NSTX Weekly Report (July 18, 2008)

FY 2008 NSTX plasma operations

Planned: 15 run weeks

Completed: 16.62 run weeks, 2571 plasmas (run completed on July 14, 2008)

Stephanie Diem successfully defended her PhD thesis from Princeton University, entitled "Investigation of EBW Thermal Emission and Mode-Conversion Physics in the National Spherical Torus Experiment". Stephanie Diem's research employed microwave radiometric measurements of thermal electron Bernstein wave (EBW) emission and computer simulation to study the physics of EBW propagation and mode-conversion in L-mode and H-mode plasmas. EBW collisional damping near the plasma separatrix and in the plasma scrape off was found to be a major loss mechanism for fundamental and second harmonic EBW coupling in the H-mode regime. In a series of dedicated experiments on NSTX lithium conditioning was successfully used to mitigate the EBW collisional damping by increasing the electron temperature inside the EBW mode-conversion layer and as a result enhancing the EBW coupling efficiency from less than 10% to 50-60%. (G. Taylor)

Jeehyun Kim and Hyelyeon Kang from the Pohang University of Science and Technology (POSTECH) in Korea arrived at PPPL. Jeehyun Kim will be working on NSTX high-k diagnostic for two years succeeding Woochang Lee and Hyelyeon Kang will be working on impurity transport with the MIST code. (R. Kaita)

No NSTX Physics Meeting Today 7/21 (S. Kaye)

Run Coordination (M. Bell, R. Raman)

On Thursday 7/10 we performed the experiment "HHFW Phase Scan and Current Drive in NB Deuterium H-Mode" [XP-835, P.Ryan], adjusting the plasma edge conditions to maximize HHFW heating of an NBI-driven H-mode plasma. When lithium evaporation was increased to 20 mg/min and between shot He glow discharge cleaning was initiated, the edge density was lowered and central electron heating was observed for both -150° and -90° array phase shifts ($k_{||}$ = 14 and 8 m-1, respectively), with outer gaps in the 6 - 9 cm range to reduce antenna/edge plasma interactions. In the afternoon we switched to "Active RWM stabilization optimization" [XP-802, S. Sabbagh]. A successful scan of RWM B_r sensor feedback phase was run using B_r and B_p sensor feedback. Favorable feedback phases were found that kept the measured n=1 B_r amplitude low, and significantly increased pulse length. ITER relevant low rotation plasmas (at speeds similar to DIII-D balanced NBI plasmas) were created with magnetic braking and n=1 fast feedback. A test to simulate feedback with two failed control coils (out of 6) showed ineffective mode control at all feedback parameters tried, including normally favorable feedback settings.

At the start of operation on Friday 7/11 we successfully demonstrated the capability to switch the neutral beams from the Plasma Control System under the NSTX Machine Proposal MP-60 "Operation of the beams from the PCS" [D. Gates]. The waveforms were preprogrammed to shut the beams off sequentially in a standard plasma shot. This was a demonstration of the technical requirements for developing beta feedback. We then performed "ELM Destablizaion by RMPs" [XP-809, J.Canik,], applying RMP pulse trains to ELM-free discharges produced by lithium

evaporation for three plasma shapes differing in elongation, with kappa = 2.0, 2.2, and 2.4. It was found that smaller, more frequent ELMs can be triggered at higher elongation, and that the ELMs again reduced the rate of radiated power and density increase. In the afternoon, we switched to "Divertor heat flux width and midplane SOL widths" [XP-815, J. Ahn] to compare upstream and target SOL widths during a low NBI power (1MW) ELM-free H-mode period with LITER. The desired conditions proved difficult to achieve, but two long ELM-free H-mode shots were obtained with 2MW beam power, for which the MPTS profiles can be ensemble averaged and the SOL profiles constructed. These data will be compared with the heat flux profiles on the divertor target. An attempt was made to study the "Effect of rotation on the L-H threshold" [XP-841, S. Kaye], but only three shots were taken, as it was found that the discharge unexpectedly transitioned into H-mode during the Ohmic phase, making it almost impossible to assess the threshold power. Finally, in the experiment "Divertor detachment with deuterium and impurity gas injection" [XP-814, V. Soukhanovskii] data were obtained to characterize divertor peak heat flux reduction and access to divertor detachment with divertor gas injection in the presence of strong pumping provided by lithium coatings.

