An efficient zero-order analysis of resonant effects on fast ion losses.

P. A. Zestanakis[1], G. Anastassiou[1], J Rueda[2], Y. Kominis[1], M. Vallar[3], the AUG Team[4]

[1] *School of Applied Mathematics and Physical Sciences, National Technical University of Athens, Athens, Greece*

[2] *Department of Atomic, Molecular and Nuclear Physics, University of Seville, E-41012 Seville, Spain*

[3] *Ecole Polytechnique Fédérale de Lausanne, Swiss Plasma Center, Lausanne, CH-1015, Switzerland*

[4] *See author list of "H. Meyer et al 2019 Nucl. Fusion 59 112014"*

Fast ion (FI) losses may compromise the performance of the fusion reactor by transporting energetic particle bursts on the plasma facing components of the wall. Such losses often occur due the interaction of the fast ion population with MHD modes [1, 2] or as a result of synergetic effects between FI and magnetic perturbations (MPs) and FI and neoclassical tearing modes (NTMs). Numerical simulations have shown that application of MPs can lead to significant fast ion losses in ITER [3] and have highlighted the role of resonances at FI transport [4].

In this work, we propose a zero-order analysis of the fast ion dynamics which aims at providing insight on the effect of resonances on fast ion losses. Our analysis is carried out in the unperturbed phase space of the single particle gyrocenter in a background equilibirum magnetic field. The key contribution is the introduction of the *resonance index*, a quantity which models the susceptibility of the gyrocenter phase space to the effect of specific external perturbations.

The value of the *resonance index* depends on the number of resonant orbits in the vicinity of a phase space point as well as the distance of these resonant orbits from the vessel wall. Conceptually, the result is a function of phase space which quantifies the probability that an elementary volume in phase space may yield escaping orbits in the presence of specific MHD modes and magnetic perturbations by the mechanism of resonance overlap. Finally, we propose a recipe of mapping the *resonance index* to the plane of the scintillator of the FILD detector. We demonstrate a remarkable similarity between the mapped resonance index profile and the FILD detector signal for selected shots in ASDEX upgrade.

References

[1] M. Garcia-Munoz et al. *Plasma Physics and Controlled Fusion*, vol. 61, p. 054007, mar 2019.

[2] J. Galdon-Quiroga et al. *Nuclear Fusion*, vol. 58, p. 036005, jan 2018.

[3] T. Kurki-Suonio et al. *Plasma Physics and Controlled Fusion*, vol. 59, p. 014013, oct 2016.

[4] L. Sanchis et al.*Plasma Physics and Controlled Fusion*, vol. 61, p. 014038, nov 2018.