

## The Effect of MHD Noise on the Vertical Observer in Tokamaks

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The spurious perturbations induced by MHD instabilities on the Tokamak à Configuration Variable (TCV) vertical position observer are investigated. The study is performed for ITER-relevant ELMs (involving high heat fluxes, and with geometry compatible with the ITER constraints), sawteeth, and magnetic islands on the  $q=2-3$  rational surfaces. In addition, “infernal” mode instabilities appearing in reverse shear are analyzed. A modified observer is calculated such as to minimize the MHD noise propagation for each case, based on three constraints: 1) equivalent response to a real vertical displacement event (VDE), based on VDE analysis; 2) minimized distance in the least squares sense from the optimized default observer; 3) orthogonality with the magnetic response to an MHD event. The result of the minimization is applied to the single instability for which it is designed, to verify the validity of the approach. In addition to that, mixed-mode observers are used to evaluate the effect of noise propagation in discharges with multiple modes. The results confirm that the design of a discharge-specific vertical observer should be sufficient for safely controlling the vertical position of the plasma in ITER.