



The PPPL Highlights for the week ending June 23, 2018, are as follows:

NSTX-U RECOVERY AND RESEARCH (J. MENARD)

Recovery:

For the inner poloidal field (PF) coils, the first vendor prototype coil was successfully electrically tested last week and has been sectioned. Mechanical inspections and turn-to-turn electrical testing has begun. The two remaining vendor prototype coils are in their molds being prepared for vacuum pressure impregnation (VPI). The PPPL prototype coil completed its post-VPI dimensional and electrical inspections. The coil is being prepared for full electrical testing on the test stand.

Research:

PPPL and NSTX-U hosted the 23rd International Conference on Plasma Surface Interactions in Controlled Fusion Devices on the Princeton University Campus on June 17-22. There were about 430 participants, with more than 60 talks and almost 400 posters. R. Maingi and C. Skinner served as overall chair and local organizing committee chair for the conference; M. Jaworski was publications chair; E. Kolemen was the Princeton University representative; and C. Austin was the resource coordinator. J. Jones and A. Datuin assisted, along with J. Coco (MIT) and S. Rosas (UCSD). J. Schwartz, A. Devitre, E. Emdee, and S. Jubin were student volunteers.

R. Goldston presented a tutorial talk at the PSI 2018 conference entitled, "SOL Physics and Heat Dissipation." He discussed new results since 2011 on: (1) the narrowness of the power scrape-off layer and its implication for heat flux in attached divertor operation, (2) the greater difficulty in achieving detachment due to the resulting reduction in SOL radiating volume, and (3) the upstream H-mode density limit resulting from the implied steep pressure gradient and ballooning stability when the separatrix density reaches about 1/2 of the Greenwald density.

E. Emdee presented a poster on the operation of a lithium vapor box for FNSF, and J. Schwartz presented a poster describing an experiment on lithium-vapor-driven detachment in Magnum-PSI.

S. Kaye participated as a panel member in the meeting of the National Academy of Sciences Panel on Burning Plasma Physics, held in Washington, DC, June 12-14. This is the final location-based meeting of the panel.

N. Bertelli participated in a DOE video call on the RF SciDAC-4 project. He gave a talk on behalf of the RF SciDAC team entitled, "Thrust 1: Production RF WDM components,



interaction with AToM / TRANSP & thrust common developments,” on one of the four thrusts of the RF SciDAC-4 project.

The paper, “TSC simulation of transient CHI in new electrode configuration on QUEST,” by K. Kuroda, R. Raman, S. Jardin, M. Ono, and K. Hanada, was published in the journal *Plasma and Fusion Research*. The paper describes the first simulations conducted in support of transient CHI studies on QUEST. These simulations indicate that lowering the CHI electrode plate closer to the existing divertor coils would allow for the generation of a much more narrower injector flux footprint width that is important for increasing the closed flux fraction in transient CHI discharges. Alternatively, as a short-term measure, the simulations suggest that energizing a lower inboard coil would also be helpful for reducing the injector flux footprint width in the present electrode configuration. This new scenario will be experimentally studied during the next CHI campaign on QUEST. The work was conducted as part of a US-Japan collaboration activity during which post-doctoral fellow Dr. Kuroda visited PPPL.

An article titled, “On the scattering correction of fast-ion D-alpha signals on NSTX-U,” by G. Hao, W. Heidbrink, D. Liu, L. Stagner, M. Podesta, and A. Bortolon has just been published in *Review of Scientific Instruments* (RSI) as an editor’s pick. The article addresses signal contamination of spectra in the wings of the bright cold D-alpha line, which is a fundamental challenge for measurements using grating-based spectrometers in Fast-Ion D-alpha (FIDA) measurements in magnetic fusion devices. Similar issues arise in high-contrast Earth scenes using a moderate resolution imaging spectro-radiometer. The paper applies the singular value decomposition (SVD) method to correct the background contamination of FIDA signals from NSTX-U. After correction, both the FIDA spectra and spatial profile are in better agreement with theoretical predictions. This SVD method is potentially applicable to other instruments where bright line contamination is a problem.

T. Nakano of Naka Fusion Institute, QST, Japan, visited PPPL on June 18 to discuss the feasibility study of the X-ray imaging crystal spectrometer with the NSTX-U/PPPL researchers including L. Delgado-Aparicio, M. Bitter, K. Hill and M. Ono.

