NSTX Weekly Report (Apr.24, 2009)

FY 2009 NSTX plasma operations
Planned: Base - 11 run weeks, ARRA - 5 run weeks (pending funding approval)
Completed: Base - 4.71 run weeks, ARRA - 0 run weeks

R. Maingi (ORNL) presented a talk on "ELM suppression through density/pressure profile modification in NSTX" at the ITPA pedestal group meeting Apr. 20-22, 2009 in Cadarache, France. He also presented the status of two multi-machine collaborative experiments in which NSTX has a key role. (R. Maingi)

Jon Menard visited the Plasma Science and Fusion Center at MIT on April 24 to meet with several PSFC researchers, tour the Alcator C-Mod facility, and give a seminar entitled "Progress and Plans for the National Spherical Torus Experiment". (J. Menard)

The May NSTX Team Meeting will be held on Tuesday, May 5, 2009 at 1:30 P.M., in B318. The agenda includes general items, programmatic highlights, engineering, research operations, and experimental run coordination activities.

Run Coordination (R. Raman , University of Washington, Deputy: E. Fredrickson)

April 16-22: Good progress was made in nine NSTX experimental proposals (XPs) that were run this week, including the achievement of a record stored energy for NSTX of 480kJ with simultaneous good energy confinement. The source of the n=3 error field in NSTX was identified as arising from imperfections in the PF5 coil. Very low L-H power threshold (~600kJ) was realized in 900kA discharges that used lithium evaporation to condition the divertor surfaces.

On April 16, XP905, "Current Profile Modifications and Fast Ion Loss from BAAEs/ EPMs" - D. Darrow, was run. The goal of the experiment was to measure beam ion losses and any changes in the plasma current profile resulting from bursts of beta induced Alfvén acoustic eigenmodes. LITER deposition of lithium and a series of small adjustments to the discharge resulted in some plasmas with multiple and sometimes single bursts. The latter cases are well suited to detecting changes in the MSE-derived current profiles. The raw MSE data suggest there are changes in the current profile arising from these single events. Pitch angle resolved measurements of the fast ion loss from the bursts obtained show a variable character, with losses sometimes limited to a narrow range of pitch angle and in other cases extending over a broad range in pitch angle. In some cases, n=3 rotational braking was applied to reduce the toroidal velocity shear inside the plasma to bring the mode conditions closer to those that can be compared with existing theories.

On the morning of April 17, XP912, "Comparison of H-mode fueling with supersonic gas injector and conventional gas injector" – V. Soukhanovskii, was run. The supersonic gas injector (SGI) was operated in this experiment at a plenum pressure of 5000 Torr. No lithium from LITER was used. First we established a long high-performance H-mode discharge fueled by the conventional high field side injector at a plenum pressure of 1100-1200 Torr. Then we developed an H-mode scenario with much reduced HFS gas flow (using 500 Torr plenum pressure) and five 10 ms SGI pulses, matching the line-average electron density evolution to 0.8 s. Good reproducibility was achieved. The SGI deposited particles in the SOL and pedestal region in a

non-perturbative manner. We were also able to establish a low field side fueled H-mode discharge (with the reduced-rate HFS injector).

On the afternoon of April 17th, five discharges were taken in support of XP833, "Halo Current Dependencies on IP/q95, Vertical Velocity, and Halo Resistance" – S. Gerhardt. A scan over the PF3 Upper/Lower offset voltage was completed, in an effort to adjust the VDE velocity when the plasma impacts the lower divertor. A preliminary analysis showed that the halo currents in the lower vessel wall and outboard divertor did not change.

During the first half of April 20th, we completed XP 902, "Search For the n=3 Error Field Source in NSTX and Implementation of Improved n=3 EF Correction" – S. Gerhardt. On this day and a previous three hour block of runtime, scans over the applied n=3 field were completed in three conditions: i) I_p= 750 kA, B_T=0.45 T, kappa=2.3, ii) I_p= 1100 kA, B_T=0.55 T, kappa=2.3, iii) I_p= 900 kA, B_T=0.45 T, kappa=2.15. These datasets complement similar sets taken in 2007 and 2008. By evaluating the applied n=3 field which maximizes the plasma angular momentum, an "optimal" n=3 correction has been found for each scan. This correction is found to scale with the PF-5 current, not the PF-3, OH, or TF coil currents. Hence, it appears that the PF-5 coil is the source of the error field. This conclusion is further supported by analysis of the measured coil shape.

