NSTX Weekly Report (August 20, 2010)

FY 2010 NSTX plasma operations
Planned: Total - 15 run weeks (Base - 14 run weeks, ARRA - 1 run week)
Total completed – 9.69 run weeks and 1812 plasma shots
Completed: Base – 8.68 run weeks and 1641 plasma shots
Completed: ARRA -1.01run week and 171 plasma shots

E. D. Fredrickson and Luis F. Delgado-Aparicio attended the joint International Congress on Plasma Physics and Latin American Workshop on Plasma Physics in Santiago, Chile, August 8-13, 2010. Fredrickson presented an invited talk entitled "Recent Results from the National Spherical Torus Experiment." The talk described the NSTX program and goals with a slight emphasis on energetic particle physics. Delgado-Aparicio presented an invited talk entitled "Development of Multi-Energy Soft X-ray (MESXR) Imaging For Magnetically Confined Fusion Studies", in which he described how this technique was developed as well as its current uses in a variety of radio frequency heating experiments, fast electron temperature measurements and perturbative impurity transport studies; examples of the impact on the ME-SXR profiles from several types of MHD activity in NSTX. This kind of imaging systems is currently being adopted in the US, Japan, Rusia and Costa Rica and are planned to be used in both tokamak and stellarator programs. (E.D. Fredrickson, L.F. Delgdo-Aparicio)

Luis F. Delgado-Aparicio attended the 13th Latin American Workshop on Plasma Physics (LAWPP) in Santiago, Chile, August 1 – 6, 2010 where he participated as a lecturer giving three talks on fundamentals of nuclear fusion, magnetic confinement schemes as well as a review on x-ray spectroscopy. At the workshop, Delgado-Aparicio was elected to serve in the LAWPP international advisory committee. (L.F. Delgdo-Aparicio)

A paper entitled "An all metal transformer core for the Spherical Torus" by D. A. Gates, C. Jun, I. Zatz, and A. Zolfaghari has been accepted for publication in Fusion Engineering and Design. The paper describes a center-stack-with-iron-core-transformer concept that incorporates high resistivity inserts to break up eddy current patterns in the copper toroidal field coil. The calculations in the paper are from a full 3-D time dependent model developed within the MAXWELL electromagnetics code. The main result was that useful loop voltages for plasma startup can be generated using this method using a system that should be compatible with high neutron flux. (D. Gates)

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

On Thursday, August 12, 2010, XMP64 (Mueller) was run to eliminate a lithium deposit on the inner divertor that was interfering with the high triangularity operation. The inner divertor was conditioned significantly, allowing operation of both low and high triangularity target plasmas by midday. XP1059 Liquid Lithium Divertor (LLD) commissioning (Kugel) followed, with the objective of placing the outer strike point on the LLD and evaluating conditions. With no additional lithium deposition after approximately 100 shots, an increase in plasma density is observed. However, the increase is sufficiently small that a reduction in gas fueling has been sufficient to counteract the increase so far.

On August 13, 2010, two XPs were attempted, Wayne Solomon's XP1042, Characterization of

intrinsic torques using torque transients and Vlad Soukhanovskii's XP1001, "Recycling and pumping characterization of the LLD." However, the required shot reproducibility for XP1042 was not achieved perhaps due to the lithium residue still left in the lower inner divertor. XP1001 LLD Pumping (Soukhanovskii), which used lower triangularity target plasmas that were not highly affected by the lithium residue, was run. Supersonic gas injector was used to inject short diagnostic gas pulses to study the recycling response of the LLD and lithium-coated divertor graphite tiles. Starting from a nearly Edge Localized Mode (ELM)-free H-mode obtained with Lithium Evaporators (LITERs), the LITER system was then turned off. In three discharges, higher-recycling divertor condition returned and ELMs re-appeared, suggesting that the lithium coating from the earlier intense lithium evaporation had been fully saturated.

On August 16 and the morning of August 17, we ran and completed the third day of Rajesh Maingi's FY 2010 Joint Research Milestone XP1043 to characterize divertor heat flux profiles with low triangularity plasmas. A shape that matches the poloidal cross-sections in Alcator C-Mod and DIII-D was run, to assess the effect of aspect ratio on the Scrape-off-Layer (SOL) width. Several good discharges with different fueling rates were used for a collisionality scan. In addition, the effect of drsep on SOL width was carefully documented in high triangularity discharges, with controlled strike point locations. Finally the effect of drsep at low triangularity was assessed. A drsep variation from -7mm to -13mm was obtained with good heat flux measurements, and the point at drsep=0 was nearly completed.

On August 17, in the afternoon, we completed Jong-Kyu Park's XP1048 to study characteristics of ELM triggering with ResonantR Magnetic Perturbations (RMPs) in an extended run until 7pm. The main goal was to measure the RMP thresholds of ELM triggering vs. q95, since q95 is one of the most important variables to determine the coupling between plasmas and RMPs. Results showed the higher threshold for the lower q95 when target plasmas have q95=6~11. The tendency was clear, but was not linear, and also the experiments showed a possibility that the threshold might be not decreased, but increased when q95>12. The indication is that NSTX RMPs may have the optimal q-window for ELM triggering.

On August 18, XP1022 (Y-S. Park) was run to examine initial operation of the new NSTX Resistive Wall Mode state-space controller (RWMSC), implemented by Columbia U. and PPPL. Control of resonant field amplification of both DC and AC applied n = 1 fields was examined, and primary controller parameters were varied. Variations in mode control were observed as the feedback phase between the sensor measurements and actuator fields was varied. Long pulse Ip = 1MA target plasmas at low li and high normalized beta were produced. This is the first application of such a controller in low collisionality, high beta plasmas.

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

NSTX plasma operations continued on extended shifts this past week with experiments utilizing lithium evaporation, neutral beam heating, and Resistive Wall Mode (RWM) feedback via the Switching Power Amplifier (SPA) driven error field coils. The control dynamics and physics of the RWM was studied in an experiment utilizing a new control scheme that incorporates a physical model for the coupling of the RWM to NSTX conducting structure, and an electromagnetic model of the expected currents in that conducting structure. Also this week, vacuum conditioning of the HHFW antennas was performed in the off-shifts.

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 Dvertor (LLD)
  - Aplan was developed for installing and testing a 4-plate air heating system as soon as ready.

• Lithium Evaporators (LITER)
  - LITER units K1 and F2 were used each day to support Experimental Proposals (XPs.
  - LITER units K2 and F1 were successfully out-gassed on their respective Fill Stands to operating temperatures of 600°C. During this process the out-gassing was monitored for the first time using a newly installed Residual Gas Analyzer (RGA) system.

• Lithium Powder R&D
  - Experiments were started on the development of a lithium powder centrifugal injection method for ELM control.