

PRINCETON PLASMA PHYSICS LABORATORY

WEEKLY highlights



The PPPL Highlights for the week ending March 27, 2015, are as follows:

NSTX (M. ONO):

Ryo Yasuhara from LHD in Japan visited PPPL from March 18-20. During his visit, he met with B. LeBlanc and A. Diallo of PPPL to discuss potential collaboration projects on the NSTX-U Thomson scattering system. Yasuhara is planning an extended visit at PPPL to collaborate with NSTX-U in the Thomson scattering group. Yasuhara and Diallo started developing the specifications for a prototype edge polychrometer for the Thomson system.

R. Kaita (PPPL) gave a colloquium lecture on fusion energy to science and engineering faculty and STEM (Science, Technology, Engineering, and Mathematics) students at Union University in Jackson, Tennessee on March 19. It included a discussion of the role of the spherical torus concept and NSTX in particular in the development of magnetic confinement fusion. He also taught a class on the nuclear physics of nuclear fusion.

The Digital Coil Protection System (DCPS) and the Power Supply Real Time Control (PSRTC) are complete and supporting Field Coil Power Conversion (FCPC) System dummy load testing. The crossover of data connections to integrate the integrated FCC and Junction Area DCPS's have been made, and combined, parallel DCPS pre-operational testing has been successfully performed.

Preparations for plasma operations in the NSTX-U configuration also continued with dummy load testing of the FCPC power supplies utilizing PSRTC, DCPS, and the new rectifier firing generators. Welding and vacuum leak checking of the coaxial lines for the deuterated trimethylboron (dTMB) system has been completed up the the NSTX-U vacuum vessel. NSTX-U coil water systems will be run this coming week to perform flow switch calibrations, and to polish the de-ionized water.

A TRANSP User's Group meeting was held at PPPL on March 23-24. The meeting brought together users from around the world, with representatives from the U.S. (NSTX-U, C-Mod, DIII-D, modelers from MIT and ORNL), Europe (JET, MAST/MAST-U, Asdex-U, EuroFusion), Asia (KSTAR, EAST) and ITER. Approximately 40 people attended on-site with approximately 15 people participating remotely. The purpose of the meeting was to discuss with present and potential TRANSP users and developers from around the world the present and future use of the code, including short-term and long-term upgrades to the physics modules as well as code modernization and framework. Specifically, a goal was to find out what upgrades would make TRANSP more valuable to the international community, including ITER, for both analysis and prediction. A further goal was to identify and encourage development external to

PPPL that could be used to enhance the TRANSP capabilities. The overall objective is to make the code more powerful and user-friendly. Talks were given by participants from each experimental device represented on how TRANSP is used at their facility including their future needs. Furthermore, talks were given on numerical frameworks and workflow managers. A strategic plan for TRANSP development both in the short (~years) and long- (~decade) terms, incorporating the input from the workshop, will be developed by July 1.

ITER & TOKAMAKS (R. HAWRYLUK):

DIII-D (R. Nazikian):

B. Grierson completed the second week of his visit to PPPL to attend the international TRANSP users group meeting and provide demonstrations of the OMFIT workflow for modeling tasks. The current application of TRANSP at DIII-D for interpreting experiments, and well as transport and equilibrium model validation was presented, with examples of time-dependent simulations of free boundary equilibrium and core profiles from TGLF for the DIII-D ITER Baseline. General Atomics researchers, Orso Meneghini and Sterling Smith, also presented the use of TRANSP for kinetic equilibrium reconstruction on DIII-D and NSTX using OMFIT.

C-Mod (S. Scott and S. Zweben):

Full spatial, angular, and optical-throughput calibration of the newly commissioned MSE background polychrometer is complete. Within measurement uncertainty of less than 0.03 degrees, the angular calibration depends only on the MSE viewing sightline (a dependence that was expected) with negligible dependence on photon detector or wavelength. The MSE background polychrometer is now fully operational under 'local' control. Analysis software is being written over the next month to accommodate the additional measurements provided by the system and is expected to be available when Alcator C-Mod resumes physics operations in late April or early May. Software to allow the MSE background polychrometer to be controlled remotely will be implemented over the summer.

