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Impact of the plasma response in three-dimensional edge plasma transport modelling for RMP ELM control scenarios at ITER[1]

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The constrains used in magneto-hydrodynamic (MHD) modeling of the plasma response to external resonant magnetic perturbation (RMP) fields have a profound impact on the three-dimensional (3-D) shape of the plasma boundary induced by RMP fields. In this contribution, the consequences of the plasma response on the actual 3D boundary structure and transport during RMP application at ITER are investigated. The 3D fluid plasma and kinetic neutral transport code EMC3-Eirene is used for edge transport modeling. Plasma response modeling is conducted with the M3D-C1 code using a single fluid, non-linear and a two fluid, linear MHD constrain. These approaches are compared to results with an ideal MHD like plasma response. A 3D plasma boundary is formed for all cases consisting of magnetic finger structures at the X-point intersecting the divertor surface in a helical footprint pattern. The width of the helical footprint pattern is largely reduced compared to vacuum magnetic fields when using the ideal MHD like screening model. This yields increasing peak heat fluxes in contrast to a beneficial heat flux spreading seen with vacuum fields. The particle pump out as well as loss of thermal energy is reduced by a factor of two compared to vacuum fields. In contrast, the impact of the plasma response obtained from both MHD constrains in M3D-C1 is nearly negligible at the plasma boundary and only a small modification of the magnetic footprint topology is detected. Accordingly, heat and particle fluxes on the target plates as well as the edge transport characteristics are comparable to the vacuum solution. This span of modeling results with different plasma response models highlights the importance of thoroughly validating both, plasma response and 3D edge transport models for a robust extrapolation towards ITER.

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