Closing the gap between experiment and modelling to understand the stability of the edge transport barrier at JET

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The most widely accepted physics model to explain the occurrence of Edge Localised Modes (ELMs) in tokamaks is the peeling-ballooning (PB) model, in which ELMs are triggered by the excitation of coupled PB modes. The validity of the model has been investigated experimentally mainly with detailed pedestal profile measurements, and theoretically with help of MHD stability codes. However, the non-ambiguous experimental identification of the PB modes themselves has so far been missing. The work presented here closes this gap by characterising of macroscopic pre-ELM fluctuation measurements of the pedestal on JET for a wide operational range, making use of a combination of improved edge profile and fluctuation diagnostics, and by carrying out a systematic comparison of the results with stability modelling predictions. We have characterised the existence domain of modes, the measured toroidal mode numbers up to $n = 16$ and the dependency on the pedestal pressure gradient and current density, and the mode numbers are consistent with stability calculations. Together with earlier findings, the properties of these fluctuations allow their identification as coupled PB modes. Effectively, this extends and generalises to higher toroidal mode numbers (up to $n \leq 16$) the identification [G.T.A. Huysmans *et al* Nucl. Fusion **38** 179 (1998)] of the lowest $n = 1$ modes (also termed 'outer modes ') as pure external kink (peeling) modes. The observation of these modes opens up a new avenue to test existing ELM models. We will show how these modes can be used to diagnose what regions of plasma boundary stability space are being accessed in the various operating scenarios on JET, and explore in how far the differences in pedestal behaviour between the previous CFC-based wall and the current Be/W-based first wall can be explained in terms of PB stability.

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