PRINCETON PLASMA PHYSICS LABORATORY
WEEKLY highlights

PPPL
U.S. DEPARTMENT OF ENERGY

The PPPL Highlights for the week ending May 31, 2013, are as follows:

NSTX (M. ONO):

Preparations for plasma operations in the NSTX-U configuration also continued with the re-commissioning of the three autotransformer and transformer rectifier sets that will provide the primary power for the NB2 ion sources, and the power testing of the new firing generators for the field coil power conversion (FCPC) system rectifiers. Twelve of the planned thirty-four firing generators have now been delivered to FCPC, eleven of which have successfully completed power testing.

ITER & TOKAMAKS (R. WILSON):

DIII-D (R. Nazikian):

B. Grierson and W. Wang are investigating the effects of turbulence on toroidal and poloidal flow in ECH H-mode discharged on DIII-D using the GTS code. In a recent publication by Grierson, the toroidal and poloidal flow of main-ions were reported to depart from neoclassical estimates at low ion collisionality. These observations are being tested by simulations of the turbulent Reynolds stress driven flow for a range of collisionality investigated in the experiment.

The Microwave Imaging Reflectometry is installed on DIII-D and final testing is underway. Optical elements have been installed and aligned and the data acquisition system is being tested. Critical in-situ system testing of the mm-wave components and IF electronics will begin next week. The objective is to commission the system during experimental operations the second week of June.

B. Tobias visited PPPL to collaborate with J.M. Park on comparing 2D ECE-Imaging of the edge kink response with IPEC simulations.

Alcator C-Mod (R. Ellis):

Bob Mumgaard (PSFC) served as an External Expert on the ITER Conceptual Design Review of the Motional Stark Effect diagnostic. He gave a presentation, “Effect of Background Light on MSE Measurements” based on the experience obtained from the Alcator C-Mod MSE diagnostic. In Alcator C-Mod, unpolarized light emitted by the plasma and/or glowing structures inside the vacuum vessel becomes partially polarized – and in some cases highly polarized – upon reflection from in-vessel surfaces. This polarized ‘background’ emission can vary rapidly

in both time and space, and cannot be adequately compensated by modulating the diagnostic neutral beam. ITER may face similar difficulties owing to its size, density, weak beam emission, metal walls, and hot invessel structures. A novel polychrometer developed on Alcator C-Mod measures the polarized background emission in real time at wavelengths near the MSE spectrum using exactly the same optical views that are used to measure the MSE spectrum itself. This system has been demonstrated to improve the accuracy of the polarized-background emission by about an order of magnitude compared to beam modulation.

ADVANCED PROJECTS (H. NEILSON):

In the W7-X collaboration, Applied Power Systems, Inc. (APS) reported progress in the fabrication of the five power supply units. Assembly of the first unit is scheduled for June 17, followed by approximately one week of in-house testing, then acceptance testing. Staff from the Max Planck Institute for Plasma Physics (IPP) and from PPPL will witness acceptance testing, scheduled for June 24.

A paper by S. Lazerson, "3D Equilibrium Reconstruction in Tokamaks and Stellarators," has been selected for oral presentation at the 19th International Stellarator-Heliotron Workshop, to be held September 16-20, in Padova, Italy.

THEORY (A. BHATTACHARJEE):

This week's theory seminar "Introduction to the Edge Equilibrium Code (EEC)" was presented by Xujing Li from LSEC, Academy of Mathematics and Systems Science, Chinese Academy of Sciences, who is currently visiting PPPL and working with L. Zakharov. The implementation of a new code, the Edge Equilibrium Code (EEC), was discussed. To find solutions faster and more efficiently, this code uses flux coordinates with finite element representation in the edge region coupled with the existing ESC code (based on Fourier representation) in the core region through a virtual boundary. Examples with fixed boundary equilibria were shown.

COMPUTATIONAL PLASMA PHYSICS GROUP (S. JARDIN):

Nate Ferraro (GA) visited the M3D-C1 group for three days to consult on implementing a new "thick" resistive wall capability in M3D-C1. The finite element computational region is now divided into three sections: plasma, wall, and vacuum. In the wall region, a subset of the MHD equations are solved describing resistive diffusion in a conductor. In the vacuum region, an elliptic equation is solved for the current-free 3D fields. This technique for introducing the resistive wall does not involve Green's functions, and uses the existing structure of the code with relatively minor modifications. The initial implementation is complete and test problems are being run and evaluated. This development is a joint activity between PPPL, GA, and the SCOREC center at RPI.

