The PPPL Highlights for the week ending August 29, 2020, are as follows:

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

Recovery (J. Galayda):

Management — Accompanied by a group of PPPL staff and NSTX-U managers, S. Cowley toured PPPL and NSTX-U facilities that included C- and D-sites and the neutral beam shop area.

Coils — A total of four coils (PF1B#1, PF1C#1, PF1A#1, and PF1A#2) were received at PPPL and passed low-power testing. Sigmaphi returned from vacation and PF1B#2 vacuum pressure impregnation (VPI) occurred as the coil cured. In addition, spare coil winding began for both the PF1A and PF1C spare coils.

Center Stack Casing (CSC) — The current phase of machining was completed in Camden, New Jersey and the CSC will be shipped to Turtle Creek to attach the collar pieces on each end; it will then be returned to Camden in early September for more machining. In addition, vacuum testing of all of the spare bellows was successfully performed at PPPL and the bellows were trimmed and inspected so they could be sent to ORT / Holtec for installation.

Machine Core Structure (MCS) — Many fabrication activities continued at the three facilities currently making sling parts. Precision Boring in Michigan continued fabrication of the PF1A and PF1B capture and common flanges and PF1C capping flanges for the sling supports. In South Carolina, Carolina Fabricators first articles and production of PF1A sling parts continued and partial shipment of PF1A hanger parts was accepted at PPPL. Also, G. J. Oliver added components to the machined PF1C supports and will ship the supports out for coating in the near term. Additional procurement activities to award contracts for the remaining MCS components neared completion.

Interspace Vacuum Pumping System (IVPS) — On-site activities to install power to the vacuum pump and perform mechanical installations of the vacuum system components will resume upon approval in early September.

Personnel Safety System (PSS) — The subcontract for the installation of the Personnel Safety System Conduit & Cable System was awarded on Aug. 28 to Electric-Tech, Inc. of Folsom, New Jersey.

PF Bus Supports — The design, analysis, and drawing efforts for coil flag position changes continued and drawings were finalized. Procurement activities continued in series to final drawing updates.
**PF1C Coil Assembly and Assembly Fixture Peer Review** — A peer review was held on Aug. 26 to review the design of the PF1C coil assembly fixture and the assembly process for PF1C coils. This review was needed to identify potential component mating issues, tolerances for assembly and to identify the assembly and sub-assembly process the PF1C can support. The design of assembly fixtures as a platform for the installation of required diagnostic instrumentations was also reviewed.

**ITER PROJECTS (H. NEILSON)**

**Toroidal Interferometer Polarimeter — TIP (M.-A. De Looz):**

A Trapped Components design team is preparing to complete the design of overhead supports for TIP laser beam tubes. The team has reviewed information shared by the central team responsible officers (ROs) on load specifications applicable to both LFSR and TIP captive components and other ex-vessel support structures. Engineer A. Buahin has identified a good proposal for applicable loads to both systems and is summarizing a proposal to be reviewed with central team colleagues. Engineer M. Mansour reviewed the wall penetration design of a first-plasma (FP) electron-cyclotron heating (ECH) system, from which many lessons learned and design constraints can be extracted. The team is working to define a clear path forward for Trapped Components design and deliverables for both TIP and LFSR.

**Motional Stark Effect — MSE (A. Cohen):**

The MSE team continued its analysis of the front mirrors of the MSE ports to determine what, if any, active cooling will be required. Multiple iterations have been analyzed for temperature and deflections. The mirror surfaces are biconic in their geometry. A spherical fit of the biconic mirrors showed deformations in the +/- 1.5 µm range. This characterization is being used to determine the effect of deformations on optical performance. PPPL has regained control over the CAD models for MSE and has updated them with new lines of sight, mirror locations and space reservations that have been changed in recent years.

**Low Field Side Reflectometer — LFSR (A. Zolfaghari):**

The LFSR team is developing technical specifications for the main components of the in-vessel antenna assembly. PPPL engineer S. Shirey led the effort, working with members of the U.S. ITER systems engineering and quality assurance teams. These documents, which ensure that ITER-approved engineering standards will be flowed down to the manufacturer, must be approved by the ITER Organization in order to close final design of the in-vessel assembly.
Electron Cyclotron Emission — ECE (G. Paraiso):

The PPPL team is modifying the design of an ex-vessel compliant seal to be compatible with changes in the primary vacuum window proposed by the ITER window design team. The compliant seal is designed to maintain a gas seal compliant enough to handle relative motion the port plug and ex-vessel transmission lines. Additional updates to the front-end optics layout are being studied in order to improve and simplify the configuration. Options for component repositioning are being explored to manage the space constraints within the new diagnostic shield module design.

