



The PPPL Highlights for the week ending September 23, 2017, are as follows:

NSTX-U RECOVERY AND RESEARCH (J. Menard)

Recovery

In the Coil Winding Facility, all components of the Vacuum Pressure Impregnation (VPI) test mold are ready. Vacuum leak checking and installations of manifolds are underway in preparation for the test VPI. Bus work and supports for inner PF Coil power testing have been set up on the Field Coil Power Conversion (FCPC) Test Stand and are ready for engineering review. A Final Design Review of the FCPC Test Stand pump cart modifications was successfully held this week.

All equipment and hardware has been located for the horizontal positioning of the NSTX-U center stack. This repositioning is required to replace the center column cooling tubes, and will accommodate plasma facing component work.

Research

Members of the NSTX-U research team attended the 19th International Spherical Torus Workshop (ISTW-2017) at Seoul National University, Seoul, Korea, Sept. 19-22, 2017. "Overview of NSTX Upgrade Initial Results and Modelling Highlights," was presented by J. Menard (PPPL). Oral presentations were "Facility and Diagnostic Commissioning for Initial Operation of the NSTX-U Facility," by M. Ono (PPPL), "NSTX-U Plasma Commissioning and Scenario Development," by D. Mueller (PPPL), "Non-axisymmetry at the center of NSTX – Lessons to optimize 3D tokamaks," by J-K Park (PPPL), "Numerical simulations of stabilization of Global Alfvén Eigenmodes (GAEs) in NSTX-U," by E. Belova (PPPL), Next-Step Low-Aspect-Ratio Tokamaks Using High-Temperature Superconductors and Liquid Metal Plasma Facing Components," by J. Menard, "Gyrokinetic heat-flux footprint in NSTX and NSTX-U plasmas," by S. Ku (PPPL), "Requirements, Designs and Plans for NSTX-U High Heat Flux Plasma Facing Components," by M. L. Reinke (ORNL), "The effects of the HHFW wave-field on the evolution of fast ion / beam ion populations in NSTX plasma," by N. Bertelli (PPPL), "NSTX Vertical Displacement Event 3D nonlinear modelling with M3D-C1," by D. Pfefferlé (PPPL), "Progress toward LTX- β ," by R. Majeski (PPPL), "Transient CHI Research on STs," remotely presented by R. Raman (University of Washington), and "Validating gyrokinetic predictions using NSTX-U plasmas," by W. Guttenfelder (PPPL). In addition, six NSTX/NSTX-U related posters were presented. The workshop was well attended with approximately 66 registered participants from 8 countries including China, Japan, Korea, Italy, the United Kingdom, Russia, and the United States.



Overall, presentations included 13 overview orals, 21 contributed orals, and 24 posters. Menard chaired and Ono served on the ISTW program committee. The program also included a guided tour of Seoul National University experimental facilities including visits to the VEST spherical tokamak.

Several NSTX-U researchers and collaborators also attended the 1st Asia-Pacific Conference on Plasma Physics held Sept. 18-23 in Chengdu, China. Researchers presented the following invited talks: "Validating gyrokinetic simulations using NSTX and NSTX-U plasmas," by W. Guttenfelder, "Optimization of Resonant and Non-resonant Magnetic Perturbations in KSTAR," by J-K Park, "Power management in ITER for NTM control, the path from the commissioning phase to the demonstration baseline," by F. Poli, "Exploring the Regime of Validity of Global Gyrokinetic Simulation with Spherical Tokamak Plasmas," by Y. Ren, "Investigation of the Generalized Neoclassical Toroidal Viscosity Offset Rotation Profile in KSTAR," by S. Sabbagh, and "Full toroidal computation of resistive MHD instabilities based on asymptotic matching approach," by Z. Wang.

