



The PPPL Highlights for the week ending January 19, 2019, are as follows:

NSTX-U RECOVERY AND RESEARCH (J. MENARD)

Recovery:

Magnets — DOE review comments on the inner poloidal field (PF) coil production procurement package have been incorporated into the RFP, which is now back with the DOE for further review. Oversight plans for the mandrel shims and shim vendor are in procurement. Production grit blasting and conductor priming is complete for all six production coils. The remaining spare conductors are expected to be completed by the end of February.

NTC Shielding — A final design review (FDR) was held on Jan. 14 for the labyrinth and wall penetration shielding. The review included the design and implementation of various improvements to the shielding and the relocation of items and fixtures within the test cell. The scope also included the relocation of electrical key card access of both north and south personnel doors. During the 2016 run campaign, measurements at locations around the NSTX-U test cell demonstrated the need to improve the test cell shielding; in particular, some doors and penetrations lacked sufficient shielding to reduce the neutron flux from the test cell to acceptable levels. The FDR was deemed successful pending resolution of CHITs.

Research:

Collaborations — On Jan. 16, R. Raman and M. Ono held discussions with ST-40 team members S. McNamara and V. Shevchenko to discuss the possibility of a transient CHI installation on ST-40. It was agreed that solenoid-free plasma start-up using transient CHI is potentially attractive for the ST-40 program. Possible future studies include assessments of the start-up current potential for ST-40, the feasibility of installing the insulator and electrode as part of the ST-40 divertor plate, and conducting TSC simulations to examine the need for possible improvements to the presently proposed ST-40 divertor coils.

R. Maingi served as a U.S. representative on the ITPA coordinating committee. During this meeting, leaders of the ITPA topical groups summarized group activities from the past year. In addition, there was an important discussion regarding research needs to answer questions of the recently released ITER research plan. There was also a discussion on the update of the ITER Physics Basis. Maingi also served as a U.S. representative on the Technology Cooperation Program for Collaboration on Tokamak Programs and summarized U.S. overseas personnel exchanges in 2018 and proposals for 2019.

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U.S. ITER FABRICATION (H. NEILSON)

The Low Field Side Reflectometer (LFSR) design team continued to make progress toward closing out the preliminary design phase of the project, following up on actions from a Nov. design review. While all 84 deliverable documents were submitted prior to the review, many were still in review at that time. Since then, reviews and approvals for more than 20 deliverable documents have been completed. In the last two weeks, the U.S. team has submitted revisions to five documents responding to Central Team review comments. Another 10 are currently in work by the U.S. team. A LFSR team delegation will visit the project site in St. Paul-lez-Durance, France, later this month for discussions with Central Team staff on how to resolve remaining issues to close out preliminary design.

In preparation to begin final design of its first-plasma hardware deliverables, the LFSR team has focused on critical manufacturing issues to identify priorities for manufacturing tests. An example is the so-called “plug welds” that seal openings left after gun drilling of cooling channels in the main support block. Desirable attributes for these small (~5 cm) items are ease of access for welding and inspection, simplicity of manufacture, a low profile above the surface, and compatibility with already-approved ITER processes. A manufacturing test sample is being prepared to compare a range of designs in terms of manufacturing feasibility.

ITER & TOKAMAKS (R. NAZIKIAN)

DIII-D (B. Grierson):

Research:

O. Nelson, an engineering graduate student at Princeton University, presented a Friday science meeting talk titled, “Pedestal fueling variations with gas and pellets.” The presentation showed that gas fueling both increases the pedestal density and shifts the density pedestal outwards towards the separatrix, in contrast to pellet fueling which increasing the pedestal density without an outward shift. Contrasting equivalent fueling rates, the pedestal pressure did not degrade with pellet fueling, but the pedestal pressure does degrade with strong gas puffing. The analysis of these results will form part of the DIII-D contribution to the 2019 JRT.

Princeton University engineering graduate students visited DIII-D with their adviser E. Kolemen, to work on DIII-D control and analysis. Students O. Nelson, Y. Fu, J. Abbate, R. Conlin, R. Shousha, and J. Wai ended a one-week visit to DIII-D. The goals of the visit



were to introduce the students to DIII-D scientists in the areas of pedestal analysis and to coordinate plasma control development with the DIII-D PCS group.

International PMI (R. Maingi):

R. Maingi presented a seminar at CEA Cadarache on the use of impurity injection for wall conditioning, power exhaust, and ELM stability. Recent results from ASDEX-Upgrade, DIII-D, EAST, and KSTAR were presented. Discussion of deploying an impurity powder dropper continued, with the next step being a technical feasibility assessment.

ADVANCED PROJECTS (D. GATES)

Stellarators (D. Gates):

On Jan. 16, N. Pablant traveled to the University of Maryland in College Park, Maryland, to give an invited seminar as part of the physics department seminar series. The talk was entitled, "Role of neoclassical transport and the radial electric field in Wendelstein 7-X," and highlighted recent work done as a collaboration between Pablant and M. Landreman (University of Maryland) to compare experimental results from W7-X with predictions made with the stellarator neoclassical code SFINCS. An active and productive collaboration between PPPL and the University of Maryland on the topics of stellarator transport and stellarator optimization has led to the publication of several important papers over recent years. Pablant gave a similar seminar at PPPL last week as part of the NSTX-U weekly science meeting series.

