# Impact of fine divertor geometrical features on the modelling of JET corner configurations

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# EUROfusion

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** See the Appendix of F. Romanelli et al., Proceedings of the 25th IAEA Fusion Energy Conference 2014, Saint Petersburg, Russia*

## On the difficulty of modelling JET corner configurations

- **2D mean-field codes** = work-horse of edge plasma modelling
- Main 2D mean-field codes (EDGE2D, SOLPS, SOLEDGE2D) use **structured mesh and flux-surface aligned grid**
- Problem when dealing with geometries where relevant solid surfaces are strongly not orthogonal to flux surface, e.g. **JET corner configurations**
- Proposed work-around: run simulations with **tile 7 slanted** (***Fig. 1***)

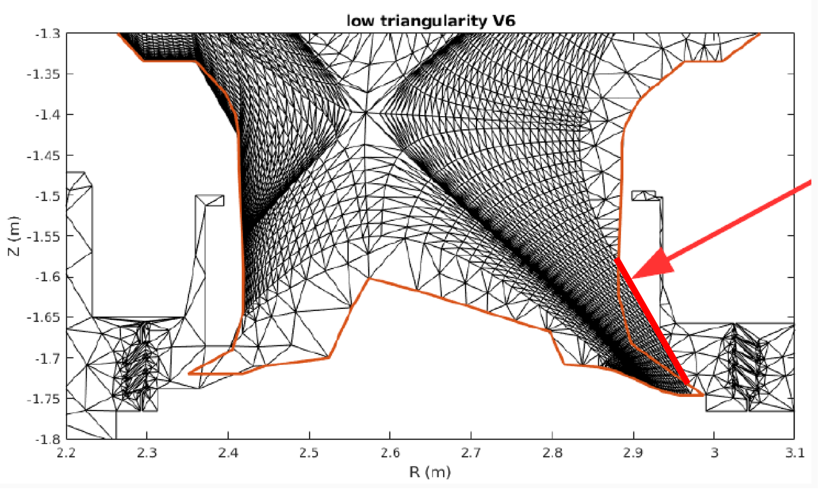



***Fig. 1:*** *EDGE2D grid for modelling of JET V6 configuration illustrating the necessary artificial change in the target geometry (courtesy D. Moulton)*

- **Question: how are simulation results impacted by this artificial modification of the geometry?**
- **Strategy: check with code able to deal with both real and artificial geometries**

## SOLEDGE2D-EIRENE simulations setup

- **SOLEDGE2D-EIRENE** [1] can tackle both geometries thanks to use of penalization method for boundary conditions [2]

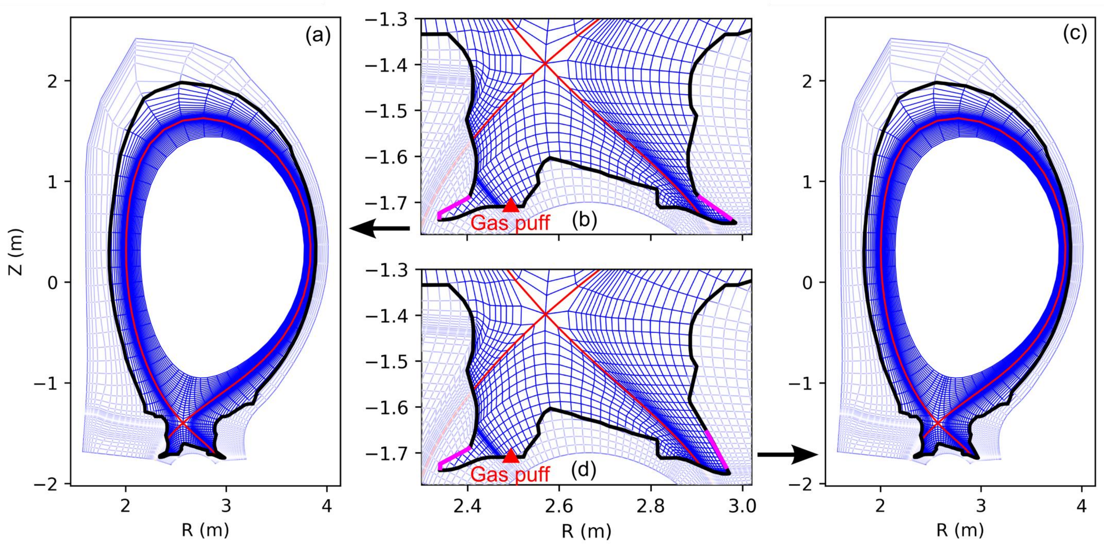



***Fig. 2:*** *Geometries and meshes used for the presented set of simulations. (a) and (b): real geometry; (c) and (d): slanted tile 7 geometry. Red full line = main separatrix. Red triangles = location of gas puff. Magenta lines = location of pumps.*

