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Experiments in Disruption Avoidance for ITER Using Passive and Active Control

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Key plasma physics and real-time control elements needed for robustly stable operation of high fusion power discharges in ITER have been demonstrated in US fusion research. Optimization of the current density profile has enabled passively stable operation without n=1 tearing modes in discharges simulating ITER's baseline scenario with zero external torque. Stable rampdown of the discharge has been achieved with ITER-like scaled current ramp rates, while maintaining an X-point configuration. Significant advances have been made toward real-time prediction of disruptions: machine learning techniques for prediction of disruptions have achieved 90% accuracy in offline analysis, and direct probing of ideal and resistive plasma stability using 3D magnetic perturbations has shown a rising plasma response before the onset of a tearing mode. Active stability control contributes to prevention of disruptions, including direct stabilization of resistive-wall kink modes in high beta discharges, forced rotation of magnetic islands to prevent wall locking, and localized heating/current drive to shrink the islands. These elements are being integrated into stable operating scenarios and a new event-handling system for off-normal events in order to develop the physics basis and techniques for robust control in ITER.

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