

PRINCETON PLASMA PHYSICS LABORATORY

**WEEKLY** highlights



**The PPPL Highlights for the week ending March 13, 2015, are as follows:**

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

The second HV substation transformers was shipped from Hyundai Heavy Industries starting March 10, beginning its journey to France. The last two transformers are scheduled to be shipped together starting March 31.

In preparation for the upcoming OPA reviews in Oak Ridge diagnostic CAMs and other project engineers completed updates to the Event Risk registry. Sixteen risks were retired and start and end dates were updated to be consistent with the latest cost and schedule estimates. A total of 129 event risks remain open. The cost and schedule uncertainty risks were also updated.

PPPL met with the group at General Atomics that is using data from the DIII-D tokamak to assess the feasibility of the Motional Stark Effect Line Shift (MSE-LS) diagnostic concept for ITER. If successful, this approach to the MSE measurement would have significant advantages for ITER compared to the conventional Line Polarization MSE measurement used on existing tokamaks. Modifications to the EFIT equilibrium reconstruction code that will allow MSE-LS data to be used as a constraint are nearly complete. A data input code and a code to generate synthetic data for verifying the modified version of EFIT have been written. EFIT analysis with DIII-D MSE-LS data will start when code verification is complete.

A new analysis flow chart and generic mode analysis model was developed for structural integrity evaluation of US ITER port plug structures under various design-driving load cases. A comparison of max transient magnetic fields under various DINA simulated plasma disruption scenarios for upper and equatorial port plugs and in-port diagnostics has been completed for the diagnostic system load specification. The analysis team was also able to complete and submit the first draft of a new generic Interspace and Port Cell load specification that is critical for advancing the design of diagnostic components.

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

J. Menard, R. Maingi, and S. Gerhardt of NSTX-U/PPPL participated in the Alcator C-Mod/Magnetic Fusion Experiments Program Advisory Committee meeting held at the MIT Plasma Science and Fusion Center on March 5-6.

Several diagnostic vacuum interfaces were completed on March 6-7 in preparation for NSTX-U research operations. The tangential bolometer assembly at Bay "G", the re-entrant window for a

Plasma TV at Bay "I", and a gate valve for a bolometer at Bay "I" were installed.

Preparations for plasma operations in the NSTX-U configuration also continued with dummy load testing of the FCPC power supplies utilizing PSRTC, DCPS, and the new rectifier firing generators. Testing of the TF rectifiers as needed for the NSTX-U CD-4 plasma has been completed, and good progress is being made on the testing of individual OH rectifier sections over their full range of operation, and on pairs of OH rectifiers configured for 2kV, 24kA operation in OH forward and reverse branches. Modifications to the test cell Emergency Stop circuits were completed and tested this week. Installation of new fibers for the Beam Emission Spectroscopy has started.

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

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

PPPL researchers participated in a multi-institution effort on DIII-D to address the physics underlying RMP ELM suppression. This work led to two back-to-back PRLs on the subject that were published online this week. In the first Letter authored by Paz-Soldan (GA), Nazikian (PPPL) et al. titled "Observation of a Multimode Plasma Response and its Relationship to Density Pumpout and Edge-Localized Mode Suppression", newly installed magnetic sensors on the high and low field side of the plasma reveal that multiple modes are excited by the applied  $n=2$  field. The surprising result is that the magnetic response of the plasma on the inner wall is most strongly correlated with density pump out and ELM suppression. This inner-wall response is qualitatively different from the usual kink response measured on the outer wall with magnetic probes. Detailed simulations with IPEC and MARS-F reveal that the inner wall magnetic response is consistent with an edge localized resonant response of the plasma to the  $n=2$  field. <https://journals.aps.org/prl/abstract/10.1103/PhysRevLett.114.105001>

In the second Letter authored by Nazikian (PPPL), Paz-Soldan (GA) et al., titled "Pedestal Bifurcation and Resonant Field Penetration at the Threshold of Edge-Localized Mode Suppression in the DIII-D Tokamak", it was revealed that at the peak of the edge resonant magnetic response of the plasma the pedestal electron temperature and rotation profiles undergo a bifurcation at the onset of ELM suppression. The bifurcation in the profiles consist of a rapid reduction in the temperature gradient and an increase in rotation and turbulent fluctuations at the top of the pedestal together with a nonlinear increase in the non-axisymmetric magnetic response on the inner wall. These profile changes are indicative of the penetration of the resonant magnetic fields at edge rational surfaces, based on non-ideal MHD simulations using the M3D-C1 code. <https://journals.aps.org/prl/abstract/10.1103/PhysRevLett.114.105002>

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

Assembly of the MSE background polychrometer is essentially complete, and we took the first full test shot this week. All 40 data channels were acquired successfully. A spatial calibration of the MSE diagnostic was performed, and standard angular calibration will be carried out the week of March 16. The goal is to have a fully functioning, calibrated MSE background polychrometer system by March 20.

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

H. Neilson attended an “International Workshop on the Strategy of Stellarator / Heliotron Research,” held March 4-6 in Nagoya, Japan. The meeting was organized by Japan’s National Institute for Fusion Science (NIFS). Neilson made two presentations, “Present Status and Near Future Plan of U.S. 3D Fusion Plasma Research,” and an untitled presentation addressing ways in which conferences are being used to facilitate scientific exchange on critical issues for stellarator advancement toward DEMO. Regarding the former, it was pointed out that the U.S. stellarator program is largely carried out through international collaboration, highlighted by a U.S. partnership with Wendelstein 7-X. Regarding the latter, examples given were the planned session on “Design and Analysis Tools for Stellarator DEMO Devices” at the 2015 Symposium on Fusion Engineering (SOFE) in Austin, Texas, and the inclusion of stellarators in the IAEA DEMO Programme Workshop series.

