The PPPL Highlights for the week ending October 25, 2013, are as follows:

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

In a teleconference involving precision active spectroscopy experts from the IO, PPPL, Nova Photonics, JET, and General Atomics, capabilities were discussed for using MSE line shift measurements on JET and DIII-D to constrain equilibrium analysis in combination with, or in comparison with the use of conventional polarimetry measurements as a constraint. Proposals to move forward on both devices are being investigated.

RFP-13-082-F for Design and Fabrication of ITER Upper Visible/IR Wide Angle Viewing diagnostic was released.

RFP-13-081-G for ITER ECE Diagnostic Front-End and X-Mode Radiometer Physics and Engineering Design Support was released.

Feedback was provided to the IO on the impact to U.S. diagnostics of a proposed change in the port plug vacuum seal that reduces the space on the back of the plug for diagnostic components. This change would adversely impact the capabilities of several U.S. systems and would require significant redesign.

NSTX (M. ONO):

B. LeBlanc of PPPL gave a poster presentation entitled "Alignment of the Thomson scattering diagnostic on NSTX" at the Symposium on Laser Aided Plasma Diagnostic held September 22-26 in Madison, Wisconsin. The companion manuscript by B. LeBlanc and A. Diallo (PPPL) has been accepted for publication in Journal of Instrumentation.

Five researchers from the National Fusion Research Institute of South Korea visited PPPL on October 21 – 22 to present research results from the KSTAR superconducting tokamak device and discuss continued and new future collaborative research between NSTX-U and KSTAR. Presentations were additionally made by present PPPL, Columbia University, and ORNL collaborators regarding continuing KSTAR experiments and their analysis. Several hours of discussion were conducted pertaining to NFRI-PPPL collaboration activity, with a focus on NSTX-U/KSTAR joint research. The agenda and presentations are available for reference at: [http://nstx.pppl.gov/DragNDrop/NSTX_Meetings/Monday_Physics_Meetings/2013/2013_10_21/](http://nstx.pppl.gov/DragNDrop/NSTX_Meetings/Monday_Physics_Meetings/2013/2013_10_21/) (S.A. Sabbagh, Columbia University)
During October 14-15, S. Kaye (PPPL) participated as a member of the International Advisory Committee (IAC) in the annual review of the Research Laboratory for the Physics of Advanced Tokamaks (RLPAT), which is a Russian sponsored consortium of the fusion research being carried out in St. Petersburg, and which is headed by Dr. Fritz Wagner. The RLPAT encompasses the experimental work at the Ioffe Institute (Globus-M, Tuman-3M, FT-2), the St. Petersburg State Polytechnic Institute (SPb), which includes theory (boundary physics and waves) and the graduate program, and gyrotron development. Other members of the IAC include William Morris (Chair) and Howard Wilson from the UK, and Alexander Litwack and Boris Kuteev from the Russian Federation. The charge to the group was to assess the scientific progress made over the last year, and to make recommendations for enhancing contributions to the Russian fusion program and ITER over the next year. We were also asked to make recommendations on enhancing interactions among the various groups comprising the RLPAT from an administrative and scientific perspective. On October 16, some members of the IAC (Kaye, Wilson, Morris) gave presentations to the Ioffe and SPb fusion scientists on their respective projects and work. (S. Kaye, PPPL)

Roger Raman (U-Washington) visited General Atomics during October 16-18, to participate in Massive Gas Injection experiments conducted on DIII-D, as part of the DIII-D National Campaign. On October 18, in the first set of experiments, gas was injected from two MGI systems (that were separated in time) and located at different toroidal locations to assess variations to the toroidal asymmetries in the radiated power. In a second set of experiment, gas was injected using a single valve into plasmas with differing toroidal rotation that ranged from 100km/s in the core to nearly zero. The objective here was to see if the rotating plasma causes the injected impurities to mix more uniformly throughout the plasma. The plasma rotation was varied by first using co-directed beams, followed by balanced neutral beams and then further slowed down by braking the plasma using the internal non-axisymmetric coil set. All plasma discharges that varied from co-directed beams with high rotation, to balanced beams with n=1 braking and nearly zero rotation, were highly reproducible, allowing 43 discharges to be obtained during the run-day. All critical diagnostics including the toroidal fast bolometer arrays (needed for the radiation asymmetry measurements) functioned well for all discharges.

