Weekly HIGHLIGHTS

PPPL PRINCETON PLASMA PHYSICS LABORATORY

U.S. DEPARTMENT OF ENERGY

The PPPL Highlights for the week ending July 22, 2016 are as follows:

U.S. ITER FABRICATION (C. NEUMEYER):

Steady State Electric Network (SSEN):

Uninterruptible Power Supply (UPS) system and DC Distribution: Proposals were received and are under evaluation. Included were quotations for battery banks in support of an "Arrangement" document that will transfer procurement of the same to the ITER Organization. The objective is to sign the two contracts and the Arrangement prior to the end of FY2016 so that U.S. ITER can obligate the funds.

Power Transformers: Shipment of Lot #1 and Lot #2 oil-filled units (eight @ 35MVA and four @ 7MVA) from the Schneider Electric factory near Istanbul, Turkey is scheduled for August 24.

6.6kV Switchgear: Shipment of the remaining 110 cubicles in Lot #3 and #4 from the Schneider Electric factory in Manisa, Turkey, is scheduled for July 29. Inspection of packaging by our subcontract QC inspector was completed and the PPPL shipping release was signed.

Diagnostics:

Upper Port Wide Angle View Vis-IR Cameras (UWAVs): UWAVS held a three-day long peer review of the Optical-Mechanical System lead by M. Smith. Over 22 people participated in-person and remotely from six different institutions. Roger Reichle, the diagnostic TRO from ITER attended onsite. Also in attendance were experts from: ITER remote handling, assembly, diagnostics, optics, IR experts from Los Alamos and Max Plank Institute, along with several PPPL, GA, TNO engineers and physicists. Much productive discussion was generated resulting in actions, which aids in achieving a successful PDR scheduled for 2017.
Upper Port 11 and 14 Integration and DSM Engineering: Remote handling design and the engineering processes and procedures to verify compliance with ITER RH standards are new subjects for PPPL engineers. A. Jariwala, the lead project engineer for the Upper Port 11 and 14 integration engineering job, has taken the lead in working through this process of RH certification. This week, final mark-ups on the Plant Definition Form (PDF) and the Task Definition Form (TDF) has been received. These documents are part of the larger comprehensive Remote Handling Compatibility Assessment Report and are ready to file in iDocs and IDM for approval. Jariwala will continue to work through the ITER RH "learning curve" and then help to train the rest of the team.

Core Imaging X-Ray Spectrometer (CIXS): L. Delgado-Aparicio visited ITER and the new WEST tokamak ("Tore Supra upgrade" at CEA). He presented a talk on multi-energy SXR and HXR cameras for MCF plasmas entitled "Alternative method for measuring Te, nZ, dZeff and ne,fast." The abstract reads: "Scientists at ITER are recently considering several options for broadband X-ray diagnostic systems with the appropriate time, space and energy resolution. The possibilities of measuring the plasma emissivity at various energy ranges opens up an attractive alternative option for providing profile measurements of electron temperature, impurity density, contributions to Zeff and the fast electron distribution. The new results obtained by the PPPL's X-ray group aim at developing this soft- and hard X-ray capability for burning plasmas (ITER and beyond)."

L. Delgado-Aparicio visited the Microelectronics Institute of Barcelona at National Center of Microelectronics (IMB-CNM) in Spain. This large research facility leads the development of radiation hardened 3D silicon detectors for the high-luminosity experiments at CERN, currently providing pads, strips and pixel detectors for ATLAS, CMS and LHCb. The X-ray group at PPPL is actively searching for new detectors to be used at ITER (and beyond) for the development of X-ray crystal imaging spectrometers as well as soft and hard X-ray multi-energy arrays. The main concern is the extreme radiation hardness requirements which our future detectors will have to withstand, with a 1MeV neutron equivalent fluence of several times 1015 up to 1016 cm^{-2}. We are currently using Pilatus detectors, which might withstand a fluence of several times 1014 to 1015 cm^{-2}. We are thus interested in potential solutions for radiation hard semiconductor devices for very high luminosity using silicon (e.g. 3D detectors, oxygen enrichments techniques) and the possibility to use semiconductor materials other than silicon (e.g. diamond, silicon-carbide, semi-insulating GaN, CdTe and others). Scientists at the IMB-CNM are interested in providing 2D and 3D silicon and silicon-carbide sensors for fusion experiments, which we can test here at PPPL. First detectors can be ready by the fall and can be tested here at PPPL by the end of the year. We also received the recommendation of joining the CERN-RD50 collaboration on radiation hard semiconductor devices for very high luminosity colliders and attend their annual conferences.

