

PRINCETON PLASMA PHYSICS LABORATORY

WEEKLY highlights



The PPPL Highlights for the week ending July 11, 2014, are as follows:

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

A port integration meeting for Equatorial Port Plug 11 was held with representatives from the integrating institution in the RF (Budker Institute), the ITER Organization, and PPPL. PPPL presented progress integrating the two U.S. diagnostics, the low-field-side reflectometer and the residual gas analyzer. A resulting action is to mesh the schedules between the port plug and diagnostic design efforts.

PPPL responded to DOE comments on a proposed contract award for "Design and Fabrication of the ITER Upper Port Visible/Infrared Wide Angle Viewing System".

PPPL engineer Y. Zhai held a peer review of a document defining the interface between the diagnostic first wall and the diagnostic shield modules.

NSTX (M. ONO):

Several NSTX-U research team members gave presentations at the public sessions of the 2014 FESAC Strategic Planning Panel (SPP) meeting held July 8-10 in Gaithersburg, Maryland. NSTX-U: ST research to accelerate fusion development”, R. Majeski (PPPL) “LTX: Exploring the advantages of liquid lithium walls”, R. Fonck (University of Wisconsin – Madison) “Initiatives in non-solenoidal startup and edge stability dynamics at near-unity aspect ratio in the PEGASUS experiment”, R. Raman (University of Washington) “Simplifying the ST and AT concepts”, N. Crocker (UCLA) “Validating electromagnetic turbulence and transport effects for burning plasmas”, S. Sabbagh (Columbia University) “Critical need for disruption prediction, avoidance, and mitigation in tokamaks”, M. Podestá (PPPL) “Development of tools for understanding, predicting and controlling fast-ion-driven instabilities in burning plasmas”, R. Maingi (PPPL) “A liquid-metal plasma-facing-component initiative”, M. Jaworski (PPPL), “Liquid metal plasma material interaction science and component development toward integrated demonstration”, and J.P. Allain (University of Illinois) “Establishing the surface science and engineering of liquid-metal plasma-facing components”.

The paper "Effect of a deuterium gas puff on the edge plasma in NSTX" by S. J. Zweben (PPPL), et al. was published in *Plasma Physics and Controlled Fusion* *Plasma Phys. Control. Fusion* 56, 095010 (2014), <http://stacks.iop.org/0741-3335/56/095010>. This paper describes a detailed examination of the effects of a relatively small pulsed deuterium gas puff on the edge plasma and edge turbulence in NSTX. This gas puff caused little or no change in the line-

averaged plasma density or total stored energy, or in the edge density and electron temperature up to the time of the peak of the gas puff. The radial profile of the D α light emission and the edge turbulence within this gas puff did not vary significantly over its rise and fall, implying that these gas puffs did not significantly perturb the local edge plasma or edge turbulence. These measurements are compared with modeling by DEGAS 2, UEDGE, and with simplified estimates for the expected effects of this gas puff.

A new Reactive Metal Chemist has joined the PPPL Team and is supporting planning for NSTX-U Lithium Operations.

ITER & TOKAMAKS (R. HAWRYLUK):

DIII-D (R. Nazikian):

B. Tobias presented an invited talk at the PPPL Disruption Physics workshop on the coupling and phase locking of NTM modes on DIII-D.

T. Stoltzfus-Dueck (Princeton University / PPPL) visited DIII-D as part of a collaboration on intrinsic rotation physics. He is contributing to the modeling of intrinsic rotation with D. Battaglia and comparison to main ion D-alpha measurements with B. Grierson aimed at characterizing the relationship between the edge rotation layer and core intrinsic rotation.

N. Greenough visited DIII-D to install and test the prototype magnet current monitor on one gyrotron. The monitor chassis and current sensors were installed into the gyrotron control system. The system is operating successfully. It performs the appropriate current measurements and activates the interlock when current limits are exceeded. An FDR took place on July 11.

C-Mod (S. Zweben):

This week S. Zweben and M. Podesta participated in a conference call with Jim Terry and Brian LaBombard of MIT, and Federico Halpern and Paolo Ricci of EPFL Lausanne, on turbulence simulations of the C-Mod SOL being done with the Lausanne GBS code. Good agreement was found between the GBS code results for simulated D α GPI signals such as the fluctuation level and correlation lengths and previously published GPI measurements of SOL turbulence in C-Mod. More detailed GBS comparisons are being planned with GPI, Langmuir probe, and SOL width measurements made on recently completed C-Mod inner-wall-limited experiments.

