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Analysis of Fusion Burn Control Approaches Using METIS[1]
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— Controlling the fusion power through regulation of the plasma density and temperature is one of the most fundamental problems in fusion reactors and will be critical to the success of burning plasma experiments like ITER. In this work, a volume averaged model for the evolution of the density of energy, deuterium and tritium fuel ions, alpha-particles, and impurity ions is used to synthesize nonlinear feedback controllers for stabilizing and modulating the burn condition. Adaptive control techniques are used to account for modeling uncertainty. The control approaches make use of the different possible methods for altering the fusion power, including adjusting the temperature through auxiliary heating, modulating the density or isotopic mix through fueling, and altering the impurity density through impurity injection. The different methods are simulated and compared using a simulation framework based around METIS, a module of the CRONOS code. The simulations include the effects of 1D plasma profiles and particle recycling, and the framework allows for testing the robustness and performance of the controllers in various scenarios, including confinement changes, impurity content changes, and actuators faults.

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