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**Fully 3D RWM and Feedback Stabilization Studies for ITER and AUG**[1]

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A high $\beta$-limit is a necessary condition for a working power plant. However, instabilities associated with ideal internal and external modes limit the plasma beta. External kink modes of MHD equilibria can be stabilized by a perfectly conducting wall sufficiently close to the plasma. In case of a real wall with non-zero resistivity the modes become unstable and grow on the resistive timescale of magnetic field diffusion through the wall. The growth rates of resistive wall modes (RWMs) are typically orders of magnitude smaller than of kink modes in the no-wall case so that the stabilization of RWMs by an active feedback system becomes feasible. Some axisymmetric approaches already exist which deal with this problem numerically. Nevertheless, because of experimental needs a realistic external wall has a complex three-dimensional shape. Usually, it is a multiply-connected structure. Besides the resistive wall also the feedback coils violate the axisymmetry of a tokamak configuration. Therefore, a three-dimensional, numerical treatment of the feedback stabilization problem is necessary. For this reason, starting from a stellarator code (CAS3D code) we developed the fully three-dimensional stability code STARWALL, and the feedback optimization code OPTIM. With these codes, we are able to compute the growth rates of resistive wall modes in the presence of non-axisymmetric, multiply-connected wall structures (i.e. with holes), and to model the active feedback stabilization of these modes. Analogue to the axisymmetric approaches, the problem is divided into two parts. In the open-loop part, the complete set of eigenvalues and eigenfunctions of the plasma-resistive-wall system without feedback currents is determined. Then, in the closed-loop part an initial value problem is formulated for the time evolution of the RWMs and the currents in the feedback coils. The feedback logics controlled by a set of free parameters specifies the interaction between the feedback currents and the RWMs. After choosing their values, the effectiveness of the feedback can be studied by solving the characteristic equation of the closed-loop system. The procedure has been implemented numerically (STARWALL code) and applied to resistive wall configurations for ITER and ASDEX Upgrade. For an optimal choice of the feedback parameters, the OPTIM code has been developed which optimizes the stability of a truncated closed-loop system under variations of the free parameters.

[1]EURATOM Association