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Impact of ELM control in JET experiments on H-mode terminations with/without current ramp-down and implications for ITER

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An important aspect of ITER operation will be the termination of the high confinement H-mode phase (I_p ramp-down phase) in a controlled and safe way. Previous ramp-down studies in JET and other devices focused on aspects related to flux consumption and vertical stability control. In this work the emphasis is on aspects related to W accumulation and its control, which can be particularly challenging in a Be/W wall environment, such as JET or ITER. The dynamics of a slow H-mode ramp-down (to mimic the power ramp-down scenario foreseen for ITER) have been systematically studied in JET during both the I_p flat-top and I_p ramp-down phases, in order to explore the conditions under which W accumulation develops and how it can be controlled using external actuators that are known to affect the impurity transport, such as central electron heating (ICRH in JET) or ELM control (vertical kicks and pellet injection).

The use of vertical kicks for ELM control has proven to be an effective method to avoid W accumulation during the H-mode termination phase in JET-ILW. With ELM control the long ELM free phases, typically observed as the plasma approaches the H-L transition, can be avoided, allowing the impurity content of the plasma to be significantly reduced. As a result, the plasma remains in type I ELMy H-mode for a longer period, leading to a slower decrease of the plasma energy, which can mitigate the radial control requirements in ITER. It is found that ELM control with vertical kicks provides not only impurity control but also density control, which is also a key aspect in the ITER ramp-down scenario. Attempts to use pellet pacing for ELM control has resulted, so far, in terminations with low radiation levels but poor density control and further investigation is required to assess the effectiveness of this ELM control approach. In addition to the ELM control studies, other mechanisms affecting the plasma transport properties during H-mode termination, such as central electron heating (ICRH), NBI momentum and particle sources and plasma shape variations (reduced elongation maintaining q_{95} ∼constant) during the I_p ramp-down, were also investigated. The full set of experimental observations, as well as the more recent modelling results obtained with the JINTRAC suite of codes will be presented and the implications for ITER discussed.

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