The PPPL Highlights for the week ending September 11, 2015, are as follows:

NSTX (M. ONO):

NSTX-U is in the Upgrade Project outage in FY15

An article "Numerical optimization of three dimensional coils for NSTX-U" by S. Lazerson (PPPL) et al., has recently been published (http://iopscience.iop.org/article/10.1088/0741-3335/57/10/104001) in Plasma Physics and Controlled Fusion 57 (2015) 104001. In this article the newly developed IPECOPT code is used to explore the effect of 3D fields in NSTX-U for torque control. The IPECOPT code is an optimizer built around the IPEC linear ideal MHD perturbed equilibrium code and coupled PENT neoclassical toroidal viscosity calculation. The work highlighted a capability of the proposed Non-axisymmetric Control Coils (NCC) to drive core torque with n=1 and edge torque with n=3. This work was presented at the Workshop on MHD Stability and Control, and has been selected to provide a cover image for the October issue of Plasma Physics and Controlled Fusion

J.-W. Ahn (ORNL) gave an invited talk, “Effect of 3-D fields on heat and particle transport in tokamak divertors”, in the Workshop on Stochasticity in Fusion Plasmas in Bad Honnef, Germany on September 10. The travel was supported by the Wilhelm and Else Heraeus Foundation. The talk highlighted recent progress on the understanding of 3-D divertor physics, for both steady state and transient conditions, with experimental data from NSTX and DIII-D.

The bake of the NSTX-U vessel is in progress, and will continue to the end of September. New IR cameras installed at Bays G & H are operational and will be calibrated while the vessel tiles are at bake-out temperatures. Local testing of the Switching Power Amplifier (SPA) system used to power the NSTX-U Resistive Wall Mode (RWM) is in progress, and will continue during the bake. Pre-operational testing of MG#2 continued this week (MG#1 is already fully operational). Time will be scheduled during the bake for beam conditioning of the NB2 ion sources, RF conditioning of the High Harmonic Fast Wave (HHFW) sources, and power testing of the PF1cU rectifier.

ITER & TOKAMAKS (R. HAWRYLUK):

DIII-D (R. Nazikian):

The FY15 PPPL milestone on the confinement of energetic ions in steady state plasmas on DIII-D was accomplished this week. The research focused on testing quantitative models of energetic particle transport in high qmin plasmas where Alfvenic activity and large neutron deficits are observed. The importance of this work is two fold. First, we need to understand if existing quantitative models of beam ion transport based on multiple Alfven eigenmodes can reproduce observations. Second, we need to use this information to predict the anomalous transport in future steady state reactors and in developing methods to mitigate their effects in present day experiments.

Two models were validated against the experimental measurements of Alfven eigenmodes and neutron deficit. The first is the Critical Gradient Model (CGM) developed by N. Gorelenkov, and the second is the kick model developed by M. Podesta. Detailed analysis of Alfven stability using NOVA-K and comparison to mode measurements in DIII-D was performed by G. Kramer. The results are that both the CGM and the kick model accurately reproduce the observed ~ 20% neutron deficit in steady-state plasmas where high frequency RSAE, TAE and EAEs from 100-300 kHz are observed in the plasma. However, the worst-case neutron deficit of ~ 40% could not be explained with the NOVA-K modes and detailed analysis revealed intense global modes in the BAE range of frequency that was not evident in the NOVA-K output. When ad hoc low frequency modes were introduced into the kick model based on experimental observations of the internal mode structure then the kick model was able to account for the full 40% neutron deficit.

The work revealed important directions for future study of the low-frequency modes with nonperturbative or gyrokinetic codes and it also revealed ideas for ways to avoid beam ion loss in future steady-state experiments. The results of this research were presented in a recent DIII-D science meeting talk by G. Kramer and at the IAEA Technical Meeting on energetic particles by N. Gorelenkov and M. Podesta (oral presentations) held in Vienna, Austria on September 1-4.

A new TRANSP module has been released within the OMFIT integrated modeling framework. The module provides a powerful visual interface for the TRANSP code, enabling a wider user-ship of TRANSP in the DIII-D program. A single interface guides the user through the steps necessary to prepare the input data, run the code, inspect output and perform post TRANSP analysis. The module was developed by N. Logan and B. Grierson with strong support from the GA OMFIT developers.

