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Modelling of sawtooth-induced mixing of trace tritium and deuterium beam with the TRANSP code

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Fast sawtooth-induced particle mixing is clearly observed in dedicated tokamak experiments with short minority gas puff or laser ablation where the injected minority penetrates towards the centre on the time scale of the sawtooth collapse (see for example Refs. 1, 2). Similar experiments have been performed recently on JET by puffing small amounts of tritium in sawtoothing H-mode plasmas heated by deuterium neutral beams [3]. The 14 MeV neutrons born in deuterium-tritium reactions were measured by neutron diagnostics with high time resolution (~10 ms) along 19 chords. These neutrons are produced mainly in the reaction between the beam deuterium and thermal tritium therefore, theoretical models describing the mixing of these species by the sawtooth collapse can be tested in predictive simulations of neutron emission along the chord of measurements.

The simulations of neutron emission during the sawtooth crashes in H-mode JET plasmas are performed here using the TRANSP code which allows different assumptions on sawtooth mixing of various plasma species. Although the sawtooth model in TRANSP is based on the Kadomtsev full reconnection mechanism, a variation in mixed beam particle and current density fractions is possible. Such variation is theoretically justified by the partial reconnection model [4], though the partial mixing used in TRANSP does not fully follow this theoretical model. The simulations presented here will show to what extent the TRANSP partial reconnection and theoretical model [4] reproduce the observed oscillations of neutron emission.

The oscillations of neutron emission correlated with the sawteeth were clearly observed in low density plasma, but they are absent at high density although the electron temperature oscillations are equally strong in both cases. This puzzling phenomenon will be explained and illustrated in numerical simulations [5].

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