

Weekly

HIGHLIGHTS



The PPPL Highlights for the week ending October 21, 2016 are as follows:

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

Steady State Electric Network (SSEN):

Uninterruptible Power Supply (UPS) and DC Distribution; Kickoff meeting for both contracts was held on October 18, with participation of the supplier's project teams (Schneider/Gutor) from the USA and Switzerland.

Arrangement for the Transfer of the Battery Banks and LV Distribution Panels to the IO for Procurement; Comments have been received from the IO legal team and discussions are underway to resolve the issues.

Power Transformers; Planning, logistics and shipping documents for the shipment of the Group 1 and 2 transformers from the Schneider Electric factory near Istanbul, Turkey have been received. French customs approval is in process.

Reactive Power Compensators; Factory acceptance testing for the first two lots of RPC units was held in Pringy, France from October 19 – 22.

Diagnostics:

Ned Sauthoff and Graeme Murdoch from the US ITER project in Oak Ridge visited PPPL this week. The purpose of the visit was to discuss high level project management issues with PPPL management and with the US ITER diagnostics and port plug engineering team.

Electron Cyclotron Emission (ECE): Early this week we completed testing of the encapsulated molybdenum heater mockup in the prototype hot calibration source assembly. The molybdenum filament heater was used to heat the 30 degree grooved molybdenum sample which in turn heated the SiC emitter. During the last test (# 158) the SiC emitter temperature was initially heated to 770 C for over 40 hours then the temperature was reduced to 715 C where it remained stable for over 3 days with less than 0.5 degree variation. The UT ECE team also provided a detailed CAD model of the latest hot calibration source to PPPL, which is needed for neutron shielding calculations.

Equatorial Port 9 Integration and DSM Engineering; The port plug engineering team is working hard to minimize the weight of Equatorial Port 9 below 45 metric tons while satisfying structural and nuclear shielding requirements. Equatorial port 9 assembly weight is currently in the range

of 45.8 - 48.7 mT. This range is defined by a lightened vs. unmodified generic port plug structure. It is important to note that DSM1 weight (excluding DFW) is assumed IO generic and estimated at 7.5 mT. The Preliminary Design Review "Hold Point 1" neutronics assessment will be based on this model.

Toroidal Interferometer and Polarimeter (TIP); Scoping analysis of the TIP cooled mirror, including mounts and water-cooled base, indicate that the mounting scheme will be robust against disruption-induced load conditions.

Diagnostic I&C Integration Engineering (ORNL, Bill DeVan); A US-ITER Diagnostics Workshop was held at General Atomics on October 18-20. The meeting was very informative and useful and we feel it was a very successful event. Another meeting is considered in the February 2017 timeframe. A key topic of this meeting was to obtain a better understanding of what specific level of detail is required in the I&C area in order to successfully pass both the PDR and FDR, and what are the key differences between the two. Another important topic was a discussion on the obsolescence of components, modules and the management of obsolete technologies. The team talked through ways to utilize stable interfaces between modules early in the design process to enable technological upgrades path that have a minimal impact on the overall design. Additional topics including updates on I&C building integration and the use of "shielded corners", project wide use of National Instruments hardware and software that is in compliance with ITER standards and linking the US ITER diagnostics in to the ITER Plasma Control System. The team agreed that the next I&C workshop should be modeled as a Value Engineering meeting across the seven diagnostic systems.

NSTX-U (M. ONO):

