PRINCETON PLASMA PHYSICS LABORATORY
WEEKLY highlights

PPPL
U.S. DEPARTMENT OF ENERGY

The PPPL Highlights for the week ending August 30, 2013, are as follows:

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

Final drafts of the Statement of Work for design support for the ITER ECE and Upper Camera diagnostics were submitted for PPPL signoff.

Plans for prototyping the corner cube reflectors designed for the Toroidal Interferometer Polarimenter were discussed with IO experts, who agreed to include this activity as a milestone in the interface sheet with the blankets which will house these optical components.

Diagnostics cost and schedule estimates, and risks were reviewed at a Lehmann Review at the USIPO in Oak Ridge, TN.

NSTX (M. ONO):

D. Darrow (NSTX-U/PPPL) visited MAST August 12-23 to contribute to tests of the Florida International University (FIU) MeV proton detector on MAST plasmas. This detector system aims to measure the radial profile of the DD fusion reactivity of the plasma through detection of the 3 MeV protons and 1 MeV tritons produced in DD reactions. The testing was conducted in conjunction with Prof. W. Boeglin and R. Perez (FIU), and the MAST team. All 4 channels of the system registered clear signals from both types of fusion product ions. Data on the radial profiles were obtained under a wide variety of conditions, including quiescent plasmas, sawtoothing discharges, and during fishbone modes. In all cases, data from radial scans of the MAST neutron camera was also acquired. This camera also measures the fusion rate radial profile, but by means of the neutrons emitted by the fusion reactions. Comparison of the profiles produced by the two diagnostics is underway. These initial results are encouraging for the development of a system with more channels to measure the fusion rate profile in NSTX-U plasmas.

Steve Sabbagh and Young-Seok Park of Columbia University ran the KSTAR tokamak experiment MP2013-05-03-003 for two sessions last week (August 19 – 23) at the National Fusion Research Institute (NFRI) in Daejeon, South Korea, which addressed high normalized beta plasmas and studied several aspects of non-resonant n = 2 magnetic braking by neoclassical toroidal viscosity (NTV) in the device. Various magnetic field spectra were applied by utilizing the flexible capabilities allowed by KSTAR's in-vessel control coils over pulse lengths (~ 10 seconds) much longer that the momentum confinement time (~ 100ms). Plasma collisionality was effectively changed by supersonic molecular beam injection of deuterium during the period

of the applied n = 2 field, and rotation profile control by the combined effect of 110 GHz second harmonic and 170 GHz third harmonic electron cyclotron heating in the plasma core, and n = 2 NTV was examined. Along with the strong effect of n = 2 NTV to reduce plasma rotation in KSTAR, the various combinations of rotation control tools stated above were also used to change the toroidal rotation profile shear. Experiments by S.A. Sabbagh, et al. on both the National Spherical Torus Experiment (NSTX) at PPPL, and at KSTAR have shown significant controlled modification of plasma rotation by non-resonant NTV in each device (~ 100% reduction in NSTX, ~ 50% reduction in KSTAR). As NSTX and KSTAR differ significantly in aspect ratio, comparison of KSTAR data to the NSTX data will provide important physics insight on the effect, and comparisons to NTV theory.

ITER & TOKAMAKS (R. HAWRYLUK):

Alcator C-Mod (R. Ellis):
[see publications]

KSTAR (J.-K. Park):
[see publications]

ADVANCED PROJECTS (H. NEILSON):

C. Kessel participated in the Committee of Visitors Program Review of the ARIES Systems Studies at DOE-Fusion Energy Sciences. Presentations were given by F. Najmabadi on the overall program, M. Tillack presented the engineering activities, and C. Kessel presented the physics activities. The review covered the last ~ 5 years.

During a visit to the Max-Planck Institute for Plasma Physics in Greifswald, Germany, H. Neilson met with Wendelstein 7-X leaders to finalize the plans for the U.S.-IPP collaboration for the next one to two years. Key tasks include the preparation of an x-ray imaging crystal spectrometer by PPPL, design of a prototype diverter scraper element by ORNL, and on-site engineering collaboration by PPPL's Michael Mardenfeld. Task agreements for all planned tasks were drafted, in accordance with the DOE-IPP Project Agreement for collaboration in the Wendelstein 7-X research program. In addition, Neilson attended an Intermediate Design Review of the Scraper Element program; PPPL's D. Gates, B. Ellis, and T. Brown participate remotely as reviewers for this successful review.

