The PPPL Highlights for the week ending March 6, 2015, are as follows:

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

R. Feder, A. Basile and A. Jariwala attended a weeklong IO-DI diagnostics meeting at the ITER site in Cadarache, France. There were many discussions but a major topic is finding ways for the Domestic Agencies to kick in more shared design effort for common components.

Hecate is a large SMP computing system at Princeton University, with 12 TB of available memory. Current Attila neutronics analysis on the very large ITER 40° full port models have been stressing our cluster at PPPL due to memory limitations. Attila has been installed and verified on the Hecate system using a simple benchmark problem. Full port plug neutronics analysis will be run in the near future.

The ITER Core Imaging X-ray diagnostic conceptual design featured a spectrometer located within the equatorial port plug. This is in the space between the rear of the diagnostic shield module and the closure plate. One concept for assembly and maintenance of this spectrometer is to install it as a module through a hole in the side of the port plug structure. PPPL engineers will be investigating, through structural analysis, whether suitably large openings can be cut without compromising the structural integrity of the plug.

NSTX (M. ONO):

The NSTX-U Research Forum for 2015 was held February 24-27, 2015 at the Princeton Plasma Physics Laboratory. The purpose of the Forum is to provide fusion researchers the opportunity to present ideas for experiments to be conducted on NSTX-U in the upcoming run and for theoretical work supporting NSTX-U. An important goal of the Forum is to produce a preliminary prioritization of experiments to be conducted during the research campaign. An overview plenary session was held on the first morning of the meeting and included presentations on: “NSTX-U 2015 Research Program Overview” by J. Menard (PPPL), “NSTX-U facility and diagnostic status” by M. Ono (PPPL), “MAST Upgrade: Status, plans and complementarity with NSTX-U” by A. Kirk (Culham Centre for Fusion Energy), “Status and Plans for DIII-D and General Atomics Collaborative Research Grants in Support of NSTX-U” by R. La Haye (General Atomics), and “Alcator C-Mod – Current status and plans and Collaboration ideas for NSTX-U” by B. Labombard (MIT). These presentations were followed by presentations on the agendas for the Boundary, Core, and Scenarios Science Groups. The next two days were comprised of Topical Science Group parallel meetings for Pedestal Structure and Control, Energetic Particles, and Advanced Scenarios and Control, Macroscopic Stability,
RF Heating and Current Drive, Materials and Plasma Facing Components, Divertor and Scrape-off Layer, Turbulence and Transport, Solenoid Free Start-up and Ramp-up, and the new Particle Control Task Force. In the afternoon of February 26, Science Group Parallel Sessions were held for Boundary, Core, and Scenarios to look for areas of proposal overlap and possible consolidation. On Friday, February 27, Science Group Summary presentations were held and a very preliminary run plan was presented. An updated preliminary run plan will be shared with the team later in March. The forum concluded with a Team Photo in the auditorium with a large fraction of the team able to participate. Forum presentations are downloadable from: http://nstx.pppl.gov/DragNDrop/NSTX_Meetings/Research_Forum/FY2015/Presentations/

Naoki Tamura of National Institute for Fusion Science, Japan visited PPPL/NSTX-U under the US-Japan personnel exchange program. He collaborated on the physics of non-local transport including the analysis of the TFTR data with E. Fredrickson (PPPL).

ITER & TOKAMAKS (R. HAWRYLUK):

DIII-D (R. Nazikian):

PPPL researchers participated in the DIII-D Research Opportunities Forum this week. A total of 37 ROF proposals were submitted from PPPL.

In-vessel measurement of the region viewed by the Microwave Imaging Reflectometer was performed on DIII-D. These 3D measurements of the antenna pattern and field of view provide data for the calibration of the ECE-I/MIR diagnostic. Alignment was improved over previous years, which was helped by the reinforcement and improved stability of the diagnostic platform.

I. Zatz visited DIII-D this week to review the installation of the NB330 pole shields. Irving was the project manager for producing four upgraded pole shields for NB330. The new copper pole shields include molybdenum tiles in the high heat flux zone.