NSTX-U is in the maintenance and repair outage in FY 2017

The IAEA Fusion Energy Conference was held October 16-22 at the Kyoto International Conference Center in Kyoto, Japan. A total of 29 talks and posters were presented by NSTX-U associated researchers including: OV/5-2 - J. Menard (PPPL), "Overview of First Results from NSTX-U and Analysis Highlights from NSTX", TH/P1-2 - F. Ebrahimi (Princeton University), "Physics of Flux Closure during Plasmoid-Mediated Reconnection in Coaxial Helicity Injection", TH/P1-6 - J.-K. Park (PPPL), "Self-Consistent Optimization of Neoclassical Toroidal Torque with Anisotropic Perturbed Equilibrium in Tokamaks", TH/P1-7 - S. C. Jardin (PPPL), "Nonlinear 3D M3D-C1 Simulations of Tokamak Plasmas Crossing a MHD Linear Stability Boundary", TH/P1-10 - A. Fil (Princeton University), "Modelling and Simulation of Pedestal Control Techniques for NSTX-U", TH/P1-21 - Z. R. Wang (PPPL), "Nyquist Analysis of Kinetic Effects on the Plasma Response in NSTX and DIII-D Experiments", FIP/2-5 - M. Ono (PPPL), "Liquid Lithium Loop System to Solve Challenging Technology Issues for Fusion Power Plant", EX/P3-30 - V. Soukhanovskii (LLNL), "Snowflake Divertor Configuration Effects on Pedestal Stability and Edge Localized Modes in NSTX and DIII-D", TH/P3-14 - W. Guttenfelder (PPPL), "Analysis and Prediction of Momentum Transport in Spherical Tokamaks", EX/P4-30- J.-W. Ahn (ORNL) "Shielding and Amplification of Nonaxisymmetric Divertor Heat Flux by Plasma Response to Applied 3D Fields in NSTX and KSTAR", EX/P4-33 - S. A. Sabbagh (Columbia University), "Isolation of Neoclassical Toroidal Viscosity Profile under Varied Plasma and 3D Field Conditions in Low and Medium Aspect Ratio Tokamaks", EX/P4-34 - J.W. Berkery

(Columbia University), “Characterization and Forecasting of Unstable Resistive Wall Modes in NSTX and NSTX-U”, EX/P4-35 - Y. Ren, (PPPL) “Exploring the Regime of Validity of Global Gyrokinetic Simulations with Spherical Tokamak Plasmas”, EX/P4-36 - F. Scotti (LLNL), “Kinetic Profiles and Impurity Transport Response to 3D-Field Triggered ELMs in NSTX”, EX/P4-38 - R. Maingi (PPPL). “Comparison of Helium Glow and Lithium Evaporation Wall Conditioning Techniques in Achieving High Performance H-Mode Discharges in NSTX”, EX/P4-40 - D. Smith (University of Wisconsin), “Identification of Characteristic ELM Evolution Patterns with Alfvén-Scale Measurements and Unsupervised Machine Learning Analysis”, EX/P4-41 - E. Fredrickson (PPPL), “Parametric Dependence of EPMs in NSTX”, EX/P4-42 - R. Perkins (PPPL), “Large RF Field Amplitudes in the SOL and Far-Field RF Sheaths: A Proposed Mechanism for the Anomalous Loss of RF Power to the SOL of NSTX”, EX/P4-43 - M. D. Boyer (PPPL), “Feedback Control Design for Noninductively Sustained Scenarios in NSTX-U Using TRANSP”, TH/P4-16 - G. Fu (PPPL), “Hybrid Simulations of Beam-Driven Fishbone and TAEs in NSTX”, TH/P4-17 - E. Belova (PPPL), “Coupling of Neutral-Beam-Driven Compressional Alfvén Eigenmodes to Kinetic Alfvén Waves in NSTX and Energy Channelling”, EX/5-3 - A. Diallo (PPPL), “Energy Exchange Dynamics across L-H Transitions in NSTX”, MPT/P5-30 - M. A. Jaworski (PPPL), “High-Temperature, Liquid Metal Plasma-Facing Component Research and Development for the NSTX-U”, EX/P6-46 - C. Myers (PPPL), “A Multimachine Analysis of Non-axisymmetric and Rotating Halo Currents”, TH/P6-12 - J. Lore (ORNL), “Pedestal-to-Wall 3D Fluid Transport Simulations on DIII-D and NSTX”, FIP/P7-1 - T. Brown (PPPL), “Development of a 3 m HTS FNSF Device and the Qualifying Design and Engineering R&D Needed to Meet the Low AR Design Point”, FIP/P7-36 - R. Lunsford (PPPL), “ELM Pacing with High Frequency Multispecies Impurity Granule Injection in NSTX-U H-Mode Discharges”, FIP/P7-42 - R. Raman (University of Washington), “NSTX-U Contributions to Disruption Mitigation Studies in Support of ITER”, and a post deadline paper - N. Gorelenkov, “Suppression of Alfvén modes through additional beam heating.”

