ITER Test Blanket Module Error Field Simulation Experiments*

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Recent experiments at DIII-D used an active-coil mock-up to investigate effects of magnetic error fields similar to those expected from two ferromagnetic Test Blanket Modules (TBMs) in one ITER equatorial port. The largest and most prevalent observed effect was plasma toroidal rotation slowing across the entire radial profile, up to 60% in H-mode when the mock-up local ripple at the plasma was ~4 times the local ripple expected in front of ITER TBMs. Analysis showed the slowing to be consistent with non-resonant braking by the mock-up field. There was no evidence of strong electromagnetic braking by resonant harmonics. These results are consistent with the near absence of resonant helical harmonics in the TBM field. Global particle and energy confinement in H-mode decreased by <20% for the maximum mock-up ripple, but <5% at the local ripple expected in ITER. These confinement reductions may be linked with the large velocity reductions. TBM field effects were small in L-mode but increased with plasma beta. The L-H power threshold was unaffected within error bars. The mock-up field increased plasma sensitivity to mode locking by a known n=1 test field (n = toroidal harmonic number). In H-mode the increased locking sensitivity was from TBM torque slowing plasma rotation. At low beta, locked mode tolerance was fully recovered by re-optimizing the conventional DIII-D 'I-coils' empirical compensation of n=1 errors in the presence of the TBM mock-up field. Empirical error compensation in H-mode should be addressed in future experiments. Global loss of injected neutral beam fast ions was within error bars, but 1 MeV fusion triton loss may have increased. The many DIII-D mock-up results provide important benchmarks for models needed to predict effects of TBMs in ITER.

*Supported by the US DOE under DE-FC02-04ER54698.