The coupling effects of divertor configuration and drift on detachment in EAST new lower tungsten divertor for long-pulse operation

by

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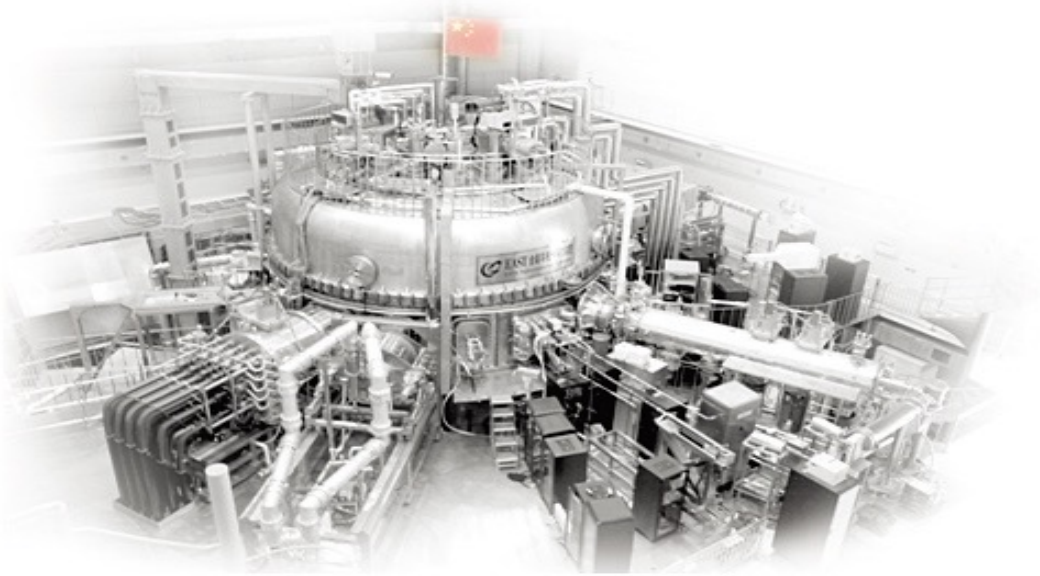

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Outline

- Introduction
- Basic setup in the SOLPS-ITER code
- The effect of divertor configuration on detachment in EAST
- Coupling effects of drift and divertor configuration on detachment in EAST
- Summary

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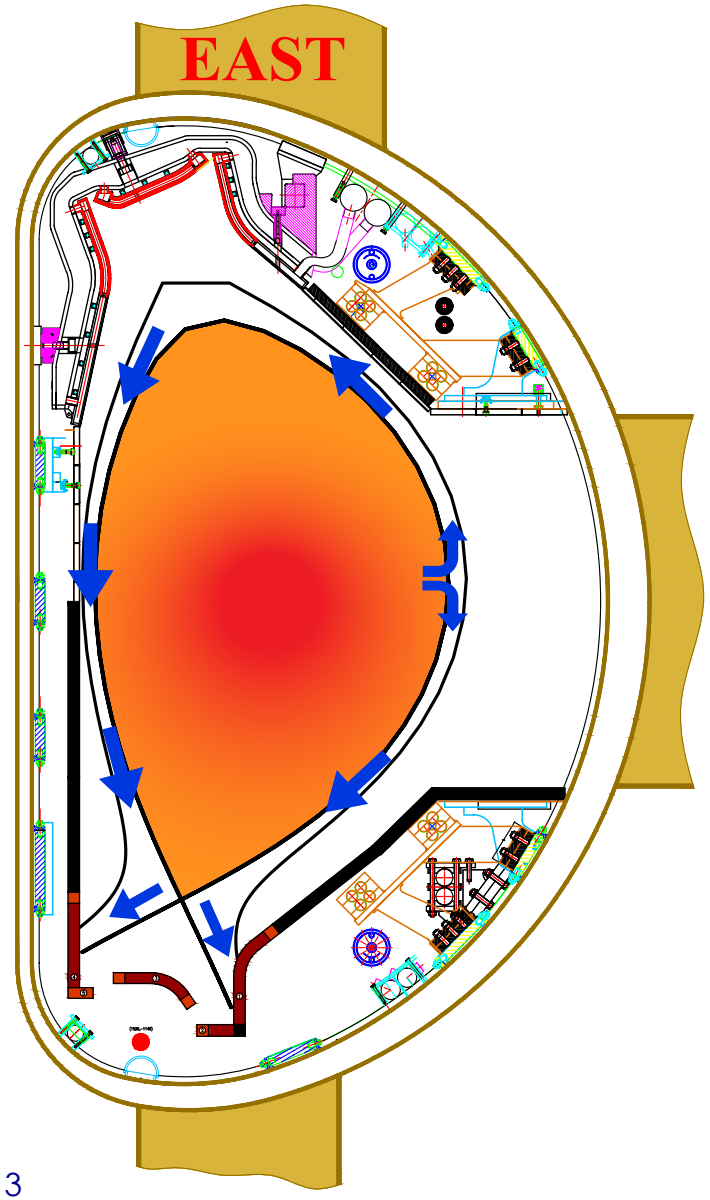
The main divertor challenges for EAST long-pulse operation



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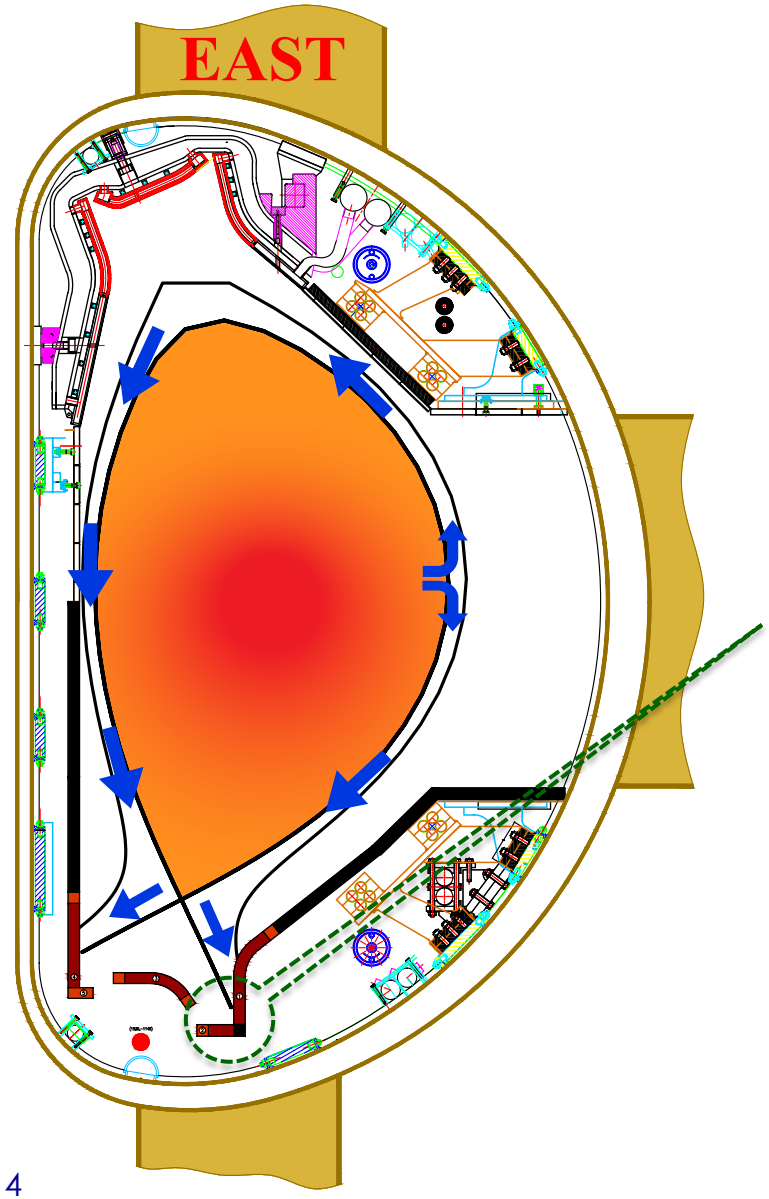

