Experimental observations of fast-ion losses correlated with Global and Compressional Alfvén Eigenmodes in MAST-U

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Due to their relatively higher $V_{beam}/V_{Alvén}$ ratio, spherical tokamaks like MAST-U are ideal to investigate high-frequency modes such as Compressional Alfvén Eigenmodes (CAEs) and Global Alfvén Eigenmodes (GAEs) [1, 2]. Besides, the recently installed scintillator-based Fast-Ion Loss Detector (FILD) [3] in MAST-U, provides enough sampling frequency to detect fast-ion losses induced by such instabilities. In the 1st MAST-U experimental campaign, Fourier analyses of the FILD signal revealed coherent fast-ion losses matching the frequencies identified as CAEs and GAEs by Mirnov coils in the low field side of the machine. To date, this is the most direct evidence of fast-ion losses induced by CAEs and GAEs, suggesting that CAEs/GAEs may have an adverse impact on the fast-ion confinement. The losses are likely to be caused by pitch angle scattering due to anomalous doppler-shifted cyclotron resonance. Thus, understanding these losses becomes of paramount importance for ITER, where an anisotropic fast-ion distribution with velocities above the Alfvén velocity could make up the essential ingredients to drive GAEs and CAEs unstable [4].

[1] L. C. Appel et al., Plasma Phys. Control. Fusion 50, 115011 (2008)

[2] S. E. Sharapov et al., Plys Plasmas 21, 082501 (2014)

[3] J. F. Rivero-Rodriguez et al., Rev. Sci. Instrum. 89, 10I112 (2018)

[4] W.W. Heidbrink et al., Nucl. Fusion 46, 324 (2006)

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