Toroidal and poloidal currents are driven in the open field line region known as a “halo” when a plasma becomes limited during a disruption current quench. A semi-analytic calculation has been done to estimate expected halo currents in NSTX-U, making use of the new TokSys model of the upgraded system. While typical growth rates in NSTX range from 20-100 rad/s, comparable targets are expected to produce somewhat higher growth rates in NSTX-U owing to its higher aspect ratio. With an increase in aspect ratio of perhaps 20%, growth rates for comparable target equilibria may increase by a factor of 2. Poloidal halo current fractions calculated for a typical NSTX vertical disruption event (shot #129449) using typical Type II VDE post-thermal quench conditions in DIII-D yields a peak of ~ 0.12 MA, which agrees well with the experimentally measured value of ~ 0.13 MA. Artificially increasing the aspect ratio and growth rate of this case to model the possible effects of the new NSTX-U geometry yields a relatively small increase in peak halo current of a few percent, to a peak of ~ 0.14 MA. (Dave Humphreys, General Atomics)
ITER & TOKAMAKS (R. HAWRYLUK):

R. Budny attended the ITPA Integrated Operating Scenario and Transport and Confinement topical group meetings in Fukuoka, Japan. He gave two talks: "Status of the RF kick operator in NUBEAM" and "Status of TGLF in TRANSP". TGLF modeling in TRANSP now incorporates ten kinetic species and is used to predict temperature, density, and angular momentum in tokamaks. Results are being compared with DIII-D and JET plasmas for validation.

ADVANCED PROJECTS (H. NEILSON):

The Laboratory and South Korea's National Institute for Fusion Science (NFRI) signed a research agreement for the next phase of their joint pre-conceptual design of a fusion nuclear facility, K-DEMO, as a possible next step on South Korea's roadmap to fusion energy. In the first phase of the collaboration, the team established an initial reference design point, which PPPL supported with machine configuration modeling, system code analysis, structural analysis, and superconductor analysis. In the next phase, PPPL will collaborate with NFRI in the validation of the design point, continuing the modeling and analysis work started in first phase, and contributing to an NFRI conceptual studies report of the K-DEMO concept. PPPL's work on this collaboration is sponsored by NFRI.

In this week's Wendelstein 7-X Scraper Element collaboration meeting, H. Neilson made a presentation on project planning aspects for the inertially cooled "TDU Scraper Element (TDU-SE)." This component will be a physics and engineering prototype of a steady-state, high heat flux scraper element system. The TDU-SE is intended to be installed during the first full operating campaign on W7-X and will enable U.S. and IPP researchers to study the plasma heat loading patterns and the effects on particle control in order to check the physics models used in the design. It will provide an opportunity for controlled edge physics experiments starting from the early stages of the program. The W7-X Scraper Element program is led by ORNL on the U.S. side, but plans are being developed for PPPL to contribute in certain engineering analysis tasks. The ORNL-PPPL partnership will enhance flexibility and take advantage of the combined skills of the two institutions in optimizing the U.S. contribution to this activity.

THEORY (A. BHATTACHARJEE):

Jacob Bortnik, from UCLA, visited PPPL on October 23. He gave a space seminar about the role of whistler chorus in energizing electrons in the radiation belt region, and showed how traditional quasilinear approaches do not adequately describe the transport when the wave amplitudes are sufficiently large. He was also the PPPL colloquium speaker and discussed the role of waves in the inner magnetosphere and showed new results on acceleration processes from NASA's Van Allen Probes mission.

J. Johnson led an international team working on plasma entry and transport at the International Space Science Institute in Bern, Switzerland October 16-18. The team is preparing a review article on plasma entry and transport in the plasma sheet that will be submitted to Space Science Reviews.
P. Damiano was in Boulder, Colorado between October 15-18 visiting both the High Altitude Observatory (HAO/NCAR) and the Laboratory for Space and Atmospheric Physics (LASP) at the University of Colorado, Boulder. He presented a colloquium at HAO on October 16 entitled "Kinetic simulations of electron acceleration in Alfvenic Aurora" and engaged in research discussions with several colleagues at both institutions on topics including, Alfvenic aurora in terrestrial and giant planet magnetospheres, plasma sheet transport and coronal heating.

