Design of EAST lower divertor by considering target erosion and W ion transport during the external impurity seeding

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Abstract

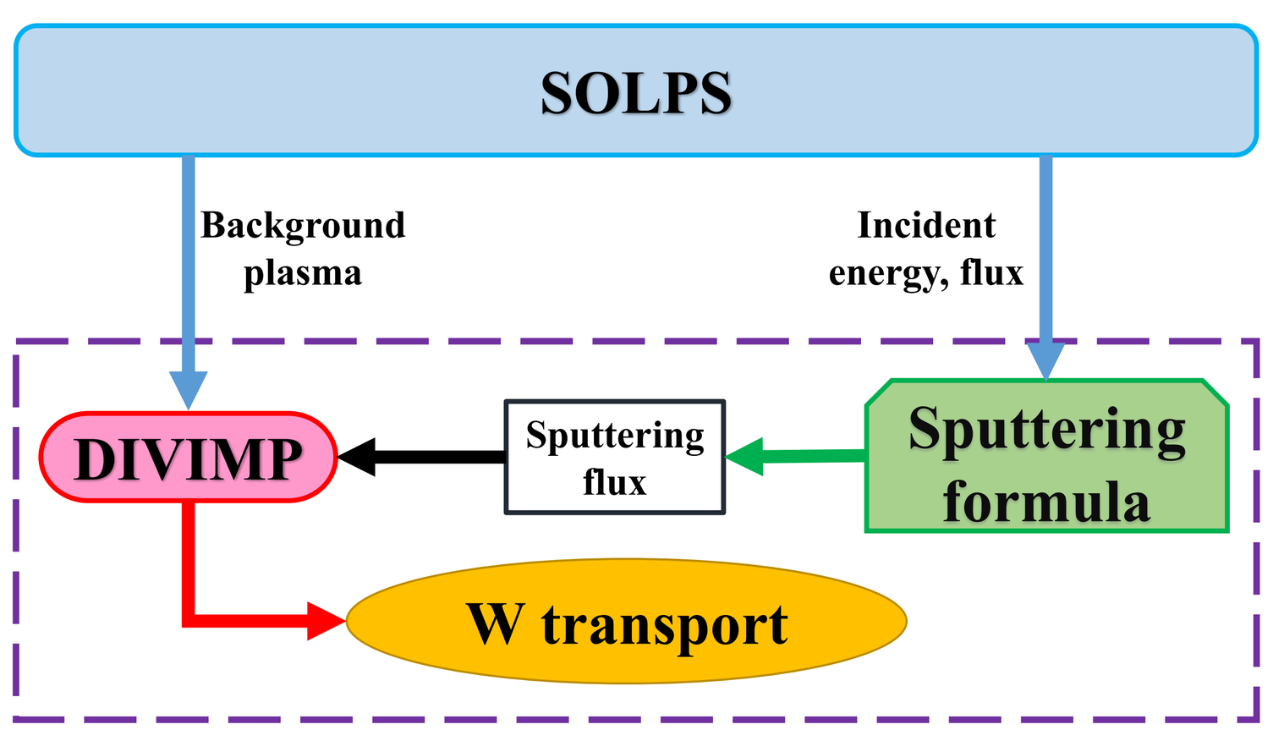
The upgrade of EAST tungsten lower divertor is almost finished. This work presents the physical design of the EAST lower divertor to find out the optimized geometry to achieve further high performance long-pulse discharge by using 2D edge plasma code SOLPS and Monte Carlo impurity transport code DIVIMP. The optimized divertor geometry is proposed after systematic examination of target shapes, target slant angles and the pump opening locations. The performance of the designed divertor is further assessed by impurity seeding.

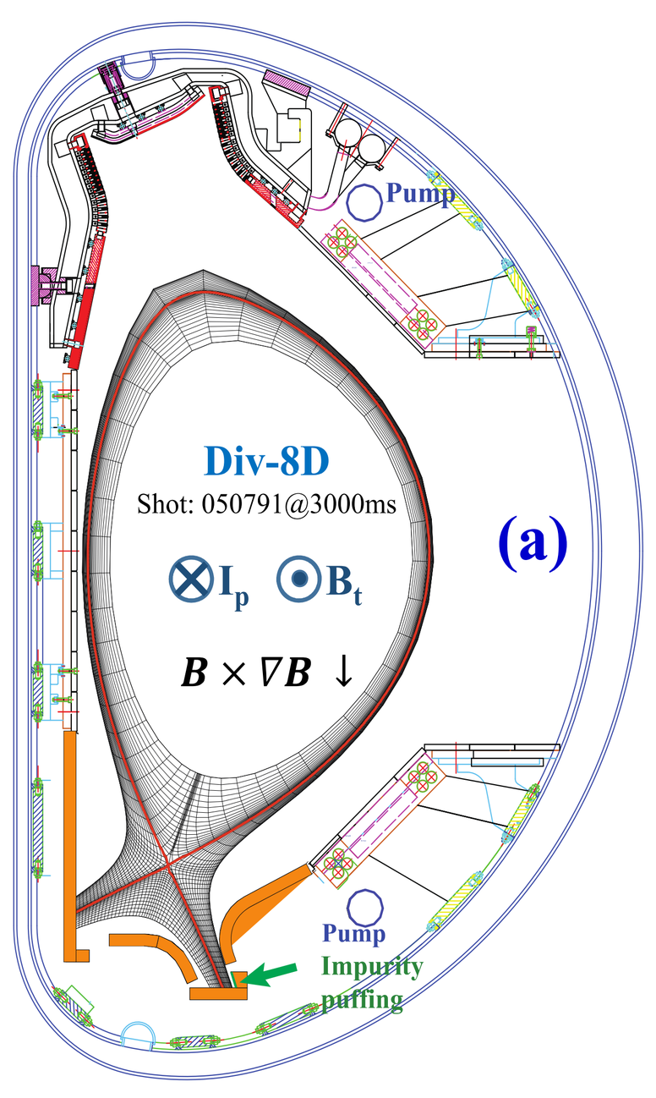
1. The background and motivation

- The control of the power load on targets becomes to a critical issue during high performance long-pulse discharges.
- EAST is planned to upgrade its lower divertor by the usage of W as the PFM.
- The divertor geometry has great impact on the edge plasma.
- The W target erosion and W impurity transport are very crucial for divertor.
- Drifts change divertor in-out asymmetry.