At the IAEA Fusion Energy Conference in Kyoto Japan, Rob Goldston (PPPL) received the 2015 Nuclear Fusion Journal award for his 2011 paper on the Heuristic Drift model for the power scrape-off width in H-mode tokamaks. IAEA Direction General Yukiya Amano made the award. The Editorial Board of Nuclear Fusion cited the paper as, “Potentially one of the most important results obtained in recent years in fusion” research. The model “provides a simple yet elegant model for the scrape-off layer power width,” the editors said, “and ultimately could have significant impact on the future direction of the field.” At a separate ceremony, Goldston thanked the many members of the Edge Physics research community who welcomed him and contributed to his understanding of this area of fusion physics, when he decided to focus his research on this area after stepping down from the PPPL directorship in 2009.

Preparations for the removal of the NSTX-U Center-stack continued this past week. The center-stack stand has been readied and bolted in place in the high bay area adjacent to the test cell, and the procedure for the center-stack removal has been reviewed and approved. In-vessel clean-up and wipe-downs are in progress as the sequence to remove the center-stack proceeds. Also, in-vessel metrology for the upper diverter is in progress. The dissection and forensics of the damaged PF1aU coil continued with the completion of the vertical cuts, and coil sections are now being removed from the mandrel for borescope inspections. Work continued on the recommissioning of the coil winding facility this week with testing of the oven and the coil conductor tensioning fixture. The PF1a VPI mold has been moved into the coil winding facility and checked. A test stand is being prepared in the Field Coil Power Conversion building with the

required power, cooling water, and instrumentation systems needed for individual coil power testing.

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ITER & TOKAMAKS (R. HAWRYLUK):

Dr. Mitsuru Kikuchi, chair of the Nuclear Fusion Board of Editors, announced the end of his term and that R. Hawryluk will be the next chair of the Nuclear Fusion Board of Editors.

DIII-D (R. Nazikian):

The following DIII-D presentations were given at the IAEA FEC in Kyoto, Japan by PPPL research staff:

Alessandro Bortolon, Effectiveness of High-Frequency ELM Pacing with D2 and Nonfuel Pellets in DIII-D (Oral). B.A. Grierson, Validation of Theoretical Models of Intrinsic Torque in DIII-D and Projection to ITER by Dimensionless Scaling (Oral). R.M. Nazikian, First Observation of ELM Suppression in ASDEX Upgrade in a Shape Matching Experiment with DIII-D (Post-Deadline, Oral). M. Okabayashi, Physics of Unlocked Tearing Modes and Disruption Avoidance by Feedback-based Electromagnetic Torque Injection
E. Kolemen Adaptive Real-Time Pedestal Control for DIII-D and Prospects for ITER
W.X. Wang, Understanding and Predicting Profile Structure and Parametric Scaling of Intrinsic Rotation. G.J. Kramer, Improving Fast-ion Confinement in High-Performance Discharges by Suppressing Alfvén Eigenmodes. R.M. Churchill, Kinetic Understanding of Scrape Off Layer Physics, Comparison with Fluid Modeling, and Experimental Validation.

The DIII-D off-axis 210 beam engineering team (with A. Nagy as the lead engineer) is in their 5th month of design work with approximately 8-10 design reviews completed at the PDR level. The off-axis beam foundation, vessel interface, carriage, cryo system, pole shields, calorimeters, collimator, and pit interface design issues have been resolved.

This week a successful absolute collimator requirements review was held with PPPL engineers, who will build this collimator. Also a successful cryo system PDR was held outlining the vacuum jacketed cryogenics connection. The aim is to have most of the parts in house for the scheduled start of the installation in August 2017.

C-Mod: (L. Delgado-Aparicio):

Luis Delgado-Aparicio gave a presentation at the FEC meeting on: “Locked mode avoidance and recovery without external momentum input using ICRF” at the IAEA meeting.

ITER: (F. Poli):

Francesca Poli gave a presentation at the FEC meeting on: “Electron Cyclotron power management in ITER, the path from the commissioning phase to demonstration discharges”.