- Simulations have been run in both geometries (***Fig. 2***) with following parameters:
  - pure D plasmas, no drifts
  - $P_{SOL}$ = 9.2MW
  - H-mode transport coefficients (*Fig. 3*)
  - separatrix density scan through feedback on gas-puff

*[1] H. Bufferand et al., Nucl. Fusion 55, 053025 (2015).*
*[2] L. Isoardi et al., J. Comp. Phys. 229, 2220 (2010).*

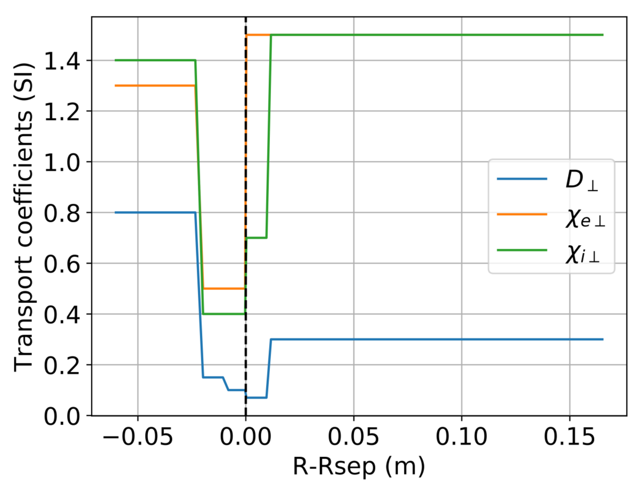



***Fig. 3:*** *Perpendicular transport coefficients profiles*

## Impact on upstream profiles

- **Strong impact in far SOL** beyond T7's apex: slanted T7 systematically denser
- At low density difference propagates to near SOL (deeper penetration of neutrals)

