



The PPPL Highlights for the week ending September 12, 2020, are as follows:

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

#### **Recovery (J. Galayda):**

**Coils** — A total of five coils (PF1B#1, PF1C#1, PFC#2, PF1A#1, and PF1A#2) have all been received at PPPL. Two have passed low-power electrical tests on site and the remaining three are being prepared for testing. At Sigmaphi in France, PF1B#2 is being electrically tested and winding and brazing was completed on spare coil PF1C-S. Layer 3 of winding was completed on PF1A-S.

**Center Stack Casing (CSC)** — Center stack casing welding of the collar pieces continued at Turtle Creek. Welds on both ends were completed and back grinding continued. Additional welding will continue for the next three weeks. When welding is finished, the CSC will be returned to Camden, New Jersey, for final machining. In addition, post-machining vacuum testing of all of the trimmed spare bellows was performed at PPPL so the spares 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 of the PF1C capping flanges for the sling supports. (These parts are due to be shipped in the next couple of weeks.) In South Carolina, Carolina Fabricators production of PF1A sling parts continued. Also, G. J. Oliver added components to the machined PF1C supports and will ship the supports out for coating in the near term, with delivery of the lower PF1C support scheduled for the end of the month. Additional procurement activities to award contracts for the remaining MCS components neared completion.

**IVPS** — On-site activities to install power to the vacuum pump and perform mechanical installations of the vacuum system components will resume in late Sept., followed by electrical and controls work in Oct.

**NSTX Test Cell** — The NSTX test cell labyrinth sprinkler system was installed and tested.

**Personnel Safety System (PSS)** — AC Power completed crating of the first 12 PSS breakers to be refurbished by ABB, Inc. Breakers will be shipped to the vendor the week of Sept. 14.

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**PF Bus Supports** — The design, analysis, and drawing efforts for coil flag position changes continued, along with finalization of drawings. Procurement activities continued in series to final drawing updates. The NSTX test cell labyrinth sprinkler system was installed and tested.

**PF5 Coil Bus Support Modifications Peer Review** — A peer review was held Sept. 10 to review the additional support clamps needed for the PF5 coil connections, based on the result of a work comparison with the PF4 coil BUS and BUS connections. The review covered the additional PF5 coil hard BUS clamp, design drawings, as well as analysis results from a work comparison with PF4 coil BUS connections.

## **ITER PROJECTS (H. NEILSON)**

### **Low Field Side Reflectometer — LFSR (A. Zolfaghari, S. Shirey):**

Team leader A. Zolfaghari completed an updated electromagnetic analysis of the LFSR in-vessel assembly and surrounding conducting structures. The analysis was performed to investigate the effect of a change in structure material of the close-fitting shield elements, from a copper-based alloy to stainless steel, that is being proposed by the Central Team. The forces on the LFSR components were found to be slightly increased but still manageable. I have to confirm with Wasee. I'll run the analysis to address the IO comments next.

The manufacturing development program made progress with the completion of the first batch of machined parts for planned welding trials; the parts are currently under inspection by the General Atomics (GA) team. Once inspected, these parts will allow welding development of all weld plug configurations within the test antenna block assembly (TABA). In addition, GA provided responses to PPPL questions concerning their recent cost and schedule proposal for completing the manufacturing development program. Upon review by PPPL engineer S. Shirey, GA's responses were judged to be acceptable.

### **Electron Cyclotron Emission — ECE (G. Paraiso):**

The ECE team met with Central Team counterparts to discuss progress in the development of an actuation mechanism for shutter-mirrors which the ECE operators will use to switch between calibration and measurement modes of operation. The PPPL team of K. Yu and G. Paraiso reported that its options are limited by a requirement to be able to operate the shutters during periods when the tokamak magnetic field is off, precluding electro-mechanical options which take advantage of an ambient magnetic field. Central Team colleagues shared results of ongoing R&D investigations of actuation

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options by various parties. The PPPL team has focused on thermo-mechanical options using bi-metal actuators. The meeting discussion yielded ideas for continuing development of the thermal actuators, as well as alternative avenues to pursue.

