RAPTOR : optimization, real-time simulation and control of the tokamak q profile evolution using a simplified transport model

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RAPTOR: Optimization, real-time simulation and control of the tokamak q profile evolution using a simplified transport model FEDERICO FELICI, OLIVIER SAUTER, TIMOTHY GOODMAN, JAMES PALEY, EPFL-CRPP, Association Euratom-Confédération Suisse, CH-1015 Lausanne, Switzerland, TCV TEAM — Control of the plasma current density and safety factor profile evolution in a tokamak is crucial for accessing advanced regimes. The evolution of the current density profile is steered by a combination of inductive voltage and auxiliary current drive actuators, and is nonlinearly coupled to the evolution of the (ion/electron) temperature and density profiles. Using appropriate simplifications, a model has been obtained which can be simulated on time scales faster than the tokamak discharge itself, but still retains the essential physics describing the nonlinear coupling between the profiles. This model, dubbed RAPTOR (Rapid Plasma Transport simulatOR) has been implemented in the new real-time control system on the TCV tokamak at CRPP, and can be used for real-time reconstruction and model-based control of the q profile. It can also be used off-line to determine optimal actuator trajectories in open loop simulations to steer the plasma profiles towards their required steady-state shapes while remaining within a constrained set of allowable profiles.

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