



**The PPPL Highlights for the week ending July 19, 2013, are as follows:**

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

Simulations of the contributions of background light sources to the MSE signals were completed using LightTools. This work was done by a visiting researcher from the University of Technology in Eindhoven working with Nova Photonics. Because of the Be inner walls, reflections can contribute to this background. The simulations considered thermal bremsstrahlung radiation from the hot divertor and the core plasma regions. Reflected thermal radiation from the divertor was found not to be a problem. Reflected bremsstrahlung from the divertor was only significant relative to directly viewed core bremsstrahlung at the highest anticipated x-point densities.

The ITER Toroidal Interferometer Polarimeter (TIP) diagnostic features five chordal sightlines where laser beams propagate from an equatorial port plug to retro-reflectors located on the outer wall. Locations for three of these retros have been determined. They will reside behind apertures, deep within blanket shield modules at the intersection between the heating beam ducts and the main vessel. Initial analysis of thermal distortion of these precision optical components indicate that active water cooling may be avoidable. This is desirable, to facilitate robotic replacement of these critical components.

The LFSR diagnostic utilizes corrugated waveguides in the port plug to launch and receive microwaves in the frequency range 50-170 GHz. PPPL is investigating options for transmitting this radiation across the vacuum boundary. Among the options being considered is the use of mirrors to image the radiation from/to waveguides on either side of a double quartz window.

Vendor responses were received to a list of clarifying questions by the SPEB for RFP 13-031-A - "ITER Low-Field Side Reflectometer (LFSR) R&D, Physics and Engineering Design Support and Diagnostic Hall Instrumentation Development".

**NSTX (M. ONO):**

Members of the NSTX-U Research Team gave three contributed oral talks and two poster presentations at the European Physical Society Conference on Plasma Physics in Espoo, Finland (July 1-5). These are: R. Raman (University of Washington), Non-inductive current start-up and Ramp-up studies in support of NSTX-U Research (oral), V. Soukhanovskii, (LLNL) Snowflake diverter studies in DIII-D and NSTX aimed at the power exhaust solution for the tokamak (oral), A. Diallo (PPPL), Pedestal growth studies between ELMs (oral), E. Fredrickson,

(PPPL) Predator-prey modeling of coupling of co-propagating CAE to kink modes (poster), and S.C. Jardin (PPPL), Nonlinear calculations of soft and hard beta limits in NSTX (poster).

S. Gerhardt (PPPL) presented a talk titled "Disruption Detection and Halo Currents in NSTX" at the Theory and Modeling of Disruptions workshop. As indicated by the title, this talk discussed a set of halo current results from NSTX, including observations of the halo current path jumping as arcs between various components and a discussion of the timing and time-scales of the observed halo currents. The talk also described in detail a disruption detection algorithm that has been developed using NSTX data, and that provides the basis for realtime disruption detection on NSTX-U. Additional NSTX halo current data appeared in the talk by Tim Hender (CCFE, UK). This talk discussed the rotation dynamics of non-axisymmetric halo currents, with NSTX data being compared to data from JET, ASDEX-Upgrade, and DIII-D. Tyler Abrahms (Princeton University) presented a poster titled "Simulations of Deuterium and Helium Massive Gas Injection for NSTX-U and ITER". This poster describes DEGAS II modeling of massive gas injection done in collaboration with Daren Stotler (PPPL) and Roger Raman (University of Washington). M3D-C1 simulations of a soft beta-limit in NSTX plasmas were shown in the talk "Disruption Modeling Status and Opportunities" presented by Steve Jardin (PPPL).

The Materials Analysis and Particle Probe Upgrade (MAPP-U) was installed and operated on the Lithium Tokamak Experiment (LTX) last week. This collaborative effort involved researchers from Purdue University led by Prof. Allain (soon to join UIUC) and PPPL, with the goal of in situ analysis of samples exposed to tokamak plasmas. X-ray photoelectron spectroscopy (XPS) was performed on stainless steel samples of the same composition as the LTX plasma-facing components (PFCs) in the MAPP-U chamber, prior to their insertion into the LTX vacuum chamber. The samples were then moved to the plane of the LTX PFCs, and exposed to LTX plasmas. The presence of the samples did not affect plasma performance, and no qualitative changes in the XPS spectra after plasma exposure were observed. This was not unexpected, however, since the LTX PFCs were not conditioned with lithium, and had low plasma currents and densities. The measurements constitute the first "between shots" XPS data from PFC samples on any tokamak, and provide a good baseline for comparisons with samples exposed to plasmas after lithium PFC conditioning. Near-term plans are to make additional MAPP-U diagnostics operational (e. g., low-energy ion scattering and thermal desorption spectroscopy), and prepare them for remote control when MAPP-U is moved to NSTX-U next year.