NSTX-U (M. ONO):

A FY2016 NSTX-U plasma operations update: The department has completed 10.06 run weeks and 1066 plasma shots. The total operation target is 18 run weeks.

On July 17-21, J. Menard (PPPL) travelled to the United Kingdom to visit the Culham Centre for Fusion Energy (CCFE) to discuss future MAST-U/NSTX-U collaborations. Menard toured Tokamak Energy Ltd and gave a presentation entitled "First results from NSTX-U and some NSTX physics highlights." He heard presentations on the progress and plans for the Centre for Doctoral Training in the Science and Technology of Fusion Energy at the York Plasma Institute, University of York, and participated in the Research Councils UK Fusion Advisory Board (FAB) meeting, also hosted by the York Plasma Institute.

Z. Liu of ASIPP, China completed a one-year visit (PPPL-ASIPP post-doctoral exchange) to analyze NSTX data with the BOUT+++ code. He simulated a pre-lithium ELMy H-mode reference case, as well as a lithiated ELM-free H-mode. A small peeling/ballooning mode was

found for the discharge without lithium conditioning. The ballooning drive was larger than the kink/peeling drive for this mode, which appeared only with finite resistivity, suggesting a resistive ballooning mode. There was no sign of ITG. With lithium, no peeling ballooning mode was found, not even a resistive one, due to reduced gradients. The dominant instability was identified as drift Alfven waves. These results will be submitted to a journal, including a comparison with the use of lithium injection for improved ELM stability in D3D.

M. Ono (PPPL) visited the Center for Plasma-Material Interactions (CPMI), University of Illinois–Champaign campus on July 21-22 to discuss collaboration research on liquid lithium. He met with CPMI researchers and students including professors Daniel Andruczyk and David Ruzic, and visited facilities including the HYDRA and other CPMI facilities, the IGNIS facility, and Starfire Industries. M. Ono also gave a seminar entitled "NSTX-U status and plans."

The Liquid Lithium Filler for the LITER (LIFTER) is an apparatus for efficiently filling the Lithium Evaporators (LITERs) prior to their installation on NSTX-U. There is a LIFTER for each of the two LITERs used during lithium operations. Both LIFTERs were successfully filled with lithium under argon in the glove box in L-245, one of the rooms approved for lithium handling. They will be kept in the glove box until needed to fill the LITERs with lithium.

ITER & TOKAMAKS (R. HAWRYLUK):

DIII-D (R. Nazikian):

N. Logan has developed a new module within the OMFIT integrated modeling framework for preparing the inputs, executing the models, and visualizing the outputs of the Generalized Perturbed Equilibrium Code (GPEC) suite. This complements the recent public releases of profile, TRANSP and kinetic equilibrium analysis tools. It also furthers the capabilities of current users TRANSP to analyze the time dependent plasma response to 3D fields. This will see immediate application in calculating the time evolution of the plasma stability using DCON. In the long term, it will enable the integration of 3D plasma response and NTV torque with established TRANSP workflows.

C-Mod (L. Delgado):

L. Delgado-Aparicio attended the EPS Conference on Plasma Physics in Leuven, Belgium, and presented his results on "Locked-mode avoidance and recovery without external momentum input using ICRH." Delay of the mode onset and recovery from pre-existing locked-modes has been successfully obtained using Ion Cyclotron Resonance Heating (ICRH). The use of external heating concomitant with the $n=1$ error-field ramp-up resulted in a delay of the mode-onset avoiding the density pump-out and achieving high-confinement "H-modes." Heating the low-density plasma after the mode-onset was not conducive to an L->H transition but resulted in unlocking the plasma without external torque and obtaining co/counter-current flows at the edge/core. This simple heating technique could provide an important actuator to circumvent error-field-induced locked-mode disruptions in tokamak plasmas.

