NSTX-U Weekly Report (December 19, 2014)

NSTX-U is in the Upgrade Project outage in FY 2014

The paper "Rotation and kinetic modifications of the tokamak ideal-wall pressure limit" by J. E. Menard (PPPL) et al., has been published in Physical Review Letters **113**, 255002 (2014). In this paper, the impact of toroidal rotation, energetic ions, and drift-kinetic effects on the tokamak ideal wall mode stability limit is considered theoretically and compared to experiment for the first time. It is shown that high toroidal rotation can be an important destabilizing mechanism primarily through the angular velocity shear, non-Maxwellian fast-ions can also be destabilizing, and drift-kinetic damping can potentially offset these destabilization mechanisms. These results are obtained using the unique parameter regime accessible in the spherical torus NSTX of high toroidal rotation speed relative to the thermal and Alfven speeds and high kinetic pressure relative to the magnetic pressure. Inclusion of rotation and kinetic effects significantly improves agreement between measured and predicted ideal stability characteristics and may provide new insight into tearing mode triggering. This work involved substantial collaboration with Dr. Yueqiang Liu from the Culham Centre for Fusion Energy and was also inspired in part by the Max-Planck/Princeton Center for Plasma Physics. The paper is available at: https://journals.aps.org/prl/abstract/10.1103/PhysRevLett.113.255002. (J. Menard)

Mario Podestà (PPPL) submitted the FY2015 Joint Research Target (JRT-15) 1st Quarter Report to the Office of Fusion Energy Science. The report summarizes recent analysis from the three facilities (C-Mod, DIII and NSTX-U) in support of the JRT goals of quantifying the impact of broadened pressure and current profiles on plasma stability and performance. In particular, the goal of the 1st Quarter was to begin analysis of previously collected data to define initial plans for new joint experiments and analysis in FY15. Following team discussions at the three facilities, topics for collaborative research have been identified as (i) effects of on- vs. off-axis current drive from both Neutral Beams (DIII-D and NSTX-U) and LH waves (C-Mod), (ii) effects of broadened profiles on fast ion driven mode stability during NB-CD and, pending definition of the experimental schedule, (iii) sustainment of operations with peaked pressure profile. The JRT-15 coordination team is composed of M. Podestà and S. Gerhardt for NSTX-U, C. Holcomb and W. Solomon for DIII-D, and G. Wallace and S. Scott for C-Mod. (M. Podestà)

Walter Guttenfelder (PPPL) visited General Atomics Dec. 15 – 17, 2014 to participate in the DIII-D experiment "Physics studies of TEM with electron heating" led by Darin Ernst (MIT), an extension to a previous National Fusion Science Campaign experiment in 2013. To further probe the nature of trapped electron mode (TEM) behavior in the inner core of QH mode plasmas, ECH deposition was varied (r/a=0.2-0.4) to increase and alter the profile of electron temperature, which leads to a corresponding decrease in electron density gradient due to density gradient driven TEMs. ECH modulation was used to probe perturbative electron transport in the same region. DBS turbulence measurements at different wavenumbers appear to reproduce the presence of coherent fluctuations associated with the TEMs observed previously. (W. Guttenfelder)

A continuation of the Lithium Granule ELM pacing experiment begun in November was performed on December 17, 2014 at DIII-D. The experiment was led by members of the NSTX-U team (A. Bortolon, R. Maingi, D. Mansfield, A. Nagy, L. Roquemore, R. Lunsford) and supported by on site contributions from the DIII-D staff from GA, ORNL, and LLNL.

Granules (0.7 mm and 0.9 mm sizes) were injected at controlled velocities ranging from 50-100 m/s and were found to increase the natural ELM frequency of the discharge from 20-25 Hz to 50-100 Hz. The increased ELM frequency led to an observed clamping of the high Z impurity content and a reduction of the peak ELM heat flux. An expected concomitant reduction in the global energy confinement was also observed with increasing ELM frequency. The experiment further compared the ELMs generated with D2 pellets with those created by the 0.7mm and 0.9mm Lithium granules. These experiments were run under the ITPA Pedestal and Edge Physics Joint Experiment #30, to which NSTX-U will contribute with its own granule injector when operations commence in 2015. (R. Lunsford, PPPL)

