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

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An important progress has been made for the correction of 3D fields in tokamaks, with the 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 corrections is to reduce a part of 3D fields that breaks magnetic surfaces significantly, often by an order of magnitude more than another, and thus that is most dangerous to tokamak plasmas. The most dangerous 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 most dangerous 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 most dangerous part in TBM 3D fields. The structure of the most dangerous 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 since the highly reliable corrections of 3D fields can be utilized over wide range of different operations in ITER when the design of coils are articulated based on the patterns of the most dangerous 3D fields [4].

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