

PRINCETON PLASMA PHYSICS LABORATORY

WEEKLY highlights



The PPPL Highlights for the week ending December 13, 2013, are as follows:

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

Several members of the PPPL ITER port plug design team participated in the Final Design Review for the generic structure of the diagnostic equatorial port plug led by the ITER Organization Diagnostic Division.

The Preliminary Design Review for the diagnostic first wall was held in Cadarache, France. Under Task Agreement from the ITER Organization, D. Loesser led a team at PPPL to develop this design. There was one class 1 chit regarding the load requirements associated with the photon flash, which occurs during massive gas injection to mitigate disruptions. There were 15 class 2 chits to be resolved during the final design phase.

NSTX (M. ONO):

A paper "Characterization of divertor footprints and the pedestal plasmas in the presence of applied $n=3$ fields for the attached and detached conditions in NSTX" by J-W. Ahn (ORNL) et al. has been published in Plasma Physics and Controlled Fusion. The paper describes recent progress in the study of 3-D field effects on the divertor and pedestal plasmas with the use of a new set of diagnostics. A high speed, wide-angle visible camera provides 2-D data of lower divertor surface covering almost the full range of radius and toroidal angle. The spatial distribution of connection lengths calculated by vacuum field line tracing for $n=3$ fields agrees with the footprint pattern observed in the 2-D wide angle camera images. The image data show that the phase locking of ELM footprints to the applied $n=3$ fields has dependence on the ELM size. The 3-D fields can re-attach detached divertor plasma, which is associated with the rise of pedestal T_e . Profile measurements and TRANSP analyses show that this is likely to be dominated by a change in the electron thermal transport processes.

ITER & TOKAMAKS (R. HAWRYLUK):

DIII-D (R. Nazikian):

B. Grierson participated in in-vessel CER back-calibrations this week on DIII-D and has begun removing CER fibers and fiber clamps in preparation for the installation of the CER upgrade for the 2014 campaign. The upgrade will include an expanded fiber set with a larger radial range for impurity CER measurements of the radial electric field. Additionally, sixteen fiber optic

sightlines for main-ion CER will be installed during this event. Four of the main-ion sightlines will be connected to spectrometers as a prototype for edge main-ion CER on DIII-D.

A. Nagy has continued with the I-coil dissection on DIII-D with the removal of the lower half of the IU60 coil that contains the short. The upper half, without the short, was high potted to 950kV with 2 mA leakage detected.

A. Nagy and Bobby Dannels (ORNL Tech) are in the process of removing the 285 antenna from the DIII-D vessel. Samples of dust were taken from the antenna box for analysis. The antenna Faraday shields, and straps have been removed. No large arc tracks or marks were found in the antenna inner box surfaces or the vacuum coax. This is a marked improvement from past arc damage, and is thought to be related to the antenna box being installed inverted with the strap grounds on the bottom to reduce the dust getting into the antenna high voltage region (now at the top).

R. Maingi presented "ITPA Pedestal Group 2013 Annual Report and report and proposal for Joint Experiments" on behalf of the ITPA Pedestal and Edge Physics (PEP) Group at the Annual ITPA Coordinating Committee meeting from December 9-11 at Cadarache, France. This report included a summary of group activities for the year, as well as an overview of the joint chapter on the ITER divertor strategy from both the PEP and Transport and Confinement Topical groups.

R. Budny visited GA from December 2-6 to work with W. Solomon and B. Grierson on analysis of DIII-D high beta advanced inductive plasmas. Work has started on the TGLF analysis of the Joint DIII-D / EAST experiment on Fully Non-Inductive Operation candidate shots for EAST.

R. Hawryluk chaired the "Assembly Review" at the IO this week. An international panel met to review the methodology used to plan the assembly of the machine. On the fifth day of the review, the panel provided the Director General a draft Executive Summary of their observations.

ADVANCED PROJECTS (H. NEILSON):

D. Gates and S. Lazerson visited the Max Planck Institute for Plasma Physics (IPP) in Greifswald, Germany, December 9-13 to discuss ongoing Wendelstein 7-X (W7-X) stellarator collaborations. Numerous meetings were held on the following topics: Diagnostic development including the US X-ray Imaging Crystal Spectrometer and instrumentation issues for the inertially cooled "TDU Scrapper Element", equilibrium reconstruction and vacuum flux surface measurements, turbulence optimization calculations in W7-X and QUASAR, future collaboration topics (TDU scrapper, fast particle physics, transport analysis), and scenario modeling. At the W7-X/IPP theory seminar, Lazerson presented "3D equilibrium reconstruction for stellarators and tokamaks" reporting on forward modeling results for W7-X and reconstruction results for DIII-D. Discussions regarding the forward modeling of diagnostic signals for W7-X, turbulent transport optimization in stellarators, bootstrap current calculations for W7-X were held.

