Overview of the plasma response to resonant magnetic perturbations on TEXTOR

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Resonant magnetic perturbation (RMP) fields are known to cause magnetic reconnection in plasmas, resulting in changes to the magnetic topology and thus influencing magnetohydrodynamic (MHD) instabilities such as edge-localized modes (ELMs). With ELM control being of critical importance for ITER and future tokamak reactors, the plasma response to RMPs is of increasing significance for the physics of magnetized plasmas. An overview of recent results on the plasma response to resonant magnetic perturbations on TEXTOR is presented.

The fast movable Mirnov probe can provide direct measurements of the magnetic topology in the edge of TEXTOR plasmas with applied RMPs from the Dynamic Ergodic Divertor (DED). Comparing the magnetic field structure in the plasma edge with that in the equivalent vacuum case reveals the effect of the plasma response to the RMPs. Shielding currents have been observed to form as a plasma response to applied rotating low-n RMP fields. Multiple shielding currents on neighbouring resonant surfaces have been observed concurrently for perturbation fields of different amplitudes, frequencies and phases. A systematic comparison of the dynamics of the plasma response to RMPs shows a good qualitative agreement between the experimental observations and the results from quasi-linear MHD modelling.

One criterion for the ignition of a fusion plasma is sufficient confinement of fast ions, and a key aspect of this is the ability to maintain good confinement of fast ions in the presence of non-axisymmetric fields such as RMPs. A study of the effect of RMPs on fast ion losses for static or rotating perturbation fields with different mode numbers (m/n = 3/1 or 6/2) has been carried out using a rotating directional probe. A clear influence of the RMPs is only observed at lower values of the edge safety factor ($q_a \approx 4$), where a strong reduction in fast ion losses is measured for large RMPs with m/n = 6/2.