NSTX-U Weekly Report (October 25, 2013)

NSTX-U is in the Upgrade Project outage in FY 2013

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 Nucl. 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. (M. Ono)

Benoit LeBlanc of PPPL gave a poster presentation entitled "Alignment of the Thomson scattering diagnostic on NSTX" at the 16th 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. (B. LeBlanc)

Five researchers from the National Fusion Research Institute of South Korea visited PPPL on October 21 – 22, 2013 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 U., 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/ (S.A. Sabbagh, Columbia University)

During 10/14-15/2013, 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 10/16/13, 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)

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. (R. Raman).

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)

Engineering Operations (A. von Halle, C. Neumeyer)

NSTX Upgrade activities continued with the application of the Aquapour on the TF inner bundle to provide the base for OH winding. The OH winder assembly has been installed in the coil winding facility, and final tests are in progress. In the NSTX-U test cell, an ion source is being fitted onto each of the three NB2 source positions to complete alignments. Tray-work for new NB2 power cabling is being installed between the neutral beam power conversion building and the NSTX Test Cell.

Preparations for plasma operations in the NSTX-U configuration also continued with the

ongoing commissioning of the 34 new firing generators for the Field Coil Power System (FCPC) rectifiers. 26 of the new firing generators have now been installed in rectifiers, and all rectifiers are expected to be complete with new firing generators and fiberoptic control/communication links by the end of November.

Access to the NSTX test cell will be available only through previous arrangement with the Upgrade Work Control Center.