Stability limits for tokamak plasma with negative triangularity


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Negative triangularity tokamak plasmas are subject of an increased interest both in existing experiments [1] and in studies of core physics as well as power handling relevant to the fusion demonstration power reactor [2].

The ideal MHD stability calculations for the negative triangularity plasma extend the investigation of the TCV tokamak beta limits and edge stability [3, 4] to double null shapes, lower aspect ratio and negative shear. In case of the negative triangularity, the 2nd stability access is closed for ballooning modes and a well defined limiting pressure gradient profile exists in the positive shear region. The external kink mode stability limit can be obtained by rescaling the limiting profile. The normalized beta limits dependence on the internal inductance $\beta_N \sim 2.5l_i$ corresponds to lower beta values compared to standard positive triangularity configurations with $\beta_N \sim 4l_i$.

H-mode discharges with upper negative triangularity in TCV demonstrate significant mitigation of type I ELM peak power losses [1]. This is consistent with lower edge stability limits for the pedestal [3]. For double null negative triangularity configurations higher pedestals can be stable due to higher shear at low pedestal current density. At the same time a destabilization of a whole range of global modes takes place once the Mercier criterion for localized modes is violated simultaneously with the ballooning mode destabilization implying possible changes in the ELM characteristics. The effect of diamagnetic stabilization on the edge stability is estimated.

References