Edge localized mode control with an edge resonant magnetic perturbation

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Abstract. A low amplitude ($\delta b_r/B_T$ = 1 part in 5000) edge resonant magnetic field perturbation with toroidal mode number $n = 3$ and poloidal mode numbers between 8 and 15 has been used to suppress most large Type I edge localized modes (ELMs) without degrading core plasma confinement. ELMs have been suppressed for periods of up to 8.6 energy confinement times when the edge safety factor q_{95} is between 3.5 and 4. The large ELMs are replaced by packets of events, (possibly Type II ELMs) with small amplitude, narrow radial extent and a higher level of magnetic field and density fluctuations, creating a duty cycle with long "active" intervals of high transport and short "quiet" intervals of low transport. The increased transport associated with these events is less impulsive and slows the recovery of the pedestal profiles to the values reached just before the large ELMs without the $n = 3$ perturbation. Changing the toroidal phase of the perturbation by 60 degrees with respect to the best ELM suppression case reduces the ELM amplitude and frequency by factors of 2-3 in the divertor, produces a more stochastic response in the H-mode pedestal profiles, and displays similar increases in small scale events, although significant numbers of large ELMs survive. In contrast to the best ELM suppression case where the Type I ELMs are also suppressed on the outboard midplane, the midplane recycling increases until individual ELMs are no longer discernable. The ELM response depends on the toroidal phase of the applied perturbation because intrinsic error fields make the target plasma non-axisymmetric, and suggests that at least some of the variation in ELM behavior in a single device or among different devices is due to differences in the intrinsic error fields in these devices. These results indicate that ELMs can be suppressed by small edge resonant magnetic field perturbations. Extrapolation to next-step, burning plasma devices will require extending

the regime of operation to lower collisionality and understanding the physical mechanism responsible for the ELM suppression.