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Simulation study of the density threshold for the reverse of the detachment priority between inner and outer divertor for quasi-snowflake configuration

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In future fusion reactor, it is critical to achieve detachment for the divertor, in order to protect the targets and sustain the steady state operation. By introducing an additional X-point in the poloidal field, the snowflake divertor [1] has larger flux expansion and connection length compared with the single-null divertor. Thus, the snowflake divertor is expected to promote the detachment, and considered as a promising candidate for the future fusion reactor. In this work, the quasi-snowflake divertor is studied. In the quasi-snowflake divertor, the additional X-point is at a distance from the main X-point and thus only two strike points exist on the two divertor targets. Although the increase of flux expansion and connection length is not as large as that for exact/near-exact snowflake divertor, the requirement of the ability of poloidal field coils and the complexity in the engineering can be reduced. During the simulation study for China Fusion Engineering Test Reactor (CFETR), in addition to the promotion of detachment [2], it is found that the outer divertor could be detached in prior to the inner target under relatively low upstream density [3].
The reverse of the detachment priority between inner and outer target is further studied [4]. A series of quasi-snowflake divertor configurations with similar flux expansion in inner divertor and increasing flux expansion in outer divertor, are created using EFIT. By the scan of upstream density in the SOLPS-ITER simulation, the density threshold is identified for each quasi-snowflake divertor, below which the outer divertor is detached in prior. The density threshold is found positively related to the flux expansion in outer divertor. The existence of the density threshold is due to the competition between the neutral compression, which benefits the detachment in the inner divertor, and the flux expansion, which benefits the detachment in the outer divertor. At the low upstream density, the magnetic flux expansion plays a dominant role, while at high density, the neutral density gradually manifests and finally overcomes the former. The seeded neon impurities is more likely to radiate power at the side which is detached in prior, thus impurity seeding acts as an amplifier of the asymmetry between the inner and outer divertor.
To explore the influence of the machine size on the detachment priority between inner and outer divertor, SOLPS-ITER simulations are carried out further for the artifact EAST quasi-snowflake configurations. The influence due to E×B drifts on the detachment asymmetry is also studied. The details will be reported in the conference.

Reference
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Speaker's Affiliation

University of Science and Technology of China, Hefei

Member State or IGO

China, People's Republic of

Primary author: RUAN, Xinglei (USTC)

Co-authors: YE, Minyou (University of Science and Technology of China); MAO, Shifeng (University of Science and Technology of China)

Presenter: RUAN, Xinglei (USTC)

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