## **Equatorial Port Integration — EP03/09 (A. Basile):**

Design work on the EP09 diagnostic shield modules (DSM) progressed with the incorporation of EP12 DSM cooling circuits into EP09 DSMs. This design approach serves as a productive “jump-start” to cooling design within DSMs and leverages already developed R&D from the ITER project into USDA diagnostics. The European Domestic Agency has provided information on the equatorial visible/infrared camera system needed for design integration into both EP03 and EP09, where that system is a tenant.

## **Upper Wide Angle Viewing — UWAV (M. Smith):**

The UWAV team continued its work with Central Team (CT) counterparts to document and consolidate the system requirements that will drive the UWAV design. A first draft by team leader M. Smith was submitted to the CT for review.

## **THEORY (S. HUDSON)**

A paper titled, “Simulating pitch angle scattering using an explicitly solvable energy conserving algorithm” by X. Zhang, Y. Fu, and H. Qin was published on Sept. 1 in *Physical Review E*: <https://doi.org/10.1103/PhysRevE.102.033302>. The authors show that the standard Euler-Maruyama algorithm for stochastic differential equations (SDEs) does not converge for the SDE describing the pitch angle scattering. As a remedy, an explicitly solvable energy-conserving algorithm is developed. Its consistency is theoretically and numerically proved. This study demonstrates that for applications in plasma physics, the structure-preserving property is even more important for SDE algorithms than it is for deterministic differential equation algorithms.

A paper, “Calculating RF current condensation with consistent ray-tracing and island heating,” by R. Nies, A. Reiman, E. Rodriguez, N. Bertelli, and N. Fisch, has been published in the journal *Physics of Plasmas*. The paper was selected to be an Editor's Choice. By exploiting the nonlinear amplification of the power deposition of radio frequency waves, current condensation promises new pathways to the stabilization of magnetic islands. A numerical analysis of current condensation is presented, coupling a geometrical optics treatment of wave propagation and damping to a thermal diffusion equation solver in the island. Taking into account the island geometry and relativistic damping, previous analytical theory can be made more precise and specific scenarios can be realistically predicted. With this more precise description, bifurcations and



associated hysteresis effects could be obtained in an ITER-like scenario at realistic parameter values. Moreover, it is shown that dynamically varying the radio frequency wave launching angles can lead to hysteresis and help to avoid the nonlinear shadowing effect.

M.-G. Yoo participated remotely in *OpenACC Summit 2020* (the annual meeting of OpenACC developers/users, Aug. 31-Sep. 4) and gave an invited talk titled, “Accelerating Gyrokinetic Tokamak Simulation (GTS) code using OpenACC.” In the talk, he reported that the GTS code is ported to the GPU system using OpenACC directives, achieving 20 times acceleration for particle calculations and four-time acceleration for the total performance.

#### **COMMUNICATIONS & PUBLIC OUTREACH (A. ZWICKER)**

##### **Communications (L. Bernard):**

The Office of Communications posted one press release to the PPPL website. It reported that the Department of Energy has awarded \$21 million in funding for collaborators to install and operate new scientific instruments on NSTX-U. The story was also posted to the *Newswise* and *EurekAlert* press release distribution services.

L. Bernard participated remotely in the Office of Science, Communications and Public Affairs monthly meeting with National Laboratories’ Communications offices on Sept. 10.

##### **DIRECTOR’S OFFICE (S. COWLEY)**

Friday, Sept. 11, 2020 marked the 19-year anniversary of the 9/11 terrorist attacks on the World Trade Center in New York City, the Pentagon, and United Airlines Flight 93. Patriot Day serves as a remembrance of the lives lost on that September morning. PPPL commemorated Patriot Day by lowering the American flag at half-staff and placing a floral arrangement in the LSB lobby.

**This report is also available on the following web site:**

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