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3D simulation study of fast ion loss and heat load on the limiter effected by the MHD perturbation field in EAST

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When the MHD perturbation amplitude is sufficiently large or the MHD perturbation modes are overlapped, the tokamak toroidal equilibrium field symmetry is broken and the effect of the MHD perturbation on fast ion loss may exceed that of the ripple field. In this paper, we calculate the loss of fast ions produced by ICRF-NBI synergy in EAST under the synergistic effect of MHD perturbation fields, ripple fields and collisions with the heat load distribution of the lost particles on the limiter by the full-orbit-following program ISSDE[1]. The measured information used to demonstrate the underlying physics of energetic particles at EAST is insufficient and therefore a reliable theoretical modelis needed to describe the energetic ions and the corresponding effects.

Previous models that have studied the effect of MHD perturbation fields on fast ions have not considered the overlap of MHD perturbation fields and most studies of fast ion losses have used toroidal uniform boundaries[2]. This work considers the ICRF-NBI synergistic generation of fast ions at 1% minority H concentration on the basis of considering the limiter boundary[3], the fast ion loss under the influence of MHD perturbation field, ripple field and collision with the heat load distribution on the limiter.

The MHD perturbation breaks the toroidal symmetry of the equilibrium field and consequently changes the trajectory of the fast ions. As the amplitude of the MHD perturbation increases, the share of fast ion loss increases. When the MHD perturbation amplitude is greater than 1×10^{-3}, the effect of the MHD perturbation on the fast ion loss is greater than that of the ripple field. the overlap of the MHD perturbation modes increases the fast ion loss share from 4% to 33% . When the MHD perturbation amplitude increases, the heat load region on the limiter becomes larger but the peak position is almost unchanged, while the fast ion peak position on the limiter changes when the MHD perturbation modes are different. Overlap of the MHD perturbation modes increases the heat load to four times that of a single mode and shifts the peak position to the limiter edge region. By exciting and suppressing the MHD perturbation, we can better perform helium ash exclusion and reduce the effects of MHD perturbation.

References
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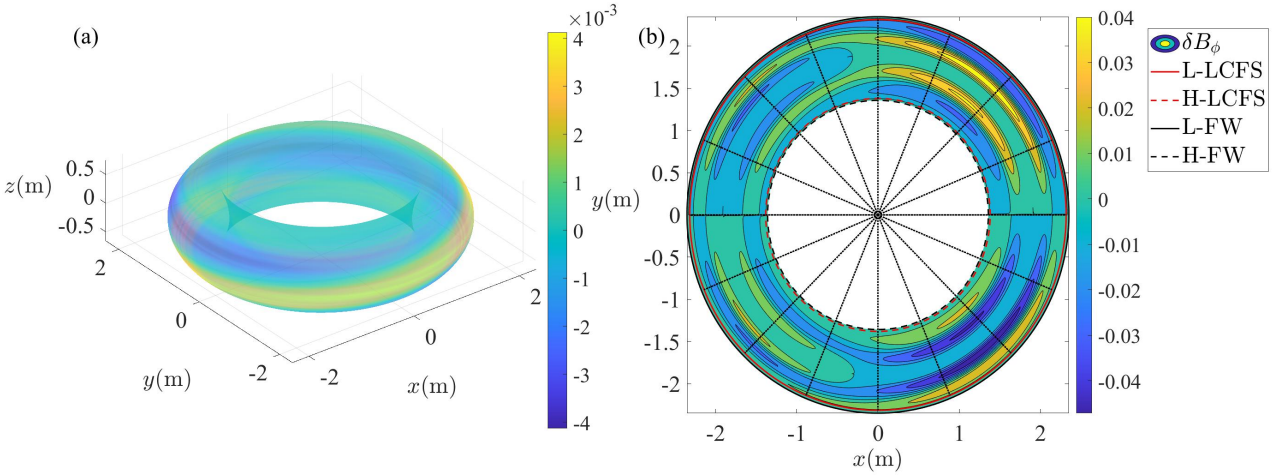

Figure 1. Distribution of the overlap of (2,1) mode and (3,2) mode on the last closed flux surface and midplane.