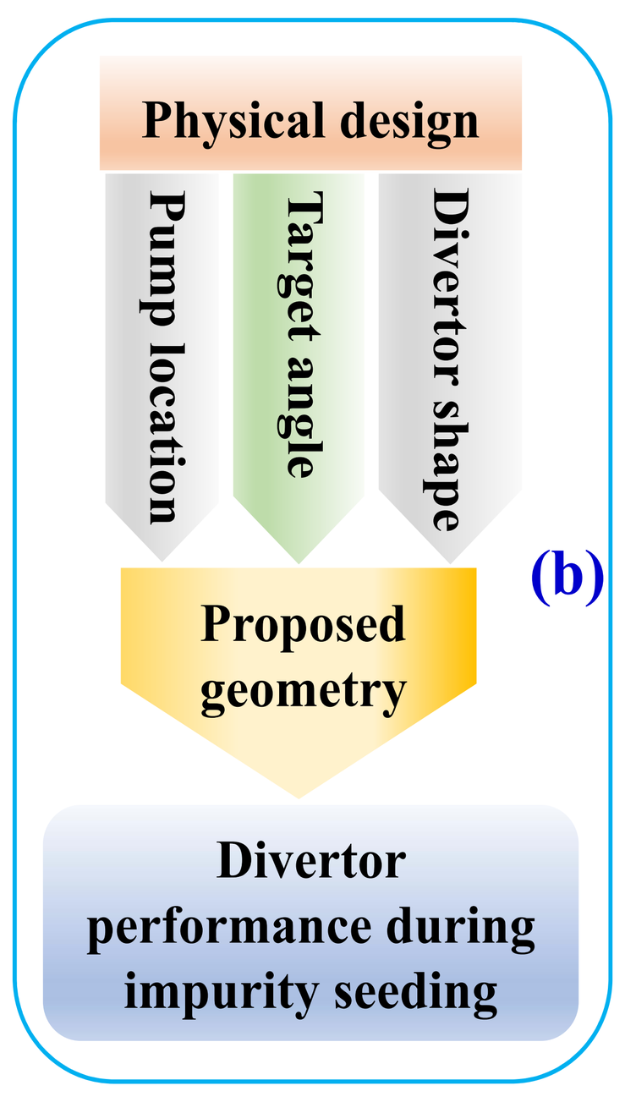
2. Simulation model

- SOLPS modeling is applied to the divertor plasma modeling.
- The transport of W impurity is simulated by DIVIMP code.





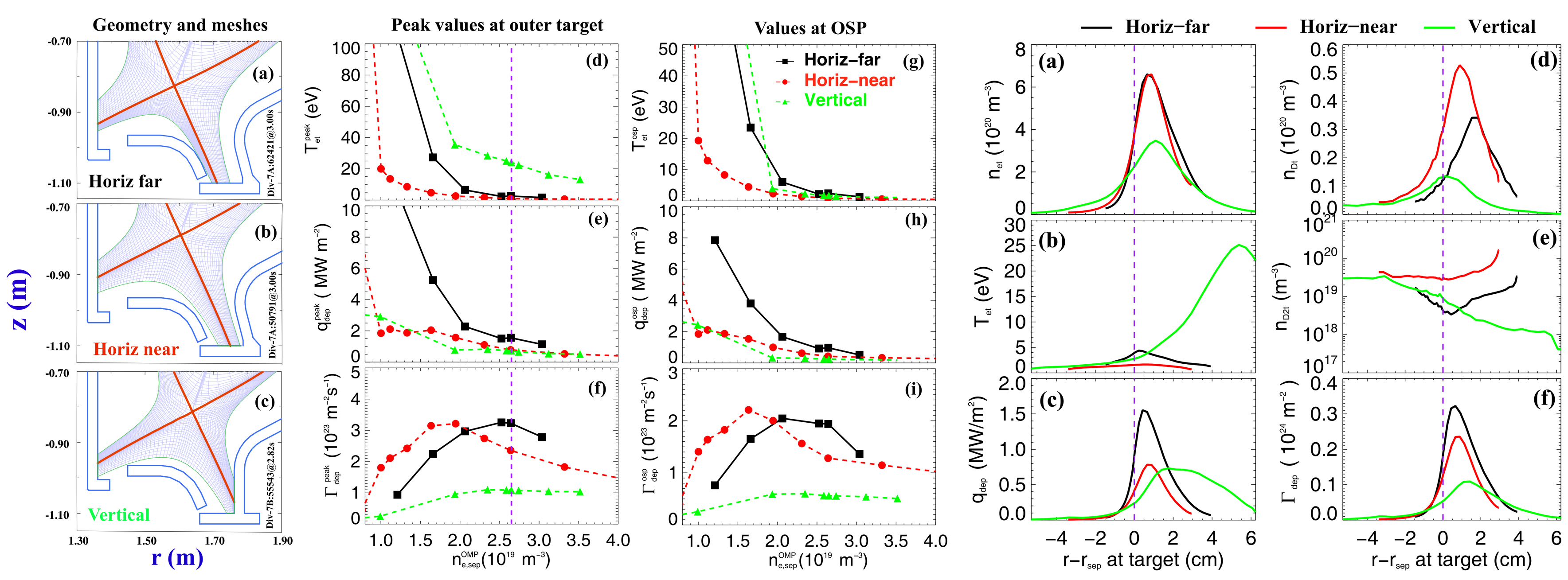
(a)



