Recent Progress and Near-Term Plans of NSTX Research Program

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The National Spherical Torus Experiment (NSTX) Team began in October 2000 a 3-month initial study of Spherical Torus (ST) plasma properties using large auxiliary heating power. Up to 4.5 MW from Neutral Beam Injection (NBI) and 3 MW from High Harmonic Fast Wave (HHFW) heating was applied to plasma pulses with durations up to 0.5s and with up to 4.5 kG toroidal field applied at the device major radius of 85 cm [1]. Modern device capabilities and diagnostics also came online to produce a broad range of plasma conditions at the MA current level and measure the plasma properties [2].

The initial results are encouraging and intriguing. NBI heating produced peak ion temperatures > 2 keV, a rich collection of plasma oscillations including Alfvén modes, average densities of $2\text{-}5 \times 10^{19}$ m^{-3}, and plasma rotation speeds up to 200 km/s. Peak electron temperatures > 1 keV were obtained using HHFW alone. Stored energies > 150 kJ, energy confinement times up to 70-80 ms, and toroidal average betas (β_T) ~ 20%, were estimated from magnetic equilibrium analysis for some of these plasmas, which were obtained with up to 3 MW NBI power apparently without H-mode transitions. Separately, "High-Confinement-Mode" plasmas also emerged using ~ 1 MW NBI power. Electron Bernstein Wave emission was measured, showing the expected strong dependence on the plasma edge density gradient. Toroidal currents up to 260 kA were produced noninductively using Coaxial Helicity Injection (CHI) alone. Many phenomena new to toroidal plasma confinement were observed, pointing to new opportunities for scientific progress as well as challenge in magnetic fusion research.

Research in the next three years will use non-inductive assisted operation to create plasma conditions for the investigation of ST plasmas for durations much larger than the energy confinement times. Research in the succeeding three years will use non-inductive sustained operation to create the plasma conditions for investigation for durations comparable to the plasma current penetration time. The implications of the planned research to future ST development will be discussed.

[1] M. Ono et al., "NSTX Project Overview," this workshop.
[2] M. Bell et al., "NSTX Diagnostics and Operation: Status and Plans," this workshop.

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