Weekly HIGHLIGHTS

PPPL PRINCETON PLASMA PHYSICS LABORATORY

U.S. DEPARTMENT OF ENERGY

The PPPL Highlights for the week ending October 14, 2016 are as follows:

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

Steady State Electric Network (SSEN):

Uninterruptible Power Supply (UPS) and DC Distribution Contracts and Arrangement for Battery Banks and LV Distribution & Sub-Distribution Panels: Both contracts are signed and the kickoff meeting has been re-scheduled for October 18. Comments have been received from the IO legal team on the Arrangement for the transfer of the battery banks and LV distribution panels to the IO for procurement.

Power Transformers: Nearing completion on the planning, logistics and shipping documents related to shipment of Group 1 and 2 transformers (that comprise shipping lots one and two) from the Schneider Electric factory near Istanbul, Turkey. Packing lists and Pro forma invoices have been received. French customs approval process is underway.

Diagnostics:

Low Field Side Reflectometer (LFSR): An important design meeting was held this week between the PPPL LFSR design team and the RFDA EP11 integration team. The purpose of the meeting was to review progress in the design of LFSR interspace components with a focus on inspection and maintenance of vacuum windows and other safety critical components on the EP11 vacuum closure plate.

Motional Stark Effect (MSE): J. Klabacha and R. Feder visited Nova Photonics for a review of the MSE project and to visit some of the Nova Photonics testing labs. The MSE team is making good progress in optical-mechanical design, window and mirror cleaning testing and in physics system studies of measurement uncertainties.

Equatorial Port 9 Integration and DSM Engineering: DSM3 (TIP) is near the completion of the structural weight reduction and cooling design CATIA effort, allowing an updated weight assessment of the Port Plug assembly and readiness for neutronics analysis. CATIA concept modeling of a DSM4 port plug shield and interfacing water feedthroughs resumes to update Closure Plate design and refine configurations for neutronics analysis.

Core Imaging X-Ray Spectrometer (CIXS): For the CIXS nuclear detector testing at the LENS facility in Indiana University, the planned dates will be December 5 - 9. The testing will incorporate an ITER like neutron fluence that will allow us to observe the survivability of the

CIXS detector. Currently our colleagues at Indiana are planning this week on exposing a few activation foils to accurately calculate the neutron flux from the Beryllium source.

NSTX-U (M. ONO):

PPPL/NSTX-U researchers attended the First International "All-about-Divertor" Symposium on October 14 – 15, in Kyoto Japan, (link). This Symposium is intended to bring together some of the world experts on the development of plasma-facing components (both solids and liquid metal) with a new perspective as to how one can come up with a sensible PFC/divertor design for the DEMO reactors. Invited talks given by the NSTX-U researchers were "Advantages and challenges of liquid lithium based divertor" by M. Ono, "Fast flowing liquid metal development for fusion reactors" by E. Kolemen, and "Long-leg and liquid metal divertors for ST-based fusion facilities" by J. Menard. M. Ono served as a member of the international program committee for the symposium.

J. Menard (PPPL) traveled to the Culham Centre for Fusion Energy (CCFE) in the United Kingdom on October 3-5, to participate in a MAST-U Project status review and to attend the CCFE advisory committee meeting.

NSTX-U in-vessel diagnostic post-run calibrations and metrology have been completed. Lithium evaporator (LITER) probe alignments have also been checked and documented. The LITERs can now be removed from the vessel. The neutral beam (NB) #1 and #2 calorimeters have been removed from the test cell for maintenance and repairs. The NB #2 Calorimeter may be ready for reinstallation as early as next week. The dissection and forensics of the damaged PF1aU coil is in progress with the initial vertical cuts of coil insulation and conductor. Borescope inspections of individual conductor cooling paths is next. Preparation of a new PF1a coil mandrel is in progress in the shop. Work continues on the recommissioning of the coil winding facility with the successful testing of the curing oven thermocouples, and the ongoing testing of the HVAC system controls. A test stand is being prepared in the Field Coil Power Conversion building for individual coil power testing.