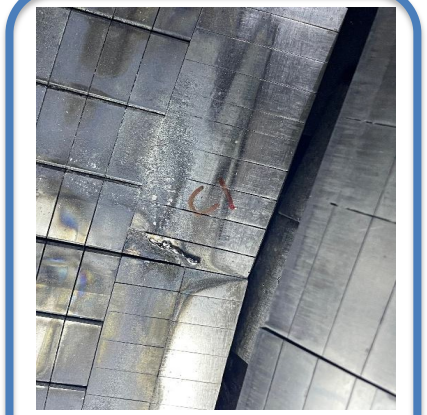

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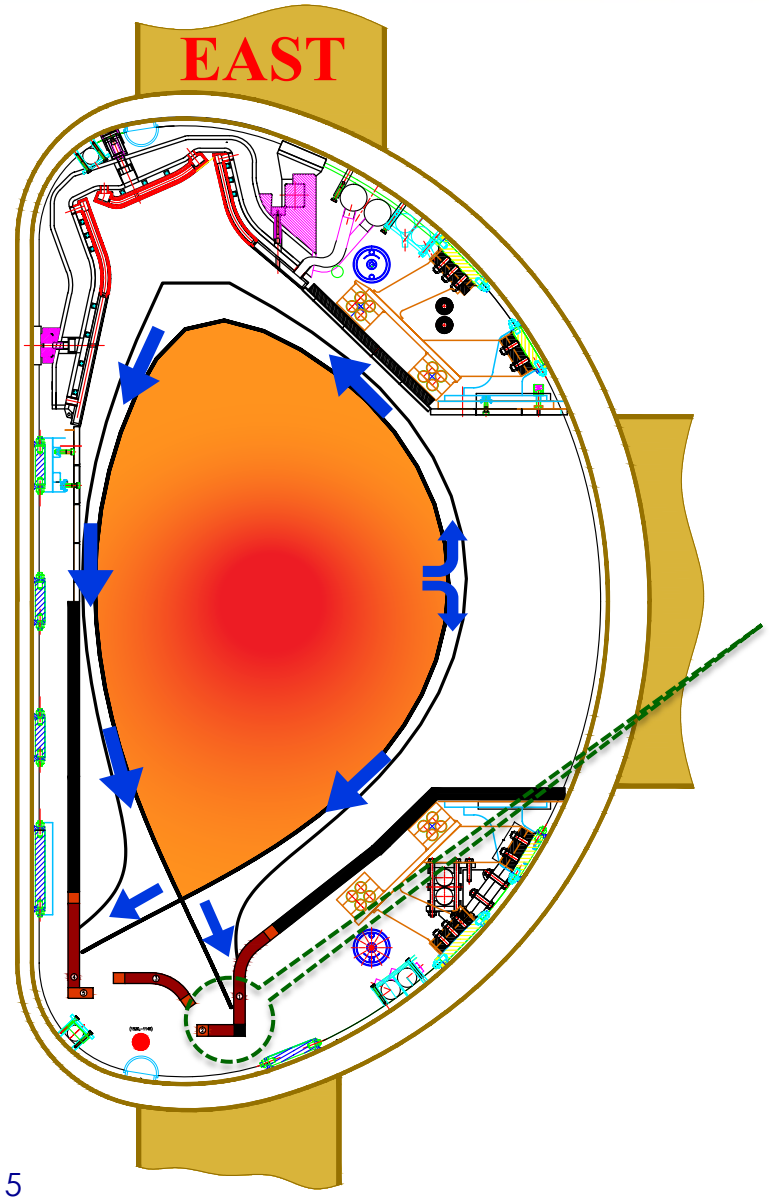

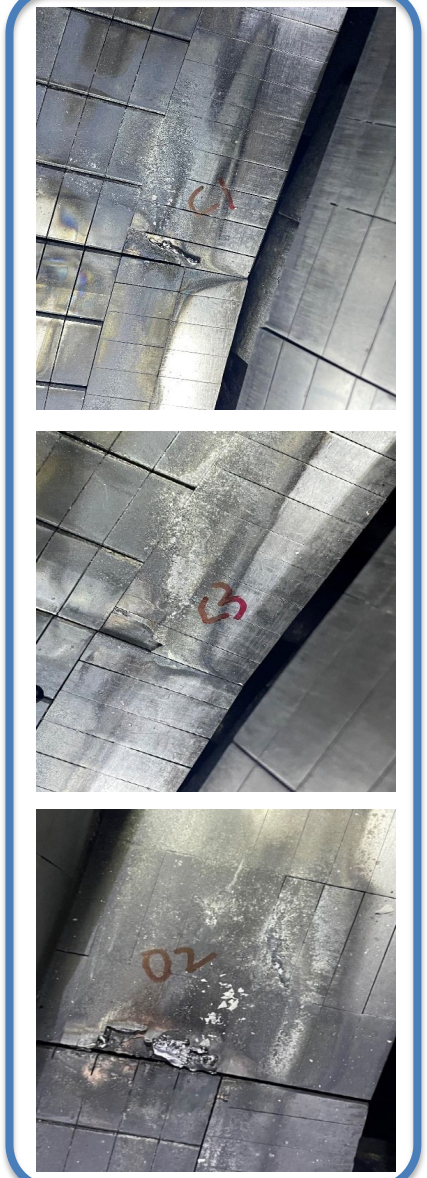

Both upper and lower divertor with full W plasma-facing components

Control of heat flux and W erosion :

- **Divertor heat load ($q \leq 10$ MW/m^2)**
- **Acceptable divertor target erosion ($T_e \leq 5 \sim 10$ eV)**
- **Compatible with core plasma scenario**

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Developing advanced divertor solutions in EAST

Heat flux and erosion control

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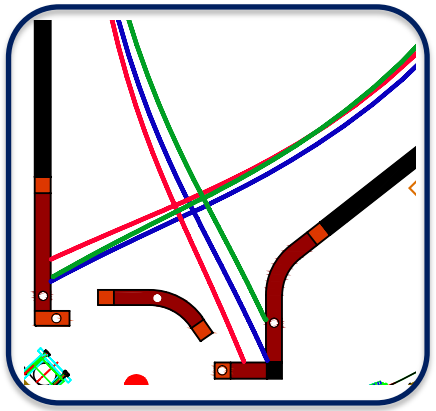
Heat flux and erosion control

Closed Divertor

- Neutral baffling



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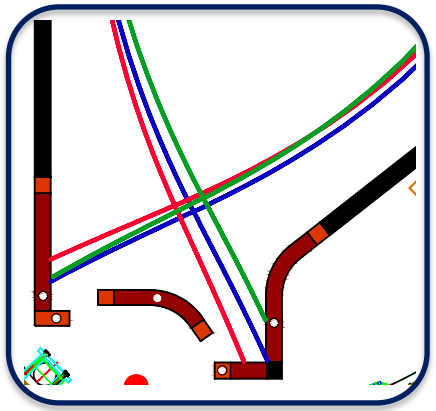
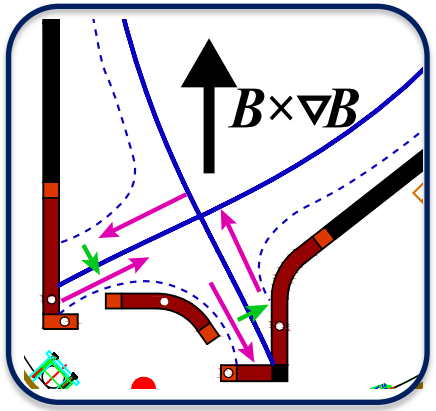


Operation scenario

- Unfavorable B_t direction



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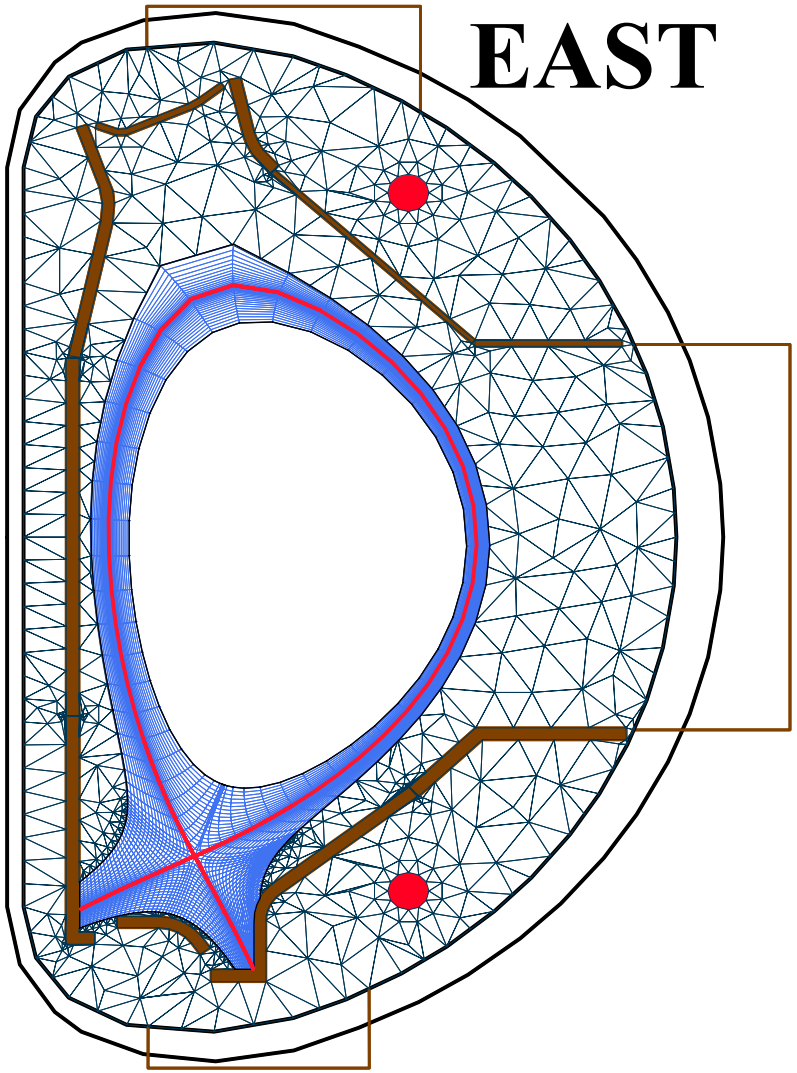
Modeling setup in SOLPS-ITER



