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**TRANSP-based Trajectory Optimization of the Current Profile Evolution to Facilitate Robust Non-inductive Ramp-up in NSTX-U**[1]
WILLIAM WEHNER, EUGENIO SCHUSTER, Lehigh University, FRANCESCA POLI, Princeton Plasma Physics Laboratory — Initial progress towards the design of non-inductive current ramp-up scenarios in the National Spherical Torus Experiment Upgrade (NSTX-U) has been made through the use of TRANSP predictive simulations [Nucl. Fusion **55** (2015) 123011 (12pp)]. The strategy involves, first, ramping the plasma current with high harmonic fast waves (HHFW) to about 400 kA, and then further ramping to 900 kA with neutral beam injection (NBI). However, the early ramping of neutral beams and application of HHFW leads to an undesirably peaked current profile making the plasma unstable to ballooning modes. We present an optimization-based control approach to improve on the non-inductive ramp-up strategy. We combine the TRANSP code with an optimization algorithm based on sequential quadratic programming to search for time evolutions of the NBI powers, the HHFW powers, and the line averaged density that define an open-loop actuator strategy that maximizes the non-inductive current while satisfying constraints associated with the current profile evolution for MHD stable plasmas. This technique has the potential of playing a critical role in achieving robustly stable non-inductive ramp-up, which will ultimately be necessary to demonstrate applicability of the spherical torus concept to larger devices without sufficient room for a central coil.

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