Weekly HIGHLIGHTS

PPPL PRINCETON PLASMA PHYSICS LABORATORY

U.S. DEPARTMENT OF ENERGY

The PPPL Highlights for the week ending August 19, 2016 are as follows:

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

Steady State Electric Network (SSEN):

Uninterruptible Power Supply (UPS) system and DC Distribution Technical issues were resolved, and contract award recommendations were made for both procurements. Best and Final Offers were requested. Included were quotations for battery banks in support of an "Arrangement" document that will transfer procurement of same to the ITER Organization. The objective is to sign the two contracts and the Arrangement prior to the end of FY16 so that US ITER can obligate the funds.

Power Transformers: Shipment of Lot 1 and Lot 2 oil-filled units (8 @ 35MVA and 4 @ 7MVA) from the Schneider Electric factory near Istanbul, Turkey has been delayed until next week as plans for loading/transport are being finalized. Note that each 35MVA unit, and perhaps each 7MVA unit, will require a separate truck so there may be as many as 12 individual trucks involved.

6.6kV Switchgear: The remaining 110 cubicles in Lot 3 and 4 from the Schneider Electric factory in Manisa, Turkey, were shipped and are due at their destinations on August 24. The Lot 3 delivery destination is the ITER site but Lot 4 is being delivered to a EU factory in Spain for installation in prefabrication substation containers.

DIAGNOSTICS:

This week the team focused on preparations for the upcoming Red Team review, taking place at the US ITER office in Oak Ridge week of August 29. A total of 10 PPPL persons will be in attendance, traveling on separate flights. Several members of the team are also preparing for the TOFE and SOFT conferences. As a result of these demanding activities no other highlights are presented this week.

NSTX-U (M. ONO):

The FY 2016 NSTX-U plasma operations were completed. The department has completed 10.06 run weeks and 1066 plasma shots.

The paper "Fusion nuclear science facilities and pilot plants based on the spherical tokamak" by J.E. Menard, et al. was published online in the journal Nuclear Fusion on August 16. The paper describes the possible missions of a Fusion Nuclear Science Facility (FNSF) and Pilot Plant including: providing high neutron wall loading and fluence, demonstrating tritium self-sufficiency, and demonstrating electrical self-sufficiency. ST-FNSF configurations have been developed simultaneously incorporating for the first time: (1) a blanket system capable of tritium breeding ratio TBR approximately 1, (2) a poloidal field coil set supporting high elongation and triangularity for a range of internal inductance and normalized beta values consistent with NSTX/NSTX-U previous/planned operation, (3) a long-legged divertor analogous to the MAST-U divertor which substantially reduces projected peak divertor heat-flux and has all outboard poloidal field coils outside the vacuum chamber and superconducting to reduce power consumption, and (4) a vertical maintenance scheme in which blanket structures and the centerstack can be removed independently. Importantly, it is found the threshold major radius for tritium self-sufficiency is greater than or equal to 1.7m, and a smaller 1m ST device has TBR approximately 0.9 which is below unity but substantially reduces T consumption relative to not breeding. Further, an A=2, major radius = 3m device incorporating high-temperature superconductor toroidal field coil magnets capable of high neutron fluence and both tritium and electrical self-sufficiency is also presented following systematic aspect ratio studies. The paper URL is: http://iopscience.iop.org/article/10.1088/0029-5515/56/10/106023

As part of the General Atomics' "core" grant collaboration to support NSTX-U, Matt Lanctot gave a talk to the NSTX-U Macroscopic Stability Topical Group titled "Extending 3D Magnetic Diagnostics on NSTX-U". He will be leaving soon to work for DOE and Stefano Munaretto who is a recently started ORAU postdoc working on 3D magnetics on DIII-D will join Ted Strait part-time on this NSTX-U task. Lucas Morton is starting as an ORAU postdoc and will be based at PPPL to work full time on the "core" grant collaboration task of macroscopic plasma stability.

The upper NSTX-U TF bus links have been removed, and the upper TF joint resistances have been verified to be consistent with pre-run measurements. Lower TF joint integrities will be verified after the removal of the PF-1AU coil. The NSTX-U vacuum vessel has been vented to air, and the dismantling/removals of systems inside the upper machine umbrella continues. Vacuum vessel hi-pots and resistance checks continue daily during the removals to track the integrity of the inner to outer vessel electrical insulation. The PF-1AU coil with the shorted turn will be removed from the machine by mid-September for post-failure analysis. The Coil Shop is being set up to begin the winding of a new PF-1AU coil. Neutral beam (NB) power and cryogenic system maintenance has started. The NB1 beam line is being vented to the stack in preparation for removal of its calorimeter, and pump/purges of NB2 will start this coming week. The schedule to remove the NB duct to provide in-vessel access has been accelerated to start by Sept.15th, and will help to get the in-vessel diagnostic calibrations done by mid October.