International (W. Solomon):

D. Mueller visited EAST from June 22-July 3 with a goal of improving the fast vertical control system used on EAST. The improvement was to use up/down symmetric loop voltage differences to provide a less noisy estimate of dz/dt compared with differentiating the integrated signals that make up the fast z signal, as well as to test the new internal coil and its new power supply in plasma control. The power supply and internal coil had been tested earlier in the absence of plasma. The loop voltage signals were input into the plasma control system (PCS) and were tested. However, the low temperature bake (~120°C) used on EAST following the extended opening lead to rather poor wall conditions so that it was not possible to produce the

high quality elongated plasmas necessary to test the vertical control. After this visit, a higher temperature bake was done and plasma conditioning is proceeding. The vertical control experiment will be attempted remotely at a later date.

Testing and calibrations of the EAST LGI continued this week. Injection velocities of greater than 80 m/s were demonstrated using 300 micron Li granules. At that velocity repetition rates in the neighborhood of 400 Hz were attained

ADVANCED PROJECTS (H. NEILSON):

Doctors K. Kim and K. Im from S. Korea's National Fusion Research Institute (NFRI) visited PPPL to discuss progress in our joint study of a next-step fusion nuclear facility, K-DEMO. The NFRI team reported their work in developing a blanket configuration compatible with tritium self-sufficiency and available balance-of-plant technology. PPPL's C. Kessel and D. Mikkelsen reported progress toward developing an optimum heating and current drive configuration for K-DEMO. A preliminary time-dependent simulation was presented in which the TSC code was used to develop a scenario that reached a steady state with about 1,500 MW of fusion power and 12 MA of plasma current, two-thirds from bootstrap current and the remainder from external current drive sources. It was shown that capabilities to drive current near the plasma axis, near the edge, and the intermediate layer are needed, and could be satisfied with a combination of neutral beams, and ion cyclotron, electron cyclotron, and lower hybrid wave systems. Detailed calculations of power deposition and current drive efficiency neutral beams and lower hybrid, covering a range of launch positions and directions, were reported.

H. Neilson participated in the first meeting of the Technical Program Committee for the IAEA DEMO Programme Workshop, to be held the week of May 11, 2015 in Hefei, China. The meeting will focus on three topics: 1. DEMO Readiness: Closing the Gaps; 2. In-vessel Systems Design and Engineering; and 3. Blanket and First Wall Development Strategy. The Committee, which is chaired by Professor T. Muroga of Japan's National Institute for Fusion Science (NIFS), exchanged ideas for invited speaker and topic chairs for each topic. Neilson was appointed to be topic chair for Topic 1.

THEORY (A. BHATTACHARJEE):

The special theory seminar on July 8 was presented by Dr. Bruce Scott from Max-Planck-IPP EURATOM Association, entitled "Relaxation to neoclassical flow equilibrium in gyrofluid simulations". The abstract of the talk is "The theorem for toroidal angular momentum conservation within gyrokinetic field theory is used as a starting point for consideration of slow transport of flows under quasistatic force balance. The content of the momentum by itself yields a relation between the electric field and the parallel flow, if conserved/transported quantities are taken as given. The relation of poloidal to parallel flow then yields the radial electric field in terms of the poloidal flow as in the standard case. If the toroidal Mach number is not small this gives an iterable solution for the electric field provided neoclassical theory has given the poloidal flow of each ion species. In a gyrokinetic computation, provided the collision operator is sufficient (is conservative) this is enough to recover neoclassical results in the appropriate limit but is also applicable to more general situations. This treatment serves merely to underpin the

ability of global gyrokinetic computations to treat neoclassical physics even when conventional ordering is relaxed. Finally, the pathway of relaxation to slowly varying conditions from an arbitrary initial state is detailed. The time scale hierarchy is separated to have Alfvén and then geodesic oscillations damp away, and then on the ion collisional time scale the electric field is established, and then on the much slower confinement time the conserved quantities are transported. All of the important effects go through first order drifts, with the quadratic term in the Hamiltonian accounting for polarization."

PLASMA SCIENCE AND TECHNOLOGY (P. EFTHIMION):

M. Yamada attended the SHINE (Solar Heliospheric and Interplanetary Environment) conference held in Telluride, Colorado June 23-27. The SHINE is an annually held meeting for the solar, interplanetary, and heliospheric communities for an enhanced understanding of the processes in the sun and/or accelerated in interplanetary space. Yamada gave two talks regarding magnetic reconnection and the flux rope stability experiments on MRX. There were very productive discussions and exchanges were made among space solar physicists and laboratory experimentalists, particularly on the energy inventory of the reconnection layer and the tension force of flux ropes in solar flares as well as those made on MRX.

