NSTX Weekly Report (May 28, 2004)

FY 2004 weeks of operation planned: - 18 weeks, Completed: - 13.9 weeks

Department, Project, Program (M. Ono, M. Peng, M. Williams, E. Synakowski)

• The following NSTX contributions were presented at the 16th International Conference on Plasma Surface Interactions in Controlled Fusion Devices Portland MA, May 24-28, 2004:
Oral Presentation: "ELMS in H-Mode Pedestal in NSTX" by R. Maingi (ORNL), et al.
Poster Presentations:"First Results from a Systematic Characterization of the Boundary and Power Flow to the Divertor in NSTX" by S. Paul, et al., "Development of NSTX Particle Control Techniques", by H.W. Kugel, et al., "Time Resolved Hydrocarbon Deposition in NSTX", by C.H. Skinner, et al., "Analysis of Divertor Regimes and Core Fueling in the National Spherical Torus Experiment", byV.A. Soukhanovskii (LLNL), et al., and "3D Simulation of Gas Conduction Experiments on Alctor-C Mod and NSTX" by D. Stotler, et al.

Run Coordination (S. Kaye, J Menard)

Five experiments were performed during this week of operation, with a significant contribution being made to most of them by reflectometer measurements of long wavelength turbulence in the core. PF only startup was attempted using HHFW preionization and magnetic field topologies with and without field nulls. An experiment to study the relation of electron internal transport barriers to the magnetic shear and electron density was performed. Discharges with steep Te gradients were produced and appeared to be associated with reversed magnetic shear. Core fluctuation measurements were made using the UCLA reflectometer during this experiment. Two RF experiments were performed, and HHFW-only H-mode and a combined HHFW+NBI heating study. Numerous L-H mode transitions were observed at all phasing, but most were short-lived. One long-lived H-mode (~100 msec duration) led to stored energies of ~100 kJ, a record for HHFW plasmas. Finally, a dedicated experiment to study core fluctuations in low density L-mode plasmas was performed.
• An XP was performed in an attempt to initiate the plasma and start up the plasma current using inductive flux from outboard PF coils only (PF2, PF3 and PF5) with an assist from HHFW. Two scenarios were attempted. In the first scenario, an X-point was formed on the outboard side, similarly to the scenario that produced 10kA of plasma current during the previous week. Plasma formation near the X-point was observed, but plasma current start-up was not observed. In the second scenario, PF coil currents were precharged in the reverse direction and ramped through zero, similarly to the scenario being developed on JT-60U and TST-2. If successful, this scenario can utilize more flux input from the PF coils. A sign of possible plasma current start-up (less than 5kA) was observed when a field null formed inside the vacuum vessel, but the evidence was not conclusive. The difficulty appears to be due to the mismatch of the neutral gas pressure required for HHFW preionization (higher than 10^-5 Torr) and the pressure that favors plasma current formation, low 10^-6 Torr (Y. Takase, J. Menard).
• An XP to study the generation of electron ITBs and their relation to reversed magnetic shear was started. Among the techniques used to control the magnetic shear were current ramp rate, neutral beam injection timing and plasma density. For low plasma density, indications that ITBs formed in the electron temperature profiles were observed with fast current ramps and early beam injection, conditions conducive to formation of reversed shear. Preliminary TRANSP analysis performed during the run, and made possible by the between shots analysis of CHERS data, indicated low electron thermal diffusivities and non-monotonic q-profiles. For slower current ramps and later injection, the q-profiles were calculated to be monotonic and the electron thermal diffusivities were higher. Core turbulence measurements were taken in the low density plasmas. Neon was injected to probe the ion transport, which appeared to increase for decreased electron transport levels. The development of higher density discharges was problematic due to MHD activity (D. Stutman, E. Synakowski).
• HHFW-only induced H-modes were explored with a phasing of 14 m-1. The L-H threshold power in a 500 kA discharge (with shape similar to the one used in the NSTX/MAST L-H identity experiment with NBI) was determined to be higher with HHFW than with NBI. Transitions were observed at 0.6 and 0.8 MA, but they were often short lived, preventing the buildup of density “ears”. Low energy beam blips were used to document the ion temperature and toroidal velocity. There were a few sustained H-modes (with turbulent “ELMs”) produced at the 2.5 to 3.0 MW level, and these had stored energies up to 100 kJ, a record for HHFW heated plasmas. The real-time EFIT algorithm was used for plasma control (B. LeBlanc).
• A combined HHFW and NBI heating experiment covered a lot of ground during an extended day of operation. To allow reduction of the outer gap for proper antenna loading, the fast ion heating of the antenna observed with 90 keV injection was reduced by reducing the injected neutral energy to 70 keV. Power was kept above 2 MW through the addition of two neutral beam sources. The gap was reduced to enable good antenna loading, and no detrimental fast ion-antenna interactions were observed. Three different k//, nominally 14, 7 and 3.5 m-1, were applied. Magnetic, profile, and fluctuations measurements (by the GPI fast camera and the UCLA reflectometer) were acquired. The responses of the plasma stored energy to the applied HHFW was a complex function of HHFW power and is being studied. The possibility of HHFW effects on the plasma rotation, as well as the possibility of HHFW power is being diverted before core propagation takes place, is being examined to elucidate these results. Finally, HHFW was injected into electron ITB discharges developed earlier in the week in an attempt to strengthen further the transport barriers. (B. LeBlanc).
• The first detailed study of long wavelength turbulence (usually associated with ion temperature gradient driven modes) in the core of NSTX L mode plasmas was carried out in collaboration with the UCLA group. Correlation and quadrature

reflectometers were employed to determine radial correlation length and fluctuation amplitude as a function of radius. Scans in rho-star were performed to determine correlation length scaling for future comparison with non linear gyrokinetic calculations. In addition H-mode transitions were also investigated for comparison with gas puff imaging data under similar conditions. The run went well and data was obtained deep into the core of NSTX plasmas (T.Peebles, S. Kubota, N. Crocker).

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

NSTX plasma operations continued this past week on extended run days with all technical subsystems operating reliably. The week began with an experiment on PF-only plasma start up (XP-431), followed by an experiment studying electron transport barriers in reversed-shear plasmas (XP-411). The RF systems coupled 3 MW, achieving good HHFW heating, in an experiment on H-modes with HHFW heating (XP-425). The following day the RF systems operated at 3.5MW with good coupling at several different phasings in a combined HHFW and NBI heating experiment (XP-413). A vacuum vessel boronization was completed before finishing the week with an experiment studying core turbulence (XP-439). In the off-hours, the cabling from the new CHI capacitor bank to the NSTX test cell was completed, and the commissioning of that system is in progress. Installation of the new Lithium Pellet Injector continued over the weekend.

By the end of this past run week, which included extended run days, NSTX had completed 13.9 run weeks this year, producing 1497 plasmas.

Access to the NSTX test cell will be restricted during plasma operations this week. Test cell access will be available from 5:00PM to 10:00PM each evening, except for Thursday, June 3rd, when plasma operations will be extended to 7:00PM. The next maintenance period is scheduled for June 5th - 17th. (A. von Halle)

Research Operations (M. Bell)

Boundary Physics (H. Kugel)

• The Lithium Pellet Injector (LPI) was installed. (G. Gettelfinger)

• Two Morning Boronizations were performed (5/25, 5/28). (J. Winston, W. Blanchard)