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Diagnostics for plasma control - from ITER to DEMO

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The development of the plasma diagnostic and control (D&C) system for a future tokamak demonstration fusion reactor (DEMO) [1] faces significant challenges [2]. These comprise the required reliability of operation, the high accuracy to which the plasma parameters are to be controlled, and the robustness of components and methods against any adverse effects or disturbances.
The ongoing developments for the ITER D&C system represent an important starting point for progressing towards DEMO. ITER diagnostic development is guided by a measurement requirements table, in which different categories of diagnostics for machine protection, basic and advanced control, as well as for evaluation and physics studies are being distinguished. Since ITER is an experiment aiming to explore and optimize in detail the physics of a burning plasma, ambitious targets for space and time resolution as well as for the measurement accuracies have been defined. These are pushing the ITER diagnostic design towards using sophisticated methods and aiming for large coverage and high signal intensities, forcing to mount many front-end components in forward positions. This results in many cases in a rapid aging of diagnostic components, so that additional measures like protection shutters, plasma based mirror cleaning or modular approaches for frequent maintenance and exchange have to be developed.
Under the even stronger fluences of plasma particles, neutron/gamma and radiation loads on DEMO, high reliability and long lifetime of diagnostics can only be achieved by selecting the methods with
regard to their robustness, and retracting vulnerable front-end components into protected locations in the machine. Based on this approach, an initial DEMO D&C concept has been elaborated, which is covering all major control issues by main control parameters to be derived using at least two different diagnostic methods.
Within this paper, on overview on the current status of D&C development for DEMO will be provided.
References:
[1] G. Federici et al., Fusion Engineering and Design 109-111 (2016) 1464-1474
[2] W. Biel et al., Fusion Engineering and Design 96–97 (2015) 8–15

Primary author: Dr BIEL, Wolfgang (Insttitute of Energy and Climate Research EK-4 01.10, Research Center Jülich)

Presenter: Dr BIEL, Wolfgang (Insttitute of Energy and Climate Research EK-4 01.10, Research Center Jülich)

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