NSTX Weekly Report (Aug. 7, 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 - 4.61 run weeks with 791 plasma shots

• The NSTX ARRA funded fourth run week was completed on August 3, 2009.

• J.P. Allain, Purdue University gave the following talk at the NSTX Physics meeting, "Dynamic surface chemistry effects on lithium-coated graphite surfaces from deuterium irradiation". (H. Kugel)

• Wonho Choe (Professor, Korea Advanced Institute for Science and Technology, Daejeon, Korea) visited NSTX for discussion of research collaboration on tokamak start-up and transport related diagnostics.

• Woochang Lee of POSTECH, Pohang, Korea, successfully defended his Ph.D thesis entitled "Collective Thomson Scattering System for Transport Study on NSTX". (W. Lee)

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

NSTX Plasma Experimental Highlights for July 30 - August 5, 2009**:** I n the area of solenoid-free plasma startup using CHI, record levels of solenoid-free startup current were obtained in NSTX. The internal GAE fluctuations were measured using the high-k system while changing the nature of the GAE modes using beam power steps. The electron temperature profiles showed significant changes.

On Jul 30 and 31, two CHI experiments, XP927, “CHI use of absorber coils – D. Mueller” and XP928, “Flux savings from inductive drive of a Transient CHI started plasma – R. Raman, B.A. Nelson, D. Mueller, T.R. Jarboe et al.” were run. Good progress was made and the CHI startup performance was considerably improved over the previous May 22 CHI run. The absorber coils were run in a configuration to provide a short pulse buffer flux to reduce interaction of the evolving CHI plasma with the upper divertor. This helped reduce the intensity of absorber arcs. Discharges were reliably run using 3 capacitors and for the first time in NSTX 4 capacitors (20mF) were used to produce CHI started discharges that successfully coupled to induction with resulting savings of inductive flux. The electron temperature in the CHI phase, for the first time in NSTX, continued to increase with the capacitor bank energy indicating that the additional injected energy was contributing to heating the plasma instead of being lost as low-Z impurity radiation. Maximum electron temperatures of 50eV during the CHI phase were measured and the coupling current increased to 175kA. Up to 200kA of flux savings was realized as a result of the much hotter CHI started discharges.

On Aug 3, three discharges were produced as part of XMP26 "Bring HHFW online and raise power to 6MW – J. Hosea" to check out a new fast digitization of RF signals which is needed to be able to compare reflection coefficient characteristics for ELMs and arcs.

On the morning of August 3, XP950 "Dependence of metallic impurity accumulation on Ip and outer gap in the presence of lithium deposition – S. Paul" was run to obtain additional data. The goal was to determine if delaying the initiation of NBI (thus avoiding injecting during the low current stage of the current ramp) reduces the accumulation of metallic impurities. In addition, transients in the outer-gap evolution present in preceding runs were mitigated. The timing of NBI into a .7 MA plasma was scanned from 40 to 60, 80, 100, and 140 msec. Very little change in Zeff, metals Zeff, density or radiated power was observed, indicating that the flat- top value of the plasma current is the important variable. However, flux consumption was reduced and the neutron rate improved considerably with delayed beam injection. A subset of the scan was repeated at a plasma current of 1.2 MA and slightly higher toroidal field. In these discharges, the electron density rose considerably, but Zeff and metals Zeff dropped slightly. This was not due solely to the increased deuterium density as both the total radiated power and the central radiated power density were lower in the higher-current, higher-particle-density discharges.

On the afternoon of August 3 and the morning of August 4, XP921, “Characterization of GAE modes and their effect on electron thermal transport – K. Tritz” was run. The internal GAE fluctuations were measured using the high-k system at 109cm and 115cm while changing the nature of the GAE modes using beam power steps. The electron temperature profiles showed significant changes, and an attempt will be made to relate the GAE measurements to predicted effects on electron thermal transport. Measurements were also made at higher and lower magnetic fields to attempt to separate any predicted rho-i dependence of the transport on the parallel electric fields. Because of high-k problems, it was not possible to measure the fluctuations at larger major radius, but the inner points are the more crucial ones. Neon was also puffed in several discharges to help determine whether the predicted electric field effects would also be evident in changes in the impurity particle transport.

