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Modelling of wall currents excited by plasma wall-touching kink and vertical modes during a tokamak disruption, with application to ITER

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To understand plasma disruptions in tokamaks and predict their effects, realistic simulations of electric current excitation in three-dimensional vessel structures by the plasma touching the walls are required. The Wall-Touching Kink Modes are frequently excited during vertical displacement events and cause large sideways forces on the vacuum vessel which are difficult to withstand in large tokamaks like ITER [1]. The amplitude and localization of the sideways force are determined by the sharing of electric current between the plasma and the wall.

The present paper describes a wall model that covers both eddy currents, excited inductively, and source/sink currents due to current sharing between the plasma and the thin conducting wall of arbitrary three-dimensional geometry [2,3]. The developed ***ssec*** code (standing for "source/sink and eddy current" code) calculates the electromagnetic wall response to perturbation of magnetic fields and to current sharing between the plasma and the wall. The code accepts the vector $\mathbf{j}_{perp}$ of values of current density entering/exiting the wall surface from the plasma at each vertex and the time derivative of the magnetic vector potential $\partial \mathbf{A}^{pl}/\partial t$ at each vertex. The third input vector is the set of space points in which ***ssec*** returns the magnetic field $\mathbf{B}^{wall}$ and its vector potential $\mathbf{A}^{wall}$ from the wall currents. The numerical results have been checked against analytical examples [2,4] and for a high-resolution mesh (16384 triangles on the wall surface) a relative accuracy of 0.001 has been found. Figure 1 presents the results of calculation of eddy and source/sink currents in the tokamak wall.

Using this approach, JOREK-STARWALL [5,6] presently limited to eddy currents, will be extended to self-consistent non-linear MHD simulations including eddy and source/sink currents.

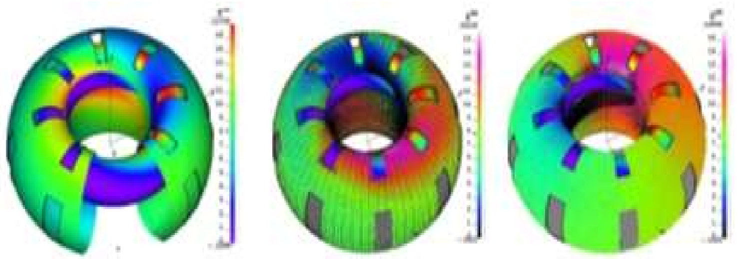

Figure 1: *Left: Wetting zone created by a vertically shifted plasma with a m/n=1/1 surface perturbation, Middle: Eddy currents excited by the plasma. Colours corresponds to their stream function, Right: Total surface current with the Sink/Source current as the dominant component.*

References

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