THEORY (A. BHATTACHARJEE):

This week's theory seminar was presented by Nick Murphy from Harvard-Smithsonian Center for Astrophysics on "Asymmetric Magnetic Reconnection in the Solar Atmosphere". He presented the concept of asymmetric magnetic reconnection with some observational evidence. The numerical MHD simulations of magnetic reconnection, but with imposed magnetic asymmetry, was then shown for two configurations (i) in a general set up (ii) with plasmoid instability. The abstract of his talk is "Models of solar flares and coronal mass ejections typically predict the development of an elongated current sheet in the wake behind the rising flux rope. In

reality, reconnection in these current sheets will be asymmetric along the inflow, outflow, and out-of-plane directions. We perform large-scale simulations to investigate the consequences of asymmetry during solar reconnection. We predict several observational signatures, including flare loops with a skewed candle flame shape, slow drifting of the current sheet, asymmetric hard X-ray emission and motion of flare loop footpoints, and rolling motions within the erupting flux rope. We perform simulations of the plasmoid instability with asymmetric upstream magnetic fields and show that islands grow preferentially into the weak field upstream region. The islands develop net vorticity because the outflow jets impact them obliquely rather than directly. All of these simulations show non-ideal plasma flow across X-points. To understand this, we derive exact expressions for the rate of motion of a magnetic null point. Finally, we discuss how comparisons to observations will necessary to fully understand the roles of global and 3D effects."

ENGINEERING AND INFRASTRUCTURE (M. WILLIAMS):

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

Construction: Welding of the JK reinforcements continues in-vessel and welding of the upper outer TF support spilce plates continues. Rework of the bay L cylinder continues in the shops. The fabrication of the new tFIDA tube has been completed. Fit-up of the new PF5 clamps continues. All flags on the TF outer legs have been re-silverplated. Fabrication of category 3 cables continues in the shop. The assembly of the MPTS optics box is underway.

CS Upgrade: The full TF Bundle has been wrapped with ground wrap tape and is ready for installation into the mold. The final pieces, end spacers, are being reworked for as-built dimensions in the Tech Shop. The lift into the mold now scheduled for Thursday or Friday next week. The OH winding station is being worked on in the C-site MG area. The final punch list items are being addressed before the station is transported to the winding area. The disassembly of the priming room in the CS area has commenced in preparation for the changeover to the OH Winding phase. Power has been removed from the room and the walls are being removed. ECP / WAF review for the CHERS Passive Plate fabrication was conducted.

NBI Upgrade: Welding of LHe line in the NTC is complete and leak checking continues. Welding and leak checking of the bayonet is in progress. The Nitrogen system welding is complete and final assembly is in progress. The DI water system subcontract continues with pipe prep and fitting, welding, and installations in the MER. The Ion Source and Ion Dump DI H2O Pump procurement continues. Vacuum system installation detailed drawings are in progress. The power system cable and tray procurement is in progress with award expected next week. The cable tray support structure order delivery is expected early next month with installation in TTC and NTC to follow. The VV leg modification engineering work to clear the NBI duct installation is complete and drafting has started. Progress on the rectangular duct shields continued but some interferences were discovered which will require some rework. The JK VV reinforcements and SFLIP piece installation on the VV continues and nears completion. Thermocouple installation on armor tiles has been started with bench tests of TC fabrication. Management preparations have begun for the upcoming Office of Science review scheduled for early October 2013.

PUBLICATIONS:

The paper "Alcator C-Mod experiments in support of the ITER baseline 15 MA scenario," by Charles Kessel et al, was published in Nuclear Fusion 53 (2013) 093021 [ITER and Tokamaks]

A paper entitled "Rotational Resonance of Nonaxisymmetric Magnetic Braking in the KSTAR Tokamak", J.-K. Park et al., has been published in Physical Review Letters 111 095002 (2013). This work describes the observation of strong magnetic braking and neoclassical toroidal viscosity (NTV) in a particular level of rotation, which was predicted by and agreed with IPEC-NTV calculations as the first bounce-harmonic rotational resonance. These rotational resonances are important to predict NTV and rotation evolution in the presence of 3D fields, and may be useful to find a stable equilibrium state for rotation and kinetic energy. The n=1 field was particularly desired to isolate each bounce-harmonic resonance as much as possible, and the unique three-row internal coils in the KSTAR was fully utilized to produce a highly non-resonant n=1 field and thus to minimize possible degradation associated with n=1 resonant responses. [ITER and Tokamaks]

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