The spatio-temporal structure of type I edge localized modes investigated by fast imaging on the DIII-D tokamak

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Abstract.

Fast imaging, with an integration time equal to 1 μs and a time between frames about 15 μs, is used for the first time to investigate the spatio-temporal evolution of type I edge localized modes (ELMs) in H-modes with a low pedestal collisionality $\nu^{\star} \simeq 0.3$ on the DIII-D tokamak. Four phases are identified based on the D_{α} light emission that results from the ELM-wall interaction. In phase I, oscillations are observed in the D_{α} signals taken at the midplane with a frequency about 1 kHz. They reflect a toroidally rotating filament with spatial scale and intensity increasing with time in agreement with the expectations from the nonlinear peeling-ballooning theory of ELMs. In phase II, we show that ELMs onset takes place with the filamentary structure(s) strongly interacting with the first wall. The ballooning filament(s) in this phase comes in contact with the first wall at the outer midplane. Phase III is characterized by the process of filling of the scrape-off layer with plasma and neutrals reflecting a transition to global deterioration of confinement. This occurs not only around the ballooning filament(s) but also at all other locations. In phase IV, this perturbation dies out at all poloidal angles. The full cycle of type I ELMs is thus analyzed and reported. Moreover, comparison with other diagnostics, including filterscopes and magnetics, are shown to support the above description.