Results of ITER test blanket module mock-up experiments on DIII-D

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A series of experiments was performed on DIII-D to mock-up the field that will be induced in a pair of ferromagnetic Test Blanket Modules (TBMs) in ITER. A set of coils producing both poloidal and toroidal fields was placed inside a re-entrant horizontal port close to the plasma. These experiments investigated the effects of the resulting localized error field on plasma startup, plasma equilibrium, H-mode access, H- and L-mode particle and energy confinement, plasma rotation, energetic particle loss, and interaction with rotating and locked MHD modes. The coil currents were varied to produce locally up to 700 G toroidal field and 200 G poloidal field at the plasma edge. The localized ripple due to the TBM defined by $(B_{max}-B_{min})/(B_{max}+B_{min})$ on the last closed flux surface at the outboard midplane was varied up to 4.8%, exceeding the value of ~0.8% expected from a pair of representative 1.3 ton TBMs in ITER. The direct effects of TBM error fields increased with localized ripple. The largest effects were on plasma rotation, which dropped by 10% at 1.2% ripple and by 40% to 50% above 2.4% ripple. The TBM effects depended on the global plasma normalized β, β_N, with very little effect for $\beta_N < .5$ (e.g., plasma initiation, L-mode, H-mode threshold). The effects increased with β_N, leading to drops of up to 15%-18% in H98(y,2), β_N, and n_e for β_N up to 2.6 and local TBM ripple >3%. The interaction with existing MHD modes also caused mode locking and disruptions at high ripple and β_N values. Detailed measurements indicate no more than a small fast ion loss due to the TBM error field under all conditions. Error field tolerance to locked modes by the additional torque from the TBM error field, but re-optimization of the standard error field correction recovered the previous error field tolerance in L-mode. Recommendations for the ITER TBM program will be discussed.