Modeling of the plasma performance of EAST tungsten divertor by considering external impurity seeding and W impurity transport

Chaofeng Sang[1], Qingrui Zhou[1], Yilin Wang[1], Xuele Zhao[1], Guosheng Xu[2], Liang Wang[2], Dezhen Wang[1]

[1] School of Physics, Dalian University of Technology, [2] Institute of Plasma Physics, Chinese Academy of Sciences

e-mail (speaker):sang@dlut.edu.cn

The divertor target serves as the most intense plasma-surface interaction area in tokamaks, and the control of power load on the target becomes to a critical issue during high power long-pulse discharges. EAST just finished its upgrade of lower tungsten divertor, which is expected to have better power handling capability, in 2021.

The present work mainly reports the physical design of the EAST lower divertor[1], with the consideration of the effects of plasma-facing material, the divertor shapes, the target slant angles and the pump opening locations on the edge plasma, by using SOLPS code package. The optimized divertor geometry for EAST is given, as shown in Fig. 1. The importance of energy and particle reflections as well as intrinsic impurities on the divertor plasma and detachment is demonstrated and explained [2]. It is revealed that for the W divertor the external insert gas seeding is required.

To study the effect of external impurity seeding, the performance of argon (Ar) and neon (Ne) seeding into the plasma and the resulting W target erosion and its impurity transport are simulated by the SOLPS coupled DIVIMP modeling [3]. It is found that both insert gas can enable the achievement of highly dissipative divertor condition, and the radiation efficiency of Ar is higher than that of Ne. To achieve the similar divertor plasma condition, Ar seeding is better for divertor impurity screening. However, Ar may cause more serious W erosion, resulting in severe core contamination by W impurity [4][5]. The study indicates the erosion of W is a critical problem during the Ar seeding, even with Te at the target below 10 eV. It is observed that the W impurity makes slightly contribution to the power radiation in the edge plasma with the EAST condition. However, it may be a potential disaster in the core plasma during high power discharge. To reduce the target erosion and enrichment of W impurity in the core region, the deuterium gas puffing at upstream SOL region combined with external impurity seeding at divertor region is proposed. These studies improve the understanding of W target sputtering and W impurity transport control during the radiative divertor discharges for fusion reactor.

References

[1] Sang C et al 2021 *Nucl. Fusion* **61** 066004

[2] Zhang C, Sang C et al 2019 *Plasma Phys. Control. Fusion* **61** 115013

[3] Zhou Q , Sang C et al 2020 *Nucl. Mater. Energy* **25** 100849

[4] Wang Y , Sang C et al 2021 *Plasma Phys. Control. Fusion* **63** 085002

[5] Zhao X , Sang C et al 2020 *Plasma Phys. Control. Fusion* **62** 055015

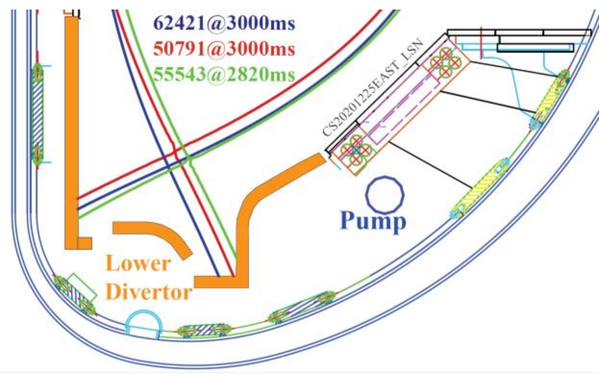

Figure 1. The sketch of the new EAST lower divertor