Confinement, Transport and Turbulence Properties of NSTX Plasmas

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NSTX operates at low aspect ratio (R/a≤1.3) and high beta (up to 40%), allowing tests of global confinement and local transport properties that have been established from higher aspect ratio devices. NSTX plasmas are heated by up to 7 MW of deuterium neutral beams with preferential electron heating as expected for ITER. Confinement scaling studies of H-mode plasmas indicate a strong B_T dependence, with a current dependence that is weaker than that observed at higher aspect ratio. Dimensionless scaling experiments indicate a strong increase of confinement with decreasing collisionality and a weak degradation with beta. The increase of confinement with B_T is due to reduced transport in the electron channel, while the improvement with plasma current is due to reduced transport in the ion channel related to the decrease in neoclassical transport levels. Both linear and non-linear microinstability simulations indicate the potential importance of ETG modes at the lowest B_T. Improved electron confinement has been observed in plasmas with strong reversed magnetic shear, showing the existence of an electron internal transport barrier (eITB). The reduction in transport in the Reversed Shear plasmas is associated with reduced microtearing activity, as predicted by linear gyrokinetic calculations. Perturbative studies show that while L-mode plasmas with reversed magnetic shear and an eITB exhibit slow changes of L_{Te} across the profile after the pellet injection, H-mode plasmas with a monotonic q-profile and no eITB show no change in this parameter after pellet injection, indicating the existence of a critical gradient that may be related to the q-profile. Localized measurements of high-k fluctuations exhibit a sharp decrease in turbulence levels across the L-H transition, associated with a decrease in calculated linear growth rates across a wide k-range, from the ITG/TEM regime up to the ETG regime.

This work was supported by U.S. DOE Contract DE-AC02-76-CH03073.