

Initial simulation study of super H-mode operation scenario on the HL-2M tokamak

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Abstract: As the newly built tokamak with the high operation parameters in the China, HL-2M is going to explore higher performance operation scenario after the achievement of first plasma at 2019^[1]. Super H-mode^[2] is one of the desired operation scenarios for HL-2M due to the high confinement factor and large pedestal parameters. Achieving super H-mode on HL-2M can further enhance the confidence for ITER and other future devices to access higher plasma performance. Based on the pedestal simulation code EPED^[3], it reveals that the pedestal density is larger than $7 \times 10^{19} \text{ m}^{-3}$ ($\sim 0.78 n_{GW}$) for the HL-2M super H-mode operation. With the equilibria generated by the integrated workflow^[4], stability analysis of edge localized mode is worked out by BOUT++. Low n peeling mode dominates in the linear phase and will cause much energy loss (17%) from the pedestal region. Such a large ELM will cause much damage to divertor target. Moreover, it will also lead the transition from super H-mode to normal H-mode which is dominated by ballooning mode. Though the increase of E_r shear will stabilize the high n mode and expand the space of ballooning boundary. It may also increase the ELM size near the peeling boundary. However, decrease of edge current may both lower the growth rate and ELM size at the same time. Impurity seeding and modification in the torque by neutral beam injection will be considered to mitigate the ELMs in the HL-2M super H-mode operation.

Key words: super H-mode, edge localized mode, EPED, integrated simulation, HL-2M.

References

- [1] Duan X.R. et al 2022 Progress of HL-2A experiments and HL-2M program Nucl. Fusion 62 042020
 [2] Snyder P.B. et al 2015 Super H-mode: theoretical prediction and initial observations of a new high performance regime for tokamak operation Nucl. Fusion 55 083026.

[3] Snyder P.B. et al 2009 Pedestal stability comparison and ITER pedestal prediction Nucl. Fusion 49 085035.

[4] Yiren Zhu et al 2022 Simulations on edge localized modes mitigation with impurity seeding in the HL-2A tokamak Nucl. Fusion 62 076011.

Figure 1. Density of super H-mode regime on HL-2M.

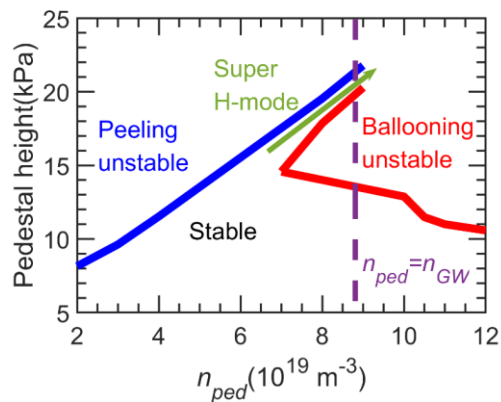


Figure 2. Evolutions of ELM size and growth rate with different E_r shear. Positive D_s indicates the larger E_r shear, and negative D_s represents smaller E_r shear.

