Weekly HIGHLIGHTS

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

The PPPL Highlights for the week ending April 20, 2019, are as follows:

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

Recovery (R. Hawryluk):

TF Bundle — A peer review for the inner toroidal field (TF) bundle was held on April 17. The purpose of the review was to confirm that the method developed for fabricating TF bundle test samples at PPPL will satisfy all requirements. The review covered the materials, processes, and procedures planned for the sample fabrication, up to and including the cutting of laminates into individual samples. The review was deemed successful, pending resolution of chits.

Private Flux Region Fueling — A successful preliminary design review (PDR) was held April 19 for the private flux region injector. These injectors would support operations through deuterium or impurity fueling to mitigate heat flux to plasma-facing components and support research activities. They would regulate the flow rate, first by setting the system pressure and then by injecting gas through fully-open valves. The mechanical design for these injectors was reviewed during this PDR, and the PDR was deemed successful pending completion of chits.

Research (S. Kaye):

M. Cecconello (Uppsala University, Sweden), W. Boeglin (FIU) and A. Netepenko (FIU) visited PPPL the week of April 15 to work with M. Podestà, F. Poli, and S. Kaye on TRANSP analysis of MAST discharges with unstable TAE/EPMs and fishbones within the NSTX-U/MAST collaborations. Collaborators have been trained on using the “kick model” implemented in TRANSP to account for enhanced fast ion transport by AEs and fishbones. Plans have been discussed to extend previous analysis from [Cecconello NF2015] using the improved TRANSP analysis tools for a more comprehensive comparison with data from the MAST Neutron Camera, Fusion Product Array and FIDA diagnostics, thus contributing to ongoing validation activities for fast ion transport models in TRANSP.

NSTX-U researchers R. Raman, B. Nelson (University of Washington), and M. Ono (PPPL) visited Kyushu University in Japan April 8 to 19 to perform the coaxial helicity injection (CHI) experiment and to discuss future CHI improvements on QUEST. Experiments tested the possibility of initiating a CHI discharge that connected the bias electrode plate to the center stack, as on NSTX, to take advantage of the higher toroidal field at the inboard location. In addition, the feasibility of initiating a CHI discharge using only the ECH pre-ionization system on QUEST was also tested, as this injected much less gas than the normal CHI gas injection system.

J. Menard visited the Department of Applied Physics and Mathematics at Columbia University on April 19 to present a talk entitled "NSTX-U Recovery and Ideas for Next-Step Low-A Tokamaks," at the departmental plasma physics colloquium.

U.S. ITER FABRICATION (H. NEILSON)

The Laboratory's ITER diagnostics design team completed validation tasks satisfying software quality assurance (SQA) requirements for two installations of ANSYS, version 19.0. This widely-used commercial simulation software is used to perform the calculations that are documented in structural integrity reports for both in-vessel and ex-vessel diagnostic equipment. ITER SQA procedures require configuration management and validation for software used in such calculations.

ITER & TOKAMAKS (R. NAZIKIAN)

DIII-D (B. Grierson).

Research:

W. Guttenfelder and G. Kramer attended the Sherwood Fusion Theory Conference. Guttenfelder presented an invited talk titled, "Predictions of electron scale pedestal turbulence in DIII-D ELMy H-modes." The talk described recent analysis showing that electron scale ETG transport predicted by nonlinear gyrokinetic simulations (CGYRO) provides a substantial contribution to the experimentally inferred electron heat flux.

Kramer gave a presentation of recent modeling of curved Alfven eigenmode wave fronts titled, "Enhanced radial energy transport induced by radially curved Alfven eigenmode wavefronts," as a poster.

M. Churchill visited General Atomics to further collaborations on machine learning with DIII-D diagnostics and scrape-off layer modeling using the XGC code. He presented a talk at the DIII-D Friday Science meeting entitled, "Deep convolutional neural networks for long time-series classification," presenting a general machine learning algorithm for working with time series data from fusion diagnostics, and showing results on applying this algorithm to the DIII-D ECEi diagnostic for disruption prediction.

