NSTX Weekly Report (July 24, 2009)

FY 2009 NSTX plasma operations
Planned: Base - 11 run weeks, ARRA - 5 run weeks
Completed: Base - 10.95 run weeks with 1,705 plasma shots
ARRA - 2.34 run weeks with 386 plasma shots

• The second ARRA run week milestone was completed on July 21, 2009.

• Stan Kaye attended the ITPA Coordinating Committee meeting in Cadarache, France on July 15-16, 2009 in his role as Chair of the Transport and Confinement Topical Group. The purpose of the meeting was for the ITPA Topical Group leaders to present their annual reports to the CC. The presentations primarily addressed how the TGs addressed the ITER high priority items, what issues arose that impeded more rapid progress and how the ITPA and ITER IO could work towards overcoming obstacles. (S. Kaye)

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

NSTX Plasma Experimental Highlights for July 16 - 22, 2009**:** This was a very productive week. ELM stability characteristics were studied as the plasma triangularity was reduced. The ELM-free edge of H-mode plasmas were diagnosed using a reciprocating probe and with an ultra-fast gas puff imaging diagnostic. The Li-dropper was successfully used to improve discharge parameters without the need for between-shots He-GDC. A new software capability that allows the time duration of the neutral beam pulses to be feedback modulated based on a pre-specified plasma beta was fully tested and used in a subsequent experiment. Record electron temperatures of 5.7 keV in HHFW heated He plasmas were obtained. These He discharges heated by HHFW also transitioned into an H-mode.

On the morning of July 16th, XP919 "Development and characterization of an intermediate triangularity discharge with lithium PFC coatings – J. Kallman" was run again to obtain additional data points from the power/current scan of the previous half day. The inner strike point controller was improved, which allowed for greater stability against eddy currents early in the discharge and provided another lever on x-point height. Shots continued to exhibit high normalized beta and temperatures. In these discharges fueling conditions were modified so that at high lithium rates, part of gas the gas provided by the high-field side fueling system was successfully replaced by the supersonic gas injector.

On the afternoon of July 16 and the morning of July 17 XP-952,"SOL measurements in the ELM-free H-mode – J.W. Ahn", was run. The machine behaved very well and produced low power ELM-free H-modes which allowed deep probing using the reciprocating probe. Good probe data was obtained at NBI power of 0.8MW. Then the NBI power was raised to 1.3MW and good probe data was obtained at this condition also.

On the afternoon of July 16 and the morning of July 17 XP929 "Ultra- high speed GPI measurements of the L-H transition - S.J. Zweben, R.J. Maqueda, S. Kubota", was run and completed. The best ever GPI images of the L-H transition in NSTX were obtained, with a framing rate of 300,000 frames/sec in a 64x64 pixel format. This was made possible by using

two Phantom 7.3 cameras viewing the same region of the outer midplane, and interleaving their frames. Six successive shots with a sharp transition were obtained, and in each a clear transition from a high level of L-mode turbulence to a low level of H-mode turbulence was observed. Four other shots with a dithering L-H transition were also obtained. In addition, good data was acquired on all these shots using the UCLA reflectometer system, which should allow a comparison of the turbulence inside vs. outside the separatrix vs. time across the transition.

On the afternoon of July 17, the first half of XP-913 "Injection of Lithium Powder into NSTX – D. Mansfield" was run. Using a single dropper and no LITER evaporation, reasonably high performance ELM-free discharges were produced without HeGDC. Improvements in plasma parameters (stored energy, OH consumption, pulse length, etc) typical of those obtained with the dual LITER system were attained during the course of the experiment. Typical lithium influxes delivered from the Bay I unit were in the neighborhood of 70 mg/s for 1s. The Bay C unit was used briefly and successfully to introduce lithium particles into the midplane area of the center stack at or near plasma breakdown. Initial analysis of the data suggests that much of the lithium introduced by this technique ended up on the center stack.