Diagnostic Residual Gas Analyzer — DRGA (C. Klepper, ORNL):

The DRGA team is preparing a document describing the periodic maintenance, test and inspection plan for the system. Existing documentation includes a maintenance procedure for removal and service of the DRGA analysis station, while maintaining tritium containment. The present document is more general and covers periodic inspection both of vacuum integrity of the system and of proper functioning of the electronics instrumentation that powers and controls their sensors.

ITER & TOKAMAKS (R. NAZIKIAN)

International PMI (R. Maingi & A. Diallo):

R. Maingi presented a webinar to the USBPO (Burning Plasma Organization) Research Council that described conclusions from a 2014 BPO study titled, “Modes of Participation in ITER.” The report made recommendations on how ITER could operate, based on U.S. facility operating practices, as well as how the US ITER team should be formulated. The report foresaw the need for a bottoms-up assessment of strategic technical opportunities for U.S. participation in ITER, in which the BPO is now engaged.

R. Lunsford completed the programming of the control system for the WEST impurity powder dropper. The LabVIEW based compact RIO stand-alone hardware control system provides rapid integration of the impurity powder dropper into collaborative facilities with low overhead on the facility’s native data acquisition support team. The PPPL-written impurity powder dropper control program has been simplified to allow for ease of operation by the local WEST team so that experiments can continue even during times of restricted travel. Also, architecture has been put in place to begin exploring feedback control of the powder dropper during WEST long-pulse discharges.
H. Zhu, a graduate student in the Program in Plasma Physics, successfully defended his thesis, “Phase-space Theory of Drift Wave–Zonal Flow Interactions and the Dimits Shift,” and passed his Final Public Oral Examination (FPOE) on Aug. 25. His thesis advisor was I. Dodin. He will be working as a postdoctoral researcher with T. Stoltzfus-Dueck at PPPL.

M. Churchill and R. Kube attended the Brookhaven National Laboratory Virtual GPU Hackathon Aug. 17-19, where they worked in a team with J. Choi from Oak Ridge National Laboratory and mentors from NVIDIA to profile and accelerate the disruptCNN code, a deep learning code for tokamak disruption prediction.

A paper titled, “Analytic theory of the tertiary instability and the Dimits shift within a scalar model,” by H. Zhu, Y. Zhou, and I. Dodin has been published by the Journal of Plasma Physics: https://doi.org/10.1017/S0022377820000823. This paper is devoted to the problem of the Dimits shift, which is the shift between the threshold of the primary instability of drift waves and the actual onset of turbulent transport in a magnetized plasma. The authors report a basic explanation and a detailed calculation of the Dimits shift within the modified Terry-Horton model of drift-wave turbulence, which makes the problem analytically tractable.

A paper titled, “The physics of spontaneous parity-time symmetry breaking in the Kelvin-Helmholtz instability,” by Y. Fu and H. Qin was published in the New Journal of Physics: https://iopscience.iop.org/article/10.1088/1367-2630/aba38f/meta. They found that the classical Kelvin-Helmholtz instability in an inviscid shear flow is triggered when and only when the parity-time symmetry admitted by the system is spontaneously broken. To prove the main theorem of the paper, the authors adapted a key result from Wigner’s theory on normal forms for anti-unitary operators. The analysis of PT symmetry also reveals that the relative phase between parallel velocity and pressure perturbations needs to be locked at 90 degrees when the instability is suppressed.

Communications (L. Bernard):

The Office of Communications posted two press releases to the PPPL website. The first highlighted research by A. Glasser and H. Qin that demonstrates how to preserve fundamental mathematical properties of plasmas in simulation algorithms. The second reports that an international team of physicists including S. Hudson has upgraded a key computer code for calculating forces acting on magnetically confined plasmas. The
stories were also posted to the *Newswise* and *EurekAlert* press release distribution services.

L. Bernard participated in the virtual National Laboratory Chief Communications Officers (NLCCO) monthly meeting on Aug. 27.

**DIRECTOR’S OFFICE (S. COWLEY)**

Laboratory leadership has been communicating ongoing updates to staff regarding the COVID-19 virus and PPPL.

S. Cowley, J. Menard, and M. Zarnstorff participated in a virtual Fusion Energy Sciences Advisory Committee (FESAC) meeting on Aug. 24. The primary purpose of the meeting was to hear another update from the FESAC subcommittee on development of a long-range plan for the FES program.

C. Ferguson hosted the virtual PPIC CD-1 Independent Project Review Sept 25-27.

S. Cowley, J. Menard, and C. Ferguson participated in the webinar by the National Academies of Sciences, Engineering and Medicine Committee titled, “Key Goals and Innovations Needed for a U.S. Fusion Pilot Plant.” The purpose of the meeting was to develop its work plan for an upcoming report.

This report is also available on the following web site:

[http://www.pppl.gov/publication-type/weekly-highlights](http://www.pppl.gov/publication-type/weekly-highlights)