

PRINCETON PLASMA PHYSICS LABORATORY

WEEKLY highlights



The PPPL Highlights for the week ending March 20, 2015, are as follows:

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

An 'Introduction to Value Engineering' workshop was organized this week with Bruce Lenzer from Jefferson Laboratory. Value engineering assessments of the US ITER diagnostic system components are required and this is the first step in the process. Engineers from General Atomics and the University of Texas will join PPPL staff for the introductory session.

The ITER Low Field Side Reflectometer (LFSR) team presented a new approach to alignment of the transmission line waveguide inside with that outside the port plug. The current concept uses a quasi-optical telescope with active alignment mirrors, but problems with low frequency signal transmission have arisen in the design. The new waveguide alignment system presented this week is more compact and does not sacrifice the low-frequency transmission.

In the ITER Toroidal Interferometer/Polarimeter (TIP) diagnostic, part of the laser beam is split and sent along a 'reference leg' before being combined with the beam that traverses the plasma - providing interference fringes to measure the changes due to the plasma. Space has been reserved in the diagnostic hall for this reference leg. The space reservation CAD model was transferred to the TIP design team at General Atomics.

The ITER ECE diagnostic system engineering progressed this week with the finalization of a concept for what is called the "Compliant Gas Seal". This set of flanges and bellows provides a mechanical and optical coupling between the US and India ECE components. The ECE signal is heavily attenuated by water vapor in normal air and the gas seal will be used to provide a rough vacuum to prevent this attenuation. The bellows also provides mechanical compliance as the port plug moves relative to the fixed interspace structures.

NSTX (M. ONO):

J. Menard (PPPL) presented the PPPL Science on Saturday talk on March 14 entitled "Scientific Opportunities and Challenges in the Upgraded National Spherical Torus Experiment". Several NSTX-U researchers participated in question and answer sessions during tours of the NSTX-U control room, test cell, and mock-up area. The presentation and NSTX-U fly-over movie are downloadable from:

http://nstx.pppl.gov/DragNDrop/Publications_Presentations/Presentations/2015/Science_on_Saturday_March14/

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. Testing of the rectifiers has been performed (with some outstanding items) on the TF, OH, PF5, and PF3U systems, and bi-polar (anti-parallel) rectifier control has been successfully demonstrated. Outstanding items (repairs) and system reconfigurations will be made in parallel with the redundant DCPS testing, and rectifier dummy load testing will resume next week.

Welding of the coaxial lines for the deuterated trimethylboron (dTMB) system continued this week, and control wiring is being installed. The installation of the gas delivery lines and gas injectors #1, 2 and 3 is in progress, as well as the connection of signals to the new Plasma Current (I_p) Calculator. The Coaxial Helicity Injector (CHI) Cap Bank is being reactivated, and preparations are being made for dummy load testing.

ITER & TOKAMAKS (R. HAWRYLUK):

Last week, R. Hawryluk participated in an ITER External Management Advisory Board meeting.

DIII-D (R. Nazikian):

W. Solomon presented a talk entitled, "Realization of the High Pedestal Pressure Super H-mode Regime" at this week's PPPL research meeting. The talk outlines the theory and observation of a bifurcation in the pedestal pressure at high electron density, resulting in the Super H-mode regime.

B. Grierson visited PPPL and presented a talk titled "Impurity transport in H-mode Plasmas Without ELMs" at this week's PPPL research meeting. While at PPPL, Grierson is also working with the Theory Department to apply the XGC0 and DEGAS 2 neutral modeling code to address main ion CER measurements in DIII-D and the GTC code to address momentum reversal in the core of DIII-D plasmas.

KSTAR (R. Ellis):

PPPL has shipped a steady-state, water-cooled fixed mirror to KSTAR for installation on the PPPL-designed and built 110GHz ECH launcher. This mirror was built using additive manufacturing, commonly known as 3-D printing, and will be the first use of this technology for heat-absorbing components in an ECH launcher. The mirror has passed a vacuum leak check at KSTAR, and the team there is preparing it for installation.

ADVANCED PROJECTS (D. GATES):

On March 20, the support structure for the W7-X X-ray Imaging Crystal Spectrometer (XICS) was installed on W7-X in Greifswald, Germany. The part appeared to fit correctly for the most part, with a slight non-conformance on the attachment flange that was welded on the W7-X vessel. The non-conformance is being studied to see if it is acceptable. The support structure is the first part of the diagnostic to be completed, having been fabricated at Carolina Fabricators in the US. The remainder of the diagnostic is expected to be shipped sometime in May. The XICS

diagnostic can measure both the ion and electron temperature profiles as well as the poloidal rotation and the absolute density of Argon.

