

Evaluating the impact of plasma toroidal rotation on the pedestal stability with ELITE on JET

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Abstract:

Earlier results have shown that the ELM instabilities in JET seem to be triggered before the peeling-ballooning (PB) stability limit is reached [1 - 3]. Basically, the maximum pre-ELM normalized pressure gradient α_{exp} is often lower than the prediction of critical gradient pressure α_{crit} by the ideal MHD PB model. Recently, a systematic correlation was observed between $\alpha_{\text{crit}}/\alpha_{\text{exp}}$ ratio and some relevant plasma parameters, mainly the relative shift (difference in the position of electron temperature and density profiles) [3]. Aforementioned results are based on the calculations of PB pedestal stability done with ELITE code [4], which implements linear ideal MHD model, while neither plasma toroidal rotation nor diamagnetic term were included.

Including the plasma toroidal rotation to the calculation, which is the primary content of this contribution, could have a significant effect on the stability of MHD modes, as shown in [5, 6], where the diamagnetic term and plasma rotation were included. The aim of this work is to examine if the integration of plasma toroidal rotation into ELITE calculation can remove the discrepancy between the experiment and theoretical predictions (i.e. to get $\alpha_{\text{crit}}/\alpha_{\text{exp}} \approx 1$).

Presented investigations are mainly focused on the impact on predicted α_{crit} . Firstly, the experimentally measured toroidal rotation profiles using CXRS diagnostics were used and its effect on the α_{crit} was examined. The amplitude of the rotation was increased gradually to observe the evolution of the resulting impact on the growth rate of given modes depending on their mode number, thus being able to assess the gradual effect on the α_{crit} . Additionally, the impact of shape of the toroidal rotation profile was investigated.

In conclusion, presented results confirm that toroidal rotation has an effect on α_{crit} , however, we have found that α_{crit} is affected by 10% at the maximum. Therefore, according to current findings the inclusion of toroidal rotation to pedestal stability calculation using ELITE does not resolve the issue and the $\alpha_{\text{crit}}/\alpha_{\text{exp}}$ ratio was not affected significantly, as $\alpha_{\text{crit}}/\alpha_{\text{exp}} > 2$ for a substantial part of studied set of discharges.

References

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