



The PPPL Highlights for the week ending May 30, 2014, are as follows:

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

At a review of recent thermal analysis of the ITER low-field-side reflectometer front end components, it was shown that feasible cooling concepts now exist for both the single waveguide monostatic launcher/receiver and the bistatic, closely spaced and angled, bistatic pair of waveguides. Physics modeling needs to be completed to optimize the functionality of the seven available waveguides.

The present baseline design for the ITER electron cyclotron emission diagnostic features quasi-optical propagation of received microwave emission transitioning to waveguide just outside the port plug. Now under consideration is to continue the quasi-optical relay out at least to the port cell region. If adequate space is available for such a relay, the benefits could be better access to the splitter boxes and improved overall transmission.

Pipe support designs were presented at a progress meeting reviewing preparations for the Divertor RGA Sampling Tube Final Design Review.

ITER & TOKAMAKS (R. HAWRYLUK):

DIII-D (R. Nazikian):

A mid-plane port has been assigned for the PPPL Lithium Granule Injector on DIII-D. After the first phase of operation in FY15, the injector will be relocated to an R-1 (below mid-plane) port. Discussions were held regarding the high vacuum compatibility of the ferro-ferritic feedthrough that is used to spin the granule impeller up to 15000 RPM.

The NB Pole Shield design team meeting this week focused on the copper shield stresses around the molybdenum insert. The molybdenum takes most of the heat load for the pole shield however there is some residual thermal stress on the surrounding copper plate, which is the subject of further analysis. The thermal stress on the copper plate nearest the molybdenum inserts was found to be significant, requiring nonlinear thermal cycling analysis. A. Khodak presented nonlinear simulations of the copper plate focusing on the high stress region. The analysis showed that the heat induced thermal stress was highly compressive, resulting in <1mm horizontal movement of the copper plate with very low tensile stresses when the plate cooled down. The low value of the tensile stress, combined with the low direct heat deposited in this region of the copper plate, indicates that thermal fatigue will not be an issue on the copper plate. This

concludes the analysis portion of the pole shield project. The FDR is scheduled for June 6.

B. Tobias visited PPPL this week to present recent results on the non-linear phase locking of multiple core tearing modes and to attend a peer review of the ITER low field side reflectometer design.

R. Maingi and E. Kolemen attended the PSI conference in Kanazawa, Japan. Maingi served as a Session Chair and Egemen delivered a talk entitled "Heat flux management via advanced magnetic divertor configurations and divertor detachment".

C-Mod (S. Scott):

It has been known for some time that the MSE diagnostic collects partially-polarized background light arising from three sources: (1) visible Bremsstrahlung; (2) glowing structures in the vacuum vessel; and (3) a component that correlates with the measured D_α intensity (recently, a 4th source was discovered – emission from relativistic electrons, but this occurs only under unusual conditions). The light from these three sources is initially unpolarized, but becomes partially polarized upon reflection from the MSE viewing dump, aka the C-Mod D and E RF-antennas. The fact that three different mechanisms contribute to the background emission and the fact that some of them vary rapidly in time and space pose serious difficulties for estimating the magnitude of the background light when the DNB is turned on. Back in 2010, during changes in the plasma equilibrium (LSN to USN, “ssep sweeps”), it was observed that the MSE background light smoothly changed in magnitude (factor ~5) and the polarization angle smoothly changed 10’s of degrees in deuterium Ohmic plasmas. This behavior is consistent with molecular D₂ emission from the plasma edge acting as a moving “light bulb” whose reflection angle off the RF antenna changed in time. To further elucidate this issue, the same discharge was repeated last week in a single discharge under MP647, but in a dominantly helium plasma. Initial analysis is supportive of the conjecture that the component of the MSE background light, which correlates with the measured D_α emission, is in fact due to molecular D₂ emission. In the helium plasma, the intensity of the polarized background light is down a factor of 2.5 to 10 relative to a deuterium plasma; the intensity rises during the helium ssep sweep (similar to the behavior of VB emission) whereas it fell during the ssep sweep in deuterium; and there was much less change in the polarization angle of the background light in helium relative to deuterium. In the near future we hope to repeat this discharge one more time (in deuterium) with the MSE diagnostic configured exactly as it was for the helium discharge.

ADVANCED PROJECTS (H. NEILSON):

The report of the 2nd IAEA DEMO Programme Workshop, held 17-20 December 2013 in Vienna, was issued by the IAEA. PPPL's R. Hawryluk and H. Neilson contributed to the report, which is available at http://advprojects.pppl.gov/ROADMAPPING/IAEA2/DEMO2_index.asp.

D. Gates and H. Neilson met with Professor H. Karoji, a visitor from Japan's National Institute of Natural Sciences (NINS). The discussion centered on scientific opportunities for collaboration on the Large Helical Device (LHD) stellarator at the National Institute for Fusion Sciences, for which NINS is the parent organization. It was agreed to work with authorities on both sides to maintain a healthy continuing collaboration on LHD.

In its collaboration with the Wendelstein 7-X stellarator project at Germany's Max Planck Institute of Plasma Physics (IPP), it was reported by IPP that preparations for the on-site commissioning of the U.S. trim coil power supplies are complete. The 400 VAC primary supply was activated and the grid breakers were successfully operated. A dummy load has been connected to cooling water and to the U.S. safety disconnect switch. An engineer from the manufacturer, Applied Power Systems, Inc. of Hicksville, New York, is en route to IPP to lead the commissioning under contract to PPPL.

