Toroidal field ripple effects on high triangularity ELMy H-modes in JET and implications for ITER

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This paper describes the results of experiments carried out in JET to study the effect of toroidal filed ripple δ_B on high triangularity ELMy H-modes. JET has 32 TF coils, normally fed an equal current. The standard ripple is δ_B~0.08% at 3.8m (typical location of the plasma separatrix for full bore plasmas). To vary the ripple, the 16 odd and the 16 even coils are powered independently producing different level of current in each set of coils. In this way, the TF ripple can be varied by feeding different values of the current in each set of coils.
The results of the JET ripple experiment at low plasma triangularity were reported in [1]. While low triangularity allows access to lower plasma density and collisionality, high triangularity plasma is best suited to study the ELMy H-mode behaviour at high density [2]. The JET experiment described in this paper was aimed at establishing if the effect of Toroidal Field ripple on ELMy H-mode confinement and ELMs depends on plasma triangularity. The plasma studied had average triangularity of $\delta \cong 0.42$, compared to $\delta \cong 0.22$ of the plasmas described in [1]. As observed at low triangularity, and despite the higher natural density of high triangularity plasmas, the effect of increased ripple (from 0.08 to 1%) in plasmas with no external gas fuelling is a reduction of the plasma density and some (~10%) reduction in the plasma energy confinement enhancement factor. Nevertheless, the density could be increased with external gas fuelling and the observed different in energy confinement time was decreasing as the density was increased, similarly to what observed in the low triangularity cases.
The effect of ripple on the power required for the transition from Type I to Type III ELMy H-mode was also investigated. In high triangularity ELMy H-modes the minimum power required to obtain a Type I ELMy H-mode with good confinement is limited by impurity accumulation and uncontrolled peaking of density profiles [2]. This power his higher than the power required to obtain an H-mode with Type III ELMs (i.e. loss power just above L-H threshold power). Higher power was required for steady Type I ELMy H-modes with increased TF ripple.
The effect of ripple on the access conditions for the mixed Type I/II ELMy regime at high density was also studied. The access to this regime was found more difficult with increasing ripple, with the operational space reduced both in terms of input power and pedestal density.
The implications of these results for ITER operations will be discussed.

[2] G Saibene et al ,EPS Conference 2007
[2] R Sartori et al, Proc of 20th IAEA conference, 2004, Vilamoura, EX1-4