



The PPPL Highlights for the week ending January 16, 2015, are as follows:

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

Number one of four 400kV transformers was the first 'exceptionally heavy load' to be delivered to the ITER site on a multi-wheeled trailer. There was a special gathering at the ITER site to celebrate this first such delivery. This delivery was one of many resulting from PPPL procurements of Steady State Electric Network components managed by C. Neumeyer.

The RF-DA introduced EPP11 Integration Tenant Request forms last month for submission this week. The US ITER Diagnostic RGA team submitted their forms and the Low Field Side Reflectometry team completed their drafts ready for review. Completion of these reports helped the DRGA and LFSR teams identify issues needing attention with integration into EP11.

A Statement of Work and a set of drawings were completed, and a requisition was placed for a manufacturability study and cost estimate for diagnostic shield modules for the equatorial and upper port plugs.

The current Low-Field-Side Reflectometer diagnostic system has seven microwave antennas. New EPP11 port integration studies are showing that, due to the size of the vacuum windows, only six antennae may be feasible.

The EP9 and ECE team developed an improved design for the ECE hot calibration source shutters. The new design moves the mirror tilt axis such that the reflecting surface of the calibration mirror will be better protected from dust and plasma deposition. The current actuation design may have to be altered for this new design to be realized.

A new thermal-hydraulic analysis of a detailed EP9 diagnostic shield model was completed this week. This model contains the pockets of Boron Carbide pellets that are needed for lightening the DSM while providing adequate nuclear shielding. The analysis shows that the B4C pellets at the front of the DSM get very hot because they cannot be cooled. The surrounding steel also gets very hot. As a result, the design team has decided to only use the B4C in the rear 2/3 of each shield module to avoid thermal problems.

NSTX (M. ONO):

The first preparatory "Pre-Forum" meeting for the upcoming NSTX-U Research Forum was held on Tuesday, December 16, 2014 at PPPL. Agenda items included discussions of the new

organizational structure including roles and responsibilities of the various groups, issues raised during the one-on-one discussions with new group leaders and University representatives, and the procedures for proposing a machine and experimental proposal. Topical science group leaders also presented initial/draft lists of Experimental Machine Proposals/ Experimental Proposals (XMP/XPs) topics/titles deemed necessary to re-commission systems and diagnostics and to cover approximately the first run-month of research operations. A more comprehensive Pre-Forum meeting #2 will be held on January 28-29 also at PPPL to discuss operational status of diagnostics and other systems, and to have additional discussion of preparatory XMP/XPs. Detailed information on both Pre-Forum meetings can be found at: <http://nstx-u.pppl.gov/research-forum/nstx-u-research-forum-2015/pre-forum-meetings>

A new postdoc, Dr. Gustavo Canal, has recently joined the General Atomics (GA) collaboration on plasma boundary interfaces and macroscopic stability at NSTX-U. Dr. Canal's graduate research focused on sawtooth generated magnetic islands and properties of the snowflake divertor in the TCV tokamak. He is currently familiarizing himself with codes and analysis tools at GA prior to the start of NSTX-U physics operations and will then move to PPPL as a fulltime onsite collaborator. (T. Evans, GA)

The Digital Coil Protection System (DCPS) and the Power Supply Real Time Control (PSRTC) development efforts are working towards the start of Field Coil Power Conversion System dummy load testing. PSRTC testing continues to make good progress with current and voltage control successful demonstrated for both unipolar and bipolar supplies, and in good agreement with 2009 ISTP test data.

Preparations of non-upgrade equipment for plasma operations in the NSTX-U configuration also continued. Reactivation and open circuit testing of the Field Coil Power Conversion System rectifiers has been completed, and preparations are underway to start dummy load testing. The D-Site Motor Generator Set #1 was successfully run to ~300rpm (adequate to support NSTX-U CD4 and FY15 operations) before the holiday and the vibration/shaft run-out measurements were found to be well within allowables. Dewars of helium have been loaded into the Neutral Beam Helium refrigerator and operations to liquify the inventory needed to support beam conditioning continues around the clock. Installation of fire protection systems for the new deuterated trimethylboron (dTMB) injection system is in progress, and installation of the Multi-Pulse Thompson Scattering (MPTS) diagnostic flight tubes continues.

