Weekly HIGHLIGHTS

The PPPL Highlights for the week ending September 7, 2019 are as follows:

NSTX-U RECOVERY (J. GALAYDA) AND RESEARCH (S. KAYE)

Recovery (J. Galayda):

Recovery Project — The Project is pleased to announce that L. Hill was named its permanent program manager this week. Hill has significant experience managing large, complex projects in the commercial nuclear power industry and has worked in the DOE system managing projects for almost 20 years, first at Brookhaven National Laboratory and at PPPL since April 2016.

Research (S. Kaye):

The paper "Modeling of chirping toroidal Alfvén eigenmodes in NSTX,' by R. White and V. Duarte has been published in *Physics of Plasmas*. It reports the first modeling of wave chirping phenomena in a spherical tokamak. Guiding-center simulations indicate that the onset of chirping in NSTX is triggered by a sudden increase in the wave background damping due to the continuum interaction. In addition, the role of pitch-angle scattering in suppressing the chirps is confirmed numerically.

A paper by F. Ebrahimi was published in *Physics of Plasmas* on Sept. 3 entitled, "Three-dimensional plasmoid-mediated reconnection and the effect of toroidal guide field in simulations of coaxial helicity injection:" https://doi.org/10.1063/1.5098482
Ebrahimi used computer simulations to investigate the effect of toroidal fields on the 3-D stability of edge-reconnecting, current-carrying filaments in spherical tokamaks. During simulations of transient coaxial helicity injection (CHI), she found the following: 1) even in the presence of non-axisymmetric edge magnetic fluctuations, current-carrying axisymmetric plasmoids are rapidly formed while twisted open field lines are being injected at an arbitrary toroidal guide field, and are merged to form a large current-carrying magnetic bubble for plasma startup in a tokamak, and 2) complete stabilization of nonaxisymmetric fluctuations arising from current-sheet instabilities was also achieved at a higher toroidal flux. These findings are important for startup scenarios in spherical tokamaks around the world — including NSTX-U, URANIA, QUEST, and ST40 — since they will operate at higher toroidal fields.

The 2019 US-Japan workshop on radio-frequency heating and current-drive physics was held at PPPL Sept. 4-6, 2019. Thirty oral presentations in eight sessions were given by researchers from the National Institute for Fusion Science, Kyushu University, University of Tokyo, and Kyoto University from Japan; and MIT, PPPL, ORNL, GA, TAE, and UCLA from the U.S. PPPL presentations included "Suppression of tearing modes by RF current

condensation," by A. Raiman; "Synergies between alpha channeling and current drive and current condensation," by N. Fisch; "From a reflectometry code to a 'standard' EC code to investigate the impact of the edge density fluctuations on the EC waves propagation," by N. Bertelli; "Theory of mode-converting quasioptical wave beams in inhomogeneous plasma" by I. Dodin; "Modeling of 2nd harmonic electron cyclotron heating and current drive solenoid-free start-up experiment in QUEST," by M. Ono; "Numerical modeling of helicon and slow waves," by E-H Kim; "Recent progress on simulation of lower hybrid power on EAST," by W. Choi; "3D HHFW full wave simulations with realistic antenna geometry and SOL plasma in NSTX-U," by N. Bertelli; "Effect of wall boundary on the scrape-off layer losses of high harmonic fast wave in NSTX and NSTX-U," by E-H Kim; "Plans for the NSTX-U HHFW antenna," by R. Ellis; and "High-resolution spectroscopic measurements for RF power deposition studies," by L. Delgado-Aparicio. The workshop information can be seen at https://sites.google.com/pppl.gov/us-japan-workshop-on-rf.

U.S. ITER FABRICATION (H. NEILSON)

A document describing the structural analysis of the Low Field Side Reflectometer (LFSR) waveguide support structure in the ITER Tokamak Building gallery was issued for review. The report, by PPPL engineer M. de Looz, focuses on a change from the preliminary design review (PDR) design, namely a custom welded solution, to one based on a commercial off-the-shelf structural system. It describes the analysis performed for the switch in design with respect to geometries, constraints, materials and layout; concentrating on a side-by-side comparative approach between the previous design and calculations documented in the LFSR Ex-Vessel Structural Integrity Report and an off-the-shelf solution laid out to meet the same goals. The off-the-shelf solution was developed by the ITER Central Team and documented in a Captive Components final design review held in 2018. A description of the activity performed is included, outlining assumptions, routines and methodologies, comparisons, verifications and the results obtained. The analysis described is the primary basis for the agreed decision to switch to an off-the-shelf solution.

Final design and manufacturability studies for the LFSR in-vessel antenna assembly continue to progress. A current design focus is the development of strategies to minimize the requirements on component design for maintenance by remote handling. The aim is to limit requirements and simplify design scope, in order to maintain a team focus on efforts required to meet overall final design review (FDR) objectives. In addition, the PPPL team is working closely with partner General Atomics to optimize the division of design work responsibilities, clarifying scope and parameters to facilitate

efficient parallel efforts that support the FDR schedule objectives. Fabrication of a steel sample for welding trials is nearly complete. The sample will be used to investigate the performance and inspection of welds that must be made at a chamfered corner to seal two intersecting cooling channels in the LFSR antenna support block.

THEORY (S. HUDSON)

R. Hager, S. Hudson, and B. Sturdevant attended the 2019 International Conference on Numerical Simulation of Plasmas in Santa Fe, New Mexico, Sept. 3-5. Hager gave a talk titled, "Realization of Moment-Preserving Resampling in a Particle-in-Cell Code," and Sturdevant gave a talk titled, "A Fully Implicit Particle-in-Cell Method for Gyrokinetic Electromagnetic Modes."

M. Churchill co-lead the fusion energy breakout session at the AI for Science Townhall at Oak Ridge National Lab.

N. Gorelenkov attended the 16th IAEA Technical Meeting on Energetic Particles in Magnetic Confinement Systems — Theory of Plasma Instabilities, in Shizuoka City, Japan, Sept. 3-6. He gave a talk titled, "Predator-Prey model interpretation of nonlinear dynamics of Alfvénic instabilities."

COMMUNICATIONS & PUBLIC OUTREACH (A. ZWICKER)

Communications (L. Bernard):

The Office of Communications posted a news story to the PPPL website about the formation of the new Princeton Collaborative Research Facility on Low-Temperature Plasma. This new national facility will be open to researchers from across the country to study low-temperature plasma, which pertains to fields ranging from electronics to health care to space exploration. The facility, to launch this October with DOE funding of $1.2 million a year for five years, opens the extensive diagnostic and computational resources at PPPL and Princeton University to the academic, scientific and industrial communities. The story was also posted to the *Newswise* and *EurekAlert* press distribution services.

This report is also available on the following web site:

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