

Weekly

HIGHLIGHTS



The PPPL Highlights for the week ending February 10, 2017 are as follows:

U.S. ITER FABRICATION (H. NEILSON):

H. Nielson, R. Feder, E. Nassar and Y. Zhai attended the annual diagnostics all-hands meeting at the ITER offices in Cadarache, France. Representatives from all the Domestic Agencies (DAs) providing diagnostic systems to ITER attended. The purpose of this meeting was to work on solutions to design, interface and management issues and risks that effect all of the DAs. Optimization of the equatorial port plugs nuclear shielding performance continues to be one of the main topics of discussion. It was agreed by the meeting panel that an expert peer review of the IO equatorial port DSM "Modular Design" will be partly lead by the US ITER engineering team. The US equatorial port design will then be reviewed two months later in order to bring this topic to a close and allow for the equatorial port diagnostic systems designs to advance. Other topics discussed included design review documentation preparation and review, the use of Boron Carbide for nuclear shielding and the status of important remote handling structures. The PPPL team was very fortunate to be taken on an in-depth walking tour of the ITER construction site. Hutch, Russ, Emil and Yuhu were taken into the machine pit to see concrete works, into the massive assembly building to see the ITER machine assemble crane system and to generally experience the rapid progress of ITER construction.

ITER Steady State Electrical Network (J. Dellas):

RPC (Reactive Power Compensators): Ongoing preparation efforts continue for Release for Shipping approval for Lots #1 & 2. Each lot contains two sets of power factor correction capacitor banks for the ITER SSEN system.

UPS (Uninterruptible Power Supplies) & DC Distribution: Ongoing preparation efforts continue for Release for Manufacturing approval of these last two procurement contracts for the SSEN.

ITER Diagnostics (R. Feder):

Upper Wide Angle View VIS-IR Cameras (UWAVs): Upper Wide Angle View VIS-IR Cameras (UWAVs): The General Atomic Upper Camera design effort is moving on to the Back End Optics Design. The kickoff coordination meeting was very productive. The mirror cleaning R&D is nearing completion and has successfully identified a methodology for remotely cleaning contaminated mirrors. PPPL is now reviewing General Atomic quote for performing the previously deferred optics Instrumentation and Control (I&C) work in order to bring the I&C effort forward to align with the Camera mechanical I&C PDR.

Upper Port Plugs 11 & 14: Weekly meeting held with DMS and IO team to resolve the integration issue. DMS team is looking into using a Feedthrough at the closure plate (CP) instead of Flange attached on the CP. This may resolve the clash with lifting lug at the CP and VisIR/UWAVs window; IO's report on Post First Plasma (PFP) interfaces has been reviewed by diagnostic system's engineer and comments have been shared with USITER. In IO's report most of the PFP interface sheet doesn't have a commitment date from IO, which imposes a risk of "changing interfaces" for PDR level design.

Electron Cyclotron Emission (ECE): New molybdenum heater was successfully tested as a part of a ECE hot source prototype assembly including housing, and silicone carbide emitter. The test showed ability of the heater to provide enough energy so emitting surface is at required 700C. The test was conducted by UT team in Austin. Progress was made in PPPL on defining cable arrangement and configuration.

Equatorial Port 09: CATIA modeling for conversion to neutronics analysis format remains in work, however, key components were finalized this week for the high priority analysis. Preliminary analysis steps can now begin in a few days.

ITER Analysis Team: The volumetric heating data from UP14 neutronics analysis were interpolated onto the UP14 thermal hydraulic model for cooling assessment of the in-port primary components. This is a necessary step to develop temperature distribution on the UP14 in-port components for structural integrity evaluation. Electromagnetic (EM) analysis of the UP11 with NAS system was also performed. EM loads are evaluated for input to the UP11 system load specification.

NSTX-U RECOVERY PROJECT (R. HAWRYLUK):

NSTX-U is in a maintenance and repair outage.