S. Zweben has finished an analysis to compare the edge turbulence seen by two different detector arrays viewing the outer midplane GPI gas puff. The 9x10 APD array and the 64x64 Phantom camera pixel array generally showed a high cross-correlation in their time series ($\geq 90\%$), which is good. The turbulence scale lengths and velocities seen by these two detectors are within a factor-of-two of each other, but do show some systematic differences. The interpretation of these differences depends on the details of the gas puff size and viewing geometry, and is now being investigated.

ADVANCED PROJECTS (D. GATES):

The Laboratory has assumed leadership of the Wendelstein 7-X TDU Scrapper Element (TDU-SE) project following a successful preliminary design review on February 18. R. Strykowski was appointed as the U.S. Project Manager with the responsibility of leading the project to completion. D. Loesser has been appointed as the lead engineer. The aim is to deliver two TDU-SE units to the Greifswald, Germany project site by January 2017. A procurement action

for the graphite plasma-facing armor has been initiated and passed administrative reviews. A memorandum of understanding (MOU) among the project participants has been drafted and issued for comment. The MOU documents the U.S. deliverables, technical requirements, participant responsibilities, funding plan, and schedule. Once approved, it will establish the project performance baseline. While funding for the project has at this time not been approved by DOE, funds have been provided that enable the project to move forward with project planning and initiation of final design.

With the decision by DOE to award Wendelstein 7-X collaboration grants to MIT and Xantho Technologies, PPPL has taken steps to integrate these new projects into the U.S. Wendelstein 7-X program, acting in its role as lead U.S. lead institution for the collaboration. Information about the U.S. program was sent to the new Principal Investigators, and an orientation meeting was held with MIT, PPPL, and Max Planck Institute for Plasma Physics.

The physical alignment of the W7-X X-ray Imaging Crystal Spectrometer support structure was measured by IPP technical staff and found to be within specifications. Final alignment of the diagnostic sight-lines will be performed when the crystal and detector chambers are installed. Work is now proceeding to fabricate and deliver the remaining components of the diagnostic to IPP in Greifswald, Germany.

Masayuki Yokoyama visited PPPL from LHD for collaboration on the Task3D transport suite. Current and future work on measurements of heat transport and the radial electric field in LHD were discussed, along with the finalization of a collaborative paper to be submitted for publication.

THEORY (A. BHATTACHARJEE):

W.X. Wang attended the IAEA topical meeting on the theory of plasma instabilities in Frascati, Italy, and presented an invited talk on “Distinct turbulence sources and confinement feature in spherical tokamak plasma regime”. Two important turbulence sources newly found in ST regime through gyrokinetic simulations of NSTX experiments are drift wave Kelvin-Helmholtz (K-H) instability and collisional trapped electron mode (collisional-TEM). The topic discussed in the talk includes: how K-H mode and collisional-TEM are identified; what are their linear and nonlinear features; what roles they play in driving plasma transport for NSTX/U, namely, whether they drive experimentally relevant transport, and how they possibly contribute to transport scaling observed in STs. An interesting prediction of existence for a minimum plasma transport in advanced ST collisionality regime, and future experimental identification of K-H and collisional-TEM are also discussed.

On March 26, Alan Glasser (University of Washington) presented a theory seminar on resistive DCON, successful completion, benchmarks, and future plans. He described a new package of codes to determine the resistive MHD stability of toroidal plasmas. Resistive DCON solves for the ideal region matching data by an advanced singular Galerkin method. DELTAC solves the inner region resistive MHD equations to obtain the corresponding inner region matching data. MATCH combines these results to obtain a global solution for any number of singular surfaces. The code has been successfully benchmarked against the straight-through MARS-F code. The method is much faster and more accurate than any previous approach in the thermonuclear

regime. Plans are being formulated to incorporate additional physics in the inner region, including fluid, kinetic, and nonlinear effects.

