Weekly HIGHLIGHTS

PPPL PRINCETON PLASMA PHYSICS LABORATORY

U.S. DEPARTMENT OF ENERGY

The PPPL Highlights for the week ending February 16, 2019 are as follows:

NSTX-U RECOVERY AND RESEARCH (J. MENARD)

Recovery:

NSTX-U Test Cell - The NSTX-U Test Cell (NTC) Door Radiation Annunciation final design review was held on Feb. 12. This FDR presented the final design of the expanded radiation annunciation system, and reviewed the system's final hardware and configuration of the radiation monitoring system. Updated FMEA was also discussed and reviewed to cover system design concerns. The main design objective was to expand the capability of the existing radiation monitoring system by adding posts and alarms at the entrance doors to the Test Cell. The review was deemed successful, pending resolution of findings and recommendations.

Research:

Collaborations - S. Sabbagh and J. Berkery visited Culham Centre for Fusion Energy (CCFE) to conduct collaborative activities, give related presentations, and attend the MAST-U Research Forum. The presentations included the discovery and stability analysis of resistive wall modes on MAST, initial investigation of the impact on the RWM of the additional conducting structure of MAST-U, and the further development and application of the Disruption Event Characterization and Forecasting (DECAF) code on MAST. Comparisons were made to NSTX results. In addition, the collaboration between CCFE, Columbia U./PPPL, and the University College London (UCL) on the application of specific, innovative artificial intelligence approaches to DECAF analysis began, with specific tasks and quantitative goals discussed with two UCL researchers. Sabbagh also gave a special presentation on DECAF for the benefit of UCL and interested CCFE researchers. Five experimental proposals were also submitted by Sabbagh and Berkery to the MAST-U Research Forum, directly supporting the DOE collaborative international research plan on tokamak disruption prediction and avoidance on MAST/-U.

V. Soukhanovskii of Lawrence Livermore National Laboratory (LLNL) completed a one-week visit to the Culham Center for Fusion Energy, Culham, UK. He participated in the MU01 Research Forum, toured MAST-U tokamak, and met with a number of physicists and engineers to discuss the LLNL collaborative research program in divertor detachment and snowflake divertor studies on MAST-U. Details of the LLNL divertor spectrometer diagnostics, their MAST-U installation schedules, multifluid two dimensional divertor transport modeling with UEDGE code, and planned snowflake divertor experiments were discussed.

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U.S. ITER FABRICATION (H. NEILSON)

An article by PPPL engineer W. Wang, *et al.*, "Thermal Loads and Cooling Design for ITER In-Port Low Field Side Reflectometer Diagnostic System," has been accepted for publication in the journal Fusion Engineering and Design. The paper, which was presented at the Symposium on Fusion Technology in Italy last September, reviews the design and presents the thermal loading and water cooling design for the LFSR in-vessel equipment. The system consists of an array of microwave antennas and associated waveguides and support structure, parts of which are directly exposed to the plasma. The paper reports on the methodology used to determine the heat loads on the system, predominantly volumetric heating due to DT fusion neutrons coming from the plasma. Computational fluid dynamics (CFD) analyses were performed to optimize the design of the water channel configuration that is required to provide the active cooling needed to handle the intense steady state heat loads (up to 7.5 MW/cm^3) on the components.

A report, "Low Field Side Reflectometer (LFSR) Safety Barrier Design Approach," has been received from subcontractor General Atomics. The ITER LFSR waveguides pass through three so-called confinement barriers along their 50 m path from the in-vessel port plug to the diagnostic building. These barriers, which include the vacuum vessel closure plate and internal and external building walls, maintain pressure differentials and fire zoning within the complex. The LFSR safety barriers are penetrations through the confinement barriers which are specially designed to transmit diagnostic microwaves while maintaining a pressure differential across the barrier during operation. They include active shutters that can be closed to protect workers from exposure to stray radiation during maintenance operations, and to close automatically to contain toxic materials under accident conditions such as fire or earthquake. The report describes the LFSR project's current approach to designing its safety barriers to meet this combination of requirements. It incorporates updates in response to chits raised at the November 2018 preliminary design review of the LFSR system.