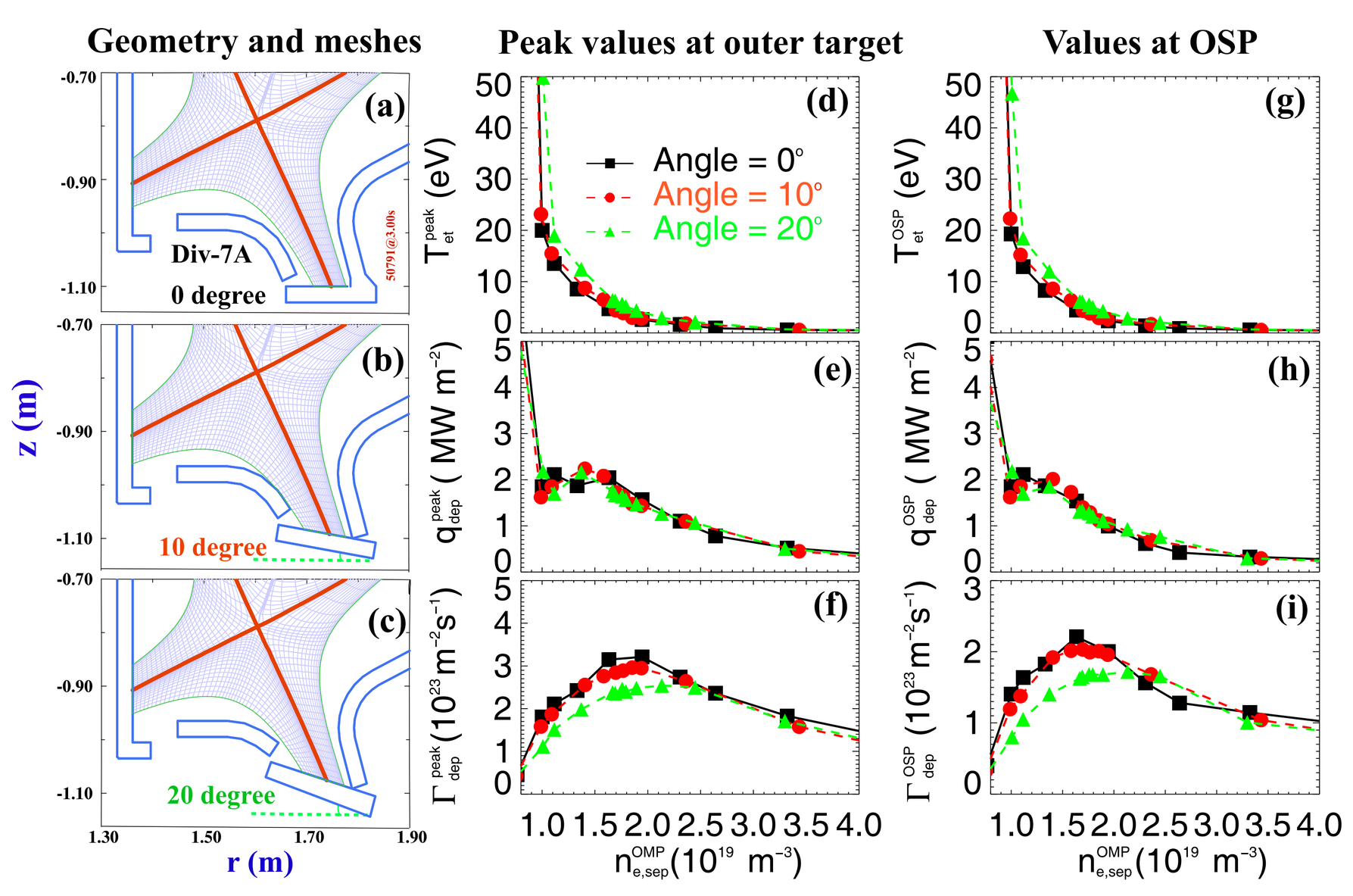
(b)

3. Simulation results

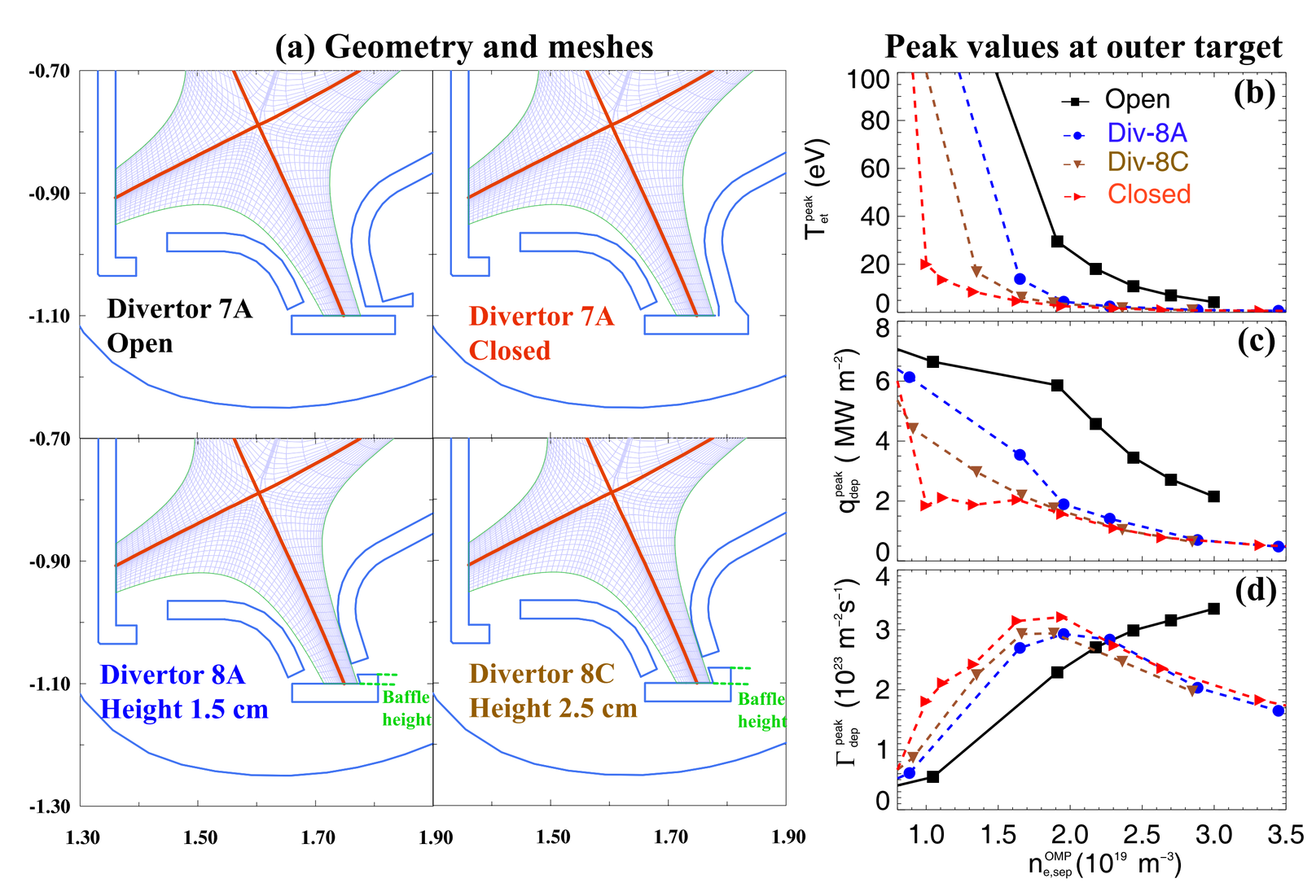
3.1 Design of the geometry of EAST lower divertor



