



The PPPL Highlights for the week ending February 20, 2015, are as follows:

NSTX (M. ONO):

NSTX-U is in the Upgrade Project outage in FY14. NSTX Upgrade construction activities continued this week and are highlighted in the Engineering section below.

Preparations for plasma operations in the NSTX-U configuration continued. The NSTX-U vessel is under high vacuum and the operating routine of daily inner vacuum vessel electrical insulation tests has resumed. Preparations to start the dummy load testing of the FCPC rectifiers are in progress, and Kirk Key interlock system testing has been completed for the MG systems, FCPC, the NSTX Test Cell, and the ground switches. The Power System Safety Lockout Device (SLD) has been pressurized to complete the remainder of the hardwired interlock system testing.

ITER & TOKAMAKS (R. HAWRYLUK):

DIII-D (R. Nazikian):

A recent article based on the 2014 APS invited talk by B. Grierson entitled “Impurity confinement and transport in high confinement regimes without ELMs on DIII-D” has been accepted for publication in *Physics of Plasmas*. The article explores impurity confinement in RMP ELM-suppressed and QH-mode discharges.

Discussions were started this week on ideas to improve the Lithium Granule Injector (LGI) dropper design during FY15. The LGI dropper releases Lithium granules into a spinning impeller that injects them into the plasma outer edge. The current granule dropper mechanism is hampered by clogging and irregular release of granules to the impeller. The meeting explored approximately ten concepts ranging from using vibrating trays, to rotating disks and belts, to loading tubes with piezo driven gates. Another meeting will be held to identify the strongest concepts for further analysis.

C-Mod (L. Delgado-Aparicio):

L. Delgado-Aparicio, PPPL, visited C-Mod on February 11-13 to analyze mode locking data and to discuss plans for the multi-energy Pilatus measurements in the next run campaign.

THEORY (A. BHATTACHARJEE):

W. Fox traveled on February 8-11 to the University of Rochester Laboratory for Laser Energetics to participate in an ongoing series of Laboratory Basic Science experiments at the OMEGA EP facility. The experiments focused on experimentally observing particle energization and acceleration by magnetic reconnection between colliding, magnetized, laser-produced plasma plumes.

On February 19, Z. Wang (PPPL) gave a theory seminar on progress on understanding three-dimensional (3D) plasma response in tokamak plasmas: Studying 3D plasma response can be important to the prediction of the reliable plasma behavior in high performance tokamak operation. In order to study the drift kinetic effects on ideal 3D plasma response, the upgraded MARS-K code, which has the capability to solve linearized hybrid MHD equations with drift kinetic effects self-consistently, has been employed. Firstly, the numerical reliability of MARS-K code has been shown through the successful numerical benchmarking with IPEC-PENT code based on the equivalence between the drift kinetic energy and neoclassical toroidal viscosity (NTV) torque. Both codes indicate the importance of the bounce harmonic resonance, which can greatly enhance the NTV torque when EXB drift frequency reaches the bounce resonance condition. Secondly, with this upgrade MARS-K, a quantitative interpretation of the experimentally measured high beta plasma response to externally applied 3D magnetic perturbations, across the no-wall beta limit, is achieved. The self-consistent inclusion of the drift kinetic effects in MHD modeling successfully resolves a long standing issue of ideal MHD model, which significantly over-predicts the plasma induced field amplification near the no-wall limit, as compared to DIII-D and NSTX experiments. The model leads to quantitative agreement not only for the measured field amplitude and toroidal phase, but also for the measured internal 3D displacement of the plasma, where the kinetic effect due to thermal particles plays a major role in modifying the response structure. At last, the progress of developing resistive DCON development to compute the resistive plasma response with the opening island, based on the asymptotic method, is presented. A singular Galerkin method, using an advanced choice of basis functions is implemented into the code to accurately and efficiently compute outer region matching data near the singular surfaces which can also be important to determine the resistive instability even in high beta tokamak plasmas with the full toroidal geometry.

On February 20, Ravi Samtaney (KAUST) gave a theory seminar on non-modal stability analysis and transient growth in a Vlasov plasma: Collisionless plasmas, such as those encountered in tokamaks, exhibit a rich variety of instabilities. We investigate the stability properties of a 3-dimensional collisionless Vlasov plasma in a stationary homogeneous magnetic field. We narrow the scope of our investigation to the case of a Maxwellian plasma and examine its evolution with an electrostatic approximation. We show the occurrence of transient growth, followed by classical Landau damping in a stable magnetized plasma. The linearized Vlasov operator is non-normal leading to the algebraic growth of the perturbations using non-modal stability theory. The typical time scales of the obtained instabilities are of the order of several plasma periods. The first-order distribution function and the corresponding electric field are calculated and the dependence on the magnetic field and perturbation parameters is examined. Finally, we present some preliminary analysis for the case of a spatially varying magnetic field.

A paper was published in Nuclear Fusion, "Influence of resistive internal kink on runaway current profile", H. Cai and G. Fu. This paper presents the first simulations of resistive internal

kink mode in a toroidal plasma with runaway current. The simulations were based on an extended MHD model which takes into account of self-consistent effects of runaway electrons. It is found that sawteeth oscillation is suppressed in a runaway plasma. The nonlinear evolution of the $n = 1$ mode only leads to a single sawtooth crash before reaching a new steady state axisymmetric equilibrium with flattened current profile in the plasma core.

