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Pedestal and Transport Properties of Steady-state I-mode Plasmas over Expanded Operational Space in Alcator C-Mod[1]

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I-mode operation on Alcator C-Mod combines a strong edge thermal transport barrier with L-mode levels of particle and impurity transport, allowing access to very high performance discharges with low pedestal collisionality and central temperatures up to 8 keV, and without large ELMs or other intermittent edge instabilities. In recent campaigns, C-Mod I-modes have been extended to quasi-steady-state, with access in both favorable and unfavorable ion drift directions and typical normalized energy confinement quality factor H_{98} $\sim$1.0 to 1.2. Adding ICRF mode-conversion flow-drive enhances toroidal flow shear near the plasma edge and confinement is further enhanced. I-mode has been maintained with input power up to nearly 2x the I-mode threshold power, with the largest accessible range in closed divertor geometry at modest triangularity. Simple extrapolations at fixed field imply that ITER in unfavorable drift could access I-mode with available power, and stay in I-mode with alpha-dominant heating. Detailed pedestal fluctuation measurements reveal changes in the turbulence, with decreases in the power at some frequencies and size scales, and growth of a weakly coherent mode (WCM) (k_θ $\sim$1.5 cm-1, $\delta f/f \sim .3$) which propagates in the electron diamagnetic direction in the plasma frame. The WCM, which has density, temperature and magnetic signatures, appears to play a key role in pedestal density and impurity regulation, and detailed experimental results and associated modeling are presented. The distribution of divertor exhaust power depends on ion drift direction; new measurements of I-mode heat flux footprints on the outer divertor are compared with those in H-mode. Pedestal stability analyses will be shown for I-modes, including some which exhibited small ELMs.

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