The Enhanced Pedestal H-mode in the National Spherical Torus Experiment*

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Spherical tori (ST) have demonstrated higher β operation than higher aspect ratio devices, as predicted by theory[1]. In present-day STs, this higher β operation is enabled partly by operation at low toroidal field, B_t. An apparent consequence of this parameter regime is relatively low H-mode pedestal temperatures, as also prediced by some theories[2]. Indeed, typical H-mode pedestal electron temperatures in the National Spherical Torux Experiment (NSTX) and the Mega-Amp Spherical Tokamak range from 100-300 eV[3, 4]. However, a new operating regime has been observed in NSTX in which the pedestal ion temperature spontaneously increased to ~ 650 eV in about 50ms, or one energy confinement time, resulting in a global energy confinement (τ_E) improvement, i.e. with $\tau_E/\tau_E^{ITER89\text{-}P}$ up to 2.7. Ion temperature gradients as high as 30 keV/m are observed.

The regime is correlated with a localized braking of the edge toroidal rotation several cm inside of the separatrix near the q=3 surface, and increased rotation in the core plasma. Locally near the low rotation point, the radial electric field, E_r, as calculated from the lowest radial force balance becomes dominated by the pressure gradient term, as both the toroidal and poloidal rotation have negligible contributions. Coupled with increased rotation in the core, the radial electric field shear is also increased. In certain cases these discharge scenarios have a very low or no central current density, possibly leading to a reduced normalized beta limit β_N~ 4.5 (%-m-T/MA). The observed characteristics of this scenario will be presented.

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