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Spatially resolved measurements of the tail temperature of RF accelerated deuterons at JET

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Energetic deuterons leave pronounced signatures in the neutron emission spectrum from fusion plasmas. In this work, this is exploited in order to obtain information about the properties of ICRF-accelerated deuterons using the neutron camera system at JET. By combining data from the ten horizontal, and nine vertical lines of sight, a spectroscopic analysis of each detector's pulse height spectra has been used to determine the spatial profile of the effective tail temperature of fast deuterons.

The procedure entails fitting parametrised models of the neutron energy spectra to the pulse-height spectra measured by the neutron camera detectors. Fitting the parametrised models gives an estimation of the model parameters, including the temperature of the hot ion-tail.

The analysis method is validated and benchmarked on synthetic data. We demonstrate that pulse-height spectra from the camera's liquid scintillator detectors provide enough spectroscopic information to estimate the line-of-sight averaged fast-ion temperature. Using a model of the ICRF resonance-layer, which includes a resonance height and width, we show that the neutron camera at JET can be used to determine the spatial and energy distribution of fast RF-accelerated ions in a Tokamak.

The developed method is then applied to various ICRF-scenarios at JET, including 2nd and 3rd harmonic acceleration of deuterium ions, as well as the "3-ion" scenario. The results clearly show how the tail temperature profile peaks in the vicinity of the resonance position, where the most energetic ions are located.

The potential for using this method to study rapid transient phenomena, such as redistribution of fast ions during MHD instabilities, is also discussed.

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