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Simulation Study of the Influence of flux expansion on the Detachment Sequence of HFS and LFS divertor targets

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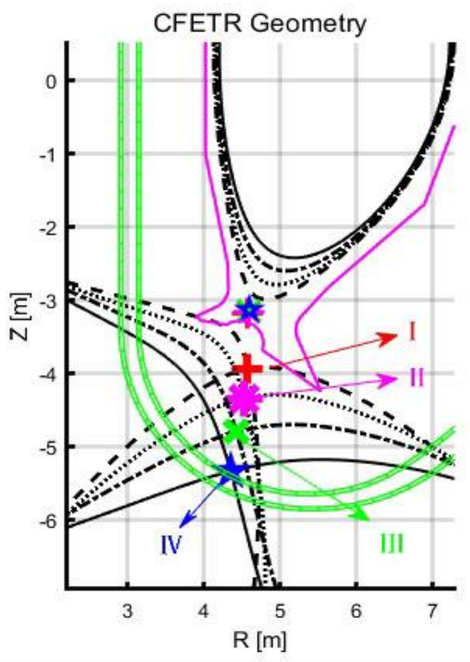
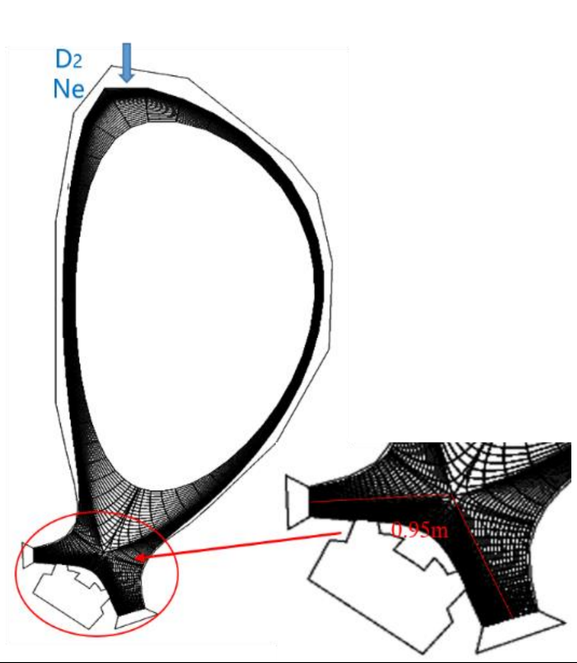
Abstract

- It is found that the detachment sequence can be influenced in the snowflake divertor, i.e. the low-field-side (LFS) target can be detached in prior to the high-field-side (HFS) one when the plasma density is relatively low.
- The simulation results show that, the increase of the flux expansion and connection length in the LFS leads to a low plasma temperature near separatrix , which in turn cause the detachment in prior when upstream density is low.
- By scanning the upstream density, it is found that the sequence of detachment changes from the LFS to HFS, the detachment sequence should be determined by a combined effect of the flux expansion and the geometry.

