The PPPL Highlights for the week ending December 8, 2018 are as follows:

**NSTX-U RECOVERY AND RESEARCH (J. MENARD)**

*Recovery:*

**Magnets** — ICAS Tratos is preparing a spooling process using PF1B legacy conductor and will start production of PF1a conductor upon sign off of the manufacturing inspection test plan. Compression testing of the glass tape is underway and tooling modification design began in the coil shop.

*Research:*

**Conferences** — M. Ono attended the 35th Annual Meeting of the Japan Society of Plasma Science and Nuclear Fusion Research in Osaka, Japan from Dec. 3-6. He gave an invited talk entitled, “Liquid-Lithium Divertor/PFCs Experiments and R&Ds at NSTX-U/PPPL,” at the liquid metal divertor/PFCs symposium and participated in the panel discussions.

**Publications** — The article, “Supersonic Gas Injector for Plasma Fueling in the National Spherical Torus Experiment,” by V. Soukhanovskii, W. Blanchard, J. Dong, R. Kaita, H. Kugel, J. Menard, T. Provost, R. Raman, A. Roquemore, and P. Sichta was published in *Fusion Science and Technology*. The article describes the development of a supersonic gas injector (SGI) and how it is used for fueling and diagnostic activities on NSTX. The SGI has been used for the fueling of ohmic and 2- to 4-MW neutral beam injection–heated L- and H-mode plasmas and has enabled better fueling efficiency and better density control.

**Collaborations** — S. Sabbagh, J. Ahn, and J. Riquezes traveled to NFRI in South Korea to run an experiment on KSTAR to drive plasma rotation and high rotation shear in plasmas without external torque from neutral beam injection, with attention on diagnosing the effect with further diagnostics. The effect was successfully produced as expected from theory and diagnosed. The effect has produced levels of rotation many times higher than projected for ITER by other means in the outer region of the plasma and has now produced further increase of the rotation in the core plasma. The group joined Y.-S. Park of Columbia University for the run and also to plan for the coming high beta experiments on KSTAR by the group in 2018.

**U.S. ITER FABRICATION (H. NEILSON)**

Following a successful preliminary design review in Nov., the Low Field Side Reflectometer (LFSR) team continued to develop plans to build a component prototype that will validate fabrication methods for specific deliverable hardware. The team held discussions resulting in concurrence on 1) readiness of design for prototype, 2) objectives of prototype, 3) drawing definition and dimensional schemes, and 4) next steps in manufacturing coordination.
ITER & TOKAMAKS (R. NAZIKIAN)

DIII-D Research (B. Grierson):

N. Logan and B. Grierson worked closely with M. Lee and J. Kang from the Korean National Fusion Research Institute (NFRI) to develop an OMFIT framework interface for preparing TRANSP runs for KSTAR. Logan and Lee were able to add KSTAR data into the widely used OMFIT profiles workflow that is capable of providing fitted kinetic profiles for TRANSP analysis. In parallel, Grierson and Kang were able to build the necessary TRANSP neutral beam interface for KSTAR. When these capabilities are publicly released after proper testing, KSTAR researchers will be able to execute interpretive and predictive time-dependent transport analysis for KSTAR experiments.

The paper titled, “Identification of multiple eigenmode growth rates in DIII-D and EAST tokamak plasmas,” by Z. Wang, et al., has been accepted for publication in Nuclear Fusion. Wang and the coauthors developed an advanced 3D MHD spectroscopy method based on multi-modal transfer functions from magnetic measurements. The method successfully extracts the dominant eigenmodes and the corresponding eigenvalues in DIII-D and EAST multi-mode plasma response experiments. The effort continues to further improve the efficiency of 3D MHD spectroscopy for the real-time detection of marginally stable MHD instabilities in tokamaks.

International PMI (R. Maingi):

E. Gilson, A. Bortolon, A. Diallo, and R. Maingi led experiments on KSTAR with NFRI and KAIST colleagues on Dec. 3 and 4. The PPPL Impurity Powder Dropper was used to drop boron and boron nitride powder into 20s-duration ELMy H-mode discharges to study the effect of the powder on wall conditioning, pulse duration, divertor dissipation, energy confinement, and edge turbulence. The IPD was successful to generate windows of ELM suppression up to 1 second in duration. Future studies will focus on optimizing conditions for the complete suppression of ELMs and to further explore the conditioning effect of the dropper.

International 3D (J-K Park):

This week N. Logan and J.-K. Park ran two ELM-suppression experiments on KSTAR with NFRI collaborators. The experiments were able to reproduce n=1 ELM suppression in a low-power H-mode discharge where density pump-out was not observed. This is interesting for the understanding the transport consequences of edge-resonant RMPs.

