Measurement of tokamak error fields using plasma response and its applicability to ITER

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Abstract. The nonlinear response of a low-beta tokamak plasma to non-axisymmetric fields offers an alternative to direct measurement of the non-axisymmetric part of the vacuum magnetic fields, often termed "error fields". Possible approaches are discussed for determination of error fields and the required current in non-axisymmetric correction coils, with an emphasis on two relatively new methods: measurement of the torque balance on a saturated magnetic island, and measurement of the braking of plasma rotation in the absence of an island. The former is well suited to ohmically heated discharges, while the latter is more appropriate for discharges with a modest amount of neutral beam heating to drive rotation. Both can potentially provide continuous measurements during a discharge, subject to the limitation of a minimum averaging time. The applicability of these methods to ITER is discussed, and an estimate is made of their uncertainties in light of the specifications of ITER's diagnostic systems. The use of plasma response-based techniques in normal ITER operational scenarios may allow identification of the error field contributions by individual central solenoid coils, but identification of the individual contributions by the outer poloidal field coils or other sources is less likely to be feasible.

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