ITER & TOKAMAKS (R. NAZIKIAN)

DIII-D (B. Grierson)

B. Grierson, R. Maingi and A. Bortolon recently attended the ITPA Transport and Confinement and Pedestal and Edge Physics working group meetings in Helsinki, Finland. R. Nazikian presented a talk to the Pedestal and Edge Physics group via teleconference. Bortolon presented results on the analysis of the ELM peak heat flux as a function of collisionality and pedestal pressure in the DIII-D tokamak. The study indicates that collisionality plays a weak role in the scaling of the peak heat flux, consistent with recent work from AUG and JET. R. Nazikian presented a talk on the suppression of large amplitude ELMs in steady state plasmas in the DIII-D tokamak. These so-called hybrid plasmas approach conditions of confinement, current drive and stability that project favorably to ITER steady state operation.

ITER-JET: (F. Poli)

F. Poli attended the first meeting of the Asian Pacific Physics Society, Division of Plasma Physics (APPS-DPP) in Chengdu, People's Republic of China, September 18-23. She gave an invited talk entitled "Electron Cyclotron power management in ITER: the path from the commissioning phase to demonstration discharges." This research has been accepted for publication in *Nuclear Fusion* in a paper titled "Electron Cyclotron power management for control of Neoclassical Tearing Modes in the ITER baseline scenario." The paper describes simulations using TRANSP with a reduced model for NTM stability and EC feedback to assess how beam misalignment with the resonant surface, broadening

of the EC deposition, and discharge evolution affect the stabilization of neoclassical tearing modes. The research concludes that pre-emptive control of tearing modes should lead to higher overall fusion gain than the alternative method of applying EC power when the mode goes unstable.

C-MOD: (R. Nazikian)

L. F. Delgado-Aparicio is visiting the X-ray group at the Institute of Plasma Physics (IPP) Chinese Academy of Sciences (CAS) in Hefei, China, to work on an ITPA activity for using xenon as a working gas for present and future X-ray crystal spectrometer systems. The large benefit over krypton is that xenon can be used for both core ($r/a < 0.5$) and mid-radius ($0.5 < r/a < 0.9$) measurements in fusion experiments. The reason to undertake an experiment with xenon in EAST is to check whether the emission lines will be seen, and are usable, in high-Te plasmas. First results from Alcator C-Mod were encouraging since neon-like lines were clearly observed, but are also marginal since the core temperature did not exceed 3-3.5 keV. L. Felipe and K. Hill have proposed leading an ITPA Joint Experiment in five tokamaks and stellarators worldwide to assess the measurement capability for fusion devices.

ADVANCED PROJECTS (H. NEILSON)

Stellarators (D. Gates)

An article written by D. Gates, *et al.*, “Recent Advances in Stellarator Optimization,” was accepted for publication in the journal *Nuclear Fusion*. The article outlines the basis for a program in stellarator optimization based on four basic new elements, namely: 1) turbulent transport optimization, 2) coil simplification, 3) divertor optimization, and 4) fast particle confinement optimization. The paper was submitted in conjunction with the 2016 IAEA Fusion Energy Conference held in Kyoto, Japan in 2016.

As part of the Laboratory’s collaboration with Germany’s Wendelstein 7-X (W7-X) stellarator project, an experiment, “Trim coil modulation of divertor heat loads,” was conducted by PPPL physicist S. Lazerson this week. The experiment used the U.S.-built trim coil system to apply a perturbing magnetic field in a pattern known as a “compass-scan.” This experiment will help researchers dial in magnetic field perturbations designed to improve performance and protect sensitive wall panels.

A seminar, “The U.S. Stellarator Research Program,” was presented by PPPL stellarator physics head D. Gates at the University of Illinois at Urbana-Champaign. The seminar, which described current U.S. activities as well as opportunities in stellarator research, was attended by approximately 100 people including graduate students and faculty. Dr. Gates also toured the facilities and met with faculty members.