COMPUTATIONAL PLASMA PHYSICS GROUP (S. JARDIN):

S. Jardin attended the Integrated Modeling Expert Group (IMEG) meeting at the ITER Organization (IO) headquarters as one of the two U.S. representatives (with L. Lao, GA). The meeting served several purposes. (1) Presentations were made by the representatives of each of the seven domestic programs on IM developments of interest to ITER since the last meeting; (2) The IO IM team described progress in developing an Integrated Modeling and Analysis Structure (IMAS) since the last meeting; and (3) The IMEG group served as a program advisory panel and provided advise on prioritizing future activities. It was observed that substantial progress has been made in defining an ITER data model and analysis framework, and recommendations were made that the domestic agencies begin to adapt their analysis tools to be compatible with the emerging ITER data model. Some of this activity is already occurring.

A poster and a two-page paper titled "Hybrid MPI/OpenMP/GPU Parallelization of XGC1 Fusion Simulation Code" by E.F. D’Azevedo, J. Lang (PPPL), P. H. Worley, S.A. Ethier (PPPL), S.-H. Ku (PPPL), and C.-S. Chang (PPPL) was submitted to The International Conference for High Performance Computing, Networking, Storage, and Analysis (SC13). The abstract reads "By exploiting MPI, OpenMP, and CUDA Fortran, the FORTRAN fusion simulation code XGC1 achieves excellent weak scalability out to at least 18,624 GPU-CPU XK7 nodes, enabling science studies that have not been possible before. XGC1 is a full-f gyrokinetic particle-in-cell code designed speci cally for simulating edge plasmas in tokamaks. XGC1 was recently ported to and optimized on the 18,688 node Cray XK7 sited in the Oak Ridge Leadership Computing Facility, making use of both the 16-core AMD processor and the NVIDIA Kepler GPU on each node. XGC1 uses MPI for internode and intranode parallelism, OpenMP for intranode parallelism, and CUDA Fortran for implementing key computational kernels on the GPU. XGC1 also uses the CPU and GPU simultaneously for these computational kernels. The optimized version achieves a four times speed-up over the original CPU-only version."

ENGINEERING AND INFRASTRUCTURE (M. WILLIAMS):

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

Construction: In-vessel work continues on the lower divertor gas injection system. Installation of the new PF5 clamps continues. Alignment of the lower TF support weldments continues with the fabrication of shims and machining of the splice plates. Fabrication of new TF turnbuckle shims continues. Powers Electric is working on the RTD cables in the water rack in the NTC. Electricians have prepared a new rack for NB instrumentation. Electricians are installing fiber mounting plates and other hardware for the vacuum and gas injection systems.
CS Upgrade: The Aquapour process was started this week and the layer is approximately 40% complete. Work is scheduled to continue through the weekend to finish the Aquapour early next week. Wet layup of the TF end pieces continued this week. The first PF1B arrived at Everson and PPPL engineering personnel visited the morning of October 23 to inspect the weldment. During the visit, an interference between the inside weld fillet and the first conductor layer was discovered. Everson returned the mandrel to the machine shop on the afternoon of October 23 to cleanup up fillet welds and restore the space in the corner for the coil. Testing of the OH winder tensioner and winch was conducted. The generated tension was lower than expected and troubleshooting is underway. The TF Coil winder mounts were installed in the OH winder head and tail stock. A peer review was held this week to look at installing a ground plane on the inside surface of the OH coil. The plan is to add a mesh screen ground plane layer between two wet layup layers under the first OH conductor layer.

NBI Upgrade: TTC East wall hole drilling, stud installation, and support installation Complete. NSTX west wall hole drilling, stud installation, and support installation Complete. The power system cable and tray subcontract installation work continues in both the TCB & TTC. Fabrication of parts for the BL2 DI water manifold is being performed in the Tech Shop. The Ion Source and Ion Dump DI H2O Pump procurement continues. Trial fit of ion source enclosure in all three positions has been performed. The trial fit shows the existing flange of the source is higher than OMA flange by 3/16". A second source is being brought from Rad Waste and will be trial fit in all three positions and compared to the results from the first source. Installation of the port extension shielding is under way at the tech shop. Thermocouple fabrication for the armor tiles continues. Final welding of t-bar studs is complete and the T-bars are in the vacuum prep lab for cleaning. 4C buss duct was re-installed. 3A and 5B buss ducts were removed in preparation for replacing the failed 5B Auto-Transformer. Requisition of the vacuum flanges for the roughing and forelines has been completed. A 6" vacuum pipe has been ordered. Vacuum line support fabrication has started in the tech shop. Ceramic brake copper washers fabrication has been completed. The TVPS backing line drawings nearing completion (temporarily on hold for a higher priority job). Planning for VV leg modification and duct installation continues with procedure development.

