

PRINCETON PLASMA PHYSICS LABORATORY

WEEKLY highlights



The PPPL Highlights for the weeks ending December 21, 2012 – January 4, 2013, are as follows:

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

Deliverables for the recently signed ITER Diagnostic Procurement Arrangements include Risk and Mitigation Plans. Control Account Managers for the associated systems met with the WBS Manager to review identified risks, impacts, and mitigation strategies.

A neutronics analysis of a new configuration of the Core Imaging X-ray Spectrometer was completed. The preliminary indication is that this configuration would meet the shielding requirements while giving up fewer measurement capabilities than previous configurations, which provide adequate shielding. The full dose-rate analysis will be completed soon.

The Quality Plan for the ITER ECE Diagnostic was submitted for PPPL sign-off prior to submission to the ITER Organization.

NSTX (M. ONO):

NSTX-U is in the Upgrade Project outage in FY 2013.

Y. Ren (PPPL) attended the US-Japan Joint Institute for Fusion Theory Workshop on Neoclassical and Turbulent Flow Generation and Associated Transport held at Uji, Kyoto, Japan from November 25-26 and gave a talk entitled "Response of Electron-scale Turbulence and Thermal Transport to Continuous ExB Shear Ramping-up in NSTX". In the talk, experimental observation of reduction in electron-scale turbulence and thermal transport in the NSTX NBI-heated L-mode plasmas is presented together with comparisons with linear and nonlinear gyrokinetic simulations. ExB shear induced by NBI-driven toroidal flow is found to be temporally and spatially correlated with reductions in electron-scale turbulence and thermal transport. Linear and nonlinear gyrokinetic simulations have shown that stabilization of Ion Temperature Gradient (ITG) turbulence due to ExB shear can be responsible for the observed reductions although there are qualitative discrepancies between experimental and predicted heat fluxes. Future work to address the discrepancies is also discussed. Ren had discussion with Professor T.S. Hahm of Seoul National University on what flow should be used for calculating Doppler shift frequency (ExB flow vs. impurity toroidal flow), the definition of ExB shear quenching and the difference in ion thermal and momentum transport in the NSTX H- and L-mode plasmas. Ren also held discussion with Dr. Tanaka from NIFS (National Institute for

Fusion Science), Japan on the 2-D Phase Contrast Imaging diagnostic and its measurements on LHD (Large Helical Device).

Y. Ren (PPPL) visited ASIPP (Academy of Sciences Institute of Plasma Physics) in Hefei, China on November 28-29 and SWIP (Southwestern Institute of Physics) in Chengdu, China on December 3-4. A seminar entitled "Recent Progress in Understanding Anomalous Electron Thermal Transport in NSTX" was presented at both institutes. In the presentation, recent findings of electron thermal transport on NSTX were reviewed: the first nonlinear gyrokinetic simulation of microtearing turbulence which predicts experimentally relevant level of electron thermal transport; studies of parametric dependence of high-k turbulence measured with a microwave scattering diagnostic and the implications on electron thermal transport; and mechanisms underlying the flattening of central Te profile in NSTX high-power NBI-heated H-mode plasmas. Y. Ren was given the tours of EAST and HL-2A tokamaks and their major diagnostics. Discussions on interpretation of CO₂ laser scattering results on EAST were held with Dr. Li Yadong and his students. Ren discussed near term collaboration on the CO₂ diagnostic and future data analysis and experiments on EAST. Ren also held discussions with Mr. Wulu Zhong of SWIP on profile reflectometry and Doppler backscattering measurements in a variety of experimental conditions and their interpretations. He also referred Shige Kubota's 2012 IAEA paper on k-r backscattering measurements on NSTX using UCLA FMCW (frequency-modulated continuous-wave) reflectometry which can be applied to their FMCW reflectometer. The possibility of conducting experiments on HL-2A in the future was also discussed.

NSTX Upgrade construction activities continued this week and are highlighted in the Engineering section below.

Preparations of non-upgrade equipment for plasma operations in the NSTX-U configuration also continued with the ongoing fabrication of the new field coil power conversion system firing generators. Over half the printed circuit boards for all the production units are now on site and undergoing bench testing. Engineering has started on the design of new diagnostic system signal integrators and digitizers.

