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Physics-model-based Modeling and Control of the Toroidal Rotation Profile for DIII-D[1] W. WEHNER, E. SCHUSTER, Lehigh U., M.L. WALKER, D.A. HUMPHREYS, General Atomics — A model suitable for control purposes, a so-called "control-oriented" model, requires only capturing the dominant underlying physics that is relevant for control design. A control-oriented model of the toroidal rotation profile evolution for DIII-D has been derived from a simplified version of the first-principles-based momentum diffusion equation combined with scenario-specific models of the momentum sources. For DIII-D, four momentum sources are available for consideration: the non-axisymmetric field coils; which provide rotation damping; the co-current on-axis neutral beam injectors (NBI); the co-current off-axis NBI; and the counter-current on-axis NBI. These four sources allow not only control of the bulk plasma rotation, but also control of the profile shape. Optimal state feedback with integral action has been designed from the model and demonstrated in simulation to regulate the rotation profile around a desired target shape.

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