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Combined Current Profile and β_N Control to Facilitate Accessibility and Reproducibility Testing of High-qmin Steady-State Scenarios¹ W. WEHNER, J.M. BARTON, M.E. LAURET, E. SCHUSTER, U. Lehigh, C.T. HOLCOMB, B. VICTOR, LLNL, J.R. FERRON, T.C. LUCE, R. LA HAYE, GA, F. TURCO, Columbia U., W. SOLOMON, PPPL — The capability of combined current profile and β_N control to enable access and repeatability of steady-state scenarios for high $q_{min} > 1.5$ discharges is studied in both nonlinear simulations and experiments. The presentation focuses on model-predicted q-profile $+\beta_N$ control, which numerically solves successive optimal control problems over a receding time horizon by exploiting efficiently solvable quadratic programming techniques. One of the key advantages of this control approach is that it allows for explicit incorporation of state/input constraints to prevent the controller from driving the plasma outside of stability/performance limits and obtain, as closely as possible, steady state conditions in the q profile. To characterize the q profile $+\beta_N$ response, empirical correlations are combined with first-principles laws to arrive at a control-oriented model, which captures the dominant physics that is necessary for model-based optimal control design.

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