



The PPPL Highlights for the week ending June 19, 2015, are as follows:

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

An ITER Diagnostic Instrumentation and Control Workshop was held at ORNL on June 16-17. Attendees included personnel from ORNL, PPPL, IO, F4E, and several commercial vendors along with educational institutions participating remotely. Key topics discussed were IO I&C requirements along with the status and examples of past and current I&C projects. Future I&C workshops are planned in the coming year.

The beryllium window analysis was completed for the Core Imaging X-ray Spectrometer and uploaded to iDocs.

The compliant interface for ECE windows was modified to include flexible hose connection instead of bellows. Design variants were presented on EPP09 port integration meeting.

Detailed ITER port cell neutronics data have been difficult to acquire with appropriate accuracy. New analysis methods have been developed to acquire the nuclear results due to the addition or subtraction of ITER components. Initial results for the analysis are coming in and the evaluation looks promising for quick and accurate port cell analysis.

Evaluation boards are currently considering vendor bids for design support contracts for the ITER MSE diagnostic and the Upper Camera sensors and software.

NSTX (M. ONO):

NSTX-U is in the Upgrade Project outage in FY15.

A paper by M. Ono (PPPL) et al., entitled "Progress toward commissioning and plasma operation in NSTX-U" was published online in Nuclear Fusion 55, 73007 (2015) and is available at <http://stacks.iop.org/0029-5515/55/073007>. The National Spherical Torus Experiment-Upgrade (NSTX-U) is the most powerful spherical torus facility at PPPL, Princeton USA. The major mission of NSTX-U is to develop the physics basis for an ST-based Fusion Nuclear Science Facility (FNSF). The ST-based FNSF has the promise of achieving the high neutron fluence needed for reactor component testing with relatively modest tritium consumption. At the same time, the unique operating regimes of NSTX-U can contribute to several important issues in the physics of burning plasmas to optimize the performance of ITER. NSTX-U further aims to determine the attractiveness of the compact ST for addressing key research needs on the path

toward a fusion demonstration power plant (DEMO). The upgrade will nearly double the toroidal magnetic field B_T to 1 T at a major radius of $R_0 = 0.93$ m, plasma current I_p to 2 MA and neutral beam injection (NBI) heating power to 14 MW. The anticipated plasma performance enhancement is a quadrupling of the plasma-stored energy and near doubling of the plasma confinement time, which would result in a five–ten fold increase in the fusion performance parameter $n\tau T$. A much more tangential second NBI system, with two–three times higher current drive efficiency compared to the first NBI system, is installed to attain the 100% non-inductive operation needed for a compact FNSF design. With higher fields and heating powers, the NSTX-U plasma collisionality will be reduced by a factor of three–six to help explore the favorable trend in transport towards the low collisionality FNSF regime. The NSTX-U first plasma is planned for the summer of 2015, at which time the transition to plasma operations will occur.

The electronics rack for the Materials Analysis and Particle Probe (MAPP) has been moved to the NSTX-U Test Cell (NTC). Preparations are in progress to establish communications with the MAPP control computer in the D-Site Data Acquisition Room (DARM), using a "remote desktop" in the NSTX-U Control Room. The connectivity will then be checked between the DARM computer and the electronics rack in the NTC. Initial tack welding of the support brackets to the upper umbrella structure was completed for both Bay F and Bay K Lithium Evaporators (LITERs). Bakeout of the bellows will begin after the LITER probe drives are leak-checked. This will enable the insertion of the LITERs into the vacuum vessel to check their alignment relative to the upper divertor penetrations.

A new algorithm has been implemented in the tshare version of the code that describes feedback on the anomalous fast ion diffusivity in order to have the calculated neutron rate match the measured one within one TRANSP run. A description of this feature can be found in <https://docs.google.com/document/d/1jCAA0nNWscULvwRc2yXLdAqyh7I6DYONaK8ArzjEnlc/edit> or in the TRANSP Wiki <http://theorycodes.pppl.wikispaces.net/TRANSP> This feature will be made available in a soon to be released pshare version of TRANSP. This will be announced when it happens.

