PRINCETON PLASMA PHYSICS LABORATORY
WEEKLY highlights

PPPL
U.S. DEPARTMENT OF ENERGY

The PPPL Highlights for the week ending September 18, 2015, are as follows:

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

Diagnostics:

RAMI Training for all PPPL-US ITER Diagnostic projects occurred on September 15. The training was provided by Lee Cadwallader from Idaho National Laboratory and provided an overview of the RAMI process and requirements related to ITER.

Mark Smith completed several UP14 and Upper WAV specific Maxwell transient EM simulations. Benchmarking and troubleshooting of these results is underway. TNO developed a 3D model of the optical path (from the port plug to the port cell), which is essential for evaluating space claim issues and ensuring the system meets the measurement requirements.

A working prototype of the LP12 RGA heated aperture pipe will be fabricated as part of the RGA R&D testing. After heating/baking tests are concluded, the pipe will be connected to the RGA Prototype system for conductance/performance tests. A subcontract was just awarded to THERMOCOAX to fabricate this heated pipe, with delivery expected near the end of CY15.

Steady State Electric Network (SSEN):

Preparations are underway for award of contract for Reactive Power Compensators procurement.

“Release for Manufacturing” (RFM) documents from Schneider Electric are being processed for Power Transformers procurement.

The department is arranging to obtain a replacement shipment of a LV control panel door for HV Substation Transformer Unit #4; the original door was damaged during shipment.

As-built drawings for HV Control & Protection I&C Cubicles (1,953 drawing sheets) were uploaded to the ITER drawing management system SMDD.

NSTX (M. ONO):

A “featured article” was published in the September 2015 issue of Nuclear Fusion: "Edge and SOL turbulence and blob variations over a large database in NSTX”, by S.J. Zweben (PPPL) et al., Nucl. Fusion 55 (2015) 093035. A a short description is also at:

http://iopscience.iop.org/collections?collection_type=FEATURED_ARTICLES&journal=0029-5515&subject=&online_date=all. This paper describes the range of variations in edge and SOL turbulence observed using a gas puff imaging (GPI) diagnostic in NSTX discharges. The database consists of 140 shots including Ohmic, L-mode, and H-mode plasmas measured during steady-state conditions (e.g. without ELMs). Turbulence quantities were evaluated using both cross-correlation analysis and blob tracking. Relative fluctuation levels varied from ~ 0.15–1.0, correlation times were ~ 15– 40 μs, correlation lengths were Lpol ~ Lrad ~5– 10 cm, and turbulence velocities were Vpol ~ 2±1 km s−1 and Vrad ~ 0. 5± 0.5 km s−1 outwards. These variations were evaluated with respect to both the global and local edge plasma parameters, and compared with simplified theoretical models.

An article, "Modeling the effect of lithium-induced pedestal profiles on scrape-off-layer turbulence and the heat flux width" by D.A. Russell (Lodestar), et al., has just been published online in Physics of Plasmas 22, 092311 (2015) and may be viewed at http://dx.doi.org/10.1063/1.4930285. The effect of lithium wall coatings on scrape-off-layer turbulence in NSTX is modeled with the Lodestar SOLT code. The work focuses on two NSTX discharges occurring pre- and with-Li deposition. The simulation density and temperature profiles are constrained, inside the last closed flux surface only, to match those measured in the two experiments, and the resulting drift-interchange-driven turbulence is explored. The power entering the SOL measured in the experiments is matched in the simulations by adjusting "free" dissipation parameters. At power-matching, (a) the heat flux SOL width is smaller, as observed experimentally, and (b) the simulated density fluctuation amplitudes are reduced with Li. The instabilities and saturation mechanisms that underlie the SOLT model equilibria are also discussed.

On September 16, R. Hawryluk, J. Menard, and S. Kaye of PPPL visited FermiLab in Batavia, Illinois to discuss with the scientific and technical personnel their experience setting up their Remote Operations Center (ROC) and how they approach collaborative research. The FermiLab group is part of an international collaboration on the Compact Muon Solenoid experiment on the Large Hadron Collider and is the host institution for the U.S. CMS team. Their experience can help in developing our plans for Remote Control Rooms for future ITER collaborations, as well as helping us optimize our approach to collaborative research on NSTX-U. We heard presentations by a number of FermiLab personnel on the CMS (and earlier CDF) collaborations, their LHC Physics Center (LPC), computing facilities and plans, and how they developed their approach to setting up their ROCs for the CMS and for the four neutrino experiments with which they are involved. We were also given tours of the two ROCs. These presentations and discussions helped us understand both the similarities and differences in our requirements for remote participation. Later in the day, Menard gave a general introductory talk on fusion energy research, with emphasis on work being done at PPPL, to the FermiLab physicists. The talk was attended by approximately 15 scientists, and it engendered many questions and much discussion. The trip was useful, and we plan to have follow-up on discussions in the future with the FermiLab personnel to get their input on our plans once they are better developed.

J. Menard (PPPL) visited the University of Wisconsin - Madison on September 14-15 to give a plasma physics seminar entitled "Progress and plans for NSTX Upgrade and prospects for next-step spherical tori", meet with UW scientists, and visit local plasma research facilities.

