



The PPPL Highlights for the week ending September 14, 2019 are as follows:

NSTX-U RECOVERY (J. GALAYDA) AND RESEARCH (S. KAYE)

Recovery (J. Galayda):

J. Malo, R. Camp, and J. Petrella attended the Accelerator Safety Workshop in Oak Ridge, TN. They made presentations on topics including the ASO implementation at NSTX-U and the NSTX-U Personnel Safety System Implementation.

Design Review "T-1" meetings were held this week for conceptual design reviews (CDRs) Beam Emission Spectroscopy (BES) Shutter Upgrade, Neutral Beam Injection (NBI) Duct Shield, and NSTX-U Seal Repair; preliminary design reviews (PDRs) Real Time Control and Protection Spares FPDP Input Multiplexor Module (RTCP-FIMM-2) and NSTX-U Shorted Turn; and a final design review (FDR) for the NSTX-U RTCP spares DITS (Digital Input and Time Stamp). These reviews will be held the week of Sept. 16-20.

The complete set of pre-ESAAB IPR recommendations were closed out this week.

Research (S. Kaye):

M. Podestà attended the 23rd ITPA Energetic Particles meeting in Mito, Japan, Sept. 9-11. Podestà reported on the status of and plans for Joint Experiment EP-8 on "Validation of Neutral Beam Current Drive And Projections To ITER," which is led by NSTX-U/PPPL. This involves several other devices from the US and abroad. Recent work focused on the effect of fishbone and NTM instabilities on NB-CD from MAST, KSTAR, and NSTX-U, and shows the detrimental effect of those instabilities for maximizing neutral beam current drive efficiency. Future research activities on other EP-relevant areas where NSTX-U can contribute, such as NB ion transport by 3D fields, were also discussed.

U.S. ITER FABRICATION (H. NEILSON)

Manufacturability studies for the Low Field Side Reflectometer (LFSR) in-vessel antenna assembly continue to progress. A series of small-scale manufacturing trials for LFSR hardware was completed, showing excellent results that validate current design and fabrication approaches. Deep-bore "gun drill" holes for cooling water passages were machined along the length of a 44-cm-long stainless-steel tube prototypical of an LFSR antenna. The achieved accuracy was well within design tolerances, validating the assumption that design requirements could be achieved with this drilling process. In addition, several "weld plugs" were fabricated and welded to seal holes a steel test block. The weld plugs are complex, design-critical steel parts that are machined and welded over open ends of the gun-drilled cooling passages in the antenna components,

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sealing them against water leakage. Successful plug welds were performed in several prototypical configurations and will soon undergo inspections.

ITER & TOKAMAKS (R. NAZIKIAN)

DIII-D (B. Grierson):

Research:

The article titled, “Formation of a High Pressure Staircase Pedestal with Suppressed Edge Localized Modes in the DIII-D Tokamak” by A. Ashourvan has been published in *Physics Review Letters*: <https://doi.org/10.1103/PhysRevLett.123.115001>. This article presents the formation of a staircase in the pedestal density and temperature profiles during periodic widening and narrowing of the H-mode barrier that occurs during ELM suppression by static 3D fields. As the pedestal widens, a region of low ExB shear in the middle of the steep gradient region broadens and the profiles flatten locally. CGYRO simulations indicate that core-like turbulent transport emerges in this region where the gradients are flattened. The confinement is not degraded by the emergence of this local flattening because the pedestal grows higher as it widens.

A. Reiman traveled to DIII-D and presented a seminar entitled, “Suppression of magnetic islands via RF current condensation,” to the 3D & Stability Physics group. The seminar examined the physics of a nonlinear current condensation effect recently predicted in [Reiman & Fisch, *Physical Review Letters* 121(22), 2018] and facilitated ongoing optimization of a FY20 DIII-D experimental plan to test and validate the theoretical predictions.

F. Laggner traveled to PPPL for acceptance testing of upgraded amplifiers for the Ly-alpha diagnostic, which has been implemented on DIII-D through a collaboration with the MIT PSFC. Upgraded amplifiers now have one order of magnitude higher gain of 10^8 , and passed acceptance testing on all channels. This achievement completes the design upgrade, which was performed in-house at PPPL with a fast one-month turn-around, now ready to be installed at DIII-D. The compact, highly customized system reliably resolves the low photocurrents that are on the order of nano-amperes. Initial measurements indicated that the gains could be increased further to use the full range of the digitizer, prompting the upgrade of the transimpedance amplifier system.

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Operations:

The waveguide switch network for the DIII-D helicon system produced by Mega Industries has been delivered to DIII-D. This waveguide switch network is needed to direct power to each end of the traveling wave antenna to study plasma coupling in both directions. The switch functions and RF losses are currently going through receipt inspection and will be installed on Mezzanine 2 at the end of September before being connected to the helicon transmission lines.

