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Pedestal regulation techniques for enhanced confinement regimes on Alcator C Mod[1]

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Recent research on Alcator C-Mod has achieved greater leverage on global confinement through both optimization and active modification of the edge pedestal. Pedestal scalings that are quite robust in typical H-mode operation can be broken, and particle and thermal transport in the edge barrier can be decoupled substantially. In H-mode, pedestal parameters show a striking sensitivity to the ion $B \times \nabla B$ drift direction, relative to the active x-point position, with considerable variability observed when the distance between separatrices is on the order of the pedestal width ($\approx$5mm) or less, *i.e.* very near double null (DN). Near DN H-modes can have improved confinement factors ($H_{98} > 1$) as a result of elevated pedestal temperature (T_{ped}), with the edge regulated by benign small ELMs or continuous modes, regimes desirable for ITER and other future devices. Operating with a single null and with ∇B drift away from the x-point allows the formation of discharges with L-mode-like particle confinement, yet with excellent energy confinement. This enhanced confinement regime has demonstrated $H_{98} \approx 1$, T_{ped} $\approx$1keV, and can be maintained steady-state with no ELMs by operating with high current and strong shaping, while holding input power below the L-H threshold to suppress particle barrier formation. Additional pedestal modification has also been obtained in H-modes by application of lower hybrid (LH) waves. Strong relaxation of the density pedestal is observed and accompanied by increases in T_{ped}, providing a substantial reduction in overall collisionality and somewhat improved confinement. Direct interaction of the LHRF with the edge plasma appears to play a role in enhancing the pedestal particle transport, which conveniently relaxes the discharge to a less dense and hotter state, one more conducive to core LH penetration and damping. In all cases, strongly modified pedestals affect core properties, often including surprising effects on core rotation.

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