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Controlling a burning plasma in the DEMO tokamak away from disruptive events

In a commercially viable tokamak-based fusion power plant, the burning plasma must be steered such that major disruptions do not occur at all. In present experimental devices, disruptions usually appear as sudden major events leading to plasma termination and damage to the plasma facing components. Via post-discharge analysis often one is able to identify a precursor or a chain of events that leads to the disruptive regime. Therefore, in preparation for the next generation of electricity-producing large devices, it is vital to establish which control scheme, diagnostic coverage and actuator management will maximise the control of the plasma and break the chain of events towards a disruption as soon as a precursor is identified. Moreover, the scenario itself must be qualified in terms of how prone it is to develop such chain of events.

In this work the tokamak flight-simulator Fenix, gives us the opportunity to design, simulate and validate various DEMO plasma scenarios with respect to the key issues described above. Fenix has been developed to address kinetic control simulations for DEMO with realistic actuators and diagnostics. This allows different studies close to either plasma physics limits (radiation or density limit), operational limits (actuator saturation), loss of an actuator, NTM at the beta limit and an unpredictable event such as drop of a tungsten flake.

In this work we present studies of plasma control when either catastrophic scenario is triggered by an unwanted perturbation. We discuss how efficient the control scheme is in preventing the disruption with foreseen diagnostics.

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