9th Asia-Pacific Conference on Plasma Physics, 21-26 Sep, 2025 at Fukuoka

Optimization of Electromagnetic Pellet Injector for disruption mitigation on J-TEXT tokamak

Z. Y. Chen[1]*, W. Yan[1], Y. L.Yu[1], Z. S. Nie[1], Y. Yang[1] and the J-TEXT team
[1] International Joint Research Laboratory of Magnetic Confinement Fusion and Plasma Physics, Huazhong University of Science and Technology, Wuhan 430074, China
e-mail (speaker): zychen@hust.edu.cn

Disruption mitigation is essential for large-scale tokamak devices such as ITER, which will reach 1 GJ of thermal and magnetic energy when operating at high performance. Current disruption mitigation systems (DMS) relying on high-pressure gas for impurity injection are limited by the sound speed of the propellant gas, restricting the injection speed of massive gas injection or shattered pellet injection to a few hundred m/s. For next-generation devices, a fast-response DMS with high injection speed is critical. The Electromagnetic Pellet Injection System (EMPI), developed by the J-TEXT team, is based on the railgun concept and has demonstrated significant advancements. The second-generation EMPI system features a vacuum system and a curved recovery rail, which ensures smooth armature retrieval and enhances the safety of the recycling process. Additionally, the system incorporates an augmented rail design that improves launch performance. The arc suppression system has been established to reduce arc ablation as shown in Fig.1. Compared with non arc suppression, the amplitude and number of sawtooth in U_m after arc suppression are reduced, especially when active and passive arc suppression are used at the same time. Test results show that the new EMPI system achieves a 20% increase in maximum launch speed while reducing the maximum current by approximately 60%. With the ability to accelerate payloads to over 1000 m/s and a reaction time of less than 10 milliseconds (considering a 6.3-meter injection tube length for ITER). The preliminary test result has shown that the EMPI system has a great potential to be the DMS of the large scale fusion devices.

References

[1] Y.L. Yu, Z.Y. Chen, W. Yan, S.G. Xia, N.C. Wang, Z.S. Nie, X. Zhou, Y. Sheng, Y.W. Sun, J.G. Fang, Y. Zhong, the J-TEXT Team. Optimal design and experimental testing of EMPI system for plasma disruption mitigation on J-TEXT. Fusion Engineering and Design, 208 (2024) 11470.
[2] Y.L. Yu, Z.Y. Chen, S.G. Xia, W. Yan, W.K. Zhang, F. Li, N.C. Wang, J.H. Tang, G.N. Zou, F.X. Liu, Z.S. Nie, Y. Li, J.G. Fang, Y. Zhong, the J-TEXT Team. Design an arc suppression system for the Electromagnetic Pellet Injection System, Fusion Engineering and Design, 2024, 198 (2024) 114100.

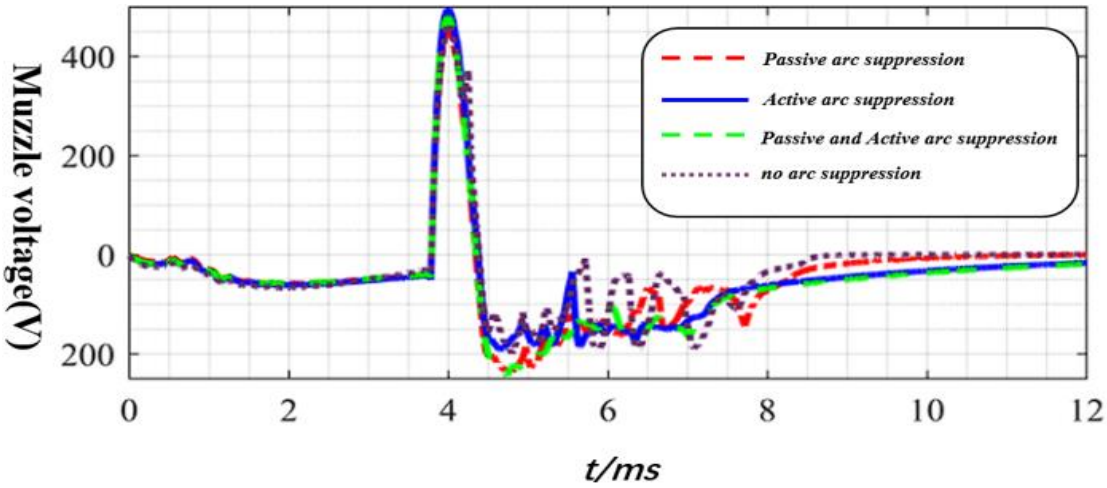

Fig.1 Compared with non arc suppression, the amplitude and number of sawtooth in U_m after arc suppression are reduced, especially when active and passive arc suppression are used at the same time.