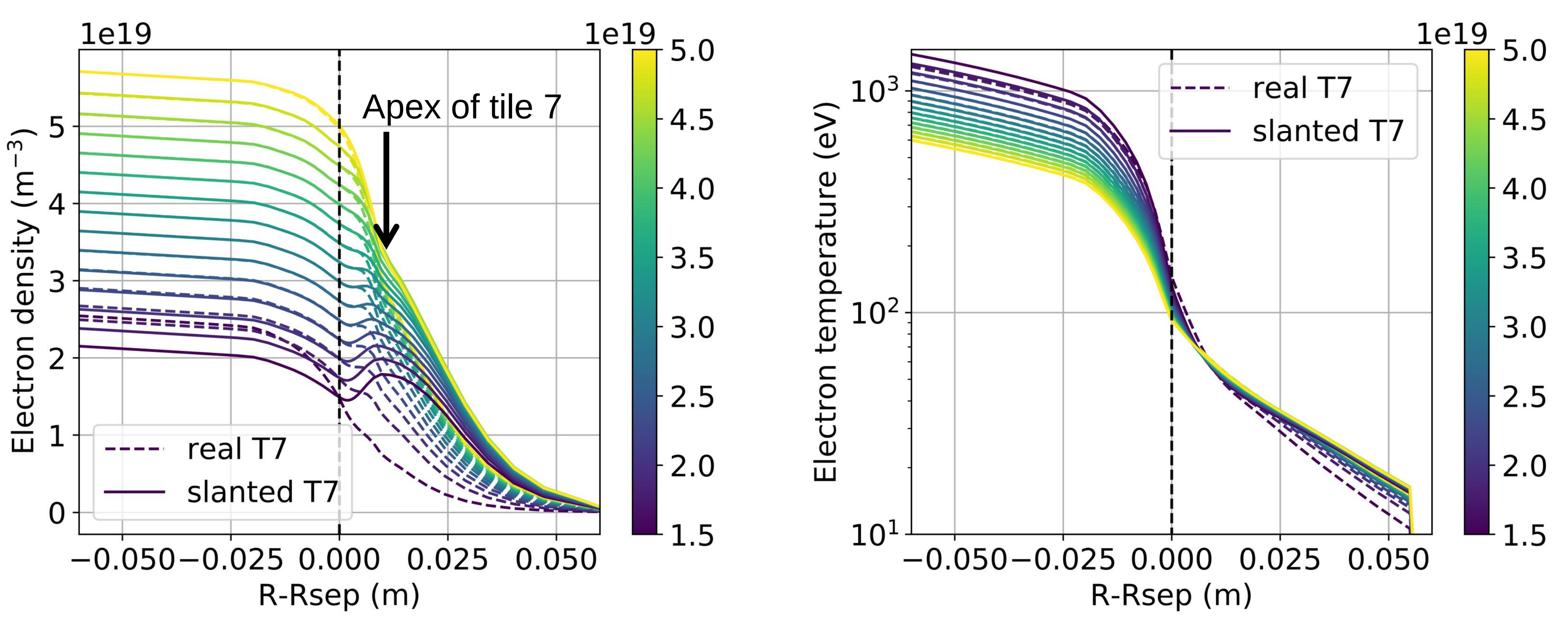



***Fig. 4:*** *Outer mid-plane profiles of density (left) and electron temperature (right) for all simulated cases. The color scale corresponds to the various separatrix densities (in $m^{-3}$). Dashed lines = real tile 7, full lines = slanted tile 7.*

## Impact on divertor conditions

- **Neutrals distribution little impacted** except for larger density in slanted case on HFS baffle (***Fig. 5***)

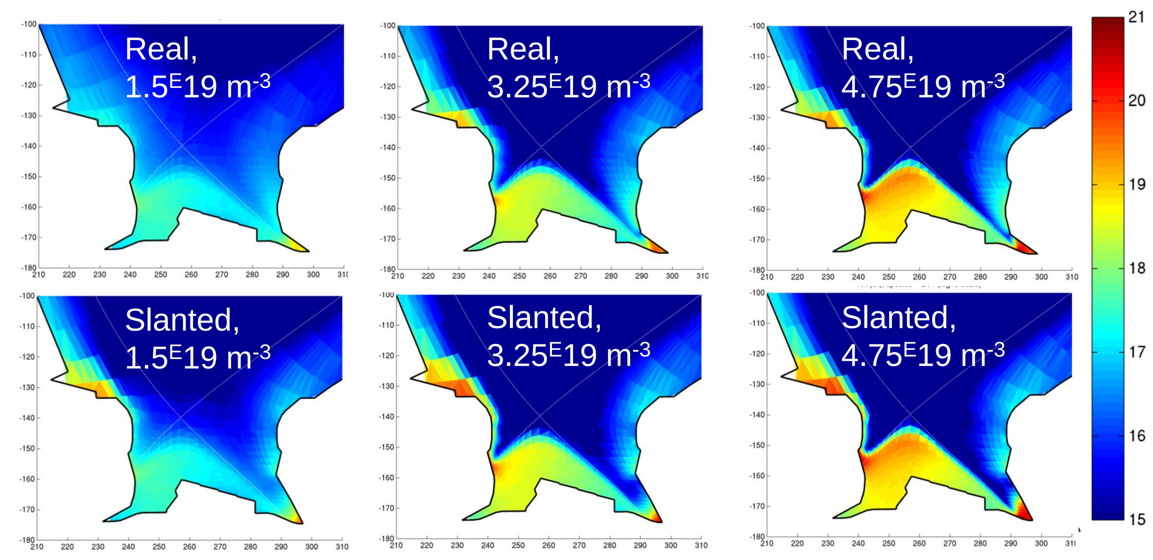
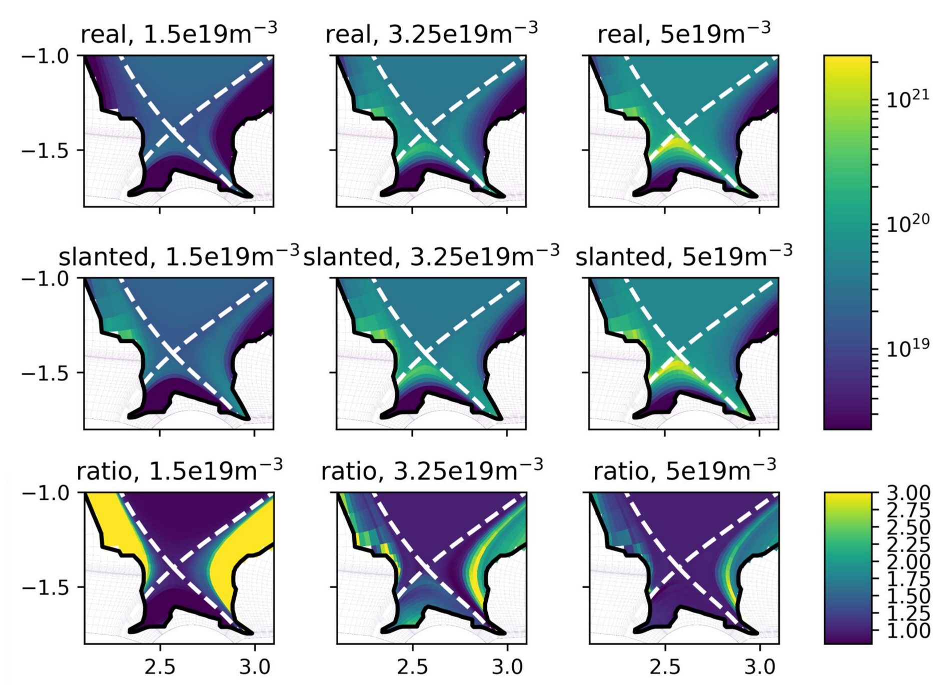


