



**The PPPL Highlights for the week ending March 28, 2014, are as follows:**

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

The manufacturing phase has started for the ITER HV Substation Transformer at the Hyundai factory in Ulsan, Korea.

Diagnostic WBS Leader D. Johnson and PPPL engineer D. Loesser attended the IO-DA Diagnostics Meeting in Cadarache. Generic issues affecting ITER diagnostic developments in all the domestic agencies are discussed at these meetings. A primary topic this year was the linking of diagnostic schedules around the port integration activities. The U.S. made a proposal to place milestones and inter-project links in the schedules, reflecting the freezing of interfaces between the port integration scope and the tenant diagnostic scope. There was a general consensus supporting this proposal.

After discussions at the IO-DA Meeting mentioned above, the IO decided to modify the present diagnostic shield module design to make each module the same width, and to make the diagnostic first wall panels co-planar (rather than faceted to match the plasma outer surface). These changes will make the provision of spare 'blanks' for these components much easier to achieve.

Other modifications to the diagnostic first wall components were presented at the meeting by D. Loesser. These included optimized attachment tabs, various small changes in cutouts and gaps, and welding features.

In a meeting with IO experts, chits from the conceptual design review for the core imaging x-ray spectrometer were reviewed prior to submission for closeout. Closeout is needed for class 1 chits prior to the completion of the Procurement Arrangement for this diagnostic.

Using weekly coordination meetings, the PPPL port engineering team is producing revised schedules and estimates for it's scope in ITER port plugs and diagnostic front-ends.

**NSTX (M. ONO):**

A paper entitled '*Electrostatic detection of stainless steel dust particles for fusion applications*' by P. Landy (Cornell University), et al., was published in Review of Scientific Instruments 85, 036110 (2014). Dust accumulation inside next-step fusion devices poses a significant safety concern and dust diagnostics will be needed to assure safe operations. This paper presents

laboratory results showing that detection of stainless steel particles at levels as low as several microgram/cm<sup>2</sup> is possible. The work was performed by summer undergraduate Patrick Landy under the auspices of the PPPL Science Undergraduate Laboratory Internship (SULI) program and supervised by Charles Skinner and Hans Schneider of PPPL.

J. Menard (PPPL) attended the KSTAR Program Advisory Committee (PAC) meeting held in Daejeon, South Korea during March 24-26. He also gave a research seminar to NFRI/KSTAR research staff entitled: "Rotation and kinetic effects on kink pressure limits".

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

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

R. Maingi, with substantial contributions from D. Mansfield, G. Jackson, and L. Roquemore gave a presentation to the Lithium Granular Injector (LGI) Physics Validation Review (PVR). The LGI is being proposed as an ELM pace-making system with frequencies up to 500 Hz and four reservoirs with selectable granule sizes. The PVR identified open physics questions on ELM pace-making from current experiments, and highlighted the successful pace-making results from a similar device deployed on EAST.

A CDR was held for the proposed upgrade to the existing neutral beam pole shields. The present copper pole shields crack under high beam power long pulse operation and has been replaced several times. Two designs were identified as possible solutions, one a microchannel cooling plate, requiring costly cooling system upgrades, and a solid molybdenum plate inserted in the high heat flux zone that can be replaced in situ. The design review covered thermal analysis, heat stresses, radiative cooling, and thermal cycle data with TZM molybdenum. The present conservative thermal analysis calculated maximum stress levels of 480 MPa for 3.2 MW, 6 sec. beam pulse with 10 min rep rate. Further analysis will be performed taking into account additional conductive cooling paths around the plate and using an increased (12 min.) rep rate, which is expected to reduce the thermal stress. A follow up meeting will be held to resolve the outstanding issues and complete the conceptual design phase.

#### **International (R. Hawryluk)**

R. Hawryluk participated in the KSTAR PAC meeting in Daejeon, Korea and had private conversations with the NFRI staff. In addition, he gave presentations to the KSTAR staff, entitled, "Challenges of Steady-State Operation in ITER and Opportunities for KSTAR."

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

The Laboratory's C. Kessel submitted three manuscripts for publication as part of a collection of papers documenting the recently-completed ARIES-ACT study. These are: "The ARIES Advanced and Conservative Tokamak (ACT) Power Plant Study," by C. E. Kessel, M. S. Tillack, F. Najmabadi, et al.; "The Physics Basis for an Advanced Physics and Advanced Technology Tokamak Power Plant Configuration, ARIES-ACT1," by C. E. Kessel, F. M. Poli, et al.; and "The Physics Basis for a Conservative Physics and Conservative Technology Tokamak

Power Plant Configuration, ARIES-ACT2" by C. E. Kessel, and F. M. Poli.