Recovery from an external arc fault at the Ohmic Heating (OH) coil terminals continued this past week. Drawings for upgrades to the new OH cooling tube supports are complete, and electrical insulation tests (Hi-Pots) of prototype supports were successful. Fabrication of the new OH ground clamp has been completed, and fit-ups are in progress. A review of the OH Coax connector was held this week. A pre-operational test procedure to document resistance measurements of TF flex bus assemblies has started. Low power laser alignments of the Multi-Pulse Thompson Scattering (MPTS) diagnostic flight paths continue to make good progress. The probe rack for the Purdue MAPP diagnostic has been installed on NSTX-U.

Access to the NSTX-U Test Cell is expected to be available this coming week. Access must be arranged through Work Permits approved by the D-Site shift supervisors.

ITER & TOKAMAKS (R. HAWRYLUK):

DIII-D (R. Nazikian):

In preparation of the 2015 physics campaign, the calibration for the charge-exchange recombination diagnostic on DIII-D has been completed with acquisition of tokamak data during beam injection into the vessel with a variety of neutral gasses. This calibration procedure uses deuterium, xenon, neon and helium gas to calibrate the CER system wavelength and instrumental response, as well as the in-vessel geometry from main-ion CER based on the Doppler shift and Stark splitting of the beam emission. New edge main-ion CER chords with eight measurement points are ready for diagnostic validation this year.

L. Cui, who was recently awarded her PhD from UCSD for work on turbulent transport, began her postdoctoral appointment with PPPL this week. She will be working jointly on DIII-D and EAST, conducting scenario modeling using TRANSP aimed at optimizing steady-state performance on the two devices.

The Helicon Team led by A. Nagy visited Stanford Linear Accelerator (SLAC) to discuss the transfer of a 1.2 MW Klystron, designed and build by SLAC, for powering of the DIII-D Helicon Antenna in the summer of 2016. The tour was very successful with walk downs of the Klystron, its high voltage transformer/rectifier, and associated control systems. Five SLAC engineers and physicists met with the DIII-D team to discuss lessons learned and operating scenarios based on their many year of experience with the equipment.

International (R. Hawryluk):

R. Hawryluk gave a presentation to the EUROfusion STAC about the recent assessment of JET's readiness for DT.

ADVANCED PROJECTS (H. NEILSON):

An article entitled "The tokamak density limit: A thermo-resistive disruption mechanism," by D. A. Gates, D.P. Brennan, L. Delgado-Aparicio, R. B. White has been published as a letter in Physics of Plasmas. The paper discusses new developments in modeling radiation driven islands that have now reached the state where a complete dynamic model of the growth mechanism has been developed. Major new developments include: 1) a semi-analytic model that shows the correct dynamics for the density limit island growth mechanism including the effects of island asymmetry, 2) a full numerical treatment of the mode growth using a modified version of the DEBS code (a cylindrical fully non-linear resistive-MHD code), and 3) a discussion of the effects of impurities on the radiation driven island threshold. These new developments bring the cylindrical theory to a mature state. The first development 1) is the subject of a more detailed paper authored by R. B. White, and items 2) and 3) will be covered in follow on papers authored by L. Delgado-Aparicio and D. P. Brennan respectively.

N. Pablant (PPPL) and S. Massidda (Auburn University) completed their working visit to Germany's Max Planck Institute for Plasma Physics, having successfully installed the majority of components for the U.S. X-ray imaging crystal spectrometer (XICS) diagnostic on the

Wendelstein 7-X (W7-X) stellarator. A complete test fit of the bellows and a mockup of the beryllium window (since the actual window is still in manufacture) was completed, which fully confirmed the positioning of the crystal camber. In addition to verifying the fitup, this also served as practice for in preparation for installing the actual window, which is much more delicate. The detector chamber was fully aligned through laser alignment; traditional measurements were trigonometrically verified against the 3D solid model to verify the final positioning. The final bellows was test-fitted to verify the detector chamber alignment, completing the test assembly of all components and verifying that all vacuum chamber components are aligned and can be installed as soon as the few outstanding parts are delivered. Finally, the crystal holder assembly and alignment was completed, and the assembly was installed within the crystal chamber. Staff also completed final metrology measurements of the as-built component positions and completed basic mdsplus integration.