THEORY (A. BHATTACHARJEE):

Members of the PPPL Theory Department attended the International Sherwood Fusion Theory Conference in New York City, N.Y. on March 16-18.

N. Fisch presented an invited talk "Alpha Channeling and Current Drive with Lower Hybrid Waves", with co-authors I. Ochs and N. Bertelli. An oral talk was also given by R. White, "Thermal Island destabilization and the Greenwald Limit", with co-authors, D. Gates and D. Brennan. The Theory Department's visiting postdoctoral researcher, Joaquim Loizu from Ecole Polytechnique Federale, Switzerland, presented an invited talk entitled "Computation of singular currents at rational surfaces in non-axisymmetric MHD equilibria".

Many others from the Department presented posters, as follows: F. Ebrahimi "Plasmoids formation during coaxial helicity injection experiments in the NSTX/NSTX-U", N. Gorelenkov "Fast ion distribution anisotropy and toroidal flow in plasma equilibrium models", R. Hager, "Total-f gyrokinetic study of the bootstrap current in the edge pedestal and a novel analytic formula", G. Hammett, "Scrape-off-Layer ELM Heat Pulse Results from the Gkeyll Discontinuous Galerkin Kinetic Code", S. Hudson, "A comparison of linear and nonlinear solutions of MHD equilibria in perturbed cylindrical geometry", S. Janhunen, "ITG turbulence in coupled XGC1-XGCa multiscale simulations", S. Jardin, "Self-organized stationary states of inductively driven tokamaks", J. Lang, "Electromagnetic modes in the edge gyrokinetic code XGC1 using gyrokinetic ion – fluid electron hybrid method", W. W. Lee, "Issues Related to Finite- β Gyrokinetics: 1) MHD and Equilibrium, and 2) Singularly Perturbed Equations", Z. X. Lu, "Effects of q-Profile structure on Intrinsic Torque reversals", E. Startsev, "Gyrokinetic simulation of the collisional micro-tearing mode instability", F. Wang, "Simulation of Fishbone mode driven by passing fast ions in HL-2A plasmas", and W. Wang, "Distinct turbulence sources and confinement feature in spherical tokamak plasma regime".

The Theory Department's visiting research scholars presented a poster: Vinicius Duarte, University of Sao Paulo, Brazil, "Nonlinear chirping structures and the regions of applicability of quasilinear theory" and Di Hu, Peking University, China, "Reconsidering the meaning of asymptotic matching".

Theory Department graduate students attended the conference. L. Ellison, presented a poster "Incorporation of Collisional Effects in Variational Algorithms for Test Particle Trajectories", and won a student poster prize for this work. E. Shi presented a poster, "Recent Results from the Gkeyll Discontinuous Galerkin Kinetic Code" and Q. Teng, presented a poster "A Simplified Simulation of Greenwald Density Limit".

On March 19, Liu Chen (UC Irvine and Zhejiang University) presented a theory seminar on spontaneous excitations of convective cells by kinetic Alfvén waves: Spontaneous excitations of electrostatic (ES) as well as magnetostatic (MS) convective cells by Kinetic Alfvén Waves (KAW) are investigated both analytically, via nonlinear gyrokinetic theory, and by numerical simulations. It is found that finite ion-Larmor-radius (FILR) effects play a crucial destabilizing

role in the excitation via modulational instabilities. Furthermore, ES and MS convective cells are intrinsically coupled and must be treated on an equal footing. Results of kinetic ion-fluid electron hybrid simulations show excellent agreements with theoretical predictions.

Also on March 19, Alex Zylstra (MIT) presented a theory seminar about studying inertial fusion and nuclear astrophysics with fusion-particle spectroscopy: In Inertial Confinement Fusion (ICF), spherical implosion compresses and heats the fusion fuel; sparking ‘ignition’, a thermonuclear burn wave and energy gain, is a goal of the National Ignition Facility (NIF). In these implosions, nuclear fusion reactions produce charged particles. In ignition experiments, the Deuterium-Tritium (DT) fuel produces alpha particles that provide bootstrap heating. Alternatively, surrogate implosions are filled with Deuterium-3He fuel (D3He), producing energetic protons for diagnostic purposes. Compact proton spectrometers have been developed for NIF. D3He-proton spectroscopy on surrogate implosions has been used to study NIF implosion physics and characterize implosion symmetry. Key results include observation of an anomalously early shock convergence for some implosions, and a disagreement between symmetry measurements and hydrodynamic growth models. At the OMEGA laser facility, the first high-precision measurements of the energy loss rate, or ‘stopping power’, of charged particles in dense plasmas have been performed. Charged particle stopping is key to interpretation of the implosion proton spectroscopy and modeling DT- α heating in ICF, part of the larger challenge of energy transport in the implosion. Nuclear diagnostics can also be used to study basic nuclear physics and nuclear astrophysics using implosions. The first plasma measurements of several reactions have been performed at OMEGA: the $3\text{He}+3\text{He}$ reaction, relevant to solar fusion, the $\text{T}+3\text{He}$ reaction, relevant to big-bang nucleosynthesis, and the $\text{p}+\text{D}$ reaction, relevant to protostars and brown dwarfs.

