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TCV Experiments towards the Development of a Plasma Exhaust Solution

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Present research towards a plasma exhaust solution for a fusion power plant aims at validating edge physics models to strengthen the predictive capabilities and improving the operating regime and the divertor configuration. The TCV tokamak is used in particular to investigate to what extent geometric modifications of the configuration can affect the plasma exhaust performance by decreasing the peak heat loads, improving the control of the detached condition and enhancing the compatibility of the divertor solution with core performance. Detachment experiments in TCV have so far been restricted to Ohmically heated L-mode plasmas. Recent TCV experiments connect to previous detachment studies using standard single-null configurations, where the onset of detachment is best observed at sufficiently high density when the direction of the magnetic field results in an ion grad B drift away from the X-point. The studies were extended to nitrogen seeding and to an entire suite of alternative magnetic configurations, including the variation of the poloidal flux expansion at the outer target, the introduction of flux flaring towards the target (X divertor), the movement of the secondary X-point inside the vessel (X-point target) as well as various snowflake configurations. The snowflake minus configuration has attracted particular interest as recent EMC3-Eirene simulations predict a large region of radiation between two X-points. In addition to the detachment characteristics the effect of the altered connection length and magnetic shear on turbulent transport is investigated. The recent experiments benefited from a range of improved diagnostic capabilities including a new divertor spectroscopy system, an upgraded infrared thermography system, an extended set of wall-mounted Langmuir probes and a newly installed reciprocating probe. Experiments in 2016 will also be able to take advantage of the newly installed neutral beam injection (NBI) heating system, which allows for auxiliary heating of high density plasmas and thereby for testing of potential solutions under higher heat fluxes and in regimes with a higher SOL pressure.

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