Access to the NSTX test cell will be available only through previous arrangement with the Upgrade Work Control Center.

ITER & TOKAMAKS (R. WILSON):

A paper titled "Description of the Full Particle Orbit following SPIRAL Code for Simulating Fast-ion Experiments in Tokamaks" by Gerrit Kramer et al., has been accepted for publication in Plasma Physics and Controlled Fusion.

The main-ion CER system on DIII-D has received new spectroscopic gratings for the 2013 run campaign. New gratings are blazed for 500nm and provide better throughput at narrower instrumental response than the previous gratings. The new gratings also permit higher throughput and better signal at lower wavelengths, previously limited to C-VI(8-7), but now producing enough throughput to operate at the He-II 4686 angstrom line.

PPPL engineers C. Kung, E. Fredd, N. Greenough, together with J. Hosea visited DIII-D this week to investigate possible ECH tasks for FY13. Work has begun on scoping out job details.

Alcator C-Mod (R. Ellis):

B. Ellis traveled to MIT January 3-4 to work on the Advanced Divertor Upgrade. Various design issues were discussed. A conference call with PPPL was held. Han Zhang presented graphs of thermal gradients at the plasma facing surfaces inside the vacuum vessel. This information will be used to predict heat flux on diagnostics inside the vacuum vessel due to steady state operation of the divertor.

ADVANCED PROJECTS (H. NEILSON):

A manuscript reporting work performed under the Laboratory's LDRD Pilot Plant study, "Comparison of Options for a Pilot Plant Fusion Nuclear Mission," by T. Brown *et al.*, " was accepted for publication in a special issue of *Fusion Science and Technology* containing the Proceedings of the ANS Topical Meeting on the Technology of Fusion Energy (TOFE-2012).

The Laboratory received funding from South Korea's National Institute for Fusion Science (NFRI) for the first phase of work under the recently-executed research agreement for "cooperation in R&D for K-DEMO and strategic planning to expedite the realization of magnetic fusion energy." Detailed planning for this work, which will include pre-conceptual design and engineering analyses to support design point selection for the K-DEMO device, is in progress. The new research agreement was described in a featured article on the Princeton University web site, available at <https://www.princeton.edu/main/news/archive/S35/60/40I47/index.xml?section=topstories>.

A proposal, "Improved Stellarators (QAS) for Fusion Nuclear Missions," has been selected for Laboratory Directed Research and Development (LDRD) funding in FY-2013, subject to DOE approval. The purpose of the study is to demonstrate methodologies that can generate configurations which, when compared to the NCSX/ARIES-CS generation of quasi-axisymmetric stellarator (QAS) designs, will have better construction and maintenance properties, making it more attractive as a basis for fusion nuclear facilities including DEMO. Indeed a stellarator-based net energy-producing fusion system could be significantly simpler than one based on a tokamak. However, the coil geometry is a complication that detracts from the stellarator's advantages, so concept simplification continues to be a priority for QAS development. Incremental improvements over the NCSX / ARIES-CS designs have already been made and, more importantly, promising strategies for substantive improvements have been identified. In addition a promising new optimization strategy will be used to identify configurations with improved confinement, substantially improving the promise of stellarator concepts.

THEORY (A. BHATTACHARJEE):

Y.-M. Huang of the University of New Hampshire (UNH) and A. Bhattacharjee of PPPL have published a new study on the "Distribution of Plasmoids in High-Lundquist-Number

Reconnection" in Physical Review Letters on December 28, (PRL, 265002, 2012). Over the last three years or so, there has been much interest in the discovery that the secondary instability of thin current sheets in large systems, above a critical value of the Lundquist number, produces a new regime of fast reconnection in which the reconnection rate, within the framework of resistive MHD, becomes independent on the Lundquist number (to a first approximation). By means of an analytic phenomenological model and direct numerical simulations, Huang and Bhattacharjee have obtained a distribution function of plasmoids in a thin current sheet in 2D as a function of the magnetic flux. This distribution function shows a power-law behavior that differs from other recent theoretical predictions. The predictions of the model are presently being tested by laboratory experiments as well as observations of post-flare heliospheric current sheets by graduate student Lijia Guo of UNH, who is presently at Princeton University as a visiting student. The plasmoid instability and its consequences for fast reconnection was also the subject of an invited paper at the 2013 DPP-APS meeting by Huang, an account of which has been submitted recently to the Physics of Plasmas (<http://arxiv.org/abs/1301.0331>).