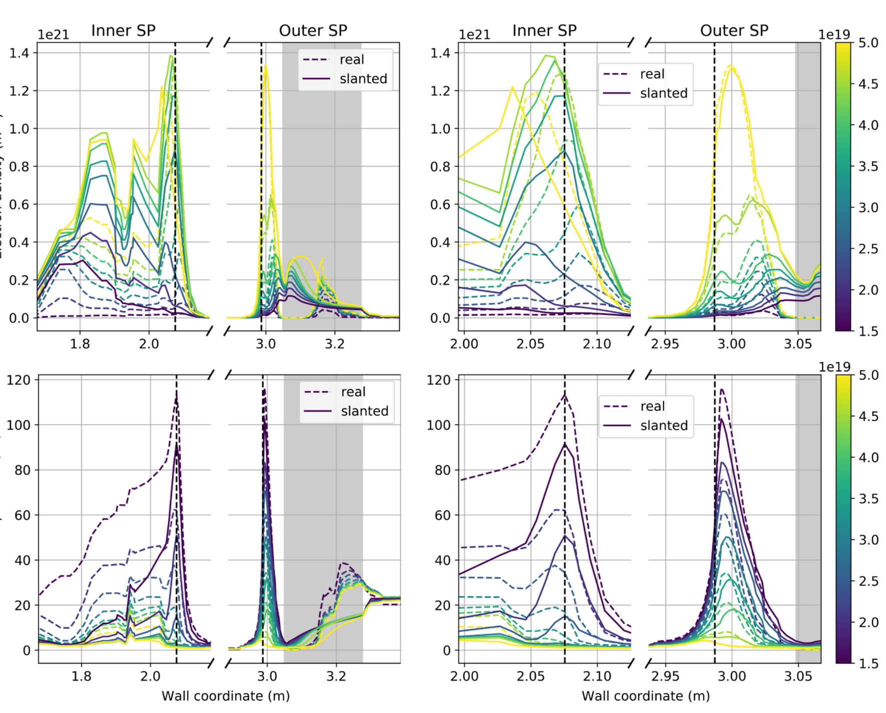

***Fig. 5:*** *neutral density ($log_{10}(m^{-3})$) in the divertor for 3 upstream densities. Top: real T7; bottom: slanted T7*




- Contrasted impact on electron density distribution (***Fig. 6***):
  - Relatively small in LFS near SOL
  - But slanted T7 leads to **much denser plasma (especially at low density) in far SOL and HFS target**

***Fig. 6:*** *electron density (in $m^{-3}$) in the divertor for 3 upstream densities. Top: real T7; middle: slanted T7; bottom: ratio slanted / real.*