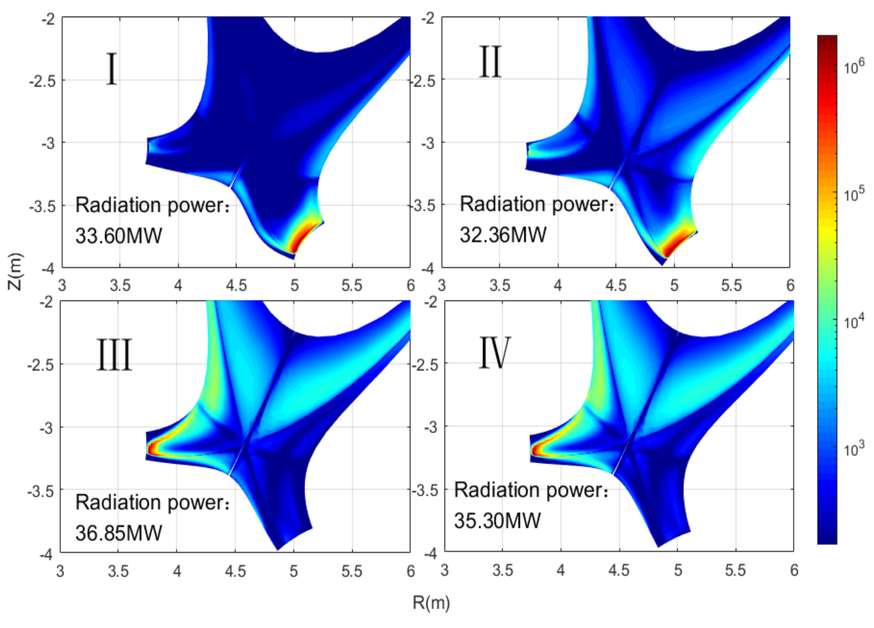
Simulation Settings

- Based on the CFETR geometry, four quasi-snowflake divertor configuration is generated.
- The geometry is adjusted to keep the divertor targets are perpendicular to the field line in the poloidal cross section.
- In the four configurations, while the flux expansion at the HFS target is similar, the flux expansion at the LFS target increases with the decreasing distance between the two X points.
- During the simulation by SOLPS, the D_2 and Ne are puffed from the top in the main chamber.

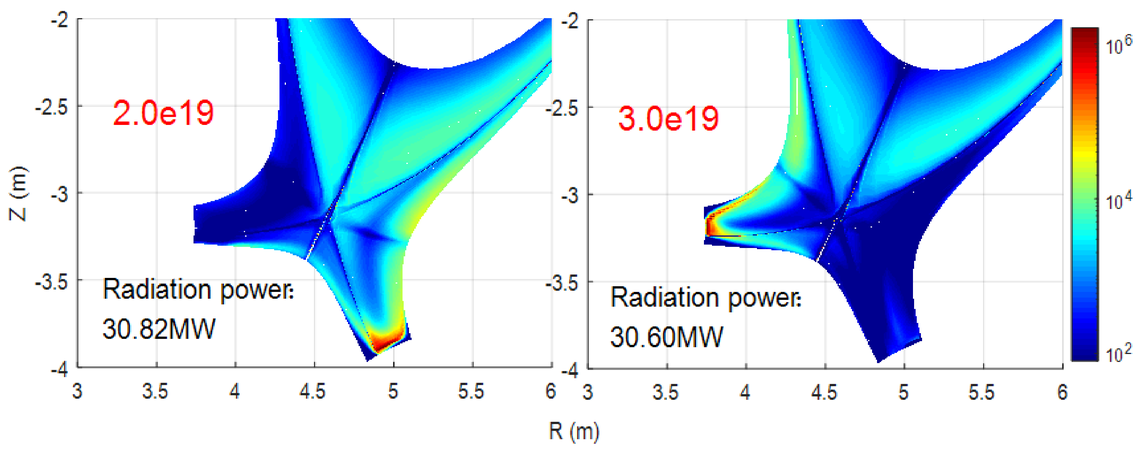




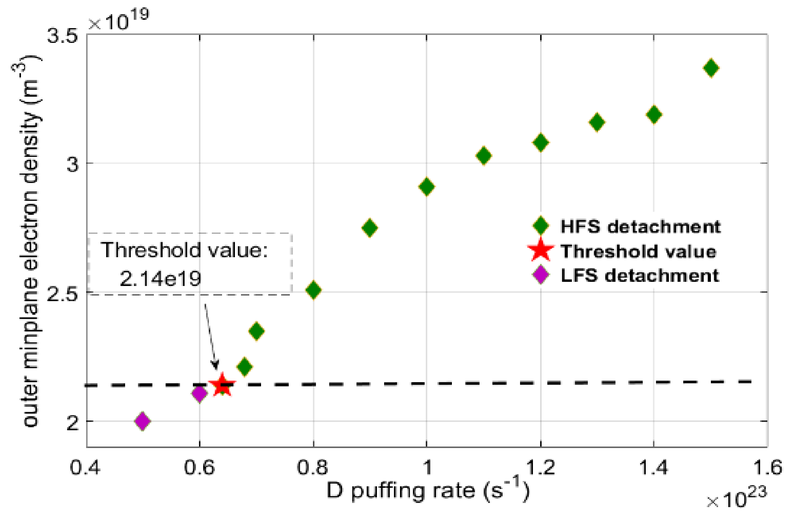
Results and discussions



With the upstream density of ~ 2×10^{19} m^{-3}, the detachment is found in prior in LFS for the cases of larger flux expansion there, while the detachment can occurs at the HFS in prior when the flux expansion is smaller.