Effects of target shapes on the divertor plasma

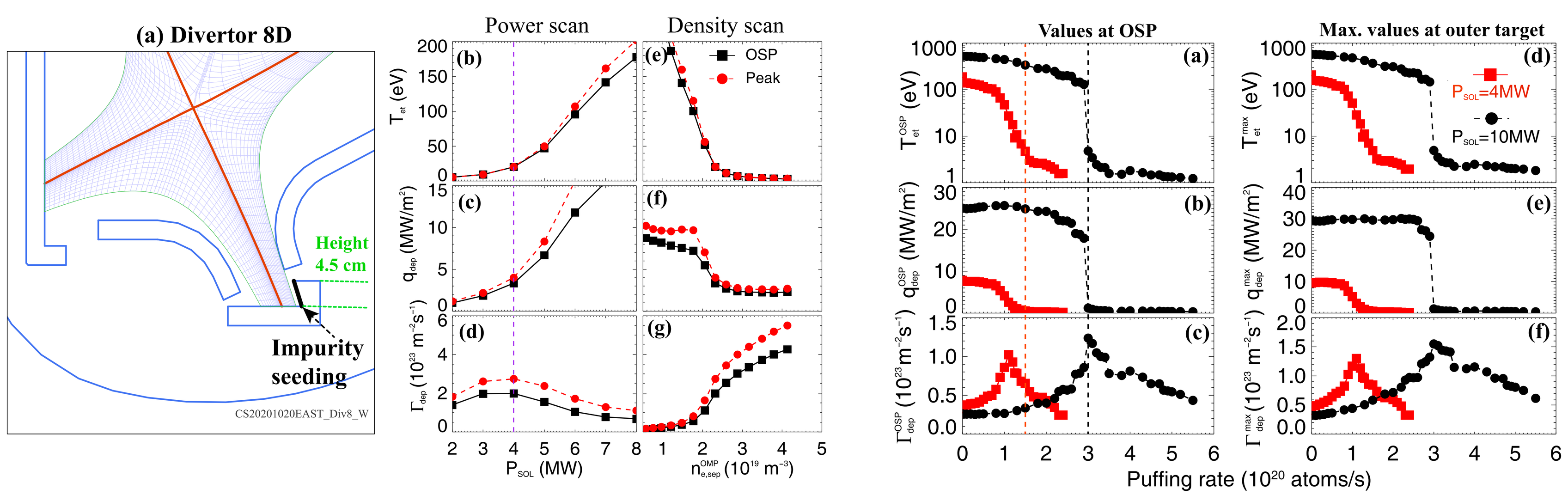


Effects of target slant angle on the divertor plasma

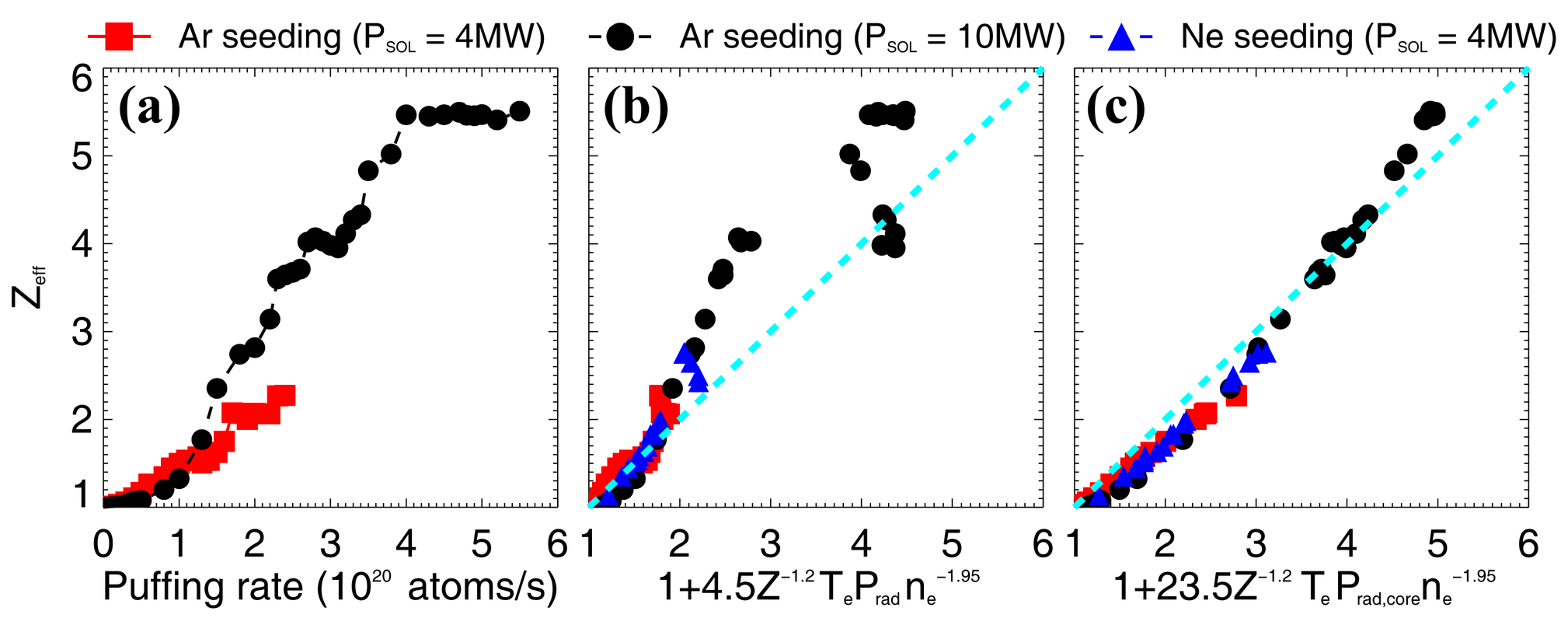


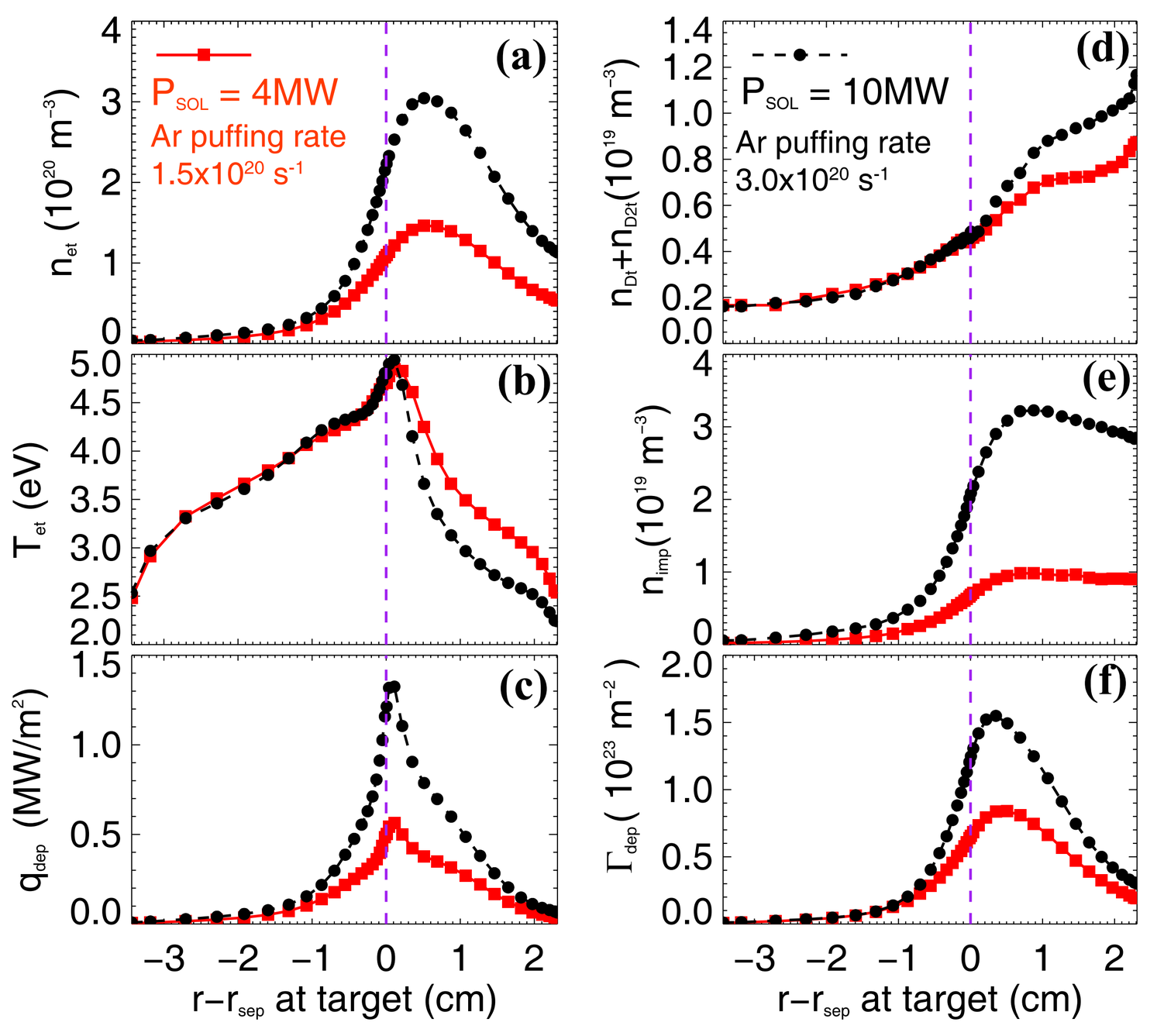