THEORY (A. BHATTACHARJEE):

On June 15, Davide Curreli (University of Illinois Urbana-Champaign) presented a theory seminar on 6D particle simulations of ion kinetics at the plasma material interface in oblique magnetic fields: In the edge region of magnetically-confined plasmas the interaction of plasma and material surfaces poses significant challenges to the survivability of plasma-facing components, currently limiting the successful development of commercially-viable nuclear fusion reactors. In this seminar, we discussed the computational challenges of modeling the plasma-material interface. Establishing an adequate model for the prediction of the plasma fluxes is necessary for a more accurate representation of the incident particle spectrum across the material interface. We also discussed the ion energy distributions and ion angular distributions at the material wall of a magnetized plasma; calculations have been done using different techniques (fluid-Monte Carlo and 6D Particle-in-Cells), giving insights on the plasma behavior from the quasi-neutral region up to the material boundary, and across the magnetic presheath where the ions become supersonic. The energy-angle distributions strongly affect the material response, comprising secondary electron emission and material sputtering.

On June 18, Bruce Scott (Max Planck Institute for Plasma Physics) presented a theory seminar on gyrokinetic field theory as a gauge transform, or gyrokinetic theory without Lie transforms: Gyrokinetic theory is a basis for treating magnetized plasma dynamics slower than particle gyrofrequencies where the scale of the background is larger than relevant gyroradii. The energy of field perturbations can be comparable to the thermal energy but smaller than the energy of the background magnetic field. Properly applied, it is a low-frequency gauge transform rather than a treatment of particle orbits, and more a representation in terms of gyrocenters rather than particles than an approximation. By making all transformations and approximations in the field/particle Lagrangian one preserves exact energetic consistency so that time symmetry ensures energy conservation and spatial axisymmetry ensures toroidal angular momentum conservation. This method draws on earlier experience with drift kinetic models while showing the independence of gyrokinetic representation from particularities of Lie transforms or specific ordering limits, and that the essentials of low-frequency magnetohydrodynamics, including the equilibrium, are recovered. It gives a useful basis for total-f electromagnetic gyrokinetic computation. Various versions of the representation based upon choice of parallel velocity space coordinate are illustrated.

ENGINEERING AND INFRASTRUCTURE (M. WILLIAMS):

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

Construction: Resistance measurements of TF bus assemblies removed from the machine were tested and found to be satisfactory. Work continues on the additional gas delivery lines and gas injection assemblies on the machine. Terminations for the GDS system in the gallery are near completion. Diverter water lines were successfully hi-potted. Hydro testing and heating of the lines continues and will be followed by an additional hi-pot test. The OH upper ground clamp was successfully test fitted and final assembly of the braid and wire lead is underway. Silver-plating of TF bus connections and the upper bundle surfaces continues. Liter probes at bays K and F top were successfully aligned and the new supports tacked in place. The probes were removed from the machine and the final welding is underway. The MPTS camera system electrical work is near completion.

CS: Design review of the OH coax connector and lower OH ground plane connection. Upper OH ground clamp braid was installed. WAF review of the OH water heater installation was held. H. Schneider held a review of the early test data of the TF lead extension joints. All data taken so far appears to indicate nominal resistance value. A plan was developed for the sequence of installation of the flexes that will allow voltage drop testing of the joints while injecting a current of 200 amps.

NBI: An ion source removal and replacement for N2C started this week. The source that failed was removed and moved to the Source Shop for troubleshooting and repair. The spare source installation on N2C was started but curtailed when an interference was discovered. The job was halted and the unit was taken back to the Source Shop to repair a water fitting and hydrostatic testing. The installation will be re-scheduled for next week. BL1 roughing line and connections were completed and leak checked. BL1 was pumped down to high vacuum and is on its turbomolecular pump. Thermocouple troubleshooting and repair took place this week on BL1, BL2, and the VV armor.

DCPS/PCS: Dummy Load Testing of rectifiers resumed this week. DCPS startup procedure OP-DCPS-779 was performed in support. A problem with a downstream server for PCS was discovered; communication and data transfer was moved to another server but transfer timing was very slow. Testing was halted while IT addresses the situation. DCPS was unaffected.

Engineering (L. Dudek, D. Loesser):

The new Instron cyclic test machine is being delivered on June 19. The RFQ for the FLARE vacuum vessel has been issued.

Project Management Office (T. Stevenson):

Work continues on Conduct of Operations procedure reviews. A draft training deck has been developed and is in review also. The Work Planning and Control system was presented to the Lithium Safety Review committee this week. COG/RLM training development continues and has moved on to the narration for the online package. Several WAF reviews have been held

recently. A System Engineer list revision is in progress. The PMO chaired more reviews for OH recovery.

