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Control of elongated plasmas in superconducting tokamaks in the absence of in-vessel coils

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The roadmap for the commissioning and first operations of superconductive tokamaks envisages the possibility of running discharges with fairly elongated plasmas before the complete installation of the in-vessel components, including vertical stabilization coils, or any other specific sets of coils to be used for the magnetic control of fast transients.

In the absence of dedicated actuators, the magnetic control system shall perform the essential fast control actions by using the out-vessel superconductive coils, if needed. These are typically less efficient in reacting to fast transients, due to the shielding effect of the vessel and imply a coupling with other control tasks relying on the same actuators, such as plasma current, position, and shape control. Hence, effective actuator-sharing strategies must be put in place.

This talk will present a possible control architecture and a related control strategy that is able to cope with vertically unstable elongated plasmas subject to fast varying disturbances, in the absence of dedicated actuator. The architecture exploits a control-oriented plasma model-based for the offline identification of practically decoupled control directions to be assigned to each control task, i.e. plasma current, shape and vertical stabilization. Such model-based actuator-sharing approach allows to accomplish the main magnetic control objectives while minimizing the cross-couplings among the various tasks.

As case study, the setup of JT-60SA during the integrated commissioning and OP1 will be considered. Indeed, in this first phase, this machine has operated with vertically elongated plasmas in absence of dedicated in-vessel control coils.

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