ADVANCED PROJECTS (H. NEILSON):

The Fusion Energy Systems Studies team discussed their technical decisions for the FNSF on a recent conference call, as part of documenting the many choices made in the process of the project. These choices were driven by recent experimental databases (e.g. lower radiation limits on magnets), relevance to power plants (e.g. exclusion of water cooling), credibility of the development for a technology (e.g. choice of advanced low temperature super-conductors), clear advantages of a design, or as a placeholder to address a function, but where data and/or design is lacking (e.g. a thin tungsten coating on the first wall). A wide range of physics assumptions for the plasma were also discussed weighting the impact of targeting ultra-long pulses (e.g. operating around the no wall beta limit), being power plant relevant (e.g. operating near the Greenwald limit), integration into the facility (e.g. examining radiating divertors like ITER and fully detached), and providing the performance required for the device's nuclear mission. Documentation of the FNSF study is continuing and will be reported in papers submitted to the journal Fusion Engineering and Design.

The department's work was represented in several papers at the IAEA Fusion Energy Conference, held 17-22 October in Kyoto, Japan. Research in collaboration with the Wendelstein 7-X team was reported in “Investigation of initial plasma parameters on the Wendelstein 7-X stellarator using the x-ray imaging crystal spectrometer,” by N. Pablant, et al. and in “Error field measurement, correction, and heat flux balancing on Wendelstein 7-X,” by S. Lazerson et al. Progress in stellarator design was reported in “Recent Advances in Stellarator Optimization,” by D. Gates, et al. Finally, reactor physics and engineering analysis work in collaboration with S. Korea's National Fusion Research Institute was reported in “Progress in K-DEMO Heating/Current Drive and Tokamak Configuration Development,” by G. Neilson, et al.

THEORY (A. BHATTACHARJEE):

Many members of the Theory Department attended the IAEA Fusion Energy Conference held in Kyoto, Japan.

Dr. C.S. Chang presented an invited talk “Gyrokinetic Projection of the Divertor Heat-flux Width from Present Tokamaks to ITER”, and Dr. S. Hudson presented an invited talk title “Penetration and Amplification of Resonant Perturbations in 3D Ideal-MHD Equilibria”.

Dr. S. Jardin presented a poster “Nonlinear 3D M3D-C1 Simulations of Tokamak Plasmas Crossing a MHD Linear Stability Boundary”, with co-authors N. M. Ferraro, J. Breslau, J. Chen, S. Hudson, I. Krebs and D. Pfefferle. Dr. B. Tang presented a poster “Big Data Machine Learning for Disruption Predictions W. Tang”.

Dr. F. Ebrahimi presented a poster “Physics of Flux Closure during Plasmoid-Mediated Reconnection in Coaxial Helicity Injection”. Dr. A. Reiman presented a poster “Pressure Driven Currents Near Magnetic Islands in 3D MHD Equilibria: Effects of Pressure Variation within

Flux Surfaces and of Symmetry”. Dr. D. Brennan presented a poster “Collisional Generation of Runaway Electron Seed Distributions Leading to Subcriticality, Avalanche, or Fast Transfer”, with co-authors , E. Hirvijoki, C. Liu and A. Bhattacharjee. Dr. R. Hager presented a poster “A New Understanding of the Bootstrap Current in Steep Edge Pedestal and its Effect on the Pedestal Stability”, with C.S. Chang. Dr. W.W. Wang presented a poster “Understanding and Predicting Profile Structure and Parametric Scaling of Intrinsic Rotation”. Dr. G-Y. Fu presented a poster “Hybrid Simulations of Beam-Driven Fishbone and TAEs in NSTX”. Dr. E. Belova presented a poster “Coupling of Neutral-Beam-Driven Compressional Alfvén Eigenmodes to Kinetic Alfvén Waves in NSTX and Energy Channelling”. Dr. A. Hakim presented a poster “Scrape-Off-Layer Turbulence in Tokamaks Simulated with a Continuum Gyrokinetic Code”. Dr. D. Stotler presented a poster “Neutral Recycling Effect on Edge ITG Turbulence and Transport”. Dr. R. Churchill presented a poster “Kinetic Understanding of Neoclassical Scrape-Off Layer Physics, Comparison with Fluid Modelling, and Experimental Validation”. Dr. S-H. Ku presented a poster “Understanding the Blobby Turbulence in Edge Plasma from Gyrokinetic Simulation” with R. Churchill and C.-S. Chang.

