

Weekly

HIGHLIGHTS



The PPPL Highlights for the week ending October 7, 2016 are as follows:

U.S. ITER FABRICATION (C. NEUMEYER):

Steady State Electric Network (SSEN):

SSEN

Uninterruptible Power Supply (UPS) and DC Distribution Contracts and Arrangement for Battery Banks and LV Distribution & Sub-Distribution Panels: Both contracts have now been signed and a kickoff meeting has been scheduled for October 13. Although continuing support from Procurement will be required for oversight and amendments, it is noteworthy that these are the final SSEN contracts. Now that these contracts have been signed, the Arrangement for transfer of the battery banks and LV distribution panels for ITER IO procurement can be signed by the US ITER manager and the Director General of ITER. The DOE Federal Project Manager is performing the final review of the Arrangement document before releasing for signature.

Power Transformers: Progress is being made on planning, logistics and shipping documents related to shipment of Group 1 and 2 transformers (that comprise shipping lots one and two) from the Schneider Electric factory near Istanbul, Turkey. The forecast shipping date is now October 27. Three dispatch batches have been agreed between the ITER Logistics Support Provider (LSP) and the supplier. Trucking will be scheduled so that all main bodies arrive at ITER site in a single day, and all accessories on another day. Packing lists and Pro forma invoices on a per batch basis is pending. Once packing lists and pro formas are received, French customs approval process can commence.

Diagnostics:

Project and Administrative Notes and Highlights: The US ITER Diagnostics and Port Plug Engineering team continues to prepare for the November 14 DOE CD-2 project review.

Upper Port Wide Angle View Vis-IR Cameras (UWAVs): RAMI experts from the french company Bertin were contracted to perform this assessment for the UWAVs diagnostic systems. The kick off meeting for this effort occurred on September 29. The RAMI assessment is expected to continue for the next four months.

Electron Cyclotron Emission (ECE): UT conducted preliminary analysis of the ECE performance under 1.8 T ITER field operations. Detailed analysis will be performed when scenarios will be released by ITER. Analysis was performed also to access the effect of the

change of the vacuum window diameter from 160mm to 130 mm. The 130 mm clear aperture is completely filled for 50 GHz using our standard 3W criterion. ECE group is investigating whether any manufacturer can produce fused silica 160 mm window. The hot source testing of the Molybdenum sample with V-grooves is progressing well. The 30 degree grooves are producing a normal spectral emissivity in the vicinity of 0.7, which provides comfortable margin in the performance of the hot source. Molybdenum encapsulated heater have been ordered, and will be tested later this year at UT.

Andrei Khodak and Gary Taylor visited ITER September 12-14 to discuss various aspects of the ITER electron cyclotron emission (ECE) diagnostic design and its important application for detecting neoclassical tearing mode (NTM) activity to provide a sensor for the system to suppress NTMs by EC heating. They had wide ranging, productive, discussions with members of the ITER diagnostics, plasma operations and control, and EC heating groups that covered the design of the ECE primary vacuum window, the Diagnostic Shield Module in the Port Plug, neutronics modeling, planning for a peer review of the hot calibration source development at ITER early next year, the viability of an inline ECE diagnostic in the EC launchers to enhance NTM detection, and the ability of the ECE diagnostic to support low field H/He plasma operations at axial toroidal fields down to 1.8T.

Upper Port 11 and 14 Integration and DSM Engineering: Dynamic Frequency Response data (FRS) for the Upper Port 14 implementation of WAVs at each attachment points for Vertical Disruption Events (VDEs) and Seismic (SL) load cases were received from analysis team. Similar data for other Tenant system (GDC, DMS) has been requested. Work is going on to identify status of Interface sheet with various PBS and UP14. This information is requested by USITER to identify if all interface with different PBS are frozen for PDR or they need some more work.

Equatorial Port 9 Integration and DSM Engineering: With an eye on starting the next EP9 integration system neutronics analysis as soon as possible, preparation of DSM2 and DSM3 CATIA models was completed for an internal status review at week's end. Concept studies for Port Closure Plate water feedthroughs and DSM4 in-vacuum shielding has resumed. These inter-related design studies will offer refinement to the planned neutronics analysis.

