

PRINCETON PLASMA PHYSICS LABORATORY

WEEKLY highlights



The PPPL Highlights for the week ending April 10, 2015, are as follows:

NSTX (M. ONO):

NSTX-U is in the Upgrade Project outage. NSTX Upgrade construction activities continued this week and are highlighted in the Engineering section below.

The 2nd Quarter Report of the JRT-15 was submitted to FES/DOE. The report summarizes the plans to address the JRT-15 goals of “quantifying the impact of broadened current and pressure profiles on tokamak plasma confinement and stability”. NSTX-U plans include experiments to characterize plasma performance as the NBI mix is varied to achieve broader current and pressure profiles. The initial run plan has been discussed by Mario Podesta (PPPL) with the NSTX-U research team at the NSTX-U Monday Meeting on 03/30. In a first experiment, scenarios at two I_p values (at fixed $B_t=0.65T$) will be explored using combinations of sources from the 1st and 2nd NBI lines. A second experiment will study plasma confinement as a function of B_t and plasma current. Stability of MHD and other fast ion driven modes will be investigated to quantify the plasma performance. Initial plans for coordinated analysis and experiments with DIII-D and C-Mod have been defined, with emphasis on performance improvement with off-axis current driven by either NBI or Lower Hybrid waves. Scenarios with elevated $q_{min}>1.5$ will be the primary target for cross-machine comparison.

J. Menard (PPPL) visited the Culham Centre for Fusion Energy (CCFE) in the UK on March 30-April 1 to discuss collaboration opportunities and participate in the advisory committee for CCFE.

The Electron Cyclotron Heating- Preionization (ECH-PI) Startup procedure PTP-RF-044 has been completed and the system is operational. A ECH-PI setup LabView control application has been written for the RF pulse setup. It is now running on the RF control computer located in the HHFW 1-2 area. The ECH-PI system is ready for supporting operations on NSTX-U.

Preparations for plasma operations in the NSTX-U configuration also continued. Dummy load testing of all of the power supplies required for CD-4 plasma operation has been successfully completed. Coil System flow switch calibrations will be performed next week with the restart of the cooling water systems, and systems are being configured for a bake of the vessel center column. Installation of ex-vessel MPTS equipment continues. Coil Cooling System hose installations/hydrostatic testing has been completed for the TF, OH, and PF coils, and flow switch calibrations are in progress. Also, end-to-end plasma current (I_p) Calculator testing needed before CD-4 plasma operations has been completed, including all of the Rogowski signals and the vessel current sums. Pre-operational testing of the field coils (insulation testing,

resistance and polarity checks, impulse testing etc) will be performed this coming Monday. The center-stack bake is scheduled for the latter part of the week. Inner and outer vacuum vessel electrical insulation checks (hi-pots) are now being performed daily

ITER and Tokamaks Department (R. Hawryluk)

DIII-D (R. Nazikian)

Adaptive real-time ELM control for DIII-D was commissioned and tested for DIII-D. The motivation for the control is that the optimal ELM control changes as the plasma evolves (e.g. q variation). This is especially important for ramp up and ramp down parts of ITER. The system finds the best configuration of the 3D coils (currently the phase between the upper and lower I coil sets in $n=2$ perturbations) and the amplitude of the 3D coils based on the real-time ELM frequency detection based on D_α signals. This is achieved by first finding the vacuum response to the 3D perturbations. Real-time EFIT and SURFMN codes are used to find the Fourier components of the perturbation in straight-line field coordinates $Br(m,n)$ in 20-100 milliseconds. Using the same infrastructure, real-time EFC was developed and tested as well. The adaptive EFC uses this insight to adjust the 3D coils (phase, amplitude) in real-time to minimize the most important component of the EF ($n=1$).

A paper titled "Control of plasma stored energy for burn control using DIII-D in-vessel coils" by Richard Hawryluk et al. has been published online in the journal Nuclear Fusion. The paper demonstrates how resonant 3D fields can be used to control the stored energy in DIII-D ITER shape plasmas and by extension to a fusion reactor in order to controlled the rate of fusion energy production. The control acts rapidly to effectively minimize stored energy excursions by modulating the confinement using active feedback control.

Wayne Solomon presented the status and plans for EAST collaboration on steady state research at the second EAST DIII-D planning workshop held at DIII-D this week. The presentation focused on progress in developing a noninductive target plasma on DIII-D that can be used as a basis for developing fully steady state plasmas on EAST.

PPPL acquired a 200 MHz digitizer in order to detect Ion Cyclotron instabilities on DIII-D. The digitizer is currently being installed in the DIII-D data acquisition system and will be ready to take data during physics operations on restart in June.

