NSTX Weekly Report (October 15, 2010)

FY 2011 NSTX plasma operations started on October 4, 2010
Planned Run Weeks: TBD
Run Weeks Completed: 1.73 run weeks and 347 plasma shots

At the 23nd IAEA Fusion Energy Conference held October 11-16, 2010 in Daejeon, Republic of Korea, twenty-five NSTX related presentations were made. The oral presentations were as follows: "Overview of Physics Results from the National Spherical Torus Experiment (NSTX)" by R. Raman (University of Washington), "Modification of edge profiles, edge transport and ELM stability with lithium in NSTX " by R. Maingi (ORNL), "L-H Threshold Studies on NSTX" by S. Kaye (presented by H. Meyer of CSC, UK), "Simulation of Energetic Particle-driven Alfven Instabilities with Source and Sink" by G. Fu, "Resistive wall mode stabilization and plasma rotation damping considerations for maintaining high beta plasmas in NSTX" by S. Sabbagh (Columbia University), "Optimization of Density and Radiated Power Evolution Control using Magnetic ELM Pace-making in NSTX" by J.M. Canik (ORNL), "Prospects for pilot plants based on the tokamak, ST and stellarator" by J. Menard and "Lithium Technologies and Their Impact on Boundary Control, Core Plasma Performance, and Operations" by H.W. Kugel. The poster presentations were as follows: "Progress in the Development of Advanced Spherical Torus Operating Scenarios in NSTX" by S.P. Gerhardt, "Demonstration of 300 kA CHI Startup Current Coupling to Transformer Drive on NSTX" by B.A. Nelson (University of Washington), "Onset and Saturation of a Non-Resonant Internal Mode in NSTX and Implications for AT Modes in ITER" by J.A. Breslau, "Dependence of impurity transport on ϱ*, ν*, rotation and MHD in NSTX" by L. Delgado-Aparicio, "Pedestal Characterization and Stability of Small-ELM Regimes in NSTX" by J-W. Ahn (ORNL), "Dependences of the divertor and midplane heat flux widths in NSTX" by T.K. Gray (ORNL), "Plasma Modeling Results, Control Improvement for NSTX" by E. Kolemen, "Pedestal Characterization and Stability of Small-ELM Regimes in NSTX" by A. Sontag (ORNL), "Synergy Between Lithium Plasma-Facing Component Coatings and the Snowflake Divertor Configuration in NSTX" by V. Soukhanovskii (LLNL), "H-mode transition and E formation analysis of NSTX based on the gyrocenter shift" by K.C. Lee (UC Davis), "Global Gyrokinetic Simulation of Electron Temperature Gradient Turbulence and Transport in NSTX Plasmas" by S. Ethier, "Characteristics of Turbulence Driven Multiple-Channel Transport in Tokamaks, and Comparison with Experiments" by W.X. Wang, "The Impact of 3-D Fields on Tearing Mode Stability of H-modes" by R. Buttery (General Atomics), "Robust Correction of 3D Error Fields in Tokamaks including ITER" by J-K. Park, "Observation of Global Alfvén Eigenmode Avalanche events on the National Spherical Torus Experiment" by E. Fredrickson, "Recent Developments in High-Harmonic Fast Wave Physics in NSTX" by B.P. LeBlanc, and "Non-linear dynamics of toroidicity-induced Alfven eigenmodes on NSTX" by M. Podestà,

Run Coordination (E. Fredrickson, S. Sabbagh - Columbia University)

Thursday 10/7:

Dave Smith completed his XP1038 to study multi-scale turbulence with the BES diagnostic. In the afternoon Guo-young Fu completed XP1015 to acquire data for validation of the numerical modeling codes NOVA and M3D-k.

Friday 10/8:

Due to the failure of the Bay-K LITER shutter, we began this and subsequent run days by evaporating ~2g of lithium from the Bay-K unit, after which we turned off the evaporator for the rest of the run day. This allowed the Thomson scattering diagnostic to operate with a lower risk of suffering from lithium coating of its viewing window.