A collaborative experiment to carefully document the pedestal density and temperature recovery between ELMs on DIII-D was led by A. Diallo and D. Battaglia of PPPL, in collaboration with Rich Groebner (GA) and the DIII-D teams. The Thomson system was operated in a burst mode that allowed detailed measurements of the first few msec after an ELM crash. This work seeks to compare pedestal recovery in DIII-D with the measurements made in NSTX. Another collaborative experiment to compare VH-mode in DIII-D with EP H-mode in NSTX was led by John Canik (ORNL), in collaboration with T. Evans (GA) and R. Maingi (PPPL). VH-modes were reliably produced and the profiles and fluctuations were documented with the extensive diagnostic set.

Preparations for plasma operations in the NSTX-U configuration also continued with the removal of an RF antenna from the NSTX Vessel to the RF Test Stand in order to test a new compliant center conductor HHFW center post.

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

Advanced Projects activities were well represented at the International Conference on Magnet Technology (MT-23), held July 14-19 in Boston. Work in collaboration with Germany's Max Planck Institute for Plasma Physics (IPP) was reported in "Mechanical Analysis of Trim Coils for the Wendelstein 7-X Stellarator Experiment," by M. Mardenfeld (PPPL), et al. and in "The Wendelstein 7-X trim coil system," by T. Rummel (IPP), et al. Progress in an ongoing study of a next-step fusion nuclear facility, K-DEMO, being carried out in collaboration with South Korea's National Fusion Research Institute, was reported in "Performance evaluation of K-DEMO cable-in-conduit conductors using the Florida electro-mechanical cable model," by Y. Zhai (PPPL).

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

A workshop on the Theory and Modeling of Disruptions was held at PPPL from July 17-19. Participants included experimentalists from major facilities (DIII-D, C-MOD, JET, NSTX), physicists from the ITER organization, and theorists from both the United States and Europe.

Stuart Loch (Auburn University) visited PPPL on July 16-18. He gave an overview of atomic research being done at Auburn and within the Atomic Data and Analysis Structure (ADAS) consortium that will be of particular interest to the NSTX-U program. Loch also engaged in one-on-one discussions with T. Abrams, S. Kaye, D. Stotler, V. Soukhanovskii, and F. Scotti.

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

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

Construction: The vessel plug between bays F and G for the MPTS diagnostic has been installed and welded to the vessel. Welding of the upper umbrella stiffeners has been completed. There are three more sets of lower umbrella stiffeners yet to weld. Holes have been drilled in the vessel for the five new gas injection ports. Rack 419 has been re-installed near bay J and receptacles are being installed on the west platforms. Alignment fixtures have been fabricated and installed on the upper outer TF support weldments. PF4/5 clamp modifications continue.

CS Upgrade: PPPL engineers visited Astro machine in PA to witness the weld preps and progress on the Center Stack turning fixture. The fixture work was approved and is expected to finish and ship in the next 2 weeks. Quadrants 3 and 4 have been mated together and placed in the full coil taping fixture. The first two quadrants are being prepped for mating to the full bundle. All of the required CS studs have been welded to the CS casing. Pull tests were conducted on the OH conductor braze samples all sample exceeded the requirements for the test. An e-beam weld test sample was also pulled and separated at ~40 ksi in the weld joint as would be expected. Some additional tests are planned for next week to measure the hardness in the parent material of the e-beam weld test samples. Procurement will be awarded today to purchase copper materials for the OH, PF, and TF Coils Bus Runs. The CHI materials will be purchased at a later time as the new design is still in progress. A bottom-up-cost estimate is being prepared. Analysis is in progress. Hardness tests were successfully performed on the raw passive plate material in the warehouse to confirm its temper.