PLASMA SCIENCE AND TECHNOLOGY (P. EFTHIMION):
(see publications)

ENGINEERING AND INFRASTRUCTURE (M. WILLIAMS):

NSTX Upgrade (R. Strykowsky, E. Perry, L. Dudek, T. Stevenson):

Construction: Work on TF13 and PF4/5 is on hold. Upper umbrella stiffener welding continues, as does the in-vessel fit-ups of the neutral beam armor mounts.

CS Upgrade: The fourth quadrant is assembled in the quadrant mold, with all nine conductors. Final positioning of the conductors is now underway. The TF Bundle mold at Reno passed pressure and helium tests and is now undergoing final dimensional inspection. Reno will submit all paperwork to PPPL for final review prior to shipping release as soon as the inspection reports are available. Kyocera has delivered the first ceramic break ring to PPPL and it has completed dimensional inspection at receiving inspection. The OH winding fixture welding is essentially complete. It has been assembled in the RESA building and will be on display for the open house on June 1.

NBI Upgrade: Installation of the magnetic shielding on the BL OMA boxes continues. Fabrication and leakchecking of LHe cryo line continues in the NB shop. LHe cryogenics line installation, welding, and leakchecking on the TFTR Test Cell East wall continues. Fabrication continues on the NB/TVPS duct components in the Tech Shop. Leakchecking of the circular bellows took place; welding on its flanges has started. The DI water system subcontract continues and demolition work has started. The power supply cable and tray SOW has been approved; drawings are in review. NBI Armor fit-up and support installation in the VV continues. JK VV reinforcements are on order.

DIRECTOR'S OFFICE (B. SOBEL):

On May 28, Director S. Prager delivered the State-of-the-Laboratory address to PPPL staff.

On May 30-31, S. Prager hosted a meeting between representatives from PPPL, General Atomics, and MIT to discuss developing a compelling ten-year strategy for the fusion program.

AWARDS:

S. Prager presented the 2013 outstanding research awards to physicists S. Sabbagh and G. Hammett. Sabbagh received the Kaul Foundation Prize for Excellence in Plasma Physics Research and Technology Development for his work on advancing the understanding, and enhancing the stability, of high-performance plasmas in fusion facilities called tokamaks. Hammett was named winner of the Distinguished Research Fellow Award for his work on deepening the theoretical understanding of turbulence in fusion plasmas.

INVITED TALKS:

H. Mynick attended the IAEA Technical Meeting on Theory of Plasma Instabilities in Vienna, and gave an invited talk, "Progress in Turbulent Optimization of Toroidal Configurations Via Shaping".

H. Neilson was invited to present a plenary paper on the topic, "Fusion Magnets-ITER, DEMO, and Beyond," at the International Conference on Magnet Technology, to be held July 14-19 in Boston.

PUBLICATIONS:

Last week, a new paper was published in Phys. Rev. Letts from MRX, entitled "Observation of Ion Acceleration and Heating during Collisionless Magnetic Reconnection in a Laboratory Plasma" by J. Yoo, M. Yamada, H. Ji, and C. E. Myers. Magnetic reconnection phenomena observed in solar flares, the earth magnetosphere and in the laboratory fusion plasmas are accompanied with acceleration and heating of plasma particles. An example is an observation of high energy electrons and ions associated with reconnection of magnetic field lines in solar flares. In this work, the mechanisms of the energization of ions in the magnetic reconnection layer has been studied by monitoring the behavior of electrons and ions in the MRX dedicated to the study of magnetic reconnection. Ions are accelerated by an electrostatic field across the separatrices to the plasma exhaust region of the reconnection layer and become thermalized through re-magnetization by the exiting magnetic fields. While they are consistent with some recent 3-D simulation results, the present results will bring a new insight into the conversion mechanism of magnetic energy to ions during magnetic reconnection.

The paper "Negative-Mass Instability in Nonlinear Plasma Waves" by I. Y. Dodin (PPPL), P. F. Schmit, J. Rocks, and N. J. Fisch (PPPL) was published in Phys. Rev. Lett. 110, 215006 (2013). The paper shows that the negative-mass instability, previously found in ion traps, appears as a distinct regime of the sideband instability in nonlinear plasma waves with trapped particles. As the bounce frequency of these particles decreases with the bounce action, bunching can occur if the action distribution is inverted in trapping islands. In contrast to existing theories that also infer instabilities from the anharmonicity of bounce oscillations, spatial periodicity of the islands turns out to be unimportant, and the particle distribution can be unstable even if it is flat at the resonance. An analytical model is proposed that describes both single traps and periodic nonlinear waves and concisely generalizes the conventional description of the sideband instability in plasma waves. The theoretical results are supported by particle-in-cell simulations carried out for a regime accentuating the negative-mass instability.

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