Weekly HIGHLIGHTS

PPPL PRINCETON PLASMA PHYSICS LABORATORY

U.S. DEPARTMENT OF ENERGY

The PPPL Highlights for the week ending September 9, 2017, are as follows:

NSTX-U RECOVERY AND RESEARCH (J. MENARD)

Recovery

A Cost and Schedule Review was held September 6-8. The committee was chaired by Robert Iotti, former Chair of the ITER Council. A de-brief presentation was made by the committee on Friday, and a written report will be delivered in the coming weeks. The final Extent of Condition Report, in response to DOE Notable 2.1, will factor in the latest cost and schedule estimate, along with the findings of the committee, and be delivered to DOE prior to the end of the fiscal year.

In the Coil Winding Facility, the test copper bundle is being fitted in the mold enclosure and plumbing connections are being made to the Binks pressure tanks in preparation for the upcoming VPI.

Research

Koji Kusumi and Shoki Nakamura, graduate students from Kyoto University, visited Egemen Kolemen's group (PPPL/Princeton University) to work on the Liquid Metal eXperiment (LMX) over the summer. They worked on thermal mixing enhancement of localized heated on free-surface of liquid metal film flow under various strength of the transverse magnetic field with 3 kinds of inline hemispheres arrays configurations and 3 kinds of staggered hemispheres arrays configuration. It was found that the best optimized inline configuration for the thermal mixing efficiently which is the middle length of pitch in flow direction under relatively low magnetic and high magnetic field. Two research papers are in development based on this analysis. The results will be presented at the International Symposium on Fusion Nuclear Technology (ISFNT).

Prof. Tomoaki Kunugi of Kyoto University also visited PPPL in August for a week. The main aim of the visit was to exchange ideas on liquid metal flow with Egemen Kolemen and advise his visiting graduate students (K. Kusumi and S. Nakamura). The collaboration will continue in the following year.

The paper "Edge loss of high-harmonic fast-wave heating power in NSTX: a cylindrical model" by R.J. Perkins et al [https://doi.org/10.1088/1741-4326/aa7860] has been published in the journal Nuclear Fusion. Previous High-Harmonic Fast Wave heating operation on NSTX exhibited a large loss of fast-wave power to the divertor along scrape-off-layer field lines for edge densities above the fast-wave cutoff. It was postulated that the wave amplitude is enhanced in the scrape-off layer due to cavity-like

modes, and that these enhanced fields drive sheath losses through RF rectification. In this work the influence of annulus resonances on wave-field reconstructions is studied

and instances have been found in which annulus resonant modes dominate the spectrum and trap over half of the total wave power in the edge. The work is part of an ongoing effort to determine the mechanism underlying these scrape-off layer losses on NSTX, identify optimal conditions for operation on NSTX-U, and predict whether similar losses occur for the ion-cyclotron minority heating scheme both for current experiments and future devices such as ITER.

U.S. ITER FABRICATION (H. NEILSON)

Steady State Electrical Network (J. Dellas)

Uninterruptible power supply (UPS) and DC Distribution: Fabrication, assembly, and acceptance testing for all systems is complete. The DC equipment is ready to ship and pickup by the Logistics Services Provider is scheduled for 11 September.

Diagnostics (R. Feder)

Toroidal Interferometer-Polarimeter (TIP): M. Van Zeeland of General Atomics, the Laboratory's partner in the TIP project, completed a draft report, "Design and Test Report for the ITER Toroidal Interferometer and Polarimeter (TIP) Prototype Installed on DIII-D." The prototype is a close match to the baseline ITER design, including path length and number of optics. It is able to meet ITER's density measurement requirements with demonstrated phase resolution of 0.05° and 1.9° for the polarimeter and vibration compensated interferometer respectively. The ITER target values are 0.1° and 10°. Density measurements are in excellent agreement with other DIII-D diagnostics. Real time feedback alignment of both the plasma and reference legs was needed to achieve these results. Experience with the prototype points to several significant improvements for optimization of the ITER design. The report is currently under review at PPPL.

ITER & TOKAMAKS (R. NAZIKIAN)

Two presentations were made this week at the 15th IAEA technical committee meeting on energetic particles in magnetic confinement systems, held at PPPL. The presentations focused on the notable outcome for PPPL to predict energetic particle transport by Alfven eigenmodes in DIII-D. Dr. V. Duarte gave an invited talk titled "The Likelihood for Alfvénic instability bifurcation in experiments." The speaker focused on progress made at

PPPL, in collaboration with IFS, to develop a criterion for predicting the breakdown of energetic particle diffusion models in tokamaks. The work produced an analytical

criterion, based on the scattering of energetic particles by turbulent fluctuations, that explains why NSTX-U discharges have chirping frequency Alfven waves with convective fast-ion loss while DIII-D discharges predominantly have slowly varying frequency Alfven waves with a diffusive loss. This work is instrumental in identifying the applicability of quasi-linear diffusion models in future experiments and in predicting regimes of strong nonlinear behavior.

