



The PPPL Highlights for the week ending February 6, 2015, are as follows:

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

Release for Shipment paperwork is in the final approval cycle at ITER for the second HV transformer from Hyundai, and early March is targeted for shipment for this large component.

Two new cost/ schedule scenarios for completion of the Steady State Electric Network scope were submitted to the US ITER Project Office. One follows the recent US ITER budget guidance, and includes a significant delay before finishing the last four procurements. The other re-starts the last four procurements beginning in April. The final scenario will be decided by U.S. ITER management based on budgetary considerations.

General Atomics engineers Ray O'Neill and Armando Chavez visited PPPL to discuss mechanical design issues for several ITER diagnostics. Kurt Vetter, the newly appointed head of Instrumentation and Control for the US ITER Project, visited PPPL to discuss the I&C strategy for US diagnostics.

Project Change Requests (PCRs) were drafted, reflecting re-planned efforts for ITER Upper Cameras, the Core Imaging X-ray Spectrometer, the Upper Port Plugs 11 and 14, and Diagnostic Management.

Responding to comments from the DOE Princeton Site Office, modifications were made to the Statement of Work and the Source Selection Plan for the Physics and Engineering Design Support for the Motional Stark Effect Diagnostic.

At the Monthly meeting with the ITER Diagnostics Group in Cadarache, France, R. Feder presented a preliminary list of several CY15 goals for each of the US systems that can be tracked informally in subsequent meetings. A final list with completion target dates will be produced.

NSTX (M. ONO):

A two-day "pre-forum" meeting was held on January 28-29 at PPPL. The goal of this meeting was to help ensure that NSTX-U scientific research can begin as soon as possible and that FY15 NSTX-U research and FES Joint Research Target (JRT) milestones are successfully met. The first day of the meeting focused on operations, diagnostics, and software support status. The goal of presentations from this day is to provide materials for team members to use in writing eXperimental Machine Proposal (XMP) and eXperimental Proposal (XP) ideas for the forum - in

particular estimates of which NSTX-U capabilities will be available and when. The second meeting day provided a program update on group roles and responsibilities, and also discussed commissioning and initial operations. The primary goal of this meeting day was to discuss topics, titles, and nominal authors of XMPs and XPs to cover the commissioning phase (run month #1) and first research phase (run month #2) of NSTX-U operation. The meeting agenda and presentations are archived at this URL:

<http://nstx-u.pppl.gov/research-forum/nstx-u-research-forum-2015/pre-forum-meetings>

Seniors Cynthia Guo and Rohan Khodiam from High Technology High School in New Jersey completed a research project that was begun last fall at PPPL. They investigated liquid metal embrittlement by subjecting stainless steel samples to liquid gallium under different temperatures and stress levels, to determine if they had any effect on their yield and ultimate strengths. Their experiments were prototypes for future studies with liquid lithium, since it will be contained in stainless steel components as part of future divertor concepts for NSTX-U.

ITER & TOKAMAKS (R. HAWRYLUK):

DIII-D (R. Nazikian):

R. Nazikian led an experiment with Craig Petty (GA) and the DIII-D team to explore ELM suppression in steady state Hybrid plasmas. Full ELM suppression was obtained in a steady state hybrid discharge. The Ohmic primary was clamped for three seconds and the current actually rose slightly during this time, indicating full non-inductive current drive. There was not a single ELM during this time and good confinement ($H_{98} > 1$) was maintained throughout the steady state phase of the discharge.

E. Kolemen and D. Eldon are working with the DIII-D Boundary Physics group and tested an upgraded PCS control algorithm for the partial detachment of the divertor in DIII-D H-mode plasmas. The resulting improvements have allowed stable attached/detached plasma control. Part of the experimental plan was to compare the stability of detachment in long versus short divertor legs. A shape was developed with a higher X-point but not tested.

ADVANCED PROJECTS (D. GATES):

On February 4, Dr. Keeman Kim (Director of NFRI) and Dr. Kihak Im (Head of K-DEMO) visited for discussions about the Korean fusion program and discussions about NFRI - PPPL collaboration activities. The agenda included concurrent meetings set up to discuss KSTAR collaboration and PPPL involvement in the K-DEMO project. The K-DEMO project meeting was attended by P. Titus, C. Kessel, D. Mikkelsen, T. Brown and Kihak Im. With current K-DEMO project activities at PPPL on hold, waiting for the start of the next phase of the project – the meeting discussion centered on efforts to get ready for the project re-start in its next phase. Planned H&CD and design/analysis task elements were reviewed. It was agreed that early definition of port geometry requirements for diagnostics and H&CR systems would be made to upgrade details of the K-DEMO blankets. Upon further design definition of the in-vessel systems the focus of the structural analysis effort will be to evaluate (and qualify) the validity of the concept in supporting disruption loads.

D. Gates presented a colloquium entitled "The Tokamak Density limit: a thermo-resistive disruption mechanism" on February 2 at General Atomics in La Jolla, California. In the talk he presented the results of recent work done in collaboration with D. Brennan, L. Delgado-Aparicio, and R. White investigating the dynamics of tearing modes near the density limit. A sudden onset of exponential growth of the islands is found when a small perturbation to the internal island temperature is applied. This is consistent with the idea that radiation drive is responsible for the density limit.

