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Development of a plasma scenario for the EU-DEMO: current activities and perspectives

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In order for the first fusion reactor DEMO to accomplish its mission, it is necessary to identify a plasma scenario which is at the same time performing in terms of fusion power generation and sufficiently stable to ensure the integrity and availability of the machine components for a long time. In the present work, the activities undertaken for this purpose by EUROfusion PMU are summarized.

In the course of the current pre-conceptual design analysis phase for the European DEMO, it is necessary to define scenarios by considering from the early phases their compatibility with the performance of the available diagnostics, of the actuators for plasma control and with the response of the heating and current drive systems. A coupling between the 1D transport code ASTRA and the control software Simulink has been performed, providing a tool able to simulate the plasma behavior while accounting for the constraints linked to the detectability of the signals and the delay and power limitations of the actuators responses. In our work, the DEMO-related results of such a tool are presented. In parallel, the numerous ongoing activities concerning the open issues which require to be addressed before the scenario could be considered complete and robust enough (e.g. plasma ramp-up and –down definition, identification of disruption precursors, ELM mitigation etc.) are also illustrated.

The reference scenario which is considered for the EU-DEMO is the so called "DEMO 1", i.e. a pulsed scenario based on conservative physics assumptions and analogous, at least from a macroscopic level, to the ITER 15 MA. However, other, alternative scenarios are investigated in parallel. The main alternative concept developed is the so called Flexi-DEMO, which relies on more advanced scenarios as compared to DEMO 1, with a large fraction of auxiliary current drive and a tailoring of the safety factor profile which aims at maximizing the bootstrap current fraction to achieve a steady-state discharge. Furthermore, the possibility of extrapolating other, more speculative scenarios to a reactor condition is also considered inside our activities.

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