The Laboratory and Princeton University are members of a proposal for a Consortium for Verification Technologies headed by the University of Michigan. It won a competition over 20 such proposals, with the result that the National Nuclear Security Administration will fund PPPL over the next five years to continue our work with Princeton University, which will also be funded by the NNSA, on the Zero-Knowledge Protocol for arms control verification.

R. Goldston gave a talk at the German Physical Society meeting titled, "Fusion Energy and Nuclear Non-Proliferation", and a talk at the Sherwood Meeting, titled, "Understanding and Innovation in MFE".

S. Lazerson presented a talk entitled "An enstrophy minimizing method for 3D equilibrium with flow" at the International Sherwood Fusion Theory Conference. The talk introduced a variation principle where magnetic energy and flow enstrophy are minimized subject to various helicities. The resulting Euler-Lagrange equations describe a relaxed system, which asymptotically reduces to the Taylor state and swirling pipe flow. Various discussions regarding how to incorporate thermal relaxation into the principle were discussed.

A stellarator strategy paper, "Next Steps in Quasi-Axisymmetric Stellarator Research," by G. H. Neilson, *et al.*, was published in the March issue of *IEEE Transactions on Plasma Science*.

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

A PRL by F. Ebrahimi and A. Bhattacharjee entitled "Helicity-Flux-Driven Alpha Effect in Laboratory and Astrophysical Plasmas" has been published online on March 25 at <http://dx.doi.org/10.1103/PhysRevLett.112.125003>. In this Letter, the dynamo problem in both laboratory and astrophysical plasmas is analyzed from a common perspective. The constraint imposed by magnetic helicity conservation on the alpha effect is considered for two important and very different examples of self-organization: tearing instability in laboratory plasmas (magnetically dominated), and the magnetorotational instability in flow-driven astrophysical disks (flow dominated). By analysis and direct numerical simulations, it is demonstrated that in both cases a dominant contribution to the alpha effect can be cast in the functional form of a total divergence of an averaged helicity flux, called the helicity-flux-driven alpha effect.

Many members of the Theory department and the Princeton University/ Theory team attended the International Sherwood Theory Conference on March 24 -26, in San Diego California. Y-M. Huang gave a talk, "Rapid Change of Field Line Connectivity and Reconnection in Stochastic Magnetic Fields" (in collaboration with A. Bhattacharjee and A. Boozer). D.P. Brennan presented a poster, "Control of resistive wall modes in a cylindrical tokamak with plasma rotation and complex gain". J. Breslau presented a poster, "Halo Currents and the M3D Boundary Condition". F. Ebrahimi presented a poster, "Physics of forced magnetic reconnection in coaxial helicity injection experiments in NSTX." S. Hudson presented a poster, "A new class of magnetic confinement device in the shape of a knot." W.W. Lee presented a poster, "Effects of Background-Inhomogeneity-Generated Zonal Flows on Microinstabilities and Plasma Pressure Balance."

Theory Department Visiting Research Scholars presented posters also: Xujing Li, *Chinese Academy of Sciences*, "The Tokamak MHD (TMHD) plasma model", Michael. R. Halfmoon, *University of Tulsa*, "Energetic Particle Effects on Tearing Mode Stability with Varying  $\beta$ " and Spencer D. James, *University of Tulsa*, "Self-consistent calculations of the interaction between drift wave turbulence and the tearing mode". S. James was one of six out of thirty two graduate students that won best student posters.

A. Bhattacharjee presented an invited talk on "Fast reconnection mediated by the plasmoid instability in high-Lundquist-number plasmas: dynamics and statistics," at the Parker Workshop on Magnetic Reconnection, Sao Paulo, Brazil, March 18-21.

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

E. Feibush presented "Introduction to Python Programming" as a mini-course sponsored by the Princeton Institute for Computational Science and Engineering on March 27. Researchers from 12 different university departments attended. The hands-on programming session emphasized the elements and features of Python and how it can be used in a scientific workflow. Tools and techniques for self-paced learning of Python were demonstrated. PPPL teaching assistants M. Knyszek and M. Lotocki facilitated the programming exercises.

