Robust Correction of 3D Error Fields in Tokamaks and ITER*

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Important progress has been made for the correction of 3D fields in tokamaks using improved understanding for plasma response by the Ideal Perturbed Equilibrium Code (IPEC) [1] and its applications to various error field correction experiments [2,3]. The key to error field correction is to reduce the part of 3D fields that breaks magnetic surfaces significantly, often by an order of magnitude more than the rest, and thus dominantly degrades tokamak plasmas. The dominant 3D fields change little across different plasma profiles and configurations. The empirical corrections of intrinsic fields for NSTX, DIII-D, and CMOD L-mode plasmas can be explained consistently based on the robust structure of the dominant 3D fields. An extreme case can be found in the DIII-D mock-up experiments for the ITER Test Blanket Modules (TBMs). Although the TBM 3D fields are highly localized and thus can not be corrected by typical error field correction coils, the optimal level of operations could be achieved since the I-coils in DIII-D can effectively control the dominant part in TBM 3D fields. The robust structure of the dominant 3D fields is also persistent in H-mode, as shown in the recent locking experiments in NSTX and DIII-D H-mode plasmas. The implications are favorable for ITER, since the highly reliable 3D field compensation can be provided for a wide range of different plasmas if the correction coil is designed based on the robust patterns of the dominant 3D fields [4].

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