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Overview of High-Field Divertor Tokamak Results from Alcator C-Mod*

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C-Mod is the only divertor tokamak in the world capable of operating at B fields up to 8 T, equaling and exceeding that planned for ITER. C-Mod is compact, thus accessing regimes of extreme edge power density (1 MW/m2 average through the plasma surface). Scrape-off layer (SOL) power widths are of order of a few mm, with measured parallel power flows >1 GW/m2 at the divertor, surpassing the design for ITER, and approaching the levels envisioned in power plants. C-Mod results are particularly important for providing the physics basis of the high-field, compact tokamak approach, which can lead to a faster path in the development of fusion energy.[1] Results of experiments and related modeling, obtained since the last IAEA FEC meeting, span the topics of core transport and turbulence, RF heating and current drive, pedestal physics, scrape-off layer, divertor and plasma-wall interactions. ICRF has been successfully applied to control and reverse accumulation of high Z impurities in the core plasma. ICRF has also been employed to control and mitigate locked-modes induced by error fields. For the first time ever, feedback of low Z seeding for divertor power dissipation has been tied directly to real-time plasma power fluxes measured on the high-Z metal PFCs in the divertor, and used to mitigate those fluxes with no degradation of the pedestal pressure or core confinement. The naturally ELM-free I-mode regime has been up to BT=8T, and to double-null topology. I-mode threshold scalings show a weak dependence on B, yielding a significantly broader window for I-mode operation at high field. Quiescence of the high-field side scrape-off layer makes this a potentially attractive location for placement of RF actuators to ameliorate plasma interactions with launchers; the wave physics for penetration and damping, for both ICRF and LHRF appears very favorable for high-field side launch. BOUT++ edge plasma simulations are shedding important light on the nature of I-mode pedestal fluctuations which regulate impurity transport in this regime. LHRF has been employed as an actuator for controlling plasma rotation and rotation shear, critical parameters for turbulence control. A new disruption database has been populated, and used to identify key variables that could be used for disruption prediction and avoidance.
[1] B. Sorbom et al. Fusion Eng. Design 100 (2015) 378.

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