

PRINCETON PLASMA PHYSICS LABORATORY

**WEEKLY** highlights



**The PPPL Highlights for the week ending May 2, 2014, are as follows:**

### **U.S. ITER FABRICATION (D. JOHNSON):**

PPPL awarded a contract to General Atomics, teaming with a group from UCLA, for Physics and Engineering Design Support and Diagnostic Hall Instrumentation Development for the ITER Low-Field-Side Reflectometer. Planning is underway for a "kick-off" meeting of the full design team, which includes experts from PPPL and ORNL.

Firm dates have been set for the Final Design Review of the Divertor RGA Sampling Tube Final Design Review (July 29-30) and the associated U.S. Readiness Review (June 24).

Work plans for ITER diagnostics are being revised to be consistent with funding constraints.

### **NSTX (M. ONO):**

A paper entitled "Calculation of neoclassical toroidal viscosity with a particle simulation in the tokamak magnetic braking experiments" by Kimin Kim (PPPL) et al. has been published in Nuclear Fusion 54 (2014) 073014, and is available online at <http://stacks.iop.org/0029-5515/54/073014>. The paper describes numerical verification of fundamental neoclassical toroidal viscosity (NTV) physics, such as collisionality dependency, field resonance, and mode coupling, and experimental NTV analyses in DIII-D and NSTX using delta-f guiding-center particle code POCA. The paper presents that particle simulation is useful to validate NTV theories, investigate new physics, and improve the prediction of toroidal rotation damping by 3D magnetic field in tokamaks.

G. Taylor (PPPL) attended the Joint Workshop on Electron Cyclotron Emission and Electron Cyclotron Resonance Heating (EC-18) that was held in Nara, Japan, April 22-25. He presented a paper entitled "A megawatt-level 28 GHz heating system for the National Spherical Torus Experiment Upgrade". Taylor also chaired a session on non-inductive plasma start-up with electron cyclotron and electron Bernstein wave heating.

Preparations for plasma operations in the NSTX-U configuration also continued with the preparations of the Field Coil Power Conversion (FCPC) and Neutral Beam Power systems for upcoming power testing. Commissioning of the new TF and OH PLC based fault relaying system continued, and a contractor has completed the maintenance of the neutral beam deionized cooling water skids. The FCPC cooling water pump is scheduled to be repaired and back on site May 19. A contract is now in place to support the D-MG #1 weld repairs and the welding

contractors are scheduled to be on site the week of May 5.

### **ITER & TOKAMAKS (R. HAWRYLUK):**

#### **DIII-D (R. Nazikian):**

A. Nagy and W. Brown completed an inspection of the F-coil patch panel connection pins after a pin connection failure due to high resistance due to the pin connection welding itself to the bus contact at the spring finger joint. The inspection revealed that 50% of the 200 bus pins had a resistance greater than 50 micro-ohms. The high resistance spring finger contacts were replaced, solving the problem. Analysis revealed that the high resistance contacts arose due to wear and spring tension relaxation after five years of maintenance free operation.

R. Hawryluk visited DIII-D this week and participated in the Dynamics and Control Group meeting and gave a presentation on analysis of his experiment from last year.

#### **C-Mod (R. Hawryluk):**

E. Edlund gave presentation at the C-Mod Science meeting entitled "Characterizing the QC modes of the 2002-2005 campaigns" using the PCI diagnostic.

### **ADVANCED PROJECTS (H. NEILSON):**

In its collaboration with Germany's Wendelstein 7-X (W7-X) project, the Laboratory completed a successful preliminary design review (PDR) of the x-ray imaging crystal spectrometer being prepared for that experiment. This instrument will provide high-resolution profile measurements of electron and ion temperatures and poloidal flow velocities. The project team of N. Pablant, M. Mardenfeld, and S. Langish of PPPL and A. Langenberg of Max Planck Institute for Plasma Physics presented a mature design that is ready to proceed to final design and procurement of long-lead items. The international review team, chaired by PPPL's T. Stevenson, found that "all of the PDR Charge Questions were certainly satisfied in the affirmative sense allowing the project to move forward and act swiftly to meet schedule requirements." Successful completion of this review completes one of the Notable Outcomes in PPPL's performance plan for FY14.

