Contribution ID: **1281**                                                           Type: **Regular Poster**

# Experimental and simulation study of error field penetration on EAST

*Friday 14 May 2021 18:25 (20 minutes)*

In the EAST tokamak, density scaling of n=1 error field penetration has been investigated under auxiliary heated discharges. It is found that the density scaling of resonant magnetic perturbation coil current threshold is about $b\_r \propto n\_e^{0.4}$, where $b\_r$ represents the error field amplitude and $n\_e$ measured by hydrogen cyanide (HCN) is the line averaged electron density. The results show a weaker density dependence compared to previous ohmic discharge ($b\_r \propto n\_e^{0.5}$). For better understanding the density scaling, we convert the key discharges parameters into theoretical penetration region, and infer the error field penetration lies in Waelbroeck regime. The observed scaling is consistent with the estimated theoretical result by taking into account the density determination with electron temperature, viscosity diffusion time and plasma mode frequency in experiments. The fitted linear curve obtained by scanning heating power can also give the 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).

Considering the heating effect of Lower hybrid wave (LHW) depends on electron density, the strong relationship $T\_e \propto n\_e^{(-0.65)}$ results in weaker density scaling in auxiliary heated experiments. Using the discharges parameter under auxiliary and ohmic heated as input respectively, the numerical scaling based on reduced four-field two-fluid model agrees well with magnetohydrodynamic (MHD) penetration theory by considering the relationship of multiple parameters on density. In view of electron diamagnetic flow ($f\_{(e)}$), the theory is still valid. In fact, the mode frequency $f\_0$ based MHD scaling can be replaced by $f\_{(E \times B)} + f\_{(e)}$. In L-mode confinement (low $\beta\_n$), MHD theory of error penetration enough to explain the experimental scaling.

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**Session Classification:**  P8 Posters 8

**Track Classification:**  Magnetic Fusion Theory and Modelling