



The PPPL Highlights for the week ending April 21, 2018, are as follows:

NSTX-U RECOVERY AND RESEARCH (J. MENARD)

Recovery:

A successful final design review (FDR) was held on April 17 for the TF/OH bundle and CS casing fit.

A successful preliminary design review (PDR) was held on April 19 for the replacement of NSTX-U Bay B and Bay G glow discharge cleaning (GDC) insulators.

In the PPPL coil shop, all four layers of the PF1A prototype coil have been completed and are ready to have the outer lead bend implemented. Also, the vacuum pressure impregnation (VPI) delivery plumbing is being assembled. In addition, Everson-Tesla has resumed winding for the PF1A prototype coil fabrication — the fourth layer is complete, and the outer lead has been brazed. At Sigma-Phi in France, winding on first layer has commenced.

An as-built model of the passive plates has been created in support of analysis and design activities for the upcoming passive plate PDR.

Machining of plasma-facing component (PFC) test coupons has begun at PPPL machine shops. These test coupons will be sent out and used to obtain material certifications and down-select the PFC material choice once properties are verified.

ORNL researcher T. Gray presented the poster, “Plasma-facing component calorimetry for measurement of shot-integrated deposited energy in NSTX-U,” at the 22nd High-Temperature Plasma Diagnostics Conference in San Diego. The presentation focused on test results from the Penn State Applied Research Laboratory. The testing evaluated performance of one of the embedded thermocouple PFC diagnostics considered by the project, and is developing quantitative evaluations of the heat-flux capabilities to be used for prototype testing.

All the purchased components and raw materials for the TVPS backing pump assembly drawing package have arrived at PPPL.

Coarse Wavelength Division Multiplexing (CWDM) testing resumed with the receipt of the fiber optic test equipment. PI&C and IT staff are working closely with both the IT switchgear manufacturer and CWDM equipment vendors to review test results and details of the NSTX-U test cell network infrastructure.

Research:

V. Soukhanovskii (LLNL) completed a one-week visit to the Culham Center for Fusion Energy, Culham, UK to initiate a new collaboration between LLNL and the MAST-U tokamak. LLNL is planning a collaborative research program in divertor detachment and snowflake divertor studies on MAST-U. To support the planned studies, two new divertor spectrometers will be installed. Details of the diagnostic installations, multifluid divertor modeling, and planned snowflake divertor experiments were discussed.

S. Sabbagh and J. Berkery of Columbia University visited CCFE to begin collaborative research on MAST-U on disruption prediction and avoidance. The research has already begun by starting the interface to and analysis of MAST data, which has included examination of rotating MHD, initial connection to the DECAF code, and construction of models supporting kinetic equilibrium reconstruction. Work continues to develop seamless interfaces to MAST-U database standards.

The High Temperature Plasma Diagnostics (HTPD) conference was held April 15-19 in San Diego, California. M. Reinke (ORNL) presented results from the infrared video bolometer (IRVB) that was originally built for and installed on NSTX-U, but did not see plasma emission due to the early termination of NSTX-U operations in July 2016. This diagnostic was able to be tested on Alcator C-Mod in September 2016 and results showed good agreement with core radiated power measurements from existing resistive bolometry tools, although additional work would be needed to confirm quantitative accuracy to the 5-10 percent level generally required for power balance. In particular, the IRVB was immune to ICRF interference, which can impact the C-Mod resistive bolometers. This demonstrates a radiated power measurement concept that could mitigate against high-power switching/RF noise if these are shown to be problems for NSTX-U.

S. Munaretto of General Atomics gave a presentation titled, “Conceptual design of extended magnetic probe set to improve 3D field detection in NSTX-U,” at the HTPD conference. The work explored where new magnetic probes should be installed in NSTX-U to improve the detection of non-axisymmetric perturbations based on predictions from the linear MHD code MARS-F/K. Optimal size of the probes and optimal connection configurations were also addressed from a physics point of view.

The paper titled, “Regarding the optimization of O1-mode ECRH and the feasibility of EBW startup on NSTX-U,” by N. Lopez (Princeton University) and F. Poli (PPPL) has been published online in *Plasma Physics and Controlled Fusion*. The paper describes simulations with TRANSP toward the optimization of the geometry of injection of the EC waves for the non-inductive startup and ramp-up on NSTX-U. A range of injection angles is recommended that is robust against variations of the plasma density evolution

and that maximizes first pass absorption after plasma formation both at half and full field. It is also shown that EBW startup on NSTX-U would be possible through O-X-B mode conversion if the waves are injected from below the midplane.

