



The PPPL Highlights for the week ending July 20, 2019, are as follows:

NSTX-U RECOVERY (R. HAWRYLUK) AND RESEARCH (S. KAYE)

Recovery (R. Hawryluk):

Director's Review — A successful director's review was held on site from July 16 through July 18. This review was an important step in the process as the recovery project moves toward an independent project review (IPR) and to baseline. The review panel was impressed with the amount of work done on action items listed during the last review, and felt that, with a few adjustments, the project is ready to move forward to an IPR.

TF Bundle — The plan for turn-to-turn tensile testing at Composite Technology Development (CTD) in Colorado has been revised due to problems that CTD experienced with sample fabrication. Tensile testing will now proceed based on a back-up program that uses samples prepared at PPPL, quadrant-to-quadrant sample testing at the PPPL Material Test Lab, and turn-to-turn testing at CTD. Initial trial testing of the PPPL sample at room temperature exhibited very good results with very low scatter. The next step is to perform the final round of testing at PPPL at 50C for which an elevated temperature test chamber has been fabricated. Static short beam shear (SBS), turn-to-turn, and quadrant-to-quadrant sample testing was completed at the Element Materials Technology lab in California. Cyclic testing will begin on the quadrant-to-quadrant samples next. The high-fidelity and delimitation growth rate analyses have been completed to the extent possible with available data and have been documented and submitted for checking. The delamination simulation model continues to be refined. The FEA model for analysis of the effect of delamination on the external load path is running cases to determine the boundary of maximum allowable delamination. Once the remaining material test data becomes available, the calculations will be finalized prior to the Stage 2 review scheduled for Aug. 7-8.

Research (S. Kaye):

A new phenomenon called "blob wakes" was discussed in a recently published *Physics of Plasmas* paper titled, "Blob Wakes in NSTX," by S. Zweben, J. Myra, A. Diallo, D. Russell, F. Scotti, and D. Stotler. They are transient, small-scale structures seen in the wake of blobs moving poloidally through the scrape-off layer of high-powered H-mode plasmas in NSTX, using data from the gas puff imaging (GPI) diagnostic taken in 2010. A plausible theoretical interpretation of the wakes is discussed: the observed wakes share some features of drift waves and/or drift-Alfven waves that could be excited by the blobs.

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U.S. ITER FABRICATION (H. NEILSON)

The Laboratory's Fabrication Group is performing manufacturability tests to inform the final design of the Low Field Side Reflectometer (LFSR) antenna assembly. The equipment requires long, narrow water-cooling channels to remove the heat from fusion neutrons that thermalize in the material volume. Such channels are created by drilling long, narrow-diameter holes (commonly known as gun drilling) and welding metal seals (commonly known as weld plugs) in place to form a closed internal cooling circuit. The manufacturing requirements are challenging, as the channel must maintain a minimum distance from neighboring channels or walls, and the welds must meet strict requirements for reliability and vacuum compatibility. Initial gun drilling trials to a depth of 440 mm showed a path deviation within the required 1.5 mm per meter tolerance. This gives confidence that the requirements can likely be achieved, especially with the tools available to commercial machining suppliers. Planning to check this assessment is in progress. A steel block for plug welding trials has been received; sample preparation is starting. The material is of a special type that conforms to ITER standards, and the planned tests will deliver information on different plug geometries and filler materials needed to optimize the specifications and processes.

ITER & TOKAMAKS (R. NAZIKIAN)

International PMI (R. Maingi):

R. Maingi presented a Science Undergraduate Laboratory Internship (SULI) lecture titled, "Plasma exhaust via an X-point divertor." The talk introduced basic concepts in plasma-materials interactions and then described experimental and theoretical results in particle exhaust, momentum exhaust, and power exhaust. The talk ended with challenges to heat exhaust posed by transients, such as edge-localized modes.

International Long Pulse (F. Poli):

W. Choi gave a seminar entitled, "Simulation of LHCD in the EAST tokamak" during the monthly research meeting on July 16. The presentation discussed the challenges of validating heating and current drive from lower hybrid waves, which is now being done for the first time self-consistently with TRANSP. Initial results, limits of the model itself, and uncertainties from the diagnostic data have been discussed. This analysis has guided the design of new experiments on EAST and focused on validating and calibrating the lower-hybrid model in reproducible conditions. The experiments ran last May and are now being analyzed.

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A conference call was held with CompX on modernization of the interface between TRANSP and CQL3D for more robust simulations of lower hybrid in long-pulse tokamaks. TRANSP developer G. Wright completed the conversion of CQL3D into modern Fortran, which is critical for the coupling in TRANSP using a more modern architecture. Testing is currently in progress.

