First Results From The New Baffled TCV Divertor

O. Février for the TCV team[a] and the EUROfusion MST1 team[b]

Ecole Polytechnique Fédérale de Lausanne (EPFL), Swiss Plasma Center (SPC),
CH-1015 Lausanne, Switzerland
[a] See author list of S. Coda et al 2019 Nucl. Fusion 59 112023
[b] See author list of B. Labit et al 2019 Nucl. Fusion 59 086020

olivier.fevrier@epfl.ch

The first experimental TCV campaign with a strongly baffled divertor confirms key design predictions and is extensively used to investigate the effect of divertor geometry on divertor performance. Today, the most promising solution to keep divertor heat fluxes in a fusion power plant within engineering limits is to operate in the detached divertor regime. This will require high divertor neutral pressures and the ability to prevent neutral gas from entering the main chamber and degrading core confinement. Gas baffles were recently installed on TCV [1] to study such closed divertors for a wide range of divertor configurations. Understanding divertor physics in this new configuration employs an extended suite of divertor diagnostics, providing two-dimensional measurements of kinetic, fluctuation, and spectroscopic quantities across TCV's divertor volume. In parallel, substantial upgrades of the ECRH and NBH systems access operation at higher heat flux levels and higher upstream separatrix pressures.

Following predictions from SOLPS-ITER and SOLEDGE2D-EIRENE simulations, TCV experiments with a strongly baffled divertor show higher divertor neutral pressures (up to 4x) and a typical reduction of ~30% in the core density required to access detachment in L-mode. In H-mode, the operational range for detachment studies is substantially increased, due to the increased divertor neutral pressure and a, surprising, substantial decrease in the L-H power threshold. Two-dimensional measurements across the divertor volume from a reciprocating probe array with 12 Mach probes reveal a ~30% reduction in upstream particle source prior to detachment and increased divertor ionization levels, demonstrating an increased "particle decoupling" between upstream and divertor plasma, ascribed to the baffles. The key role of divertor neutral pressure in determining the degree of detachment in these plasmas is demonstrated by comparing experiments with upstream and divertor fueling, both through the private and common flux regions. The baffles further reduce the differences in neutral trapping between different divertor geometries, simplifying their comparison and highlighting advantages of Super-X and X-Divertor configurations. In particular, it is observed that an increase of the poloidal flux expansion from 3 to 10 reduces the detachment density threshold by ~30%.

[1] A. Fasoli, et al, Nuclear Fusion 60, 016019 (2020)