



The PPPL Highlights for the week ending April 18, 2014, are as follows:

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

PPPL is reviewing Release for Manufacturing documents from a number of Steady State Electric Network vendors, and is also arranging Quality Control inspections to these vendor sites.

In an effort to enlist additional Control Account Managers (CAMs) for the ITER diagnostic work, a training session was held, introducing engineers to the responsibilities of this position.

The Diagnostics WBS Leader also briefed CAMs on relevant information presented at the IO-DA Diagnostics Meeting held in Cadarache, France on March 25-27.

These CAMs are now working on revised cost estimates for the PPPL diagnostic scope. Two meetings were held this week to review progress on these estimates. More work is needed before these are entered into Primavera for resource loading. Internal PPPL review of these estimates is also planned.

Scoping studies on new piping configurations for the divertor RGA sampling tube were performed and suggest that using thinner-wall pipe will likely resolve the issue of large moments on the ITER style vacuum flanges, which arose at the recent Readiness Review for this system. Locations for a second isolation valve were also discussed.

NSTX (M. ONO):

PPPL/NSTX researchers participated in the ITPA Pedestal and Edge Physics (PEP) topical science group in Prague, Czech Republic from April 15-17. S. Gerhardt presented a talk "Results from JRT 2013: regimes devoid of large ELMS." These results included new analysis on Enhanced Pedestal H-modes from NSTX. The technical program was organized and chaired by R. Maingi.

Commissioning of the new TF and OH PLC based fault relaying system continued, and the 350HP FCPC cooling water pump is in the process of being removed for repair. The first set of fiber-optic transmitters/receivers for the new plasma current (I_p) calculator are complete and being tested. The contract to make the weld repairs to the MG#1 rotor is expected to be awarded the week of April 21. Maintenance of the neutral beam power supplies also continued with the completion of the Bending Magnet supplies.

ITER & TOKAMAKS (R. HAWRYLUK):

DIII-D (R. Nazikian)

R. Nazikian presented a talk at the ITPA Pedestal and Edge Physics (PEP) topical science group in Prague, Czech Republic from April 15-17 in a focus session on pedestal performance and core confinement in ELM suppressed and mitigated regimes: "Density and global performance dependence of the pedestal pressure in plasmas with applied RMP in DIII-D". R. Nazikian also presented a talk during a session on the effect of impurities on pedestal and confinement: "DIII-D results and plans on impurity seeding".

International (R. Maingi):

J. Hu from ASIPP presented a talk "Long pulse H-mode with lithium dropper in EAST" at the ITPA Pedestal and Edge Physics (PEP) topical science group in Prague, Czech Republic from April 15-17. The first observation of a quasi-steady ELM-free H-mode using active lithium conditioning was accomplished by a lithium dropper, based on a device invented by D. Mansfield. Mansfield was deeply involved in analysis of these data, and a joint IAEA paper on these results and NSTX results with lithium wall conditioning is planned at the Fusion Energy Conference.

ADVANCED PROJECTS (H. NEILSON):

In its collaboration on Germany's Wendelstein 7-X (W7-X) project, the Laboratory has awarded a subcontract to Applied Power Systems, Inc. (APS) of Hicksville, New York to direct the commissioning of the U.S. trim coil power supplies. The units were manufactured by APS and delivered last year, and are now installed in the W7-X facility and ready for initial operational tests into a dummy load. Under the contract, an APS engineer will travel to the project site in Greifswald, Germany to carry out the commissioning tests, supported by W7-X staff. The work is scheduled to occur during the first week of June.

Two papers reporting research on 3D physics of stellarators and tokamaks have been submitted for publication. S. Lazerson is a co-author of an international team paper, "Three dimensional distortions of the tokamak plasma boundary: Boundary displacements in the presence of resonant magnetic perturbations," submitted to *Nuclear Fusion*. The paper reports good agreement between experimental measurements and a range of models – be it vacuum field line tracing, ideal three-dimensional MHD equilibrium modelling, or nonlinear plasma amplification. A paper by M. McMillan and S. Lazerson, "BEAMS3D Neutral Beam Injection Model," reports on the development of a fully 3D neutral beam injection (NBI) model, which addresses the growing need to study non-axisymmetric effects on neutral beam heating and fueling. The paper has been submitted to *Plasma Physics and Controlled Fusion*.

THEORY (A. BHATTACHARJEE):

L. Zakharov visited Institute of Plasma Physics in Prague, Czech Republic and the COMPASS tokamak group on April 12-18. On April 14, Leonid gave an introduction to the advanced

equilibrium reconstruction technique and demonstrated its implementation, the equilibrium code ESC-EEC. On April 16, he gave a talk entitled "Where is the edge in a tokamak plasma? Understanding the temperature pedestal" to the ITPA Pedestal and Edge Plasma meeting. On April 18 he also gave two talks entitled "Understanding disruption" and "LiWall Fusion: No Alternative, No Other Option" and discussed the problems of common interests with the COMPASS group.

