# Power Exhaust and Detachment in Divertor Tokamaks with 3D Magnetic Perturbations in ASDEX Upgrade

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One of the major challenges for future fusion devices, such as ITER, is the control of heat flux onto the divertor targets. If the steady state peak heat flux is not mitigated it will exceed the material limit of about 10 $MW/m^2$ substantially. The ways to mitigate the target heat flux and access a detached divertor state have been investigated in numerous studies, which largely assume an axisymmetric magnetic field geometry. However, in recent years 3D Magnetic Perturbation (MP) fields, have been increasingly applied in several tokamaks, in order to control edge localized modes. If MP fields are applied in future fusion devices, their beneficial as well as harmful consequences for power exhaust have to be studied.

Under attached conditions, IR thermography shows the occurrence of toroidally localized heat flux maxima with MP fields. It has been speculated that these may 'burn-through' an otherwise detached divertor leading to intolerably high heat flux densities. In future fusion devices, this would require countermeasures, which would entail substantial engineering efforts. On the other hand, MP fields could lead to the beneficial effect of an increased toroidally averaged power decay length, and an increase of the volume in which impurities, such as nitrogen, can radiate efficiently.

In this contribution, experimental and numerical results of ASDEX Upgrade (AUG) discharges with MPs will be presented and their implications in view of ITER discussed. Based on measurements by divertor Langmuir probes in AUG with a rotating MP field, it will be argued that a burn-through event is unlikely in ITER, since toroidal asymmetries are smoothed out by perpendicular transport at low divertor plasma temperatures. In addition to that, the comparison of the experiments with simulations by the transport code EMC3-EIRENE revealed several strong arguments for the importance of screening currents induced in the plasma that reduce the amplitude of the MP fields in the confinement region. Due to this, the impact on both, the toroidally averaged fall-off length $< \lambda_q >$ and the radiated power is rather small and barely measurable with the present diagnostics in AUG. In ITER, however, where the power decay length is predicted to be of the same order as in AUG, while the radial perturbation of field line paths is much larger, a much stronger effect of the MP field is predicted.

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* *A. Kallenbach et al., Nucl. Fusion 57 (2017) 102015**

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