ENGINEERING AND INFRASTRUCTURE (M. WILLIAMS):

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

Construction: The upper umbrella lid has been installed and torqued. The lower lid has been installed, the splice plates have been tack welded, and the lid has been removed so full welding can occur. The CHI bus installation has been completed. The cooling water hoses have been installed on the top and bottom of the machine. Kirk key installations in the Gallery have been completed. TIV and shutter air lines are being reinstalled. The RWM cables are being re-connected and re-supported. The water-cooled bus has been connected. Additional clamps are being designed and fabricated for the PF2 and PF3 terminals. Additional supports for the PF2 and PF3 cables are being designed.

CS Upgrade: The OH Water Heater vendor, Wattco submitted final documentation for review and approval. The lower lid welding and installation is underway as well as cooling water hose installation. PF2/3 supports are being fabricated for installation on March 28-29.

NBI Upgrade: The BL2 vacuum, IS and ID DI water, and LN are functioning. The LN cool down of BL2 is complete. The cryogenic startup of the LHe refrigerator is in progress and power supply work continues. The IS water system is being evaluated to consider options to increase pressure on the magnet pole lines. Management participated in the weekly IPT meeting.

Digital Coil Protection System: Dummy load testing resumed with both DCPS codes active and operational. Dummy load testing has challenged each by design with success. The parameter tree creation and concomitant utility development to support dummy load testing, ISTP, and Ops continues. Experience is being gained with the use of OP-DCPS-779 setup and startup procedure and run copies are tracking the current configurations. Spares are in development and testing. A new utility has been created to expedite DCPS PTP testing in the future and the Autotester has been modified to accommodate. A meeting will be held to discuss limits.

DIRECTOR'S OFFICE (C. AUSTIN):

On March 23-25, A. Cohen, S. Prager, M. Zarnstorff participated in Fusion Energy Sciences Meetings in Maryland and Washington, DC.

On March 25, Professor Herschel Rabitz from Princeton University presented a colloquium entitled, " Theoretical and Experimental Aspects of Controlled Quantum Dynamics"

On March 26, S. Prager, A. Cohen, and D. Boyle participated in Fusion Day in Washington, DC.

On March 24, John DeLooper participated in the Lab meeting for the DOE Science and Energy plan in Forrestal.

PUBLICATIONS:

M. Podestà, M. Gorelenkova, D.S. Darrow, E.D. Fredrickson, S.P. Gerhardt and R.B. White, Effects of MHD Instabilities on Neutral Beam Current Drive, PPPL-5094

N. Bertelli, E.F. Jaeger, J.C. Hosea, C.K. Phillips, L. Berry, P.T. Bonoli, S.P. Gerhardt, D. Green, B. LeBlanc, R.J. Perkins, C.M. Qin, R.I. Pinsker, R. Prater, P.M. Ryan, G. Taylor, E.J. Valeo, J.R. Wilson, J.C. Wright, X.J. Zhang, Full Wave Simulations of Fast Wave Efficiency and Power Losses in the Scrape-off Layer of Tokamak Plasmas in Mid/high Harmonic and Minority Heating Regimes, PPPL-5095

A. Diallo, R.J. Groebner, T.L. Rhodes, D.J. Battaglia, D.R. Smith, T.H. Osborne, J.M. Canik, W. Guttenfelder, and P.B. Snyder, Correlations between Quasi-coherent Fluctuations and the Pedestal Evolution during the Inter-ELM Phase on DIII-D, PPPL-5096

C.E. Kessel, J.P. Blanchard, A. Davis, L. El-Guebaly, N. Ghoniem, P. Humrickhouse, S. Malang, B. Merrill, N. Morley, G.H. Neilson, et al., Fusion Energy Systems Studies: Year-end Report on the Fusion Nuclear Science Facility, 2014, PPPL-5097