D. Eldon successfully defended his dissertation on back transitions out of H-mode on September 8 at UCSD. The presentation was attended by DIII-D scientists, UCSD students/ researchers, and his family. This defense satisfies all the requirements for his Ph.D.

International Collaborations (R. Hawryluk):

R. Hawryluk attended the ITER Organization schedule workshop at the ITER Organization Headquarters in Cadarache, France.

ADVANCED PROJECTS (H. NEILSON):

D. Turnbull (now of LLNL), working with R. Goldston of PPPL and A. Glaser of Princeton University, has just published "Investigating the value of fusion energy using the Global Change Assessment Model" in the journal Energy Economics. This study included fusion energy in the Pacific Northwest National Laboratory's Global Change Assessment Model, GCAM, using a simplified costing developed in the European Union. We find that the estimates of present value for fusion energy are very large relative to fusion's development cost in the case where CO2 emissions need to be restrained and there are issues limiting very aggressive deployment of either carbon capture and storage or nuclear fission.

THEORY (A. BHATTACHARJEE):

On September 10, W.-L. Lee presented a theory seminar on gyrokinetic MHD for collisionless plasmas: The effort to obtain a set of "hydromagnetic" equations for a magnetized collisionless plasma started nearly 60 years by Chew, Goldberger and Lowe. Many attempts have been made ever since. Here, we will show the derivation of a set of collisionless MHD equations from the gyrokinetic perspective. This set of equations is energy conserving and, in the absence of fluctuations, recovers the usual MHD equilibrium.

COMPUTATIONAL PLASMA PHYSICS GROUP (S. JARDIN):

A new capability that uses a feedback algorithm to adjust dynamically the Anomalous Fast Ion Diffusivity (AFID) in order to match the measured neutron rate has been added to TRANSP. This feature will allow for a reduced number of runs necessary for matching experimental conditions. The algorithm uses a simple proportional-integral-derivative simple (PID) feedback control algorithm, and can work with either a zero baseline AFID (BDIFBA=CDIFBA=0) or with some non-zero, time-dependent baseline. The algorithm will "change" the AFID from whatever level is at the previous time step to bring the measured and calculated neutron fluxes into agreement, or as close to agreement as possible.

PLASMA SCIENCE AND TECHNOLOGY (P. EFTHIMION):

I. Kaganovich, Y. Raitses, and their collaborator Professor Andrei Smolyakov from the University of Saskatchewan attended the Workshop on Electron Transport in Hall Thrusters hosted at the Jet Propulsion Laboratory, California Institute of Technology. The workshop is dedicated to electric propulsion for Asteroid Redirect Vehicle, part of NASA's Asteroid Initiative concept. Asteroid Redirect Mission (ARM), which in the mid-2020s will test a number of new capabilities needed for future human expeditions to deep space, including to Mars. (http://www.nasa.gov/asteroidinitiative).

BUSINESS OPERATIONS (K. FISCHER):

Budget Office:

A proposal was submitted to NASA entitled "Multiscale Simulation and Observations of Alvenic Auroral Procesess". The proposal is requesting funding for three years in the amount of $479,298. The Principle Investigator is P. Damiano.

A proposal was submitted to NASA entitled "Generation and Propagation of Non-Thermal Terrestrial and Kilometric Continuum Radiation." The proposal is requesting funding for three years in the amount of $342,941. The Principle Investigator is E.-H. Kim.

A proposal was submitted to NASA entitled "Cross-Scale Coupling in Kelvin Helmholtz Structure in the Magnetospheric Boundary Layer." The proposal is requesting funding for three years in the amount of $443,161. The Principle Investigator is J. Johnson.

Two one-year renewal proposals were submitted to FES for FY2016 funding:
"The Princeton FRC (PFRC): FRC Plasma Heating by Odd-parity Rotating Magnetic Fields"; S. Cohen is the Principal Investigator; expected FY16 funding is $245K.
"Self-Consistent Integrated Simulations of RF Wave-Plasma Interactions in Burning Plasmas"; N. Bertelli is the Principal Investigator; expected FY16 funding is $198K.

DIRECTOR'S OFFICE (C. AUSTIN):

On September 5-13, A. Cohen led the Princeton Journey's Program, Quarks and a Quest: 21st-Century Research at CERN and ITER in France. This program is coordinated through the Princeton University Office of Alumni Affairs.

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