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L-H Transition Studies under Non-axisymmetric Magnetic Fields in KSTAR

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Non-axisymmetric magnetic field is actively employed in controlling edge-localized-modes (ELMs) in H-mode plasmas [1]. Such non-axisymmetric magnetic field changes pedestal transport, effectively regulating pedestal profiles to stay below the stability boundary of peeling-ballooning modes. Recently, KSTAR has shown that the presence of non-axisymmetric magnetic fields would reduce both height and width of pedestal in the KSTAR H-mode plasmas [2]. Also, a typical H-mode power threshold (P_{TH}) without non-axisymmetric field (at B_T = 1.8 T, n_e = $2x10^{19}$ m^{-3}, Surface area ~ 49 m^2) has been found to be well below ~ 1 MW neutral beam injected power. For the time being, we speculated that such low level of P_{Th} could be due to an order of magnitude lower intrinsic error field ($<\delta B/B_0>_{m/n=2/1}$ ~ $1x10^{-5}$ [3]) and toroidal field ripple (δ_{TF}=0.05% [4]) in KSTAR than in the other existing devices. Thus, multiple low-n non-axisymmetric fields have been systematically scanned to determine the influences on H-mode power thresholds. As expected, the increase of non-axisymmetric fields has led to a higher power threshold. On the other hand, we have found a rather sensitive dependence of n=1 and n=2 even at a very low level of non-axisymmetric magnetic fields. Overall, this strongly suggests that intrinsic non-axisymmetric fields should be minimized to economically secure the access to H-mode in ITER and future reactors.

A more refined study has been in progress to clarify the underlying physical mechanisms of the L-H power threshold by non-axisymmetric magnetic field, which may have influenced the change of E x B shear at edge pedestal. The details of the L-H power threshold study will be discussed, comparing the influences of low-n non-axisymmetric fields (i.e. n=1, 2 and mixed n).

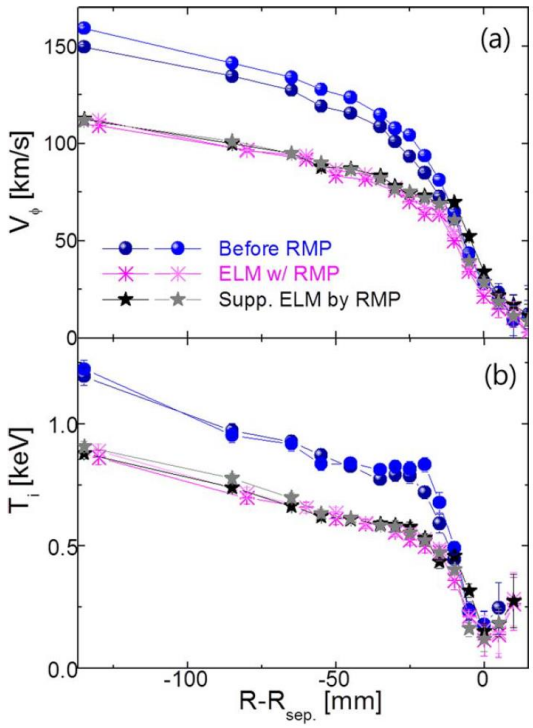

Figure 1. The pedestal top of the toroidal rotation and ion temperature profiles has a big drop and sustains after applied n = 1 RMPs. Every double-point for steps is used to check the plasma fluctuation [5].

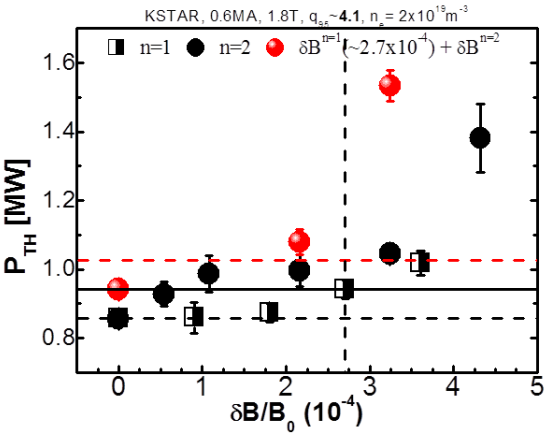

Figure 2. Lower P_{TH} has been measured in KSTAR with only intrinsic error field (black dashed line). Solid line is P of nominal n=1 error field ($\delta B/B_0$ ~ $2.7x10^{-4}$)

References

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