Dr. N. Ferraro was a co-author on the invited talk presented by X. Chen titled “Bifurcation of Quiescent H-Mode to a Wide Pedestal Regime in DIII-D and Advances in the Understanding of Edge Harmonic Oscillations”. He was also a co-author on the poster presentation “Toroidally Localized Turbulence with Applied 3D Fields in the DIII-D Tokamak” given by R. S. Wilcox, and also the poster presentation “Validating Extended MHD Models of Plasma Response against Measurements of Islands in DIII-D” presented by M. Shafer, and on the poster presentation “The Contribution of Perturbation Coil Geometry Induced Sidebands and MHD Response in KSTAR and DIII-D” by D. Orlov, and on the poster “Pedestal-to-Wall 3D Fluid Transport Simulations on DIII-D and NSTX” by J. Lore. Dr. R. White was a co-author on the oral presentation “Critical Gradient Behaviour of Fast-Ion Transport from Alfvén Eigenmodes Guides Predictive Models for Burning Plasmas” given by C. Collins. Dr. N. Gorelenkov was a co-author on the poster presentation “Electron Cyclotron Heating Modification of Alfvén Eigenmode Activity in DIII-D” given by M. A. Van Zeeland. Dr. S. Jardin was a co-author on the poster presentation “Investigation of MHD Stability in KSTAR High- β_N Plasmas” given by Y.-S. Park, and on the poster presentation by “Validation of $q_0 > 1.0$ in the MHD Quiescent Time after Crash of the Sawtooth Instability in KSTAR” by H. Park, and on the poster presentation “Study of Nonlinear Phase of the ELMs by Comparison between ECEI ELM Observation and Nonlinear MHD Simulations” given by M. Kim, and on the poster presentation “Plasma Disruption and VDE Modelling in Support of ITER” given by I. Bandyopadhyay, and on the poster presentation “NSTX-U Contributions to Disruption Mitigation Studies in Support of ITER” by R. Raman. Dr. D. Stotler was a co-author on the poster “Investigation of Neutral Particle Dynamics in ADITYA Tokamak Plasma with DEGAS2 Code” presented by R. Dey.

COMPUTATIONAL PLASMA PHYSICS GROUP (S. JARDIN):

Eliot Feibush presented Python Programming Techniques in a Mini-course sponsored by PICSciE, the Princeton Institute for Computational Science and Engineering. The presentation on October 19 emphasized the elements of the Python language and how to continue learning Python. Attendees completed several hands-on programming exercises. Teaching assistants were Shaantam Chawla, Mollie Bakal, and Angad Singh.

Feibush presented a lecture on Visualization Tools and Techniques as part of Princeton University course APC 524 organized by Professor J. Stone. The presentation on October 20 covered visualizing multi-dimensional data with Python numpy and matplotlib. Data selection using operators was shown in specialized visualization programs, VisIt and ParaView, based on the Visualization Toolkit. Students are encouraged to incorporate visualization into their computational science class projects.

BUSINESS OPERATIONS (K. FISCHER):

Accounting Division issued a Key Performance Indicator for “Timely Payment of Invoices” for FY2016, the year-to-date invoice payment timeliness was within prescribed time goal of 95%. Additionally, an increase in invoice payment timeliness was observed in the fourth quarter of FY2016.

Accounting submitted PPPL's International Transaction Report for the fourth quarter of FY2016 to the Department of Energy. The report covers receipts and payments from/to foreign countries for supplies, materials, equipment, services, and travel. Department of Energy forwards this data to the Department of Commerce.

The Procurement Division underwent a PERT CAP Effectiveness Review performed by procurement directors and managers from Ames, Fermi, and Argonne. The review was organized by J. Graham of Best Practices and Quality Assurance. The purpose of the review was to validate that corrective actions were implemented as intended, and to assess the overall impact and potential sustainability of the CAP that was implemented as a result of the FY15 PERT.

The review team reported generally strong, positive comments. It was noted that the hiring of the new Procurement Director was a strategic hire, and feedback from technical, procurement, and PSO staff was positive regarding the direction of the procurement division. The team also noted that the CAP was nearly complete in accordance with a very aggressive schedule. The team commented that the significant relevant training provided to procurement staff, along with the re-implementation of the procurement liaison program was successful. Communications have improved through the procurement liaison program and with the regular reporting of procurement KPIs.