The fourth Design Verification and Validation Review (DVVR), reviewing the NSTX-U magnets including the TF, OH, and PF inner/outer coils, TF-OH interactions, the OH coil Pre-Heater, the DC Bus systems, and the Resistive Wall Mode (RWM) coils, was held this week. This was a very intensive four day meeting and continued during the lab closure on February 9 by means of a Zoom conference call. The external members of the review team included Bill Beck, of MIT's Plasma Science and Fusion Center, Nicolai Martovetsky, the United States ITER Magnet Systems R&D manager; consultant Dick Reed, Iain Dixon, of the National High Magnetic Field Laboratory; John Smith, central solenoid project manager at General Atomics; as well as Tom Todd, the chair of the External Condition Review Committee. Among those attending remotely were: Frank Casella, of US ITER, Martin Cox of the Culham Centre for Fusion Energy, James Irby, Brian LaBombard, and Rui Viera, of MIT's Plasma Science and Fusion Center; Michel Huguet, former head of ITER EDA site; and Rem Haange, former ITER Deputy Director General, all of whom attended via video conference, and numerous PPPL staff members. Also attending were Josh King, program manager for Spherical Tokamaks at the DOE's FES and Matthew Lanctot, program manager for Long-pulse Tokamaks at the DOE's FES. Comments and suggestions on coil system design and as-built documentation are being recorded during this extended review and will be incorporated into the Corrective Action Plan.

Regarding test cell work, the installation of the OH Coil Pre-Heater system continued, and progress was made on diagnostic installations such as FIRETIP wave guides and equipment for the new Pulse Burst Laser System (PBLs). Recommissioning of the coil winding facility continued with the completion of the clean room reconfiguration and the ongoing assembly of the tensioning skid. The PF1A coil mandrel has been mounted on the coil winder turning fixture. The commissioning of a PF inner coil test stand in the Field Coil Power Conversion Building is in progress.

NSTX-U RESEARCH (J. MENARD):

J. Menard, R. Hawryluk, and M. Zarnstorff visited FES in Germantown on February 6 to present the NSTX-U FY2017 Q1 quarterly report. The agenda included discussions of the Recovery Project, QUEST collaboration results, NSTX-U outgoing collaborations, and FY2017 research milestones.

On February 7, Walter Guttenfelder presented “NSTX-U first results, and progress in transport research” at the University of Washington as part of the NSTX-U Outreach Seminar series. The talk summarized initial results from the first NSTX-U run campaign, provided a brief tutorial on tokamak micro-instabilities, illustrated the benefits of low aspect ratio on micro-instabilities, summarized measurements and predictions of various micro-instabilities that can contribute to thermal transport in NSTX-U, and outlined future research plans.

Steve Sabbagh (Columbia University) gave the presentation “Kinetic Resistive Wall Mode Stabilization in Tokamaks and Initial Results from NSTX-U” at the KTH Royal Institute of Technology in Stockholm, Sweden on February 8. He also served as the opponent for a doctoral thesis defense on February 9.

Olivier Izacard (LLNL) was named by IOP as one of their Outstanding Reviewer Award winners for 2016, in recognition of the high quality and timeliness of his publication peer reviews for Plasma Physics and Controlled Fusion.

ITER & TOKAMAKS (R. NAZIKIAN):

KSTAR:

A Zoom conference was held (S. Scott/PPPL, R. Mumgaard/PSFC, J. Ko/NFRI) to discuss the status of the proposed shipment of the MSE background polychrometer from MIT to KSTAR. Shipment of the polychromator is expected between March 10-17. R. Mumgaard (MIT) will travel to KSTAR mid-April to assemble the polychrometer and integrate into the KSTAR system. The polychrometer should be operational on KSTAR at the start of the FY17 campaign.

EAST:

R. Maingi hosted a conference call of the principle investigators on the US-China PMI collaboration on EAST to discuss ideas for experiments to be presented at the 2nd EAST General

Planning Meeting in March. Additional meetings were held to discuss the flowing liquid lithium limiter results and mass transport during pellet injection in EAST.