NBI Upgrade: BL2 handrails on the source platform were installed. Temporary sections were added until manifolds are installed. TTC HVAC duct reinstallation was completed. Some decon of the TTC SE side was performed and more is planned but this work was limited due to HVAC problems. Fabrication and leakchecking of LHe and LN cryo line continues in the NB shop. Installation of LN supply line in the NTC took place. Installation of the N2 vent line is in progress. Vacuum system piping layouts are completed for NTC field installations. Fabrication and welding of the NB/TVPS duct and bellows shield components in the Tech Shop is done. Leakchecking is planned. Modifications to the TMP shielding were required due to as built dimensions of the TMPs; this work is in progress in the shop. The DI water system subcontract continues with pipe fitting, welding, and installations in the Pump Room. Setup and piping prep in the MER is in progress. The power system cable and tray procurement process is in progress. The cable tray support structure procurement is in progress. The JK VV reinforcements and SFLIP pieces are expected next week. Management participated in the monthly IPT meeting.

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

The Procurement Division reported the Laboratory's third quarter procurement cost savings results to the DOE Office of Management and the Office of Science.

PPPL submitted the following four proposals to NASA:

Comparing global gyrokinetic simulations of ballooning instability in the near-earth plasma sheet with wave observations associated with substorm onset". The Principal Investigator is J. Johnson. The total budget request is \$414,400 for the three-year period of performance.

A Multiscale Investigation of Electron Acceleration by Alfvén Waves during Solar Flares ". The Principal Investigator is J. Johnson. The total budget request is \$373,100 for the three-year period of performance.

Kinetic simulations of plasma heating by Alfvén waves in the solar corona". The Principal Investigator is J. Johnson. The total budget request is \$372,500 for the three-year period of performance.

Electromagnetic Ion Cyclotron Waves and Propagation in the Magnetosphere-Ionosphere ". The Principal Investigator is E.W. Kim. The total budget request is \$389,000 for the three-year period of performance.

### **ENVIRONMENT, SAFETY, HEALTH & SECURITY (J. LEVINE):**

DOE/PSO concurred with the Site Protection Division Implementation Plan prepared in response to the recommendations from the DOE "PPPL Physical Protection System Risk Assessment" Report. The Implementation Plan responds to the 13 recommendations; these recommendations will be tracked to completion by PPPL Quality Assurance.

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

K. MacPherson worked with the reporter Mok Chi Leung of Next magazine in Hong Kong for an interview with A. Cohen on nuclear safety issues.

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

July 15-19, Science Education hosted a group of ten teachers from across the nation who came to participate in the weeklong Plasma Camp Workshop. Nick Guilbert, of Peddie School, led the course. A. Dominguez and A. Zwicker also lectured during the workshop.

On July 18, Jose Lopez, of Seton Hall University, gave a lecture on Microplasmas to the summer undergraduate interns.

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

On July 18 - the Laboratory Management Review was held. A consolidated matrix with input from each department head was presented. Each PEMP goal (8 total) was assigned a grade (- A, A+, A-, B, etc.) with bullet points for supporting the assigned grade. Risks and issues associated with each goal and how those might affect the grade were also indicated.

## **INVITED TALKS:**

H. Neilson opened the International Conference on Magnet Technology (July 14-19 in Boston) with an invited plenary talk, "Fusion Magnets from ITER to DEMO," presenting a look at fusion magnets from a functional perspective— what they do and what they must do in future devices. [Advance Projects]

## **PUBLICATIONS:**

The following PPPL Reports were posted to the web:

Simulation of Non-resonant Internal Kink Mode with Toroidal Rotation In NSTX PPPL-4930  
Authors: G. Fu, et. al.  
Submitted to: Physics of Plasmas (June 2013)

Performance Evaluation of K-DEMO Cable-in-conduit Conductors Using the Florida Electro-Mechanical Cable Model PPPL-4931  
Authors: Yuhu Zhai, et. al.  
Submitted to: 23rd International Conference on Magnetic Technology, Boston, Ma. (July 14-19, 2013)

The Hamiltonian Mechanics of Stochastic Acceleration PPPL-4932  
Authors: J. W. Burby, A.I. Zhmoginov and H. Qin

Submitted to: Physical Review Letters (APS) (July 2013)

Progress in Simulating Turbulent Electron Thermal Transport in NSTX PPPL-4933

Authors: Walter Guttenfelder

Submitted to: Nuclear Fusion (January 2013)

This report is also available on the following web site:

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