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

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

Construction: The RF antennas have been removed from the vessel. Installations of the Langmuir probes and the MSE-LIF hardware will start today. Work on the centerstack casing tubing continues. RWM coil fabrication continues (this is holding up installation of the bay I port cover). Trials are underway for potting the TF outer leg aluminum blocks to the umbrella structure. TIV and shutter cable installations continue. The installation of the gas injection system solenoid boxes on the 119' platform continues. Busbar fabrication and trial fit-ups continue.

CS Upgrade: Completed winding of approximately 70% on layer 3 of the OH Coil and another set of inline brazes. The crew is now performing the third pair of inline brazes and should complete layer 3 the Week of March 31. Requisition for the new segmented G10 crown pieces was submitted for review and approval. The OTF Lead support fingers procurement was awarded to Hollis line machine, and the Finger bracket plates BPA release was awarded to Carolina Fabrication. Zenex has the drawings for the MPTS baffles and drift tube for quoting. The outer lead extension production is underway and proceeding smoothly. The welding was completed on 6 production articles. EB Welding is predicting 3 to 4 articles per eight-hour shift based on the first batch. Martinez is still working towards a March 31 ship date on these parts. The PCHERS passive plates Ebeam weld procedure was approved and production is proceeding on track.

NBI Upgrade: Armor spool sections for small ports were welded onto the VV Bay H port cover

and the armor water lines were brought out and welded and checked also. BL2 Optical Multichannel Analyzer (OMA) box leak checking has started and HVE water line installation continued in NTC. The pipe connections to the DI water pumps continued in the Pump Room. Transmission line relocation preparations are planned to start next week. The Mod/Reg controls work and preparation continues. NBPS water skid maintenance is planned next week. The VV RWM coil evaluation and fabrication continues for the Bay JK area. The NBI/TVPS duct rework is in progress to re-align the clocking of the bolt holes on the circular flange. The NBI duct was fit up and aligned, tacked at the bellows seam, and removed to the NB shop for seal welds and leakchecking with re-installation is scheduled for the week of March 31. TVPS flange rework is in progress also; new flanges have been ordered with delivery expected in about two weeks. The NB Controls work on interconnecting wiring on racks in the gallery continued.

Digital Coil Protection System: PPPL at-large and the NSTX-U Digital Coil Protection System project in particular experienced the sad and untimely loss of our colleague and friend Ron Hatcher. While the shock is still very real and very heartfelt, we held several meetings and numerous discussions this week to attempt to regroup and continue the project that Ron so ably led for so long. Thanks to Ron's hard work and the efforts of the DCPS team, preliminary DCPS stage I testing using the Autotester has begun.

#### **Facilities and Site Services (M. Viola)**

PPPL's first Inbound International loan agreement with POSTECH was approved by HQ.

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

PPPL received the final report from the DOE Office of Inspector General (DOE-OIG) regarding the audit they conducted of PPPL's Statement of Costs Incurred and Claimed (SCIC) for FYs 2011 and 2012. The DOE-OIG reported that PPPL received a "clean audit" report without findings or recommendations.

#### **OFFICE OF COMMUNICATIONS: (K. MACPHERSON):**

The Daily Princetonian posted a story on PPPL's Facility for Laboratory Reconnection Experiment on March 21.

The Times of Trenton posted a story on the Young Women's conference on March 21, the Star-Ledger posted a story on the conference on March 21 and an expanded version of the story on March 23, the Princeton Packet published a story on March 24. The Times of Trenton ran an editorial on the importance of STEM, citing the conference on March 24.

#### **DIRECTOR'S OFFICE (C. AUSTIN):**

A. Cohen attended a NLCOO (National Laboratories Chief Operating Officers) meeting in Washington, DC on March 27-28.

## **PUBLICATIONS:**

Landy, P. (Cornell University); et al., '*Electrostatic detection of stainless steel dust particles for fusion applications*,' Review of Scientific Instruments 85, 036110 (2014)

Neilson, G.H.; *et al.*, "Next Steps in Quasi-Axisymmetric Stellarator Research," March issue of *IEEE Transactions on Plasma Science*

Ebrahimi, F.; and Bhattacharjee, A., "Helicity-Flux-Driven Alpha Effect in Laboratory and Astrophysical Plasmas," <http://dx.doi.org/10.1103/PhysRevLett.112.125003>

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