

PRINCETON PLASMA PHYSICS LABORATORY

**WEEKLY** highlights



**The PPPL Highlights for the week ending April 3, 2015, are as follows:**

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

The final two of four high voltage transformers are being shipped to France from Hyundai Heavy Industries in South Korea.

G. Kramer used the full-wave code FWR3D, developed by E. Valeo, to simulate various front-end antenna configurations being considered for the ITER LFS reflectometry. These simulations confirm that unless a bistatic pair of antennas is set back from the edge of the plasma and closely spaced, coupling is inferior to that of a monostatic antenna.

Considerable progress was made in freezing the strategy for splitting of the images from the ITER upper cameras. This splitting, which occurs in the port cell region, provides a secondary image plane for flexible use by various instruments, while also separate image planes for visible and two IR wavelengths, for the machine protection role.

**NSTX (M. ONO):**

A TRANSP User's Group meeting was held at PPPL on March 23-24. The meeting brought together users from around the world, with representatives from the U.S. (NSTX-U, C-Mod, DIII-D, modelers from MIT and ORNL), Europe (JET, MAST/MAST-U, Asdex-U, EuroFusion), Asia (KSTAR, EAST) and ITER. Approximately 40 people attended on-site with approximately 15 people participating remotely. The purpose of the meeting was to discuss with current and potential TRANSP users and developers from around the world the present and future use of the code, including short- and long-term upgrades to the physics modules as well as code modernization and framework. Specifically, a goal was to find out what upgrades would make TRANSP more valuable to the international community, including ITER, for both analysis and prediction. A further goal was to identify and encourage development external to PPPL that could be used to enhance the TRANSP capabilities. The overall objective is to make the code more powerful and user-friendly. Talks were given by participants from each experimental device represented on how TRANSP is used at their facility including their future needs. Furthermore, talks were given on numerical frameworks and workflow managers. A strategic plan for TRANSP development both in the short (~years) and long- (~decade) terms, incorporating the input from the workshop, will be developed by July 1.

Installation of the MPTS laser beam exit hardware continued with all three beam turning mirror crosses and the connecting beam line sections installed. Maintenance on the Ng:YAG lasers has been completed and they have been operated at good power levels.

Preparations of non-upgrade equipment for plasma operations in the NSTX-U configuration also continued with the completion of power testing of the supplies needed to support CD4 plasma operations. Dummy load testing of the supplies will continue into next week to complete verifications of the DCPS. Coil System flow switch calibrations will be performed next week with the restart of the cooling water systems, and systems are being configured for a bake of the vessel center column. Installation of ex-vessel MPTS equipment continues.

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

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

R. Nazikian and C. Greenfield (GA) chaired the community input workshop on transients in fusion plasmas from March 30-April 1. There were 44 community-wide presentation at the workshop on disruption and ELM physics and research needs. PPPL researchers Rajesh Maingi, A. Bortolon, J.-K. Park, Z. Wang, D. Brennan, E. Kolemen, F. Poli and L. Zakharov gave 20-minute presentations at the workshop. Alberto Loarte and Joe Snipes also attended remotely from ITER to provide perspectives on current research and ITER needs to the workshop participants.

R. Ellis and D. Miller visited DIII-D to continue work on the repair and refurbishment of the ECH launchers. R. Ellis addressed the engineering details of the repair this week while D. Miller will continue his visit to participate in the refurbishment of the launchers and repairs. The launchers are being prepared for re-installation on DIII-D in early May.

Work is progressing on the neutral beam control system (NB LCS8), which is in its final week of wiring. In addition, work has begun on the second neutral beam control system NBLCS5.

A meeting was held of the LGI team to discuss the physics requirements for the upgrades. The most challenging aspect of the requirements is the need to deliver granules at a regular frequency. This is achieved through the dropper design. The dropper design has three candidate approaches that will be assessed for the best approach to regulate the injection rate. Cost estimates are being developed, including plans to prototype the concepts.

### **ADVANCED PROJECTS (D. GATES):**

The next phase of the Laboratory's collaboration with S. Korea's National Fusion Research Institute (NFRI) was recently approved. In this phase, PPPL will continue its work to develop a heating and current drive scenario for K-DEMO using state of the art tokamak plasma simulation tools and high-fidelity models for candidate heating and current drive techniques. In addition, PPPL will continue to develop a machine configuration model of the K-DEMO tokamak, supported by structural analysis. A joint manuscript, "Design concept of K-DEMO for near-term implementation," has been accepted for publication in Nuclear Fusion. The

Laboratory's main contributions are reflected in the machine configuration description, physics assessment, and magnet structure analysis sections of the paper.

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

R. White gave a Research and Review presentation on April 3, the talk was titled "Two problems - Alfvén Mode Saturation and The Greenwald Density Limit". The first part of the talk reported research performed in collaboration with Nikolai Gorelenkov detailed Saturation of Alfvén waves in tokamaks, guiding center simulations of Alfvén modes are studied using a  $\delta f$  formalism and Poincaré identification of resonances. The goal is to understand multi-mode saturation and to compare with models used for energetic ion transport studies.

The second part reported research performed in collaboration with D. Gates, D. Brennan, and Q. Teng on tearing mode destabilization and the Greenwald limit. A destabilizing term due to local asymmetric flattening of the current profile by a tearing mode, combined with a small amount of radiation cooling, can lead to explosive growth of an  $m=2$  mode in a tokamak. This process is a good candidate for the Greenwald density limit. A simple cylindrical analysis captures the essential physics, and the mechanism is very robust. It is being more fully analyzed using time dependent codes with thermal conduction, DEBS and NIMROD.

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

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

Construction: The lower umbrella lid has been installed and torqued. Water hoses to coils are installed. All paths, except for PF1AU, have been hydro tested and passed. The flow switch calibration is under way. RWM cables have been reinstalled additional supports are being fabricated. The Gas Injection System TIV and valve control air line installation is 90% complete. The PF2 & 3 upper and lower supports are completed and passed hi-pot testing. Daily hi-pots of the inner and outer vessel have been acceptable. The TMB gas delivery coax supply line installation continues. Gas Delivery System tubing installation is near completion, leak checking of GDS is in progress. The test cell scrub continues.

CS Upgrade: A peer review was held to review the lead supports for the PF2/3. The review was declared successful with only three minor chits to resolve. The PF2/3 Lead supports have been installed along with cable restraints. The installation of cooling water hoses continues and leaks are being corrected as they are found. The checking of flows and flow switch setting are also underway.

NBI Upgrade: BL2 is operational with all services completed. The Liquid Helium refrigerator is operational. The feedstock deuterium gas system fiber optics testing is in progress. Work continues to activate the BL2 and Armor thermocouple scanning systems. Ion source operations with PTP-NB-11 are scheduled to begin the week of April 6. Management participated in the weekly IPT meeting.

Digital Coil Protection System: Dummy Load testing continued with both DCPS codes active

and operational. A meeting was held to discuss DCPS configuration spreadsheet limits and incorporation into ISTP-001 is in progress. Parameter tree creation to support ISTP and Ops is in progress. The efforts on the remainder of the real time system supporting PCS continues.

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

A. Cohen participated in a CAS Review of Jefferson National Laboratory in Newport News, Virginia on April 2-3.

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