ELM control by low *n* magnetic perturbations on JET

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Active control of edge localized modes (ELMs) by resonant magnetic perturbation fields offers an attractive method for next-generation tokamaks, e.g. ITER. D-III D has shown that type-I ELMs are completely suppressed when n = 3 magnetic perturbations are applied [1]. On JET, when a low n (1, 2) field with amplitude of a few Gauss at the plasma edge (Ψ> 0.95) is applied during the stationary phase of a type-I ELMy H-mode plasma, the ELM frequency rises by a factor of ~ 4-5 and follows the applied perturbation field strength [2,3]. This allows for ELM control in a wide range of plasma parameters. The frequency of the mitigated ELMs is proportional to the input heating power similarly to type-I ELMs, but the controlled ELMs have a higher frequency and are smaller in amplitude.

Recently, a series of ELM control experiments have been performed on JET aiming at a better understanding the plasma response on the magnetic perturbation: (i) Compensation of the density pump-out effect of perturbation field has been achieved by means of gas fuelling up to a Greenwald fraction of 0.73 in low triangularity plasmas, and by pellets fuelling. (ii) ELM control has been also carried out in slower rotating plasmas with toroidal field (TF) ripple. A clear difference in the effects on the plasma rotation and density pump-out between TF ripple and EFCC was observed. (iii) Multiple resonances in the ELM frequency as function of the edge safety factor q_{95} with n = 1 and 2 perturbation fields were observed for the first time. (iv) Strong toroidal rotation braking by more than 50% has been observed, and found to be independent of the safety factor. The calculated Neoclassical Toroidal Viscosity (NTV) torque profile in the 1/ν regime is similar to the observed torque induced by the n = 1 field on JET [4]. (v) No complete ELM suppression was obtained by application of n = 1 or n = 2 fields with a Chirikov parameter close to 1 for a normalised flux Ψ>0.915 which is one of the important criteria for the design of ITER ELM control coils [5]. (vi) ELMs changed their character from compound to more regular type-I when an n = 1 field was applied.

In this paper, an overview of the influence on the plasma confinement and key physics issues related to ELM control with magnetic perturbation fields is given from the experimentalist's point of view.

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* See the Appendix of F. Romanelli et al., Proceedings of the 22nd IAEA Fusion Energy Conference, Geneva, Switzerland, 2008