MHD Simulations with Resistive Wall and Magnetic Separatrix

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The M3D (Multi-level 3D) project [1] carries out simulation studies of plasmas using multiple levels of physics, geometry, and grid models. The present study is done with a resistive MHD model including a resistive wall having the shape of the ITER first wall. The simulation region includes the magnetic separatrix. The plasma resistivity self consistently evolves with the temperature. M3D combines a two dimensional unstructured mesh with finite element discretization in poloidal planes [2], with a pseudo spectral representation in the toroidal direction.

Simulations were done of VDE (vertical displacement event) instabilities and the growth rate was found inversely proportional to the resistive wall penetration time. 3D disruption simulations found the toroidal peaking factor of halo current is as high as 3, and the halo current fraction is transiently as high as 40%.

The part of the mesh containing open magnetic field lines was generated using the ellipt2d package [3]. The code includes a temperature equation, with thermal conduction along the magnetic field modeled by the artificial sound method The resistivity is proportional to $T^{-3/2}$, where T is the temperature. The halo region between the plasma core and the wall is modeled as a cold resistive plasma. Simulations have been done with core temperature 100 times the halo temperature, for a resistivity contrast of 1000. Resistive wall boundary conditions match the solution inside the resistive wall to the exterior vacuum solution. The exterior problem is solved with a Green's function method, using A. Pletzer's GRIN code [4].

References

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