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Mechanics of ELM control coil induced alpha particle transport

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We model alpha particle transport in ITER under the influence of all major externally induced perturbations, namely ELM control coils (ECCs), toroidal field ripple, and test blanket modules, with emphasis on how the plasma response (PR) modifies the transport mechanisms and fast ion loads on the divertor. The modeling is done with an orbit-following code ASCOT.

Earlier studies have shown that PR shields the plasma by healing the flux surfaces broken by ECCs which leads to reduction of passing particle losses compared to vacuum approximation [1,2,3]. However, we found that PR also opens a new loss channel for marginally trapped particles: PR causes strong toroidal variation of the poloidal field near the X-point which leads to de-localisation of banana tips and collisionless transport as illustrated in Figure. 1.

The reduction in passing particle losses and the increase in marginally trapped particle losses shift divertor loads from targets to the dome and under-the-dome structures. The shift is undesired as the under-the-dome structure cannot endure heat loads as high as the main divertor components.

The plasma response was calculated independently by both MARS-F and JOREK codes. We compared the alpha particle loss mechanisms between these cases, and found them to be qualitatively similar. However, the new transport mechanism was stronger for PR calculated by JOREK which, unlike MARS-F, explicitly includes the X-point.

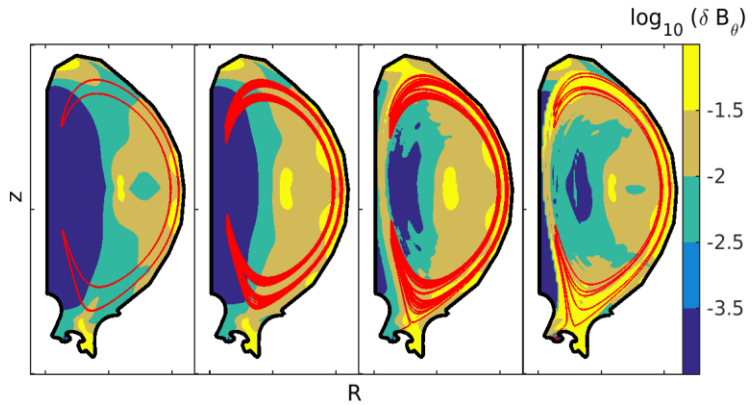

Figure 1: *Illustration of the collisionless motion of an alpha particle in different cases which are, from left to right: without ECCs, ECCs present but without PR, ECCs present with MARS-F calculated PR, ECCs present with JOREK calculated PR. The contours show toroidal variation of the poloidal field.*

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References

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