ITER & TOKAMAKS (R. HAWRYLUK):

DIII-D (R. Nazikian):

B. Grierson led a half-day experiment to prepare target discharges for impurity transport studies in the hybrid scenario. The experiment is to determine the impact of the $3/2$ tearing mode on impurity accumulation. The $3/2$ mode commonly associated with sawtooth-free hybrid operation. Discharges were obtained with co- I_p and ctr- I_p ECCD to suppress and enhance the $3/2$ mode, as well as on-axis EC heating. Active tracking of the ECCD was used due to the motion of the $3/2$ surface.

Richard Fitzpatrick of the University of Texas, Austin, visited DIII-D to work with B. Tobias on understanding NTM coupling on DIII-D and to deliver a Friday science meeting presentation on the theory of nonlinear mode coupling in tokamaks. An application of this theory to the dynamic phase-locking of tearing modes has been developed and applied to DIII-D Microwave Imaging data.

Improvements made to boost signal to noise and eliminate interference for the Microwave Imaging Reflectometer on DIII-D have resulted in the first 2D reflectometer measurements of Alfvén eigenmodes obtained during the current ramp in neutral beam heated L-mode plasmas. This demonstration of the Microwave Imaging Reflectometer (MIR) as a density fluctuation diagnostic is the first milestone toward obtaining simultaneous MIR and ECE-Imaging data for Alfvén eigenmodes.

The Neutral Beam Local Control System upgrade and assembly is in progress. An electrical connection database has been developed to include all wiring and connection locations, labels, and needed details. There are 54 drawings planned, with 15 produced this week. The installation is scheduled for the next vent period.

A 3D CAD model is being developed of the Lithium Granular Injector (LGI) that is integrated into the polarimeter interface on the 285R0 location. This should allow the LGI to remain at the mid plane location. Several upgrades are planned for the LGI before it goes into this location in about one year.

ADVANCED PROJECTS (D. GATES):

The Support Structure Weldment for the Wendelstein7-X X-ray Imaging Crystal Spectrometer (W7-X XICS) was received from the manufacturer on January. This is the first of two major procurement packages for the W7-X XICS and is the current critical path item for installation of the XICS diagnostic in time for the initial operations of W7-X. The structure was manufactured by Carolina Fabricators in South Carolina to exacting material and manufacturing standards. Pending successful completion of onsite inspections, the structure will be shipped to Max - Planck-Institut für Plasmaphysik – Greifswald, Germany for installation on W7-X.

THEORY (A. BHATTACHARJEE):

On January 15, Matthew Kunz presented a theory seminar on kinetic and gyrokinetic astrophysical turbulence above and below the mirror and firehose stability thresholds: The solar wind is weakly collisional. As such, the particle populations that comprise it exhibit a variety of non-Maxwellian features, which are customarily described in terms of interspecies drifts and pressure anisotropies relative to the magnetic field direction. The solar wind is also turbulent, with a power spectrum extending over many orders of magnitude above and below the ion Larmor scale. These two facts, both well documented by the observational community, are not always treated on equal footing in concomitant theoretical work. Current gyrokinetic and reduced-MHD treatments of solar-wind turbulence take the plasma distribution to be Maxwellian. Analyses of pressure-anisotropy-driven Larmor-scale instabilities rarely focus on their contribution to the kinetic-scale turbulent cascade. These issues borne in mind, I will

present analytical and numerical efforts to construct a more suitable theoretical framework for describing inertial-range and Larmor-scale kinetic turbulence in non-Maxwellian astrophysical plasmas.

PLASMA SCIENCE AND TECHNOLOGY (P. EFTHIMION):

A paper by William Berdanier (The University of Texas at Austin), Prabir K. Roy (LBNL), and I. Kaganovich (PPPL) has been published in *Physics of Plasmas* [<http://dx.doi.org/10.1063/1.4905631>]. The authors show both experimentally and making use of particle-in-cell simulations that even an under dense background plasma with a small relative density can achieve high neutralization of intense ion beam pulses. This finding reduces requirements for plasma production in the drift section for the upcoming National Drift Compression Experiment (NDCX-II) at Lawrence Berkeley National Laboratory, where intense ion beams are focused onto a thin target to study Warm Dense Matter.