SOLPS-ITER mesh

- SOLPS-ITER with full drifts
- Plasma species: D and Ne
- P_{SOL}= 2 MW
- D=0.3 m^2/s, χ=1.0 m^2/s
- Ne puff rate = 1.0e18 /s
- Scan of D puffing rate

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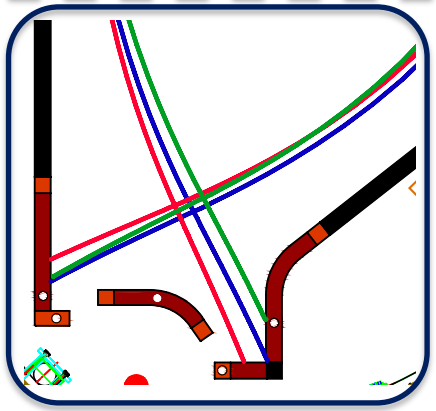

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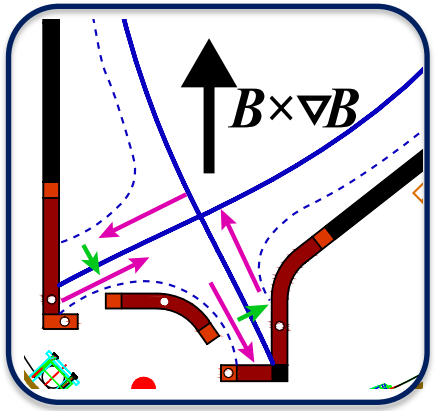

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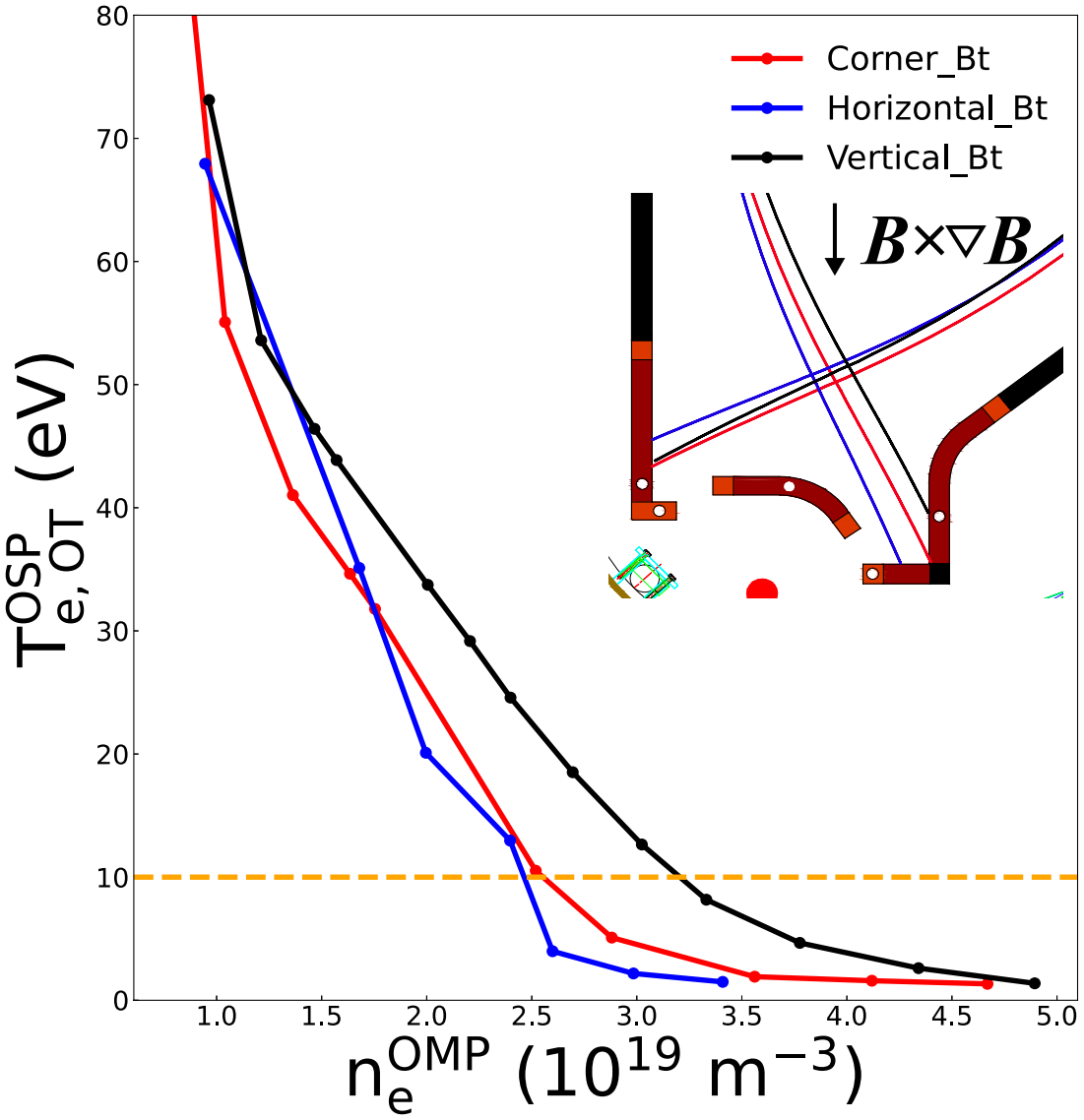
The effects of outer otrike point(OSP) locations (Fav. B_t)



- **Three different OSP locations are compared.**
- **Te at the OSP can be reduced with increasing the upstream electron density.**
- **The divertor configuration with the OSP on the horizontal target can achieve detachment more easily.**
- **The divertor configuration with the OSP on the vertical target has the highest T_e with the same $n_{e,sep}$.**