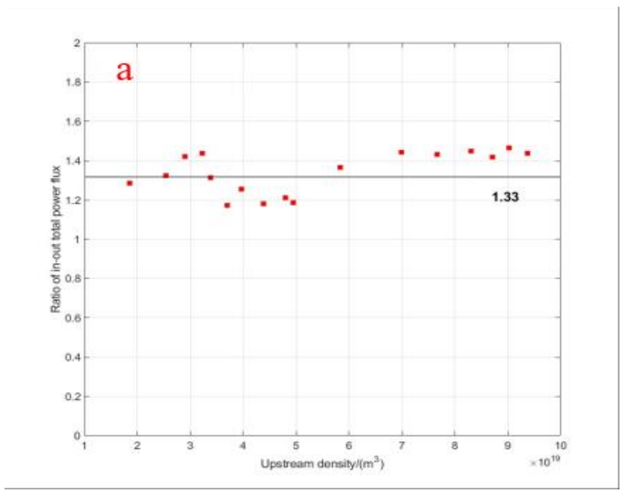


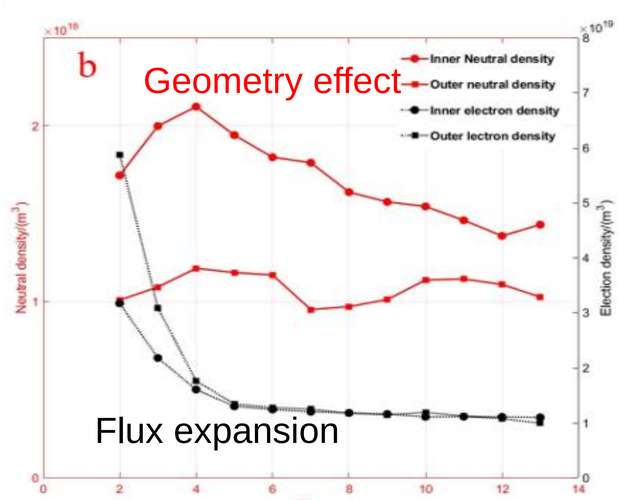
For the same configuration, the detachment occurs in prior at the LFS for low density, and at the HFS for high density.



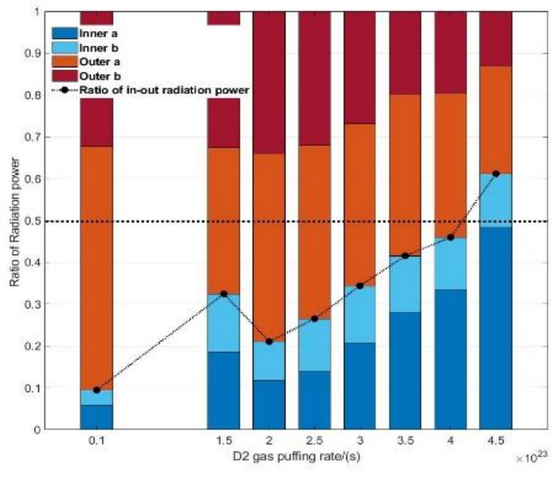
According to the density scan, it is found that the density threshold exists. The density threshold is found positively related to the flux expansion at the LFS.

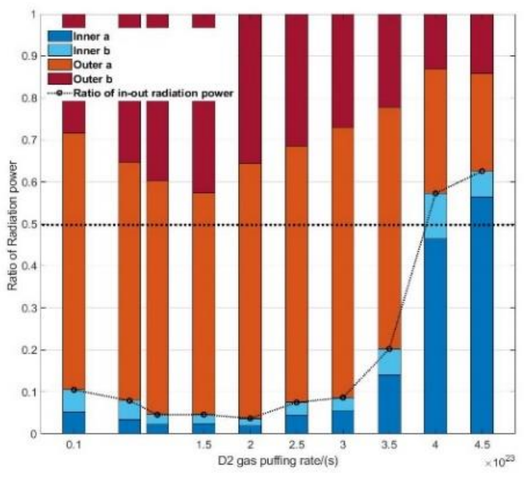
Configuration	I	II	III	IV
Threshold value ($10^{19}m^{-3}$)	4.30	2.91	2.24	2.14





The density scan without impurity puffing is performed. The power flow to the inner and outer divertor keeps. The plasma density is found higher at LFS (due to the flux expansion), while the neutral density is higher at HFS (due to the geometry effect).





The DIVIMP simulation is performed by seeding Ne on the pure D background. It is found that the impurities is likely to stay at LFS for low density and at HFS for high density. With large flux expansion, the asymmetry of the impurity distribution is more obvious.