Experimental simulation of ITER discharge rampdown in DIII-D*

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Because of the high value of the stored energy expected in ITER plasmas, the safe and controlled termination of ITER discharges is an important aspect of ITER operation. In a series of experiments on the DIII-D tokamak, we have simulated the proposed ITER rampdown for the 15 MA baseline operating scenario. These scaled discharges match the reference scenario (including scaled time dependence) with regard to key parameters such as normalized current, poloidal beta, elongation and internal inductance. The scaled plasma current is reduced to an ITER equivalent of less than 1 MA, well below the 1.4 MA specified for ITER as the maximum acceptable for disruptive termination. The plasma shape and position are controlled during rampdown so that the high heat flux zones near the strike points of the separatrix are held within the equivalent of the armored zones of the ITER divertor; the regulation of the strike point location is an order of magnitude better than required. Scans of the current rampdown rates indicate that a more rapid rampdown than the ITER reference case may be needed to avoid excessive current in the ITER central solenoid. Rampdown with a full-size plasma was studied, but was found to be unsuitable for ITER because of transitions to ELM-free H-mode with a consequent lack of density control, as well as large excursions in poloidal beta and internal inductance. We find that ELMs play an important role during the H-mode phase of the rampdown, helping to reduce the density as the current is reduced. In several discharges VDEs were triggered during rampdown by freezing the control coil commands. The data obtained on VDE growth rates validates modeling of these events. In addition to experimental simulation of the ITER baseline discharge, we have developed discharges that simulate (from initiation to rampdown) an entirely ohmic 15 MA ITER plasma, and an enhanced baseline scenario discharge with flattop at the equivalent of 17 MA (q_{95}=2.7).

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