ENGINEERING AND INFRASTRUCTURE (M. WILLIAMS):

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

Construction: The Toroidal Field coil lead supports have been completed in the upper umbrella and those in the lower umbrella will be completed today. Strain gauges are being attached to the upper umbrella lid and the lid will be installed this week. Four of the mounting holes in the lower umbrella lid are being opened, and that lid will be installed March 21-22. The TMB coax line has been welded and leak checked up to the vacuum vessel. TMB control wiring has been completed. The installation of Kirk keys on the cages in the Gallery continues. The gas delivery lines are being leak checked. The CHI bus will be completed this March 21-22. Covers are being installed on the electrical tray on top of the machine. All open wall penetrations will be fire sealed March 21-22. All coils/bus and water systems in the NSTX Test Cell will be ready for a walk-down on March 23. Vessel hi-pots continue on a routine basis.

CS Upgrade: CS Upgrade: Installation of the OTF finger supports in the upper & lower umbrella continued. Drawing discrepancies for fasteners on the lower umbrella lid were found and are being reconciled. An ECN will be drafted to correct the drawings once reconciled.

NBI Upgrade: IS water reconnection took place and ion sources were filled. The flow switch pretesting is imminent. PLC control testing continues with much progress. The BL2 box Hi Vac pump down was completed with the turbo pump. Ion source gas injection system checkout has

started. The LHe refrigerator was configured to make liquid Helium. Leakchecking of the Helium process system continues. Another Helium shipment is expected this week. Power supply testing and tuning continues. Procurement of an IR camera is being evaluated. Management attended the weekly IPT meeting. Evaluation of scope completion is underway for project closeout.

Digital Coil Protection System: Hardware and software reconfiguration took place this week. Real-time system changes and troubleshooting problems were required. The TF < OH aquapoxy algorithm code is now deployed in both Systems. DCPS pretesting resumed in AT mode for both FCC and JA. Parameter tree creation and concomitant utility development to support dummy load testing, ISTP, and Ops continues. Dummy load testing is expected to resume this week and continue the week of March 23. Experience is being gained with the use of OP-DCPS-779 set up and startup procedure. Spares are in development and testing.

BUSINESS OPERATIONS (K. FISCHER):

A. Bleach attended the National Laboratory Chief Financial Officers (NLCFO) meeting in Washington D.C. this week.

K. Fischer and W. Myers attended the PERT Conference meeting in Las Vegas, Nevada this week.

BEST PRACTICES & EXTERNAL AFFAIRS (J. DELOOPER):

On March 19, over 450 young women in grades 7-10 attended the 14th annual Young Women's Conference in STEM. Over 70 exhibitors participated in the hands-on session. A group of panelists from Bristol Myers Squibb were on hand during the break-out speaker session to answer the young women's questions about how they started careers in science. Kamana Misra, neuroscientist and President of the Association of Women in Science (AWIS)- central NJ chapter, also participated as a break-out speaker with a talk titled "Getting nervous, the brain, the spinal cord and stem cells." The group went on various lab tours throughout Princeton University's main campus and ended their day with a keynote session given by Dr. Kersten Perez, physicist and Associate Professor at Haverford College. The 2015 Young Women's Conference in STEM was a huge success thanks to the help of over 75 volunteers from PPPL and Princeton University.

Best Practices provided DOE-PSO with an update of the progress towards the Lithium Independent Peer Review, tentatively to be held in the second half of June. Staff also prepared a rough draft of the PPPL Lithium Safety Program Description, in support of preparation for the review.

Best Practices also led the Root Cause Analysis of an incident involving a lead shield cart and resulting personnel injury. The report is being prepared.

DIRECTOR'S OFFICE (C. AUSTIN):

On March 19-20, A. Cohen participated in a National Laboratory Chief Operating Officers meeting at DOE in Washington, D.C.

On March 20, Dr. Martin Greenwald, Massachusetts Institute of Technology, presented a colloquium entitled, "20+1 Years of Research on the Alcator C-Mod Tokamak".

On March 20, S. Prager, M. Zarnstorff, D. Gates, J. Menard, C. Kessel, R. Maingi, R. Hawryluk and R. Majeski had onsite meetings at the Massachusetts Institute of Technology to discuss ongoing collaborations. R. Majeski presented a seminar.

This report is also available on the following web site:

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