Facilities and Site Services (M. Viola):

Engineering Services: A Final Design Review was held to review the design of the C-Site Motor Generator concrete demolition and associated support work. A final design review was performed for installation of temporary enclosure walls surrounding existing electrical equipment within the C-Site Motor Generator Building. These walls will serve as temporary barriers to protect the equipment from dust and debris during demolition of the concrete motor generator foundations. A draft condition assessment report has been generated for the pedestrian walkway connecting the Lyman Spitzer Building and L-Wing. The Princeton Technical Representative for the furniture contract received proposals from two furniture manufacturers (Haworth and Teknion) in connection with the PPPL modernization. These proposals represent typical workstation configurations and include itemized pricing. In response to Audit 1503 Lockout-Tagout Corrective Action item 2.1, four Facilities Procedures were revised and issued: EFMS-001 Boiler Startup, EFMS-002 Steam System Startup, EFMS-003 Steam System Shutdown and EFMS-004 Boiler Shutdown. Closeout of this corrective action item has been requested.

Fire Protection: The Fire Protection engineer participated in the Lithium External Review and met with HDR to discuss the IOI requirements for fire systems in the buildings being renovated.

Program Management: The June monthly status report on the Building Hazard Assessment (BHA) Initiative was submitted to DOE/ PSO. The following items were completed in advance of the Facilities Information Management System (FIMS) data validation. Building identification signs were ordered and should arrive the week of June 22. A work order has been submitted to install these signs on all PPPL buildings and real property trailers. Several FIMS source documents were received from the DOE Princeton Site Office and from PPPL Subject Matter Experts. Following discussion with Environmental Services, the LEC Tank FIMS Usage Code was changed from 4500 (Storage Shed) to 4521 (Tanks - Sewage). Efforts to update the facility drawings (AD-300 series) continue with the active support of Drafting. The ESAT, C-Site MG Building, Annex, Pump House and Engineering Wing drawings were completed and are ready for internal review.

Material Services: Stockroom inventories were completed for electrical and electronic commodities with excellent results. Two detectors were returned from Japan and taken off Loan Agreement P12-06. One detector was shipped to a PPPL employee in Germany and the other detector was returned to PPPL this week. Collaboration C15-04 with General Atomics was approved. FY15 Controlled/ Accountable Statistical Sampling Inventory is complete with a 100% find rate.

Maintenance Services: Work continues in the B116 Office Suite (Rooms B116, B116A and B119). Staff finished demolition work to renew the area for new occupants and began correcting deficiencies that have been identified. Staff continues to fill in with renewal activities related to the five (5) additional office moves requested by the IT Division. Staff successfully completed the replacement of the gear drive in cell 2 of the D-Site Cooling Tower. We will shutdown and inspect the unit after this brief break-in period to ensure everything is satisfactory. We are

working with Procurement to expedite inspection and repair of the damaged gear drive to ensure we have a spare on-site during the critical summer months. Maintenance staff continues to make progress on various repairs related to Building Hazard Assessments (BHAs) including sealing holes and penetrations in fire barriers, sprinkler head repairs and replacements. Staff continues working on June annual and monthly PMs (including HVAC, Fire and Life Safety). Annual steam maintenance activities in the central plant continue. Procurement has solicited responses for a new boiler maintenance contract and responses are due June 26. Energy staff continues with preparations for the annual Facilities Information Management System (FIMS) validation activities scheduled for June. A contractor has been selected to repair six (6) storm drains around the Laboratory including: two in the D-Site Lot, one in the Facilities Lot, two in the RESA roadway and one in the Warehouse Courtyard. A contractor has been selected to remove the copper flooring and related asbestos materials for the Low Temperature Plasma Laboratory (LTPL) area.

BUSINESS OPERATIONS (K. FISCHER):

The Accounting Division has almost completed the testing phase of the Department of Energy (DOE) mandated Office of Management and Budget (OMB) Circular A-123 reporting requirements. PPPL's evaluation includes testing the design and operating effectiveness of each control in the processes identified by DOE.

A. White (PPPL Small Business Liaison) attended the DOE Annual Small Business Forum and Exposition. This event offers opportunities to network with colleagues to share experiences, challenges, and success as well as to share and learn Best Practices.

The first phase of the Business System Upgrade Project (BSUP) continued with Huron Consulting shadowing users of the current business system in order to better understand the requirements that a new system will have to meet and the current business process flow. The goal of this phase of the project is to determine how well the delivered PeopleSoft 9.2 product fits with the Laboratory requirements and also to determine the current business processes that will drive system modifications or re-engineering.

