Background

- Total flux expansion (increasing Rt) in Super-X divertor is expected to reduce the detachment threshold and provide a wider detachment window.
- Modified 2pt. model prediction:
  \[ T^2_r \propto \frac{1}{R^2_t} \]
  where \( T^2_r \) is the transport relaxation time and \( R^2_t \) is the target ion current.
- Behavior confirmed by SOLPS in “box” divertor.
- Wider detachment window expected from diminished parallel heat flux in parallel poloidal incidence angle.

- Past density ramp experiments on TCV did not show expected benefits, despite 70% variation in \( R^2_t \).
- Recent SOLPS simulations of intermediate \( R^2_t \) cases largely reproduce these experiments.
  - \( R^2_t \) effect masked by difference in neutral trapping.
  - Simulations predict \( R^2_t \) effect recovered if
    1. Target poloidal incidence angle \( \beta \) matched.
    2. Gas baffles added.

Goal of present work

Guided by the SOLPS simulations of [8], revisit the role of total flux expansion in the newly upgraded, baffled TCV tokamak.

Rt scans, attached

Radial scan of outer target at constant density (250kA, Rev. B, attached).

2pt. model predicts:
- \( J_{\text{det}} \) profile depends on \( R^2_t \).
- Total target ion current to scale as \( R^2_t \).

\[ J_{\text{det}}(r) \propto r^{\beta} \]

- Peak \( J_{\text{det}} \) drops with \( R^2_t \) slightly less so with baffles.
- Total current increases only with baffles, but trend weaker than \( R^2_t \).
- HFS baffles and “no baffle” cases show same behavior (not shown).

Target profiles vs \( R^2_t \)

- \( J_{\text{det}} \) profile shape changes with \( R^2_t \) especially without baffles. Changing SOL transport?

- \( n^2 \) and \( t_f \) fairly independent of \( R^2_t \).

Detachment access

- Performed density ramps at different, fixed values of \( R^2_t \).
- Infer density threshold for detachment in two ways:
  1. Integrated, outer target ion flux at maximum.
  2. CIII emission front at 15 cm below X-point.

- Detachment threshold from LPs and CIII front very similar (except for the two non-baffled shots).
- Threshold reduced with baffles, especially for PFR fueling.
- For baffled shots, data better ordered by \( \beta \) than \( R^2_t \).
- A subset of shots with closely matched \( \beta \) for different \( R^2_t \); shows threshold reduction, but weaker than predicted.

Conclusions

- Guided by SOLPS simulations, the \( R^2_t \) effect on target profiles and detachment onset have been revisited in TCV L-mode, rev. B plasmas in attached conditions. \( J_{\text{det}} \) vs \( R^2_t \) does not follow the 2pt. model prediction; with baffles, agreement is better.
- Consistent with SOLPS and SOLEDGE-2D simulations, baffles and target angle \( \beta \) are found to influence the detachment threshold.
- With baffles and for constant \( \beta \), limited dataset suggests that \( R^2_t \) effect on detachment is partly recovered.
- Next: Extend dataset and pursue H-mode studies.


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[8] A. Fil et al., submit to PPCF
[10] Fasoli et al. et al., NP in press
[13] Galaisi et al., this conference

This work was supported in part by the Swiss National Science Foundation.