Stochastic Magnetic Fields and the Saturation of Beta in W7-AS*.

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Quasi-stationary, MHD-quiescent discharges with $\langle\beta\rangle$ up to 3.5% were sustained with neutral-beam heating in W7-AS for more than 100 energy confinement times.. The achieved $\langle\beta\rangle$ is limited by confinement, not stability, and is above the linear ideal stability threshold. The maximum $\langle\beta\rangle$ is observed to vary strongly with the magnetic configuration, including the rotational transform (iota) and excitation of the divertor control coil. Neutral beam heating power scans are analyzed for vacuum iota values of 0.445 and 0.575. The scans saturate at $\langle\beta\rangle$ values of 3.1% and 2.1%, respectively. At low power, both scans show confinement incrementally varying as $\tau_E \propto P_{NB}^{-0.5}$. At high P_{NB}, the confinement incrementally varies as $\tau_E \sim P_{NB}^{-0.8}$. In both scans, only the central T_e responds to increasing power. T_e and ∇T_e do not change appreciably in the outer region of the plasma as P_{NB} increases, indicating an increase in local thermal diffusivity. The edge ∇T_e is approximately a factor of two larger for lower iota. The role of the magnetic flux topology has been analyzed using the PIES 3D equilibrium code. It calculates that a stochastic field region forms at the edge with increasing $\langle\beta\rangle$, and that it reduces the minor radius by ~30% at the saturated $\langle\beta\rangle$ value. In the higher iota scan, this occurs at lower $\langle\beta\rangle$ and the stochastic region has a shorter connection length, plausibly explaining the reduced ∇T_e, and lower saturated $\langle\beta\rangle$. Similarly, the variation of maximum $\langle\beta\rangle$ with the excitation of divertor control coil is also correlated with the calculated stochaticization of the outer ~30% of the flux surfaces.