Shige Kubota was able to produce Ohmic H-modes for a study of turbulence at the transition with the correlation reflectometer (XP1039). Data from a full complement of turbulence diagnostics including correlation reflectometer, Gas-Puff Imaging, far infrared tangential later interferometer, edge probes was obtained from more than a dozen ohmic L-H transitions. In the afternoon, Dave Smith completed his experiment to measure the anisotropy of turbulence with the high-k scattering diagnostic (XP1070).

Monday 10/11 and Tuesday 10/12:

On both days, the RF team conducted conditioning of the HHFW system under XMP026.

We gradually increased the coupled power to 1.35 MW in RF-heated helium shots. Initially, ejections of material from the plasma-facing surface of the antenna shield occurred as the power was raised, but these gradually subsided. We then tested the thesis that we might be able to clean the antenna surfaces by running plasmas heated by NBI close enough to it that escaping neutral beam ions would heat the protective boron nitride tiles at the center of the antenna. Similar plasmas were then run with the center displaced +/- 20cm vertically. The location of the peak heating measured on the boron nitride also moved up and down and strong interaction with antenna surface was observed. This demonstrated that, in principle, this technique could be used to clean a large amount of the lithium from the outer surfaces of the antenna.

Wednesday 10/13:

In the morning, we conducted Joel Hosea's XP1017 to measure heating at the outer divertor plate produced by RF power lost directly through the SOL plasma along the field lines. RF power up to 1.35MW was used. The power deposition on the outer divertor plate during the RF-heating was measured with the fast dual-band IR camera at Bay H for the first time. Although the power deposited was lower than some shots in 2009, it was sufficient to give a clear measurement of the tile heating with good time resolution. A scan of the magnetic field pitch confirmed that the RF heat deposition moved to lower major radius as the field pitch was increased. This had been observed previously with the slower IR system at Bay I. These new measurements will also provide the magnitude of ELM heat deposition adding to the RF deposition.

In the afternoon, Devon Battaglia used the HHFW heating system to investigate the L- to H-mode transition power in XP1029. Good progress was made in characterizing the threshold power in deuterium plasma, although progress was slowed somewhat by locked modes which developed in some of these relatively low-density plasmas.

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

NSTX plasma operations for FY11 continued this past week with a set of experiments utilizing High Harmonic Fast Wave (HHFW) and neutral beam heating, and lithium conditioning via evaporation and the Li dropper. The lithium evaporation probe ran dry late in the week, and will be replaced with a freshly-loaded unit over the weekend to be ready to support experiments on Monday. Also this week, the commissioning of a hot air system proposed to be used to heat

the four LLD plates continued, and is expected to be ready to use later this month.

Access to the NSTX test cell will be restricted during plasma operations this coming week. Access is expected to be available each evening.

Research Operations (M. Bell)

Boundary Physics Operations (H. Kugel)

• Liquid Lithium Divertor (LLD
- The plate air heating controls were completed, and are awaiting operational testing.
- The plate air heating air supply connection manifold was completed, and is awaiting operational testing.
- Preliminary checkout of the air compressor was successful. This system is awaiting installation of the high capacity drier and final testing.
- Preparations are underway for the Final Design Review

• Lithium Evaporators (LITER)
- The LITER-K2 unit was emptied of lithium in support of operations.
- Outgassing of the reloaded LITER-K1 unit was completed.
- Preparations were completed for replacing the LITER-K2 with reloaded LITER-K1.

• Molybdenum Inner Divertor Tiles
- A preliminary engineering report was completed on "Recommendations for Attachment of TZM Molybdenum Plates to Lower Inboard Row-1 Divertor Tiles in NSTX" based on 3D analysis for lithium coated, 0.5 inch, Mo(TZM) plates for LSN and DN plasmas for the worst case power depositions of 4.73 MW/m2, 5 sec.
- Analysis of a brazed Mo(TZM) assembly concept found that it had the lowest peak front face temperatures relative to bolted concepts, but it had the highest peak stress, well above acceptable limits.
- Analysis has found that stress in both the brazed and tightly clamped cases exceeded acceptable limits. However, it was found that mild attachment via locating bolts with loose Belleville washers will allow TZM plates to expand/contract/distort freely. Without brazed contact with the graphite, the Mo(TZM) will see higher front-face temperatures but still within a reasonable service range.