Weekly HIGHLIGHTS

PPPL PRINCETON PLASMA PHYSICS LABORATORY

U.S. DEPARTMENT OF ENERGY

The PPPL Highlights for the week ending April 7, 2017 are as follows:

NSTX-U RECOVERY PROJECT (R. HAWRYLUK):

Removal and vacuum leak checking of the in-vessel neutral beam is in progress, and preparations for the reassembly and reinstallation of the bay H port cover have started. Recommissioning of the coil winding facility also continued with vacuum leak checking of the trial PF1A mandrel after heat cycling, and preparations of copper conductor for sand blasting and priming. The vendor has begun the priming process for the first spool of PF1 coil conductor. PPPL representatives witnessed the transfer of the copper to the handling fixture.

Installation of buswork for the PF1 coil test stand in the Field Coil Power Conversion Building is nearing completion.

Conditioning of the deionized water to the first spare neutral beam ion source is making good progress, and insulating gas enclosures have been installed in preparation for electrical testing. A second spare source is being assembled in the Clean Room.

NSTX-U RESEARCH (J. MENARD):

The paper titled "Full-wave simulations of ICRF heating regimes in toroidal plasma with non-Maxwellian distribution functions" by N. Bertelli et al. was published in Nuclear Fusion. The paper describes the full wave TORIC extension to include the non-Maxwellian ion effects for both ICRF minority and HHFW heating regimes. The evaluation of the wave-field and power absorption, through the full wave solver, with the ion distribution function provided by either a Fokker–Planck (CQL3D) and a Monte-Carlo particle (NUBEAM) codes was examined for Alcator C-Mod and NSTX plasmas. Non-Maxwellian effects generally tend to increase the absorption with respect to the equivalent Maxwellian distribution.

A second quarter NSTX-U progress report has been submitted to DOE FES for the FES Joint Research Target 2017 “Conduct research to examine the effect of configuration on operating space for dissipative divertors”. The NSTX-U contribution includes a summary of NSTX divertor operating space based on previous experimental and modeling work and a new analysis of NSTX experiments. The new analysis focuses on the dependence of detachment characteristics on divertor poloidal magnetic flux expansion, and the dependence of the radial extent of the partially detached region on divertor scrape-off layer width, divertor geometry (flux expansion), and gas seeding. Two-dimensional multi-fluid modeling using the UEDGE code with experimental constraints on transport and boundary conditions is used in the study.

J. Menard and Matt Reinke (ORNL) traveled to the University of Oxford, in Oxford, UK the week of April 3 to attend the Institute of Physics (IOP) Plasma Physics Conference and the MAST Upgrade Research Forum both held at Worcester College. At the IOP conference, M. Reinke presented a poster entitled "Experimental paths to improve the physics basis for high q-parallel exhaust strategies" and J. Menard presented an invited talk entitled "Physics and technology innovations for compact tokamak fusion pilot plants". At the MAST-U Research Forum J. Menard gave an invited talk entitled "Progress and plans for research on NSTX Upgrade". Both travelers had collaboration discussions with MAST-U researchers and leadership in preparation for future MAST-U operation.

ITER & TOKAMAKS (R. NAZIKIAN):

KSTAR:

The PPPL shipment of the MSE background polychromator has cleared customs in South Korea and delivery at NFRI is expected this week. This places out FY17 milestone on track for completing an assessment of the C-MOD MSE background measurement method on KSTAR.

JET/ITER/AUG:

A presentation on the newly developed Impurity Powder Dropper was held by R. Maingi, with A. Nagy presenting to a team from ASDEX-U. The Dropper will be installed on ASDEX-U this year. Bench testing and development work on the Dropper is about 50 % complete.

DIII-D:

A. Ashourvan presented a talk to the DIII-D research team on the validation of a theory-based model of edge intrinsic rotation developed by Tim Stoltzfus-Dueck (Princeton U). Ashourvan showed that the model quantitatively agrees with the toroidal velocity of the main-ions for a range of configurations for neutral beam power. At high heating power and high beta the finite edge JxB torque from the beam leads to a discrepancy with the model. However, when incorporating this finite torque into the model prediction, the discrepancy is resolved.

A Preliminary Design Review (PDR) was held this week by Peter Fisher, (PPPL Student Intern working for Alex Nagy) on his design for rearranging the water and high voltage cables inside the off-axis 210 neutral beam. A Final Design Review (FDR) will be held within 1 month.

A PDR was held by A. Khodak and I. Zatz on the 210neutral beam calorimeter design. Heat load analysis showed that the coolant water will not exceed 46 degrees C, with 6.3 MW beam power for a 30 ms pulse. The short pulse width is required to not melt the front copper face. An FDR is scheduled for April 19.

Prototype testing of a new 210 neutral beam High Voltage snubber (which reduces voltage transients) was successful. The snubber will be relocated in the pit south shield wall is a new approach. The new standoff distances are ~5-6", verses the original 9". The prototype test arced at 120kV, surpassing the 90kV requirement. Follow up testing, and smoothing sharp edges should improve this value, 140kV standoff is the target.

ADVANCED PROJECTS (H. NEILSON):

Stellarators (D. Gates):

N. Pablant was at W7-X in Greifswald, Germany from April 3 - April 7 to begin preparation of the XICS and HR-XIS diagnostics for the upcoming OP1.2a experimental campaign. During this visit the detector for Ar16+ channel of the XICS diagnostic was reinstalled, and is now ready for operation. Additionally a new Pilatus detector was received for the HR-XIS diagnostic, which was tested and fully integrated into the XICS/HR-XICS diagnostic acquisition system. A full alignment of the selectable crystal system of the HR-XIS diagnostic was also completed, making this system ready for installation. Finally testing of remote access to the MDSplus shot database at W7-X was completed, marking an important step in allowing full remote access to the W7-X experiment. During this trip Novimir was also able to participate in several meetings regarding planning of the next experimental campaign.

THEORY (A. BHATTACHARJEE):

A Research and Review Seminar was presented by E. Belova on the topic of "Hybrid simulations in application to NSTX, FRCs, and basic plasma physics" on 07 April. The abstract reads: "The HYM code is used to study the excitation of high-frequency Alfvén eigenmodes by energetic beam ions in NSTX/NSTX-U. Numerical results support an energy channeling mechanism for Te flattening, in which beam-driven CAE dissipates its energy at the resonance location close to the edge of the beam, therefore significantly modifying the energy deposition profile. A set of nonlinear simulations show that the CAE instability saturates due to nonlinear particle trapping, and a large fraction of beam energy can be transferred to several unstable CAEs of relatively large amplitudes and absorbed at the resonant location. Absorption rate shows a strong scaling with the beam power. Initial NSTX-U simulations of GAE stabilization have been performed showing that off-axis neutral beam injection reliably and strongly suppresses GAEs. Numerically calculated most unstable toroidal mode numbers, polarization, and Doppler-shift corrected frequencies are in a good agreement with experiments. HYM shows suppression of all unstable counter-rotating GAEs by the additional beam injection. 2D and 3D hybrid simulations of counter-helicity spheromak merging have been performed using the HYM code. Hybrid simulations results show that even in the MHD-like regime, there are significant differences between hybrid and fluid simulations of global reconnection, and demonstrate the need for a full kinetic description of plasma. These findings are in a sharp contrast with generally accepted paradigm that the inclusion of the Hall effects is sufficient to reproduce realistic reconnection rates of kinetic plasmas. Results of this study are also consistent with 2D full PIC and hybrid simulations of island coalescence, where it was found that fluid description including the Hall term does not describe reconnection in large systems correctly.

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