International (R. Maingi):

R. Maingi visited MIT on July 18 to plan collaborative work on the EAST device. Graham Wright and Leigh Ann Kesler reviewed progress on R&D to use Fluorine depth markers for tiles in devices like EAST where other low-Z materials are commonly observed/used. The plan is to use these depth markers to assess long pulse erosion rates in EAST. Schedule options for marker deployment and analysis schedules were identified, depending on EAST availability.

ADVANCED PROJECTS (H. NEILSON):

D. Gates and H. Neilson visited the DOE Fusion Energy Sciences office this week as members of a National Stellarator Coordinating Committee delegation. The team made a budget planning presentation, "Stellarator Program Vision," covering plans for the national Wendelstein 7-X collaboration and domestic experiments. Recent advances in stellarator theory and experiment have opened new opportunities for concept improvements needed for viable magnetic fusion energy (MFE) systems. These were highlighted in the presentation, as well as the research needs and a plan for a new initiative in stellarator theory and optimization that would lead to new experiments based on designs that exploit recent advances in physics understanding. The team argued for a bold initiative that would position the U.S. to influence the directions of fusion energy science in an era marked by new machines such as Wendelstein 7-X, JT60-SA, and ITER.

A new book, "Magnetic Fusion Energy: From Experiments to Power Plants," edited by H. Neilson, was recently published by Elsevier, Ltd. The book's nineteen chapters were written by international leaders in fusion research, including PPPL's M. Bell, S. Kaye, and R. Maingi, describing the key issues in fusion science and technology, while focusing on experimental devices, their contributions to the scientific foundations for ITER and their contributions to developing the basis for going beyond ITER. An introductory chapter by Neilson notes that "it is a reasonable approximation to say that progress in magnetic fusion research has been and continues to be paced by results obtained from a wide array of experimental facilities around the world."

THEORY (A. BHATTACHARJEE):

A week-long International Symposium on Gyrokinetic Particle Simulation in honor of W. Lee took place in University of California at Irvine on July 18-22 (http://www.physics.uci.edu/Lee-Symposium-2016/index.html). The symposium was organized by Zhihong Lin (UCI), Scott Parker (U. Colorado), and W. Tang (Princeton University/PPPL) with over 40 participants from the U.S., Canada, China, Germany, Italy, and Japan. There were about 30 talks and eight discussion sessions. The emphasis was on gyrokinetic theory and simulation and its coupling with MHD. PPPL participants included: S. Ethier, C. S. Chang, G. Fu, W. Lee, W. Tang, L. Shi, and G. Dong. A special journal issue for the symposium, possibly with Physics of Plasmas, is being planned.

C. Dong, who works with A. Bhattacharjee, is a NASA Jack Eddy Fellow in the Living with a Star program. C. Dong is a member of the Mavens Science Team, which recently received the RHG Exceptional Achievement Award for fundamental discoveries about the Mars environment from the Mavens spacecraft.

PLASMA SCIENCE & TECHNOLOGY (P. EFTHIMION):

Y. Raitses attended the International Congress on Plasma Physics Republic, June 27–July 1, in Kaohsiung, Taiwan where he gave a plenary talk entitled "Plasma Science of Hall Thrusters."

ENGINEERING & INFRASTRUCTURE (L. DUDEK):

Budget Office:

PPPL submitted ten proposals in response to Program Announcement, LAB 16-1592, Opportunities in Basic Plasma Sciences. Eight of the proposals are led by PPPL and remaining two are collaborations with LANL as the lead laboratory. A Strategic Partnership Project proposal was submitted to NASA. The proposal is titled "Laboratory Experiment on the Magnetic Reconnection Layer Supporting the Magnetospheric Multiscale Mission (MMS)." The Principle Investigator for this effort is M. Yamada. The proposed funding amount is $612,772 over a three year period.

COMMUNICATIONS & MEDIA RELATIONS (L. BERNARD):

The DOE's blog web site, energy.gov, featured a video from PPPL on a next generation centrifuge. The video, narrated by E. Gilson with text by J. Greenwald, shows the development of a new centrifuge that can separate nuclear waste.

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