On January 3, Dr. Robert Leamon gave a theory seminar entitled "On the Modulation of the Solar Activity Cycles." The talk addressed the origin of the 11-year sunspot cycle by tying it to the temporally overlapping activity bands of the 22-year magnetic activity cycle. Importance of the temporal asymmetry of solar activity between the Northern and Southern hemispheres was emphasized. The decadal variation in flux distribution on the solar disk which impacts plasma energetics on small scale and on the large scale, such as cosmic ray flux, was attributed to the lead/lag between the two hemispheres (and their phasing).

COMPUTATIONAL PLASMA PHYSICS GROUP (S. JARDIN):

The National Energy Research Supercomputer Center (NERSC) announced its 2013 allocation awards in late December 2012. PPPL researchers received a total of 68,120,000 CPU hours in 8 different awards. The projects, PIs, and awards were as follows: Center for Integrated Computation and Analysis of Reconnection and Turbulence, A. Bhattacharjee (4,000k); Nonlinear Delta-f Particle Simulation of Collective Effects for Heavy Ion Fusion Drivers and High Intensity Particle Accelerators, R. Davidson (50k); Simulations of Field-Reversed Configuration and Other Compact Tori Plasmas, R. Davidson (70k); Center for Edge Physics Simulation, C. S. Chang (25,000k); Center for Simulation of Energetic Particles, G. Fu (6,000k); 3D Extended MHD simulation of fusion plasmas, S. Jardin (10,000k); Turbulent Transport and Multiscale Gyrokinetic Simulation, W. Lee (15,000k); Experimental Tests of Gyrokinetic Simulations of Microturbulence, D. Mikkelsen (8,000k).

ENGINEERING AND INFRASTRUCTURE (M. WILLIAMS):

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

Construction: Welding of the NE vessel leg clevis continues. The upgrades have been started for the aluminum castings at the TF/Umbrella interfaces. TF outer leg support weldments are being installed along with the associated turnbuckles back to the vessel. Rack to rack wiring continues in the north gallery for the vacuum/RGA/GDC systems.

Center Stack: Rework to adjust the insulation thickness on the TF bundle conductors continues. The quad mold cover was fitup multiple times this week to check hole locations and seal surface interface. The OTF weldments received from the vendor were inspected in receiving inspection. Two of the units were rejected for undersized welds and will need rework. Quotes were received from a material vendor for Cu-Cr-Zr to perform test samples for the Electron Beam Weld process for the TF Lead Extensions. A meeting was held to discuss remaining work on the TF/PF coil buswork. Designs are essentially complete, some analysis remains to verify changes that were made to address structural issues found with the first iteration. The Centerstack Casing was shipped from Martinez to PPPL.

NBI Upgrade: The JK weldment weld prep was completed. JK was lifted into place and final alignment was performed successfully. JK has been tack welded to the Vacuum Vessel and lift equipment has been removed. Final structural full penetration welding has started. Resolution was reached on the external fillet weld also. With the completion of JK, the BL installation has resumed to bolt the BL supports to the NTC floor. Final hydrostatic testing of water lines on BL 90 inch flange and the ion dump are in progress. Relocation to NTC BL2 is expected this month. The calorimeter awaits final drives from the vendor to complete. The Armor installation procedure is out for review. Another in-vessel fit-up is required to resolve support mount dimensions on one piece. Procurement packages for cable and tray and for water piping are in development. Water system drawings are in progress. Fabrication in the Tech Shop continues on the central spool section for the NBI duct. LHe cryogenics line installation on the TFTR Test Cell South wall continues.

Office of Project Management (T. Stevenson):

The System Engineer online training module was completed and issued. Training is in progress. These efforts address QA Action Items from audits.

The ENG-006 Statement of Work/Specification Word template was posted to the Engineering Department web site for use.

