JET ITER-like and JET Carbon wall discharges: 2 different scaling for the frequency of type I ELMs. Consequences for the pedestal structure.

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We compare the results of the scaling previously obtained for the frequency of type I ELMs in JET ITER-like wall (ILW) with new results in JET carbon wall obtained over a database of 270 shots. The frequency scaling in JET ILW has been found to be a linear function of Np/dNp [1] where Np is the pedestal density and dNp is the density drop of the pedestal after the ELM crash. We find that in JET carbon wall discharges; this is no more the case. The frequency scaling is a linear function of Psep/dWp, where Psep is the power through the separatrix and dWp is the energy drop after the ELM crash. Such a result is in agreement with what has been found in the literature [2].

We propose a simple interpretation for these two different scaling. After the ELM crash, energy and density are expelled from the plasma and must be recovered before the next ELM crash can be triggered. In both cases, the recovery is the result of an imbalance between source terms and outward transport. For the recovery of the energy, the source term is the additional heating (Psep) while for the density recovery the source term is provided by the neutrals fueling the plasma. These two processes occur on different time scales and the slowest one will set the frequency scaling of the ELMs.

In the case of JET carbon wall, it is speculated that the wall releases during the discharge a very high flux of trapped particles towards the plasma providing a strong fueling. The density is faster than the energy recovery and one must wait for the additional heating to rise the temperature to the threshold pressure gradient. In the case of JET ILW, the situation is reversed. The wall does not outgas anymore and only the recycling and gas fueling are available to feed the plasma. The top pedestal temperature saturates and one must wait for the density to reach the peeling ballooning threshold pressure gradient.

We expect the competition between these two processes to have some consequences for the pedestal structure. In carbon wall, the pedestal density will reach first the maximum allowed by the instabilities and a lower temperature will be sufficient to reach the threshold pressure gradient for the ELM crash. In ILW, it will be the opposite. As a result for the same pedestal pressure and pressure gradient, density and temperature are expected to be different in the two machines. A very simplified simulation of the competition between these two processes, allows recovering this behavior. Additionally we show that the coupling between these two nonlinear processes through the pressure can generate in some cases the appearance of several mixed frequencies for the ELMs.

[1]P. Devynck et al. Plasma Phys. Control. Fusion **58** (2016) 125014 (9pp)
[2] H. Zhom, Plasma Phys. Control. Fusion 38 (1996) 105–128

- See the author list of X. Litaudon et al., Nuclear Fusion 57, 10 (2017)