ENGINEERING AND INFRASTRUCTURE (M. WILLIAMS):

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

Construction: Leak checking of the vacuum vessel continues. The shims have been added to increase the compression of the upper and lower o-rings on the centerstack. Machining of spacers for the TF bus inside the umbrellas continues on two shifts. Final installation of TF flex bus is just beginning. Rework of the center TF lead extensions for the upper umbrella continues. All PF, OH and CHI bus are ready for installation inside the umbrellas. Electricians are fabricating a fourth MOV, installing MPTS electrical on the exit side (bay L), installing Kirk keys on the cages in the gallery, and finalizing wiring for the gas delivery system and the TIVs/shutters. Work continues on MPTS exit side parts in the Vacuum Prep Laboratory and the weld shop. The new upper umbrella lid has been trial fit and gussets for it have been tack welded in place and welding will be completed over the next several weeks. In addition, work continues on the gas delivery system piping.

CS Upgrade: The coil busywork insulation and testing continued in the CS winding area. There are only a couple of OH pieces and several CHI pieces that remain to be insulated and tested. The OH water heater drawings were received by PPPL this week. The drawing review revealed interferences out in the field that required some changes to the drawing. The marked up drawings have been transmitted to the vendor for implementation of the changes. Staff is working with the vendor of the OH high temp hoses to verify the maximum working pressure at 100 degrees Celsius. Initial tests at PPPL were lower than expected. Engineering has been working with construction crews to recommend changes to lead extensions hardware as problem areas are identified. All issues have been solved at this time, with over 75 percent of the joints having been fit up at least once. Testing of the super nut load versus torque were completed, and tests of the plugged and relocated fastener holes in the OTF lead extensions have been completed.

NBI Upgrade: VV leak checking continued with improved vacuum conditions noted. Turbomolecular pumps have been started in local mode. Services work remaining includes a platform step and elephant trunk stack stations and work is scheduled for the week of January 19.

NBI DI water system repair on the piping on the MER mezzanine continues. Power testing of M/Rs continues. Controls work and troubleshooting continues with installation of cable, trays, and terminations in NTC and gallery. Concrete work on the N gallery shield wall has started. Progress continues on BL PLC software pages. The cryogenics system helium gas operations continues and the refrigerator has made liquid briefly as a system check. The development of NB procedures continues and nears completion. Management participated in the monthly Integrated Team Meeting for the project.

Digital Coil Protection System: Integration of DCPS into PCS-FCC environment along with ACQ and NOS continued in conjunction with RTC but work for dummy load testing has highest priority. Testing continued in preparation for support of dummy load testing. The SDD reliability assessment document was approved. Work continues on the DCPS buffer chassis implementation. Consideration of parameter tree development to support PTP, dummy load, ISTP, and CD4 continues. Discussions about DCPS algorithm modifications for CD4 took place. Requirements for this change have been compiled. The final software build process is in progress. Work continues on the procedure for setup and daily startup of the DCPS system.

OFFICE OF ACADEMIC AFFAIRS (N. FISCH):

N. Fisch visited the Naval Research Laboratory on January 14-15. On January 14, he gave the NRL Plasma Physics Division Colloquium on "Wave Compression in Plasma."

DIRECTOR'S OFFICE (C. AUSTIN):

On January 13-16, A. Cohen conducted a staffing review for the ITER (IO) Organization in Marseilles, France.

A colloquium was presented on January 13 by Professor Alan Hirshfeld, Dartmouth, entitled, "Starlight Detectives: How Astronomers, Inventors, and Eccentrics Discovered the Modern Universe".

On January 14, S. Prager participated in the National Laboratory Director's Council meeting in Washington, D.C. The meeting was hosted by Secretary Moniz.

PUBLICATIONS:

Berdanier*, W. (University of Texas at Austin), Roy, P.K.; and Kaganovich, I., "Intense Ion Beam Neutralization Using Underdense Background Plasma," *Physics of Plasmas*, 22, 013104 (2015) [<http://dx.doi.org/10.1063/1.4905631>].

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

