PRINCETON PLASMA PHYSICS LABORATORY
WEEKLY highlights

PPPL
U.S. DEPARTMENT OF ENERGY

The PPPL Highlights for the week ending June 26, 2015, are as follows:

NSTX (M. ONO):

The paper, "The contribution of radio-frequency rectification to field-aligned losses of high-harmonic fast wave power to the divertor in the National Spherical Torus experiment" by R. J. Perkins, (PPPL) et al. was published by Physics of Plasmas 22, 042506 (2015) (http://dx.doi.org/10.1063/1.4916034). The High Harmonic fast wave (HHFW) heating system on NSTX has been known to suffer from parasitic absorption of fast-wave power in the SOL, resulting in a relatively large heat flux on the outer divertor. The paper explores the possibility that RF rectification is the mechanism responsible for converting HHFW power into the observed heat flux. An expression for the heat flux delivered to a material surface in the presence of an RF voltage is developed and applied to Langmuir probe data from the outer divertor. Estimates of the RF voltage and heat flux are made and compared to infrared camera measurements of the heat flux. Unfortunately, due to toroidal separation of the measurement locations and the non-axisymmetric nature of the losses, a rigorous comparison cannot be made at present; however, extrapolations of the existing data do suggest that the heat flux estimates based on probe data compare favorably with the IR camera measurements. This suggests a promising experiment on NSTX-U, where a wide-angle IR camera view of the divertor and a new dedicated set of Langmuir probes will provide an opportunity for rigorous validation.

S. Sabbagh (Columbia University) led the Disruption Prediction sub-panel at the DOE Workshop on Transient Events (June 8–11). The workshop brought together efforts by six subpanels and the fusion community over the past several months to prepare a final document summarizing suggestions for research programs to solve disruption and ELM issues in tokamaks - considered high priority by the FESAC Strategic Planning Priorities Assessment in 2014. The Disruption Panel, consisting of three sub-panels (Prediction, Avoidance, and Mitigation) reviewed draft documents on each topic and brought in further community input and comments on the documents, to prepare for final document compilation.

Installation of support stand for UV spectrometers at Bay "E" started this week, expected completion June 24. The Divertor Tangential Imaging diagnostic was disassembled after its test fit. Parts are awaiting vacuum preparation and final welding. Fabrication of Bay "H" infrared camera brackets continues in the PPPL shops. Drawings for the Bay "G" IR camera brackets were completed. Drawings for the divertor SPRED stand and flight tube were completed.

Recovery from an external arc fault at the Ohmic Heating (OH) coil terminals continued this past week. Reassembly of the OH Cooling Tubes in the upper and lower umbrellas is in progress, and the final design for the lower OH Ground Plate and for the potting of the OH Coil Coaxial

Connection has been completed. A pre-operational test procedure to document resistance measurements of TF flex bus assemblies has been performed, and previously made up joints were found to be within specifications and will be reinstalled as is. A new procedure to verify in-situ high current bolted joint integrity is being developed, and will be performed during reassembly. The vacuum bake of the bay F and Bay K Lithium evaporator (LITER) probes was completed, and the probes have been inserted into the NSTX-U vacuum vessel to successfully complete alignments. The probes have now been temporarily removed from the vessel to be prepared for permanent installation/welding. Dummy load testing of the FCPC rectifiers resumed this week on parallel TF Rectifiers, and recommissioning of the auxiliary systems for the Resistive Wall Mode (RWM) Coil Switching Power Amplifiers (SPAs) continued to make good progress. Alignments of the Multi-Pulse Thompson Scattering (MPTS) diagnostic flight paths continue. Electrical insulation tests (Hi-Pots) of the probe rack for the Purdue MAPP diagnostic have been successfully completed.

ITER & TOKAMAKS (R. HAWRYLUK):

DIII-D (R. Nazikian):

N. Gorelenkov and G. Kramer visited DIII-D to discuss the analysis of high qmin steady state plasmas for Alven eigenmode induced fast ion transport. N. Gorelenkov presented a talk at the June 26 science meeting showing that the fast ion critical gradient model can account for about 50% of the beam ion loss in plasmas with strong Alfvenic mode activity. Further analysis is planned to identify the modes from internal measurements of temperature and density perturbations and to compare to other models of fast ion transport.

B. Grierson and OMFIT developers have implemented a new equilibrium analysis tool to produce error estimates for quantities such as P’, FF’, current density, q-profile and shear by Monte-Carlo trials on the input data. Given an EFIT reconstruction, the measurements (magnetics, MSE pitch-angles, diamagnetic flux, etc.) and constraints (pressure, edge current density) are randomly varied within their uncertainties, and a new equilibrium produced. This workflow provides an arbitrary number of EFIT reconstructions that satisfy the measurements, as well as an ensemble mean and standard deviation. These equilibria are being used for uncertainty quantification for transport model validation in DIII-D ITER Baseline discharges with dominant electron heating by constructing a set of TGYRO solutions using TGLF+NEO with perturbed equilibria.

In her first two weeks as an intern working with A. Nagy, Madeline Vorenkamp made significant progress testing a new photo diode detector for counting granules dropped by the LGI. This system replaces the bulky camera setup used previously. It consists of a collimated LED source projected through a .004-inch slit in the granule drop tube, illuminating a photodiode. As the granules fall past the slit the photodiode signal is modulated. By analyzing these voltage trends, the rate of granule injection can be determined. Vorenkamp was tasked with designing and machining the fixture that holds all of the system components. The first trials were a success. Glass granules as a proxy for lithium were hand dropped through the tube. System refinements are in progress. The photodiode sensitivity and the intensity of the LED source need to be optimized. Also a piezo-dropper will be installed to release the granules at a more steady rate. Vorenkamp is currently a junior in the engineering department at the University of San Diego.

