

## **NSTX Weekly Report (May 29, 2009)**

### **FY 2009 NSTX plasma operations**

**Planned: Base - 11 run weeks, ARRA - 5 run weeks (pending funding approval)**

**Completed: Base -7.72 run weeks with 1160 plasma shots, ARRA - 0 run weeks**

The paper "Internal transport barriers in the National Spherical Torus Experiment," by H. Y. Yuh et al. has been published in Physics of Plasmas (Vol.16, Issue 5). The paper reports on findings of NSTX internal transport barriers (ITBs) in the electron and ion temperature, and the toroidal momentum channels. In particular, a transition from the normal to the enhanced electron temperature gradients observed in ITBs was found when the value of the local magnetic shear reached a sufficiently negative value, consistent with measurements showing reductions of high-k fluctuations under strongly negative shear conditions and previously published simulation results predicting Electron Temperature Gradient (ETG) mode suppression under these conditions. (H. Y. Yuh, Nova Photonics)

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

**May 21-27:** Very good progress was made in the area of CHI start-up and coupling to induction and in experiments dedicated to the understanding RWM physics in support of the FY09 MHD milestone.

On May 21 and on May 22, XP-928, "Flux savings from inductive drive of a Transient CHI started plasma – R. Raman, B.A. Nelson, D. Mueller, T.R. Jarboe et al." was run. On May 21, the 400ms long CHI discharges developed on May 20 were used to further condition the lower divertor plates. Then the CHI power system was reconfigured for operation using the capacitor banks and the system was tested by generating a few transient CHI discharges. On May 22, Li evaporation was used and the target discharges developed on May 18 were reproduced. The combination of electrode discharges cleaning and Li coatings allowed the performance of CHI started discharges to be significantly improved. Four new CHI results were obtained. First, transient CHI discharges that used three capacitors (15mF) could be successfully coupled to induction. During 2008, the maximum number of capacitors that could be usefully used were limited to two as discharges with three capacitors resulted in more than an acceptable amount of low-Z impurity influx into the plasma. Second, the coupling current was increased to 140kA, which is a new record as the previous record was 100kA obtained on the HIT-II experiment. Third, for the first time in NSTX inductive flux savings was observed, which means that at these levels of startup current in NSTX, low-Z impurities are not an issue. Finally, compared to similar discharges in 2008, higher levels of electron temperature were seen, which is also consistent with the observed flux savings.

On May 26, XP933 "Neoclassical Toroidal Viscosity (NTV) physics at varied normalized ion collisionality and search for offset rotation in NSTX – S.A. Sabbagh" was run. NTV braking from/to varying normalized ion collisionality ( $\nu_i/q\Omega_e$ ) was produced, mostly with lithium conditioning using the  $n = 3$  configuration, with several shots utilizing  $n = 1$  dynamic error field correction. Braking was strong in all cases, indicating no saturation of the effect. Braking of resonant surfaces appeared in many instances, but without locking, even at very low rotation, indicating a lack of the usual inverse scaling with plasma rotation frequency ( $1/f$ ) scaling on resonant surfaces. This effect, and stronger NTV braking at increased  $T_i$  correlate

with lithium operation. Control room analysis does not show evidence of a strong NTV offset rotation – analysis continues.

For part of May 26 and for part of May 27, XP935 “Search for multiple Resistive Wall Mode (RWM) behavior at high BetaN – S.A. Sabbagh” was run. Long pulse lengths and high betaN were produced, with Resonance Field Amplification seed fields (~ 30 Hz co and counter-propagating fields). SXR data showed clear mode activity in the ~ 30 Hz frequency range, penetrating to the core channels at high betaN, which continues to apparently be distinct from the global RWM that causes plasma terminations. Exceptionally high levels of beta-N between 6 and 7 were repeatedly produced, with one shot at reduced plasma current (0.52 MA) reaching a record betaN = 7.4 in the device.

During the afternoon of May 27, XP932 “Influence of Hot Ions on Resistive Wall Mode (RWMs) Stability – J.W. Berkery” was completed. The goal of this experiment was to measure the effect of energetic particles on RWM stability and compare to kinetic theory. We performed a scan of three different beam voltage conditions which all gave the same 4MW of beam power (90 kV on A and B only, 90kV on A and C only, and 90kV on A, 65kV on B and C) for three different plasma current and magnetic field conditions (0.7MA, 0.35T; 0.8MA, 0.40T; and 1.0MA, 0.50T). Unexpectedly, the lower voltage cases seemed to be more stable, in general. We are currently analyzing why this is the case. Preliminary Fast Ion D-Alpha measurements indicate that the hot ion densities were similar for the three beam conditions. Full stability analysis with the MISK code will follow.

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

NSTX operations continued this past week on extended run days, with systems reconfigured for ohmic operations after last week's Coaxial Helicity Injection (CHI) experiments. Lithium evaporation (LITER), the machines error field coils, and neutral beam injection were used in support of experiments studying resistive wall mode behavior, the control of plasma rotation damping, and the formation of plasma edge localized modes. HHFW wave-guide installations continued on the off-shifts this past week.

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.'

#### **Boundary Physics Operations (H. Kugel)**

- Liquid Lithium Divertor (LLD)
  - A teleconference was held with SNL and PPPL to discuss LLD progress and planning.
  - The molybdenum spray vendor completed assays of the spray technique.
  - The LLD plate spraying will start during week of 6/01/09. Delivery to PPPL ~6/15/09.
  - The Control Rack rewiring was completed.
  - 3 heaters with internal thermocouples were vacuum outgassed, coated with graphite, and mounted in an LLD test plate in a vacuum chamber, and pumpdown is in progress for testing to establish control system software design parameters. (M.Viola)
- Lithium Evaporator - LITER 2009
  - LITER-F was removed for the vessel for reloading. (J. Winston)

\* Lithium Powder Dropper

- The vacuum pumpdown of Unit-1 has been completed.
- The vacuum conditioning of the lithium powder was nearing completion.
- The assembly of Unit-2 has started. (D. Mansfield)

Diagnostic Operations (R. Kaita)

- The loan of a PPPL neutral particle analyzer to the Academia Sinica Institute of Plasma Physics in Hefei, China, has been approved by the US Department of Energy. It will be used to perform measurements on the new EAST tokamak.