A. Nagy and W. Brown emptied the Lithium Granule Injector of the left over granules from the run campaign. Inspection revealed that the dropper section was in good shape with little wear and no significant granule clumping. The LGI will be reconfigures for a smaller footprint for reinstallation on DIII-D in FY16.

International (G. Taylor):

On February 23-27 B. Ellis and G. Taylor visited KSTAR and the KSTAR Conference in Daejeon, Korea. On February 23-24, they visited the National Fusion Research Institute where they had two productive days of technical discussions regarding the KSTAR ECH and ICRF heating systems. During February 25-27, they attended the KSTAR Conference that was held this year in the Daejeon Convention Center. There was an extensive program of technical talks and poster papers on KSTAR-relevant research at the conference. During the conference Ellis and Taylor had several informal discussions with senior program managers at KSTAR and Ellis presented a talk entitled “Additive Manufacturing Techniques for KSTAR ECH Launcher Components”
ADVANCED PROJECTS (D. GATES):

On March 6, the first large component of the W7-X X-ray Imaging Crystal Spectrometer (XICS), the support structure frame, was shipped to IPP in Greifswald, Germany. The structure was inspected at PPPL and was found to sufficiently meet the requirements for installation on W7-X. The XICS will measure the plasma ion temperature by looking at the emission of Helium-like Argon. It is also capable of measuring the poloidal rotation, the electron temperature (as a back-up to Thomson scattering). It is now anticipated the entire system be delivered in May.

THEORY (A. BHATTACHARJEE):

On March 3, Matthew Beidler (West Virginia University) presented a theory seminar on the theory and simulation of incomplete reconnection during sawteeth due to diamagnetic effects: The sawtooth crash in tokamaks limits the core temperature, adversely impacts confinement, and seeds disruptions. Adequate knowledge of the physics governing the sawtooth crash and a predictive capability of its ramifications has been elusive, including an understanding of incomplete reconnection, for example, why sawteeth often cease prematurely before processing all available magnetic flux. I will introduce a model for incomplete reconnection in sawtooth crashes resulting from diamagnetic effects in the nonlinear phase of magnetic reconnection. Physically, the reconnection inflow self-consistently convects the high-pressure core of a tokamak toward the $m=n=1$ rational surface, thereby increasing the pressure gradient at the reconnection site. If the pressure gradient at the rational surface becomes large enough due to the self-consistent evolution, incomplete reconnection will occur. Predictions of this model are borne out in large-scale proof-of-principle 2-fluid simulations of reconnection in a 2D slab geometry and are also consistent with data from the Mega Ampere Spherical Tokamak. Additionally, I will present simulations from the 3D extended-MHD code M3D-C1 used to study the sawtooth crash in a toroidal geometry. As part of this study, I outline a method to identify the proper oblique plane in which reconnection takes place, and check it’s validity using 3D toroidal resistive simulations.

On March 4, Hans George Rinderknecht (MIT) presented a theory seminar on studies of ion kinetic dynamics in inertial confinement fusion implosions: Inertial confinement fusion (ICF) and high-energy density (HED) programs rely on hydrodynamic simulations to design and understand the results of experiments. However, recent experimental studies on the OMEGA laser facility have demonstrated that the hydrodynamic assumptions break down for the conditions relevant to the shocked central plasma of the ICF ignition design. In one study, implosions of thin-glass shells filled with various mixtures of deuterium and 3He gas showed anomalously reduced fusion yields and burn-averaged ion temperatures, and anomalous trends in the yields and temperatures as the deuterium concentration in the fuel was changed. The observed anomalies have been explained by invoking two ion kinetic mechanisms: ion diffusion and ion thermal decoupling. Results from experimental campaigns and simulations demonstrating the importance of kinetic physics in the evolution of ICF-relevant plasmas will be presented, and the relevance of these findings to ignition on the NIF will be discussed.
On March 6, E.-H. Kim presented Theory Department Research and Review Seminar entitled "Waves in the ion cyclotron frequency range at Earth and Mercury". Abstract reads: "The presence of different ion species has an influence on the plasma’s dispersion characteristics near the ion gyrofrequencies, thus new multi-ion resonances, such as ion-ion hybrid (IIH) resonance, are added with each additional ion species. When the frequency of incoming fast compressional waves matches the IIH resonance condition, wave energy from incoming fast compressional waves concentrates and mode converts to field-aligned propagation waves. In this talk, wave simulations using 1D and 2D multi-fluid wave code has been performed at Mercury and Earth. The results show that efficient mode conversion from the fast compressional waves to the ion-ion hybrid resonance occurs at Mercury and Earth; (2) At Mercury, such mode-converted waves globally oscillate similar to field-line resonance at Earth; and (3) At Earth, mode-converted waves could be localized near the magnetic equator. Thus it is suggested that the strong transverse component of observed ULF waves at Mercury in high magnetic latitude can be explained as excitation of the field-line resonant waves at the ion-ion hybrid resonance and the linearly polarized EMIC waves are externally generated via mode conversion."

