Fast-ion orbit displacement induced by externally applied magnetic perturbations in the ASDEX Upgrade tokamak

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The impact of externally applied magnetic perturbations (MPs) on fast-ion losses has been investigated by means of the light ion beam probe (LIBP) technique in the ASDEX Upgrade (AUG) tokamak. The LIBP technique allows to experimentally infer the fast-ion orbit displacement of first orbit losses induced by MPs using scintillator based fast-ion loss detector (FILD) measurements. The fast-ion orbit displacement against different applied MP spectra has been studied. The experiments were conducted in H-mode plasmas with Bt=1.8 T and Ip=0.8 MA. A rigid rotation of the MP field was applied with a frequency of 1 Hz, with an n=2 configuration. Neutral heating beam sources Q7 (tangential) and Q8 (radial) were used to probe different fast-ion orbits with FILD1. The minimum of the fast-ion orbit displacement is found for a differential phase of the MP field of $\Delta\Phi=50^{o}$. These measurements have been compared to the plasma boundary displacement close to the low field side midplane, which has been evaluated using the lithium beam diagnostic. The minimum is found to be at $\Delta\Phi=0^{o}$. This shift in the minimum between the plasma boundary displacement and the fast-ion orbit displacement suggests that fast-ion losses could be disentangled from ELM mitigation/suppression. The scaling of the fast-ion losses against the intensity of the applied perturbation was investigated for two different $\Delta\Phi$. A threshold for the onset of the fast-ion losses is found for beam source Q7 and a linear scaling with respect to the applied MP coil current is observed. No conclusive indications of a saturation threshold for the FILD signal are observed. The experimental measurements are compared to ASCOT and MEGA simulations both in vacuum approach and including the plasma response. The impact of the plasma boundary displacement on the modulation of FILD signals is also evaluated.

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