ITER:

F. Poli visited the Institute for Plasma Physics (IFP) in Milan, Italy, to participate in a meeting for the ITER task agreement on EC analysis and to work with D. Farina and L. Figini on topics related to the use of EC in ITER during the pre-fusion plasma operation phase. Poli also gave a seminar on Tuesday to the IFP group entitled "EC power management for NTM control in ITER" summarizing power needs assuming different NTM control schemes and hardware constraints such as ECE diagnostics sensitivity and the precision of the magnetic equilibrium reconstruction.

DIII-D:

Lang Cui and Carlos Paz-Soldan ran TRANSP, kinetic-edits and the GPEC code to optimize the $n=2$ I and C-coil currents to maximize the resonant torque on a new plasma equilibrium. The predictions obtained were qualitatively validated in the experiment, with large breaking and transport resulting from the optimal predicted resonant coupling. This work represents a significant advance in the integration of between shot predictive modeling of the plasma response to 3D fields. The OMFIT framework's efficient integration of tokamak profile fitting, TRANSP, EFIT, and GPEC as well as a new BEAST mode for between shot TRANSP analysis at DIII-D enabled this new control room capability.

N. Logan visited PPPL from DIII-D this week. In preparation for the upcoming NSTX-U/DIII-D Collaborative Research Campaign, he held a seminar demonstrating how to access, fit and perform TRANSP analysis of profile data in DIII-D, and performing kinetic equilibrium calculations for advanced analysis.

A paper by R.M. Churchill titled "Total Fluid Pressure Imbalance in the Scrape-Off Layer of Tokamak Plasmas" was accepted for publication in Nuclear Fusion. In the paper, it is shown that simple, commonly used fluid forms of the total pressure balance are not conserved in the near scrape-off layer, based on results from a DIII-D H-mode simulation using the kinetic code XGCa. Even including neutral and viscosity effects (due to large parallel/perpendicular ion temperature anisotropy) does not remedy the pressure imbalance. This highlights the importance of kinetic effects in scrape-off layer physics and the need for main ion temperature measurements there. Complete author list: R.M. Churchill, J.M. Canik, C.S. Chang, R. Hager, A.W. Leonard, R. Maingi, R. Nazikian, D.P. Stotler.

A PDR was held on a new impurity powder dropper concept presented by David Mauzey, a PPPL student intern. The concept development work has been highly successful with testing of various powders. On January 9, David Mauzey produced a fully equipped dropper with vacuum gauges, valves, actuators, and hoppers. The prototype was reviewed by both GA and PPPL engineers. This unit will now proceed to fabrication and installation on DIII-D. It will be operational by late July in time for the NSTX DIII-D national campaign.

A lessons learned meeting was held to review the neutral beam controller LCS8 and commissioning. The installation and debugging took approximately 16 weeks but the system is

now operational. A majority of the commissioning focused on finding spurious breaker trips caused by induced noise, ground loops, and the National Instruments low level logic FPGA. The system is now running reliably 90% of the time with spurious trips being addressed as they occur. The new LCS5 under construction will incorporate changes based on the review findings.

THEORY (A. BHATTACHARJEE):

A seminar titled “Exact collisional plasma fluid theories” was presented to the Theory Department on February 10 by Eero Hirvijoki, with co-author David Pfefferlé. The abstract reads: “Following Grad’s procedure, an expansion of the velocity space distribution functions in terms of multi-index Hermite polynomials is carried out to derive a consistent set of collisional fluid equations for plasmas. The velocity-space moments of the often troublesome nonlinear Landau collision operator are evaluated exactly, and to all orders with respect to the expansion. The collisional moments are shown to be generated by applying gradients on two well-known functions, namely the Rosenbluth-MacDonald-Judd-Trubnikov potentials for a Gaussian distribution. The expansion can be truncated at arbitrary order with quantifiable error, providing a consistent and systematic alternative to the Chapman-Enskog procedure which, in plasma physics, amounts to the famous Braginskii equations. To illustrate our approach, we provide the collisional ten-moment equations and prove explicitly that the exact, nonlinear expressions for the momentum- and energy-transfer rate satisfy the correct conservation properties.”

This report is also available on the following web site:

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