Neutral beam injection driven Alfvenic modes and fast ion losses in ST40

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ST40 is a high-field spherical tokamak with a major radius of 0.4 – 0.5 m and toroidal magnetic field up to 2.1 T. It is equipped with two NBI systems with 1.0 MW at 55 keV and 0.8 MW at 24 keV in deuterium. The high beam power density in a small machine produces a high fast particle fraction, confinement of which is critical for good plasma performance. Additionally, the high toroidal field on ST40 enables investigations into fast ion driven modes at fields higher than previous spherical tokamaks, extending the parameter space towards reactors.

In this contribution we present experimental and modelling results for NBI ion driven MHD in various ST40 plasmas. Within the operating space of ST40, the neutral beam produced ions can range from sub- to super-Alfvenic, producing a range of Alfvenic modes including chirping modes and Alfven cascades (Fig. 1). The dependence of the modes on toroidal field and density within the ST40 operating space has been investigated and the scenarios specifically prone to Alfvenic modes characterised. However, while the modes are prevalent, they generally do not cause significant fast ion losses based on neutron rates and neutral particle analyser fluxes and modelling with the fast ion orbit following code ASCOT.

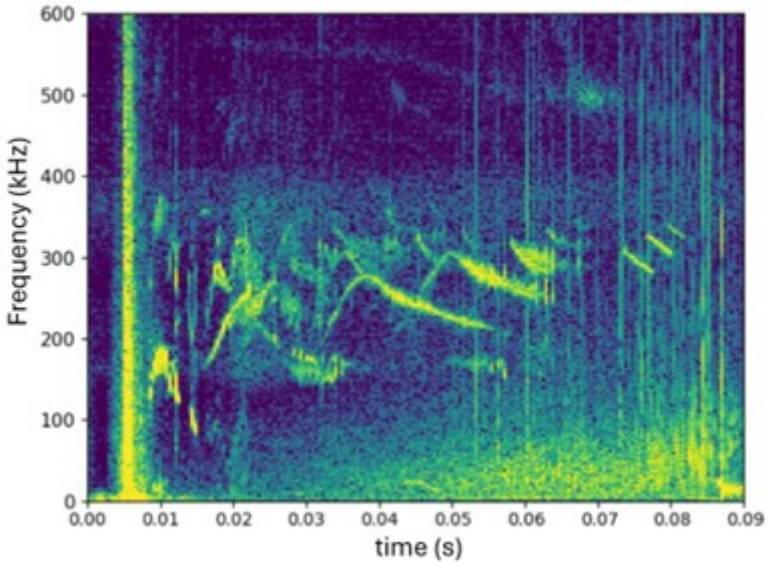

Figure 1: Magnetic spectrogram of various Alfven cascades and chirping modes in ST40 pulse with B_T = 1.2 T and 55 keV P_{NBI} = 0.9 MW.