N. Allen and S. Lazerson met with T. Wang of the Texas A&M University Ion Beam Lab to discuss plans to test the prototype W7-X fast ion loss detector on their 140 keV tunable accelerator. Topics discussed included mounting the detector on the test stage, wiring requirements, experimental timelines, experimental goals, and additional safety requirements. A U-style clamp will be employed on the testing stage. Experimental goals were well within the capabilities of the device. A timeline of two days plus one for contingency was identified. And a discussion of lab safety was carried out. The experiments are scheduled for early March.

OFFICE OF ACADEMIC AFFAIRS (N. FISCH)

G. Dong successfully earned her Ph.D. on Jan. 18 by presenting her thesis project titled, "Nonlinear Dynamics of the Kinetic Ballooning Modes." Her committee members were A. Bhattacharjee, R. Goldston, Z. Lin, and H. Qin (Chair). Her adviser was A. Bhattacharjee and her readers were H. Qin and B. Tang.

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J. Ng successfully earned his Ph.D. on Dec. 7, 2018 by presenting his thesis project titled, “Fluid closures for the modelling of reconnection and instabilities in magnetotail current sheets.” His committee members were A. Bhattacharjee, A. Hakim, G. Hammett (Chair), and J. Stone. His adviser was A. Bhattacharjee and his readers were A. Hakim and M. Kunz.

ENGINEERING (V. RICCARDO)

Plans for PPPL participation in the upcoming 28th Symposium on Fusion Engineering (SOFE) conference, June 2-6, are well underway. A total of 21 PPPL abstracts have been submitted, 16 of which are from the engineering department. Following oral presentations and posters at the conference, papers will be submitted for publication in the journal *IEEE Transactions on Plasma Science*. PPPL roles on the organizing committee include Y. Zhai (Technical Program Committee member), A. Jariwala (women in engineering and young professional events organizer), H. Neilson (publications chair), and C. Neumeyer (ombudsman).

From Jan. 14 through 16, PPPL was visited by a contingent from the COMPASS Upgrade project. The COMPASS group included R. Panek (Director of the Czech Republic Institute of Plasma Physics), T. Markovic, P. Hacek, D. Sestak, and P. Vondracek. The visit was hosted by P. Titus. COMPASS Upgrade is a cryogenic copper machine with a major radius of 0.89 meters, with five Tesla at the plasma centerline and a two-mega-amp plasma current. It is intended to develop ITER-relevant plasma densities and high-power fluxes in the divertor region. The entire vacuum vessel is planned to reach 500 degrees Celsius. This provides opportunities to investigate liquid metal divertor concepts, which was the topic of much interest on the part of the PPPL participants. The machine borrows from many of the engineering features of C-Mod, and the COMPASS group preceded their visit at PPPL with a stop at MIT. Many engineering analysis tasks are common to COMPASS Upgrade and NSTX-U. NSTX-U engineers presented analysis approaches for electromagnetic diffusion in the TF coil, disruption simulations and specifications, large-scale structural analyses, and global thermal analyses. Discussions of field error analyses for both COMPASS Upgrade and NSTX-U were included in the main meeting and break-out sessions as well. Another break-out session addressed NSTX-U solutions for high-temperature magnetic diagnostics. Project management topics including systems engineering were discussed. On Monday afternoon, Panek gave a colloquium covering the current status of COMPASS Upgrade, its mission, and its future plans. He traveled to Washington, D.C., on Tuesday to discuss with the DOE possible collaboration with U.S. labs, universities, and private labs. R. Camp led a tour of the PPPL magnet shop. A break-out session on magnet design and fabrication was held. COMPASS uses helium-gas-



cooled copper magnets but they have many design and analysis concerns similar to the coils being built for NSTX-U.

Also participating from PPPL were H. Zhang, M. Kalish, D. Bishop, F. Poli, R. Goldston, H. Neilson, P. Dugan, D. Gates, R. Camp, J.-K. Park, A. Brooks, R. Ellis, D. Boyer, and from ORNL/PPPL M. Reinke and T. Gray.

COMMUNICATIONS & PUBLIC OUTREACH (A. ZWICKER)

Communications (L. Bernard):

The Office of Communications posted four press releases to the PPPL website. One noted that C. Ferguson has been named the Lab's new deputy director of operations and COO. Another story chronicled research by A. Diallo and J. Dominksi uncovering a previously unknown process that can trigger edge-localized modes in fusion plasmas. A third story explained the Dec. 18 technology showcase that featured the unique research, technical expertise, and inventions that PPPL offers to collaborators and funders. Finally, a fourth press release highlighted research by R. White into quickly determining how the resonance between plasma particles and waves contributes to efficiency loss in tokamaks. The stories were also posted to the *Newswise* and *EurekaAlert* press release distribution services.

E. Starkman received Honorable Mention in the Council for Advancement and Support of Education District 2 awards program, for her photograph of attendees at the International Conference on Plasma Surface Interactions in Controlled Fusion Devices held at Princeton University in June 2018.

DIRECTOR'S OFFICE (S. COWLEY)

On Jan. 14, R. Panek from the Institute of Plasma Physics, Academy of Sciences of the Czech Republic presented a colloquium titled, "Status of the COMPASS-U Project."

On Jan. 16, S. Choi from the State University of New York at Binghamton presented a colloquium titled, "Microscale Engineering to Electromicrobiology."

This report is also available on the following web site:

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