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Study of pedestal parameters in *n* = 1 RMP ELM-crash control experiments on KSTAR

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For reliable edge-localized mode (ELM)-crash control by resonant magnetic perturbation (RMP) application, it is critical to understand access conditions to ELM-crash suppression. Based on the high reproducibility of the ELM-crash suppression in KSTAR, reliable edge profile diagnostics, such as Thomson scattering[1] (for n_e and T_e) and charge exchange spectroscopy[2] (for T_i and V_{tor} of carbon impurity), makes it possible to analyze pedestal conditions for ELM-crash suppression rigorously.

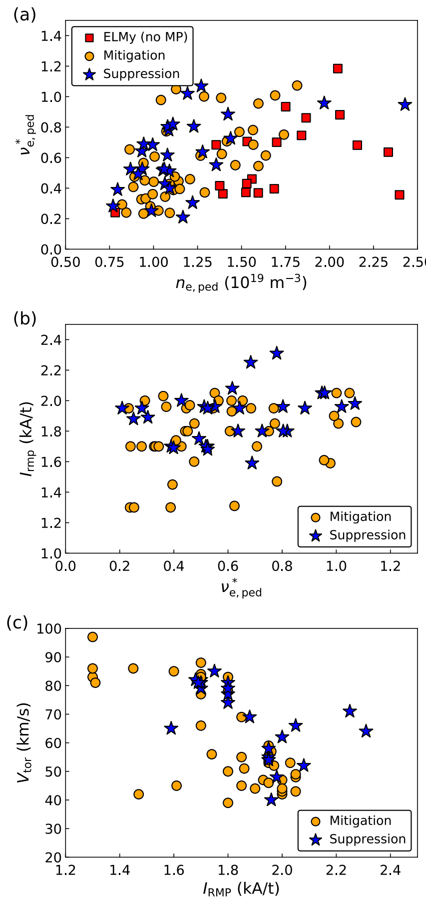

Figure 1. (a) ν_e^* vs. n_e (b) I_{RMP} vs. ν_e^* (c) V_{tor} vs. I_{RMP} space. Square: ELMy phase before RMP, circle: ELM-crash mitigation, pentagram: suppression phase.

A discharge database for the pedestal parameter study consists of 28 discharges having the same RMP coil configuration (n = 1, 90-degree phasing[3]). Discharge conditions in the database are as follows: $B_T(R_0)$ = 1.8 T constant, q_{95} ~ 4.9-5.5, I_p ~ 500-560 kA, δ ~ 0.58 ± 0.08, and κ ~ 1.74 ± 0.03. In this study, we focus on the normalized electron collisionality (ν_e^*) and toroidal rotation velocity (V_{tor}) on the pedestal top as key parameters for ELM-crash suppression onset. The pedestal profiles are quantified by the modified hyperbolic tangent curve to obtain $\nu_{e,ped}^*$ and $V_{tor,ped}$.

The ELM-crash suppression data points are distributed in range of 0.2 < $\nu_{e,ped}^*$ < 1.1 (with Z_{eff} =2 assumption) and $V_{tor,ped}$ > 40 km/s, experimentally confirmed parameter space of suppression so far in KSTAR. Some notable points are inferred from the distribution of suppression data points. I) Most suppression points are below $n_{e,ped}/n_{GW}$ ~ 0.2, where n_{GW} is the Greenwald density limit (figure 1(a)). II) The range of $\nu_{e,ped}^*$, obtained the suppression, gets wide as I_{RMP} increases (figure 1(b)). III) I_{RMP} threshold for ELM-crash suppression is lower in high $V_{tor,ped}$ compared to low $V_{tor,ped}$ plasmas (figure 1(c)). However, for the verification of the above remarks, high-density experiments and rigorous investigation for the relationship between I_{RMP} and $V_{tor,ped}$ are necessary.

The pedestal parameter database described here provides a new feasibility database that contributes to the study of ELM-crash control in ITER. We plan to conduct additional experiments in ITER-relevant conditions, unexplored parameter space in the current datasets, which make it possible to address the boundary or limit of suppression window.

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