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Simultaneous Control of Electron Density and Effective Atomic Number in Non-burning Tokamak Plasmas[1] DANIEL BOYER, PATRICK BOYLE, EUGENIO SCHUSTER, GLENN BATEMAN, ARNOLD KRITZ, Lehigh University — The control of plasma kinetic profiles is one of the most fundamental problems in tokamaks. Precise regulation of electron density and effective atomic number, or alternatively hydrogen and impurity densities, is required during routine operation. A common means of actuation toward this end is the use of fast-acting gas valves for the injection of different species. However, non-linear coupling may lead to a closed-loop oscillatory behavior when there is a failure to properly account for the multi-input-multi-output nature of the problem. In this work, controllers are sought to regulate both the average value and spatial profiles of the electron density and effective atomic number. One-dimensional transport equations for these variables are represented in cylindrical coordinates by a set of partial differential equations (PDEs) and used for control synthesis based on nonlinear and backstepping techniques. Numerical simulations illustrating the effectiveness of the resulting control laws are presented.

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