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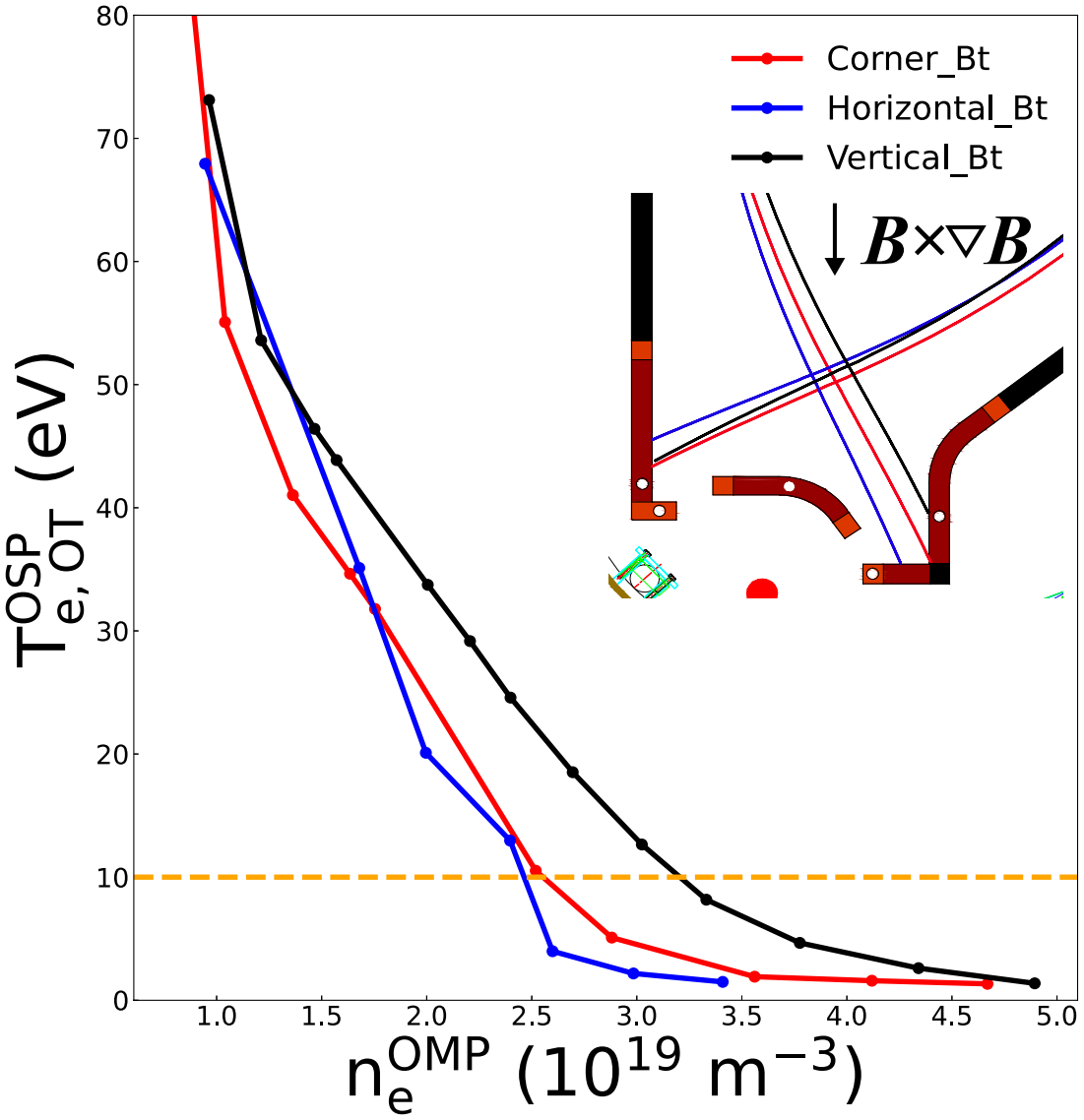

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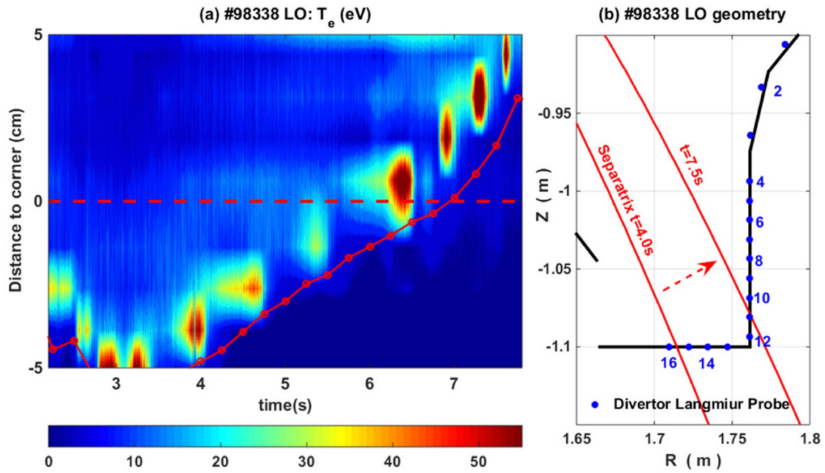

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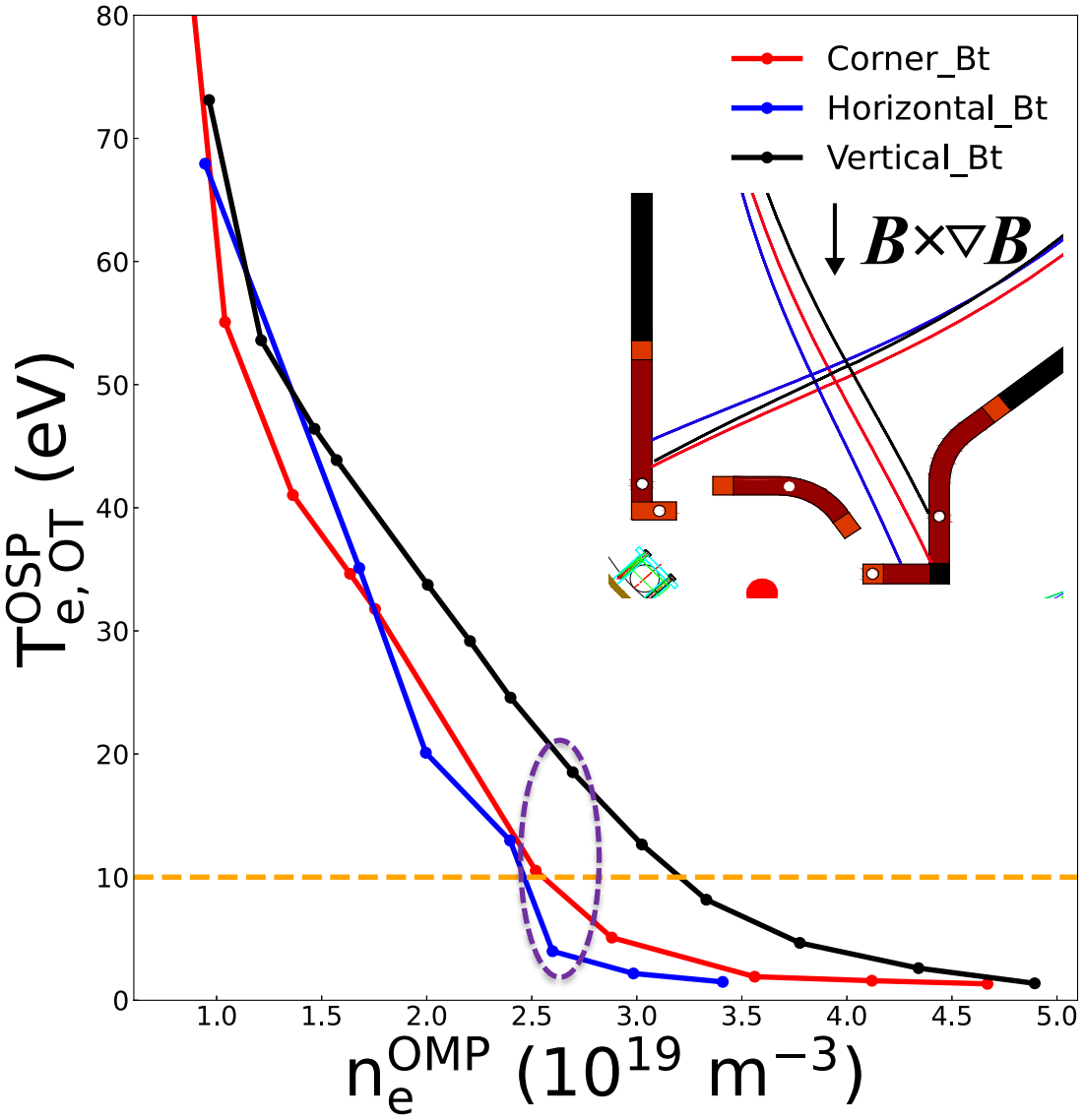