U.S. ITER FABRICATION (H. NEILSON)

Members of the Low-Field-Side Reflectometer (LFSR) design team visited the ITER site at Cadarache, France, to discuss a range of project topics with Central Team staff. Agreement was reached with the LFSR Technical Responsible Officer, A. Sirinelli, on the requirements applicable to the LFSR. Meetings with members of the Equatorial Port #11 (EP11, in which LFSR is a tenant) team clarified the status of neutronics analyses that form the basis for dose rate and nuclear heating calculations. It was concluded that the LFSR team can save time by taking advantage of analyses already



performed by the EP11 port integration team. A preliminary design strategy and division of responsibilities for fire insulation of LFSR components was developed in concert with Central Team fire safety experts. Representing the LFSR team were A. Basile, J. Gonzalez Teodoro, and H. Neilson from PPPL; A. Gattuso from subcontractor General Atomics; D. Finkenthal from subcontractor Palomar Scientific; and D. Rasmussen from the U.S. ITER Project Office.

ITER & TOKAMAKS (R. Nazikian)

DIII-D (B. Grierson)

Research:

Two papers by S. Haskey and B. Grierson have recently been accepted for publication in *Review of Scientific Instruments*. Haskey's paper demonstrates the validation of main-ion charge exchange spectroscopy in the edge of DIII-D plasmas by combining high-resolution measurements with integrated diagnostic simulations to accurately determine the deuterium temperature, rotation, and density. Grierson's paper demonstrates an improved calibration of the impurity charge-exchange spectroscopy system by using neutral beams fired into the DIII-D vacuum vessel that has been pre-filled with xenon gas, reducing the systematic channel-to-channel offsets in the inferred impurity density profile.

Operations:

Installation of new neutral beam pole shields in the upgraded 210-degree co/counter steerable off-axis neutral beamline (CCOANB project) occurred this week. The pole shield design uses molybdenum tiles installed in the heat-affected zone. The first set of pole shields with molybdenum tiles that were previously installed on the 330-degree neutral beam line have successfully survived two years of high-power operation without any visible deterioration.

International PMI (R. Maingi)

A. Bortolon gave an oral presentation at the Plasma Surface Interactions (PSI) conference titled, "Real-time wall conditioning by controlled injection of boron and boron nitride powder in full tungsten wall ASDEX-Upgrade." The work documented the first experiments with the impurity powder dropper in AUG, and will be followed up with dedicated experiments in the summer and fall on AUG.

Z. Sun presented a poster at the PSI conference titled, “Active wall conditioning for long pulse plasma by using lithium powder injection in EAST with tungsten divertor.” The work documented the lithium deposition via evaporation and powder leading up to the 100-second long record H-mode on EAST.

R. Lunsford presented a poster at the PSI conference titled, “Utilization of impurity granule induced ELM triggering in next-step fusion devices.” The presentation compared lithium granule injection for ELM triggering on EAST and DIII-D.

International Long Pulse (F. Poli)

F. Poli visited ASIPP during the week of June 11 to work with the integrated modeling group to setup the OMFIT workflow for preparation and submission of TRANSP runs for EAST. Progress includes capabilities to read and write file data for equilibrium and fundamental plasma parameters for TRANSP, as well as heating and current drive sources settings and input waveforms. The workflow does not yet include kinetic profiles, which will be done jointly with ASIPP in the short to medium term. Capability of streamlining TRANSP submission jobs will expand the pool of users at ASIPP.

Poli also visited the National Research Fusion Institute in Korea this week to discuss TRANSP support with the KSTAR team and collaborations on fast ion physics. She worked with Jisung Kang at NFRI on the installation of various TRANSP packages and tested TRANSP submissions to the US transpgrid.

In addition, the KSTAR team led by H.-S. Kim and PPPL’s N. Logan have worked with the OMFIT group (S. Smith) at General Atomics to install OMFIT on the KSTAR cluster. The next step is to customize the OMFIT/TRANSP interface for KSTAR needs.

D. Mueller visited EAST to work on the improvement of the EAST vertical control system. Discussions with the EAST control group resulted in plans to measure the delay of various magnetic sensors to the plasma motion. Plans were made to use relative magnetic measurements on several up/down symmetric magnetic sensors to increase the sensitivity of sensor pair measurements of the plasma vertical motion. This visit is the starting point for a long-term collaboration between PPPL and ASIPP to enhance plasma vertical and radial control on EAST leveraging experience gained on KSTAR.

