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Simulations of error field penetration in RF dominantly heated plasmas on the EAST tokamak

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Abstract:
Density scaling of n=1 error field penetration is investigated under radio-frequency (RF) dominant heated L mode discharges in the EAST tokamak. It is found that the density scaling of the threshold field strength for error field penetration is about $b_r \propto n_e^{0.4}$, where b_r represents the error field amplitude. The results show a weaker density dependence compared to that observed in the previous ohmically heated discharges [Wang et al, 2018 Nucl. Fusion 58 056024]. For better understanding of the density scaling, it is compared with field penetration theories, and it is found that it lies in the Waelbroeck regime. The observed scaling is consistent with that evaluated from the magnetohydrodynamic (MHD) theory on error field penetration by taking the physical parameters all determined experimentally. The fitted linear curve obtained by scanning heating power can also conform to expression about $[b_r/B_T]_{crit} \sim n_e^{7/16} \tau_v^{-7/16} T_e^{9/32} f_0^{5/8}$ (Waelbroeck regime). The strong relationship $T_e \infty n_e^{-0.65}$ caused by density dependence of heating efficiency of Lower hybrid wave results in a weaker density scaling in this auxiliary heated experiment. Using realistic parameters under auxiliary and ohmic heating as input respectively, the numerical results based on reduced four-field two-fluid model well reproduce the scaling from the MHD theory. This provides a good validation of MHD theory on error field penetration in the RF dominant heated L mode discharges.

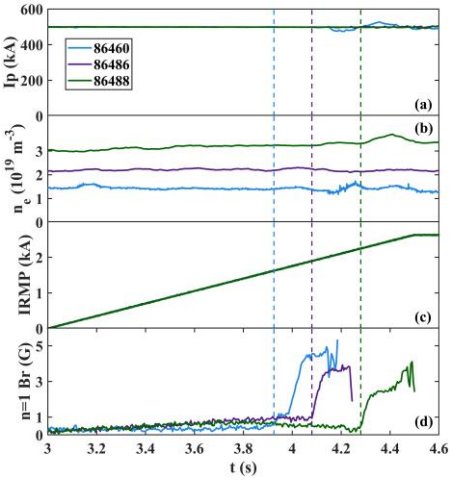

Figure 1. The error field penetration for three discharges with different electron densities in LHCD plasmas in EAST. The evolution of (a) plasma current, (b) electron density, (c) the amplitude of RMP current and (d) the penetrated detector signal $B_r(n = 1)$. The vertical dotted lines show the moment of penetration.

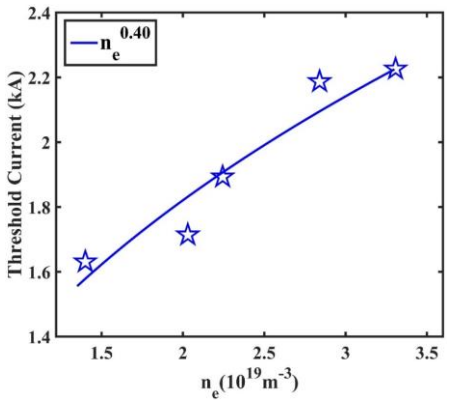

Figure 2. Density dependence of RMP current threshold for field penetration. The solid line is the fitted curve ($\propto n_e^{0.4}$).

References:
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