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Recent progresses on the RMP researches towards active control of tearing mode in the J-TEXT tokamak

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Controlling the tearing mode (TM) is one of the major topics of fusion research, since TM degrades the plasma confinement and even induces major disruption if it is locked. Previous experimental and theoretical studies showed that the resonant magnetic perturbations (RMPs) influence both the rotation and width of the TM. As a result, the static RMP could apply a net stabilizing and braking effect on a rotating TM, and hence suppress or lock the TM. Based on these effects, 3 strategies for controlling the TM have been proposed and tested in J-TEXT by applying the pulsed or fast rotating RMPs. This paper will present these recent efforts.

On J-TEXT, the RMP system is capable of providing either a static or a high frequency (up to 6 kHz) rotating RMP field, with dominant 2/1 component. To study the proposed TM control methods, extensive upgrades of the power supply (PS) system for RMP coils were carried out, such as building a pulsed DC PS which could follow the TM frequency with 50% duty cycle, a hopping frequency AC PS, an on-line system for measuring the TM phase and frequency.

The first control strategy is to apply pulsed RMP to the TM only during the accelerating phase region. By nonlinear numerical modelling, it is proved efficient in accelerating the mode rotation and even completely suppresses the mode. The followed experimental attempt with the pulsed RMP at relative low amplitude has demonstrated the acceleration effect. The second control method is to apply a RMP, rotating with varying frequency which is kept slightly higher than that of a TM. Currently, the open loop application of this hopping PS led to the locking of TM at 4, 5 and 6 kHz successively. Further investigation with feedback controlled hopping PS is needed to validate this method.

Thirdly, the fast rotating RMP field has been successfully applied for the avoidance of mode locking and the prevention of plasma disruption. A set of disruptive discharges induced by intrinsic mode locking were performed by reducing the edge safety factor from 3 towards 2. The braking of TM usually lasted for ~20 ms and the disruption followed at ~10 ms after the mode locked. Trigged by the mode locking warning system, the 3 kHz rotating RMP was applied before the mode locked. The TM was accelerated to 3 kHz and the intrinsic mode locking was avoided. As a result, the disruption was prevented.

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