



The PPPL Highlights for the week ending September 21, 2019 are as follows:

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

Recovery (J. Galayda):

NSTX-U Blanket Ordering Agreements — Significant progress was made this week. Proposals were received from nine vendors to supply fabrication and machining services. In addition, a pre-bid conference was held with prospective vendors that may bid on a metrology solicitation for the NSTX-U Recovery Project.

NSTX-U CDE-2/3A Approval — The IPR recommendations needed for approval have been closed out this week. The DOE Federal Project Director (FPD) and PPPL Project Manager jointly briefed Chris Fall, Director of the DOE's Office of Science, on the NSTX-U Recovery Project. CDE-2/3A approval is expected in the near future.

RTPC Spares Digital Input And Time Stamp (DITS-2) FDR — A final design review (FDR) was held Sept. 16 for the Real-Time Protection and Control (RTPC) digital input and time stamp (DITS-2) module. This module is part of a group of front panel data port (FPDP) electronic hardware components that form the data acquisition and physical transport layer for the group of measurements that control and protect NSTX-U. A lack of spare FPDP components was identified during a design validation and verification review (DVVR), and existing drawings showed a number of technical issues. This FDR reviewed a revised design of the DITS-2 module, which included coverage of requirements, design schematics, and circuit layout. The FDR was deemed successful, pending resolution of chits and document signatures.

RTPC Spares FIMM-2 PDR — A preliminary design review (PDR) was also held on Sept. 16 for the FPDP Input Multiplexor Module (FIMM) module. One of a group of front panel data port (FPDP) electronic components, the FIMM previously combined output from multiple FPDPs into one multiplexed data output stream. That single FPDP output stream was then serialized using an SL240 converter that sent data upstream through optical fiber to the real time protection and control (RTPC) computing system. The SL240 cards are becoming increasingly difficult to obtain; this PDR reviewed a revised FIMM-2 design to deal with that issue. The PDR was deemed successful, pending resolution of chits and document signatures.

Seal Repair CDR — The wire-seal flange bays I, H, and F in the NSTX vacuum vessel have been identified as sources of vacuum leaks. A conceptual design review (CDR) was held Sept. 17 to review a conceptual design to diagnose the source of the vacuum leaks and examine possible solutions to restore the vacuum seal integrity for each flange bay. It

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was determined that a peer review is prudent to examine two of the flanges before moving forward with the FDR. The review was deemed successful pending resolution of chits.

NBI Duct Shield CDR — A conceptual design review was held on Sept. 18 to review a design for shielding plates for the neutral beam injection (NBI) duct at Bay K in the NSTX-U test cell. This NBI duct will be exposed to re-ionized beam and radiative heating by the plasma. The design reviewed at the CDR involves the installation of molybdenum plates to shield the vacuum vessel. The review was deemed successful, pending resolution of chits.

BES Shutter Upgrade CDR — A conceptual design review was held Sept. 19 for the Beam Emission Spectroscopy (BES) shutters. It was discovered after the 2016 NSTX-U run campaign that the boron nitride (BN) covers for the BES shutter had failed, and BN fragments were found on the lower inboard diverter. This review examined a conceptual design of the BES shutter upgrade and confirmed proposed solutions to reduce the risk of future shutter failure. The review was deemed successful, pending resolution of chits.

Research (S. Kaye):

An NSTX-U Program Advisory Committee (PAC) video conference was held on Sept. 11. The charge to the PAC asked for advice on whether the present and future milestones and collaborations advance the spherical tokamak (ST) and fusion energy research in general as well as the targeted recommendations from the NAS and FESAC TEC reports. Presentations were made by S. Kaye (Status of Research Program and Team), S. Gerhardt (Status of the Recovery Project), D. Battaglia (Milestone Research), A. Diallo (Non-Milestone Research and Collaborations) and R. Maingi (Ideas for a Longer-Term Liquid Metal Program).

S. Kaye, F. Yang, and A. Pritch attended the Office of Scientific and Technical Information sponsored Data ID Service Workshop on Sept. 17-18 at OSTI Headquarters in Oak Ridge, Tennessee. The workshop focused on how to make OSTI data services (including data collections DOIs and associated metadata for publications and data files) useful for researchers. OSTI was looking for feedback from the Community on how to advance their services.

The paper titled, "From a Reflectometry Code to a 'Standard' EC Code to Investigate the Impact of the Edge Density Fluctuations on the EC Waves Propagation," by N. Bertelli, G. Kramer, and E. Valeo was published in *Plasma Physics and Controlled Fusion*. In this work, FWR2D and FWR3D codes, originally developed for reflectometer simulations,

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have been employed and extended to study the impact of the edge density fluctuations on the electron cyclotron (EC) wave beam propagation. 2D and 3D simulations for DIII-D-like plasma have been discussed with and without the presence of the edge density fluctuations in order to evaluate the impact on the EC wave beam broadening at the location of the EC resonance. Moreover, a comparison between the paraxial and full-wave solution (which are both implemented in the code, making it very flexible) of the EC beam is shown with and without edge density fluctuations. The simulations demonstrate the importance of the edge density fluctuations to the EC propagation in agreement with previous work. The paper can be found here:

<https://iopscience.iop.org/article/10.1088/1361-6587/ab4106/pdf>

F. Poli traveled to Chicago on Sept. 19 to participate in “The Third Summit on Diversity and Inclusion for Female Technical Leaders in DOE Laboratories.” Representatives from the national laboratories of the DOE complex met at the Hilton O’Hare to discuss recent progress in diversity and inclusion at their respective laboratories and perceived challenges in implementing an inclusive workplace.

