Integrated operation of diagnostics and control

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Abstract

In fusion research the ability to generate and sustain fusion plasmas with high performance gains more and more importance. Optimal combinations of magnetic shape, temperature and density profile as well as the confinement time are identified as advanced regimes. Safe operation in such regimes will be crucial for the success of ITER and later fusion reactors. The operational space, on the other hand, is characterised by nonlinear dependencies between plasma parameters. Various MHD limits must be avoided in order to minimise the risk of a disruption.

Sophisticated feedback control schemes help to solve this challenge. But in turn these require detailed information on plasma state in time to allow proper reaction. Control system and diagnostic systems therefore must establish a symbiotic relationship to realise such schemes. Today, all major fusion devices implement a corresponding concept.

An implementation of such a concept with sustained integration is presented using the example of ASDEX Upgrade. It covers data communication via a real-time network, synchronisation mechanisms for data-driven algorithm execution as well as operational aspects and exception handling for failure detection and recovery. A modular distributed software framework offers standardised user algorithm interfaces, automated workflow procedures and the application of various computer and network hardware components. Designed with a special focus on reliability, robustness and flexibility it is a sound base for exploring ITER-relevant plasma regimes and control strategies.