ITER-JET (F. Poli):

A. Teplukhina presented results from TRANSP simulations of JET discharges with ion cyclotron and neutral beam heating and current drive. The analysis has identified systematic errors in the solution of the particle balance equation from physics effects on the calculated neutron rate and plasma composition. The goal is to establish a robust approach that can be used for predicting discharges with IC and NBI with confidence, and that allows projections from deuterium to DT discharges.

ADVANCED PROJECTS (D. GATES)

Stellarators (D. Gates):

D. Gates, E. Gilson, R. Lunsford, and F. Nespoli traveled to the National Institute for Fusion Science in Toki, Japan, Sept. 9-13. The primary purpose was to help install an impurity powder dropper (IPD) on the Large Helical Device. The dropper was fabricated and designed by A. Nagy. Gilson led the installation activity on the PPPL side and implemented some minor hardware improvements. He was assisted by F. Nespoli, who will be using the IPD for experiments in the upcoming LHD campaign. Nespoli and Gilson worked with Japanese colleagues N. Ashikawa and S. Masuzaki to prepare the device for installation. Lunsford worked with Japanese colleague M. Shoji to prepare the IPD control system and to plan the interfaces to the LHD control system. All activities were successfully completed and the IPD was installed on LHD on Sept. 13.

D. Gates gave a seminar at the National Institute for Fusion Science in Toki, Japan, on Sept. 9 titled, "Preliminary plans for a stellarator based on permanent magnets." In the talk, he described a new concept for building stellarators using only planar toroidal field coils and permanent magnets to provide the plasma shaping. The talk was attended by members of the NIFS research staff. PPPL has a long-standing relationship with NIFS and there has been an active collaboration on stellarator optimization for several years now.

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THEORY (S. HUDSON)

V. Duarte gave a talk at the 23rd ITPA Topical Group on Energetic Particles Meeting titled, “First-principle formulation of resonance-broadened quasilinear theory near an instability threshold.”

M. Churchill attended the group meeting for the Exascale Project Co-Design Center for Particle applications (ECP-CoPA) in Santa Fe, NM, and presented a talk titled, “Machine learning in XGC1.”

I. Dodin gave an invited talk at the US-Japan Workshop on RF Heating Physics, held at PPPL Sept. 4-6. The talk, titled, “Theory of mode-converting quasioptical wave beams in inhomogeneous plasma,” described recent theoretical work done in collaboration with researchers from NIFS (Japan), Nagoya University (Japan), Sandia, and PPPL. The goal of this work is to improve modeling of electron-cyclotron resonant heating in fusion plasmas, particularly on the Large Helical Device (NIFS, Japan). A new code based on this theory was also presented at the workshop by one of the collaborators, K. Yanagihara (Nagoya University).

A paper by F. Ebrahimi was published in *Physics of Plasmas* on Sept. 3 titled, “Three-dimensional plasmoid-mediated reconnection and the effect of toroidal guide field in simulations of coaxial helicity injection:” <https://doi.org/10.1063/1.5098482>
The effect of toroidal fields on the 3-D stability of edge-reconnecting, current-carrying filaments is investigated using full nonlinear MHD simulations in spherical tokamaks.

C. Clouser, S. Jardin and N. Ferraro published a paper titled, “Vertical Forces during VDEs in an ITER plasma and the Role of Halo Currents,” in *Nuclear Fusion*:
<https://doi.org/10.1088/1741-4326/ab440a>

TRANSP (F. POLI)

P. Rodriguez from PSFC-MIT visited PPPL this week to work with the TRANSP group. He gave a seminar on Monday entitled, “Integrated modeling and predict-first experiments of perturbative cold pulses in tokamak plasmas.” Pablo has worked with the TRANSP group on predictive modeling for plasma discharges on SPARC.



COMMUNICATIONS & PUBLIC OUTREACH (A. ZWICKER)

Communications (L. Bernard):

The Office of Communications posted three news stories to the PPPL website. One was an overview of the research performed by summer interns. Another profiled summer intern Promise Adebayo-Ige, a rising senior majoring in chemical engineering at the University of Pennsylvania who plans to attend graduate school in nuclear engineering, with the goal of working on the quest for fusion energy. The third focused on interns Alex Ni and Remy Plattiers, who this summer worked on building an acoustic levitator that causes droplets of water to levitate in mid-air so their interaction with plasma can be examined. The stories were also posed to the *Newswise* press release distribution service.

DIRECTOR'S OFFICE (S. COWLEY)

On Sept. 10-11, S. Cowley chaired the Turbulent Dynamics of Tokamak Plasmas External Advisory Board (TDoTP) meeting, which was held at the York Plasma Institute in the United Kingdom.

J. Menard attended the ITER U.S. Business Forum, held in the chambers of the House Science Committee in Washington, D.C., on Sept. 10.

On Sept. 11, PPPL received CD-0 approval for the Princeton Plasma Innovation Center (PPIC), a state-of-the-art laboratory and collaboration building.

This report is also available on the following web site:

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