**First experimental measurements of the scintillator-based Fast-Ion Loss Detector in the MAST-U spherical tokamak**

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The first scintillator-based Fast-Ion Loss Detector (FILD) in MAST-U is equipped with a fast scintillator material, a high-resolution camera and an avalanche photo-diode camera that enable the inference of the fast-ion loss velocity space and fast-ion loss fluctuations at frequencies up to 2 MHz. The probe is installed on a rotary and reciprocating system that makes it possible to adapt the probe orientation to the plasma magnetic field pitch and radial position, respectively. The first measurements have revealed a clear dependence of the losses with the distance between the probe and the separatrix. The measured velocity-space of the neutral beam injection (NBI) prompt-losses agrees with estimates made using the ASCOT5 Monte-Carlo full-orbit code. Fourier analysis of the FILD signal revealed fast-ion losses from both on-axis and off-axis beam correlated with a wide variety of plasma instabilities, as can be observed in figure 1, such as toroidal Alfvén eigenmodes (TAE) and long-lived modes (LLM). Moreover, fast-ion losses in the range of 1 – 2 MHz have been revealed for the first time. These losses are correlated with fast-ion driven instabilities identified as either Compressional Alfvén Eigenmodes (CAEs) or Global Alfvén Eigenmodes (GAEs): their frequency is 0.3 – 0.45 times the cyclotron frequency of deuterium at the magnetic axis. Other plasma instabilities, such as sawteeth, fishbones and edge localized modes are seen to cause fast-ion losses. Measurements with a neutron camera and solid-state neutral particle analyser confirm the drops in the confined fast-ion population when the fast-ion losses are observed. These results show the unique capability of the MAST-U FILD to provide high-resolution measurements of fast-ion losses enabling a detailed physics investigation of wave-particle interactions in a spherical tokamak.

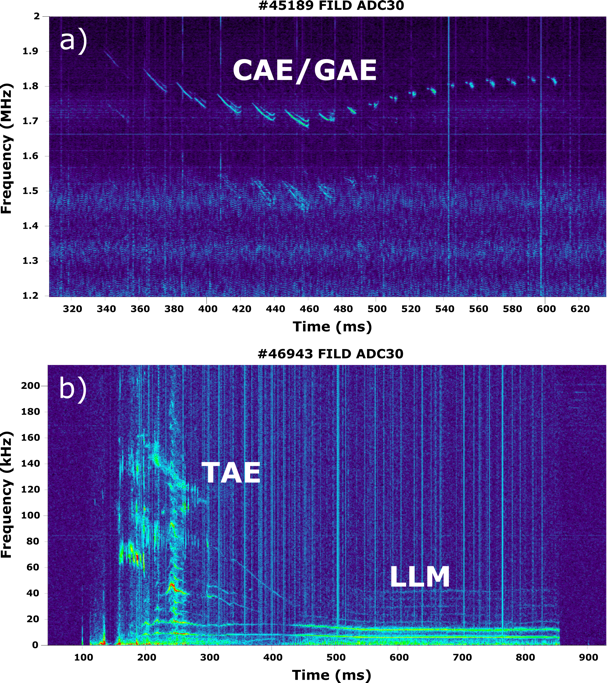


Figure 1. FILD spectrograms showing losses correlated with (a) CAE/GAE, (b) TAE and LLM.

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