Facilities and Infrastructure (M. Viola):

Telecommunications: The Telecommunications Office is attempting to reduce the costs of a recent proposal from Quality Communications for radio communications equipment, which would allow PPPL SPD to have radio communications with Princeton University's Department of Public Safety personnel. Working with the Laboratory cost center managers and the accounting department, the Telecommunications Office continues to update phone expense records in the Great Plains database. The Telecommunications Office is doing a physical inventory of each line and location, and updating all information in the Great Plains.

Materiel Control: Operations has requested approval [from DOE] for the return of two mission critical vehicles that were previously returned as part of the mandatory DOE vehicle reduction program.

BUSINESS OPERATIONS (E. WINKLER):

T. Gillars and T. Bleach met with B. Bozarth from the DOE Site Office to discuss the Accounting Division's plan to update its policies and procedures.

Representatives from the Procurement and Computer Divisions met with representatives of Microsoft Federal Systems, CDW-G, a Microsoft reseller, and Affigent, an Alaskan Native Corporation, to discuss the steps necessary to transition PPPL from its current Microsoft Enterprise Agreement (EA) to the new agreement, effective April 1. Affigent is DOE's current authorized Microsoft EA source.

PPPL received DOE approval to continue its contractual relationship with the New Jersey Water Supply Authority (NJWSA) for purchase of water from the Delaware & Raritan canal. PPPL has used canal water for process cooling and fire protection since the 1960's.

The PPPL Travel Office responded to a call from DOE to report actual conference attendance data for all PPPL participants that attended three identified conferences.

PPPL submitted its institutional cost data to DOE for the fourth quarter of FY2012. The purpose of the DOE Institutional Cost Report is to provide transparency of DOE contractor institutional and functional costs.

Project Data Sheets for an additional five Laboratory Directed R&D (LDRD) projects approved by the Director's Office for FY2013 funding were submitted to the DOE Princeton Site Office for concurrence.

PPPL responded to a call from DOE to update PPPL's cyber security budget information previously provided as part of the FY2014 budget submission with actual cost and FTE data for FY2012.

PPPL exceeded two of its five proposed small business subcontracting goals thru the first quarter of FY2013. Performance fiscal-year- to-date is as follows: overall small business, 63.1% (goal 50.2%); disadvantaged business, 2.3% (goal 5.0%); women-owned business, 7.1% (goal 7%); HUBZone business, 1.0% (goal 3.5%); and service disabled veteran owned business, 2.3% (goal 3%). As the year progresses and the Laboratory's budget situation becomes clearer, the Procurement Division will review opportunities to increase awards in the disadvantaged, HUBZone and service disabled veteran owned business categories.

PPPL's FY 2013 small business subcontracting plan has been approved by the Laboratory's US Small Business Administration Commercial Market Representative. The plan was submitted for SBA review and approval at the request of the DOE Site Office.

ENVIRONMENT, SAFETY, HEALTH & SECURITY (J. LEVINE):

ESU Engine 66 responded to Plainsboro for three mutual aid assignments, to Princeton for two mutual aid assignments, and to C-Site for an activated smoke detector. Ambulance A166 responded to Plainsboro for three mutual aid assignments.

SPD updated the PPPL Continuity of Operations (COOP) Implementation Plan. The plan was approved by the Director's Office and submitted to DOE/PSO. Each PPPLer with COOP implementation responsibilities will be provided with a paper copy of the Plan.

SPD updated the PPPL Site Security Plan (SSP). The plan was approved by the Director's Office and submitted to DOE/PSO.

The ORPS (Occurrence Reporting and Processing System) Quarterly Performance Analysis Report for CY 2012 Fourth Quarter was submitted to PPPL senior management and to DOE/PSO.

The Quarterly Report for PTENS (Princeton Telephone and E-Mail Notification System) was submitted to Business Operations.

The new ORPS Duty Facility Manager schedule for the period January 4 - March 28, was distributed.

Approximately 4 oz. of unknown petroleum product was found on an unpaved PPPL roadway, resulting in submission of an ORPS Report (SC--PSO-PPPL-PPPL-2012-0008).

Members of Platoons A and B attended High-Static Magnetic Field safety training in reference to the PTOLEMY experiment. The training was provided by M. Schaefer of the Safety Division.