THEORY (A. BHATTACHARJEE):

On December 12, Professor Luca Guazzotto (a long-term visitor to the theory department) gave a talk on "Perturbed equilibrium in tokamaks", addressing the hot topic applications, such as (a) thermal quench, (b) runaway electrons, (c) wall touching kinetic mode, (d) resonant magnetic perturbation, (e) plasma boundary perturbations. He described a theoretical and numerical approach to calculation of perturbed equilibria. The interest in the topic comes from the fundamental observation that equilibrium in tokamaks is not represented adequately by axisymmetry. Rather, the magnetic configuration is always perturbed. Even in their quiescent phase, the tokamak plasmas are subject to edge perturbations. An equilibrium description is preferable with respect to a stability one because it describes the real state of the plasma without the need to rely on a plasma model. The formalism described has removed the major difficulty in extension of the ideal stability codes to resistive models. The quasi-linear model of the islands was described. A special form of the energy principle used outside islands allows to use the same island mode in the toroidal case. The approach has been implemented into a reduced-MHD version of a numerical code, which was supplied to ITER Organization earlier. A plan for the implementation of a full toroidal perturbed equilibrium model was describe.

A. Reiman presented an experimental proposal to the DIII-D Research Opportunities Forum on December 5. General Atomics collaborators on the proposal are T. Evans, A. Turnbull, N. Ferraro, J. King, M. Lanctot, and F. Turco. It is proposed that DIII-D shot 146058 be reproduced, and that systematic scans in plasma parameters and resonant magnetic perturbation spectrum be performed around that equilibrium. The purpose is to provide a rich data set for validation that can be used by stellarator codes as well as tokamak codes. Secondly, it is believed that there is a strong possibility that these experiments will demonstrate ELM suppression in a stellarator-symmetric field for the first time. Shot 146058 had a stellarator-symmetric field, and it displayed very strong ELM mitigation, close to ELM suppression. The proposed experiments would allow the application of powerful new diagnostics that have been installed on DIII-D in recent years to stellarator symmetric plasmas for the first time. The information from these diagnostics will be valuable for validation. It will be of particular interest to compare 3D equilibrium solutions with and without strong ELM mitigation.

PLASMA SCIENCE AND TECHNOLOGY (P. EFTHIMION):

Five papers from MRX research were presented at the American Geophysical Union Fall 2013 meeting held in San Francisco December 9-13. Approximately 20,000 scientists, educators, students, and leaders attended the Meeting. Invited talks were given by Jongsoo Yoo on "Asymmetric reconnection" and by Seth Dorman on "Impulsive reconnection." Additionally, oral talks were given by Clayton Myers on "Study of sigmoidal solar flare equilibrium on a lab plasma" and by Masaaki Yamada on "Energy transport in the MRX reconnection layer". Hantao Ji gave a poster paper on "Electron dissipation near the X-line". All papers were well received and stimulated further discussion with the community. The former Princeton graduate student, Seth Dorfman, received two prestigious awards from the AGU for his dissertation research on MRX: the F.L. Scarf Award, and the Basu Early Career Award for Research Excellence in Sun-Earth Systems Science. It is very encouraging to see evidence that Seth Dorman's excellent work as well as research by the MRX team have been making important impact on space science and are well appreciated by the space physics community.

ENGINEERING AND INFRASTRUCTURE (M. WILLIAMS):

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

Construction: In-vessel installations for diagnostics continued this week with the installation of the mounting studs. All bakeout tubing clips have been welded to the vessel exterior and installation of the vacuum vessel feet re-inforcements is over 75% complete. The electricians re-installed all of the cable trays and started installing the category 4 cables. They are also completing the ex-vessel flux loops and starting the glow discharge cabling. The centerstack casing has been moved to the south high bay so the tile mounting studs can be worked on. Hydro tests of the hot helium lines and the bakeout tubing have all passed.

