Optimised ELM penetration and pedestal pressure for JET AT scenarios

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For steady-state operation it would be desirable to develop a plasma scenario with a wide Internal Transport Barriers (ITB) (R_{ITB}>3.5-3.6m, i.e. r/a>0.5) combined with a strong edge pedestal featuring small ELMs so that the ITB is not affected and the potential power loads are compatible with the operation of future devices. So far it has proved difficult at JET to combine wide ITBs with type I ELMs at the plasma edge in the case where the ELM perturbation penetrates deeply into the plasma core. Commonly used techniques to mitigate ELMs are D_2 gas puffing and injecting impurities like neon or nitrogen. In most cases D_2 puffing leads to increased pedestal density and to decreased energy losses per ELM while impurity injection acts directly on the pedestal temperature via increased radiation, and hence the changed pedestal pressure affects edge stability.

Two parallel lines of experiments have been carried out at JET during the 2006/2007 campaigns to investigate these effects: (1) To study the effect of impurity seeding on the ELM mitigation and divertor power load in AT plasmas at 3.1T /2MA. In this series the configuration was optimized for pedestal and divertor load studies.(2) To maximise β_N with an ITB at large radius and optimise edge pedestal at 2.3T/1.5MA. Both experiments had q_{95}~5 and high triangularity δ~0.45.

In the first series of experiments ELM mitigation and pedestal degradation (Fig 1a-c) occurred in two distinct regimes at radiated fractions F_{rad}~30% and at F_{rad}>50%. In both cases the diamagnetic energy loss per ELM is reduced to below 50kJ (Fig. 1b) and the plasma region affected by the ELM perturbation was reduced to R>3.6m (r/a>0.5) (Fig. 1c). This sequence can be explained by a transition from *large* type I ELMs to *small* type I ELMs at Frad~30% (without pedestal degradation, Fig 1a), via compound ELMs (Frad~40%) to type III ELMs (F_{rad}>50%) and subsequent transition to L-mode. This categorisation is confirmed by the power scaling of the ELM frequencies in this series. In both regimes the plasma region affected by the ELMs is suitably small for the formation of large ITBs, although ITB's were not always observed. In the second series a similar range of radiative fraction was covered. The best confinement, i.e. strongest and widest ITB's, occurred at two ranges of radiated fraction; F_{rad}~30% and F_{rad}>50%. ELM studies are underway for this series. *The work was conducted under EFDA and partly funded by the United Kingdom Engineering and Physical Sciences Research Council and by EURATOM.*

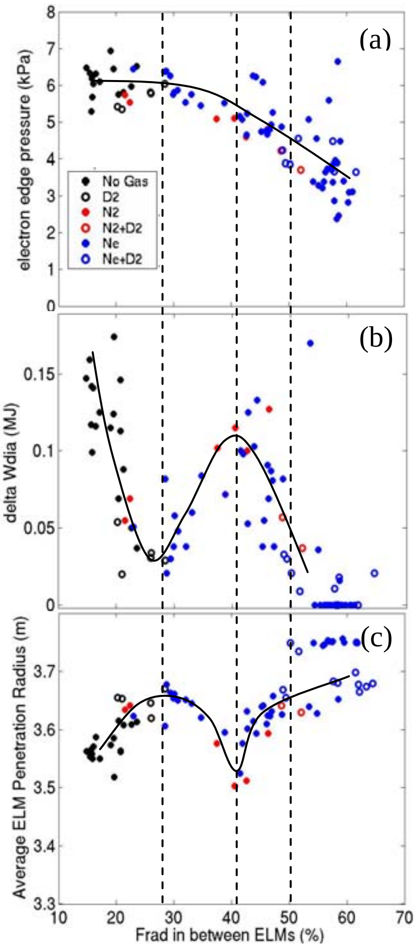

Figure 1: (a) Electron Pedestal pressure (b) averaged diamagnetic energy drop per ELM and (c) averaged penetration radius per ELM as a function of radiated power fraction (r/a=0-1 R=3-3.6m,. Regions of low ELM penetration are found at F_{rad}~30% and F_{rad}>50%. F_{rad} is varied by means of D_2 puffing and Ne or N_2 seeding.

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