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

An External Peer Review of the Lithium Safety Program took place on June 16-18. This included interviews by the team, presentations, and visits to various locations to evaluate the overall safety for lithium use. The review team found the lithium safety program to be adequate and appropriate at the current scale of lithium activities. While staff appears to have the expertise and access to additional expertise to plan for safely scaling up lithium operations, the team found that scaling up operations for plans beyond the next 5-10 years would require significant upgrades. This external review addresses the notable outcome in section 5 of the PEMP.

Hazardous awareness training was provided to the SULI/CCI students on June 19.

OFFICE OF COMMUNICATIONS (C. CANE):

J. Greenwald issued a news release about PPPL participation in a study that correlated two autoimmune diseases with the solar cycle, and worked with R. Rosen on a news release about an enhanced new model of the source of the density limit in tokamaks. The DOE Office of Science posted the solar cycle release on its homepage. Greenwald also attended an American Security Project event on breakthroughs in fusion technology.

E. Starkman did photography shoots for the following events: an ice cream party for Summer students, the Lithium Review, a tour for Princeton University's Office of Audit and Compliance, Princeton's lunch tour, the Engineering picnic and car show, L. Apericio-Delgado at main campus for the HISPA program, undergraduate students participating in Laboratory activities, ITER speaker colloquium, ITPA conference group photo, picnic lunch for participants of Federal Bike Week, and created photo galleries for Science Education, the PPPL Weekly and slideshow.

R. Rosen hosted a tour given by L. Ellison for eleven members of the FSML History Club on June 16. The group viewed the PPPL and PhD Comic videos, and visited the Control Room, QUASAR, and Science Education.

J.J. DeVoe hosted a tour given by E. Gilson for 19 students and teachers from the Mercer County Technical School. They viewed the Star Power and PhD videos and visited the NST-U Control Room, QUASAR and Science Education.

J.J. DeVoe hosted a tour for 19 people for an open public tour on June 19 given by S. Greco. The group viewed the PPPL and Star Power videos and visited the NSTX-U Control Room, QUASAR, and the Science Education Laboratory.

J.J. DeVoe & K. Palmer, with the help of J. Greenwald, put together the June 22 Weekly, with a story by J. Greenwald on research on the possible connection between rheumatoid arthritis and solar cycles and a profile of S. Zelick by J.J. DeVoe, as well as photos by E. Starkman.

BEST PRACTICES, EXTERNAL AFFAIRS, & SITE PROTECTION (J. DELOOPER):

Site Protection Division (F. White):

Engine 66 responded to LSB Second Floor East for a water leak, Carpenter Shop First Floor for a Duct Detector Activation alarm and to a D-Site freight elevator to assist a PPPL employee. Emergency Services cleared the elevator without incident.

Ambulance A166 responded to the Nano Laboratory and transported an employee to University Medical Center Princeton Plainsboro for evaluation.

Engine 66 responded to Princeton for one mutual aid assignment.

Site Protection Division staff participated in Lithium Review meetings this week.

A member of Site Protection Division participated in the PPPL IOI Design Review meeting.

DIRECTOR'S OFFICE (C. AUSTIN):

On June 17, a colloquium entitled, "Comets and the Origin and Evolution of the Solar System", was presented by Professor David Jewitt from the University of California - Los Angeles.

On June 17, A. Cohen hosted a tour of PPPL for Nilufer Shroff - Chief Audit and Compliance Officer, and eleven staffers from Princeton University's Office of Audit and Compliance.

M. Zarnstorff attended a meeting of the Chief Research Officers for the DOE National Laboratories in Washington, DC on June 15-16.

PUBLICATIONS:

Ono, M; et al., "Progress Toward Commissioning And Plasma Operation In NSTX-U," Nuclear Fusion 55, 73007 (2015); <http://stacks.iop.org/0029-5515/55/073007>

Gates, D.A.; Brennan, D.P.; Delgado-Aparicio, L.; White, R.B., "The Tokamak Density Limit: A Thermo-Resistive Disruption Mechanism," Physics of Plasmas 22, 060701 (2015); <http://dx.doi.org/10.1063/1.4922472>

This report is also available on the following web site:

<https://sites.google.com/a/pppl.gov/pppl-weekly-highlights/>