Scaling of the frequencies of the type one edge localized modes and their effect on tungsten in JET ITER-like wall discharges.

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A database of 250 pulses selected during the experimental campaigns of JET with the ITER-like wall (ILW) is used to study the frequency dependences of the type I edge localized modes (ELM). In the database, the average plasma density goes from 3.8 to 10.1 × 10¹⁹ m⁻³. The additional heating spans from 5 to 26 MW with neutral beam injection power (NBI) spanning from 4.8 to 26 MW. The ion cyclotron resonant frequency heating power (ICRF) is varied from 0 to 4.8 MW. The plasma current is from 1.3 to 3 MA and the toroidal magnetic field from 1.3 to 2.87 T. The outer strike point position changes from the centre of the horizontal target up to the corner of the vertical one.

A scaling of the ELM frequency is presented as a function of the pedestal density drop \( dN_{\text{ped}} \) and a very simple model to interpret this scaling is discussed. In this model, the frequency of the ELMs is governed by the time needed by the neutral flux to refill the density of the pedestal. The filling rate is the result of a small imbalance between the neutral flux filling the pedestal and the outward flux that expels the particles to the SOL. The ELM frequency can be governed by such a mechanism if the recovery time of the temperature of the pedestal in JET occurs before or at the same time as the one of the density. This is observed to be the case. An effect of the fueling is measured when the number of injected particles is less than 1 × 10²² particles s⁻¹. In that case an increase of the inter-ELM time is observed which is related to the slower recovery of the density pedestal. Additionally, a scaling is found for the source of tungsten during the ELMs. The number of tungsten atoms eroded by the ELMs per second is proportional to \( dN_{\text{ped}} \) multiplied by the ELM frequency. This is possible only if the tungsten sputtering yield is independent of the energy of the impinging particle hitting the divertor. This result is in agreement with Guillemault et al [1] who report that D⁺ ions hitting the divertor have energies above 2 keV. Such energies are attained by the ions as they accelerate along the field lines towards the divertor during the ELM crash as discussed in [2-4].

Finally, by plotting the \( \frac{W_{\text{content}}}{W_{\text{source}}} \) ratio during ELM crash, a global decreasing behaviour with the ELM frequency is found. However at frequencies below 40 Hz a scatter towards upper values is found. This scatter is found to correlate with the gas injection level. In a narrow ELM frequency band around 20 Hz, it is found that both the ratio \( \frac{W_{\text{content}}}{W_{\text{source}}} \) and \( W_{\text{source}} \) decrease with the gas injection.


*See the author list of “Overview of the JET results in support to ITER” by X. Litaudon et al. to be published in Nuclear Fusion Special issue: overview and summary reports from the 26th Fusion Energy Conference (Kyoto, Japan, 17-22 October 2016)