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P3.045 Simulation of magnetic control of the plasma shape on the DEMO tokamak

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This paper describes the preliminary design of a position, current and shape control for DEMO tokamak. This preliminary design relies on the availability of magnetic sensor measurements for the vertical position and for the plasma-wall gaps. The controller is designed basing on the CREATE-L model of the DEMO 2017 Single-Null (SN) configuration, and then is tested using the nonlinear evolution CREATE-NL model. The controller is designed along the guidelines presented in [1], and it consists of various nested loops: i) a Vertical Stabilization fast controller which stabilizies the plasma keeping the current in the stabilization circuit as low as possible; ii) a shape controller which calculates the Poloidal Field (PF) feedback currents that are needed to track a given reference shape or to keep the shape as constant as possible in the presence of unexpected events; iii) a PF current controller which evaluates the PF voltages needed to track the feedback currents calculated by the shape controller; iv) the plasma current controller which keeps the plasma current close to its reference.
The controller performance is assessed in the presence of a given set of events: i) the Vertical Displacement Event (VDE) of the plasma column, which consist of an instantaneous vertical displacement along the eigenvector associated to the unstable mode; ii) a so-called loss of power which occurs during a plasma H-L back-transition; iii) NTM; iv) ELMs. In the closed-loop simulations, simplified yet realistic models of the actuators, including saturation values for the PF voltages, and of the magnetic diagnostics are included.
The paper will include the main simulation results of the behaviour of the DEMO SN configuration in the most challenging events as listed before, highlighting the most critical issues.

Reference

[1] M. Ariola and A. Pironti, “Magnetic control of tokamak plasmas,” 2nd ed., Springer, 2016.

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