Changes in the radial structure of EPMs during the chirping phase
taking the uncertainties of the time-frequency transforms into account

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The understanding of energetic particle modes (EPMs) in tokamaks plays a key role regarding future burning plasma experiments. The aim of the present paper is to investigate the properties of BAE modes and EGAMs [1] primarily using soft X-ray diagnostics in ASDEX Upgrade. The interest is mostly focused on the changes in the mode structure of BAEs/EGAMs during the non-linear “chirping” phase. Continuous linear time-frequency analysis is ideal for the study of transient wave-like phenomena, thus we have chosen short-time Fourier transform (STFT), which is time and frequency shift invariant and it is very suitable to study fluctuations in a limited frequency range. Using a maximum-searching algorithm, time evolution of the maxima of the mode frequency can be traced which is called the ridge of the STFT transform [2]. Following the ridge, the time evolution of the mode amplitude can also be evaluated [3]. However, fast changes in the frequency and amplitude limit the interpretation of the ridge as instantaneous frequency and amplitude of the wave. Thus besides the uncertainty caused by additive noises of the measurements, the uncertainty arising as a side effect of signal processing is also accounted for, by implementing expressions of the upper estimate of possible deviations [2]. We analyse the changes of the mode structure during the “chirping” phase within the uncertainty limits of the results. These experimental results can serve as the basis of comparison with theoretical modelling.

References