On July 10, Scientific American published a web feature highlighting solar eruption research recently conducted in the Magnetic Reconnection Experiment (MRX) by graduate student Clayton Myers and his advisor M. Yamada. In these experiments, an arc discharge plasma is formed within a specially designed magnetic field configuration in order to study the physical mechanisms that trigger solar eruptions. Scientific American journalist Clara Moscovitz, who contacted Myers after he presented at the meeting of the American Astronomical Society in early June, visited PPPL on June 27 to interview Myers and Yamada and to photograph the MRX device. The article can be found at: <http://www.scientificamerican.com/article/experiment-triggers-superhot-plasma-outbursts-to-untangle-solar-flare-mystery/>

ENGINEERING AND INFRASTRUCTURE (M. WILLIAMS):

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

Construction: In-vessel work for sFLIP, SAMI, and the upper RF Langmuir probes has been completed. The leak checking of the RF feedthroughs is in progress. The inspections and testing of the RWM coils has been completed. The fit-up of the centerstack ceramic breaks to the PF1C coils continues as a way to leak check the assembly is developed. Re-machining of the PF coil pockets on the centerstack casing continues. The installation of supports for the cooling water hoses continues.

CS Upgrade: The OH Coil sanding continued this week. Metrology was performed on the coil to identify the high areas for sanding. The PF1A Upper coil cover was welded in place. Kapton and Wet Wrap insulation of the CHI Bus bars continued this week. A meeting was held to discuss and resolve the PF1C vacuum cover closure weld design. A decision was made to use the existing cover and flange but add an additional ring to relocate the vacuum weld away from the epoxy. TCs for temperature monitoring during operations were also added. The drawings were

revised and a peer review is being held next week. The first PCHERS passive plate was completed this week. Personnel from PPPL visited Major Tool on July 11 to witness the final inspection of the first plate and release for shipment.

NBI Upgrade: TVPS Fore line installation continues and exhaust line welding has started. The TVPS installation is in progress, including some instrumentation and cabling. The Armor manifold is in progress and fittings were bench welded. The NB Controls fabrication and installation cabling work on rack connections, cable runs, and BL wiring continued in NTC and gallery. Telemetry fiber optics end to end testing continues in NTC. Additional NB installation procedures are in development and review. The jobs status were reviewed at the monthly project meeting.

Digital Coil Protection System: The DCPS Code Peer Review is in progress; after three half-day sessions, several more days are required to complete the code review. Study and comparisons of the NSTX-U Design Point Spread Sheet, calculations data, and DCPS parameter tree content were completed for now and summarized. This study will be ongoing and will continue to be reviewed as needed. DCPS PTP testing continues as needed to support changes arising from these studies and to investigate discrepancies found in output data. Some successful software builds were performed to clean up details in the code. Progress continues on hardware layout, drawings, orders, and fabrication of digital and analog boards.

BUSINESS OPERATIONS (K. FISCHER):

Regarding the Business System Upgrade, there are 21 interested vendors (of which two already indicated they are not participating) in the project. Seven vendors (so far) requested to participate in the Pre-Proposal conference scheduled for July 16; three vendors will come to PPPL and four will be calling into the conference. The proposals are due at 2:00 PM on August 15.

PPPL submitted a proposal titled "An Informational-Dynamical Approach to Radiation Belt Acceleration and Loss Processes" to NASA. The Principal Investigator is J. Johnson. The total budget request for the three-year period of performance is \$401,900.

OFFICE OF COMMUNICATIONS (K. MACPHERSON):

A story about MRX and the work of PPPL researchers appeared on the main webpage of Scientific American on July 10:

<http://www.scientificamerican.com/article/experiment-triggers-superhot-plasma-outbursts-to-untangle-solar-flare-mystery/>

OFFICE OF ACADEMIC AFFAIRS (N. FISCH):

On July 9, N. Fisch visited Fermilab's Advanced Superconducting Test Accelerator and gave a seminar on "Wave Compression in Plasma" at the Fermilab Colloquium.

DIRECTOR'S OFFICE (C. AUSTIN):

July 8-9 - PPPL participated in the U.S Fusion Energy Sciences Advisory Committee Subpanel meeting regarding developing a Strategic Plan for the US Fusion Program. The meeting was held in Gaithersburg, Maryland. PPPL participants were: Prager, Zarnstorff, Sabbagh, Raman, Menard, Majeski, Podesta, Goldston, Maingi, Jaworski, Crocker, Allain, Koel, Jardin, Tang, Chang, Fu.

On July 9-11, A. Cohen participated in a meeting of Chief Operating Officers at DOE Headquarters in Washington, DC.

PUBLICATIONS:

Zweben, S.J. (PPPL); et al., "Effect of a deuterium gas puff on the edge plasma in NSTX," Plasma Physics and Controlled Fusion 56, 095010 (2014), <http://stacks.iop.org/0741-3335/56/095010>.

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