The Far-Infrared Tangential Interferometer and Polarimeter (FIReTIP) is being implemented in collaboration with the University of California at Davis for line-averaged density measurements of NSTX-U plasmas. In the past, vibration compensation was based on a visible laser that followed a path that included all of the reflective elements for the FIReTIP beam. An alternative approach is to use an adaptive filter that continuously tracks the vibrations and corrects for them. To determine if measurements could be taken with the necessary sensitivity, data were obtained with a compact accelerometer at locations around NSTX-U prior to shutting down the pumping system for the vacuum vessel vent.

Lisa Reusch and Daniel Den Hartog from the University of Wisconsin Madison visited PPPL to discuss their ongoing NSTX-U collaboration on integrated data analysis (IDA). Reusch gave a tutorial on Bayesian analysis for (fusion) Science and discussed with R. Bell, K. Tritz, and A. Diallo applications of the IDA to NSTX-U data. D. Den Hartog met with B. LeBlanc and A. Diallo of PPPL to discuss potential upgrades to the pulse burst laser system and also toured the future site of the pulse burst laser system in the Thomson scattering mezzanine.

ITER & TOKAMAKS (R. HAWRYLUK):

DIII-D (R. Nazikian):

The PPPL/GA site collaboration team held a follow up safety meeting where A. Nagy presented and discussed concerns generated from a PPPL All-Hands Safety Forum held at GA in June. This meeting included; a GA safety program overview by the DIII-D safety officer, a concerns review from the June meeting, and a safety based site tour visiting safety equipment e.g., door interlocks, ground switches, power systems, from the control room to the AC power yard MG set, and how they connect. There were many positive comments about this follow up meeting especially regarding the site tour.

A. Ashourvan, post-doctoral researcher studying edge main-ion rotation, and T. Stoltzfus-Dueck are considering a refinement to the intrinsic rotation model by Stoltzfus-Dueck by incorporating the passing versus trapped fraction of particles near the plasma boundary. The theory relies on passing particles interacting with spatially varying turbulence, and has been shown to capture the physics of the X-pont radius dependence of intrinsic rotation on TCV. When applying the model to DIII-D, we find a general over-prediction of the velocity. However, when the magnitude of the rotation is scaled by the passing fraction, much better agreement is obtained. Further considerations for how to include the passing and trapped populations are ongoing.

ADVANCED PROJECTS (H. NEILSON):

Fabrication of a pair of divertor scraper elements for Wendelstein 7-X (W7-X) continues to make good progress. With the receipt of machined graphite tiles from the supplier, MWI, Inc. of Rochester, New York, all parts have now been received. Fit-up trials and evaluation of critical features (e.g., first wall profile geometry) have been completed by PPPL, and the assemblies have been found to be within tolerance. Installation mockup components, which Max Planck Institute for Plasma Physics (IPP) staff will use to develop procedures for installing the equipment in W7-X, are ready to ship. It is expected that, after dis-assembly of the production units and cleaning and baking of the graphite tiles, all the remaining equipment will be shipped to IPP in September.

THEORY (A. BHATTACHARJEE):

M. Churchill attended the New York Scientific Data Summit 2016 in New York City. He presented a poster entitled "Analyzing Large Data Sets from the XGC1 Magnetic Fusion Simulations using Apache Spark." The abstract is as follows: Enabling data analysis and exploration on large scientific datasets is necessary to enable researchers to extract as much scientific understanding from the data as possible. This need is pressing for the big data sets generated from the magnetic fusion simulation code XGC1, which generates saved datasets of order 100TB per 24hour simulation, running on leadership class supercomputers such as Titan at OLCF. The Apache Spark project provides a framework with several tools useful for working with large datasets; distribution of large datasets across multiple compute nodes, machine learning and analytics library, and a simple Python interface. Exploratory tests on moderate sized (~1 TB) datasets were undertaken using Apache Spark installed on the Edison supercomputer at NERSC. Lessons learned will be presented, including working with scientific data files such as HDF5 and ADIOS, optimal Spark settings such as memory use per node and data partitions, and scalings for reading and operating on large datasets. Additionally, a Kmeans clustering technique was applied using Apache Spark and accompanying library Thunder to the XGC1 particle distribution functions data. Using this technique, similar regions of velocity space were discovered when strong turbulence in the plasma ("blobs") was present, indicating a similar generating mechanism for these features.

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