NSTX Weekly Report (June 23, 2006)

FY2006 weeks of research operations
Planned: 11 weeks
Completed: 12.66 weeks

Featured Highlights: On June23, the FY 2006 NSTX plasma operation was completed successfully. 12.66 run weeks with 1617 plasma discharges were achieved which exceeded the FY 2006 DOE-OFES Joule Milestone of 11 run weeks. During the 2007 run, 6 experimental machine proposals and 26 experimental proposals were carried out yielding important experimental results in all science areas. Notable achievements include,
• Newly implemented feedback control enabled dynamic error field and RWM stabilization at low plasma rotation of high performance long-pulse plasma operations over the no-wall beta limit.
• Plasma operations at B_T = 0.55 T provided B_T confinement scaling.
• Microwave high-k scattering system measured local electron-scaling fluctuations.
• Optimization of plasma control yielded a record plasma elongation of ~ 3 and the shape factor of 43 for advanced operations.
• High triangularity significantly reduce divertor heat load and obtained small ELM regime.
• Application of lithium coating of the wall lead to reduced recycling and greatly reduced oxygen impurity level, leading to generally improved plasma confinement.
• Finally, a successful non-inductive start-up with CHI produced significant closed flux current of 160 kA.

A manuscript entitled "Characterization of Small, Type V ELMs in the NSTX" by R. Maingi et al. (ORNL) which is based on the APS 2005 invited talk was accepted for publication in PoP. (R. Maingi)

There will be an NSTX Physics meeting on Monday, June 26 at 1:30 pm in LSB318. Below is the agenda: **XP Summary**: S. Paul – Bolometer observation during lithium experiments. **Physics Presentations**: M. Bell – Summary of the EPS, J. Kim (U. Texas) - Shot analysis of Electron Transport in NSTX. (S. Kaye)

Run Coordination (R. Raman, S. Sabbagh)

During this final run week, important results were obtained in many areas including Li evaporation, error field control, energetic particles, and high harmonic fast waves.

XP601: Effect of Evaporated Lithium PFC Coatings on Density Control (June 21-22) – H. Kugel: A 2-NB fiducial discharge was developed to allow comparisons without encountering beta limits during high performance discharges with lithium wall conditions. Then, lithium evaporation-12 (E-12) was performed at an operating temperature of 600°C, at a rate of ~6.5 mg/min for a deposition of 4.8 grams. The first reference discharge exhibited about a 7-11% decrease in the secular density trend, a very decreased divertor D-alpha luminosity, an apparent increase in confinement time of about 13-22%, increasing stored energy and beta-t, and reduced flux consumption. In the following 4 reference discharges, the density decrease reverted back to the comparison discharge after one shot, but the confinement time and stored energy continued to be higher, while the flux consumption continued to be

lower, and the D-alpha was very low and never returned to the level of the comparison discharge. During this scan, the Te profile continued to broaden and was very broad relative to that of the comparison discharge. Then E-13 was performed at an operating temperature of 650°C, at a rate of ~19 mg/min for a deposition of 1.0 grams. The following scan of 5 discharges reproduced the conditions found after the E-12, 4.8 gram deposition. In particular, the noteworthy broader Te profile was very reproducible. Then 2 Reversed Shear discharges from the XP610 comparison base were run to compare their performance during the then existing lithium wall conditions. The results were encouraging, and at this point, these and the above results supported the application of E-14 at an operating temperature of 680°C, at a rate of ~37 mg/min for a deposition of 1.0 grams. The first 2 NB reference fiducials reproduced the above results. Then, the above Reversed Shear comparison discharge was tested again, and immediately yielded the longest Reversed Shear 900 kA with the highest Te discharge this year. Then, a 1 MA Reversed Shear discharge was attempted and immediately yielded the longest lasting 1 MA Reversed Shear discharge this year and with a Te of slightly under 2 keV. This discharge was tested again and repeated the same. Finally, a Monotonic Reversed Shear discharge was tested and immediately reproduced exactly the earlier comparison discharge.