Joon-Wook Ahn (ORNL) visited GA for Dec. 15 – 19, 2014 and led, along with A.R. Briesemeister (ORNL) and O. Schmitz (University of Wisconsin), an experiment for the effect of 3D fields on divertor footprints and divertor plasma characteristics . 3D fields with both n=3 even and odd parities were applied to three plasma shapes (high, medium, and low triangularity) in medium powered H-mode plasmas. 2D Te and ne plots from divertor Thomson scattering showed lobe structures induced by 3D fields for the first time in DIII-D. It was confirmed that high triangularity shape produced plasma response for stronger strike point splitting, which is consistent with theoretical interpretation in terms of plasma response. The impact of 3D fields on upstream and downstream relation is also to be investigated. (J-W. Ahn)

On December 15-17, 2014, W. W. Heidbrink of UC Irvine visited NSTX-U for discussions with PPPL personnel and onsite UC Irvine collaborators. He also gave a PPPL experimental seminar entitled "Fast-ion transport by many small amplitude Alfvén eigenmodes". (Deyong Liu, UCI)

Experimental Research Operations (S. Gerhardt, R. Kaita)

All 12 of the high harmonic fast wave (HHFW) mid-plane resonant loops, connecting the upper and lower feed-through of each current strap, have been installed. Initial measurements of resonant frequency indicate a small shift for each loop, due to the new center conductor geometry inside the feed-throughs. Tuning of the loops will take place in January 2015. (R. Ellis, PPPL)

The UC Irvine group has successfully installed a new compact and multi-channel Solid State Neutral Particle Analyzer (SSNPA) system on NSTX-U, which will be one of the key diagnostics for the energy particle physics study on NSTX-U. The SSNPA diagnostic includes three subsystems at Bay I, Bay L and Bay B, and each subsystem has 15 radial sightlines. The new SSNPA system will provide fast-ion distribution measurements with fast temporal resolution (~120 kHz bandwidth) and coarse energy information in three bands of > 25 keV, > 45 keV, and > 65 keV. The subsystems at Bay I and Bay L aim at separating the response of passing and trapped fast ions. The subsystem at Bay B is used to monitor passive signals produced by fast ions that charge exchange with background neutrals. (Deyong Liu, UCI)

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

NSTX Upgrade activities continued with the ongoing completion of the vessel's primary vessel seals. The mechanical vacuum pumps are being commissioned in preparation for an initial pumpdown of the vessel and NB2. Bus installation inside the umbrellas continues, and

connections to the center-stack Rogowski coils and diagnostic cables have been completed.

The Digital Coil Protection System (DCPS) and the Power Supply Real Time Control (PSRTC) development efforts are working towards the start of Field Coil Power Conversion System dummy load testing. DCPS pre-operational testing and burn-in continues, now in its final configuration with the Plasma Control System's Concurrent Inc. computer and data streams. The operation procedure to exercise, set, and verify fault protection algorithms has been completed and is in final sign-off. PSRTC software testing also continues, and procedures for I/O testing, and to simulate and verify the real-time outputs against recorded shots are being exercised.

Preparations of non-upgrade equipment for plasma operations in the NSTX-U configuration also continued. Open circuit testing of the Field Coil Power Conversion System rectifiers is in progress, and systems are being configured for dummy load testing. Run-ups and testing of the D-MG#1 are in progress. Testing of the neutral beam (NB) power systems also continued, and the three NB2 modulator regulators have been conditioned to operating levels needed to complete the NB CD-4 milestone. The SF6 piping for NB2 has been completed. NB Helium refrigerator operations continues around the clock. The process gas has been purified, and the refrigerator has begun to make liquid. The cabinet for the new deuterated trimethylboron (dTMB) injection system has been installed in the test cell, and power, fire protection systems and co-axial vacuum lines are being installed. New brackets for Lithium Evaporators (Liters) are being completed in the shops and should be ready to install next week. Installation of the Multi-Pulse Thompson Scattering (MPTS) diagnostic flight tubes is in progress.

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

Start of the NSTX-U TF Flex Bus Installation (Dec. 19, 2014)