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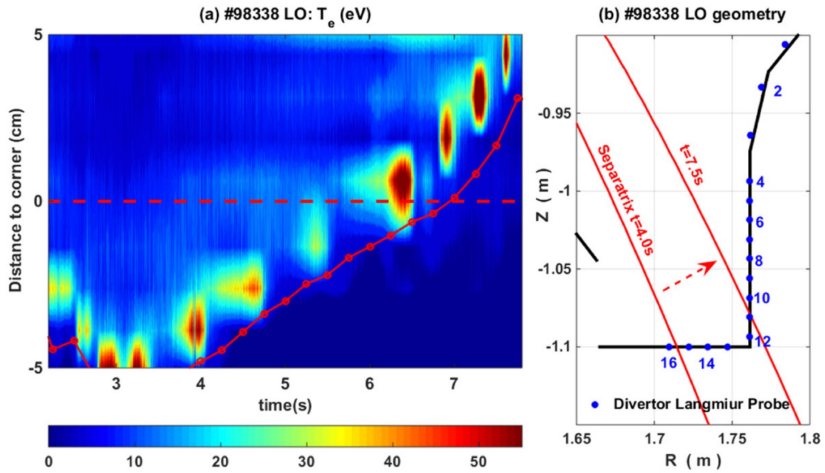
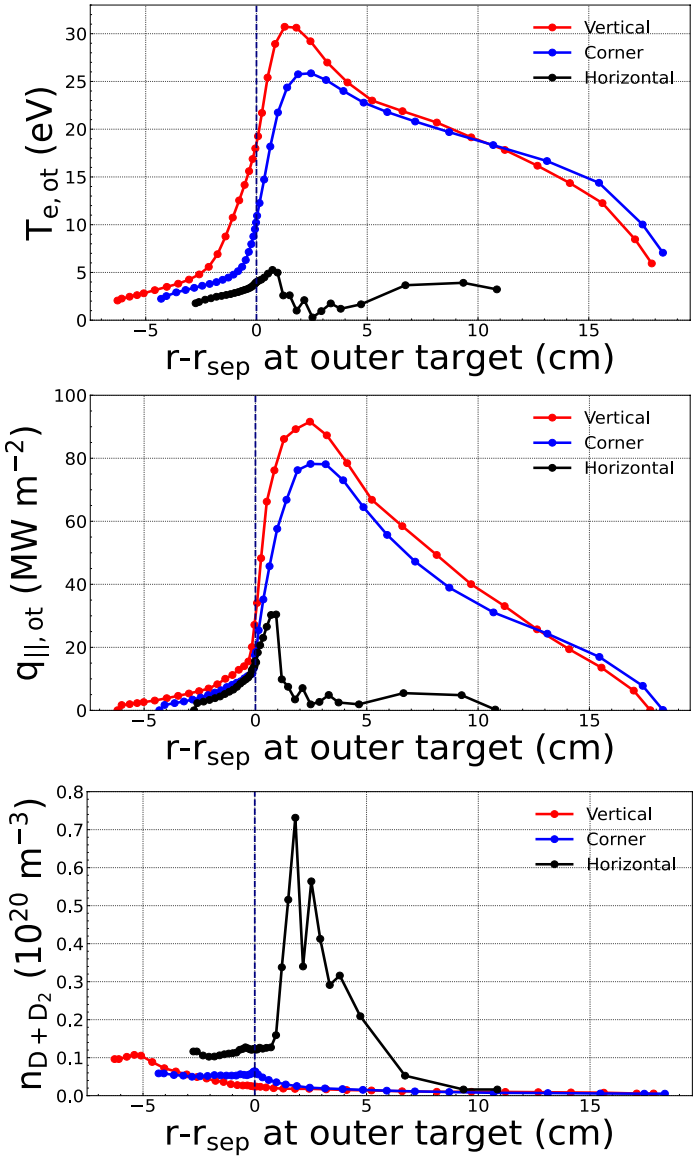


The outer target profiles for the three OSP locations with the same $n_{e,sep}$ (Fav. B_t)



The OSP on the horizontal target:

- **The lowest electron temperature**
- **The lowest parallel heat flux density**
- **The highest neutral density**

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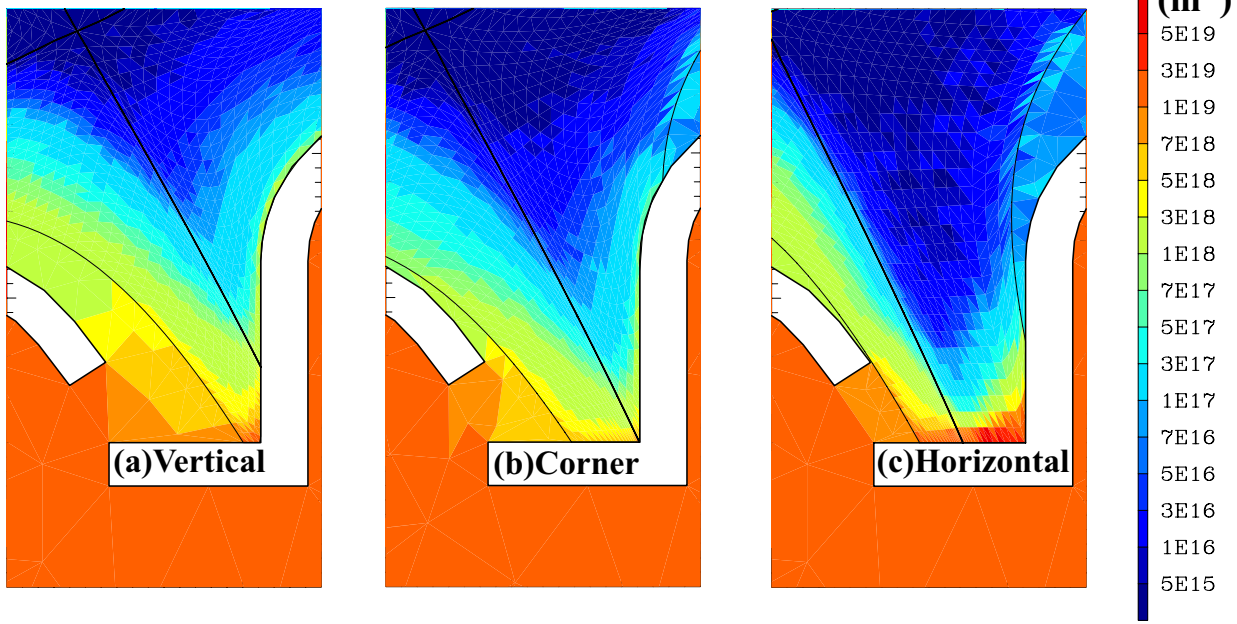
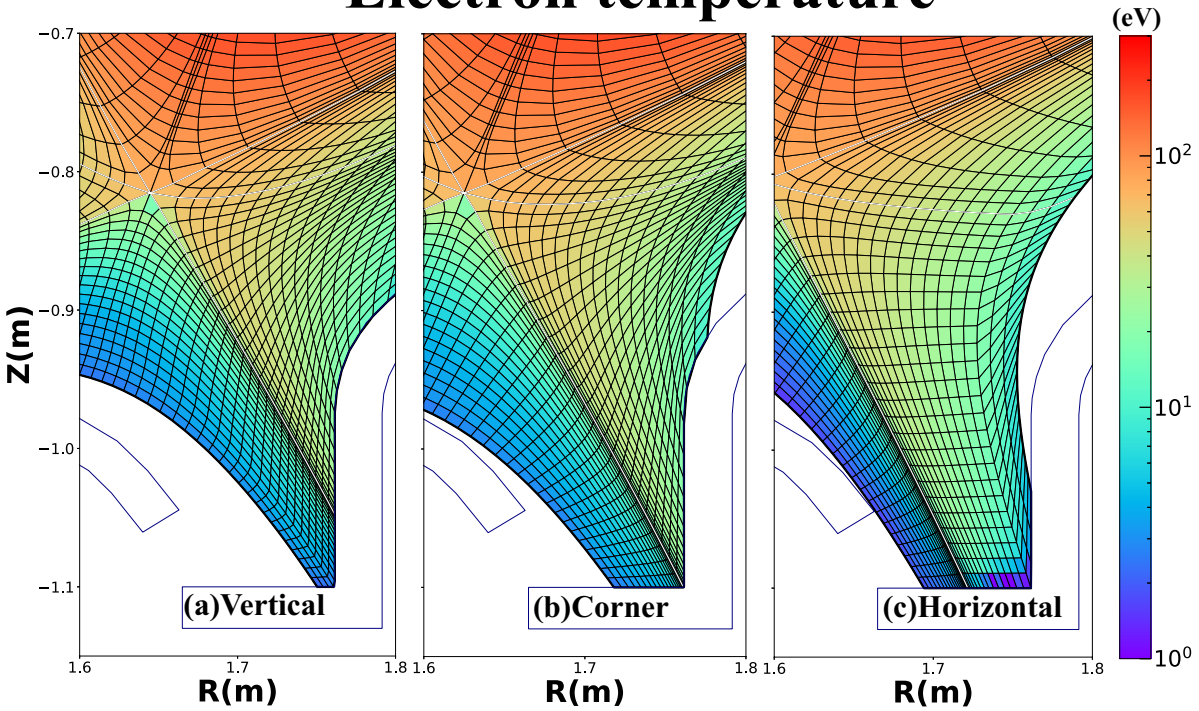
2D distributions for the three divertor configurations with the same $n_{e,sep}$ (Fav. B_t)

Neutral density($D+D_2$)



Electron temperature



- The divertor configuration with the OSP on the horizontal target can trap the most effectively the neutrals in the outer divertor region with the lowest T_e.