## Impact on target conditions




- In-line with density evolution:
  - **Denser & cooler HFS strike-point** => earlier roll-over
  - LFS strike-point much less impacted
  - Difference **mainly at intermediate densities** (high-recycling)

***Fig. 7:*** *Density and electron temperature profiles at targets. Top: electron density; bottom: electron temperature; left: wide view; right: zoom around strike points. Vertical dashed lines = separatrix. Dashed lines = real T7, full lines = slanted T7. Color = upstream density $n_e^u$ ($m^{-3}$).*

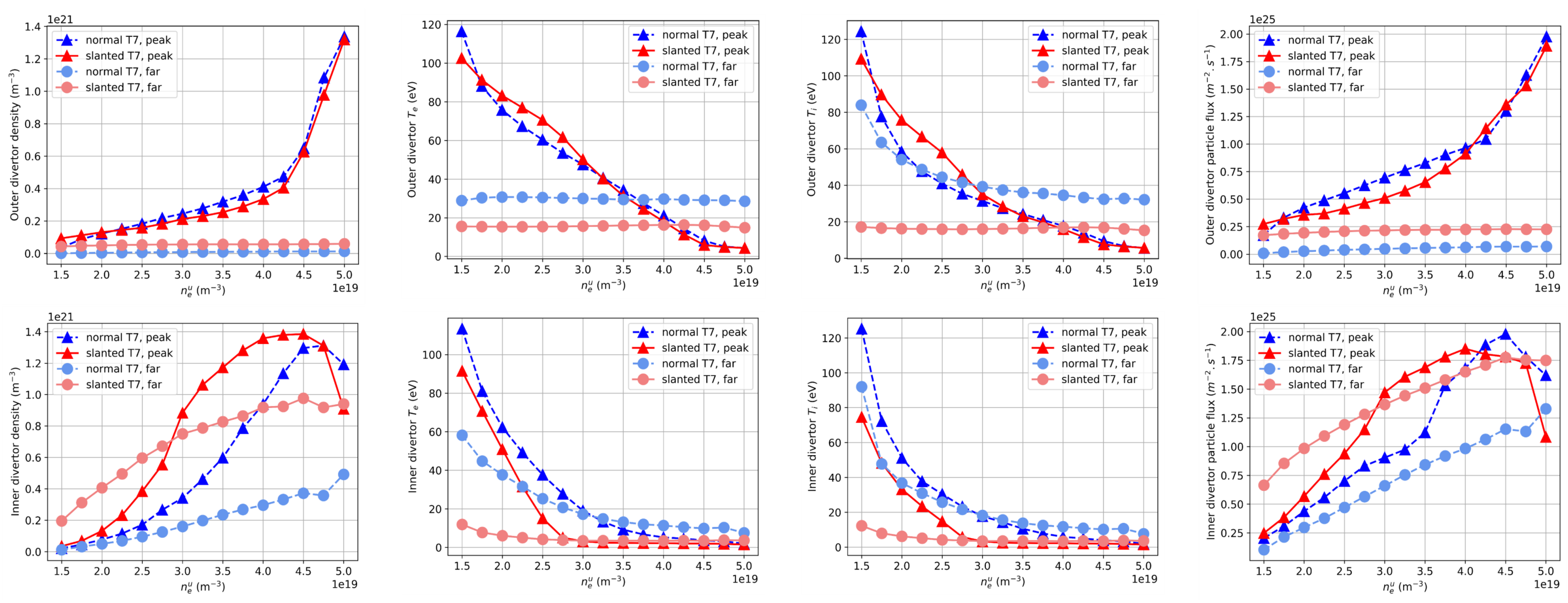



***Fig. 8:*** *Target conditions as a function of upstream density $n_e^u$. Top: outer divertor; bottom: inner divertor. Blue dashed lines = real T7, red full lines = slanted T7. Triangles = peak value at the strike point; circles = far SOL value .*

## Conclusions

- A minor modification of the target geometry in 2D mean-field simulations can lead to large differences in modelled edge plasma conditions
- In the case of JET corner configurations, strong impact on far SOL upstream profiles and **HFS target conditions**, less on LFS
- Highlights **sensitivity of edge plasma conditions to minor geometrical modifications** and need to model with **adapted numerical tools**

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