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Disruption mitigation with high-pressure argon gas injection on EAST tokamak

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Abstract
Disruptions is a serious problem for tokamak, it will cause heat loads due to sudden energy loss, electro-magnetic loads due to halo and eddy currents, and runaway electron generation, which might pose a major concern for future tokamak reactors[1][2]. Disruption mitigation has been performed with both helium gas and argon gas injection on EAST. A fast mitigation valve has been developed and successfully implemented, with valve response time less than 0.15 ms, capable of injecting up to 7×10^{22} particles, corresponding to 300 times the plasma inventory[3]. Experimental results show that MGI injection could trigger n=1 mode with rotation frequency few k Hz, the MHD event only lasts 1~2 ms, followed by thermal energy loss. Compared with helium gas injection, argon gas has a longer vacuum penetration time, in agreement with that higher Z noble gas has lower sound speed. Argon can radiated away much more thermal energy, suggesting a better radiation effect. It has been demonstrated that plasma with higher thermal energy has a longer cooling time and a longer current quench time, seen in figure 1. Compared with helium gas, argon gas injection could result in faster current quench, thus higher loop voltage and stronger eddy currents, which is additional challenging to the device.

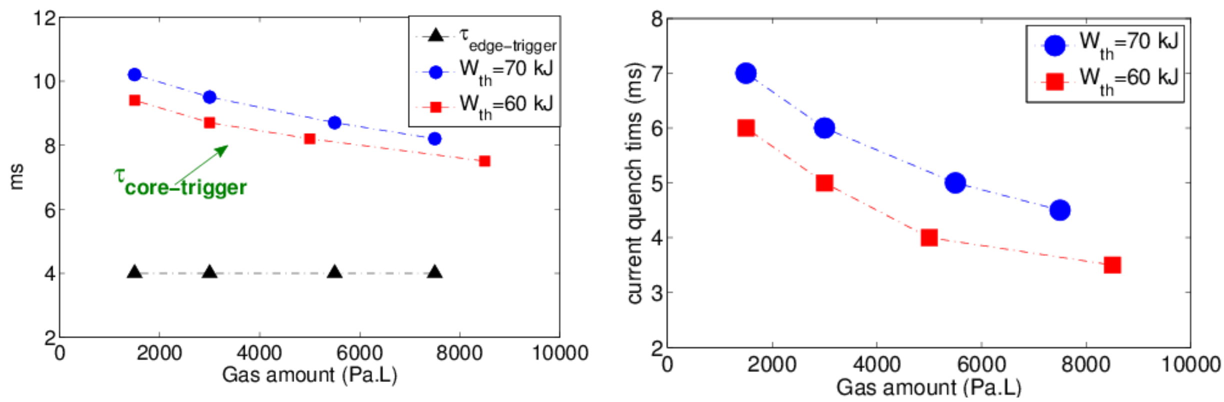

Figure 1. Vacuum penetration time, cooling time with varying injection amount

(left); Current quench time with varying injection amount (right).

References
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