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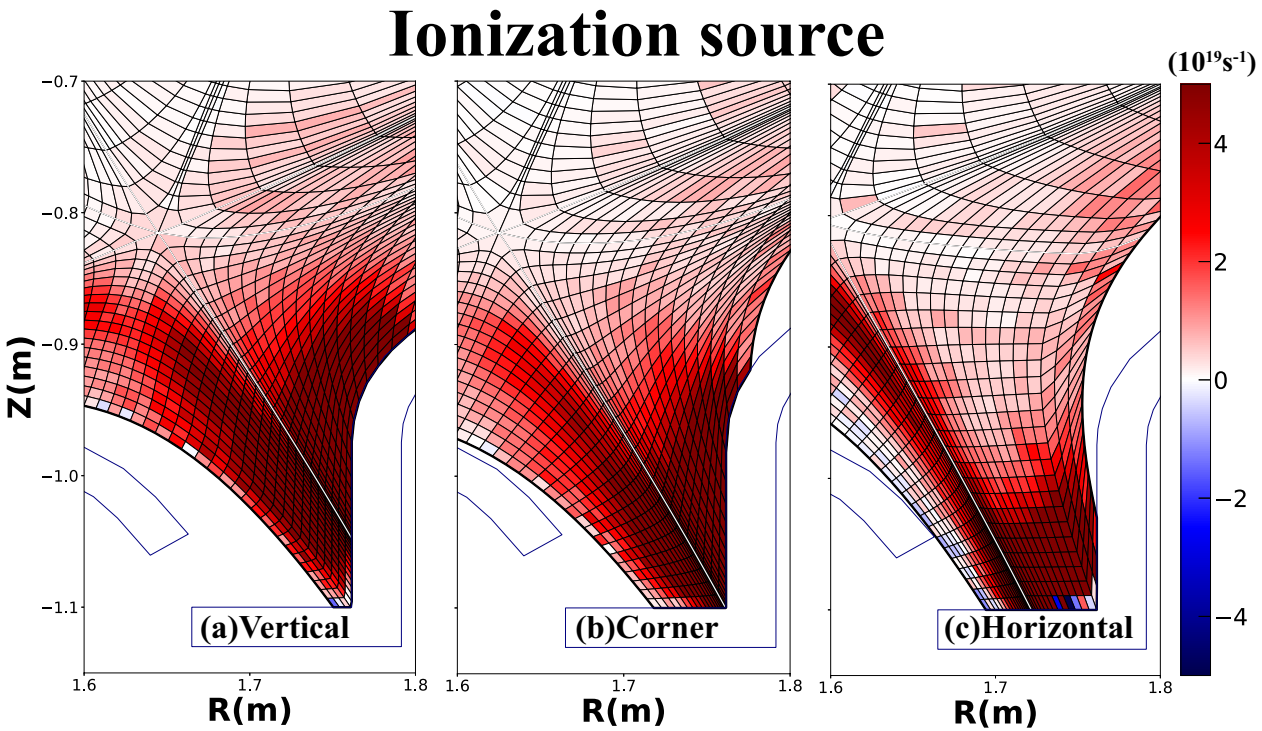
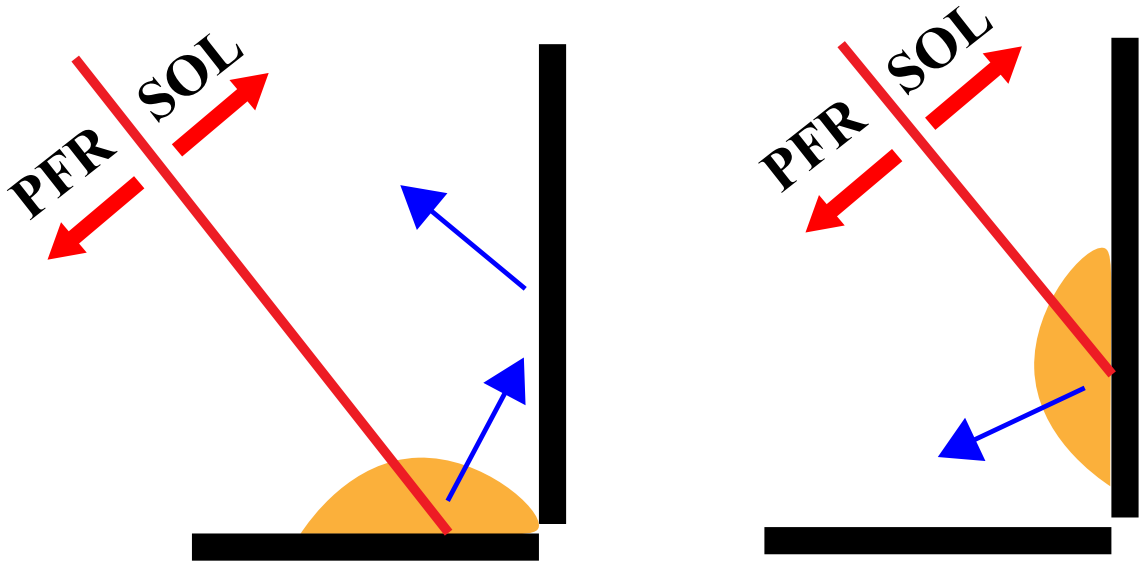
2D distributions for the three divertor configurations with the same $n_{e,sep}$ (Fav. B_t)





- When the OSP is switched from the vertical to horizontal target, the ionization region is reduced and a small recombination area is formed in front of the target.
- Different recycling behaviour of neutrals causes more neutrals trapped with the horizontal target configuration which can reduce Te.

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Developing advanced divertor solutions in EAST

Heat flux and erosion control

Closed Divertor

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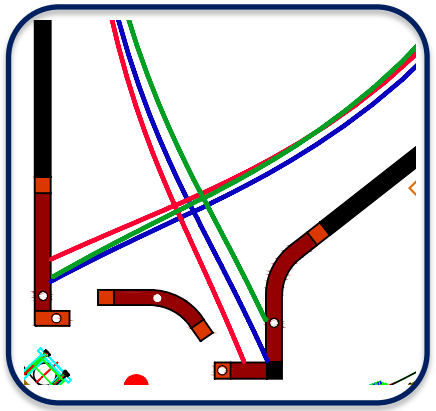

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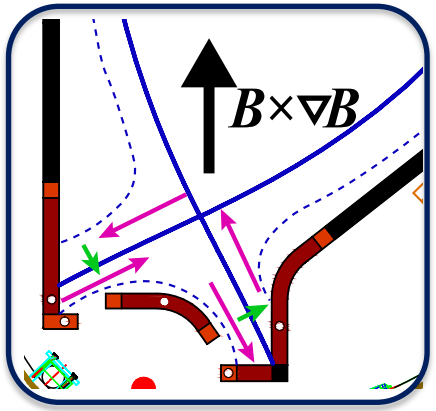

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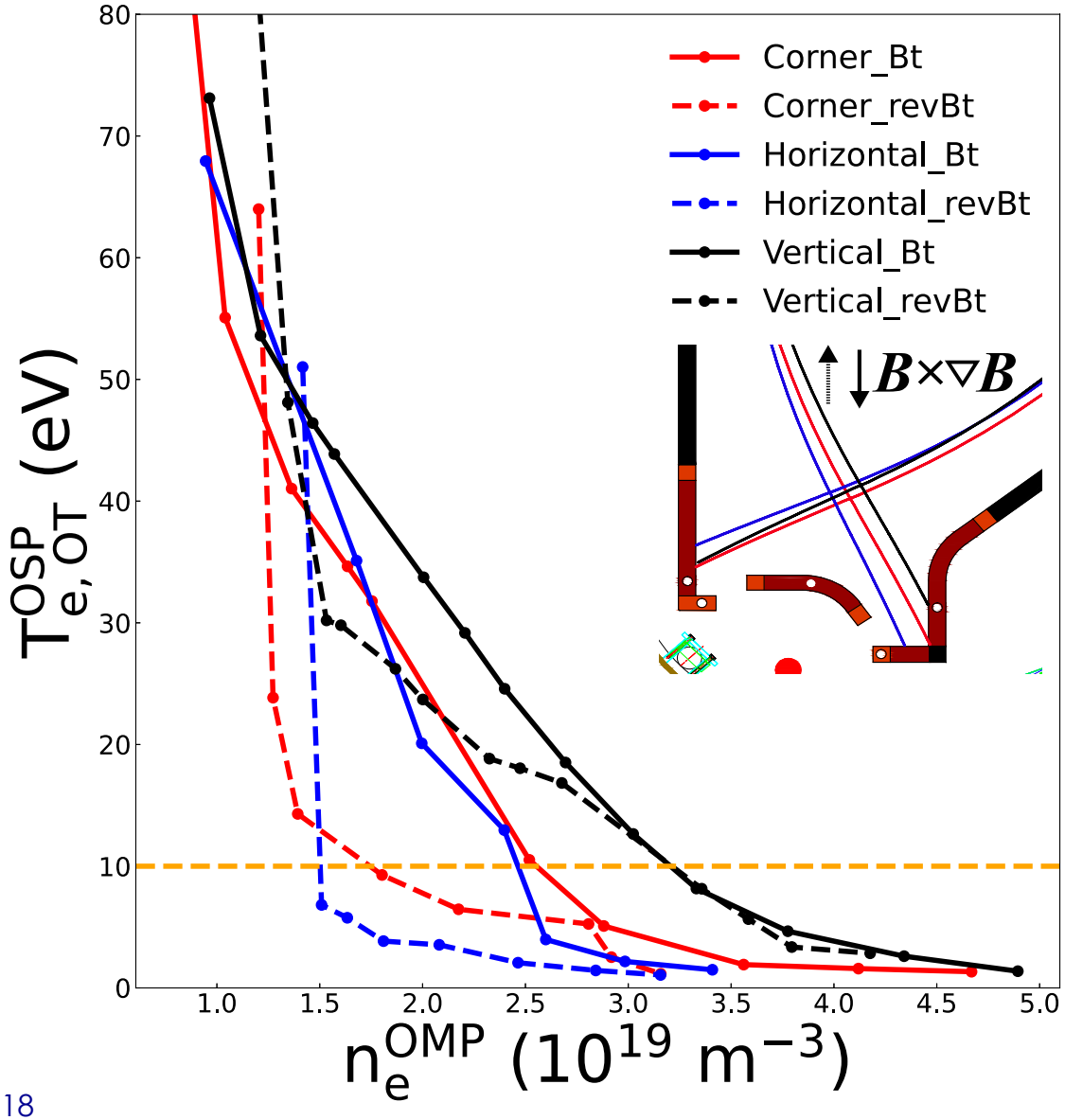
The effects of outer otrike point(OSP) locations
(Fav. B_t and Unfav. B_t)