ADVANCED PROJECTS (H. NEILSON):

S. Lazerson presented "Improvement of energetic particle confinement through stellarator optimization" at the European Physical Society's Conference on Plasma Physics in Lisbon, Portugal. In this work the NCSX fixed boundary equilibrium (LI383) was investigated for modification, which would improve energetic particle orbits. The newly coupled STELLOPT and BEAMS3D codes were used to calculate the collisionless gyro-center orbits of alpha particle analogues in NCSX. Using 10,000 particles launched from the core of the plasma it was shown that the majority of lost particles were originating from mainly those having large perpendicular energies. Focusing on this subset of particles, the STELLOPT code was used to reduce the particle losses from 15% loss to 10% loss. This was accomplished using 10,000 processors on the Hydra supercomputer at the Max-Planck Institute for Plasma Physics.

THEORY (A. BHATTACHARJEE):

On June 25, B. Scott presented a theory seminar on total-f electromagnetic gyrokinetic computation and the status of the FEFI code: The tokamak edge layer is simulated using a total-f electromagnetic gyrokinetic field theory model based on a Lagrangian designed to capture shear-Alfven (reduced) MHD and equilibrium flows on a banana width scale. At small scales it reduces to conventional form for small fluctuations. Polarisation and induction are fully nonlinear. Full Hamiltonian support including conservation laws is rigorously maintained. A nonlinear collision operator is used. Conservation laws are computationally verified. The bracket structures are discretised with an Arakawa method, while the collision operator is finite-volume. The time step uses the RK4 method. The axisymmetric version is used to study neoclassical physics in the context of a self-consistent MHD equilibrium. The main object of study is the collisionality scaling of the bootstrap current. Issues involving the presence of the Pfirsch-Schlueter current and magnetic field perturbations are addressed, mainly the shift of the distribution function in velocity space. Also addressed is the temperature contrast, according to which velocity space must be wide enough on the hot side and also sufficiently resolved on the cold side of a zone with steep temperature gradient. Ongoing attempts to establish a comprehensive equilibrium and turbulence model are described.

A paper by J. Breslau and A. Bhattacharjee entitled "Wall-touching kink mode calculations with the M3D code" was published online in Physics of Plasmas, volume 22, p. 062506. The abstract is as follows: "This paper seeks to address a controversy regarding the applicability of the 3D nonlinear extended MHD code M3D [W. Park et al., Phys. Plasmas 6, 1796 (1999)] and similar codes to calculations of the electromagnetic interaction of a disrupting tokamak plasma with the surrounding vessel structures. M3D is applied to a simple test problem involving an external kink mode in an ideal cylindrical plasma, used also by the Disruption Simulation Code (DSC) as a model case for illustrating the nature of transient vessel currents during a major disruption. While comparison of the results with those of the DSC is complicated by effects arising from the higher dimensionality and complexity of M3D, we verify that M3D is capable of reproducing both the correct saturation behavior of the free boundary kink and the 'Hiro' currents arising when the kink interacts with a conducting tile surface interior to the ideal wall."

ENGINEERING AND INFRASTRUCTURE (M. WILLIAMS):

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

Construction: The vacuum vessel hi-pots are passing every morning. The revised upper OH ground strap has been installed and has passed inspection by the cognizant mechanical and electrical engineers. The adjusted OH compression ring has been installed and passed inspection by the mechanical and electrical engineers.

NBI: The N2C source installation was completed. The source has been pumped down and wired. BL1 liquid Nitrogen cool down is in progress.

DCPS/PCS: DCPS and PCS supported the remainder of dummy load testing this week. Dummy load testing for TF, OH, and PF has been completed. Preparations are underway to test SPAs in July. The PSRTC load algorithm was tested.

OFFICE OF COMMUNICATIONS (C. CANE):

J. Greenwald arranged for World Energy TV to interview S. Prager by phone in preparation for a possible five-minute video segment on PPPL to be shown at the World Nuclear Association Annual Symposium in London, England in September.

DIRECTOR'S OFFICE (C. AUSTIN):

On June 24, S. Prager, A. Cohen, M. Zarnstorff, S. Smith, and J. DeLooper traveled to DOE Headquarters in Washington, D.C. to participate in the annual Laboratory Plan Presentation. S. Prager and A. Cohen presented for PPPL.

On June 24, a colloquium entitled "External Propulsion and the Future of Space Access" was presented by Dr. Dmitriy Tseliakhovich of Escape Dynamics, Inc.

PUBLICATIONS:

Perkins, R.J.; Hosea, J.C.; Jaworski, M.A.; Ahn, J.-W.; Diallo, A.; Bell, R.E.; Bertelli, N.; Gerhardt, S.; Gray, T.K.; Kramer, G.J.; LeBlanc,B.P.; McLean, A.; Phillips, C.K.; Podestà, M.; Roquemore, L.; Sabbagh, S.; Taylor, G.; and Wilson, J.R, "The Contribution Of Radio-Frequency Rectification To Field-Aligned Losses Of High-Harmonic Fast Wave Power To The Divertor In The National Spherical Torus Experiment," Physics of Plasmas 22, 042506 (2015) (http://dx.doi.org/10.1063/1.4916034)

Breslau, J.; and Bhattacharjee, A., "Wall-Touching Kink Mode Calculations With The M3D Code," Physics of Plasmas, volume 22, p. 062506

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