During part of the afternoon on April 20, more progress was made in XP937 "Impact of improved confinement with lithium on scenario development" – D. Gates, previously run on April 10. Plasma current and field were varied while keeping at or below the I_p*B_T product limit imposed by halo currents. All variations around the previous optimal operating point of 0.5 T and 1.3 MA led to reductions in confinement and/or plasma stability. A new stored energy record of 480 kJ was set at the previous optimal operating point.

On April 21, XP910, "Beta scaling of confinement in weakly shaped plasmas" – S. Kaye, was run in the morning. A power scan was performed to assess the scaling of confinement with beta in weakly-shaped plasmas. This experiment used lithium evaporation to suppress the ELMs that spoiled attempts to determine this dependence in previous years. The experiment was successful in producing discharges with similar collisionalities and temperatures. The confinement time was found to degrade more strongly with beta in these discharges than in more strongly shaped discharges which had small, Type V ELMs.

On the afternoon, XP922, "Ip dependence of L-H threshold, Hysteresis and Confinement quality" – S. Kaye, was run. The first attempt at this experiment early in the week produced plasmas at high triangularity with much lower power thresholds than was observed previously, possibly due to extreme lithiumization which took place early in the run day. For 900 kA discharges, the power threshold was found to be < 0.6 MW at a line-integral density of 3 x 10^{15} cm^{-2} whereas previous work with similar discharges found the threshold to be ~ 2 MW. At higher current, no transition was observed, even at much higher power, but not much time was spent on this condition. This experiment went on to study the effect of density on the L-H threshold power, and the results showed that the threshold power at transition densities of ~4.5 x 10^{15} cm^{-2} was also < 0.6 MW, indicating a weak density dependence in this condition.

The remainder of the afternoon was spent on XP936, "Dependence of Power Threshold on Rotation" – S. Kaye. The L-H threshold power was found to increase from < 0.6 MW with no magnetic braking to between 2 and 2.7 MW with magnetic braking applied. This suggests the critical importance of either rotation or existence of error fields. Coupled with RF studies from previous years, where the L-H threshold was the same with or without beam-induced rotation,

the results suggest that it is the error field, and not the rotation, that is influencing the L-H transition.

On April 22, the third part of X-P911, "Li pumping and retention in NSTX" – C. Skinner, was run in support of the FY09 Joule Milestone. On this day gas retention measurements were conducted in Ohmic plasmas, this time during the presence of lithium on the lower divertor plates. LITER was used to evaporate lithium at a rate of 5mg/min for 9.5 minutes prior to the shot. No HeGDC was used. As on April 6, ATJ graphite, Si and Pd samples were exposed to eight plasmas by a newly installed probe at Bay J.

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

NSTX plasma operations continued this past week with a fresh supply of lithium in the two LITER probes. With even modest amounts of lithium evaporation, NSTX was able to eliminate between shot glow discharge cleaning, thereby operating at a 10 minute rep rate, and reaching a record plasma energy of ~ 480kJ at 6.4MW of neutral beam injection. The Error Field Correction coils were used to complete scans needed to evaluate error field correction techniques, and the Purdue University Sample Probe for gas retention studies.

Access to the NSTX Test cell will be available during scheduled maintenance this coming week.

Research Operations (M. Bell)

Boundary Physics Operations (H. Kugel)

• Liquid Lithium Divertor (LLD)
- A teleconference was held with SNL and PPPL to discuss LLD progress and planning. (M. Viola)
- The control rack heater control panel wiring is 95% complete, the thermocouple panels are 75% complete, the interlock panels are 10% complete, the remainder of the rack is 50% complete.
- All parts were received at PPPL for the electrical and cooling gas interface.
- PPPL drawings for the Langmuir Probe array were sent for fabrication estimates.
- PPPL air baking of a candidate heater was performed to characterize its electrical isolation.

• Lithium Evaporator - LITER 2009
- LITER was used to support XP 910 (beta scaling), 911 (gas retention), 912 (SGI and gas comparison), 921 (GAE modes), and 937 (high stored energy)
- Preparation of lithium material and procedure requirements for reloading LITERs during the forthcoming maintenance were started. (J. Winston, J. Timberlake)

• Lithium Dust Dropper (D. Mansfield)
- Unit-2 was dismantled and analysis of recent test results was started. (D. K. Mansfield)

• Edge Sample Probe

- The edge sample probe was used to support XP 911 (gas retention) (C. H. Skinner)

• Supersonic Gas Injector
- The SGI was used to support XP 912 (SGI and gas comparison) (V. Soukhanovskii)