- Te at the OSP with unfavorable B_t is lower than that with favorable B_t under the same upstream electron density.
- The divertor configuration with the OSP on the horizontal target with unfavorable B_t can achieve detachment more easily.

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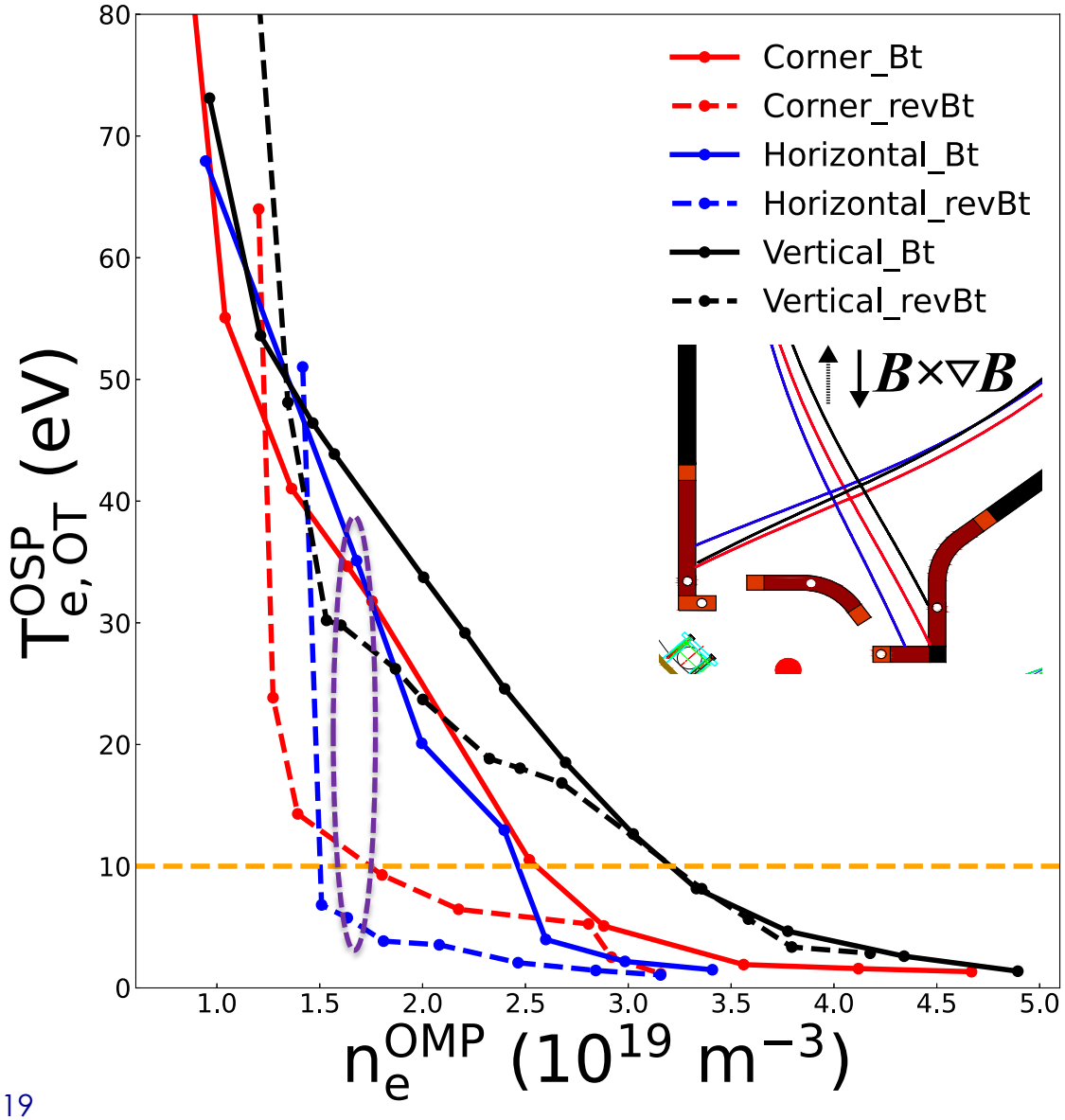

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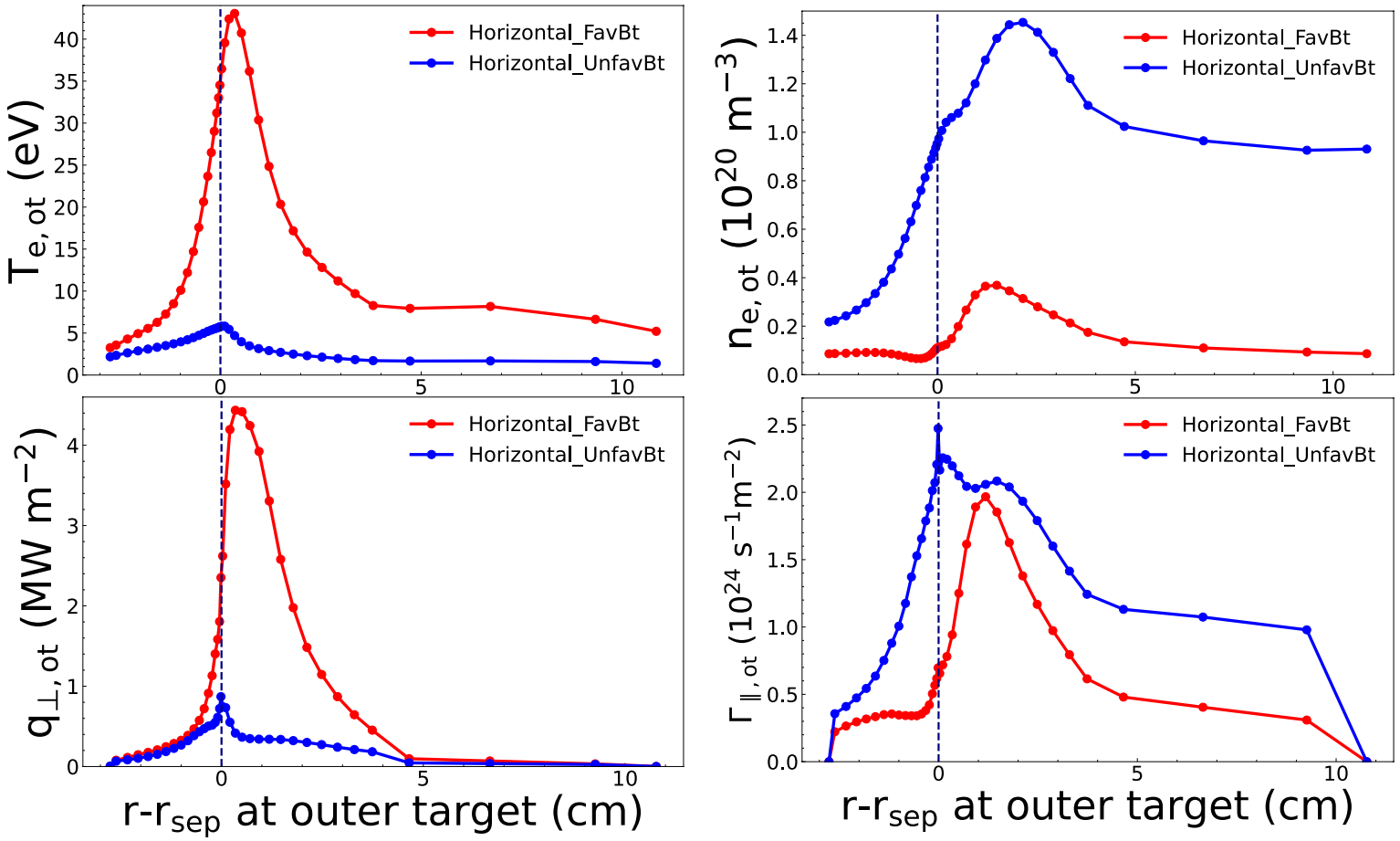
The outer target profiles of horizontal divertor configuration (Fav. B_t and Unfav. B_t)



