NSTX-U Weekly Report (July 12, 2013)

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

The article "Mitigation of Alfvén Activity in a Tokamak by Externally Applied Static 3D Fields" by A. Bortolon (UTK/UCI), W.W. Heidbrink (UCI), et al., has been published on Physical Rev. Letters (Vol. 110, p 265008). The article reports NSTX observations demonstrating that externally applied 3D fields can be used to alter the dynamic of high-frequency bursting and chirping Alfvén modes, driven by energetic beam ions. Using static n=3 pulses with field amplitude close to the threshold for ELM trigger, the amplitude of the bursting modes (GAE, 400-700 kHz) could be reduced, the bursting frequency increased, with a smaller frequency chirp. For modes of weaker bursting character, the magnetic perturbation induced a temporary transition to a saturated continuous mode. The article reports calculations of the perturbed fast-ion distribution function made with the SPIRAL code, indicating that the 3D perturbation affects the orbits of fast ions that resonate with the bursting modes. Although these NSTX high-frequency modes were not particularly detrimental to performance, the results represent an early demonstration of the possibility of controlling fast-ion instabilities by "phase-space engineering" of the fast-ion distribution function. (A. Bortolon)

The paper "Electron-scale turbulence spectra and plasma thermal transport responding to continuous E × B shear ramp-up in a spherical tokamak" by Y. Ren (PPPL), et al., has been published in Nuclear Fusion (53 (2013) 083007). It presents the first observation of the change in electron-scale turbulence wavenumber spectrum (measured by a high-k scattering system) and thermal transport responding to continuous ExB shear ramping-up in an NSTX center-stack limited and NBI-heated L-mode plasma. It is observed that as the ExB rate is continuously ramped up in the high-k measurement region, the ratio between the ExB shearing rate and maximum ITG mode growth rate continuously increases (from about 0.2 to 0.7) and the maximum power of the measured electron-scale turbulence wavenumber spectra decreases. Meanwhile, electron and ion thermal transport is also reduced in the outer half of the plasmas as long as MHD activities are not important and the L-mode plasmas eventually reach H-mode-like confinement. Linear and nonlinear gyrokinetic simulations are presented to address the experimental observations. (Y. Ren)

Member of NSTX-U participation at the 20th RF Conference held in Sorrento, Italy during June 25-28, 2013 consisted of one engineer and four physicists. Robert Ellis presented his design of the compliant center conductors needed on NSTX-U to reduce disruption forces on the center feed conductors of the HHFW antenna. Nicola Bertelli presented full wave modeling results for the NSTX-Upgrade H-mode plasma scenario obtained with the AORSA code, which importantly show that a collision term can be used as a proxy for the complex wave damping processes occurring in the scrape off layer (SOL) to determine the magnitude of damping required to match the experimental RF power deposition results. Joel Hosea examined the effect of the choice of the magnetic equilibrium for NSTX on the SPIRAL calculation for power flow along the magnetic field lines passing in front of the HHFW antenna in the SOL. LRDFIT04 gave the best matches between SPIRAL strike points and IR heat deposition measurements, and between the predicted outer vessel strike radius (OVSR) and the location of a Langmuir probe detecting the crossing of the OVSR. This supports the conclusion that RF power flow to the divertor in the SOL is essentially along magnetic field lines. Rory Perkins presented an invited talk on the magnetic field-aligned edge-loss of HHFW RF power on NSTX. A very

crude initial estimate of the power loss to the divertor plates for a given case was that up to ~ 50% of the edge power loss was in the RF heat spirals on the divertor plates. There was considerable interest in the components of the total edge power loss and further experiments will need to be conducted on NSTX-U to quantify these using a broad array of IR camera coverage. Gary Talor presented RF modeling results for EC heating of low-density CHI start-up discharges in NSTX-U and for EBW heating and current drive in NSTX-U H-mode plasma scenarios. He found that ~500 kW of 28 GHz EC heating should be sufficient to support the goal of heating a CHI discharge to 200-400 eV in 20 ms, and it should be possible to drive ~ 25 kA/MW with EBW current drive in a typical high-density NSTX-U H-mode plasma. The conference was well attended by RF physicists and engineers from all the major fusion facilities worldwide. It covered many areas of RF of interest for heating and current drive, as well as for RF machine conditioning during magnetic field operation, and RF spectra in space. (J. Hosea)

Mario Podestà (PPPL) and the DIII-D Energetic Particles group run an experiment to explore the impact of external magnetic perturbations on TAE modes. Good progress was made toward a suitable L-mode target featuring robust TAE activity and plasma rotation close to zero, to which n=1 perturbations at f=500Hz from the I-coils were added. Scenario development required a fine tuning of the NBI waveforms, with partial success in achieving the required conditions (TAEs, zero rotation, L-mode) simultaneously. Analysis is under way to define the path forward for further studies. (M. Podestà)

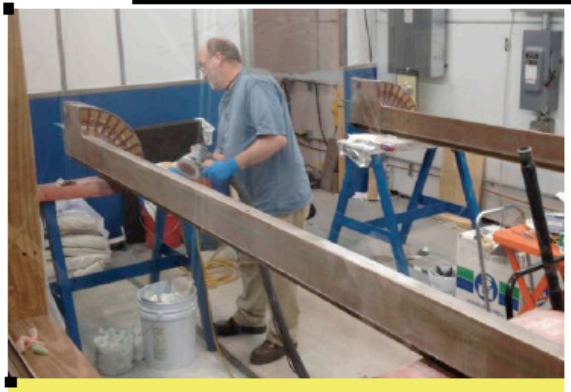
Engineering Operations (A. von Halle, C. Neumeyer)

NSTX Upgrade construction activities continued with the preparation of completed TF inner quadrants for fit-ups and subsequent taping. The full inner TF mold has been installed, fully measured, and leveled in the coil shop. On the NSTX vacuum vessel, the fit-up of the new port at bays F-G for the MPTS diagnostic is nearing completion and will be tack welded into place early next week. Vessel drilling for the five new mid-plane gas injection ports is starting.

Preparations of non-upgrade equipment for plasma operations in the NSTX-U configuration continued with the ongoing fabrication and power testing of the new firing generators for the field coil power conversion (FCPC) system rectifiers. To date, 28 of the 34 planned new firing generators have been delivered to FCPC. Blank printed circuit boards for the new diagnostic Stand Alone Digitizers (SAD) circuits are on site and being prepped to be sent out for assembly. This circuitry will then be completed and tested at PPPL.

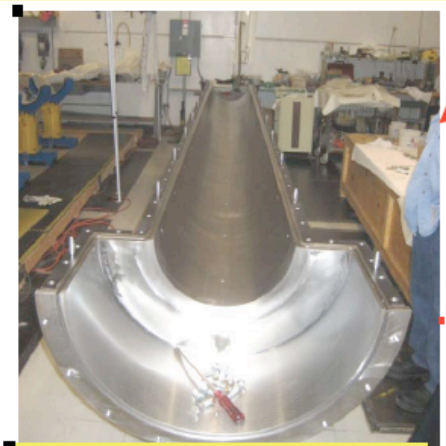
Access to the NSTX test cell will be available only through previous arrangement with the Upgrade Work Control Center.

Next step - CS Inner bundle assembly



- Two of the 4 quadrants being sanded for final assembly

- The assembly stand ready to receive the 4 quadrants



- The full Inner TF mold positioned and leveled

- *The TF mold shown with the lid installed*