TOPIC: EX-D, IT

# Innovative Divertor Configuration and Plasma-Facing Component Studies in NSTX

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This paper summarizes recent control implementations and dynamics studies on NSTX. These are, in particular, strike point (SP) position control and vertical stability analysis experiment, run on NSTX, and two new system-identification methods / control-tuning algorithms, implemented on NSTX. The PID controller for the SP was tuned by analyzing the step response of the SP position to the poloidal coil currents, employing the Ziegler-Nichols method. The resulting SP controller has RMS of 1.5-2 cm for the outer SP and 1 cm for the inner SP. The resulting SP controller was successfully employed to achieve the "snowflake" divertor configuration in NSTX. Controller tuning via experiments can be time intensive, to maximize the proportion of this process that is conducted offline, we implemented an offline system identification of the plasma response to the control inputs based on ARMAX input-output models. With this tool, rough estimates of the improvements were realized and several control improvements were identified. Also, an online automatic relay-feedback PID tuning algorithm was implemented which has the advantage tuning the controller in one shot, thus optimize the use of experimental time. Finally, the NTSX contribution to the vertical controllability analysis of ITER is presented where the maximum controllable displacement, $\Delta Z_{max}$, was experimentally obtained and compared with other devices and numerical models. This study improved our understanding of the lack of control capability in the ITER design and resulted in the addition of new inner coil sets to stabilize the vertical mode.