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The combined effect of neoclassical tearing modes and ELM control coils on fast-ions: validation in AUG and extrapolation for ITER

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This contribution aims to broaden the understanding of the interplay between the internal and external 3D perturbations on the fast ions in tokamak plasmas. At first, we used simulations using the ASCOT suite of codes to analyze an ASDEX Upgrade discharge showing clear sign of the interplay between a (3,2) neoclassical tearing mode (NTM) and external RMP coils on the fast ion loss detector (FILD) signal of neutral beam ion losses. At this context, also a code-code benchmark with the LOCUST code is presented. The same set of analysis tools is then used to predict both the alpha particle and neutral beam ion losses in the ITER 15 MA standard H-mode scenario in the presence of (2,1) and/or (3,2) NTM and ELM control coils (ECC).

Magnetically confined fusion relies on that the fusion-born alpha particles will be well confined, thus providing significant plasma heating and keeping the first-wall intact. Recent numerical simulations indeed show that this is the case for most planned ITER scenarios [1]. However, these simulations were carried out assuming that the transport is fully neoclassical, and that the plasma is MHD-quiescent. Both of these assumptions should be relaxed before making the final verdict on the fast-ion confinement in ITER. In this contribution we partly relax the MHD-quiescence condition by adding NTMs in our simulations.

Although a significant up to 100% increase in the total power losses for ITER was observed, so far no direct risk for the first wall was found. In this study both the NTM and the RMP perturbation was assumed to be static, thus maximizing the interaction between the two. Without further increased transport, by for example toroidal Alfven waves or turbulence, the fast ion power loads stay within the engineering limits.

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