DPP09-2009-000940

Abstract for an Invited Paper
for the DPP09 Meeting of
the American Physical Society

ELM mitigation studies in JET and implications for ITER[1]

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Type I edge localized modes (ELMs) remain a serious concern for ITER because of the high transient heat and particle flux that can lead to rapid erosion of the divertor plates. This has stimulated worldwide research on exploration of different methods to avoid or at least mitigate the ELM energy loss while maintaining adequate confinement. ITER will require reliable ELM control over a wide range of operating conditions, including changes in the edge safety factor, therefore a suite of different techniques is highly desirable. In JET several techniques have been demonstrated for control the frequency and size of type I ELMs, including resonant perturbations of the edge magnetic field (RMP), ELM magnetic triggering by fast vertical movement of the plasma column ("vertical kicks") and ELM pacing using pellet injection. In this paper we present results from recent dedicated experiments in JET focusing on integrating the different ELM mitigation methods into similar plasma scenarios. Plasma parameter scans provide comparison of the performance of the different techniques in terms of both the reduction in ELM size and on the impact of each control method on plasma confinement. The compatibility of different ELM mitigation schemes has also been investigated. The plasma response to RMP and vertical kicks during the ELM mitigation phase shares common features: the reduction in ELM size (up to a factor of 3) is accompanied by a reduction in pedestal pressure (mainly due to a loss of density) with only minor ($< 10\%$) reduction of the stored energy. Interestingly, it has been found that the combined application of RMP and kicks leads to a reduction of the threshold perturbation level (vertical displacement in the case of the kicks) necessary for the ELM mitigation to occur. The implication of these results for ITER will be discussed.

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