Experimental vertical stability studies for ITER performance and design guidance*

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Abstract. Operating experimental devices have provided key inputs to the design process for ITER axisymmetric control. In particular, experiments have quantified controllability and robustness requirements in the presence of realistic noise and disturbance environments, which are difficult or impossible to characterize with modeling and simulation alone. This kind of information is particularly critical for ITER vertical control, which poses the highest demands on poloidal field system performance, since the consequences of loss of vertical control can be severe. The present work describes results of multi-machine studies performed under a joint ITPA experiment (MDC-13) on fundamental vertical control performance and controllability limits. We present experimental results from Alcator C-Mod, DIII-D, NSTX, TCV, and JET, along with analysis of these data to provide vertical control performance guidance to ITER. Useful metrics to quantify this control performance include the stability margin and maximum controllable vertical displacement. Theoretical analysis of the maximum controllable vertical displacement suggests effective approaches to improving performance in terms of this metric, with implications for ITER design modifications. Typical levels of noise in the vertical position measurement and several common disturbances which can challenge the vertical control loop are assessed and analyzed.

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