Weekly HIGHLIGHTS

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

The PPPL Highlights for the week ending June 8, 2019, are as follows:

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

Recovery (R. Hawryluk):

PF 4/5 Re-Alignment — A peer review was held on May 31 for the PF 4/5 realignment. The review explored changes to the design, fabrication, and procurement of a re-positioning system for realigning the PF-4/5 double pancake coils to updated tolerance requirements compared to those used in the CDR. This review also addressed the field work scope needed to enable the coil re-positioning, pancake-to-pancake clamping mechanism, and metrology used to guide re-positioning and verify that the final position meets the requirements. The review was deemed successful, pending resolution of chits.

The following presentations were made during the 28th IEEE Symposium on Fusion Engineering (SOFE) in Jacksonville, Florida, June 2-6:

J. Fang, R. Ellis, and P. Titus presented a poster titled, “Thermal Structure Analysis of OBD Row 1&2 Tiles.” The poster examined the redesign of the original OBD12 tiles in order to meet the higher thermal requirements of the NXTX-U project.

J. Fang, P. Titus, and D. Cai presented a poster titled, “Analysis of PF4 Bus Bars Using Source36 Global Model.” The poster detailed the use of Source36 electromagnetic elements to model the global behavior of NSTX-U by developing a coupled electrical/thermal/mechanical analysis procedure.

A. Jariwla, A. Khodak, A. Brooks, R. Ellis, B. Lin, J. Klabacha, N. Allen, N. Dean, J. Fang, and S. Jurczynski presented a poster titled, “Selection of Graphite Material for National Spherical Torus Experiment Upgrade (NSTX-U) Recovery Plasma-Facing Components Based on Analysis Study and Testing.” The poster discussed analysis studies and testing carried out to select a graphite grade for the NSTX-U recovery project plasma-facing components (PFCs).

C. Neumeyer presented “Electrical Testing of NSTX-U Inner PF Coils” (C. Neumeyer, J. Dellas, N. Greenough, J. Petrella, W. Que, and Y. Zhai). The presentation reported on the electrical testing methods used to inspect the coils after their failure and the results from prototype testing, along with plans for application to the production coils.

W. Que and J.Dellas presented a poster titled “Sizing of Current Limiting Reactors for the NSTX-U Inner Poloidal Field Coil Power Circuits.” The poster examined the new design requirements for the new power circuits for the PF1B coils.

Y. Zhai, X. Peng, D. Van der Laan, and C. Kessel presented a poster titled, “High Field Superconducting Magnet Options for the Fusion Nuclear Science Facility.” The poster focused on exploring detailed low-temperature superconductors (LTS) vs high-temperature superconductors (HTS) design options as a result of high field system studies for the next-step fusion reactors such as FNSF in order to define the coil size, mechanical loading, and engineering design requirements.

Y. Zhai chaired an oral session for SOFE on June 6 and served on the SOFE technical committee. He also gave a talk titled, “Design and Analysis of NSTX-U Inner PF Replacement Coils.”

H. Zhang and P. Titus presented a poster titled, “Analysis of Magnetic Damping Effect for Passive Plates of NSTX-U Recovery.” The poster examined the approach of using ANSYS to realize the transient coupling of the EM model and structural model of passive plate, to analyze eddy current due to a changing magnetic field and plate motion, and transfer of the load to the structural model to calculate plate response, from which the plate velocity is then used in the EM model to compute eddy current due to motional EMF. The second part of the poster develops the method of estimating the damping ratio (either for constant damping or Rayleigh damping model) from the transient response of coupled EM-structural analysis, which can then be easily used in the structural model with all the design details.

In addition, C. Neumeyer served as session chair for plenary session 1 and oral session 3.

Research (S. Kaye):

On June 4, R. White gave a presentation at a special physics meeting on his work to explain the modulation of mode amplitude and frequency, or “chirps,” associated with toroidal Alfvén eigenmodes. He used the guiding center code known as ORBIT and a delta-f formulation and showed that the chirping resulted from Fourier sidebands that shifted to both higher and lower frequencies than the nominal mode frequency. These shifts were associated with mode resonance shifts as the energetic particle distribution function developed clumps and holes (i.e., shifting gradients in phase space). Equilibria with conventional positive magnetic shear as well as NSTX reversed-shear were used to investigate this effect.