D. Gates presented a talk entitled "Why stellarators" to the Annual e-affiliates meeting of the Andlinger Center for Energy and the Environment on February 6 held at the Chauncey Conference Center in Princeton. In the talk he explained the difference between the mainline tokamak concept and the stellarator. He also described what the main advantages of the stellarator are and argued that the U.S. would benefit from an investment in stellarator research. He was part of a panel that consisted of M. Zarnstorff, Deputy Director for Research at PPPL, E. Kolemen, Assistant Professor in M&AE at Princeton, and Chuck Greenfield, Deputy Director of the DIII-D program at General Atomics that discussed the potential role of fusion in the response to global warming.

THEORY (A. BHATTACHARJEE):

A paper was published in Physics of Plasmas, "Magnetic islands and singular currents at rational surfaces in three-dimensional magnetohydrodynamic equilibria ", J. Loizu, S. Hudson, A. Bhattacharjee and P. Helander. This paper, the authors provide the first numerical proof of the formation of singular current densities at and around rational surfaces in three-dimensional ideal MHD equilibria. These singularities are crucial for computing the equilibrium and stability of non-axisymmetric fusion plasmas, and were until now predicted only theoretically. Using SPEC, a fully nonlinear implementation of the recently developed Multiregion Relaxed MHD theory, the first nonlinear 3D ideal MHD equilibria with singular currents were computed. The reference for this article is: <http://dx.doi.org/10.1063/1.4906888>

ENGINEERING AND INFRASTRUCTURE (M. WILLIAMS):

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

Construction: Installation of Poloidal Field, Ohmic Heating and Coaxial Helical Injection bus inside the umbrellas has been completed and megger testing will occur February 7-8. All connector feedthrough cables have been connected and dressed in the umbrellas in support of this megger testing. Torroidal Field (TF) bus inside the umbrellas continues with three TF flex bus units installed on the east side of the lower umbrella and the associated finger supports being installed February 6. The upper center TF lead extensions are being re-worked to accommodate the variations in the elevation of the TF outer leg flags. Fabrication and installation of OH cooling tubes and hoses continues with all lower tubes now in place. Machining and silver-plating of TF bus spacers continues on both shifts. Gas delivery system piping is being installed as are the gas injectors themselves. The Electricians are working on the metal oxide varistors and the Residual Gas Analyzer cables.

CS Upgrade: Fabrication of the PF1ABC busbars and supports as well as the OH Busbars are 100 percent complete. Installation of the busbars continues as access to the umbrella permits. Dissection of some of the failed Grizzly Hose test samples revealed the hose ends were over crimped using the recommended tooling and fittings. Subsequent test samples made using a lighter crimp pressure were able to pass the 110C @ 500 psig test. We will contact the vendor to try and reconcile the results. In parallel another test sample from another manufacturer was ordered for testing purposes.

NBI Upgrade: The deionized water system repairs continued on MER mezzanine and near completion. Fabrication of the strainers for the NTC is in progress in the shop with one complete and installation of both in NTC is imminent. Stack duct installation is imminent in the NTC and platform installations are complete. Control cabling has been completed from NTC into the gallery racks where terminations continue and near completion. Troubleshooting of all cabling in support of various stages of PTP testing is in progress. M/R power supply testing and tuning continues. Software efforts continue on PLC pages. PTP testing is in progress. Consideration of an IR camera for Bay L 7:30 port to view the armor is in progress. NTC North door gate installation is scheduled for the week of February 9. Management participated in the monthly IPT meeting.

Digital Coil Protection System (DCPS): Pre-operational testing and troubleshooting continued in preparation for support of dummy load testing. Glitches on RTC outputs were ameliorated or fully remedied with some software scheduling changes and a FOMS review and change is underway to respond to this glitch issue properly on the rectifiers. Targeted testing continues to examine the success of this change. DCPS PTP rerun is complete. Further testing of PTP-ECS-034 and 035 was completed. Work continues on the DCPS buffer chassis implementation. Parameter tree development to support Pre Test Procedure, dummy load, ISTEP, and CD4 continued, including consideration of limits and their pedigree and review. The procedure for setup and daily startup of the DCPS system will be developed concurrent with pretesting. DCPS FCC integration has been completed and is ready to start local FCC PTP testing with Autotester.

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

Health Physics worked with Engineering to plan for experimental activities using a quantity of Phosphorous-32 (P-32) isotope under a Work for Others (WFO) scope.

BEST PRACTICES & EXTERNAL AFFAIRS (J. DELOOPER):

Professor James Gates, University of Maryland, presented "Is Suzy the Guardian of Our Reality from Oblivion?" at the Science on Saturday lecture on February 14.

OFFICE OF ACADEMIC AFFAIRS (N. FISCH):

On February 4-5, N. Fisch visited Sandia National Laboratory where he served on a Pulsed Power ICF "Advisory Panel."

DIRECTOR'S OFFICE (C. AUSTIN):

Dr. Georg Bollen, from Michigan State University - presented a colloquium on February 4 entitled, "Facility for Rare Isotope Beams - Scientific Opportunities and Technical Challenges".

On February 5-6, M. Zarnstorff and D. Gates participated in the e-affiliates meeting of the Andlinger Center for Energy and the Environment, and made presentations on the U.S. and PPPL fusion research programs.

PUBLICATIONS:

Loizu*, J.; Hudson, S.; Bhattacharjee, A.; and Helander, P., "Magnetic Islands And Singular Currents At Rational Surfaces In Three-Dimensional Magnetohydrodynamic Equilibria," *Physics of Plasmas*, 22, 022501 (2015); <http://dx.doi.org/10.1063/1.4906888>

This report is also available on the following web site:

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