T. Abrams, M.A. Jaworski, R. Kaita, D.P. Stotler, G. De Temmerman, T.W. Morgan, M.A. van den Berg, H.J. van der Meiden, Erosion of Lithium Coatings on TZM Molybdenum and Graphite during High-flux Plasma Bombardment, PPPL-5098

T. Abrams, M.A. Jaworski, R. Kaita, J.H. Nichols, D.P. Stotler, G. De Temmerman, M.A. van den Berg, H.J. van der Meiden, T.W. Morgan, Modeling the Reduction of Gross Lithium Erosion Observed under High-flux Deuterium Bombardment, PPPL-5099

J.E. Menard, Z. Wang, Y. Liu, R.E. Bell, S.M. Kaye, J.-K. Park, and K. Tritz, Rotation and Kinetic Modifications of the Tokamak Ideal-Wall Pressure Limit, PPPL-5100

Masaaki Yamada, Jongsoo Yoo, Jonathan Jara-Almonte, William Daughton, Hantao Ji, et al., Study of Energy Conversion and Partitioning in the Magnetic Reconnection Layer of a Laboratory Plasma, PPPL-5101

William Berdanier, Prabir K. Roy, and Igor Kaganovich, Intense Ion Beam Neutralization using Underdense Background Plasma, PPPL-5102

Andrei Khodak, Michael A. Jaworski, Parametric Study of a Divertor Cooling System for a Liquid-Metal Plasma-Facing Component, PPPL-5103

W.M. Solomon, K.H. Burrell, M.E. Fenstermacher, A.M. Garofalo, B.A. Grierson, A. Loarte, G.R. McKee, R. Nazikian, and P.B. Snyder, Extending the Physics Basis of Quiescent H-mode toward ITER Relevant Parameters, PPPL-5104

Eun-Hwa Kim, Scott A. Boardsen, Jay R. Johnson, and James A. Slavin, ULF Waves at Mercury, PPPL-5105

Renaud Gueroult, David T. Hobbs, and Nathaniel J. Fisch, Economic Feasibility of Plasma Filtering Techniques for Nuclear Waste Remediation, PPPL-5106

Eun-Hwa Kim, Jay R. Johnson, Ernest Valeo, and Cynthia K. Phillips, Global Modeling of ULF Waves at Mercury, PPPL-5107

T. Stoltzfus-Dueck, A.N. Karpushov, O. Sauter, B.P. Duval, H. Reimerdes, W.A.J. Vijvers, the TCV Team, and Y. Camenen, R_x -Dependent Intrinsic Toroidal Rotation in the Edge of TCV, PPPL-5108

C. Leland Ellison, J.W. Burby, and H. Qin, Comment on 'Symplectic Integration of Magnetic Systems', PPPL-5109

E.L. Shi, A.H. Hakim, and G.W. Hammett, A Gyrokinetic 1D Scrape-Off Layer Model of an ELM Heat Pulse, PPPL-5110

R.J. Perkins, J.C. Hosea, M.A. Jaworski, J-W. Ahn, A. Diallo, *et al.*, The Contribution of RF Rectification to Field-Aligned Losses of HHFW Power to the Divertor in NSTX, PPPL-5111

S.J. Zweben, W.M. Davis, S.M. Kaye, J.R. Myra, R.E. Bell, B.P. LeBlanc, R.J. Maqueda, T. Munsat, S.A. Sabbagh, Y. Sechrest, D.P. Stotler, and the NSTX Team, Variations in Edge and SOL Turbulence in NSTX, PPPL-5112

C. Leland Ellison, J.M. Finn, H. Qin, and W.M. Tang, Development of Variational Guiding Center Algorithms for Parallel Calculations in Experimental Magnetic Equilibria, PPPL-5113

LEADERSHIP POSITIONS:

On March 25 and 26, John DeLooper participated as a member of the Operations Advisory Board for the Brookhaven National Laboratory.

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