Real time equilibrium reconstruction for tokamak discharge control

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Abstract

A practical method for performing a tokamak equilibrium reconstruction in real time for arbitrary time-varying discharge shapes and current profiles is described. An approximate solution to the Grad-Shafranov equilibrium relation is found which best fits the diagnostic measurements. Thus a solution for the spatial distribution of poloidal flux and toroidal current density is available in real time that is consistent with plasma force balance, allowing accurate evaluation of parameters such as discharge shape and safety factor profile. The equilibrium solutions are produced at a rate sufficient for discharge control. This equilibrium reconstruction algorithm has been implemented on the digital plasma control system for the DIII-D tokamak. The first application of a real time equilibrium reconstruction to discharge shape control is described.