President Obama ordered the US flag to be flown at half-staff on December 18, as a mark of respect for the memory and long-standing service of Senator Daniel K. Inouye, President pro tempore of the Senate. Please visit <http://www.whitehouse.gov/the-press-office/2012/12/18/presidential-proclamation-death-senator-daniel-k-inouye-president-pro-te> to view the Presidential Proclamation.

New Jersey Governor Christie ordered the U.S. flag to be flown at half-staff on December 27, in honor of United States Army Staff Sergeant Zoltan Dobovich. Staff Sergeant Dobovich was last accounted for on November 1, 1946 when an air crew of eight members departed Italy on a course to England but never arrived at their destination. Staff Sergeant Dobovich was recently identified and will be buried in New Jersey with full military honors. Please visit <http://nj.gov/infobank/circular/eocc121.pdf> to view the Executive Order.

New Jersey Governor Christie ordered the U.S. flag to be flown at half-staff on January 2, in recognition and mourning of the passing of United States Army General H. Normal Schwarzkopf. General Schwarzkopf was born in Trenton, New Jersey. Please view <http://nj.gov/infobank/circular/eocc123.pdf> to view the Executive Order.

OFFICE OF COMMUNICATIONS: (K. MACPHERSON):

The PPPL Office of Communications hosted the monthly "SPIN" meeting of campus communicators from all sectors of Princeton University on January 4. A. Cohen gave a presentation on the history of PPPL, how fusion works, and updated participants on Laboratory

activities, and took several questions from the audience. K. MacPherson gave a short presentation on communications initiatives at PPPL.

G. Czechowicz assisted multiple staff members with multimedia needs.

J. Jackson DeVoe distributed a news release on the Science on Saturday program.

J. Greenwald completed a press release about three teams led by scientists at PPPL who have won major blocks of time on two of the world's most powerful supercomputers. The story has been submitted for review by the DOE press office. A story by him on a new collaborative agreement with South Korea and PPPL was posted to the Princeton University website and the contents of the story were the focus of an op-ed piece on the Slate blog.

K. MacPherson assisted Science magazine reporter Dan Clery on a story.

BEST PRACTICES & EXTERNAL AFFAIRS (J. DELOOPER):

January 5 was the first of ten lectures in the 2013 Science on Saturday lecture series. Professor James Olsen, of Princeton University, spoke to more than 396 guests from the general public on "The Large Hadron Collider."

The following PPPL Reports were posted to the web:

Observation of Ion Acceleration and Heating during Collisionless Magnetic Reconnection in a Laboratory Plasma PPPL-4835

Authors: Jongsoo Yoo, Masaaki Yamada, Hantao Ji and Clayton E. Myers

Submitted to: Physical Review Letters (December 2012)

The Physics of Tokamak Start-up PPPL-4836

Authors: D. Mueller

Physics of Plasmas (December 2012)

Mission and Readiness Assessment for Fusion Nuclear Facilities PPPL-4837

Authors: G.H. Neilson, et. al.

Submitted to: Fusion Science and Technology, (December 2012) Presented at: TOFE Conference, Nashville, TN Aug 27-31, 2012

Characteristics of Short Wavelength Compressional Alfvén Eigenmodes PPPL-4838

Authors: E.D. Fredrickson, N.N. Gorelenkov, M. Podesta, A. Bortolon, N.A. Crocker, S.P.

Gerhardt, R.E. Bell, A. Diallo, B. LeBlanc, F. M. Levinton, and H. Yuh

Submitted to: Physics of Plasmas (December 2012)

PPPL Annual Site Environmental Report PPPL-4839

Authors: Virginia Finley, Robert S. Sheneman and Jerry D. Levine

Submitted to: PPPL Reports

Instability, Collapse and Oscillation of Sheaths Caused by Secondary Electron Emission PPPL-4840

Authors: M.D. Campanell, A.V. Khrabrov and I.D. Kaganovich

Submitted to: Physics of Plasmas (December 2012)

DIRECTOR'S OFFICE (B. SOBEL):

On December 19, Professor Jeremiah P. Ostriker, Princeton University, presented a colloquium entitled, "On the Formation of Massive Galaxies".

This report is also available on the following web site:

<http://www.pppl.gov/polWeeklyHightsExternal.cfm>