PLASMA SCIENCE AND TECHNOLOGY (P. EFTHIMION):

The PS&T Department seminar was presented by Professor Haimin Wang from NJIT. The title of his talk was "Structure and Evolution of Magnetic Fields Associated with Solar Eruptions". In this talk, he reviewed the study of his group using the data from NASA satellites and Big Bear Solar Observatory (BBSO). The focus was on the evolution of magnetic topology associated with solar flares and Coronal Mass Ejections. The observational signatures of magnetic reconnection were discussed. Two kinds of reconnection are shown in observations associated with two major types of magnetic topology: the sigmoid structure, and the fan-spine topology. The former may be associated with the tether-cutting reconnection, while the later is related to the null-point reconnection. He also presented the results of rapid changes of photospheric magnetic fields associated with flares--it was discovered by the BBSO group, but has been confirmed only recently after the launch of Solar Dynamic Observatory."

ENGINEERING AND INFRASTRUCTURE (M. WILLIAMS):

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

Construction: All hoses have been installed in the umbrellas. The final installation of Toroidal Field bus continues in both umbrellas. The outer Toroidal Field lead supports are being trial fit. Lower umbrella lid outboard mounting blocks are being trial fit. Installation of the gas delivery system tubing continues. Terminations for gas injectors #1, #2 and #3 are in progress. General access to the NSTX Test Cell will end on February 28 with a full scrub of the test cell the following week.

CS Upgrade: The OH coil test samples were returned to PPPL from CTD. Megger tests on the samples indicated that the insulation was in excellent condition. The resin rich areas on the ends of the samples are being removed to get a better look at the layer-to-layer insulation. Fitup of the OTF lead extensions continued this week. Silver-plating of TF lead parts continued in preparation for final assembly. The water system hoses in the umbrella were completed along with hydrotesting. A second sample of nonconductive, high temperature and pressure hose was received from another source. This hose has a higher pressure rating than the sample that passed previously. The dummy load tests of the FCPC power system upgrades commenced with steady progress being made.

NBI Upgrade: The DI water system repairs on the mezzanine and strainer installation in the NTC were completed. The water treatment and fill and flush started this week and will extend into the week of February 23. The stack duct installation has started in the NTC. Control cabling is complete and testing and troubleshooting of all cabling in support of various stages of pretesting is underway. The gas system fiber optics terminations were completed on 138L NBPC. The M/R

power supply testing and tuning continues. PLC software programming is complete and pretesting is in progress. Procurement of an IR camera for Bay L 7:30 port to view the armor is in progress. The NTC North door gate installation is scheduled for the end of February due to resources. The operating procedure revision and approvals are in progress. In addition, the operator training records were brought up to date.

Digital Coil Protection System: The dummy load testing PTP-ECS-039 began in earnest this week with DCPS JA in full support. Various anomalies occurred requiring DCPS to issue correct and timely protective L1 faults. The DCPS functioned as designed and intended. A subtle heating algorithm issue was discovered and will be corrected on the next version. Parameter tree development to support dummy load testing was completed in order to account for the algorithm issue. DCPS FCC preparations for pretesting with AT are underway. DCPS extension and summing chassis implementation took on more prominence because the summing chassis was needed to back up and replace one of the TF current channels in support of DL testing. Development of OP-DCPS-779 set up and startup continues with a full walk down and additional notes will be added to improve clarity. Spares are in development.

BEST PRACTICES & EXTERNAL AFFAIRS (J. DELOOPER):

The article, "The suitability of 3D printed plastic parts for laboratory use", by A. Zwicker, J. Bloom, R. Albertson, and S. Gershman has been published in the American Journal of Physics (Vol.83, Issue 3): URL: <http://scitation.aip.org/content/aapt/journal/ajp/83/3/10.1119/1.4900746?email=author> DOI: 10.1119/1.4900746. Bloom was a high school intern that is now an engineering student at the Stevens Institute of Technology. Albertson was a community college intern from Mercer Community College. Gershman is a plasma physicist and high school physics teacher and a long-term PPPL collaborator working on atmospheric plasma processing and nanoparticle production.

PPPL Science Education hosted the DOE New Jersey Middle School Regional Science Bowl on February 20 and the DOE New Jersey High School Regional Science Bowl on February 21.

DIRECTOR'S OFFICE (C. AUSTIN):

On February 18-20, Scott Davis of the DOE Office of Science visited PPPL to review the startup plans for NSTX-U.

D. Gates of Princeton Plasma Physics Laboratory, presented a colloquium on February 18 entitled, "Stellarator Research at PPPL and Beyond".

PUBLICATIONS:

Cai, H.; and Fu., G.; "Influence Of Resistive Internal Kink On Runaway Current Profile," Nuclear Fusion 55 022001 [doi:10.1088/0029-5515/55/2/022001](https://doi.org/10.1088/0029-5515/55/2/022001)

Zwicker, A.; Bloom, J.; Albertson, R.; Gershman, S., "The Suitability of 3D Printed Plastic Parts For Laboratory Use," American Journal of Physics Vol. 83, Issue 3
<http://scitation.aip.org/content/aapt/journal/ajp/83/3/10.1119/1.4900746?email=author> DOI:
10.1119/1.4900746.

Bou-Zeid*, E. and Rule, K., "Building the Knowledge Base for Climate Resiliency," Chapter 6, The New York City Panel on Climate Change report, NPCC 2015.

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