Robustness of the tokamak error field correction tolerance scaling

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Abstract:

This paper presents the subtleties of obtaining robust experimental scaling laws for the core resonant error field threshold that leads to field penetration, locked modes, and disruptions. Recent progress in attempts to project this threshold to new machines has focused on advances in the metric used to quantify the dangerous error fields, incorporating the ideal MHD plasma response in a metric referred to as the 'dominant mode overlap'. However, the scaling of this or any quantity with experimental parameters known to be important for the complicated tearing layer physics requires regressions performed for databases that, for historical reasons, unevenly sample the available parametric space. This paper presents the distribution of the existing international n = 1 database and details biases in the available sampling and details the sensitivity of ITER projections to simple least-squares regressions. Downsampling and a simple kernel density estimation weighted regression are used here to demonstrate the difference in projections that acknowledging the machine sampling bias can make. This results in more robust projection to parameters far from the 'usual' devices built thus far. Two multi-device and multi-parameter scalings of the EF threshold in Ohmic and powered plasmas are presented, projecting the threshold to ITER and investigating the impact of sampling biases.