

Robust Burn Stabilization of an ITER FEAT like Tokamak with On-Line Estimations of Energy and Particles Confinement Times

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Abstract

It is widely recognized that high gain long pulse operation of tokamak reactors for power production must rely on the active control of particle densities and plasma temperature in order to regulate the power density released by fusion. Appropriate means for the suppression of plasma parameters fluctuations due to turbulence and/or changes in the confinement mode, which may lead to thermal instabilities during day to day operations, will then be needed. Thus, it is desirable to have a robust control regarding the scaling laws associated to the different confinement scenarios, e.g. whether L or H-modes, elmy or elmy-free; as well as to uncertainties in these laws. Using a two-temperature volume averaged 0D model we show that robust stabilization of the burn conditions can be achieved by means of Radial Basis Neural Networks (RBNN) in an ITER-FEAT like tokamak in which transport properties of the plasma system, represented by the energy and helium ash confinement times, are only known through on-line estimations. In the model we take into account alpha particle thermalization time delay and different amount of energy deposited to the electrons and to the ions by the α 's during thermalization. The control actions include the modulation of the DT refueling rate, a neutral He-4 injection beam and auxiliary heating powers to ions and electrons constrained to lie within allowable range values. To demonstrate the robustness of this controller transients with on-line estimations of both the energy and the helium ash confinement time are simulated assuming the system follows the IPB98(y,2) scaling for τ_E and an arbitrary independent scaling for τ_α ; we simulate noisy measurements of these two quantities by corrupting them with pseudo Gaussian noise before been input into the RBNN.

References

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