## Localization of MHD and fast particles modes in ASDEX Upgrade using reflectometry

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The physics of energetic particle driven modes is of particular interest for fast ion dynamics and transport in burning plasma devices such as ITER. Specifically Alfvén eigenmode instabilities, such as toroidicity induced Alfvén eigenmodes (TAEs), have been studied in various devices like DIII-D, TFTR, JET and JT-60U using a range of fluctuation diagnostics; including magnetic pickup coils, Beam Emission Spectroscopy (BES), CO<sup>2</sup> interferometry and Far-Infrared scattering (FIR) for example. However, microwave reflectometry with its high temporal and spatial (radial) resolution offers the additional possibility of obtaining the highly sought measurement of the TAE radial eigen-function. On ASDEX Upgrade a dual channel (Q-band: 33-49.2GHz and V-band: 49-72GHz) fast-frequency hopping heterodyne microwave reflectometer has recently been installed which allows probing of several density cutoff layers from the low field side (LFS) edge to the core during the same discharge. The data sample rate is up to 1MHz allowing discrimination of MHD modes and turbulent fluctuations up to 500kHz. Initial results show that the reflectometer is capable of determining the radial location and extent of simultaneous MHD modes: for example TAEs and sawteeth precursor activity in the tokamak core ( $\rho^{pol} = 0.6-0.3$ ) can be clearly separated from low order edge MHD modes. New results have also been obtained on the radial eigenfunction of TAEs – which can be compared with theory. In addition, the multi-channel LFS - HFS broadband FMCW profile reflectometer on ASDEX Upgrade can be operated in either fixed or swept frequency mode and can be used to compare density fluctuations on the HFS and the LFS as well as providing density profiles for the localization of the cutoff layers. The combination of reflectometry with electron cyclotron emission (ECE), soft x-ray (SXR) and magnetics creates a powerful tool for the study of Alfven eigenmodes in ASDEX Upgrade.