Contribution ID: **47** Type: **Poster**

Assessing the tightly baffled long-legged divertor (TBLLD) concept in TCV

Tuesday 28 October 2025 16:40 (1h 20m)

The TCV tokamak contributes to the development of nuclear fusion energy with proof-of-principle experiments and by validating models that are used to predict reactor performance. As part of the Swiss Roadmap for Research Infrastructures, the SPC is upgrading TCV to test a tightly baffled, long-legged divertor (TBLLD), a novel concept designed to enhance power exhaust capabilities with minimal modification to the magnetic configuration [1,2].
Simulations using the SOLPS-ITER code indicate that a TBLLD can improve TCV's power exhaust capability by an order of magnitude compared to the unbaffled configuration [2]. Tight baffling sustains a high poloidal neutral density gradient, thereby, increasing the neutral density in front of the divertor target and enhancing volumetric power dissipation. In addition to a lower detachment threshold, extended leg length and tight baffling provide a large detachment window and a mechanism for passive detachment front stability, respectively, promising a robust power exhaust solution. The neutral cushion, futhermore, provides a reservoir of potential energy that can temporarily buffer transient loads.
The simulations informed the design of a proof-of-principle TBLLD for the outer TCV divertor. A straight, vertical divertor design enables diagnostic access via TCV's reciprocating divertor probe array (RDPA), while maintaining engineering simplicity. Compatibility with neutral beam heated, high-power plasma scenarios constrains the baffled leg length to 0.34m. A trade-off between predicted plasma plugging and excessive recycling at the outer baffle yield a divertor width of 0.11m. The ability to expand the polodial flux along the divertor leg provides a means to vary both. The required gas tightness limits diagnostics access. Foreseen are poloidally distributed Langmuir probes, thermocouples, pressure gauges, and spectrometric lines of sight, to provide measurements of target fluxes, neutral density distribution, position and dynamics of the detachment front, which are critical to assess the TBLLD concept.
The main concerns for the proof-of-principle are the open inner divertor, which may limit the benefits of the closed outer divertor leg, and potential self-baffling of dense divertor plasmas. Recent SOLPS-ITER simulations also identified thermo-electric currents resulting from vastly different conditions in the inner and outer divertors as a potential project limitation. These concerns will be addressed through modelling and, ultimately, through experiments.
A dedicated experimental campaign with the proof-of-principle TBLLD is planned for 2026. Following a successful validation of the TBLLD concept, a second phase of upgrades will optimise the baffle geometry, extend the exhaust solution to the inner divertor, address particle exhaust, e.g. through pump ducts at the top of the TBLLD, similar to the mid-leg pumping proposed in [3], and integrate the plasma exhaust solution with an attractive core plasma scenario.
[1] M.V. Umansky, et al., Phys. Plasmas 24 (2017) 056112.
[2] G. Sun, et al., Nucl. Fusion 63 (2023) 096011.
[3] J. Yu, et al., Nucl. Mater. Energy 41 (2024) 101826.

Speaker's title

Mr

Speaker's Affiliation

Ecole Polytechnique Fédérale de Lausanne (EPFL), Swiss Plasma Center (SPC), Lausanne

Member State or IGO

Switzerland

Author: REIMERDES, Holger (Ecole Polytechnique Fédérale de Lausanne (EPFL), Swiss Plasma Center (SPC))

Co-authors: FÉVRIER, Olivier (Ecole Polytechnique Fédérale de Lausanne (EPFL), Swiss Plasma Center (SPC)); THEILER, Christian (Ecole Polytechnique Fédérale de Lausanne (EPFL), Swiss Plasma Center (SPC)); BROWN, Benjamin (Ecole Polytechnique Fédérale de Lausanne (EPFL), Swiss Plasma Center (SPC)); DUCKER, Richard (Ecole Polytechnique Fédérale de Lausanne (EPFL), Swiss Plasma Center (SPC)); DUVAL, Basil (Ecole Polytechnique Fédérale de Lausanne (EPFL), Swiss Plasma Center (SPC)); MYKYTCHUK, Dmytry (Ecole Polytechnique Fédérale de Lausanne (EPFL), Swiss Plasma Center (SPC)); SHEIKH, Umar (Ecole Polytechnique Fédérale de Lausanne (EPFL), Swiss Plasma Center (SPC)); SINTRE, Pierre (Ecole Polytechnique Fédérale de Lausanne (EPFL), Swiss Plasma Center (SPC)); TONELLO, Elena (Ecole Polytechnique Fédérale de Lausanne (EPFL), Swiss Plasma Center (SPC))

Presenter: REIMERDES, Holger (Ecole Polytechnique Fédérale de Lausanne (EPFL), Swiss Plasma Center (SPC))

Session Classification: Poster Session

Track Classification: Scrape-off-Layer and Divertor Physics