Development and Plans for Feedback Control of Stored Energy, Vertical Position, and q_0/l_i in NSTX-U

M. D. Boyer[1], R. Andre[1], D. Gates[1], S. Gerhardt[1], J. Menard[1], F. Poli[1]

[1]*Princeton Plasma Physics Laboratory, Princeton NJ, USA*

Lead-author e-mail: mboyer@pppl.gov

The upgrade to the National Spherical Torus Experiment (NSTX-U) adds a larger center-stack, enabling higher toroidal field and longer pulse duration, and three new neutral beam sources aimed more tangentially than the existing three, increasing available heating and current drive, and allowing deposition profiles to be tailored. In order to exploit these new capabilities and meet the high-performance operational goals of NSTX-U, advanced feedback control algorithms will be required. Major upgrades to the Plasma Control System (PCS) have been made and several algorithms are under development to improve and add capabilities, including shape control, vertical position control, beam source modulation, stored energy control, and profile control. To facilitate studying the performance of the control schemes that are under development, a framework for conducting closed loop simulations in the integrated modeling code TRANSP has been developed. The framework exploits many of the predictive capabilities of TRANSP and provides a means for performing control calculations based on user-supplied data (controller matrices, target waveforms, etc.). Among the first planned feedback control activities is the control of the stored energy and the current profile. Based on predictive TRANSP simulations, control-oriented models for the dynamic evolution of these quantities have been developed and used for model-based control design. Simulations of a control algorithm for simultaneous control of β_N and q_0 using total beam power and the outer gap using the TRANSP framework will be presented to demonstrate the framework. Progress towards application of the approach to non-inductive scenarios and an outlook for application to the design of an ST based Fusion Nuclear Science Facility will also be discussed. Status of the NSTX-U control system and preliminary results from the first NSTX-U run campaign will be discussed.

*Work supported by U.S.D.O.E. Contract No. DE-AC02-09CH11466