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EX/P4-01: Pellet Induced High Density Phases during ELM Suppression in ASDEX Upgrade

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Magnetic perturbations (MP) with n=2 have been found in ASDEX Upgrade to result in reproducible and robust ELM mitigation in a wide heating power and safety factor range. ELM mitigation is established for peripheral densities above a critical threshold. Pellets injected into mitigation phases do not trigger type-I ELM like events unlike when launched into unmitigated type-I ELMy plasmas. The absence of ELMs results in an improved pellet fuelling efficiency and persistent density build up, mostly eliminating the need for strong gas puff. No deleterious impact was found on MHD activity, plasma rotation or impurity transport. Notably, the pedestal density, temperature, pressure and rotation profiles remain virtually unchanged. Reliable and reproducible operation at line averaged densities from 0.75 up to 1.5 times n_Gw (core densities of up to 1.6 times n_Gw) has been demonstrated using pellets, no upper density limit for the ELM-mitigated regime has been encountered so far. There is no confinement improvement in the density regime above about n/n_Gw = 0.85 as predicted by the IPB98(y,2) energy confinement scaling; at best the confinement can be kept at the initial level. A prolonged train of pellets with repetition time t_P produces an enhanced plasma particle inventory which exhibits a maximum just after the pellet arrives, and which drops with a decay time tau_P towards a minimum just before the next pellet. For t_P > tau_P, an approximately linear relationship exists between the pellet flux and the time averaged plasma density. In parallel, a mild reversible plasma energy reduction takes place. This behaviour is already known from previous pellet fuelling studies performed under ELMy H-mode conditions; the achieved quasi steady-state operational boundaries can be well explained by additional pellet-driven convective losses. In the ELM suppressed regime, however, enhancing the pellet flux by reducing t_P, below the initial value of tau_P resulted in a strong sudden density enhancement. Furthermore, no further significant energy reduction takes place. The behaviour is caused by an increasing tau_P, attributed mainly to changing transport properties. Usually, fuelling performance improvement can be gained solely by deeper pellet particle deposition, which results in a slightly enhanced pellet particle persistence time.

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