7th Asia-Pacific Conference on Plasma Physics, 12-17 Nov, 2023 at Port Messe Nagoya

Design of External Rotational Transform coils and preliminary experimental results on J-TEXT

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Disruptions and their consequences have been extensively studied in tokamak research, particularly for large tokamak devices like ITER, where active control measures are crucial for disruption avoidance. Previous experiments on current-carrying stellarators and hybrid devices have demonstrated the potential for disruption avoidance and suppression of MHD activity on tokamak by introducing increasing levels of rotational transform from stellarator-like helical coils [1,2,3].

To explore a novel method of optimizing tokamak configurations and harness the advantages of both tokamaks and stellarators, a set of 3D External Rotational Transform (ERT) coils have been designed and installed in the J-TEXT tokamak, as shown in Figure 1(a)[4]. Simulation results indicate that applying the ERT coils leads to non-axisymmetric plasma shapes, modifies q profile and improves plasma stability. The dominant mode of the ERT coil is m/n = -2/2, but it can also be operated with modes of 2/2, 1/1, and -1/1 by altering the directions of coil and plasma currents [5].

Due to space limitations, the ERT coils are installed inside the vacuum vessel. To address the complex vacuum vessel environment, the ERT coils employ a modular rail structure, with each coil comprising 24 independent rail units that can be finely adjusted in position and structure during installation.

Successful application of the ERT coils in discharges has yielded promising preliminary experimental results. ERT has demonstrated the ability to alter plasma macro parameters, suppress tearing modes, avoid plasma disruption, and enhance plasma stability. Figure 1(b) illustrates a typical set of discharge signals with ERT suppressing tearing modes. Further details will be presented at the conference.

This work was supported by the National Magnetic Confinement Fusion Energy R & D Program of China (Contract Nos. 2018YFE0309100).

References

[1] D.W. Atkinson *et al*, Phys. Rev. Lett. 37, 1616 (1976).
[2] W VII-A Team, Nucl. Fusion. 20, 1093 (1980).
[3] M.D. Pandya *et al*, Phys. Plasmas. 22, 110702 (2005)
[4] J. Huang *et al*, Plasma Fusion Res. 16, 2403047 (2021)
[5] Z.H. Jiang *et al*, Plasma Sci. Technol. 24, 124014 (2022)

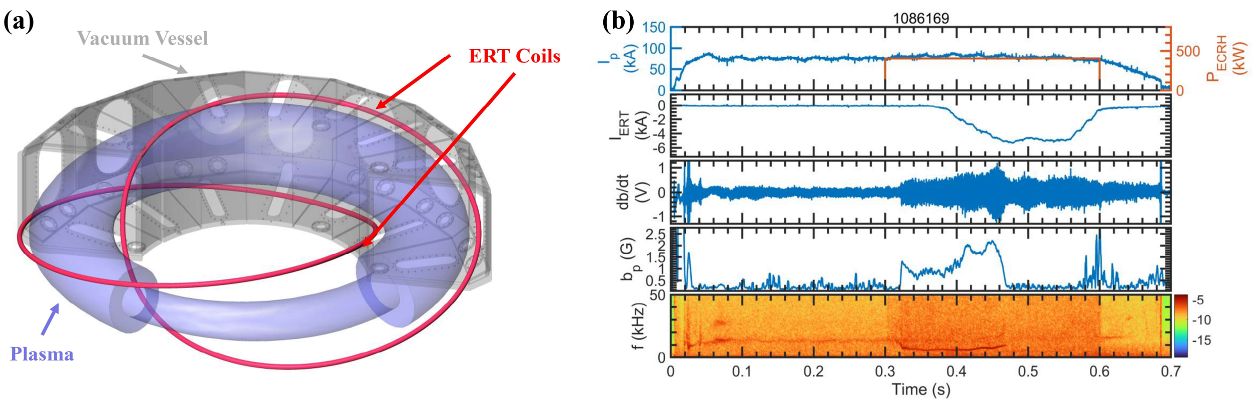

Figure 1. (a) Layout of the External Rotational Transform (ERT) coil system in J-TEXT. (b) A typical set of discharge signals with ERT suppressing tearing mode.