U.S. ITER FABRICATION (H. NEILSON)

The Laboratory’s work on the ITER Low Field SIde Reflectometer (LFSR) was represented in four presentations at the SOFE conference in Jacksonville. A poster by W. Wang titled, “Mechanical and Thermal Loading on the Integrated In-Vessel Components of the ITER \

Low Field Side Reflectometer (LFSR)," described the volumetric head loads from fusion neutrons, surface heat loads from plasma emission, electromagnetic forces due to disruptions, and seismic loading under earthquake conditions, that drive the design. A. Basile's poster, "ITER Low-Field Side Reflectometer In-Vessel Engineering," described the engineering advances in the final design of that assembly, including mechanical interfaces with the surrounding structure, achievement of final antenna positioning and aiming tolerances, and compatibility with remote handling. A poster by A. Gattuso of partner General Atomics, "System Development of the ITER Low Field Side Reflectometer," covered the overall system design. Finally, an oral presentation by H. Neilson, "Addressing Engineering Challenges in the Design of ITER Diagnostics," used the LFSR as a case study in managing the adaptation of a well developed tokamak plasma diagnostic tokamak to the requirements of a fusion nuclear facility.

ITER & TOKAMAKS (R. NAZIKIAN)

International PMI (R. Maingi):

A new set of three plates constructed out of molybdenum and used for flowing liquid lithium limiter experiments in EAST in Hefei, China, was completed. Specifically, two LIMIT tile plates, manufactured by UIUC, and one FLiLi plate, manufactured by PPPL, were successfully modified for use in EAST. Molybdenum cooling tubes designed for helium gas flow were successfully brazed onto the back of the LIMIT plates. In addition, a new heat sink to connect the lithium feed tube to the back of the plate was designed and implemented for all three plates. All of the components are awaiting final customs forms approvals, expected in early June, for experiments scheduled in EAST in July.

On May 30, R. Maingi presented a talk at the NSTXU/Magnetic Fusion Science meeting titled, "ELM suppression with B powder injection and ELM triggering with Li and C granule injection in EAST." Type I ELMs in EAST were completely suppressed by boron powder injection into the X-point region of an upper-single null configuration plasma over a wide range of operating conditions.

A. Bortolon and R. Maingi each presented one-hour lectures at the SOFE 2019 mini-course on plasma-material interactions in Florida on June 2. Bortolon's lecture was titled, "Diagnostics for PMI and Ion Beam Analysis," and Maingi's lecture was titled, "Fundamentals of PMI and Plasma Edge Physics in Fusion Devices." More than 20 participants attended the lectures, and there was a vibrant question-and-answer period.

KSTAR Stability (S. Scott):

The in-vessel calibration of the MSE background polychromator performed in May included a calibration of one sightline at an alternate retardance value (3.61 radians) of the photoelastic modulators (PEMs). This allows the system to infer the polarization angle from the sum of signal intensities at the second and fourth harmonics of the PEM frequency, which increases total signal by 30% and reduces sensitivity to variations in the PEM retardance. It will also allow direct comparison between the existing KSTAR MSE diagnostic and the MSE background polychromator.

COMMUNICATIONS & PUBLIC OUTREACH (A. ZWICKER)

Public Outreach (A. Zwicker)

Representatives from central New Jersey county vocational-technical schools visited PPPL on June 4 to learn about the Lab's new technician apprenticeship program and encourage their students to apply. S. Cowley and A. Zwicker gave brief statements about the value of this program to the lab and the local economy. S. Greco presented an overview of the lab and highlights about the new program and escorted the group on a brief tour of the Laboratory and NSTX-U. In addition, Greco visited two campuses of the Mercer County Technical Schools to meet with graduating seniors and adult students to recruit for the program, resulting in several applicants.

Communications (L. Bernard):

The Office of Communications posted one press release to the PPPL website. It focused on research by C. Lan and I. Kaganovich into a surprising new obstacle that reduces the neutralization of ion beam pulses. The story was also posted to the *EurekAlert* and *Newswise* press release distribution services.

DIRECTOR'S OFFICE (S. COWLEY)

On June 5, H. Ji presented a colloquium titled, "Frontiers of Magnetic Reconnection Research and FLARE Project."

On June 7, C. Ferguson held an offsite Operations retreat to develop and align the operations functions of the Laboratory.

This report is also available on the following web site:

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