On July 20, XP948 "Optimization of long pulse, high beta-toroidal discharges – S. Gerhardt" was partially run. Discharges with [Ip (kA), Bt (T)] combinations of [1000,0.4], [1100,0.45], and [1000,0.42] were studied, all at very high elongation and low internal inductance. Discharges in each condition were able to achieve pulse average toroidal betas of >20%, for flat-top durations >0.8 sec.

Later in the afternoon of July 20, XMP63 "Commissioning of PCS NBI Control for NBI Feedback – S. Gerhardt", was run and completed. A scan of proportional gain was completed, and a reasonable value of 10 was found. This capability was used for controlling the normalized beta during many of the shots during XP948 for the remainder of the day.

On July 21, XP942 "ELM stability dependence on plasma shape – A. Sontag" was run. Data was obtained on ELM stability characteristics as the plasma triangularity was decreased to ~0.3. Several different types of ELMs were observed, including small ELMs consistent with increased ballooning drive of the edge peeling-ballooning instability, which is expected at lower triangularity. Strike point control was used to decrease the lower triangularity by increasing the major radius of the outer strike point. PF1AL was also used to push the plasma away from the center column to further decrease the lower triangularity. Lower triangularity discharges were less robust with pulse lengths of ~0.6 s as compared to pulse lengths of ~1 s for higher triangularity discharges due to decreased global stability at lower shaping.

On the afternoon of July 21, XP926 "Characterization of magnetically triggered ELMs in lithium conditioned discharges – J.M. Canik" was run. The goal was to measure the edge profile evolution for ELMs triggered with 3-D fields very close to the triggering threshold. This was successful in that many discharges were obtained with ~ 50ms evolution of the pedestal before the ELM crash. Detailed analysis is proceeding.

On July 22, XMP26 "Bring HHFW online and raise power to 6MW – J. Hosea" was run. After vacuum conditioning the HHFW antenna for about two hours, HHFW power was coupled into an Ohmically-heated helium plasma using -90 degree current drive phasing for the rest of the day. It was clear from the vacuum conditioning that the antenna had de-conditioned significantly

since the last vacuum conditioning run three weeks ago, but cube voltages of 20 kV or better were recovered by the end of the vacuum conditioning run. By the end of the day 4.2 MW was coupled for 200 ms, achieved NSTX record $T_e(0)$ = 5.7 keV, and observed transitions to H-mode. During RF trips, surface material (which is believed to be Lithium) could be seen ablating from the upper and lower edges of the antenna, and between the antenna straps. During the day as the antenna became better conditioned, the fast camera showed less material ablating from the antenna surface.

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

NSTX plasma operations continued this past week with extended run days on Tuesday and Thursday, and with the use of HHFW and neutral beam heating, the lithium evaporator (LITER) probes, the lithium powder dropper, the machine's error field coils, and Plasma Control System (PCS) regulation of neutral beam injection for beta feedback. The HHFW systems successfully coupled 4 MW into helium L-mode plasmas, triggering H-mode transitions and achieving record NSTX central electron temperatures of up to 5.7 keV. The LITER probes were removed from NSTX at the end of the week to be refilled with lithium, and will be ready to support experimental operations on Monday.

The NSTX Test cell will be in restricted access this coming week during plasma operations, with extended run days (to 7PM) planned for Tuesday and Thursday. Test cell access will be available each evening at the end of the run day.

Research Operations (M. Bell)

Boundary Physics Operations (H. Kugel)

• Liquid Lithium Divertor (LLD)
- The coating of the front face of 6 divertor plates was completed, and the plates was received by PPPL on July 23.
- The Final Design Review for the LLD Diagnostics was held and declared a success pending resolution of 2 CHITS.
- The vacuum testing of candidate heaters of the style without embedded internal thermocouples was started. (M.Viola)

• Lithium Dropper
- P2 Lithium Droppers were used to support XP-913. (D. K. Mansfield)

• Divertor Region Sample Probe
- The Final Design Review for the Sample Probe Controls was held and declared a success pending resolution of the CHITS.
- The Purdue collaboration shipped 4 pre-conditioned graphite samples for Sample Probe exposure.
- A Boundary Physics-TSG, review of an XP for "Dust Mobilization on ITER Scale Castellations" was held. (C. H. Skinner)