DPP16-2016-000210

Abstract for an Invited Paper
for the DPP16 Meeting of
the American Physical Society

A plasma rotation control scheme for NSTX and NSTX-U

IMENE GOUMIRI, Princeton University

Plasma rotation has been proven to play a key role in stabilizing large scale instabilities and improving plasma confinement by suppressing micro-turbulence. A model-based feedback system which controls the plasma rotation profile on the National Spherical Torus Experiment (NSTX) and its upgrade (NSTX-U) is presented. The first part of this work uses experimental measurements from NSTX as a starting point and models the control of plasma rotation using two different types of actuation: momentum from injected neutral beams and neoclassical toroidal viscosity generated by three-dimensional applied magnetic fields. Whether based on the data-driven model for NSTX or purely predictive modeling for NSTX-U, a reduced order model based feedback controller was designed. Predictive simulations using the TRANSP plasma transport code with the actuator input determined by the controller (controller-in-the-loop) show that the controller drives the plasma's rotation to the desired profiles in less than 100 ms given practical constraints on the actuators and the available real-time rotation measurements. This is the first time that TRANSP has been used as a plasma in simulator in a closed feedback loop test. Another approach to control simultaneously the toroidal rotation profile as well as β_N is then shown for NSTX-U. For this case, the neutral beams (actuators) have been augmented in the modeling to match the upgrade version which spread the injection throughout the edge of the plasma. Control robustness in stability and performance has then been tested and used to predict the limits of the resulting controllers when the energy confinement time (τ_E) and the momentum diffusivity coefficient (χ_ϕ) vary.