The theory seminar on April 17 was presented by Dr. Guoyong Fu from PPPL and entitled "M3D-K simulations of energetic particle transport due to sawteeth, fishbone and TAE". This talk was a dry run for Dr. Fu's invited talk at the upcoming TTF meeting. The abstract of the talk is "Recent results of M3D-K nonlinear simulations of energetic particle transport are presented. We investigate energetic particle redistribution due to sawteeth in tokamaks and due to fishbone and TAE in NSTX. The main results are (1) Sawteeth: Test particle simulations are carried out to study the energetic particle transport due to a sawtooth crash. The results show that energetic particles are redistributed radially in plasma core depending on pitch angle and energy. For trapped particles, the redistribution occurs for particle energy below a critical value in agreement with previous theory. For co-passing particles, the redistribution is strong with little dependence on particle energy. In contrast, the redistribution level of counter-passing particles decreases as particle energy becomes large. (2) Fishbone: Nonlinear simulations of beam-driven fishbone instability in NSTX have been carried out for weakly reversed q profiles with minimum of q just above unity. Result show nonlinear saturation with strong frequency chirping and beam ion profile flattening. (3) TAE: Nonlinear simulations of multiple beam-driven TAEs in NSTX have been carried out. Preliminary results show mode saturation, frequency chirping and beam ion distribution flattening."

On April 11, a theory seminar was presented by Dr. Oleg Kirillov from the Helmholtz-Zentrum at Dresden-Rossendorf, Germany, entitled "A unified WKB analysis of instabilities in magnetized Keplerian flows at low magnetic Prandtl number". The abstract reads "I will present recent theoretical results obtained in collaboration with Frank Stefani and Yasuhide Fukumoto. We perform a local stability analysis of rotational flows in the presence of a constant vertical magnetic field and an azimuthal magnetic field with a general radial dependence characterized by an appropriate magnetic Rossby number. Employing the short-wavelength approximation we develop a unified framework for the investigation of the standard, the helical, and the azimuthal version of the magnetorotational instability (MRI), as well as of current-driven kink-type instabilities. Considering the viscous and resistive setup, our main focus is on the case of small magnetic Prandtl numbers, which applies, e.g., to liquid metal experiments but also to the colder parts of accretion disks. We show in particular that the inductionless versions of MRI that were previously thought to be restricted to comparably steep rotation profiles extend well to the Keplerian case if only the azimuthal field slightly deviates from its field-free profile. We also find an explicit criterion for the critical magnetic field at the onset of the Tayler instability (TI) and demonstrate the details of transition between TI and azimuthal MRI in support of the planned MRI-TI experiment." On April 18 Professor A. Cole from Columbia University presented a talk, entitled "Variational Principles with Pade Approximants for Tearing Mode Analysis". The abstract of his talk is "Tearing modes occur in several distinct physical regimes, and it is often important to compute the inner layer response for these modes with various effects. There is a need for an approximate and efficient method of solving the inner layer equations in all these regimes. In this talk I introduce a method of solving the inner layer equations based on using a variational principle with Pade approximants. For all the regimes

considered, the main layer equations to be solved are inhomogeneous, and Pade approximants give a convenient and efficient method of satisfying the correct asymptotic behavior at the edge of the layer. Results using this variational principle- Pade approximant method in three of these regimes are presented. These regimes are the constant-psi resistive-inertial (RI) regime, the constant-psi viscoresistive (VR) regime, and the non-constant-psi inviscid tearing regime. The last regime includes the constant-psi RI regime and the inertial regime. The results show that reasonable accuracy can be obtained very efficiently with Pade approximants having a small number of parameters."

ENGINEERING AND INFRASTRUCTURE (M. WILLIAMS):

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

Construction: Installation of the outboard diverter row one tiles is in progress. The metrology of the upper and lower flanges of the vessel indicate that they are parallel to each other. The first of two new RWM coils has been installed and has passed a megger test. Trial fit-ups for bus for the CHI and TF systems continues. Preparations are nearly complete for installing cables for the vacuum, RGA and gas injection systems. The gas injection valves have been installed at bays F and G. The cleaning of the centerstack casing has been completed and it has been moved back to the south high bay.

CS Upgrade: The conductor transition to the fourth layer was completed. We are now in the process of installing the G-10 layer-to-layer insulators and will be winding layer 4 by April 19. One of the cracked Lead Extensions has been received from Martinez and has passed dimensional inspection and the part is now being dissected in preparation for Stress Relieve cycle and further dissection for test samples. The remaining parts at Martinez & Turek are being UT tested, with results expected to be available the week of April 21. A price quote was received for the replacement G10 Crown pieces for the centerstack assembly. The price and delivery looks reasonable and we expect to award after a visit to their site during the week of April 21. Procurements for hose, fittings and flow control valves for the CS water system were placed this week. The lower PF1B coil covers had to be remade with longer width to move the weld further away from the epoxy insulation. The new covers have been completed and welding of the covers will commence on April 18.

