NSTX Weekly Report (Aug. 21, 2009)

FY 2009 NSTX plasma operations
Planned: Total - 16 run weeks (Base - 11 run weeks, ARRA - 5 run weeks)
Completed: Total - 16.84 run weeks with 2,748 plasma shots
(Base - 10.95 run weeks with 1,705 plasma shots
ARRA - 5.89 run weeks with 1,043 plasma shots)

• NSTX successfully completed its FY 2009 plasma campaign on August 14, 2009. NSTX met or exceeded all the facility operational milestones including the ARRA extended five run weeks. NSTX achieved 16.84 run weeks (target - 16 run weeks) with 2748 plasma shots, the most plasma shots per year with the highest plasma shot efficiency of 94.7%. The NSTX research team conducted over 50 experimental and machine proposals utilizing new capabilities including HHFW upgrades, dual lithium powder dropper, CHI absorber coils, a sample probe, and NBI feedback capability.

• The paper "Plasma Response to Lithium-Coated Plasma-Facing Components in the National Spherical Torus Experiment" by M. Bell et al. has been accepted for publication in Plasma Physics and Controlled Fusion. The paper accompanies Dr. Bell's invited talk at the 36th European Physical Society Conference on Plasma Physics in Sofia, Bulgaria in July. (M. Bell)

• Noah Smick of the MIT Plasma Science and Fusion Center gave a seminar entitled “Scanning Langmuir Probe Measurement of Plasma Flow in the Alcator C-Mod Scrape-Off Layer." (R. Kaita)

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

NSTX Plasma Experimental Highlights for August 13 - 14, 2009**:** During these final two days of the FY09 NSTX Run, carbon and tungsten dust transport studies were conducted in support of ITER activities. Studies related to L-H threshold and edge transport and turbulence in NSTX reversed B_t discharges were completed.

On Aug 13, XMP-26 “Bring High Harmonic Fast Wave (HHFW) online and condition antennas” - J. Hosea - was run with the toroidal field reversed for the first time. A 600 kA helium target at B_t=+0.45T was used to conduct a phase scan at -90 and +90 degree strap-to-strap phasing. Then a deuterium target, with 2 MW of NBI, was used to study HHFW coupling at -90 degree phasing. Up to 2MW of HHFW was coupled, but the central electron temperature only increased to 1.5keV. In general RF coupling in the reversed B_t configuration was found to be difficult, apparently because the discharge conditions were not as “conditioned” as for the normal B_t direction. IR camera data was obtained on divertor heating and fast high resolution visible TV cameras, located at Bay B and Bay L, were used to monitor the antenna-plasma interaction.

For part of August 12 and 13, Parts 4 and 1 of XP-956, “L-H threshold and edge transport and turbulence in NSTX reversed B_t discharges” – S. Kaye – was completed. Part 4 studied the density, radiation, and impurity evolution of reversed B_t early H-mode discharges with no or small ELMs (due to LITER operation) as a function of magnetic balance. The density evolution and carbon impurity concentration were found to be a sensitive functions of the drsep

parameter during the early ramp-up phase of the discharge following the H-mode transition. Bias in the favorable grad-B drift direction had the highest density rate of rise, and transitions to negative drsep (unfavorable direction) during the flat-top had similar density and impurity evolution. However, for discharges with negative drsep throughout the ramp-up, the H-mode transition was slightly delayed, but H-mode was obtained, and the density was reduced by 15% and the carbon density by 35-40% during the I_p flat-top. The plasma temperatures increased with negative drsep, and global energy confinement was as high or higher than for positive drsep. These results indicate that despite the higher H-mode threshold power, bias in the unfavorable grad-B drift direction can provide high thermal confinement with reduced impurity confinement in ELM-free discharges - a result important for operation with lithium. (J. Menard)

Part 1 of XP-956 studied the role of reversed B_t on SOL and divertor transport in low triangularity discharges. A power scan was obtained in LSN discharges with reversed B_t, as well as a limited I_p scan. The inner divertor was clearly attached in these cases (peaked heat flux profile, low D-alpha, no volume recombination), as compared to the normal inner divertor detached operation with forward B_t. A few extra discharges were run with gas puffing to attempt detachment of both the inner and outer divertor legs. (R. Maingi)

On August 13 a few shots were devoted to improving the real-time calculation of the plasma shape. The basis functions in use during real-time EFIT computations, used for feed-back control of the plasma shape in NSTX, were improved by using the same constraints as fully-converged reconstructions of the plasma equilibrium using external magnetic diagnostics alone (EFIT-01). The previous version of rtEFIT was limited to p' functions linear in normalized poloidal flux (psin), ff' functions quadratic in psin, and zero edge current density. EFIT-01 constraints have p' quadratic in psin, ff' cubic in psin, and allow finite edge current density. With this change, both oscillations in the time evolution of the vertical field coil current and fluctuations in the rtEFIT β_N calculation were substantially reduced. (S. Sabbagh, S. Gerhardt, D. Gates)

On August 13 and 14, a few He plasma discharges were run in support of XMP-56 "Helium shots for initial operation of the SWIFT camera" – N. Nishino. This is an ion velocity measurement diagnostic based on a Shifted Wavelength/Interference Filter Technique. The diagnostic relies on two images with He II emission to deduce the 2-D ion flow map. Two images using ~5m fiber bundle were successfully obtained. This data will be used in the future to change the spatial resolution with a different combination of fiber bundle and lenses.

