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First-Principles-Driven Model-Based Optimal Control of the Current Profile in NSTX-U[1] ZEKI ILHAN, JUSTIN BARTON, WILLIAM WEHNER, EUGENIO SCHUSTER, Lehigh University, DAVID GATES, STEFAN GERHARDT, EGEMEN KOLEMEN, JONATHAN MENARD, PPPL — Regulation in time of the toroidal current profile is one of the main challenges toward the realization of the next-step operational goals for NSTX-U. A nonlinear, control-oriented, physics-based model describing the temporal evolution of the current profile is obtained by combining the magnetic diffusion equation with empirical correlations obtained at NSTX-U for the electron density, electron temperature, and non-inductive current drives. In this work, the proposed model is embedded into the control design process to synthesize a time-variant, linear-quadratic-integral, optimal controller capable of regulating the safety factor profile around a desired target profile while rejecting disturbances. Neutral beam injectors and the total plasma current are used as actuators to shape the current profile. The effectiveness of the proposed controller in regulating the safety factor profile in NSTX-U is demonstrated via closed-loop predictive simulations carried out in PTRANSP.

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