KSTAR MSE: (S. Scott)

S. Scott traveled to KSTAR this week to participate in the in-vessel calibration of the 25-sightline MSE background polychromator, whose final 15 channels were assembled over the winter and delivered to KSTAR last month. Excellent support was received from the KSTAR team to make the installation and calibration a success. The in-vessel calibration

data has been analyzed and the measured polarization angles agree with the in-vessel light source to typically 0.001 degree. The in-vessel calibration will be supplemented with a beam-into-gas calibration in the late summer to quantify effects associated with the relative wavelength position of the beam-emitted MSE spectrum versus the filter passbands.

ADVANCED PROJECTS (H. NEILSON)

Stellarators (D. Gates):

The U.S. Department of Energy announced that S. Lazerson has won a prestigious Early Career Award for his proposal, “Exploration of Energetic Particle Confinement in Stellarators.” The award grants a total of \$2.5 million over a five-year period. This year 30 such awards were made to early career scientists at national laboratories. Dr. Lazerson will use the funds to carry out research on the confinement of energetic particles in fusion confinement devices called stellarators, with a focus on the Wendelstein 7-X (W7-X) device at the Max Planck Institute for Plasma Physics in Greifswald, Germany. Lazerson is currently stationed in Greifswald where he serves as the Task Force Leader for the Scenario Development task force on W7-X.

On Tuesday, June 19, D. Gates gave a lab tour to approximately 20 international fusion scientists who were attending the annual International Conference on Plasma Surface Interactions in Controlled Fusion Devices (PSI). This group of experts in plasma-facing materials were very enthusiastic and particularly appreciated seeing the NSTX-U center stack. The group toured the NSTX-U control room and the LMX, MRI, and MRX experiments.

System Studies (C. Kessel):

C. Kessel participated in the first IAEA Workshop on Fusion Enterprise, focused on the privately funded activities in fusion research to explore electricity-generating fusion configurations that are more compact and economically attractive than the perceived mainline concepts of the tokamak, stellarator, and spherical tokamak. Kessel presented a description of pre-conceptual design studies and their usefulness in transitioning from experiments to the power plant regime. Also presented and discussed at the meeting were ARPA-E activities, financing approaches for solving fusion problems, and ultimately developing a fusion facility, the energy landscape in the U.S. and around the world, commercializing fusion and licensing issues, tritium issues, and various concepts being pursued. A general interest in impacting climate change was driving many participants’ desire for faster development. Interest in financing under-studied or under-developed critical areas was apparent. Presentations were also given by R. Miller from ARIES, L.



El-Guebaly, K. Hollis from LANL and LM PFC studies.

THEORY (A. BHATTACHARJEE):

N. Ferraro received a DOE Early Career Research Program award. The award will provide \$2.5 million over five years for developing and validating integrated models of suppressing edge localized modes (ELMs) using 3D magnetic fields. ELMs are intermittent instabilities that may cause serious damage or erosion to the plasma-facing components of reactor-scale tokamaks. This project will study how these modes are suppressed when 3D magnetic fields are applied, by integrating sophisticated models of 3D perturbed tokamak equilibria with calculations of transport in 3D magnetic fields.

A theory seminar titled, “Conservative Discontinuous Galerkin Discretization for the Landau Collision Operator,” was presented by A. Frank, Technical University of Munich. The abstract and slides are available on the theory website:

<https://theory.pppl.gov/news/seminars.php?scid=1&n=research-seminars>

M. Churchill attended the PSI conference and presented a poster titled, “Pressure balance in a low collisionality tokamak scrape-off layer.”

COMMUNICATIONS (L. BERNARD)

The Office of Communications posted one press release to the PPPL website, announcing that physicists N. Ferraro and S. Lazerson each won a DOE 2018 Early Career Research Program award. The two five-year awards, sponsored by the DOE Office of Science, will fund PPPL research that could lead to development of the best designs for both tokamaks and stellarators. The press release was also posted on the *Newswise* and *EurekaAlert!* distribution services.

DIRECTOR’S OFFICE (R. HAWRYLUK)

On June 20 and 21, R. Hawryluk attended the National Laboratory Director’s Council (NLDC) Meeting in Washington, D.C. The NLDC advances the effectiveness of the Department of Energy (DOE) National Laboratory Complex in meeting the collective national missions and provides an interface to DOE organizations on issues and concerns of common interest, both strategic and operational.

This report is also available on the following web site:

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