Effects of pump opening location on the divertor plasma

3.2 Tungsten divertor with Argon seeding



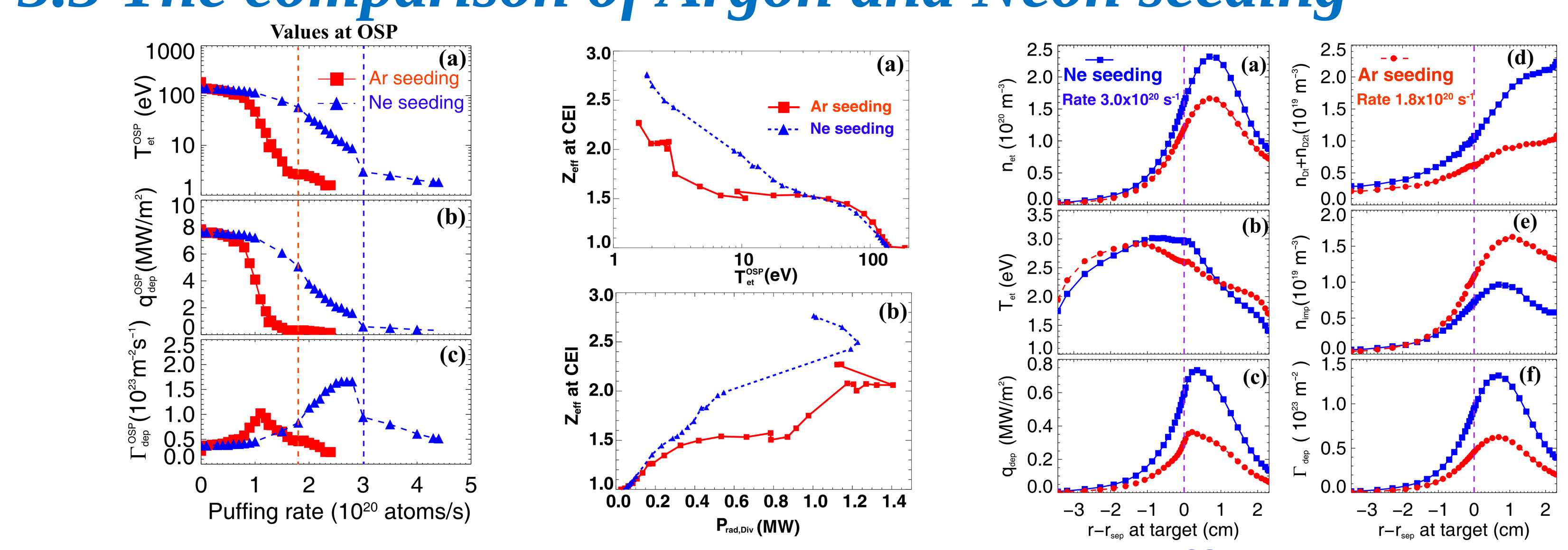
Plasma quantities with power and Argon puffing rate scan