XP614: Comparison of error field correction techniques at high beta-N – (June 22) J. Menard: Previous work on NSTX has shown dynamic error field correction to be effective in lengthening the discharge pulse length. The goal of this test was to use a previous plasma discharge that employed OHxTF error field correction + sensor-based n = 1 feedback in lengthening the pulse, and determine if an "optimal error field correction" could be computed and pre-programmed based on the average n = 1 feedback current time evolution, to maintain the plasma rotation and avoid disruption. This was indeed successfully demonstrated in a plasma with nearly identical evolution of plasma beta. In a plasma with slightly higher beta, the pre-programmed currents were no longer "optimal", confirming that the optimal currents depend on beta. In a long-pulse shot with duration of over 1 sec, the plasma rotation typically decreases in time until the discharge termination. However, with the addition of the pre-programmed time-averaged SPA currents, the decrease of plasma rotation was halted and even reversed. Plasma rotation increased in both the core and edge region.

Supporting data for beam ion confinement studies (June 23) – D. Darrow: Short beam pulses ("beam blips") were injected into NSTX plasmas over a range of plasma currents and toroidal fields to measure how beam ion confinement varies with these parameters and with the tangency radius of the neutral beam line. Good neutron rate time histories were obtained for the assessment of global beam ion confinement through analysis of the neutron blip height and decay times. In addition, the NPA and SSPNA diagnosticsacquired energy distributions of the energetic beam neutrals being emitted from the plasma, allowing direct measurement of the beam ion slowing down and pitch angle scattering by the plasma. The sFLIP and iFLIP fast lost ion probes measured the loss local to their positions for each blip. These data will permit improved comparisons between fast ion loss modeling and measurements, and will also allow comparison of the
measured and modeled fast ion pitch angle scattering rates. These comparisons are relevant to plans for fast ion work in NSTX's FY07 experimental campaign and to extrapolations of the spherical torus concept to a neutron source.

XP627 Non-solenoidal Ip Rampup (June 23) – C. Kessel: This was a continuation of work conducted on April 27. We achieved good H-modes with -7m^{-1} phasing early in the day at 400 kA plasma current without RF dropouts and Elm-free H-modes for 70-80 ms which ended (perhaps due to the very pronounced edge density ear. Later we added NBI but encountered MARFS and couldn't recover the best conditions.

XP617 HHFW Power Balance vs B at Constant q (June 23) – J. Hosea: This was a continuation of work conducted on May 19. We conducted HHFW phasing study with the edge probe and the soft xray diagnostic. Good heating was observed at 14, -7, and even some heating at -5 and -3 m^{-1} phasings. A central Te near 4 keV was achieved with -7 m^{-1}. The new RF probe showed signals consistent with our conjecture that more surface wave is present at faster phasings.

MSE calibrations (June 23) – F. Levinton: About and hour and a half was used to inject Source A NBI at 90keV into the vessel using a combination of TF and PF to finish calibrations needed for the MSE diagnostic.

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

After the successful completion of the repair of a water leak at the lead of the OH coil, NSTX plasma operations resumed this week to complete XP-601 "Lithium Deposition", as well as XP 614 "Comparison of Error Field Correction Techniques". Additional progress was also made this week on XP 627 "Non- Solenoid Current Ramp Up" and XP 617 "HHFW Power Balance" with TF operations at 5.5kG. This will bring to a close the FY06 NSTX run. The vessel will remain under vacuum next week for diagnostic calibrations while the neutral beam cryogenic systems are being brought up to room temperature. The vent of the vacuum vessel is scheduled for the 1st week in July, with entry to the vessel expected by July 12th.

Research Operations (M. Bell)

Diagnostic Operations (R. Kaita)

• The "Indigo Alpha" infrared camera for viewing the lower divertor region has been repaired. Most of the other plasma diagnostics continue to be operational. Diagnostic calibrations that must be conducted before the NSTX vacuum vessel is vented will begin at the end of plasma operations on June 23, and continue during the following week.

Boundary Physics Operations (H. Kugel)

• LITER 1C was operated to perform lithium depositions of amounts up to ~ 7 grams in support of XP601 on the effect of evaporated lithium PFC coatings on density control during long pulse high performance H-mode discharges and reversed shear discharges.