Nuclear Fusion recently published a list of their most popular work published since 2011. This

list comprises 21 of the most highly cited articles. Among the list were five NSTX related articles: “The dependence of H-mode energy confinement and transport on colliisonality in NSTX” by S.M. Kaye (PPPL) et al., “Overview of the physic and engineering design of NSTX-upgrade” by J.E. Menard (PPPL) et al., “The effect of progressively increasing lithium coatings on plasma discharge characteristics, transport, edge profiles and ELM stability in the National Spherical Torus Experiment” by R. Maingi (PPPL) et al., “Taming the plasma-material interface with the ‘snowflake’ divertor” in NSTX by V. Soukhanovskii (LLNL) et al., and “Heuristic drift-based model of the power scrape-off width in low-gas-puff H-mode tokamaks” by R.J. Goldston (PPPL).

ITER & TOKAMAKS (R. HAWRYLUK):

DIII-D (R. Nazikian):

B. Tobias traveled to PPPL this week to deliver a seminar summarizing recent TRANSP analysis and experimental data on momentum transport due to the formation of coupled magnetic islands in DIII-D.

A. Nagy and W. Brown tested and installed a new electric granule impeller motor for the LGI, replacing the older air motor design. A small permanent magnet bushless motor was chosen that fits well into the space used for the air motor. The tests were successful and the speed control was accurate. The electric motor ramps from 0 to full 10kRPM in 500-600 ms, requiring no warm up time as with the air motor. Testing also showed that variations in motor speed are possible during a shot. This could enable injection velocity sweeps in a single discharge.

C-Mod (A. Diallo):

A. Diallo had a two-day visit at MIT to discuss recent ELMy experiments with Seung-Gyou Baek, Jerry Hughes, and Ted Golfinopoulos. The work is aiming to elucidate the physical mechanism at play prior to the ELM onset and extends previous work on the inter-ELM pedestal dynamics. In addition, Diallo met with John Walk in preparation for his experiment on high field ELMy discharges characterization.

International (L. Cui):

L. Cui has been performing TRANSP analysis for EAST discharges in order to understand the current profile evolution and assess the potential of these discharges for steady-state operation. The discharges are from the preliminary experiments performed at EAST where the loop voltage was reduced to near zero. TRANSP analysis was performed with the lower hybrid current drive module and extended by adding poloidal flux diffusion to investigate how the current profiles evolves to steady-state.

ADVANCED PROJECTS (H. NEILSON):

S. Lazerson participated in the first magnetic flux surface mapping experiments on Wendelstein 7−X using the U.S.-supplied trim coils. These measurements were attempted using a

configuration at low field (0.3 T) which placed a rotational transform (iota) = 1/2 surface in the vacuum flux surface region. Initial attempts to map flux surfaces proved difficult due to the low magnetic shear (nearly flat iota profile) of the configuration. Images suggest that in the good flux surface region, the electron beam that is used to map the field line trajectory is intercepted by the backside of the electron emitter after two toroidal passes. However, this did confirm that iota ≈ 1/2 was reached. It also allowed the team to examine the hysteresis present in the motions of the emitter arm. A new configuration with greater shear has been developed and will be tested in the coming weeks.

T. Brown attended the International Symposium on Fusion Nuclear Technology (ISFNT) in Jeju, South Korea and presented a paper, "Results of availability-imposed configuration details developed for K-DEMO." The paper describes results of a two-year effort in collaboration with South Korea's National Fusion Research Institute (NFRI) to develop a tokamak reactor design that fosters simplified maintenance operations. To minimize the number of in-vessel components, enlarged toroidal field coils were defined that allow large in-vessel modules to be removed or replaced. A semi-permanent shield structure provides labyrinth interfaces between shield modules, a means to align blanket components, and support against disruption loads. The design provides a disruption load path that transmits blanket, TF, and PF loads through a base structure. Blanket piping services and auxiliary systems that interface with in-vessel components have played a major role in defining the overall device arrangement. The work is being carried out under a Strategic Partnership Project (SPP) agreement between PPPL and NFRI.

The Laboratory is leading the final design of a TDU Scraper Element for Wendelstein 7-X (W7-X), in collaboration with Oak Ridge National Laboratory and Germany's Max Planck Institute for Plasma Physics (IPP). This week, it was reported that the CAD modeling of this component has been completed. A "collision check" performed by IPP confirmed that there are no spatial interferences between the scraper as designed and neighboring W7-X components. Material selection for key support elements was completed after analysis showed that the expected operating temperatures were compatible with stainless steel, avoiding the need for a more expensive molybdenum solution. Engineering analysis to validate the final design is under way and detail drawings for manufacture are now being prepared. A final design review is being planned for early November.

COMPUTATIONAL PLASMA PHYSICS GROUP (S. JARDIN):

S. Jardin attended the ITER Integrated Modeling Expert Group (IMEG) this week. It was announced there that the Integrated Modeling and Analysis Suite (IMAS) is ready to be distributed to the ITER parties, and PPPL has now begun preparations to install it on the local UNIX cluster. J. Chen, F. Poli, and R. Andre have recently developed translators to convert data from the native TRANSP data format to and from the ITER Data model, and this was presented at the IMEG meeting and has now been installed within IMAS.

OFFICE OF ACADEMIC AFFAIRS (N. FISCH):

On September 9, N. Fisch officiated as President of the Thesis Committee for the Ph.D. defense of Ms. Emelie Nilsson in CEA Cadarache. Her thesis, awarded by Ecole Polytechnique, was

carried out at CEA Cadarache, under the supervision of Dr. Yves Peysson. The thesis is titled: Kinetic modeling of runaway electrons in tokamak plasmas. Dr. Fisch also discussed a variety of topics in magnetic fusion with Cadarache scientists on September 9 and 10.

DIRECTOR'S OFFICE (C. AUSTIN):

On September 16, A. Cohen attended a Laboratory Operations Board meeting at DOE headquarters in Washington, D.C.

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