The PPPL Highlights for the week ending May 18, 2019, are as follows:

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

Research (S. Kaye):


NSTX-U researcher R. Maingi presented an invited talk at the US-PRC Fusion Celebration Week on May 17 in Hefei, China titled, “Highlights from the US-PRC collaboration on plasma-materials interactions.” The talk included progress on the flowing liquid lithium limiter program, the impurity powder injection program, the lower divertor cryopump physics re-design, and the PFC tile diagnosis program. Over the past two and a half years, the collaboration has produced 38 refereed journal articles and more than 60 presentations at conferences, seminars, and colloquia.

NSTX-U researchers N. Bertelli, M. Ono, and F. Poli of PPPL attended the 23rd Topical Conference on Radio Frequency Power in Plasmas in Hefei, China, May 14-17. Bertelli presented an invited talk entitled, “3D full wave fast wave modeling with realistic antenna geometry and SOL plasma.” Ono presented a poster entitled, “Modeling of 2nd harmonic electron cyclotron heating and current drive solenoid-free start-up experiment in QUEST.” Poli gave a contributed poster entitled, “The challenges of integrated modeling of RF heated plasmas for long pulse operation.” Ono served as a member of the RFPPC 2019 Program Committee. After the conference, they visited the EAST tokamak and related facilities and also attended the opening event for the Sino-US Fusion Cooperation Week.

F. Cheng gave a presentation on slow-mode/Alfvén wave coupling at the physics research seminar on May 13. Calculations of the eigenfunctions of these coupled modes form gaps within which modes can grow. These modes are ubiquitous for different plasma profiles, both low- and high-beta, and in both circular and shaped configurations. The modes can resonate with lower-energy fast particles, and they may be effective for removing helium ash in burning plasmas. The next step will be to determine the actual stability of these coupled modes.

The NSTX-U group is engaged in the planning of initiative write-ups for the upcoming community planning process workshop that will be held in Madison, Wisconsin, during the week of July 22.
U.S. ITER FABRICATION (H. NEILSON)

The Low Field Side Reflectometer (LFSR) design is finalizing the interface between the LFSR equipment and the diagnostic shield module (DSM) that houses it. The LFSR support block nests in a close-fitting conformal opening in the DSM. The support bearings are a critical feature and must be designed to ensure adequate structural support as well as compatibility with installation and removal using remote handling tools and procedures, and with the achievement of tight tolerances for antenna aiming accuracy. A support concept has been developed, and a collaboration with the UKAEA’s Remote Applications in Challenging Environments (RACE) unit is helping to expedite the development of remote handling solutions and planning for a mockup test. Design details of the attachments are being developed by the LFSR team, coordinating with the Russian and ITER Central Team port integration engineers. In meetings this week, fabrication feasibility of the PPPL-proposed bearing geometry was confirmed by Russia’s DSM fabrication team.

A recent analysis by Laboratory engineers and physicists resolved a concern that misalignment of the antenna axes due to thermal distortion of the front-end antenna unit might cause loss of coupling to the plasma. It was found that when the unit goes through a thermal cycle from room temperature to its operational temperature, the maximum movement of the antenna opening relative to the last miter bend is less than 0.6 mm in the toroidal and vertical direction. The movement can have an effect on the alignment but the distance between the antenna opening and the last miter bend is 1.5 mm or more which gives a maximum misalignment of 0.02 degrees, much smaller than other alignment inaccuracies. It was concluded, therefore, that this effect is negligible, closing a Category 2 chit that was raised at the 2018 preliminary design review.

ITER & TOKAMAKS (R. NAZIKIAN)

E. Kolemen gave an invited talk titled, “Machine Learning Control for Fusion Devices,” at the International Conference on Data-Driven Plasma Science, May 13-17 in Marseilles, France. He developed and tested this control on the DIII-D tokamak by combining the machine-learning prediction capabilities with real-time control development on the last campaign and showed that machine-learning control can allow stable operations against instabilities.
DIII-D (B. Grierson).

Research:

The Lyman-alpha diagnostic on DIII-D is being implemented through collaboration with the MIT PSFC. F. Laggner visited PPPL and supported the acceptance testing of the transimpedance amplifier system, which has now passed acceptance testing. This achievement completes the design process for a 40-channel amplifier system, which was realized in-house at PPPL. Space constraints required a compact, highly customized system that reliably resolves the low photocurrents, which are expected to be on the order of nano-amperes, in a noisy environment. All amplifier channels perform nominally and the system is now cleared to be installed at DIII-D, enabling the acquisition of first data.

International PMI (R. Maingi):

While on-site at ASIPP, A. Diallo, R. Maingi, K. Tritz (JHU), and K. Woller (MIT) began planning plasma-materials interactions experiments that are scheduled for next week on EAST. These experiments will focus on the impurity powder droppers for ELM control and impurity granule injector for ELM pacing.

International Long Pulse (F. Poli):

W. Choi and F. Poli attended the 23rd conference on Radiofrequency Power in Plasmas (RFPPC), which was held in Hefei, China, May 14-17. Choi presented a poster on initial TRANSP simulations of EAST discharges with lower hybrid heating and current drive, indicating a need for measurements of the wave polarization in the scrape-off layer, especially for the 2.45 gigahertz antenna. Poli presented a poster on the challenges of integrated modeling of radio-frequency-heated plasmas, where the synergy of sources demands self-consistent simulations to understand plasma dynamics.

