

## NSTX Weekly Report (October 5, 2007)

### FY 2008 NSTX plasma operations

**Planned: TBD**

**Completed: 0 weeks**

- The FY 2007 NSTX DOE/OFES Joule milestone, “*Measure and identify magnetic modes on NSTX that are driven by energetic ions traveling faster than the speed of magnetic perturbations (Alfvén speed); such modes are expected in burning plasmas such as ITER*” was successfully completed on schedule and a report was submitted to OFES. The instabilities most clearly associated with super-Alfvénic fast ions in NSTX have been identified as three branches of various Alfvén Eigenmodes, such as Toroidal Alfvén Eigenmodes, Reversed Shear Alfvén Eigenmodes, and Beta induced Alfvén-acoustic Eigenmodes. The entire Alfvén Eigenmode stability space - from no Alfvén Eigenmodes to Alfvén Eigenmode avalanche threshold – has been mapped and comprehensively diagnosed for the first time in NSTX. This mapping was achieved by varying the Neutral Beam Injection (NBI) source voltage (power) and diagnosing the Alfvén Eigenmodes and the effects of the modes on fast-ions and the bulk plasma. As the NBI fast ion pressure is increased above threshold following beam turn-on, mode onset is observed, followed by frequency chirping of the modes as the fast ion pressure increases. As the input NBI power (and fast-ion pressure) is further increased, multiple Alfvén Eigenmodes which overlap in frequency are excited leading to a burst of rapid fast-ion transport/loss and an associated decrease in neutron rate. Also in FY 07, a scan in plasma beta in NSTX confirmed a beta threshold for suppression of Alfvén Cascade Modes in accord with theoretical predictions. Further, good agreement was found between the observed onset frequency and the frequency estimated from a simple dispersion relation for Geodesic Acoustic Modes. At higher ion cyclotron range of frequency, Compressional Alfvén Eigenmodes at frequencies in the range  $0.2 W_{ci} \leq \omega \leq W_{ci}$  are commonly seen in NSTX plasmas. Alfvénic bursts with strong frequency chirps have been observed, and the mode frequency chirps simultaneously up and down (“Angelfish”). The frequency evolution of the bursts is well described by the “Hole-clump pair” theory.

- A manuscript entitled “Microtearing Instabilities and Electron Transport in the NSTX Spherical Tokamak” by K. L. Wong et al., was published in the September 28 issue of Physical Review Letters. Microtearing modes were found to be unstable in an H-mode NSTX plasma with neutral beam heating. Due to its low magnetic field, these unstable modes saturate at high amplitude resulting in stochastic magnetic field. The calculated electron thermal conductivity based on existing theory agrees with the result from transport analysis of the experimental data. Without using any adjustable parameter, the good agreement spans the entire region where there is a steep electron temperature gradient to drive the instability. (K. L. Wong)

- A manuscript entitled “Gyrocenter Shift of Low-Temperature Plasmas and the Retrograde Motion of Cathode Spots in Arc Discharges” by K. C. Lee of University of California at Davis was published in the August 10 issue of Physical Review Letters. This work is an extension of the gyrocenter shift theory by K.C. Lee used to explain the high confinement mode (L/H transition) transition in tokamaks. The manuscript reports the generalization of same theoretical model explains the retrograde motion of cathode spot in the arc plasma discharges. The ion drift

velocity profiles calculated from the model are in agreement with the experimental results as function of magnetic flux density and gas pressure. (K.C. Lee)

- Stanley Kaye attended the 13<sup>th</sup> meeting of the ITPA CDBM, Transport and Pedestal groups, which was held in Naka, Japan from 1 to 3 October 2007. He gave updates on the NSTX 2008 Run Plan and the CDB.2 task on incorporating low aspect ratio (NSTX and MAST) into the ITPA database. In addition, he reported on results from beta scaling experiments, momentum transport and pinch studies, and density peaking studies in NSTX, the latter as a collaborative study with MAST. The three research-related talks elicited much interest. One example is with the result of confinement degradation of beta in weakly shaped plasmas, which indicated the important role of ELMS in causing this degradation. David Mikkelsen also made a presentation entitled "Recent results from ETG simulations of an NSTX discharge." Other devices such as JET and DIII-D are reporting the importance of the plasma edge and/or ELMs in controlling the beta degradation. Also attending the meeting from PPPL were Robert Budny, David Mikkelsen and T.S. Hahm. (S. Kaye, D. Mikkelsen)

- There will be an NSTX Physics Meeting on Monday, 10/8 at 1:30 pm in LSB318. The agenda is: "Status and needs for APS Invited talks" by J. Menard, "Update on analysis of EBW emission from NSTX" by S. Diem, and "Blobs in the divertor region" by R. Maqueda. We will follow up with additional meetings discussing the status and requirements for the APS Invited Talks.

**Tues, Oct. 9, 1:30 PM in LSB318** – K. L. Wong, V. Soukhanovskii, K. Tritz

**Thurs, Oct. 11, 1:30 PM in LSB318** – J. Hosea, H. Kugel

**Mon, Oct. 15, 1:30 PM in LSB318** – N. Crocker (S. Kaye)

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

The NSTX outage continued this past week with the completion of the installation of twelve new halo current sensors in the vacuum vessel. The secondary passive plates and tiles removed for this installation have been reinstalled to a point which still allows work to continue on the installation of the new divertor bolometer vacuum interface. The high-k scattering diagnostic collection mirror was re-installed in the vessel, and the installation of in-vessel parts for PCHERS is ready to start. Also, a review of the LITER system configuration for the 2008 run was held this past week.

The NSTX test cell will be in unrestricted (card reader) access this coming week.

### **Research Operations (M. Bell)**

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

- A Final Design Review was held for the NSTX FY08 Lithium Evaporator Configuration. Helpful CHITS were received.

- \* At a Peer Review for adding midplane molybdenum port shielding, the merits of using the shield at Bay K to provide an edge calorimeter for measuring edge power deposition was discussed. Adding thermocouples for this purpose is under investigation.

- A meeting was held to identify IR window viewports for FY08 experimental requirements.

#### Diagnostic Operations (R. Kaita)

- Mirror has been modified and re-installed in machine. Remainder of modifications are outside the vessel and will be pursued after the vessel is closed up
- The installation of the outboard divertor halo current sensors has been completed.
- A peer review was held on the method of installation of a thick-film magnetic sensor. If tests of it are successful under NSTX plasma conditions, it could serve as a prototype for a future poloidal array.