M. Ono (PPPL) visited the Advanced Plasma Experiment Group at the Naka Fusion Institute in Japan to discuss a feasibility study on the X-ray Imaging Crystal Spectrometer System with T. Nakano. He also met with the group leader, H. Ide. He then visited the LATE spherical tokamak group at Kyoto University to discuss the electron cyclotron and electron Bernstein wave tokamak start-up research. He met with H. Tanaka, T. Maekawa, and several graduate students. He also presented a seminar entitled “NSTX-U Initial Operations and Solenoid-Free Start-Up Research Strategy.”

U.S. ITER FABRICATION (H. NEILSON)

The Laboratory’s Low-Field-Side Reflectometer (LFSR) design team, in discussions with counterparts in the Central Team (IO-CT) Diagnostics unit, negotiated a satisfactory resolution to potential space conflicts in the ITER building. The conflicts between ITER infrastructure (tritium management system) and LFSR equipment in a complex building region carried a risk of requiring significant design and planning modifications for both PPPL and General Atomics partners. However, practical solution options were discussed and agreed to that will allow us to maintain design momentum along our current path to the LFSR preliminary design review in June 2018.

Instrumentation and controls (I&C) design work for the upper-port wide-angle visible and infrared viewing diagnostics has progressed through a subcontract with Bertin Technologies. The system will look down on in-vessel surfaces and requires sophisticated cameras and I&C hardware and software capable of image processing and controlling optical elements. Assembly of an I&C hardware prototype was recently completed, with all components now installed in a cubicle at Bertin’s subcontractor UPM. The pseudo code for the image processing functions is currently being tested before implementation.

ITER & TOKAMAKS (R. Nazikian)

R. Maingi, R. Nazikian, and M. Ono visited QST in Naka, Japan to discuss collaborations. Maingi presented a talk titled, “Discussion of possible powder dropper collaboration between PPPL and QST,” and Nazikian presented a seminar titled, “Grassy ELM regime on DIII-D.” Other possible collaborations were also discussed.

R. Nazikian visited NFRI in Daejeon, Korea, to discuss progress and plans for the KSTAR experiment program and gave a seminar titled, “Grassy ELM regime on DIII-D.”



DIII-D (B. Grierson)

Research:

As part of the NSTX-U campaign on DIII-D, a group of researchers from PPPL participated in impurity injection experiments. A. Diallo, E. Gilson, E. Kolemen, R. Lunsford, R. Maingi, J. Schwartz, and Z. Sun all participated onsite for impurity injection into the SAS divertor, and impurity transport comparison between NSTX and DIII-D.

B. Grierson traveled to Daejeon, South Korea, for the spring ITPA Transport and Confinement meeting, where he presented a study of intrinsic impurity (carbon) density profiles in ITER baseline conditions for NBI heating. Analysis indicates that both a/LTe and a/Lne are correlated, while a/LTe and a/LTi are anti-correlated, consistent with previous findings published by Grierson and others in *Physics of Plasmas* (2018).

M. Knolker gave a Friday Science Meeting presentation on divertor currents during type-I ELMs. During an ELM, an initial oscillatory phase can be distinguished from tile measurements. The oscillations take place before the heat flux increase is measured with IRTV.

S. Haskey presented an invited talk titled, "Active Spectroscopy Measurements of the Deuterium Temperature, Rotation, and Density from the Core to the Scrape-Off Layer on the DIII-D Tokamak," at the HTPD conference in San Diego. The talk described several advances in main ion charge exchange analysis in DIII-D. Several examples showing differences between the impurity and main ion temperature and toroidal rotation near the plasma edge were presented.

Operations:

PPPL staff installed the Impurity Powder Dropper (IPD) and the Impurity Granular Dropper (IGI) on DIII-D. Both systems will be loaded with three materials for injection into plasma: boron, lithium, and boron nitride.

EAST/KSTAR Scenarios and Control (R. Nazikian):

F. Poli visited NFRI on April 13 to give a seminar on integrated modeling and on the use of TRANSP for scenario development and optimization, with a focus on KSTAR applications. In the afternoon, she met with the Advanced Operation Scenario group to discuss ideas on optimization of advanced scenarios.