On the final day of operation in the 2008 run, Monday 7/14, we continued the experiment "Fast ion transport induced by Alfvén avalanches" [XP-819, E. Frederickson]. After TAE avalanches were reproduced at 0.45T, they were made at 0.55T and the avalanche power threshold was found. An attempt was then made to study avalanches at 0.35T but, although the TAE were starting to chirp strongly, they did not quite develop avalanches at this low field. This indicates that TAE avalanches are more easily destabilized as the toroidal field is increased, suggesting that they may considerably affect fast-ion confinement in devices such as ITER. After starting lithium evaporation, the experiment "Comparison of NTV among tokamaks" [XP-804, S. Sabbagh] was then completed. Non-resonant n=2 magnetic braking was observed with lithium evaporation and compared to previous plasmas without lithium. Those with lithium, which appear to have higher ion collisionality in the region of maximum braking torque, displayed stronger braking. With lithium, the applied field torque needed to be reduced by 56% to prevent rotation from reaching zero. The final two hours of the 2008 run were devoted to the Machine Proposal XMP-57 "Lithium density measurements with CHERS" which was successfully completed. Reproducible discharges lasting 1.2 s with significant lithium evaporation from LITER were produced. CHERS measurements of C VI were documented and, after a change of gratings and bandpass filters, measurments of Li III were made with similar plasmas. Additional measurements were made as lithium depositon rates were increased and the beam timing was changed. A neon glow was performed after the run for wavelength calibration.

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

The FY08 NSTX run concluded this past week, after completing 16.6 run weeks during which there were 2571 plasma discharges in 2760 attempts. Post-run Rayleigh and Raman scattering calibrations of the MPTS diagnostic have been completed, and the lithium evaporator (LITER) probes have been depleted of their remaining inventories on lithium. The neutral beam-line and liquid helium refrigerator have been warmed to room temperature, and the helium inventory moved to the tank farm, to secure the beam systems for the outage. The NSTX vacuum vessel will be vented to air next week after the completion of post-run gas injection system calibrations, and challenges of the diagnostic torus isolation valve seals.

The NSTX test cell will be placed in free (card reader) access after the vessel vent.

Research Operations (M. Bell)

Diagnostic Operations (R. Kaita)

The diagnostic calibrations that have to be performed prior to the venting of the NSTX vacuum vessel have begun. Measurements were taken during neon glow discharges with the toroidal and poloidal charge-exchange recombination spectroscopy (CHERS) systems. Rayleigh and Raman scattering calibrations were also completed for the multi-point Thomson scattering (MPTS) diagnostic.

Boundary Physics Operations (H. Kugel)

• Lithium Evaporator (LITER) - The 2 LITER units supported the last day of operation this week. After the conclusion of FY08 Experimental Campaign, the LITER units were emptied of their residual lithium by evaporation onto their respective shutters. (H. Schneider, M. Anderson)

• Liquid Lithium Divertor (LLD)

-An LLD Diagnostics Review was found to be a successful CDR pending resolution of the CHITS. The committee recommended 3 additional small reviews: (1) an FDR of the LLD controls, heaters, and associated thermocouples, (2) an FDR of the LLD graphite tile diagnostics (tile thermocouples, Langmuir Probes, and Biased Probes), and (3) a Peer Review of the port locations for the external diagnostics showing the required shutters, cables, and rack space.
- An SNL / NSTX teleconference was held to discuss mechanical fabrication sequences and options.
- An SNL /NSTX teleconference was held to discuss electrical controls design work in progress and to schedule the Controls FDR tentatively for September 2008.
(R. Ellis III, H. Schneider, and the NSTX and SNL LLD teams)