX-U configuration also continued with the calibration/setting of primary power system protective relaying for the Field Coil Power Conversion (FCPC) rectifiers and Neutral Beam power supplies. The Statement of Work for the contract weld repairs of the spider arms on MG Set #1 has been reviewed and approved.

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

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

Spatial and absolute intensity calibrations of the DIII-D CER system have been completed in preparation for the 2014 experimental campaign. Vessel entry with targets placed along the neutral beam line was used to focus fiber optics and determine the spot sizes of CER sightlines for six neutral beams. Notable enhancements to the charge-exchange system for this run campaign are four new chords for a prototype pedestal main-ion system, and one main-ion spatial chord on the high-field side of DIII-D for impurity density asymmetry measurements.

Ahmed Diallo visited DIII-D this week to continue discussions with R. Groebner and analysis of data from a DIII-D experiment that he led on July 16, 2013 to measure the recovery of the pedestal after an ELM crash for a range of plasma current. This experiment used the Thomson system in rapid burst mode to measure the fast time evolution of the pedestal during and after an ELM crash. The ultimate goal of this research is to identify the mechanisms responsible for edge transport after an ELM crash and during the pedestal recovery.

A new collaboration job list was formulated between PPPL and GA for this upcoming year. Initial job estimates are being prepared. Kickoff meetings on the neutral beam controls, and poll shields were held. Other plans for gyrotron magnet current monitors, C-supply control issues and several diagnostic projects are being assessed.

A. Nagy performed additional I-coil gas cooling tests using nitrogen and helium.

### **International Collaborations (J. Hosea):**

The midyear report to DOE for the EAST-KSTAR International Collaboration for the Development of long-pulse RF actuators and Operational Techniques for High Z PFC was presented to Steve Echstrand and John Mandrakas on January 23 by teleconference. PPPL's effort focused on the status of the fixed and steerable steady state mirrors for the ECH launchers on KSTAR and the design of a two-channel steady state launcher at the pre-conceptual stage. Also, we presented our plans for participating with MIT in helping to make the EAST ICRF launcher more robust against arcing.

Travel arrangements have been completed for R. Ellis and J. Hosea to go to Korea the last week of February to attend the KSTAR Conference and afterward visit KSTAR to 1) hold design reviews for the ECH launcher mirrors and 2) to firm up future development plans. The first week of March we will then join Gary Taylor, Nicola Bertelli and Rory Perkins at EAST to pursue collaborations there.

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

A kickoff meeting for the next phase of the national Fusion Energy Systems Studies program was held January 28-30 at the Laboratory. The three-year study is planned to focus on the mission, requirements, and R&D needs for a fusion nuclear science facility (FNSF). At the meeting, which was chaired by study leader C. Kessel, researchers from participating U.S. fusion

institutions summarized the status of key FNSF technologies, such as blankets and first wall, tritium cycle, and divertors, as well as R&D needs. The range of possible FNSF missions was discussed in terms of its role in reducing risks in preparation for a fusion DEMO to come after the FNSF, as well as the near term needs to satisfy readiness conditions for an FNSF. A summary and action plan documenting the outcome of the meeting is in preparation.

S. Lazerson presented a talk entitled "3D Equilibrium Reconstruction for Stellarators and Tokamaks" at the Columbia University Plasma Physics Colloquium. This talk highlighted reconstruction work performed on the Large Helical Device and DIII-D, along with forward modeling for the W7-X and ITER devices.

D. Gates and H. Neilson visited DOE's Fusion Energy Sciences office as members of a national delegation to discuss U.S. partnerships with overseas stellarator projects, namely Germany's Wendelstein 7-X (W7-X) and Japan's Large Helical Device (LHD). The team presentation discussed recent scientific accomplishments from PPPL's collaboration with LHD, and the opportunities available through collaboration in the W7-X experiment, which starts operating next year. Opportunities for U.S. universities to become involved in the W7-X partnership were highlighted, and a process for identifying university interests compatible with W7-X needs was proposed.

### **THEORY (A. BHATTACHARJEE):**

I. Dodin's paper titled "On variational methods in the physics of plasma waves" was published in Fusion Science and Technology. This paper is a follow-up to the invited lecture that Ilya Dodin gave at the 6th ITER International School on RF Heating and Current Drive in Plasmas (Ahmedabad, India, Dec 2-6, 2012) and reviews some of recent advances in the Lagrangian theory of plasma waves including essentially nonlinear waves like BGK modes.

