

Exploiting the influence of plasma shape on the 3D plasma response to maximize access to RMP-ELM control in tokamaks

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The 3D plasma response provides a candidate explanation for the inability to access RMP-ELM suppression at high triangularity or double-null plasma shapes in tokamaks, namely that the resonant coupling is reduced at such shapes.

Recent RMP-ELM control experiments in DIII-D found significant difference in the window of ELM suppression with different plasma triangularities, that ELMs are easier to suppress at low or moderate triangularity, while suppression was not observed at high triangularity. Meanwhile, the KSTAR experiments found that ELMs can be suppressed at lower single-null shape, while no suppression is obtained at double-null shape. To understand the influence of plasma shape on RMP-ELM control, the 3D plasma response is investigated in both experiment and modeling by systematically modeling the effect of the plasma shape, whilst keeping other equilibrium quantities largely unchanged. It reveals that the edge resonant component of plasma response is strongly suppressed at high triangularity or double-null shapes. This is validated through targeted comparison with experiments at DIII-D, EAST, ASDEX Upgrade, and KSTAR. DIII-D and EAST magnetic measurements are used to validate simulations, while at ASDEX Upgrade the plasma edge displacement is measured. However, the linear MHD model of plasma response still has limitations in modeling ELM suppression access, as it cannot explain the inaccessibility of ELM suppression at sufficiently low triangularity in ASDEX Upgrade and upper single-null shapes in KSTAR.

These findings indicate that the plasma shape should be taken into consideration when designing a tokamak

suitable for RMP-ELM control, and that predictive plasma response calculations can be used to maximize access to RMP-ELM control in future devices by maximizing the coupling between coils and the plasma.

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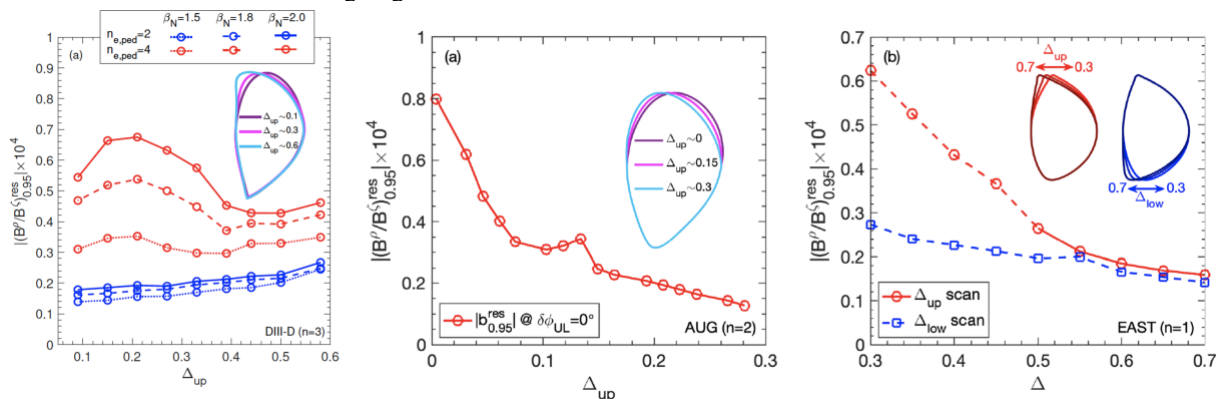


Figure 1 The plasma response is strongly suppressed at high triangularity compared to that at low triangularity in DIII-D (left), ASDEX Upgrade (middle), and EAST (right) tokamaks