Nikolai Gorelenkov presented a complimentary talk titled "Resonance line broadened quasilinear (RBQ) model for fast ion Alfvenic relaxation." The talk outlined the successful demonstration of the reduced transport model for interpretive and predictive analysis of DIII-D plasmas with enhanced fast-ion transport by Alfven eigenmodes. The RBQ model assumes fast-ion transport is diffusive in phase space, consistent the slow variation of the mode frequencies. The RBQ calculation provides the probability density functions needed by the TRANSP code to perform interpretive and predictive modeling of fusion devices such as DIII-D. The model implementation in TRANSP will be used to design advanced scenarios with improved fast ion confinement for the next DIII-D experimental campaign.

DIII-D (B. Grierson)

Research:

Nikolas Logan traveled to PPPL to work with Zhirui Wang and Jong-Kyu Park to help develop a new resistive MHD stability code to assess the effect of 3D fields on the plasma. The work involves coupling the new resistive DCON code to the Generalized Perturbed Equilibrium Code (GPEC) to evaluate the relevant metric for predicting island formation by error fields, as well as to assess the resonant and nonresonant components of magnetic braking. The code was successfully benchmarked with the ideal MHD version of GPEC and is now ready to resistive effects.

Operations:

Two successful design reviews were held by Peter Fisher (PPPL student intern) at DIII-D, one covering the TF reversing switch to introduce the concept to the DIII-D operations community. Many useful comments and ideas were listed involving interlocks, diagnostics, and run parameters. The switch will enable TF reversal between shots. The

second design covered removable decks for one of the neutral beams. Fisher's design provided a drop-in-by-crane deck structure needing only a few bolts to secure it.. Peter is now gone on to his undergraduate work at Princeton University.

ASDEX-Upgrade: (Maingi)

The powder dropper was pumped down for its first vacuum cycle last week. After a couple of days baking to 100-150C, it's ultimate pressure reached 1E-6 Torr, with no leaks found via helium leak check, just outgassing contributing to the base pressure. This unit was vented and the finish wiring and the flow meter are being added. The unit will ship to Germany the week of 9/18 for installation the week of 9/25.

ADVANCED PROJECTS (H. NEILSON)

Stellarators (D. Gates)

S. Lazerson attended the at the 16th Latin American Workshop on Plasma Physics, held 4-8 September in Mexico City. His plenary talk, "Review of the Wendelstein 7-X Experiment," addressed stellarator physics, the W7-X experiment, the first experimental campaign on the device, and recent results from OP1.2. The talk was well received and was of general interest to the physics community.

THEORY (A. BHATTACHARJEE)

The 15th International Atomic Energy Agency (IAEA) Technical Committee Meeting on "Energetic Particles in Magnetic Confinement Systems" was held at PPPL. Presentations given by the members of the Theory Department include: a) N. Gorelenkov, poster, "Resonance line broadened quasilinear (RBQ) code for fast ion Alfvénic relaxations"; b) N. Gorelenkov, invited talk "Summary of Highlights of the Theoretical Presentations"; c) V. Duarte, invited talk, "Likelihood for Alfvénic instability bifurcation in experiments"; d) G. Meng, poster, "Resonance frequency broadening of wave-particle interaction in tokamaks due to collision and micro-turbulence"; e) C. Liu, poster, "Excitation of whistler waves and magnetized plasma waves by runaway electrons in tokamaks"; f) M. Schneller, poster, "Investigation of Energetic Particle induced Geodesic Acoustic Modes"; g) J.B. Lestz, poster, "Energetic-particle-modified global Alfvén eigenmodes"; h) C. Liu, poster, "Excitation of whistler waves and magnetized plasma waves by runaway electrons in tokamaks"; i) E.V. Belova, invited talk, "Numerical simulations of GAE stabilization in NSTX-U"; j) M. Schneller, poster, "What shapes the radial structure of energetic particle induced geodesic acoustic modes?"; k) G-Y. Fu, poster, "Low-Frequency Fishbone Driven by Passing Fast Ions in Tokamak Plasmas". The conference website is: https://iaea-ep-tcm-2017.pppl.gov/index.html

Peter Damiano, PPPL Theory Department, gave a "Research & Review Seminar" on 8 Sep. titled "Alfvénic Aurora: An overview". A copy of the presentation is available on

the Theory Department Webpage,
http://theory.pppl.gov/news/seminars.php?scid=2&n=rr-seminars

ENGINEERING & INFRASTRUCTURE (V. RICCARDO)

Control and Data Acquisition (CODAC)

The CODAC group made progress on EPICS software development for the OH Water Preheater System. Three EPICS operator displays were created, and the database that integrates the Water Systems PLC and the EPICS was made using VDCT (visual editor). Remaining software work includes integration into the EPICS alarm and trending applications, and archiving data to MDSplus (shot data storage).

The group completed fabrication and deployment of the Clonezilla Image Server with RAID1 disks. With this server, a bare metal backup where the entire system disk is backed up, any Windows or Linux computer that is connected to the PPPL network can be backed up.

This report is also available on the following web site:

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