A PPPL delegation, including D. Gates and H. Neilson, visited the University of Wisconsin-Madison for a meeting to exchange perspectives on the needs and opportunities in stellarator research in the next ten years. Participants strongly endorsed a strategy, developed by the multi-institution National Stellarator Coordinating committee, that includes international collaboration, domestic experiments at a range of scales, and an integrated theory and simulation activity, for a U.S. program to close gaps in stellarator development. Preparations are under way to discuss the ten-year plan with the FESAC Strategic Planning sub-panel the week of June 2.

THEORY (A. BHATTACHARJEE):

The theory seminar on May 29 was presented by Professor Julia Mikhailova from Department of Mechanical and Aerospace Engineering, Princeton University, entitled "Laser-driven synchrotron-type emission from solid surfaces". The abstract of the talk is "High-order harmonic emission from the interaction of relativistic-intensity laser pulses with solids offers the potential for intense ultrashort XUV/x-ray pulse generation. This highly nonlinear phenomenon was predicted by numerical simulations and later observed in many experiments. It is commonly explained in terms of the so-called "relativistic oscillating mirror" model (Doppler frequency upshift of light reflected by a moving surface). Here, a clear physical picture is presented for the generation of attosecond XUV/x-ray pulses from the interaction of relativistic-intensity laser pulses with overdense plasma slabs. The sub-cycle, field-controlled release and subsequent nanometer-scale acceleration of relativistic electron bunches under the combined action of the laser and ionic potentials give rise to synchrotron-like emission. This insight into the fundamental properties of the relativistic high-harmonic emission process allows for an analytical treatment of the effect. The high-frequency cutoff in the emission spectrum is explained in terms of the basic laws of synchrotron radiation. The emerging synchrotron-like radiation is confined to time intervals much shorter than the half-cycle of the driver field. This intuitive approach will be instrumental in analyzing and optimizing laser-driven relativistic sources of intense ultrashort XUV/X-ray pulses."

ENGINEERING AND INFRASTRUCTURE (M. WILLIAMS):

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

Construction: The installation of the RF compliant centerposts was started this week. The DNB was repositioned and MSE calibrations were performed and the first PF1C coil was trial fit on the centerstack casing. The centerstack casing lift fixture was fabricated, and it will now be load tested so it can be used to reposition the casing for the PF1B installation. Work on the JK RWM

coil was completed and work on the LA RWM coil is nearly done. Buswork and bus mockups have been removed from under the machine so the TF outer leg aluminum block potting can occur (installing the upper umbrella has been completed). Bus bar fabrication and installation and termination of the vacuum system cables continues. The installation of the SSNPA cables has been started.

CS Upgrade: The OH Coil ground wrapping was completed and the water connections prepared for the VPI process. The mold is being prepared to receive the OH coil for the VPI process. Hollis passed the weld qualification procedure and is in the process of machining and welding the parts with a delivery schedule at the end of June. The first set of OTF lead extensions has been heat-treated and is now undergoing final machining at Martinez and Turek. The first batch of 12 is scheduled for June 6 shipment. Major Tool formed the PCHERS passive plate and is in the process of cutting the slots for the jumper weld connection. First plate shipment is now scheduled for June 20. The bids for the bending of the CHI busbars were received and the selection of the vendor was made.

NBI Upgrade: The high voltage transmission line installation continued in NTC. The BL2C installation is complete and transmission line support and ground wire installation continues. The VV RWM coil installation was completed for the Bay JK port area and meggering is planned next week. The vacuum system roughing line fabrication and installation continues in the NTC but was slowed due to conflicting priorities. The NB Armor thermocouple scanning system software development is in progress and mod/reg controls work, fiber optics, and preparation continues. The LCC low voltage power supply installation is in progress. The NB Controls fabrication and installation work on rack, cable, and wiring continued in NTC and gallery. Telemetry fiber optics termination and polishing is in progress in NTC. OMA hardware installations continued on BL2 source platform. Additional NB installation procedures are in development and review. Management conducted a walkdown of the NBI system for the ACC review.

Digital Coil Protection System: Work continued on the DCPS GUI with steady progress. Hardware and I/O layout and design continues toward completion. Work on hardware drawings also nears completion. The HW user interface panel and chassis design updates are in progress. The PCB design is in progress with several more PCBs and other parts being ordered. The water PLC and HSC testing development continues. A Lemo connector cable order is being tested and another larger order is planned. The DCPS procedure development, review of development of reliability, failure modes, and administrative control all continued. The review of open chits is in progress and the Hardware Interface FDR is planned the week of June 2.

BUSINESS OPERATIONS (K. FISCHER):

DOE approved a Work for Others agreement titled "Fundamental Studies of Reactive Processes at Plasma-Surface Interfaces" with Princeton University. The Principal Investigator is Y. Raitses. The budget is \$210,000 for the three-year period of performance.

DIRECTOR'S OFFICE (C. AUSTIN):

A. Cohen participated in a meeting of the ITER MAC-17 in Cadarache, France May 24-29.

May 28, Claudia Tebaldi from National Center for Atmospheric Research presented a colloquium entitled, "Future Projections of Climate Change: An Update from IPCC AR5IPCC AR5 WG1 Report".

This report is also available on the following web site:

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