- **The horizontal divertor configuration with unfavorable B_t has a lower T_e and heat flux density at the outer target than that favorable B_t.**

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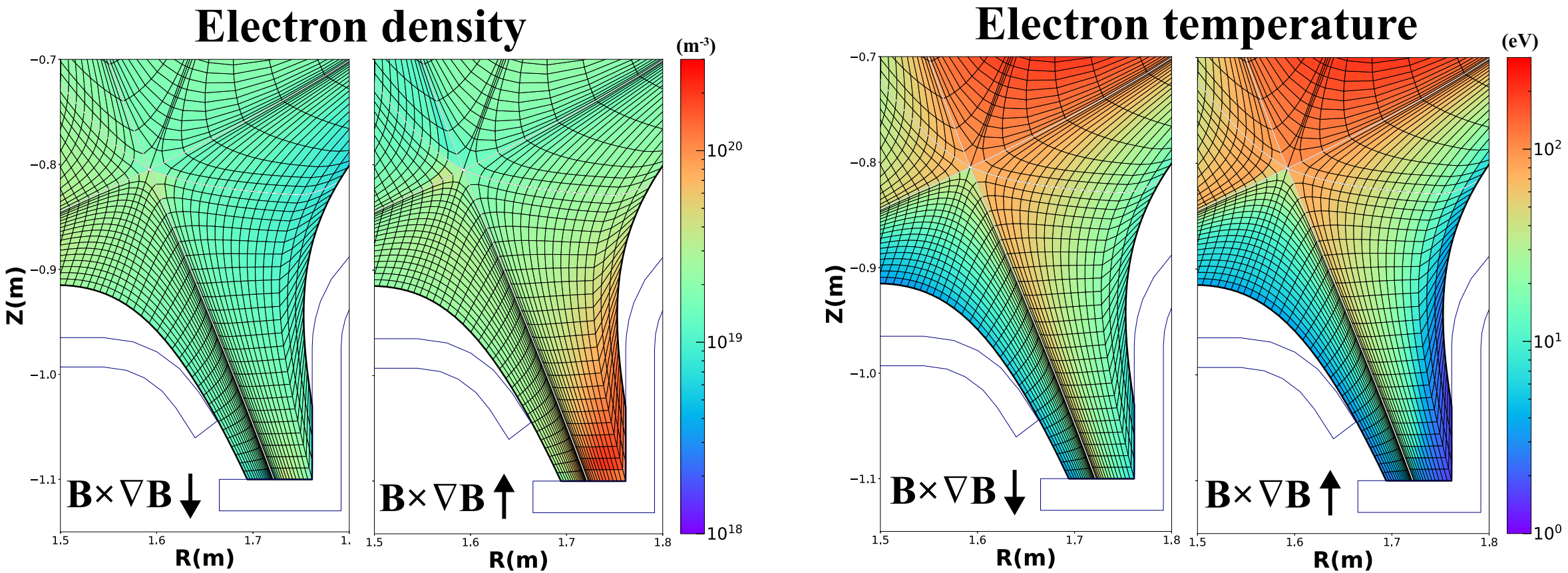
2D distributions for the horizontal divertor configuration (Fav. B_t and Unfav. B_t)



- The horizontal divertor configuration with unfavorable B_t has higher n_e and lower T_e in the outer divertor region than favorable B_t.

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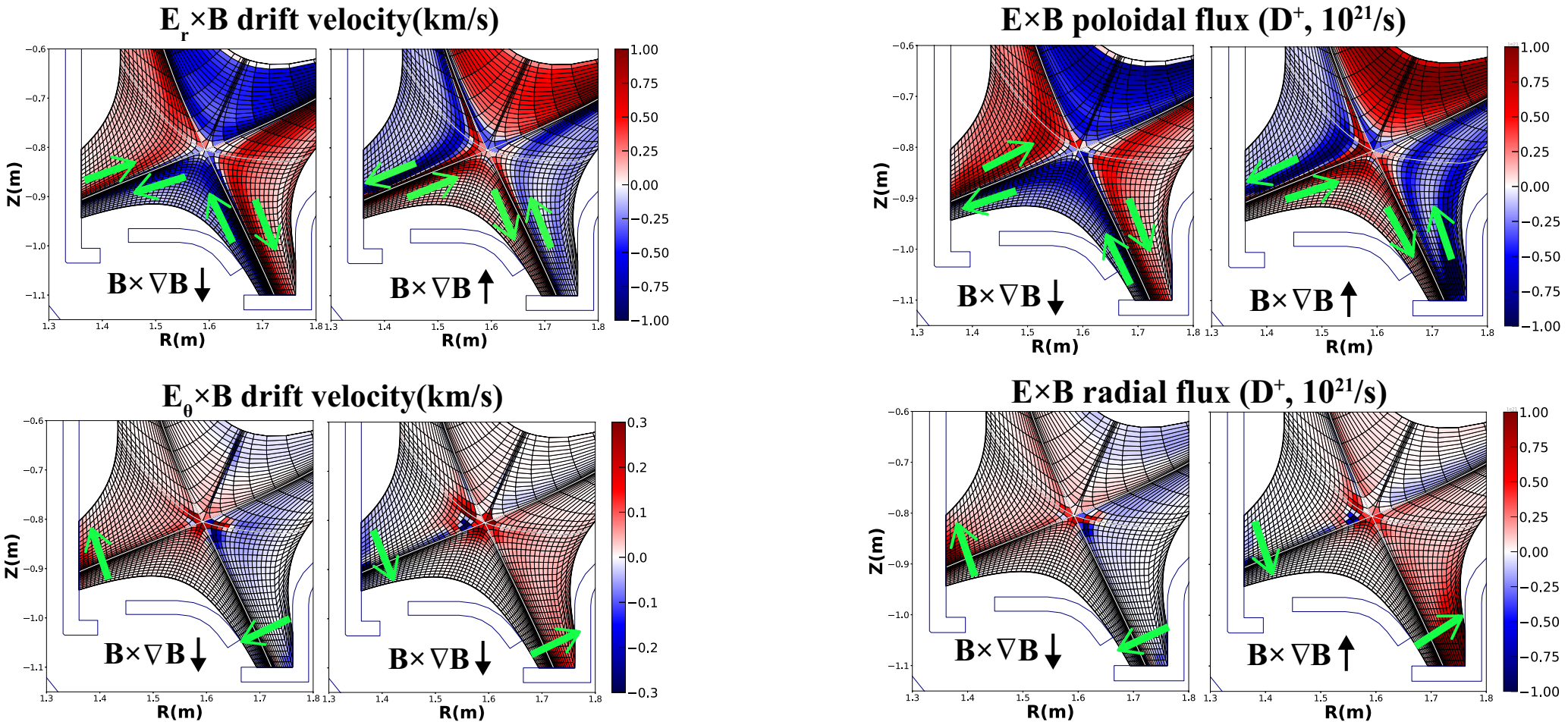
Different E x B drift direction redistributes the ions between the inner and outer targets



- E x B drift with unfavorable B_t causes ion flows from the inner divertor area to the outer divertor area crossing the private flux region.

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Summary

- ✓ The outer strike point on the horizontal target near the corner can trap more neutrals and then reduce the corresponding electron temperature and heat flux density.
- ✓ The E x B drift with unfavorable B_t can cause ion flows from the inner divertor to the outer divertor, which can reduce further the electron density and heat flux density at outer target.
- ✓ More modeling will be performed for the existing experiments for further comparison.

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Thank You!

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