Diagnostic I&C Integration Engineering (ORNL, Bill DeVan): The effort to solidify USDA Diagnostic P&IDs, Single-Line Diagrams (SLDs), and cable collection lists (CCLs) continues. These documents are useful in many ways, including supporting the IO's cable tray design effort. The TIP preliminary cable package (PID, SLD, and cable collection list) was submitted to iDocs for approval this week. This is significant because it is the last USDA Diagnostic package to be submitted for floor level 1 of the Tokamak complex. Edits continue on the preliminary cable packages for other USDA diagnostics on level 1 due to IO comments, changes in the IO's containment strategy, etc. However we do seem to be converging to the point where they should be sufficient to satisfy the IO's cable tray design effort. We will now start to focus on the level two cable packages (primarily for WAVS).

NSTX-U (M. ONO):

M. Ono was invited to attend the ICEF (Innovation for Cool Earth Forum) on October 5 – 6 in Tokyo, Japan. The ICEF is aimed at providing a global platform to promote discussions and cooperation among researchers, business persons, and policymakers from around the world in order to address climate change through innovation of energy and environmental technologies including their dissemination: <http://www.icef-forum.org>. He gave an invited talk entitled “Spherical Tokamak for Economical Fusion Energy Development” and participated in the fusion panel discussion.

Ono visited the University of Tokyo (Tokyo, Japan) on October 7. He met with Professors Y. Ono and Y. Takase to discuss the ST collaboration research under the US-Japan Collaboration. He toured the TS-3/4 ST facilities and heard the status of fusion energy research at the University of Tokyo. The facilities are undergoing upgrade for higher field and current operations to explore high-beta ST regimes with the merging-reconnection plasma heating. He gave a seminar to the University of Tokyo faculties and students on “ST Fusion Development Path and NSTX/NSTX-U Overview.”

ITER & TOKAMAKS (R. HAWRYLUK):

DIII-D (R. Nazikian):

The user base for TRANSP on DIII-D has recently seen a large increase through implementation of TRANSP and a new profile analysis tool as a module in the OMFIT workflow manager. On DIII-D alone we have a 300% increase in new users. This is due in large part to the streamlined data preparation and powerful visualization tools embedded in the OMFIT workflow and integrated into the TRANSP analysis tools. Presently, TRANSP runs are being submitted for Alcator C-Mod, NSTX, JET and DIII-D through OMFIT. Due to OMFIT’s general support for arbitrary tokamaks, a generalized approach is implemented for initializing TRANSP runs on multiple machines, each with their own unique diagnostics, timebases and legacy settings. Brian Grierson attended a video conference with Alcator C-Mod and JET to strategize on a more powerful implementation of TRANSP in OMFIT that preserves backwards compatibility, and produces a more intelligible and uncluttered namelist for new runs. The present version of the TRANSP module in OMFIT will be demonstrated to the JET team this week, with the implementation of the more general tokamak namelist software in the coming weeks.

A paper titled “Effects of Resonant Magnetic Perturbations on Microturbulence in the DIII-D Pedestal”, by I. Holod, Z. Lin, S. Taimourzadeh, R. Nazikian, D. Spong, and A. Wingen, has been published in Nuclear Fusion, Vol. 57, 016005 (2017). The paper shows that the ideal MHD response of the plasma to 3D magnetic perturbations has a negligible effect on the stability of kinetic ballooning modes, drift wave turbulence and zonal flows in the DIII-D pedestal, when the 3D equilibrium is calculated using VMEC and the stability of the modes is calculated using the gyro-kinetic code GTC. The results indicate that non-ideal MHD effects (such as islands) are required to account for the large changes in pedestal transport seen in ELM suppressed plasmas. Future work will focus on the effects of 3D non-ideal MHD physics on micro turbulence and transport integrating M3D-C1 magnetic field calculations into GTC.

A database has been developed for the measured rotation velocities of impurities at the top of the H-mode pedestal in order to validate theoretical models of intrinsic rotation. Main ion rotation velocities are presently inferred from the measured toroidal impurity velocities using neoclassical corrections, which appear to be valid at high collisionality near the top of the pedestal. Direct main-ion rotation measurements are being processed for integration into the database. Preliminary results show that the magnitude of toroidal rotation obtained from theory (T.S-Dueck, PRL 2012) and experiment are comparable provided the ratio of passing to trapped ions in the edge is taken into account.

