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EX/P4-15: Pedestal Stability and Transport on the Alcator C-Mod Tokamak: Experiments in Support of Developing Predictive Capability

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New experimental data on the Alcator C-Mod tokamak are used to benchmark predictive modeling of the edge pedestal in various high-confinement regimes, contributing to a greater confidence in projection of pedestal height and width in ITER and reactors. Measurements in conventional Type I ELMy H-mode have been used to test the theory of peeling-ballooning (PB) stability and pedestal structure predictions from the EPED model, which extends these theoretical comparisons to the highest pressure pedestals of any existing tokamak. Calculations with the ELITE code confirm that C-Mod ELMy H-modes operate near stability limits for ideal PB modes. Experimental C-Mod studies have provided supporting evidence for pedestal width scaling as the square root of poloidal beta at the pedestal top. This is the dependence that would be expected from theory if KBMs were responsible for limiting the pedestal width. The EPED model has been tested across an extended data on C-Mod, reproducing pedestal height and width reasonably well, and extending the tested range of EPED to within a factor of 3 of the absolute pedestal pressure targeted for ITER.

In addition, C-Mod offers access to two regimes, enhanced D-alpha (EDA) H-mode and I-mode, that have high pedestals but in which large ELM activity is naturally suppressed and, instead, particle and impurity transport are regulated continuously. Significant progress has been made in both measuring and modeling pedestal fluctuations, transport and stability in these regimes. Pedestals of EDA H-mode and I-mode discharges are found to be ideal MHD stable, consistent with the general absence of ELM activity. Like ELITE, the BOUT++ code finds the EDA pedestal to be stable to ideal modes. However, it does identify finite growth rates for edge modes when realistic values of resistivity and diamagnetism are included. The result is consistent with the interpretation of the quasi-coherent mode (QCM), which is omnipresent in the EDA pedestal, as a resistive ballooning mode, which could act to regulate the pedestal pressure profile in the same manner that KBMs are predicted to regulate collisionless pedestals. Full non-linear dynamics in BOUT++ are being used to simulate edge potential and density fluctuations, and the transport they drive in the EDA pedestal. Similar investigations are being initiated for I-mode.

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