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Overview of the Recent Experimental Research on the J-TEXT Tokamak

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Recent J-TEXT research has highlighted the significance of the role that non-axisymmetric magnetic perturbations, so called 3D magnetic perturbation (MP) fields, play in fundamentally 2D concept, i.e. tokamak. In this paper, the J-TEXT results achieved over the last two years, especially on the impacts of 3D MP fields on magnetic topology, plasma disruptions, MHD instabilities, and plasma turbulence transport, will be presented.

On J-TEXT, the resonant MPs (RMPs) system, capable of providing either a static (DC) or a high frequency (up to 6 kHz) rotating (AC) non-axisymmetric MP field, has been upgraded by adding a new set of 12 in-vessel saddle coils, and the total number of in-vessel RMP coils increases from 12 to 24 (3 rows × 8 columns). The new capabilities advance J-TEXT to be a forefront of international magnetic fusion facilities, allow a flexible study of 3D effects in a tokamak.

Both density and plasma rotation dependences of the m/n = 2/1 locked mode threshold, $B\_r,(2,1)\hat{}c$, have been investigated systematically on J-TEXT. Recent experimental results showed the $B\_r,(2,1)\hat{}c$ scales linearly on the toroidal rotation, and depends weakly on plasma density, n_e. The fast rotating RMP field has been successfully applied for avoidance of mode locking and the prevention of plasma disruption. Remarkably, the rotating tearing mode was completely suppressed by the electrode biasing (EB) in addition to the RMP field.

The impacts of 3D magnetic topology on the turbulences have been investigated on J-TEXT. It is found that the fluctuations of electron density, electron temperature, and plasma potential can be significantly modulated by the island structure, and a larger fluctuation level appears at the X-point of islands.

The suppression of runaway electrons (REs) during disruptions is essential to the operation of ITER, and it has been reached by utilizing the 3D magnetic perturbations on J-TEXT. The NIMROD simulation indicates that the strong stochastic in the whole plasma cross-section expel out the runaway seed and results in runaway free disruptions on J-TEXT. This may provide an alternative mechanism of runaway suppression for large-scale tokamak and ITER.

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