V. Duarte remotely presented the talk, "Realistic 2D quasilinear modeling of fast ion relaxation," at the DIII-D Friday Science Meeting. The talk described recent efforts on the development of the Resonance-Broadened Quasilinear (RBQ) code and its extension to 2D, which are occurring within the ISEP SciDAC project. Validation against DIII-D critical gradient experiments by means of TRANSP's post processing of RBQ output was also shown.

International Long Pulse (F. Poli):

Status and plans for analysis of low-frequency Alfvenic/acoustic modes below the TAE gap on KSTAR were discussed in a video-conference with KSTAR collaborators. F. Cheng and G. Kramer presented initial results from analysis of modes in the sub-TAE frequency range, including their interpretation based on analytical theory and its verification against results from the NOVA ideal-MHD code. Recent developments on theoretical understanding of modes in the sub-TAE range were also presented by F. Cheng at the Sherwood meeting hosted by PPPL.

ADVANCED PROJECTS (D. GATES)

Stellarators (D. Gates)

South Korea's National Fusion Research Institute (NFRI) has accepted the Laboratory's final report of work performed in support of NFRI's K-DEMO concept design study in 2017-2018. The K-DEMO is envisioned as a demonstration fusion power plant designed to produce 500 megawatts of net electricity. The Laboratory has collaborated in the study since 2012, performing a range of design and analysis tasks, both physics and engineering. The recent report includes simulations of the current ramp-up phase, structural analyses of the central solenoid and poloidal field coils, machine configuration studies, and a study of vertical launch electron cyclotron wave current drive. The Laboratory's work has been supported by NFRI under a Strategic Partnership Project agreement.

C. Zhu attended the Sherwood Fusion Theory Conference 2019 in Princeton April 15-17. He presented a poster entitled, "Quick identification of dangerous coil deviations using a Hessian matrix method." In his poster, he introduced a Hessian matrix method to evaluate critical coil deviations opening magnetic islands and degrading quasi-symmetry in stellarators.

THEORY (S. HUDSON)-

M. Cole was invited to the annual meeting of the Simons Collaboration on Hidden Symmetries and Fusion Energy at the Flatiron Institute in New York City, March 28-29. He presented a poster entitled, "Global gyrokinetic simulations of ion temperature gradient-driven instabilities in stellarators."

S. Ethier gave a mini-course entitled, "Introduction to Code Debugging" as part of the series of mini-courses hosted by the Princeton Institute for Computational Science and Engineering (PICSciE). The lecture introduced the Princeton University participants to

different approaches in tackling the task of debugging serial and parallel applications, including the use of advanced parallel debuggers, such as DDT.

E. Feibush presented two mini-course seminars at the Princeton Institute for Computational Science and Engineering. “Python Programming Techniques” described the elements of the Python language. Attendees from Princeton University wrote example programs and were shown how to continue learning on their own. In “Scientific Visualization with VisIt,” he presented visualization techniques, examples, and instructions on how to run the VisIt program. Attendees worked on visualization exercises to reinforce the presentation. PPPL student interns N. Lin and K. Lui served as teaching assistants for both mini-courses.

C. Dong received a NASA Group Achievement Award.

COMMUNICATIONS & PUBLIC OUTREACH (A. ZWICKER)

Communications (L. Bernard)

The Office of Communications posted two press releases to the PPPL website. One highlights research by C.S. Chang et al into the flow of plasma particles around the X point, which affects the heat exhaust from tokamaks. The other showcases research by B. Tang and others into using deep learning artificial intelligence to forecast sudden disruptions that halt fusion reactions in tokamaks. The stories were also posted to the *Newswise* and *EurekAlert* press release distribution services.

DIRECTOR’S OFFICE (S. COWLEY)

On April 17, C. Ferguson participated in the Science Laboratories Infrastructure (SLI) Workshop at Fermilab in Batavia, Illinois. The workshop was hosted by the U.S. Department of Energy.

On April 18, PPPL hosted the Joint NAS / DPP-CPP Town Hall for the NAS Plasma 2020 Decadal Study (represented by M. Kushner) and the DPP/FES Strategic Planning Activity (by E. Scime or substitute). The purpose of this meeting was to solicit community input on the two important reports that will emerge from these two studies.

This report is also available on the following web site:

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