BUSINESS OPERATIONS (K. FISCHER):

PPPL Procurement hosted a meeting of the National Contract Management Association's Pinelands Chapter. Procurement staff member N. Gnyp is the current chapter Vice President. NCMA, founded in 1959, is the leading professional organization in the field of federal contract and subcontract management. The featured speaker at the PPPL meeting was Mr. Michael Fischetti, NCMA's Executive Director. Prior to taking over the NCMA directorship, Mr. Fischetti had a distinguished career in the federal government, including service as Director of the DOE Office of Procurement and Assistance Policy.

DIRECTOR’S OFFICE (C. AUSTIN):

On October 23, Dr. Jacob Bortnik from the University of California - Los Angeles, presented a colloquium entitled, "The Chorus of the Magnetosphere".
PUBLICATIONS:

A paper “Recent progress in the NSTX/NSTX-U lithium program and prospects for reactor-relevant liquid-lithium based divertor development” by M. Ono (PPPL) et al. was published in Nuclear Fusion 53 (2013) 113030. It is available online at http://stacks.iop.org/0029-5515/53/113030. This paper investigates a possibility of utilizing liquid lithium (LL) for developing a reactor-compatible divertor solution for magnetic confinement fusion. Based on promising lithium (Li) results on NSTX and related modeling calculations, a radiative liquid lithium divertor (RLLD) concept is proposed. Li is evaporated from the liquid lithium (LL) coated divertor strike point surface due to the intense heat flux. The evaporated Li is readily ionized by the plasma due to its low ionization energy, and the poor Li particle confinement near the divertor plate enables ionized Li ions to radiate strongly, resulting in a significant reduction in the divertor heat flux. This radiative process has the desired effect of spreading the localized divertor heat load to the rest of the divertor chamber wall surfaces, facilitating the divertor heat removal. The LL coating of divertor surfaces can also provide a “sacrificial” protective layer to protect the substrate solid material from transient high heat flux such as the ones caused by the ELMs. By operating at lower temperature than the first wall, the LL covered large divertor chamber wall surfaces can serve as an effective particle pump for the entire reactor chamber, as impurities generally migrate toward lower temperature LL divertor surfaces. To maintain the LL purity, a closed LL loop system with a modest circulating capacity (e.g., ~ 1 liter/sec for ~ 1% level “impurities”) is envisioned for a steady-state 1 GW-electric class fusion power plant. (NSTX)

A paper by W. Fox, A. Bhattacharjee, and collaborators at the University of Rochester Laboratory for Laser Energetics (LLE) and the University of New Hampshire, "Filamentation instability of counter-streaming laser-driven plasmas" has been accepted for publication in Physical Review Letters. The paper includes experimental observations and associated simulations of the growth of the Weibel instability between counterstreaming collisionless plasmas. Besides being a plasma instability of fundamental interest, the Weibel instability has been proposed to be a mechanism behind astrophysical collisionless shocks in unmagnetized plasmas. These shock waves form in explosions such as gamma ray bursts and supernova remnants and are sites of cosmic ray acceleration. Classical inter-particle collisions alone are too weak to sustain shocks in these high-temperature, low-density astrophysical plasmas. Instead, plasma instabilities such as the Weibel instability are proposed to provide the requisite interaction mechanism for shock formation by generating turbulent electric and magnetic fields in the shock front. This work presents the first laboratory identification of the Weibel instability between counterstreaming supersonic plasma flows and confirms its basic features, a significant step towards understanding these shocks. The experiments were conducted on the OMEGA EP laser system, and the particle-in-cell simulations were conducted on the Titan supercomputer at ORNL, made possible by a grant of computer time through the INCITE program. (THEORY)

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