CS Upgrade: Some additional minor mechanical adjustments were performed to the taping heads on the OH winder before the final taping trials were performed. On December 13, the first several feet of conductor will be taped and drawn to the TF bundle where the final bends are being performed on the conductor before the OH terminations can be brazed on December 16. The coils bus work continued this week. The tech shop has been fabricating flags and support structures. All design changes, thus far, have been recorded and an ECN is being prepared. The modeling of the coils flex cable connections was prepared and provided for analysis.

NBI Upgrade: Progress continues on BL2 DI water manifold installations including tech shop support. The four DI water pumps previously in use have been removed in the pump room. The pump pads have been removed in preparation for the new pump mounting footprint and heights. Vacuum system parts are on order and delivery is imminent. Armor quadrant fit-up, assembly, and installation took place. Two quadrants are installed in the vessel. The remaining two quadrants are being assembled. Work continues on subcontract cable installations. Cable has been pulled into the TCB and run off allowed for the NTC side. Setup and cable pull of these ends into NTC to the HVEs has started. NB and TVPS duct component assembly was completed in the NB shop; the duct assembly was leak checked successfully. The duct support legs have been moved to the NB shop. Management participated in the monthly IPT meeting; steady progress was noted.

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

On December 10, PPPL received two awards from the U.S. Environmental Protection Agency (EPA), Region 2, for our waste minimization efforts. PPPL received a Certificate of Achievement from the Food Recovery Challenge for our food waste composting program, and the WasteWise Federal Partner of the Year award for our comprehensive waste diversion and recycling program.

BEST PRACTICES & EXTERNAL AFFAIRS (J. DELOOPER):

Nick Guilbert, a physics teacher at the Peddie school visited PPPL, along with two students, as part of their project studying the physics of avalanches. Working with A. Zwicker in the Science Education Laboratory, they filmed high speed video of sand piles looking at the dynamics of the top few layers compared to the static foundation. The video will be further analyzed by the students back at their school.

A. Zwicker gave a talk on "Fusion Energy, Creating a Star on Earth" to physics classes at Montgomery Blair High School in Silver Spring, Maryland as part of the Nifty Fifty science speakers program (<http://www.usasciencefestival.org/schoolprograms/niftyfifty.html>) sponsored by the USA Science and Engineering Festival.

OFFICE OF ACADEMIC AFFAIRS (N. FISCH):

On December 2-4, N. Fisch attended the Conference on High Intensity Laser and Attosecond Science in Israel, where he gave an invited talk, "Enhancing Resonant Raman Compression in Plasmas."

DIRECTOR'S OFFICE (C. AUSTIN):

M. Zarnstorff visited NIFS in Toki, Japan from December 9 - 13, to serve on their External International Review Committee, which reviewed their Fusion Engineering Research Project. He also collaborated on analysis of LHD high beta configurations and data.

On December 10, Dr. Richard Buttery from General Atomics presented a colloquium titled, "DIII-D Explorations of Fusion Science to Prepare for ITER and FNSF".

December 10 - 11, S. Prager, D. Meade, and T. Brown participated in the annual Fusion Power Associates meeting, held in Washington, DC.

AWARDS:

Dorfman, S., American Geophysical Union F.L. Scarf Award for his dissertation research on MRX

Dorfman, S., American Geophysical Union Basu Early Career Award for Research Excellence in Sun-Earth Systems Science

PPPL U.S. Environmental Protection Agency (EPA), Region 2, Certificate of Achievement from the Food Recovery Challenge for our food waste composting program

PPPL U.S. Environmental Protection Agency (EPA), Region 2, WasteWise Federal Partner of the Year award for our comprehensive waste diversion and recycling program

INVITED TALKS:

Yoo, J., "Asymmetric reconnection," American Geophysical Union Fall 2013

Dorfman, S., "Impulsive reconnection," American Geophysical Union Fall 2013

Fisch, N., "Enhancing Resonant Raman Compression in Plasmas," Conference on High Intensity Laser and Attosecond Science, Israel

PUBLICATIONS:

Ahn, J-W. (ORNL), et al., "Characterization of divertor footprints and the pedestal plasmas in the presence of applied $n=3$ fields for the attached and detached conditions in NSTX," Plasma Physics and Controlled Fusion 56 (2014) 015005, <http://iopscience.iop.org/0741-3335/56/1/015005>.

LEADERSHIP POSITIONS:

Zarnstorff, M., NIFS, Toki, Japan, External International Review Committee meeting

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