During the week of September 26-30, Bob Ellis and Dave Miller worked at GA to complete the maintenance of the PPPL-designed ECH launchers, including the addition of conduits for RTD wires. All four launchers were refurbished. Hard metal conduits were added for RTD wires in the vicinity of the fixed and steerable mirrors to prevent burnout by any stray ECH. They replaced waveguides on two launchers and installed a positive rotary shaft engagement modification on all 16 encoders for the four launchers. Some spare rotary shaft encoders are being prepared.

The MOU for the pole shields is in the final stages of review at GA. The information for the Calorimeter MOU has been sent to PPPL. The collimator MOU is awaiting updated heat load data, which is now ready. Irv Zatz at PPPL is the lead for all three of these projects. Estimated completion of the Calorimeter and Collimator MOUs is in November.

ADVANCED PROJECTS (H. NEILSON):

The national Fusion Energy Systems Studies team met at PPPL this week to go over technical progress on the tokamak fusion nuclear science facility (FNSF) study in areas including nuclear analysis, liquid metal analysis, transient thermal and electromagnetic analysis, RF assessments, materials issues, scrape-off layer and divertor modeling, core physics, magnet descriptions, and hot cell description. In addition, review and discussion on: systems calculations for a minimal and a maximal FNSF; mission and metrics established for the FNSF; and the pre-FNSF R&D program recommendations. This is the final meeting for the project and the team will report the project results in a special issue of Fusion Engineering and Design.

Understanding of energetic ion confinement is one of the key research needs that the stellarator community has identified, and Wendelstein 7-X (W7-X) offers opportunities to investigate this topic in the near term. In preparation, the Laboratory is investigating a compact Faraday cup style fast ion loss detector based on thin-film deposition technology. The compact design could be advantageous for integration in the complex in-vessel environment of W7-X. A plan to prototype such a detector, harnessing capabilities for fabrication and testing that are available in industry and academia, is currently being formulated.

THEORY (A. BHATTACHARJEE):

The PPPL Theory Department met for a Retreat at Andlinger Center for Energy and the Environment (ACEE) on Princeton University Campus. It has become traditional for the Theory Department to hold a Retreat every two years in order to assess recent progress, develop a prioritized action plan taking into account recent developments, and to brainstorm about

strategies to foster even more effective collaborations between members of the Department, other Departments in PPPL, as well as external collaborators. Most of the Retreat time was spent on the activities of the Research Groups on Turbulence and Transport, Macroscopic Equilibrium and Stability, Energetic Particles, Basic Plasma Science, and High-Performance Computing as well as the NSTX-U-Theory Partnership.

There were two invited external plenary speakers at the Retreat: Dr. Douglas Kothe of the Oak Ridge National Laboratory and leader of the Exascale Computing Program (ECP) (Applications) in the DOE Advanced Scientific Computing Research Office, and Professor Lynn Loo, Director of the ACEE. Dr. Kothe gave a talk about the overall scope and vision of the ECP, and how the recently awarded PPPL-led program on “High-Fidelity Whole Device Model of Magnetically Confined Fusion Plasmas” fits in as an integral part the ECP Applications category. Following Dr. Kothe’s talk, there was extensive discussion on the implications of the ECP for the PPPL Theory Department research program and its impact on the five-year plan (2015-19). Professor Loo gave a talk on the scope and range of the ACEE activities in research and teaching, highlighting areas of continuing and possible future collaborations with PPPL. The Retreat deliberations were crystallized in the form of recommendations during summary sessions, to be acted upon by the Department.

DIRECTOR’S OFFICE (C. AUSTIN):

On October 7, at an All Hands meeting, Ruth Orenstein - an organizational expert from Princeton Consulting Resources, introduced PPPLers to a project to evaluate our organizational culture. Ruth and her team will help us determine, from your perspective, any culture changes that are desirable or necessary to achieve scientific and operational excellence. Ruth presented an overview of the methodology of the organizational diagnosis approach.

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