Main parametric dependencies of Fast-Ion Edge Resonant Transport Layer induced by 3D perturbative fields in the ASDEX Upgrade Tokamak

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The use of non-axisymmetric fields has been widely extended for mitigating and even suppressing a broad spectrum of MHD fluctuations [1]. 3D symmetry-breaking fields can, however, cause a degradation of the particle confinement. Fast-ions are especially sensitive to 3D perturbative fields due to their relatively long mean free path and slowing down time [2].

Measurements from dedicated experiments in the ASDEX Upgrade tokamak have shown the existence of an Edge Resonant Transport Layer (ERTL), which causes energetic particle transport observed in the presence of symmetry-breaking fields.

Using Monte-Carlo orbit following code ASCOT and the plasma response generated by MARS-F, simulations were carried out reproducing a strong correlation of fast-ion loss intensity with the perturbation poloidal spectra. This work presents an analysis of the fast-ion resonant transport in terms of the variation in the particle toroidal canonical momentum (δP_φ) in the presence of 3D perturbative fields generated by different coil configurations. A scan in poloidal spectra, q_{95} and collisionality was carried out to assess the impact of each different contribution. In figure 1, the fast-ion $\langle \delta P_\varphi \rangle$ is presented as a function of the particle initial energy and radius (a) and particle initial radius and toroidal angle (b) for a fixed coil configuration, showing how the relative position of the particle with respect to the perturbation can affect the transport. The ERTL properties depend strongly on the fast-ion orbit topology, the perturbation spectra, the magnetic background helicity (q_{95}) and the plasma collisionality. This study may help to optimize the fast-ion confinement in the presence of externally applied 3D fields in present and future devices.

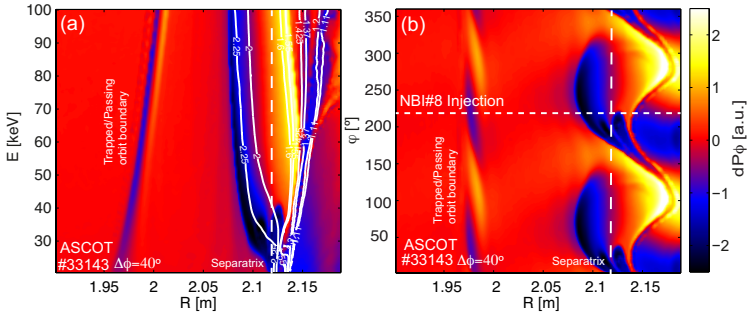

Fig 1. $\langle \delta P_\varphi \rangle$ structures in the presence of a $\Delta\phi_{UL}$=40° magnetic perturbation configuration as a function of (a) energy and initial radial position and (b) initial radial and toroidal angular position. Black-blue areas represent outwards transport while yellow-white means inwards transport.

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