### **THEORY (A. BHATTACHARJEE):**

The Center for Heliospheric Physics hosted a workshop on Space Weather at PPPL on April 16-17. Participants included invitees from Los Alamos National Laboratory, NASA Goddard Space Flight Center, University of California-San Diego, and University of New Hampshire. The primary focus of the workshop was on the integration of kinetic effects into global multi-fluid computer simulation codes of the Earth's magnetosphere. This effort is supported by a multi-institutional grant, led from Princeton University and PPPL, by the NASA/NSF Partnership on Space Weather.

Many members of the Theory Department attended the 2014 U.S. Transport Task Force Workshop held in San Antonio, Texas, April 22-25. G. Fu gave a plenary talk titled "M3D-K simulations of energetic particle transport due to sawteeth, fishbone and TAE". He also gave a summary talk on the energetic particle breakout sessions. Oral Presentations were made by C-S Chang, "Full-f gyrokinetic study of vorticity merging, meso/macro scale dynamics, and SOL-pedestal-core interaction in diverted geometry", N. N. Gorelenkov, "The effect of fast ion anisotropy and toroidal flow on plasma equilibrium", Robert Hager "Interaction between turbulence and geodesic acoustic modes near the separatrix", S-H. Ku "Effect of neoclassical and turbulence physics on divertor heat-load spread", Jianying Lang "Different Effects of ITG-dominant and TEM dominant turbulence on macro/meso scale ExB shear flow formation in the edge", Zhixin Lu ( long term PPPL visitor from UCSD) "Effects of q-profile on ITG/TEM induced intrinsic torque" and Weixing Wang "Roles of low-k Turbulence in Spherical Tokamak Plasma Transport". A poster presentation was made by Michael Churchill "Effects of a Pedestal on the Flux-Surface Variation of Impurity Density and Flows".

W. Tang participated in the invitation-only International Conference on Comparing HPC in the U.S. and China that was sponsored by the University of California Institute on Global Conflict & Cooperation (IGCC) and held at the San Diego Supercomputer Center in LaJolla, California, April 29-30. He gave an invited presentation on "Scientific Applications of HPC" that surveyed and compared prominent applications on leadership class supercomputers in the U.S. and China and also served on a panel discussing the current status of "Chinese Supercomputing Expertise."

#### **COMPUTATIONAL PLASMA PHYSICS GROUP (S. JARDIN):**

Different plasma performance (energy confinement, discharge duration) has been observed in operationally close JET discharges with carbon (C) and ITER-like wall (ILW). The presence of tungsten (W) in ILW discharges leads to increased radiation, and this may partly explain the differences observed at JET and have an impact on ITER operation. Therefore, the penetration and accumulation of W impurity during the discharge evolution is a key analysis issue for JET. The first step in this analysis is the estimation of the neoclassical W diffusion and pinch as well as transport of other seeded impurities. The present version of TRANSP, which is the main analysis tool at JET, includes only the transport of an "averaged impurity" as computed by NCLASS. At the request of the JET TRANSP group, the NCLASS output has now been modified to provide detailed information about the different impurity species including their thermal and particle transport and fluxes, as well as poloidal and toroidal velocities on the mid-plane. For further information on this new capability, contact M. Gorelenkova.

#### **ENGINEERING AND INFRASTRUCTURE (M. WILLIAMS):**

##### **NSTX Upgrade (R. Strykowski, E. Perry, L. Dudek, T. Stevenson):**

Construction: The row one tiles of the upper outboard diverter are being installed. The mid-plane gas injection valves have been installed in a number of locations and work continues on the last new RWM coils. The new PF5 strut has been installed at bay L and diagnostics are being re-installed around it. Cable runs are being pulled for the vacuum, RGA and gas injection systems. The bus bar mock-ups, trial fits and fabrication continue for the TF bus. Potting of the TF outer

leg aluminum blocks will start the week of May 5.

