Vertical stability margin studies on TCV: experiments and modelling

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The stabilization of the vertical position in future fusion devices (e.g. DEMO [1]) is particularly challenging, due to a number of reasons. First of all, the high fusion performances required of the plasma call for a relatively high elongation [2], which in turn increases the vertical instability growth rate. Secondly, toroidally conducting structures providing most of the passive stabilization (typically the vessel) are very far from the plasma, since massive blankets are required to shield and collect neutrons produced by fusion reactions.

The electric power needed for stabilization is one of the key drivers in the design of a new device. This quantity depends critically on the so-called stability margin [3], which is a fundamental indication on the passive stability properties of a given configuration.

During the recent experimental campaign carried out on TCV in the frame of the EUROFusion Medium Size Tokamak Task Force, dedicated experiments have been carried out, aimed at extensively studying the minimum achievable stability margin beyond which stability is lost. The results achieved, reported in the present paper, allow us in particular to experimentally validate the modelling approach used for the design of future devices. The experimental strategy is based on arranging a plasma configuration exhibiting a slowly decreasing stability margin, e.g. thanks to a slow ramp in elongation during a shot. The plasma is subject to repetitive perturbations (ELMs) during the configuration ramp. The instant at which the feedback controller is not able to stabilize the plasma any longer corresponds to the limit value of the stability margin, which depends on the feedback controller and the perturbation under analysis. Since the stability margin cannot be directly measured, a specific modelling activity is carried out with the CREATE_L model [4], which can provide indications on passive and active stabilization even beyond the calculation of the stability margin.

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[3] A. Portone 2005 *Nucl. Fusion* **45** 926

[4] R. Albanese and F. Villone 1998 *Nucl. Fusion* **38** 723