C-Mod (D. Mikkelsen)

David Mikkelsen spent the week at MIT working on electron temperature profile fits for C-Mod plasmas with L-mode to I-mode transitions and measurements of T_e fluctuations. Mark Chilenski provided advice and explanations of his profile fitting widget that employs Gaussian process regression techniques. A variety of fitting choices were tried for several shots and time windows per shot to establish that robust estimates of a/L_{Te} and its formal uncertainty can be obtained. Discussions with Nathan Howard concerning his multi-scale ITG/ETG simulations of C-Mod plasmas close to the ITG threshold identified several topics for further investigation.

THEORY (A. BHATTACHARJEE):

On April 7, Jonathan Katz (Washington University in St. Louis) presented a theory seminar on perytons, which are chirped pulses observed in the Parkes Multibeam Pulsar Survey. Unlike Fast Radio Bursts, they are observed simultaneously in all 13 beams, indicating either that they originate within the first Fresnel zone (within about 20 km of the telescope), are in the far sidelobes of all the beams, or enter the receivers by a "back door". They are not astronomical phenomena, but some sort of local interference, likely anthropogenic. However, their origin remains enigmatic. I consider a variety of hypotheses, none of which are satisfactory; the least implausible may be a spark in a cycling thermostat.

ENGINEERING AND INFRASTRUCTURE (M. Williams)

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

Management: Construction tasks have been completed and subsystem testing is underway. The PPPL Activity Certification Committee (ACC) has recommended that a safety certificate be granted to permit machine startup and operations. Expected to begin final integrated systems testing on Monday which will culminate in a first test plasma and initial neutral beam shot into the NB armor which define the Key Performance Parameters (KPP) of project completion. The project is also preparing to conduct a DOE-OPA project closeout review on May 5th.

Construction: Calibration of the TF and OH flow switches has been completed. PF flow switches are nearly done. All hydros have been completed. Vacuum vessel inner and outer hi-pots are occurring daily. Flex bus connections from the Power Cable Termination Structure (PCTS) to the machine have been completed with the exception of PF5 and OH - they will be completed as part of the ISTP sequence. CHI bus connectors have been installed. RWM cable supports have been installed. Gas delivery lines have been leak checked. Clear covers for the upper umbrella lid have been designed, fabricated and trial fit ... final installation after bake out has been completed. Grounds have been installed for the new PF4/5 supports. Power cables and water hoses for the centerstack bake out power supplies have been installed.

CS: NCR on OH heater was dispositioned and approved. The OH Heater manufacturers facility did not allow for the full capability testing of the heater so that test will be performed when the heater is installed at PPPL as part of the PTP. Water flow switch setting continued throughout the week in preparation for the bakeout.

NBI: Neutral Beam LHe refrigerator operations continues in support of NBI startup; another shipment of liquid helium was received and transferred into the process system. Troubleshooting of the D2 gas systems took place; numerous issues were remedied and all three (2ABC) gas systems are now working. Routine use of OP-NB-97 NBI Daily Startup has begun. PTP-NB-26 Fault Detector testing was completed. PTP-NB-11 Low Voltage Ion Source conditioning has started on 2ABC. Management attended the weekly IPT meeting.

DCPS: Dummy load testing was completed. The remaining portions of the hardware PCS online system have been brought online and checked. Progress continues on the DCPS FCC Watchdog timer feedback system. Discussions of strategies for limits for ISTP and CD4 took place with consensus reached; tree development and testing is in progress and on pace to support ISTP

starting next week. Automated testing of the DCPS PTP using the Autotester has been put into use to vet newly minted parameter trees.

ENVIRONMENT, SAFETY, HEALTH & SECURITY (J. LEVINE):

On Friday, The ACC presented its findings to the ES&H Executive Board, culminating in approval of the NSTX-U Safety Certificate for operations.

LEADERSHIP POSITIONS

Menard, J., Culham Centre for Fusion Energy (CCFE) advisory committee

PUBLICATIONS

Hawryluk, R.J.; Eidietis, N.W.; Grierson, B.A.; Hyatt, A.W.; Kolemen, E.; Logan, N.C.; Nazikian, R.; Paz-Soldan, C.; Solomon, W.M.; and Wolfe, S., "Control of plasma stored energy for burn control using DIII-D in-vessel coils" by Richard et al. has been published online in the journal Nuclear Fusion 55 053001. doi:10.1088/0029-5515/55/5/053001

This report is also available on the following web site:

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