N. Bertelli and M. Ono presented a poster entitled, “Helicon wave propagation and possible parasitic excitation of slow waves near the edge plasma of KSTAR,” by E.H. Kim et al. On Friday, the PPPL team participated in a ceremony to celebrate the 40th anniversary of the US-China cooperation at ASIPP.

ADVANCED PROJECTS (D. GATES)

Stellarators (D. Gates)

D. Gates, N. Pablant, and S. Lazerson attended a meeting titled, “Wendelstein 7-X workshop on the scientific exploitation of the experimental campaign OP 1.2,” held at the Alfried-Krupp Wissenschaftskolleg, Griefswald, Germany, May 14-17. The workshop
consisted of a series of talks designed to generate discussions about the status of data analysis for the W7-X stellarator and to help facilitate solutions to common issues identified through this process.

Pablant has submitted a proposal entitled, “Validation of core confinement in optimized stellarators” for the DOE Early Career Research Program (ECRP). This proposal aims to study core energy and impurity transport in optimized stellarators, leading to the development of predictive models for turbulent core energy and impurity fluxes. The proposal for predictive capabilities is based on an extension of work in the development of proxy models for stellarator optimization (H, Mynick, J. Proll, P. Xanthopoulos) to include experimental core fluxes and diagnostic measurements of plasma fluctuations. In support of the goal, this proposal also aims to build a new power-balance and transport code, named STELLTRAN, to calculate experimental energy fluxes in stellarator geometries and coordinate calculations from a variety of transport related computer codes. The work in this proposal will be done in collaboration with the W7-X team, the Max Planck Institute for Plasma Physics, and Eindhoven University.

R. Lunsford traveled to W7-X to discuss results and compile data from the PPPL Probe-Mounted Powder Injector (PMPI) experiments. Assisted by Lazerson and Pablant, Lunsford met with local scientists to discuss the results of the previous experiment. The PMPI is a unique actuator in the PPPL-IPP collaboration because it allows the horizontal injection of boron carbide particles directly into the edge of the W7-X discharge. These injections are being studied to determine their effects on wall conditioning and to examine the unique aspects of impurity transport in stellarator plasmas.

THEORY (S. HUDSON)

On May 15, N. Fisch served on the Trustees' Committee for the University of Rochester Laboratory for Laser Energetics.

A paper by C. Lan and I. Kaganovich titled, “Electrostatic solitary waves in ion beam neutralization,” was published online in Physics of Plasmas (Vol. 26, Issue 5). It may be accessed via this link: https://doi.org/10.1063/1.5093760. In addition, it was selected as feature article: https://aip.scitation.org/journal/php.

W. Wang has been invited to visit NIFS for one month as visiting professor. Based on mutual interest, he has collaborated with S. Satake and others at the theory department of NIFS on simulation studies of neoclassical dynamics and transport in tokamaks with magnetic island perturbations using the GTS code (PPPL) and FORTEC-3D code (developed by NIFS based on a global neoclassical code I originated at NIFS). This collaboration would strengthen our collaboration and promote our research in this
specific area. It is based on and sponsored by the program of the Joint Institute of Fusion Theory (JIFS) between the U.S. and Japan.

COMMUNICATIONS & PUBLIC OUTREACH (A. ZWICKER)

Public Outreach (A. Zwicker)

S. Greco gave an interactive workshop titled, “How to Be a Better Outreach Educator” at the Princeton University Council on Science and Technology's StudioLab. The audience was composed of members of the University community interested in educational outreach for students and the general public, primarily the Council's Student Ambassadors — graduate and undergraduate students who work in the community to share their excitement about science. Greco talked about strengthening curriculum through informal learning, demonstrated interactive explainers, and challenged what inclusive and diverse learning looks like in STEM. In attendance were graduate student B. Kraus and S. Weidner, Princeton University assistant vice president for research for PPPL. Her discussion is highlighted here: https://cst.princeton.edu/news/science-communication-outreach-and-education

S. Haskey visited the Sequoia pre-kindergarten class at Gillispie school in San Diego to give a demonstration on magnets, electricity, and plasma. The children were full of challenging questions, ideas, and enjoyed performing experiments using demonstration equipment which he borrowed from A. Nagy and R. Lee.

Communications (L. Bernard):

The Office of Communications posted two press releases to the PPPL website. One focused on research of Z. Wang and others on a new method for measuring the stability of plasmas in tokamaks. Involving both sound and a mathematical tool known as a “transfer function,” the method might lead to a technique for stabilizing plasma and making fusion reactions more efficient. The other explored research by D. Boyer and others into using machine learning to create a model for rapid plasma control. The stories were also posted to the EurekAlert and Newswise press release distribution services.
DIRECTOR’S OFFICE (S. COWLEY)

On May 14 and 15, C. Ferguson attended the S&S Workshop at Brookhaven National Laboratory.

S. Cowley participated in the WEST Advisory Board meeting, in Cadarache, France, on May 17.

This report is also available on the following web site:

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