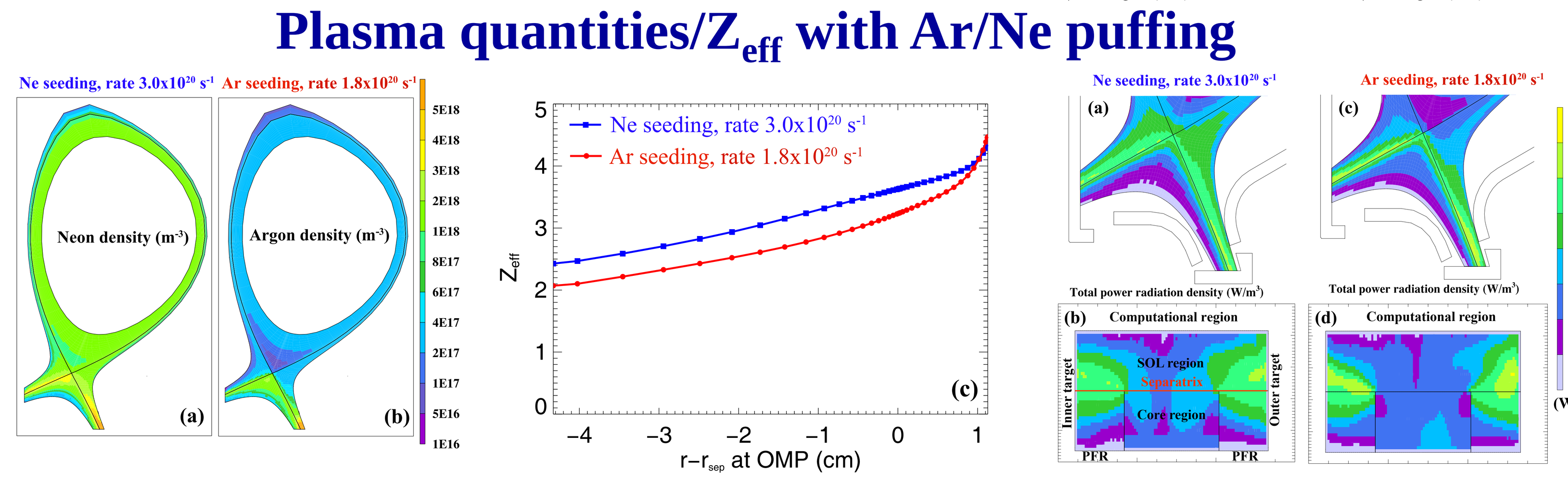


Z_{eff} at the CEI of OMP and plasma quantities along outer target

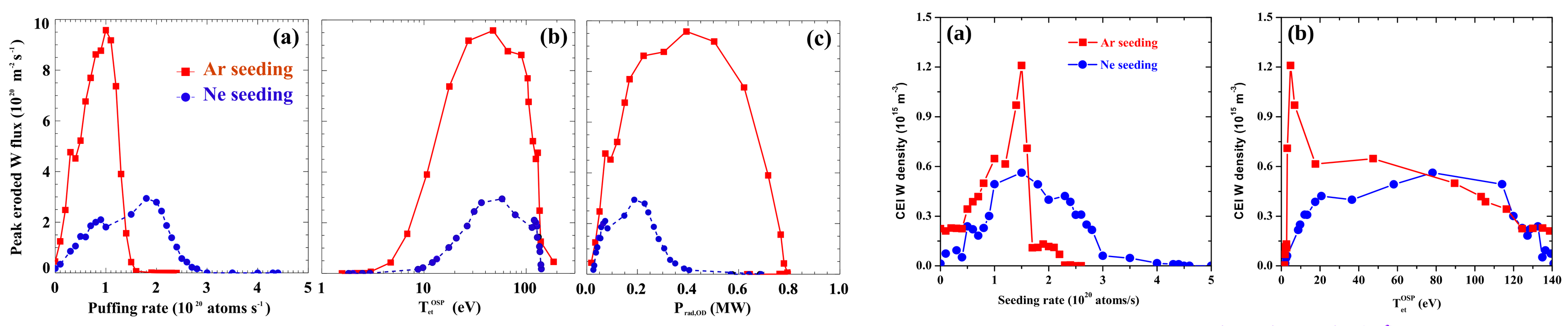
3.3 The comparison of Argon and Neon seeding