CS Upgrade: The winding on layer 4 continued smoothly this week, and approximately 75% of the layer was completed along with two inline brazes. Approximately 60 turns remain to complete the OH Coil winding. Test results from Laboratory testing were received on the CuCrZr samples from the TF lead extensions. The results indicated a significant improvement in the ductility and fracture toughness of the material after the stress relieve. The decision was made to replace the lead extensions at Martinez and Turek with new material of a softer temper to eliminate the cracking problems. Major Tool formed and machined the features in the first PCHERS passive plate. There were numerous dimensional non-conformances for both the tile mounting holes and flux loop tie downs. The NCR is currently being evaluated by PPPL for disposition. PPPL received the PF1A Lower coil on May 1. The PF1C Lower coil was installed in the mold at ETI for epoxy impregnation. The Imperial Machine began machining the first set of G10 Crown Piece segments and is on schedule to ship the week of May 5. Carolina Fabricators is on track to finish the Umbrella Structure OTF Finger brackets and expects to ship finished parts next week.

NBI Upgrade: The Armor services connections external to the VV are being evaluated. The High Voltage Transmission line preparation in the TTC is complete. The N2A transmission line has been connected to its HVE and will be positioned to connect to its source platform pressure plate and transmission line support installation has started. The Mod/Reg controls work and preparation continues; reactivation of NBPS water skids was started and water circulated through the NB supplies. BL2 Calorimeter water manifold installation is complete. VV RWM coil fabrication continues for the Bay JK area. The vacuum system fabrication and installation continues in the NTC. The TVPS turbo pump tables are ready for installation. A BL2 beamline entry was performed and completed; the BL2 mandoor has been closed and bolted. NB Controls work on rack cable and wiring continued in NTC and gallery. Additional NB installation procedures are in development and review and the SF6 piping IP was completed.

Digital Coil Protection System: Two design reviews have been planned for the week of May 5 for the Autotester panel and for the RCIM interface chassis. The parts were made and assembled for DCPS computer cable strain relief and work continued on the DCPS GUI. The autotester changes were completed to facilitate testing. Hardware and I/O layout and design continues and nears completion. The work on hardware drawings continues. The PCB design is in progress and procurements are planned. The DCPS Data Dictionary was updated to include latest information and details from ongoing interface discussions. Progress continues on the FCPC Level 1 fault circuitry drawings and plans including changes needed in the DCPS Hardware Interface chassis and rack. After evaluation, satisfactory Lemo connector cable samples have been received from a vendor demonstrating that these types of cables can be procured; this buy instead of make option will likely improve costs and schedule while relaxing demand for critical and overbooked in-house resources.

## **BUSINESS OPERATIONS (K. FISCHER):**

PPPL submitted a proposal to titled "Understanding the spatial and temporal variation of TEC using an information theoretical approach" to NASA. The Principal Investigator is J. Johnson. The total budget request for the four-year period of performance is \$677,700.

PPPL participated on five collaborative proposals in response to the LAB 14-1096, Scientific Discovery through Advanced Computing (SciDaC): Multiscale Integrated Modeling for Fusion Energy Science solicitation. PPPL was a partner institution on these proposals, which were led by universities, laboratories and industry.

## **PUBLICATIONS:**

Kim, K. (PPPL); et al., "Calculation of neoclassical toroidal viscosity with a particle simulation in the tokamak magnetic braking experiments," Nuclear Fusion 54 (2014) 073014, <http://stacks.iop.org/0029-5515/54/073014>.

The following PPPL Reports were posted to the web:

Quasilinear Carbon Transport In An Impurity Hole Plasma In LHD PPPL-5019

Authors: David Mikkelsen, et. al.

Submitted to: Physics of Plasmas (April 2014)

Energetic Particle Physics In Fusion Research In Preparation For Burning Plasma Experiments PPPL-5020

Authors: Nikolai N. Gorelenkov, et. al.

Submitted to: Nuclear Fusion (June 2013)

What Is The Fate Of Runaway Positrons In Tokamaks PPPL-5021

Authors: Jian Liu, Hong Qin, Nathaniel J. Fisch, Qian Teng and Xiagang Wang

Submitted to: Physics of Plasmas (April 2014)

Two-stream Instability With Time-dependent Drift Velocity PPPL-5022

Authors: Hog Qin and Ronald C. Davidson

Submitted to: Physics of Plasmas (April 2014)

Field Theory And Weak Euler-Langrange Equation For Classical Particle-field Systems PPPL-5023

Authors: Hong Qin, Joshua W. Burby and Ronald C. Davidson

Submitted to: Physical Review Letters (April 2014)

This report is also available on the following web site:

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