ITER-JET (F. Poli):

P. Bonfiglio, on assignment at JET for the summer, made significant progress in recommissioning the PPPL Faraday Cups diagnostic for fast ion loss measurements on JET. Working with JET colleagues, both electronics and acquisition have been checked to identify faulty channels and restore functionality for several channels after the recent refurbishment of the system. Replacement of some logarithmic amplifiers with more robust linear amplifiers is under consideration for the next campaign. The diagnostic is now routinely acquiring data during the present JET campaign. Analysis of discharges with combined NBI and RF is under way to assess the system response to fast ion losses in preparation for the D-T campaign.

International 3D (J-K Park):

Z. Wang visited Consorzio RFX, Padova, Italy, and gave a seminar entitled, "3D MHD spectroscopy to detect multi-mode stability and response." The discussions opened up the possibility of the future collaboration in RFX-mod2 once the upgrade is completed in 2020, using their 196 coils (4 poloidal array by 48 toroidal array) to detect various MHD modes in the experiments using the advanced MHD spectroscopy. Wang also discussed with RFX collaborators the potential application of resistive DCON to better understanding the tearing instability in reversed field pinch plasmas.

S. Yang, C. Zhu, N. Logan, and J.-K. Park successfully tested a new workflow for 3D field physics analysis in KSTAR. This includes the kinetic EFIT reconstructions upon various contingencies of missing profiles in a collaboration with Seoul National University, and GPEC response and NTV simulations and FOCUS coil design tools integrated into OMFIT. The kinetic EFITs for the standard $n=1$ ELM suppressing KSTAR targets, before and after RMP, were obtained and will be used for various 3D simulations tools to understand the different characteristics of RMP ELM suppression across years, especially between the 2016 and 2017 KSTAR campaign.

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ADVANCED PROJECTS (D. GATES)

Stellarators (D. Gates)

E. Gilson and F. Nespoli visited the National Institute for Fusion Science (NIFS) from July 15-19 where they completed preparations for an impurity powder dropper (IPD) installation on LHD. The dropper, built by A. Nagy and his team, was tested and LHD integration was finalized. A research proposal for the 2019 LHD campaign was developed in conjunction with N. Ashikawa of NIFS. The proposed experiments will measure the effects of boron and boron nitride injection on wall conditioning, divertor plasma properties, and transport in the LHD ergodic layer.

The kickoff meeting of a group that was formed to perform a pre-conceptual design and preliminary cost estimate of a new stellarator concept based on permanent magnets for 3D shaping was held on July 12. The group was limited to PPPL staff, although collaborators are expected to participate in the future. An initial set of action items were assigned that address the highest priority issues to resolve for the proposal plan. The attendees to this first meeting were: D. Gates, C. Gentile, C. Bovet, T. Brown, K. Corrigan, M.-A. DeLooz, J. Fang, E. Feibush, K. Hammond, and C. Zhu. This group will meet weekly until the cost-estimate is deemed sufficient for the purposes of the planned proposal.

THEORY (S. HUDSON)

I. Dodin gave an invited talk titled, "Modeling drift-wave turbulence as quantum-like plasma," at the 46th EPS Conference on Plasma Physics in Milan, Italy.

M. Churchill, et. al. published an article in *Nuclear Fusion* titled, "Pressure balance in a lower collisionality, attached tokamak scrape-off layer." Using the XGCa code, this paper identifies important terms related to drifts and non-local electric fields which need to be accounted for to correctly describe ion momentum balance in low-collisionality scrape-off layer regions.

TRANSP (F. POLI)

J. Sachdev traveled to Rockville, MD, to participate in a meeting as principal investigator for PPPL in the AToM project, which is part of the SciDAC program.



COMMUNICATIONS & PUBLIC OUTREACH (A. ZWICKER)

Communications (L. Bernard):

The Office of Communications posted three press releases to the PPPL website. One noted that J. Galayda has been named director of the NSTX-U Recovery Project. Another noted that graduate student A. Glasser has won a Charlotte Elizabeth Procter Honorific Fellowship from Princeton University. The highly competitive fellowship provides full tuition and a stipend for the 2019-2020 academic year for students “displaying the highest scholarly excellence in graduate work.” The third story focused on the Lab’s Workshop in Plasma Physics for Undergraduates, which aims to give women and underrepresented minorities the background and skills that will help them get internships and to consider a career in plasma physics and fusion energy sciences. All three stories were posted to the *Newswise* press release distribution service.

DIRECTOR’S OFFICE (S. COWLEY)

S. Cowley attended the European Physical Society (EPS) meeting, in Milan, Italy, July 8-12.

On July 18, C. Ferguson, J. Menard, T. Lee, D. Carle, and M. Solaroli participated in mission validation independent reviews for SLI infrastructure projects, which are part of our campus strategy. The meetings were held at DOE in Germantown, Maryland.

This report is also available on the following web site:

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