Weekly

HIGHLIGHTS



System Studies (C. Kessel)

A report on PPPL work supporting the China Fusion Engineering Test Reactor (CFETR) study was submitted to the sponsor, the Institute of Plasma Physics, Chinese Academy of Sciences (ASIPP). The report addresses the topics of facility configuration, plasma physics design issues, magnet mechanical design, and solid-breeder multi-phase water blanket simulation. In addition the work of two students, from ASIPP and the University of Sciences and Technology of China (USTC), hosted by PPPL for the past year, is summarized. Student X. Cheng has concentrated on Be-water/steam interactions under accident conditions for the CFETR water-cooled ceramic breeder blanket design. L. Liu is performing time-dependent plasma evolution simulations, examining structure models, feedback control, pedestal model, heating and current drive, and ideal MHD stability.

ENGINEERING & INFRASTRUCTURE (V. RICCARDO)

DIII-D Collaborations

S. Jurczynski (PPPL) hosted A. Harris (DIII-D NB) at the PPPL braze shop, collaborating on brazing techniques, with a focus on the Neutral Beam (NB) Source Langmuir probes. The original design uses several hard-to-perfect braze joints. He has found work-arounds for some of these joint designs while keeping the design form, fit, and function. They spent 3 days brazing and testing joints in this "brazathon" collaboration.

A successful final design review was held on the NB 210 OANB high-voltage transmission line. This two-port transmission line connects the high-voltage power supplies to the NB sources in both the co- and counter positions. Each position has two patch panels (left and right source) where the respective source is connected. A new tee junction in each of the two lines, splits the 28 high-voltage wires routed to these patch panels. High-voltage testing up to 180 kilovolts across a 7.5" gap (93 kilovolts required) using prototype components has qualified the line/duct assembly. The snubber located inside the shield wall 24" diameter penetration qualified at 140 kilovolts for 100 seconds across a 6" gap.

PPPL is providing three major NB210 OANB components for LTO3: the pole shields delivered in June, calorimeter delivery scheduled for September 30, and the absolute collimator, successful FDR held this week, delivery scheduled January 2018. Each of these components has PPPL engineering design features that reduce cost while increasing performance. The pole shields use moly plates (replaceable with a NB entry) in the heat-affected zone, and found to work superbly on the NB330. The calorimeter uses gun-drilled coolant channels to prevent water channel cracking and an expanded array of thermocouples for beam thermal imaging. The absolute collimator has two "diving boards" on each lower corner to spread heat load and are removable from inside the NB.



Power Systems

Substation upgrades were completed, and the CAS/RESA building has been transferred to its primary source of power (Sub 19).

New towers needed for the GPP#235 work to replace aging underground 138 kilovolt cabling were delivered to PPPL this week.

SITE PROTECTION (F. WHITE)

ESU personnel completed car fire training.

Staff members of the Site Protection Division conducted ORPS Facility Manager (FM) training sessions addressing recent changes to a DOE order that directly affects the ORPS FM process for reporting events at PPPL. Sessions included an overview of the DOE Order as well as hands-on case studies in which facility managers practiced "break-out" sessions addressing past PPPL events.

The Emergency Management Review Committee (EMRC) met to discuss future Emergency Management Activities involving PPPL Emergency Operation Systems and the PPPL Occupational Medicine Office (OMO). Staff members of the OMO have been providing guidance to the EMRC concerning potential health related events and suggested practices. A staff member of the University Medical Center of Princeton at Plainsboro attended this meeting to provide hospital operations information concerning health related events.

COMMUNICATIONS & PUBLIC OUTREACH (A. ZWICKER)

COMMUNICATIONS (L. BERNARD)

The Office of Communications posted one press release this week to the PPPL website. The release focused on PPPL physicist F. Poli being appointed an ITER science fellow. She will facilitate installation of TRANSP, the PPPL-developed computer code that is used throughout the world to analyze and predict fusion experiments. Included in her role will be the design of scenarios for the ITER research plan and the training of young researchers on operation of the code. In her role she will help develop the scientific program to be carried out during ITER's lifetime. The press release was also posted on the *Newswise* and *EurekaAlert!* distribution services.

DIRECTOR'S OFFICE (R. HAWRYLUK)

On September 20, Professor D. McComas presented a colloquium entitled, "The Interstellar Boundary Explorer (IBEX)."

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