Weekly HIGHLIGHTS

PPPL PRINCETON PLASMA PHYSICS LABORATORY
U.S. DEPARTMENT OF ENERGY

The PPPL Highlights for the week ending February 2, 2019 are as follows:

NSTX-U RECOVERY AND RESEARCH (J. MENARD)

Recovery:

Project management worked with the cognizant engineers to review task-completion status, logic ties, connectivity, linkages, and resources for all recovery tasks to support integrated schedule development and updating in support of the upcoming basis of estimate review.

Research:

N. Bertelli, L. Delgado-Aparicio, and M. Ono traveled to QUEST (Kyushu University) in Fukuoka, Japan, to attend a workshop on QUEST and related spherical tokamak radio-frequency startup and sustainment plasma research from Jan. 31 through Feb. 1. Bertelli gave a presentation entitled, "Initial Benchmark of Ray-Tracing Codes for QUEST Plasmas and Fokker-Planck Simulations in TST-2 Plasma for SXR Diagnostic." Delgado-Aparicio gave a presentation entitled, "Multi-energy X-Ray Diagnostics for LH and EC Current Drive Studies at TST-2 and QUEST." Ono gave a presentation entitled, "NSTX-U Start-Up Research Program and Modeling of 2nd Harmonic ECH and ECCD Solenoid-free Start-up Experiment in QUEST." During the visit, they discussed future collaborations on QUEST and TST-2 experiments including a multi-energy soft X-ray camera installation and radio-frequency modeling.

U.S. ITER FABRICATION (H. NEILSON)

During a team visit to the ITER Project site in St. Paul-lez-Durance, France, significant progress was made in resolving open issues from the recent preliminary design review of the Low Field Side Reflectometer (LFSR) project. Proposed revisions to the project's safety barrier design concept were accepted by Central Team (CT) safety experts. The documentation will now be updated accordingly and, once approved, two of the three Category 1 chits will be closed. In the remote handling area, two key planning documents were approved. In addition, it was agreed that a team of remote handling specialists from a United Kingdom company RACE (Remote Applications in Challenging Environments), working under contract to the ITER organization, will provide design support to the LFSR project. Discussions with members of the Equatorial Port 11 integration team led to agreements on key design details of the in-vessel LFSR equipment and on the division of responsibilities for local shielding to fill irregular-shaped volumes surrounding the LFSR equipment. The project delegation consisted of A. Basile, M. Sibilia, and H. Neilson from PPPL; and A. Gattuso and C. Muscatello from subcontractor General Atomics.

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ITER & TOKAMAKS (R. NAZIKIAN)

E. Kolemen has been selected as an ITER Science Fellow in Plasma Control. He attended an ITER control meeting in Cadarache, France, last week to discuss control development needs for ITER. Kolemen presented a talk titled, "Achieving high ITER performance with real-time stability analysis and control."

International Long Pulse:

Great progress toward routine kinetic EFIT reconstruction has been made by partnering DIII-D OMFIT developers (N. Logan, B. Grierson) with KSTAR staff (J. Kang, M. Lee). The main challenges that have been overcome are as follows: 1) The addition of KSTAR diagnostics to the OMFIT profiles module for time-dependent profile fitting and 2) the implementation of the KSTAR NBI and ECH systems in the OMFIT TRANSP module. We have confirmed that each individual component functions properly and a final demonstration of a kinetic equilibrium reconstruction is near. Once completed, we will have the same user interface for the generation of kinetic EFITs on KSTAR as the other tokamaks supported by OMFIT. The KSTAR staff are planning on visiting General Atomics for the OMFIT code camp March 4-8.

Progress in collaborative energetic particle research on KSTAR based on new data from the 2018 experimental campaign was discussed in a videoconference. KSTAR physicists are now able to perform routine NOVA/NOVA-K analysis following guidance from G. Kramer and M. Podestà. Along with the improved quality of experimental data with respect to previous campaigns, NOVA analysis is enabling a thorough assessment and more accurate identification of instabilities with a frequency near the Alfvén frequency. Progress has also been made in assessing NOVA capabilities to resolve eigenmodes below the TAE continuum. Initial results from AE analysis will be presented at the next KSTAR Conference in Seoul, Korea. One open issue in moving forward with more comprehensive TRANSP analyses is the ability to generate input U-files for long time series in a semi-automatic way. PPPL collaborators are exploring possible solutions through the OMFIT workflow.

International 3D:

Y. Park, J.-K. Park and Z. Wang are investigating the complexity of the vacuum vessel response to rotating 3D fields in KSTAR. The effective wall time for an n=1 RMP is generally considered to be as large as 500ms due to passive plates close to the 3D coils. On the other hand, one of the recent experiments demonstrated much faster n=1 vacuum response, about 10ms field penetration time, as observed by both pick-up coils and lock-mode sensors. These results are quantitatively reproduced by VALEN3D

simulations by Y. Park. The modeling and data indicate that there are significant variations in the field penetration time depending on the applied RMP spectrum and sensors. It will be important to include magnetic fields induced by these eddy currents in the dynamic 3D response simulations. A result is a new activity aimed at integrating VALEN3D and GPEC to simulate time-dependent plasma and vacuum response.

ADVANCED PROJECTS (D. GATES)

Stellarators (D. Gates):

A paper by S. Lazerson entitled, "Ion temperature gradient turbulence modification in quasi-axisymmetry" has been accepted for publication in *Physics of Plasmas*. The paper explores the role the rotational transform plays in stellarator ion temperature gradient turbulence (ITG) in the QUASAR device. In the paper, free boundary VMEC equilibria are developed using STELLOPT that scan from tokamak-like (rising safety factor) to reversed-shear-like configurations (decreasing safety factor) while maintaining a constant edge transform. Linear ITG growth rates (most unstable mode) and a widely used proxy function do not show a significant difference between equilibria. Here, the GENE code was employed to calculate linear growth rates. However, non-linear simulations show large differences in heat flux at multiple radial locations. In particular, the configuration with a tokamak like safety factor appears to have the lowest turbulent heat flux. This result was confirmed using select full-surface simulations.

DIRECTOR'S OFFICE (S. COWLEY)

On Jan. 30, E. Kalnay from the University of Maryland presented a colloquium titled, "Can large-scale solar and wind farms create a significant climate change?"

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