ITER & TOKAMAKS (R. HAWRYLUK):

DIII-D (R. Nazikian):

DIII-D discharges with negative central shear that were previously modeled with the GLF23 transport model are now being studied with TGLF to assess the turbulent instabilities and dominant transport suppression mechanisms. These conditions can exhibit ion ITB and relatively flat electron temperatures inside of q_{min}. In NCS discharges with rho(q_{min}) ~ 0.45 we applied the TGLF transport model and find that the region of deep negative shear is MHD interchange unstable, which appears to be responsible for the flat electron temperature. Near the rho(q_{min}), an ion ITB exists with transport near the neoclassical level. By systematically varying the magnitude of the ExB shear and magnetic shear in TGLF at the radius of the ITB, we find that the magnetic shear is responsible for approximately one third of the energy transport suppression, with the remaining suppression coming through ExB shear. Results of these studies will be presented at the APS-DPP Meeting in San Jose, California.

ADVANCED PROJECTS (H. NEILSON):

N. Pablant visited Japan's National Institute for Fusion Science (NIFS) to discuss participation and experimental proposals for the upcoming deuterium campaign on the Large Helical Device (LHD). The visit was also used to develop proposals for experiments for the next Wendelstein 7-X (W7-X) campaign, particularly the development of matching proposals for LHD and W7-X to facilitate cross-machine investigations. This visit was also important for discussions of neoclassical transport on W7-X, and in particular on the progress on neoclassical calculations performed by Dr. Satake using FORTEC-3D. This monte-carlo based technique currently provides the most complete treatment of neoclassical stellarator transport, plasma flow and bootstrap current production including non-local (finite gyro-radius) effects. These calculations utilize ion-temperature profiles from the XICS diagnostic (installed on W7-X by PPPL), and will be compared to both experimental power balance calculations as well as to 'local' neoclassical codes such as SFINCS (University of Maryland). While visiting NIFS, Pablant gave a seminar entitled "Plasma performance and initial confinement studies from the first W7-X experimental campaign." Pablant will return to NIFS in March of 2017 to participate in the LHD deuterium campaign and continue the detailed analysis of High-Te ECRH plasma experiments performed in previous experimental campaigns.

THEORY (A. BHATTACHARJEE):

L. Comisso, M. Lingam, Y. Huang, and A. Bhattacharjee published a Letter in Physics of Plasmas, titled "General Theory of the Plasmoid Instability", in which they derived a new theory of the plasmoid instability. The new theory differs from the previous ones as it fully takes into account the time evolution of current sheets. The scaling relations for the growth rate, number of plasmoids, aspect ratio, plasmoid width and onset time are obtained. They are shown to depend on the initial perturbation amplitude, the characteristic rate of current sheet evolution, and the Lundquist number. An important finding of this analysis is that the final results are *not* simple power laws. The detailed dynamics of the instability is also elucidated, and shown to comprise of a long period of quiescence followed by sudden growth over a short time scale.

On October 11, Lou-Chuang Lee (Institute of Earth Science, Academia Sinica, Nankang, Taiwan) presented a theory seminar on the generation of helium and oxygen electromagnetic ion cyclotron (EMIC) waves by the bunch distribution of oxygen ions associated with weak fast magnetosonic shocks in the magnetosphere. EMIC waves are often observed in the magnetosphere with frequency usually in the proton and helium cyclotron bands, and sometimes in the oxygen band. The temperature anisotropy (caused by injection of energetic ions or by compression of magnetosphere) can efficiently generate proton EMIC waves, but not as efficiently for helium or oxygen EMIC waves. A new generation mechanism is proposed for helium and oxygen EMIC waves associated with weak fast magnetosonic shocks. These shocks can be associated with either dynamic pressure enhancement or shocks in the solar wind and can lead to the formation of a "bunch" distribution in the perpendicular velocity plane of oxygen ions. The oxygen bunch distribution can excite strong helium EMIC waves and weak oxygen and proton waves. The dominant helium EMIC waves are strong in quasi-perpendicular propagation and show harmonics in frequency spectrum of Fourier analysis. The proposed mechanism can

explain the generation and some observed properties of helium and oxygen EMIC waves in the magnetosphere. The presentation can be found on the Theory Department website here.

BEST PRACTICES & EXTERNAL AFFAIRS (J. DELOOPER):

Science Education (A. Zwicker):

On October 6, Dominguez gave a TedX talk at TedXCESA titled: “Trayendo las Estrellas a la Tierra”. It was a general talk about the promise of fusion energy.

DIRECTOR’S OFFICE (C. AUSTIN):

On October 12, Dr. Alexei Sharov, National Institutes of Health, presented a colloquium entitled, “Estimating the Age of Life Using Moore's Law”.

The Laboratory Management Review meeting (LMR) was held on October 13. The LMR is a quarterly meeting at which PPPL department heads provide assessments of their departments.

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