NBI Upgrade: Armor thermocouple feedthrough terminations are in progress at Bay H. BL2 source platform decon has been completed. Flexible hoses for the HVE lines were installed. The pipe connections to the DI water pumps are complete in the Pump Room. Transmission line assembly and preparation for relocation continues and seals and parts were completed. Mod/Reg controls work and preparation continues. N4ABC low voltage power supply contactors were changed-out in the NBPC 138L. The NB 13.8 kV disconnect switch motor drive alignments were performed. VV RWM coil fabrication continues for the Bay JK area. Turbo table work is in progress; flanges were received, welded, and leakchecked and assembly is imminent. The vacuum system fabrication and installation continues in the NTC and NB Controls work on rack wiring continued. Additional NB installation procedures are in development and review. Management attended the monthly IPT meeting.

Digital Coil Protection System: DCPS stage I testing continued this week using the Autotester (AT) and waveform input files. An additional AT testing feature was identified and added. User Interface development and coding continues with significant progress noted. DCPS code development included additions and solutions for known bugs. Hardware and I/O layout and design continues. Work on hardware drawings continues. PCB design and procurement is in progress. A successful FDR was held to cover FCPC changes to incorporate Level 1 faults into the series and parallel paths. Some hardware interface changes were required also. The DCPS Data Dictionary has been updated to include latest information.

BUSINESS OPERATIONS (K. FISCHER):

A Work for Others Agreement was executed with Princeton University for the design and analysis phase of the Facility for Laboratory Reconnection Experiment (FLARE). The work is being performed under a Major Research Instrumentation grant awarded to the University by the National Science Foundation. The Principal Investigator for the design effort is Mike Kalish; the estimated cost is \$535,000.

First year funding of \$172,300 was received from NASA for the research proposal titled "Collaborative Research on the Role of Guide Field on Electron Dynamics and Waves during Fast Magnetic Reconnection". The Principal Investigator for this effort is H. Ji.

A Field Work Proposal titled "Heavy Ion Fusion Studies and Research Using the Neutralized Drift Compression Experiment II (NDCX-II)" was submitted to the DOE Office of Fusion Energy Sciences. The requested funding is \$150,000 for FY14. The Principal Investigators are E. Gilson and I. Kaganovich.

PPPL is a participant on a collaborative proposal submitted by Oak Ridge National Laboratory to the DOE Office of Advanced Scientific Computing Research titled "Large Scale Data Mining and Machine Learning for Study and Prediction of Plasma Disruptions". The PPPL Principal Investigator is Bill Tang; the requested budget is \$30,000 per year for three years.

DIRECTOR'S OFFICE (C. AUSTIN):

Mr. Dan Clery, Science Magazine, presented a colloquium on April 14 entitled, "The Many Faces of Fusion".

April 15, M. Zarnstorff participated in the National Laboratory Chief Research Officer's (CRO) meeting in Washington, DC.

On April 16-17, M. Zarnstorff, M. Ono and J. Menard participated in a FES budget planning session, in Washington, DC.

April 16, Professor Mark Pagani, Yale University, presented a colloquium entitled, "Extreme Global Warming: Examples from the Past".

PUBLICATIONS:

The following PPPL Reports were posted to the web:

Experimental Observation Of 3-D, Impulsive Reconnection Events In A Laboratory Plasma
PPPL-5013

Authors: S. Dorfman, H. Ji, M. Yamada, J. Yoo, E. Lawrence, C. Myers and T.D. Tharp
Submitted to: Physics of Plasmas (November 2013)

Equilibrium Spline Interface (ESI) For Magnetic Confinement Codes PPPL-5014

Authors: Xujing Li and Leonid E. Zakharov

Submitted to: Journal of Computational Physics (March 2014)

Three Dimensional Disortations Of The Tokamak Plasma Boundary: II Boundary Displacements
In The Presence Of Resonant Magnetic Perturbations PPPL-5015

Authors: IT Chapman, S. Lazerson, [et.al.](#)

Submitted to: Nuclear Fusion (November 2013)

Geometric View On Nonlinear Waves PPPL-5016

Authors: I.Y. Dodin

Submitted to: Physics Letters A (March 2014)

BEAMS3D Neutral Beam Injection Model PPPL-5017

Authors: Samuel Lazerson

Submitted to: Plasma Physics and Controlled Fusion (April 2014)

Laboratory Study Of Magnetic Reconnection With A Density Asymmetry Across The Current
Sheet PPPL-5018

Authors: Jongsoo Yoo, et. al.

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>