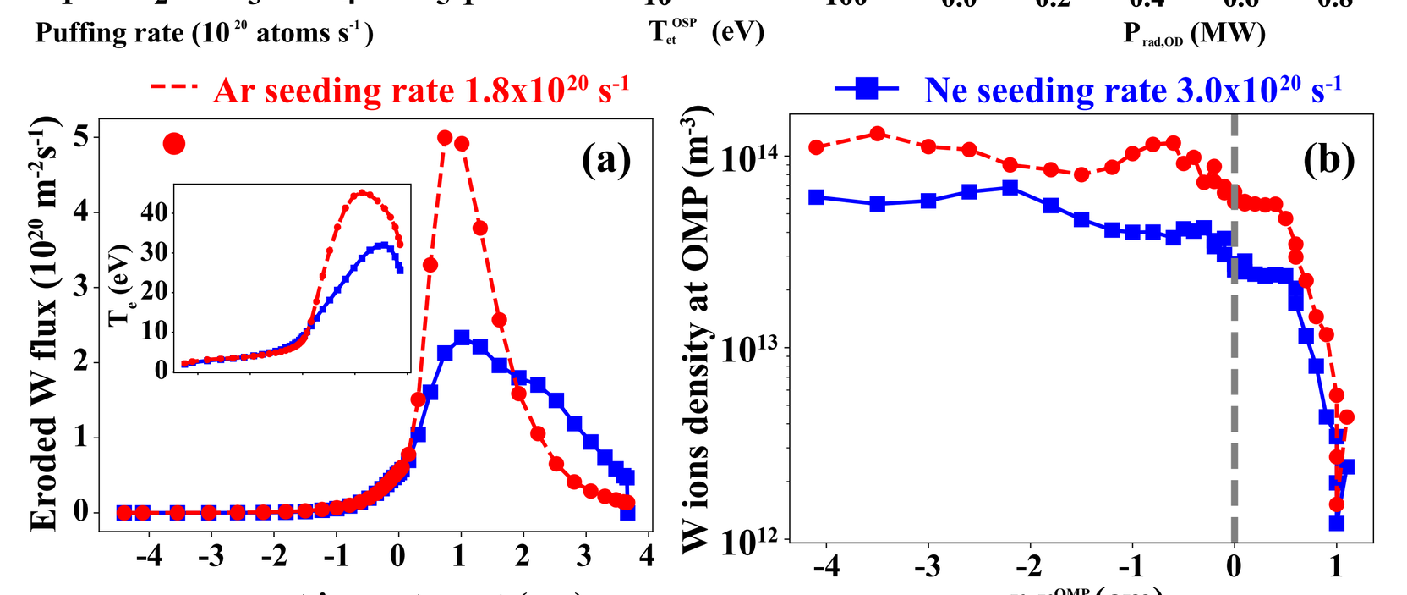


Plasma quantities/Z_{eff} with Ar/Ne puffing

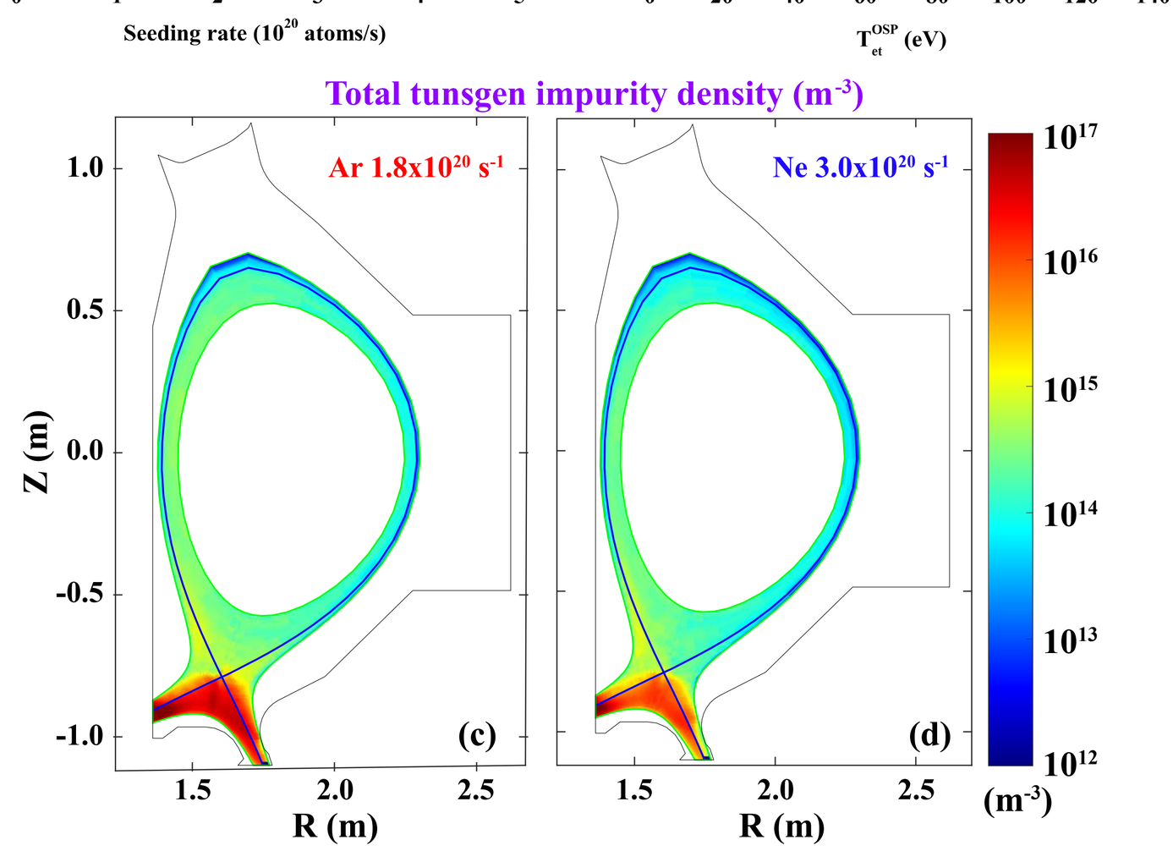


Density distributions/Z_{eff}/power radiation of Ar/Ne

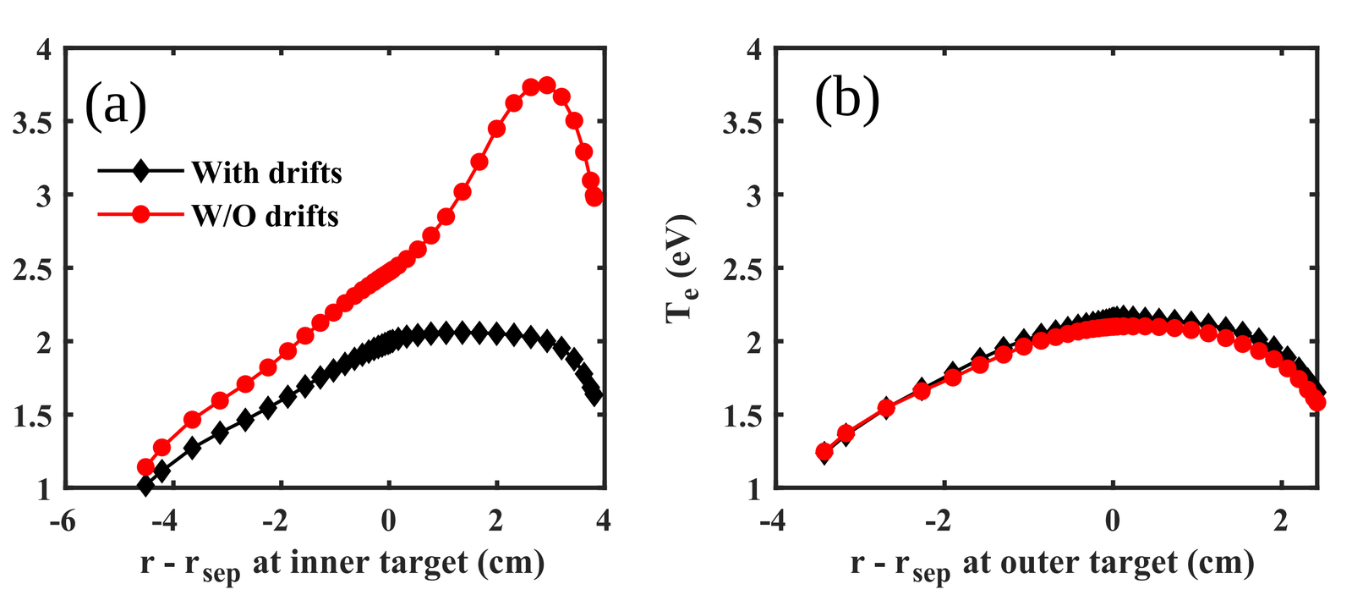


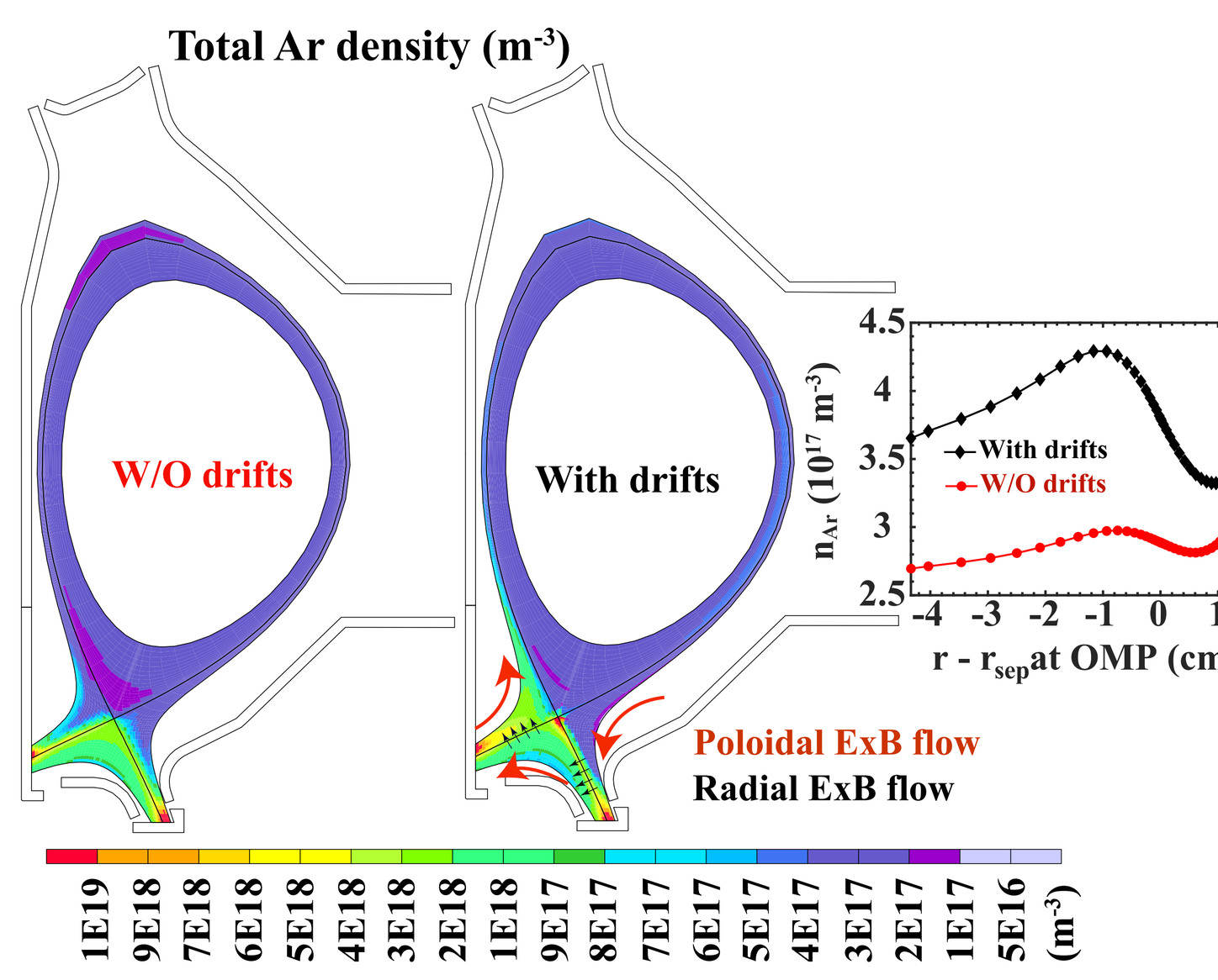


Tungsten sputtering and density distributions of Ar/Ne puffing



3.4 The divertor in-out asymmetry





Plasma quantities affects by E×B drifts

4. Summary and conclusions

a) The horizontal target with OSP close to corner can promote achievement of the fully detachment, the pump opening placing on PFR keeps enough particle exhaust. The target slant angle has slightly influence on divertor plasma.

b) Edge plasma quantities can be significantly reduced by Ar seeding.

c) Comparing with Ne, Ar impurity has higher power radiation efficiency and better divertor impurity screening, but stronger core radiation.

d) Ar seeding causes more serious tungsten target erosion and core plasma contamination problem than that of Ne seeding.

e) The in-out divertor asymmetry can be offset a certain extent by the ion flow driven by the drifts for the new designed EAST lower divertor.

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