JET-ITER (F. Poli):

F. Poli attended the ITPA-IOS meeting in Daejeon, South Korea. She gave an update on two joint activities: one on the core-pedestal coupling and the second on the modeling of a safe plasma current ramp-down phase for ITER. The IOS group and the T&C group had a joint session where F. Poli gave an overview of the issues with the modeling of ITER scenarios and proposed areas of synergy between the two topical groups.

KSTAR (S. Scott):

Assembly of the new 15 channels of the MSE background polychromator for use on KSTAR is substantially complete. Testing, measurement of the filter transmission curves, and integration with computer control will take place over the next two weeks. PPPL is on schedule to ship the complete system on or before May 4.

ADVANCED PROJECTS (H. NEILSON)

Stellarators (D. Gates):

S. Lazerson presented a talk titled, "Error fields in W7-X with predictions for OP1.2b and the scraper element," at the Coordinated Working Group Meeting held at PPPL the week of April 9. Lazerson's talk focused on his work analyzing results from the latest campaign on W7-X and preliminary predictions for the effects of error fields on the scraper elements that were fabricated by PPPL and recently installed in preparation for the next campaign. This work was performed in collaborations with colleagues at the Max Planck Institute for Plasma Physics and Forschungszentrum Jülich, and with Glen Wurden of Los Alamos National Laboratory. Lazerson is currently on a two-year assignment at W7-X where he is serving as the Scenario and Integration Task Force Leader.

N. Pablant participated in the 18th Coordinated Working Group Meeting conference, serving as chair for the session on Stellarator Impurity Transport. In this capacity, Pablant has helped to further develop the existing stellarator joint tasks on the topics of impurity transport physics, impurity hole physics, role of 2D plasma potential asymmetries, and impurity transport modeling. The presentations and following discussion during this session have led to the development of a new joint task: IT.5, Turbulent Model of Impurity Transport. In addition, Pablant made a presentation titled, "Exploration of Neoclassical Physics in Wendelstein 7-X Plasmas," in the session on Core Electron Root Confinement (CERC).



THEORY (A. BHATTACHARJEE):

On April 17, F. Ebrahimi gave a physics colloquium at the Brookhaven National Laboratory titled, “Plasma science — From laboratory fusion to astrophysical plasmas.” The same presentation was also given at Swarthmore College on April 20. The abstract is available here:

<https://theory.pppl.gov/news/seminars.php?scid=6&n=external-seminars>

The paper by J. Carlsson, I. Kaganovich, *et al.* titled, “Particle-in-cell simulations of anomalous transport in a Penning discharge” has been published in *Physics of Plasmas* **25**, 061201 (2018). The abstract and link to the paper can be found here:

<https://theory.pppl.gov/news/seminars.php?scid=4&n=publications>

On April 20, W. Fox presented a Research & Review seminar titled, “Magnetized High-Energy-Density Plasmas from Astrophysics to Fusion.” The abstract and slides are available here:

<https://theory.pppl.gov/news/seminars.php?scid=2&n=rr-seminars>

SITE PROTECTION (F. WHITE)

Members of SPD participated in the dress rehearsal for the 2018 DOE National Emergency Exercise and provided a PPPL staff accountability report for use in this event. Members of SPD also presented an update to the Emergency Management Review Committee at the ES&H Executive Board Meeting, participated in a safety discussion with members of ES&H about substances stored in the Canal Pump House, interviewed candidates for the Emergency Services Officer opening in ESU, and completed workplace violence training.

Engine 66 responded to a mutual aid assignment in Plainsboro Township.

COMMUNICATIONS (L. BERNARD)

The Office of Communications posted one press release to the PPPL website. It focused on the effects of both ion and electron heating in ITER on the plasma temperature and density. The story was also posted to the *Newswise* and *EurekaAlert!* press release distribution services.

L. Bernard accompanied physicist F. Ebrahimi to the studios of Fox 5 News New York for an interview about fusion and plasma research. Reporter Mac King interviewed her for the segment, which is scheduled to air on the 6 p.m. broadcast Tuesday, April 24.



DIRECTOR'S OFFICE (R. HAWRYLUK)

The PPPL FY 2018 Diversity and Inclusion Plan was submitted to the DOE/Princeton Site Office on April 16.

This report is also available on the following web site:
<http://www.pppl.gov/publication-type/weekly-highlights>