ENGINEERING AND INFRASTRUCTURE (M. WILLIAMS):

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

Construction: Inner vessel hi-pots are being done on a routine basis, and results have been very good. Final installation of Toroidal Field (TF) bus inside the umbrellas continues. Work is 95% complete in the upper umbrella and 30% complete in the lower umbrella. Welding of the TF lead supports continues in the upper umbrella. The vessel has been vented for the final installation of diagnostics. Installation of CHI bus outside the umbrellas continues. Kirk keys are being installed on the cages in the Gallery. New Ohmic Heating cables are being installed from the bus tower to the Power Cable termination Structure. The installation of gas injection piping continues.

CS Upgrade: Fitup of the OTF lead extensions continued this week, over half the leads have been installed so far. Installation of the OTF finger supports in the upper umbrella continued. The dummy load tests of the FCPC power system upgrades continued.

NBI Upgrade: Ion Source and Ion Dump DI water system treatment and fill and flush has been completed. The ID has been reconnected to the beam lines and IS reconnection is imminent. Stack duct installation has been completed in the NTC and PLC control testing continues. A repair on the BL2C Source Isolation Valve has been started. M/R power supply testing and tuning continues on NB dummy load. Procurement of an IR camera for Bay L 7:30 port to view the armor is in progress.

Digital Coil Protection System: Dummy load testing PTP-ECS-039 continued with DCPS JA in full support. The action algorithm correction was tested and deployed for operations. Parameter tree development to support dummy load testing continues. DCPS extension and summing chassis implementation continues and installation is planned this weekend. OP-DCPS-779 set up and startup procedures was completed and approved. Spares are in development. The TF < OH aquapoxy algorithm development is in progress.
ENVIRONMENT, SAFETY, HEALTH & SECURITY (J. LEVINE):

A DOE team (Princeton Site Office and Chicago Office) performed a comprehensive review of the Laboratory's Respiratory Protection Program. A number of program strengths and good practices were noted, and some opportunities for improvement provided. A final report of the review is expected by the end of March.

BEST PRACTICES & EXTERNAL AFFAIRS (J. DELOOPER):

Professor Pau Steinhardt, of Princeton University, presented the Science on Saturday lecture on, “Once Upon a Time in Kamchatka: the Extraordinary Search for Natural Quasicrystals.”

DIRECTOR’S OFFICE (C. AUSTIN):

On March 4-6, M. Zarnstorff and H. Neilson attended the International Workshop on the Strategy of Stellarator/Heliotron Research in Nagoya, Japan. A total of four talks were presented on various part of the U.S. fusion sciences program. The workshop had talks by researchers from Australia, Germany, Japan, Russia, Spain, and the Ukraine. On March 2-3, M. Zarnstorff visited NIFS for discussions of experimental collaborations on LHD.

On March 3-5, A. Cohen Travelled to Cambridge, Massachusetts to participate in a Nuclear Energy Workshop at MIT.

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