On August 14, shots under XP-928 "Flux savings from inductive drive of a transient CHI started plasma" – R. Raman – with the polarity reversed from normal were attempted but were not successful due to problems which developed with the gas system.

We then ran a few plasmas under XP-955 "Basic Operation with Reversed TF" – D. Mueller – during which Li powered was dropped into an upper single discharge to see if this method results in Lithium coating of the upper divertor region. Useful results were obtained.

On August 14, XP-938, "Dust mobilization from ITER-scale castellation gaps" – C. Skinner – was run. A boron nitride sample with 0.5 mm gaps filled with carbon particles was inserted into the lower vessel and subjected to a fast downward disruption. Initial results indicate that about 12% of the carbon dust was mobilized from the gaps. Data analysis is ongoing.

On August 14, XP-957, "Tungsten Dust transport using the Li powder dropper" – L. Roquemore – was run. The Li power dropper was used to introduce 5-micron diameter tungsten powder into the SOL of NSTX. Three discharges were run. One shot was obtained with strong tungsten signal. Two fast cameras observed the incandescent particles in the SOL. Tungsten lines also appeared on the Johns-Hopkins Transmission Grating Spectrometer and on the LLNL LoWEUS x-ray spectrometer. The tangential bolometer showed near record radiated power. No tungsten was introduced on the last shot of the run and both of the x-ray spectrometers recorded no tungsten lines even though the visible cameras did observe that a very few tungsten particles were dislodged from the flight tube at the beginning of the discharge. The total amount of tungsten dropped into NSTX was estimated at ~10 micrograms though this will take an off-line calibration to confirm.

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

NSTX post run diagnostic calibrations were performed this week with calibrations of the machine's ion gauges and RGA, followed by individual machine coil operation to calibrate magnetic diagnostics. The NSTX vessel pressure was then brought to various levels of nitrogen and argon to perform Rayleigh and Raman Scattering calibrations of the MPTS diagnostic. A final calibration of the LITER lithium evaporator will be performed when the remaining inventory of lithium is evaporated into the vessel early next week. Vessel pumps/purges in preparation for initial access are scheduled to begin next week.

The NSTX test cell will be in free (card reader) access Tuesday through Friday this coming week.

Research Operations (M. Bell)

Boundary Physics Operations (H. Kugel)

• Liquid Lithium Divertor (LLD)
- Dressing of the tapped support and heater holes in the test plate was completed.
- Dressing of the tapped holes in the first molybdenum-coated plate was started.
- A trial fit-up of the corner supports for the test plate was completed.
- A trial fit-up of the test plate to the divertor passive plate mockup was started.
- The nickel coating of all vertical copper edges of the test plate was completed.
- IP3178 was completed and is being tested using the test plate mockup. (M. Viola)

• Lithium Evaporator (LITER2009)
- The LITER system was used to maintain lithium wall conditions for the last week of the 2009 run. (J. Winston)

• Lithium Evaporator (LITER 2010)
- Work started on fabricating 2 spare LITER probe systems to support LLD operations. (T. Provost)

• Lithium Powder Droper
- The lithium powder dropper system was used to support experimental work during the last week of the 2009 run. (D. Mansfield, L. Roquemore)

• Tungsten Powder Dropper

- The tungsten powder dropper system was used to support XP-957. As the amount of tungsten particles injected into the machine was increased the LoWEUS spectrometer recorded spectra of first, second, and third order of tungsten lines with a time resolution of about 50 ms. On the subsequent discharge no tungsten was injected and the spectra from this discharge showed that no tungsten was present in the plasma. (D. Mansfield, L. Roquemore, J. Clementson (LLNL), P.Beiersdorfer (LLNL))

Plasma Diagnostic Operations (R. Kaita)

• The major focus of diagnostic activities has been post-run calibrations prior to venting the NSTX vacuum vessel. Measurements with magnetic sensors were completed with the pulsing of the field coils without plasmas. The Thomson scattering diagnostic was operated with the vacuum vessel at various nitrogen gas pressures to obtain Rayleigh and Raman scattering data.