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Three-dimensional disruption, vertical stability and breakdown analysis of the Italian DTT device

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The reduction of heat loads of divertor target is one of the main challenges addressed by the European roadmap to the realisation of fusion energy. In particular, eight different missions have been identified overall, of which Mission 2 'Heat-exhaust systems' is specifically devoted to this goal. Recently, the Divertor Tokamak Test (DTT) facility [1] has been proposed with the aim of investigating alternative power exhaust solutions in view of DEMO, hence with the capability of including various divertor concepts (e.g. conventional, snowflake, super-X, double null, liquid limiter).

In this paper, we numerically analyse the recently revised up-down symmetric Italian DTT device, with the aim of evaluating the effects of deviation from axisymmetry on the plasma behaviour. This will be done resorting to CarMa0NL [2] (evolutionary equilibrium in presence of 3D conductors) and CARIDDI [3] (eddy currents equations in volumetric conductors) codes. Vertical stabilization, plasma breakdown and disruptions are analysed in this respect. Three-dimensional effects may be both detrimental (e.g. ports) and beneficial (e.g. first wall) on passive stability, so the overall effect is not obvious and must be carefully evaluated. On the other hand, having significant currents flowing in the first wall during fast transients poses significant challenges on the design, to take into account the aspects related to the field penetration in the breakdown phase and the electromagnetic loads on plasma facing components during disruptions.

[1] R. Albanese, et al., Fusion Engineering and Design (2017), https://doi.org/10.1016/j.fusengdes.2016.12.025

[2] F. Villone et al., Plasma Phys. Control. Fusion 55 (2013) 095008

[3] R. Albanese, G. Rubinacci, 1988 IEE Proc. A 135 457–462