Logan gave a seminar and tutorial on the optimization of 3D fields in KSTAR using the Generalized Perturbed Equilibrium Code at NFRI. The tutorial introduced running the GPEC code through the OMFIT framework. Both OMFIT and GPEC have been installed on the NFRI cluster. There was strong interest from the researchers to learn and apply the OMFIT-based tools to KSTAR analysis.
International Energetic Particles (M. Podesta):

J. Kang and T. Rhee from KSTAR/NFRI (Korea) have concluded a two-week visit to PPPL. By the end of the second week, they were able to perform a complete simulation of Alfvénic instabilities and fast ion transport using the “kick” model for a selected KSTAR scenario. The analysis includes ideal MHD stability with the NOVA/NOVA-K codes, ORBIT analysis to infer the EP transport properties associated with Alfvénic instabilities (AEs), and TRANSP+kick model time-dependent simulations to assess the effect of AEs on fast ion transport. Due in part to uncertainties in the measured q-profile, open questions remain on the exact identification of the instabilities observed in KSTAR hybrid plasmas, i.e., whether they are toroidal AEs or modes inside the Alfvén continuum. Discussions also took place on the planning for high-power experiments in late December.

ADVANCED PROJECTS (D. GATES)

Stellarators (D. Gates):

C. Zhu was invited to give a talk titled, “Progress in magnetic field coil optimization for stellarator plasmas,” at a special symposium of the 35th annual meeting of The Japan Society of Plasma Science and Nuclear Fusion Research (JSPF) on Dec. 6 at Osaka University, Japan. He reviewed the existing tools for designing stellarator coils and introduced the development of FOCUS code. He also attended the Workshop on Configuration Optimization in Stellarator/Heliotron in Kyoto University and presented a talk titled, “Error field sensitivity analysis for modular coils of CFQS,” in which he demonstrated a recently developed Hessian matrix for analyzing error field sensitivity and applied this method to the being built CFQS stellarator.

THEORY (S. HUDSON)

The paper titled, “Suppression of Tearing Modes by RF Current Condensation,” by A. Reiman and N. Fisch, has been published in the Nov. 30 issue of Physical Review Letters. Currents driven by RF (radio frequency) waves in the interior of magnetic islands can stabilize deleterious tearing modes in tokamaks. Present analyses of stabilization assume that the local electron acceleration is unaffected by the presence of the island. However, the power deposition and electron acceleration are sensitive to the perturbation of the temperature. The nonlinear feedback on the power deposition in the island increases the temperature perturbation and can lead to a bifurcation of the solution to the steady-state heat diffusion equation. The combination of the nonlinearly enhanced temperature perturbation with the RF current drive sensitivity to the temperature leads to an RF current condensation effect, which can increase the efficiency of RF current drive stabilization and reduce its sensitivity to radial misalignment of the ray trajectories. The threshold for the effect is in a regime that has been encountered in experiments and will likely be encountered in ITER. Here is the link:

https://doi.org/10.1103/PhysRevLett.121.225001
**Computational Plasma Physics Group (S. Jardin and S. Kaye):**

S. Ethier gave a presentation titled, “Introduction to Parallel Programming using MPI and OpenMP,” as part of the series of mini-courses organized by the Princeton Institute for Computational Science and Engineering (PICSciE). The lecture introduced the Princeton University participants to parallel programming for distributed and shared memory computers using the Message Passing Interface library and OpenMP shared memory directives, which are the most widely used methods in high performance computing.

**COMMUNICATIONS & PUBLIC OUTREACH (A. ZWICKER)**

**Communications (L. Bernard):**

The Office of Communications posted two press releases to the PPPL website. One was a profile of new PPPL director Steve Cowley. The other noted that data gathered by NASA’s Magnetospheric Multiscale Satellite mission matches data gathered by PPPL’s Magnetic Reconnection Experiment, showing how field and laboratory experiments can complement each other. The press releases were also posted to the Newswise and EurekAlert press release distribution services.

**DIRECTOR’S OFFICE (S. COWLEY)**

From Dec. 3-4, R. Hawryluk attended an NLCOO meeting at Sandia National Laboratories.

From Dec. 4-5, S. Cowley and M. Zarnstorff attended the Fusion Power Associates annual meeting in Washington, D.C.

From Dec. 6-7, Cowley and Zarnstorff attended the Fusion Energy Sciences Advisory Committee (FESAC) meeting in North Bethesda, Maryland.

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