Lithium conditioning of the upper vessel was the focus of XP951 "Diffusive Lithium injection – C. Skinner" on the afternoon of August 4. Lithium was evaporated into a low pressure helium atmosphere that scattered it into previously shadowed parts of the vessel. Monte Carlo modeling was used to derive a program of helium pressures and corresponding lithium mean free paths for optimal uniformity of lithium coverage. The increased coverage was evident in images of Li-II 5485 emission and resulted in strong wall pumping as a result of which the deuterium fueling was increased to very high levels.

On the afternoon of August 4, two hours were devoted in support of XP955, “Operation with reversed TF – D. Mueller”. Upper and lower signal null discharges at low elongation and triangularity were produced in the normal TF polarity and the L-H threshold measured. These discharges will be repeated after the toroidal field direction in NSTX is reversed.

MSE calibrations on Aug 4 and 5, conducted as part of XMP33 "Gas filled Torus - H. Yuh" showed that the calibrations conducted at the start of the FY09 run are still valid.

On the afternoon of August 5, XP954 "Early error-field correction in long-pulse plasmas – J.E. Menard" was run. This experiment explored the impact of early n=3 and n=1 error field correction in NSTX long-pulse plasmas. First, early gas fueling was reduced and optimized to lower the ramp-up electron density while retaining early H-mode and H-mode onset time. An early density reduction of ~20% was achieved, and below this value early locked tearing modes caused plasma disruption. In reduced density (but non-disruptive) conditions, n=3 and n=1

error-field correction (EFC) was applied and the plasma rotation and n=1 mode activity were measured. Early n=3 EFC had only modest impact on the plasma rotation and stability. Early n=1 EFC had a much stronger impact on early plasma rotation. It was found that the optimal correction was achieved when the OHxTF compensation was quickly ramped to full value (within ~50ms) after t=0. However, the optimal correction amplitude was found to be 20-40% lower than that previously used in the high-beta phase of the plasma. With optimal correction the early peak rotation was 50% higher than with no correction, the duration of early n=1 tearing was reduced and the onset delayed, and early transient rotation reduction due to n=1 tearing was avoided. These results indicate further stable density reduction should be possible with optimized early n=1 EFC.

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 the LITER probes, the lithium powder shaker, HHFW and neutral beam heating, the RWM error field coils and neon puffing. Time was taken to complete a Motional Stark Effect (MSE) diagnostic calibration, as well as a magnetic diagnostic calibration, before reversing the machine's toroidal field direction for a planned set of experiments this week and next. The LITER probes were removed at the end of the week to be refilled with lithium and then re-installed over the weekend. Also this week, assembly of the new liquid Lithium Divertor (LLD) plates and testing of the proposed heaters continued in parallel with machine operations, and a preliminary design review of a new fault detector system for the Transrex field coil power rectifiers was held. J.P. Allain of Purdue University visited PPPL this week to lead a discussion on lithium surface chemistry.

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)
- Receiving inspection was performed on the 6 coated LLD plates. 4 plates were adopted for installation and 2 for spares.
- Support /transporter jigs for assembling the LLD plates were completed.
- The LLD plate heaters were received.
- Welding repairs to facilitate the later attachment of cooling tube extensions were completed.
- Testing of nickel coating and procedures for providing a lithium edge barrier were completed.
- A candidate heater exhibited reliable operation in a vacuum test stand for several days at 670°C and testing at 700°C was started (the vendor recommended operating limit in air is 650°C).
- The Safety Review Committee (SRC) approved revisions to the NSTX Safety Assessment Document (SAD) and the Failure Modes and Effects Analysis (FMEA) for the LLD. (M.Viola)

• Lithium Evaporator (LITER 2009)
- Preparation of lithium material for reloading both LITER units was completed.
- The LITER system was used to support experiments to determine the effectiveness of lithium

evaporation into neutral helium as a means to diffuse lithium deposition over the entire interior of the vessel. (C.H. Skinner)

• Lithium Dropper

- Lithium Dropper Bay-C was reloaded to support planned experiments.
- The Safety Review Committee (SRC) approved revisions to the NSTX Safety Assessment Document (SAD) and the Failure Modes and Effects Analysis (FMEA) for the 2 Lithium Droppers. (D. Mansfield)

• Divertor Region Sample Probe

- J. P. Allain (Purdue) visited NSTX. The current state of the data analysis was reviewed. Planning was done for the FY2010 Sample Probe experiments during LLD operations, and FY2011 installations of Purdue instrumentation for in situ analysis of exposed samples. (C. H. Skinner)