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Design and simulation of control algorithms for stored energy and plasma current in non-inductive scenarios on NSTX-U[1]
MARK BOYER, ROBERT ANDRE, DAVID GATES, STEFAN GERHARDT, JONATHAN MENARD, FRANCESCA POLI, Princeton Plasma Physics Laboratory — One of the major goals of NSTX-U is to demonstrate non-inductive operation. To facilitate this and other program goals, the center stack has been upgraded and a second neutral beam line has been added with three sources aimed more tangentially to provide higher current drive efficiency and the ability to shape the current drive profile. While non-inductive start-up and ramp-up scenarios are being developed, initial non-inductive studies will likely rely on clamping the Ohmic coil current after the plasma current has been established inductively. In this work the ability to maintain control of stored energy and plasma current once the Ohmic coil has been clamped is explored. The six neutral beam sources and the mid-plane outer gap of the plasma are considered as actuators. System identification is done using TRANSP simulations in which the actuators are modulated around a reference shot. The resulting reduced model is used to design an optimal control law with anti-windup and a recently developed framework for closed loop simulations in TRANSP is used to test the control. Limitations due to actuator saturation are assessed and robustness to beam modulation, changes in the plasma density and confinement, and changes in density and temperature profile shapes are studied.

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