The theory seminar this week was presented by Professor Hamid Saleem from National Centre for Physics, Quaid-i-Azam University, Islamabad, Pakistan entitled "Seed Magnetic Fields and Flows are Generated Simultaneously by Baroclinic Vectors in Galactic and Laser Plasmas". The abstract of the talk is "The two-dimensional exact solutions of two fluid plasma equations are obtained assuming that the density and temperature gradients are given externally. It is also shown that both the seed flows and magnetic fields are created simultaneously by the baroclinic vectors of electrons and ions. The theoretical model is applied to galactic clumps and the classical laser produced plasmas to estimate the seed magnetic and flow fields. The similar solutions are also applied to neutral interstellar medium to estimate the seed flows generated by baroclinic vector."

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

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

Construction: In-vessel work this week included the TAE coil winding, shielding of wires, tack welding NB armor hardware, cabling, filaments, installation of all except four passive plates with their tiles and installation of the shunt tiles. Termination of cables coming out of the vessel will

occur next week. The installation of thermal putty between the vacuum vessel and the bakeout tubing was completed and the installation of vessel insulation has been started. Trial fits for the PF4/5 supports at bays B and L were completed and final supports are being fabricated. Work has been completed on the centerstack casing studs. Supports are being fabricated for the new RWM coils at bays J - A. The bay H port cover lift fixture has been modified and is awaiting load testing. The electricians have finished terminating cables at the category 3 rack on the 119' EL platform and they are pulling the cables to the machine.

CS Upgrade: The first layer has been completed with approximately 230 turns. Frequent diameter checks have shown the diameter is well within tolerance. Work is now in the transition phase to layer 2, the conductors have been cut, and water fittings have been brazed onto the ends. Workers are now bending the conductors to make the two (2) lap brazes to connect layer 1 conductors to layer 2. We should be complete with the transition by February 3. Will then continue winding next week with 2-shift operation. The OH Mold is in the Tech shop for the addition of jacking screws. A meeting was held to discuss the remaining issues with the OTF lead finger supports. The PF-1B lower was shipped from Everson January 30 and was expected to arrive at PPPL on January 31. The PF-1B upper will come out of the oven January 31. Everson is set to begin winding the first PF1A coil by the middle of next week. A sample of the row 1 diverter tiles went into the oven this week for RGA analysis. The results will be available on January 31.

NBI Upgrade: NB High Voltage Transmission Lines were moved from the TCB to the TTC in preparation for relocation to NTC and installation. Progress on DI water manifold fabrication and installation continued on BL2 and made great strides. The NBI Armor shinethrough tile bakeout has been delayed due to reduced performance of the oven; bakeout is expected to finish next week. Subcontract cable installation is nearing completion including termination, labeling, and testing. Fiber optics cable pulls were completed. Subcontractor triax terminations are planned in February. Control rack wiring continues in the Gallery racks and the NBPC Building 138L. Mod/Reg controls work continues. RWM coil fit-up continues for the Bay JK area. A few final duct support parts are in progress. A shipment of rad waste material was collected, packaged and removed from the TTC by ERWM with full HP support. Some decon in the TTC also took place to recover areas and reduce postings.

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

A. Zwicker spoke at a Tedx conference held at Princeton Charter School in Princeton, New Jersey. The theme of the conference was "Change: Personal, Local, and Global". His talk, "Global Change: Clean Energy by Creating a Star on Earth", discussed the historical context of fusion energy research in Princeton and the global impact expected when net electricity from fusion is produced.

Approximately 300 individuals attended the Science on Saturday Program. Kay Bidle, from Rutgers University presented, The Invisible World of Marine Microbes: How Earth's Smallest Living Things Have the Biggest Impact on How Our Ocean Works.

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

On January 28, Professor Manish Prashar, Rutgers University presented a colloquium entitled, "Addressing Big Data Challenges in Simulation-based Science".

On January 29, Christine Di Bella, Institute for Advanced Study presented a colloquium entitled, "The Usefulness of Useless Knowledge: The History of the Institute for Advanced Study".

M. Zarnstorff attended the DOE Idea Summit Pre-Planning Meeting at the National Renewable Energy Laboratory (NREL) on January 30-31.

## **PUBLICATIONS:**

Gray, T.K. (ORNL) *et al.*, "The effects of increasing lithium deposition on the power exhaust channel in NSTX" *Nuclear Fusion* 54 023001 (2014).

Dodin, I.Y., "On variational methods in the physics of plasma waves," *Fusion Science and Technology* 65, 54 (2014)

This report is also available on the following web site:

<http://www.pppl.gov/publication-type/weekly-highlights>