Regarding sustainability of CAP improvements, the team recommended refresher training in specific areas, ongoing improvements in procurement cycle time, and communication of lessons learned to staff. Overall, the team concluded that the CAP has been very effective for the division and PPPL. The Procurement Division must maintain vigor on putting the implementations into practice, and focusing on continuous process improvements and staff development to assure sustainability of the CAP.

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

A management safety walkthrough of the D-Site Grounds (including the Liquid Effluent Collection Tank Area and Radioactive Waste Handling Facility) and the Cooling Tower Pump Houses was conducted on October 19.

Material Services recycled 2,070 pounds of electronics and 10,280 pounds of scrap metal during the past week.

COMMUNICATIONS & MEDIA RELATIONS (L. BERNARD):

J.J. DeVoe arranged the following tours: A tour hosted by DeVoe and given by R. Ellis, N. Atnafu and R. Camp for 12 members of the Greater Trenton ASME on October 19. After being greeted by T. Brog, the group viewed the PPPL and PhD videos, and visited the NSTX-U Control Room and the NSTX-U test cell; a public tour on October 21 for 20 people hosted by R. Rosen and given by D. Battaglia. The group viewed the PPPL and PhD videos and visited the model stellarator, the NSTX-U Control Room and the NSTX-U test cell. DeVoe distributed a press release on the Boy Scout Science & Technology Fair to local and regional media on October 18. DeVoe and Rosen attended a Research Spin Meeting on podcasting at the Princeton University School of Engineering and Applied Science on October 19. DeVoe, K. Palmer, and L. Bernard prepared the PPPL Weekly with a story by R. Rosen on the DOE Exascale Computing Project and a story by DeVoe on the IOI project getting CD-3 approval; photos of fire safety demonstrations by E. Starkman; and photos of freshman family tours by Starkman and Rosen, along with a photo of the Greater Trenton ASME tour by R. Ellis. L. Bernard participated in the DOE Public Affairs and Lab Communicators monthly telecon with DOE HQ on October 18. Bernard and C. Cane also participated in the first of the season DOE Office of Science Communications and Public Affairs Learn@Lunch discussions about the science of science communications and public understanding of basic research. J. Besley, Associate Professor and Ell N. Brandt Chair in Public Relations, Michigan State University, spoke about “Science Literacy: Implications for Public Support of Research.”

BEST PRACTICES & EXTERNAL AFFAIRS (J. DELOOPER):

Site Protection Division (F. White):

The Emergency Services Unit (ESU) responded to an activated smoke detector on the 3rd Floor of the RF building, a fire alarm in FCPC at D-Site, a smoke detector activation in the Lab Building and an activated alarm system at the High Performance Computing Resource Center (HPCRC) on Forrestal B-Site. All incidents were cleared.

Engine 66 responded to Princeton for one mutual aid assignment and to Plainsboro for two mutual aid assignments.

Ambulance 166 responded to Plainsboro for one mutual aid assignment.

Site Protection Division (SPD) conducted a de-briefing with the Emergency Management Review Committee (EMRC) to discuss drill observations and to begin determining all necessary after-action items resulting from the PPPL Emergency Exercise.

Members of SPD staff and ESU distributed 349 PPPL parking decals for the 2016-2018 calendar years.

SPD and ESU conducted a series of Duress Alarm testing in the LSB building.

Members of ESU hosted a Fire Prevention Week event at PPPL. Live activities included fire extinguisher and fire hose demonstrations and basic information concerning work and home fire prevention tips.

Members of ESU provided bike patrol Emergency Medical Services for the Eden Autism 5K and Fun-Run-Walk.

Members of ESU attended Modern Fire Behavior training.

ESU A-Platoon conducted Drafting Operations with Engine 66.

Officer Aaron Green completed the Chubb Institute Fire Sprinkler Training module.

DIRECTOR'S OFFICE (C. AUSTIN):

On October 19, Professor Itai Cohen, Cornell University, presented a colloquium entitled, "Flight of the Fruit Fly".

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