S. Lazerson has been awarded a startup allocation of 50,000 hours at NERSC for optimization of stellarators for improved energetic particle confinement. A key component to development of a stellarator reactor is the demonstration that they can be optimized for good energetic (alpha) particle confinement. This allocation will allow a demonstration of the newly coupled STELLOPT and BEAMS3D code. This coupling allows the calculation of energetic particle (gyrocenter) orbits in a stellarator equilibrium, providing the necessary target for the reduction (optimization) of energetic particle losses.

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

On March 10, D. Stotler, B. Davis and G. Tchilinguirian ran the Robo-Cross competition at the New Jersey Science Olympiad State Tournament. Each of the 26 middle school teams participating in Robo-Cross designed and built a robot capable of moving various objects across a playing field and then placing them in one of two "goal" boxes.

The Theory department's postdoctoral researcher Joaquim Loizu from Ecole Polytechnique Federale, Switzerland has been awarded a European Physical Society Plasma Physics Division Ph.D. Research Award for his thesis, "The role of the sheath in magnetized plasma turbulence and flows." The Plasma Physics Division of the European Physical Society (EPS) grants annually up to four prizes to young scientists from the 38 European countries associated with the EPS in recognition of truly outstanding research achievements associated with their PhD study in the broad field of plasma physics. Congratulations Joaquim!

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

S. Ethier attended the DOE workshop on Programming Models and Environments at Exascale organized by the Office of Advanced Scientific Computing Research (ASCR). The goal of this workshop was to propose, articulate, and consider multiple visions of candidate Programming Models and the essential architecture of potential Programming Environments to be explored and evaluated as part of the Exascale Computing Initiative (ECI) program. Ethier gave a presentation entitled "Fusion Applications Requirements for PM/E(s) in the Exascale Era". Several application scientists were invited to present their requirements and participate in in-depth

discussions with the computer scientists working on developing these Exascale Programming Models and Programming Environments.

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

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

Construction: All of the Toroidal Field (TF) bus inside the umbrellas has been installed. Installation of the TF lead supports continues in both umbrellas with the welding in the upper umbrella now complete. Hydro testing and connecting of hoses continues on second shift. The CHI bus installation outside the umbrellas continues. The installation of the gas delivery lines is nearly complete. The installation of gas injectors #1 – 3 is also nearly complete. Welding of the TMB lines continues. Electricians continue work on the TMB control wiring and the Kirk keys on the Gallery cages. Mounting holes are being drilled in the upper umbrella lid. The vacuum vessel is back under high vacuum following a vent to install several diagnostics and vessel hi-pots continue on a routine basis.

CS Upgrade: The installation of the OTF lead extensions were completed this week. Installation of the OTF finger supports in the upper & lower umbrella also continued. The OH Water heater was completed and tested at the vendor's facility. The shipping release and other documentation are being prepared for shipment. It is expected to arrive at PPPL the week of March 16. Dummy load testing continued this week. The details for the PF1B can weldment and the TF Lead extensions were incorporated into the design calculations and both calculations were signed and filed.

NBI Upgrade: IS water was drained and refilled. Circulation took place to further clean the system with the strainers. IS water reconnection is imminent and PLC control testing continues. A repair on the BL2C Source Isolation Valve was completed and leakchecked. A turbo vent valve was replaced. NB procedures for pump down and cool down of the BLs were approved. The BL2 box rough pumpdown has started. The M/R power supply testing and tuning continues on NB dummy load. Procurement of an IR camera for Bay L 7:30 port to view the armor is in progress. Management attended the weekly IPT meeting.

Digital Coil Protection System: Dummy load testing PTP-ECS-039 continued with DCPS JA in full support. DL testing paused at the end of the week while hardware and software reconfiguration takes place March 14-15. The DCPS extension and summing chassis implementation took place this week. The parameter tree utility development to support dummy load testing, ISTP, and Ops continues. Experience is being gained with the use of OP-DCPS-779 set up and startup procedure. Spares are in development and testing. The TF < OH aquapoxy algorithm code implementation is in progress. Pretesting Procedure of DCPS FCC is planned the week of March 16.

**BUSINESS OPERATIONS (K. FISCHER):**

Procurement released to the street the Request for Proposal (RFP) for the A/E Design and Construction Support Services associated with the IOI Project (facilities upgrade).

**OFFICE OF COMMUNICATIONS (K. MACPHERSON):**

J. Greenwald issued a news release about the publication in Physical Review Letters of a pair of joint PPPL/GA papers on ELMs mitigation

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

On March 14, J. Menard gave the final Science on Saturday lecture of the season. The talk concluded with a tour of the NSTX Test Cell & Control Room Annex.

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

On March 11, Dr. James Bray, from GE Global Research, presented a colloquium entitled, "Future Electrical Technologies From a GE Viewpoint".

On March 12-13, M. Zarnstorff, R. Hawryluk, A. Bhattacharjee, and R. Torraca traveled to Gaithersburg, Maryland to attend a meeting of the Fusion Energy Sciences Advisory Committee (FESAC).

This report is also available on the following web site:

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