U.S. ITER FABRICATION (H. NEILSON)

Documentation of the Low Field Side Reflectometer design advanced toward closure of the preliminary design phase of the project. Compliance with challenging ITER mechanical requirements is documented in two structural integrity reports (SIR), an in-vessel SIR and an ex-vessel SIR. The in-vessel SIR, which documents the response of the in-vessel equipment to a range of loading conditions including nuclear heat loads, disruption electromagnetic forces, and seismic acceleration was approved by the ITER Central Team. The ex-vessel SIR focuses on the waveguide system that transmits microwaves between the tokamak and the diagnostic building, and documents the structural performance against a range of loads and load combinations including dead weight, seismic, and thermal. It also analyzes failure modes of safety-important components in the system. Revisions to the ex-vessel SIR were recently submitted to the U.S. ITER Project Office for approval prior to submission to the Central Team.

ITER & TOKAMAKS (R. NAZIKIAN)

DIII-D (B. Grierson):

Research:

B. Grierson has been named as leader of the DIII-D Pedestal and ELM Group. The Pedestal and ELM Group is one of the three scientific groups in DIII-D Experimental Science, along with Burning Plasma Physics and Dynamics & Control. The Pedestal and



ELM group oversees research on pedestal structure physics, ELM control by 3D fields, and QH-mode.

The paper, “Integrated Zeff Analysis on the DIII-D Tokamak,” by K. Callahan, a 2018 SULI student mentored by B. Grierson, C. Chrystal, S. Haskey, J. Herfindal, and B. Heidbrink, has been accepted for publication by the *Journal of Instrumentation* (JINST). The paper, which combines active charge-exchange spectroscopy, filtered visible bremsstrahlung and spectral bremsstrahlung measurements, demonstrates the self-consistent determination of the plasma composition Zeff. This paper is based on Callahan’s summer project on DIII-D and was presented at the European Plasma Diagnostics Conference.

Operations:

The helicon system switching network has undergone radio-frequency (RF) testing and passed acceptance. The RF measurements are in conformance with the measurements provided by the manufacturer Mega Industries. Mechanical and electrical operation of the switch function is in compliance with the specifications. These tests complete acceptance testing of the switch that will be installed in the next DIII-D vent.

THEORY (S. HUDSON)

R. Hager's paper titled, “Cross-verification of neoclassical transport solutions from XGCa against NEO” (with co-authors J. Dominski and C-S Chang) has been accepted for publication in *Physics of Plasmas*. The paper discusses a rigorous benchmark of neoclassical transport physics between the global gyrokinetic particle-in-cell code XGC and the local drift-kinetic steady-state code NEO. Excellent agreement between the two codes has been found.

A paper co-authored by H. Qin titled, “Field theory and a structure-preserving geometric particle-in-cell algorithm for drift wave instability and turbulence,” was published in *Nuclear Fusion* on Sept. 9. The field theory and associated algorithm reported were customarily designed for studying magnetic fusion plasmas. The long-term accuracy and fidelity of the resulting algorithm enable the first-ever simulation study of turbulent transport based on first principles using fully kinetic particles.

S. Hudson visited the Fermi and Argonne National Laboratories as part of the Oppenheimer Science Energy Leadership Program (OSELP). The Oppenheimer cohort met with senior laboratory officials and toured the major facilities.



The paper titled, “Numerical simulations of global Alfvén eigenmodes excitation and stabilization in NSTX-U,” by E. Belova, E. Fredrickson, J. Lestz, N. Crocker, and the NSTX-U team has been published by *Physics of Plasmas*.

COMMUNICATIONS & PUBLIC OUTREACH (A. ZWICKER)

Science Education (A. Zwicker):

Mercer County Technical Schools interviewed S. Greco about PPPL’s new apprenticeship program. The interview was featured on the podcast titled, “The MCTS Experience,” and can be heard here: <https://www.buzzsprout.com/203641/1736341-s2-e1-2-princeton-plasma-physics-laboratory>

Communications (L. Bernard):

The Office of Communications posted one news story to the PPPL website. It focused on PPPL researchers having developed new insights into the physics governing the balance of pressure in the scrape-off layer. The story was also posted to the *Newswise* and *EurekAlert* distribution services.

L. Bernard attended the fourth *Science Communications Summit: Scientists as Communicators* conference hosted by the U.S. Department of Energy Office of Science, Office of Communications and Public Affairs, at the Stanford National Accelerator Laboratory in Palo Alto, California, Sept. 16-17.

DIRECTOR’S OFFICE (S. COWLEY)

On Sept. 17, PPPL received CD-0 (critical decision zero) for Critical Infrastructure Recovery and Renewal to replace and update key infrastructure and Tritium System Demolition and Disposal to remove these legacy systems and equipment which will also create space for future mission work. These are major milestones for these Science Laboratories Infrastructure (SLI)-funded projects.

On Sept. 18-19, the PPPL advisory board held one of its bi-annual meetings. The purpose of the PPPL advisory board is to provide an outside independent review of PPPL’s mission, science and operations. The advisory board then provides Princeton University with feedback and recommendations.

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