ITER & TOKAMAKS (R. NAZIKIAN)

DIII-D (B. Grierson):

Research:

W. Guttenfelder visited General Atomics Feb. 8 to present a talk at the Friday Science Meeting on "Predictions of electron scale turbulent transport in DIII-D ELMy H-mode

pedestals." The talk summarized recent nonlinear gyrokinetic simulations using CGYRO that predict significant electron-scale ETG transport in the H-mode pedestal. Numerous scans were performed to begin developing an ETG pedestal transport model usable within predictive simulations.

More than 40 submissions have been made to the DIII-D research opportunities forum (ROF) by PPPL staff, proposing experiments in a wide range of topical areas.

ADVANCED PROJECTS (D. GATES)

Stellarators (D. Gates):

A paper by A. Nagy entitled "A Horizontal Powder Injector for W7-X," has been published online by *Fusion Engineering and Design*. The paper describes the design of the Probe Mounted Powder Injector (PMPI) that was developed for W7-X and used to inject boron carbide powder into the plasma edge during the most recent run campaign, OP1.2b. The paper is available at the following link:
https://www.sciencedirect.com/science/article/pii/S0920379618308573

THEORY (S. HUDSON)

J. Sachdev attended the AToM SciDAC meeting at General Atomics in San Diego, California, Feb. 4-7. Jai gave a presentation on recent updates and plans for the TRANSP code. The objective of the AToM SciDAC is to develop an integrated framework for Whole Device Models. The meeting was held jointly with the PSI2 SciDAC to promote synergy between the two groups.

OFFICE OF ACADEMIC AFFAIRS (N. FISCH)

On Feb. 11, N. Fisch gave the Harvard Physics Monday Colloquium titled, "Exploiting Marked Plasma Oscillations." The abstract read as follows: "The simplest wave behavior characteristic of plasma is a plasma oscillation. This talk will explore how the simplest of waves in plasma, or very close cousins of these waves, can be used to create extreme effects, such as to drive mega-amps of current, to divert megawatts of power, or to mediate laser interactions, thereby to enable the next generation of laser intensities." Fisch also met with Harvard undergraduates who expressed interest in plasma physics.

On Feb. 12, Fisch visited P. Bonoli and others at MIT for a discussion titled, "RF Current Condensation Effect," a topic pursued jointly with A. Reiman. Fisch also met with MIT physics undergraduate students interested in graduate studies in plasma physics.

COMMUNICATIONS & PUBLIC OUTREACH (A. ZWICKER)

Science Education (A. Zwicker):

A. Dominguez traveled to Alabama and Georgia to give talks at various historically black colleges and universities and meet with faculty members to discuss possible collaborations. On Jan. 28, he gave a seminar at Alabama A&M University and met with representatives of the Alabama EPSCoR Program to coordinate the PPPL visit of their interns during the Summer 2019 period. On Jan. 29 he met with faculty members of Tuskegee University; on Jan. 30 he gave a talk at Auburn University and met with faculty members to discuss collaborations; on Jan. 31 he gave talks at Morehouse and Spelman Colleges and met with students and faculty members; and on Feb. 1 he gave a talk at Georgia Institute of Technology and met with students and faculty members.

Communications (L. Bernard):

The Office of Communications posted a story on the PPPL website concerning a model of behavior of plasma particles in fast magnetic reconnection that shows reconnection can occur in partially ionized systems. The research, led by J. Jara-Almonte and H. Ji, was published in Physical Review Letters. The Office of Communications also posted the story on press release distribution services *EurekAlert!* and *Newswise* as well.

L. Bernard attended the annual meeting of the America Association for the Advancement of Science (AAAS) in Washington, DC, Feb. 14-17. Bernard met with journalists from across the globe as well as with representatives of ITER from France and the United States. He also attended a National Laboratory Communications Council meeting, which included discussions with DOE Office of Science communications and public affairs staff, as well as staff from the DOE headquarters public affairs office.

DIRECTOR'S OFFICE (S. COWLEY)

February 15-17, R. Hawryluk attended the AAAS annual meeting in Washington, DC.

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