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OV/1-1: DIII-D Overview - Research Toward Resolving Key Issues for ITER and Steady-State Tokamaks

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The DIII-D Research Program has made significant advances in the physics understanding of key ITER issues and operating regimes important for ITER and future steady-state fusion tokamaks. Edge localized mode (ELM) suppression with resonant magnetic perturbations (RMP) has been now been demonstrated in the ITER baseline scenario at q_95=3.1 by controlling the poloidal mode spectrum of n=3 RMP. Temporal modulation of the n=2 and n=3 RMP toroidal phase reveals a complex plasma response that includes an island-like modulation in T_e consistent with recent theory that predicts such island formation can inhibit the pedestal expansion. Pellet pacing experiments with injection geometry similar to that planned for ITER produced a ten-fold increase in the ELM frequency and a strong reduction in ELM divertor energy deposition. Disruption experiments producing reproducible runaway electron beams (I_RE˜300 kA with 300 ms lifetimes) reveal RE dissipation rates ˜2x faster than expected and demonstrate the possibility of full RE ramp down with feedback control. Long-duration ELM-free QH-mode discharges have been produced with co-current NBI by using n=3 coils to generate sufficient counter-I_P torque. With electron cyclotron heating, ITER baseline discharges at beta_N=2 and scaled neutral beam injection torque have been maintained in stationary conditions for more than 4 resistive times. Successful modification of a neutral beam line to provide 5 MW of adjustable off-axis injection has enabled sustained operation at beta_N˜3 with minimum safety factors well above 2 accompanied by broader current and pressure profiles than previously observed. With qmin above 1.5, stationary discharges with beta_N=3.5 have been extended to 2 tau_R, limited only by available beam energy (power and pulse length).

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