Overview of recent snowflake divertor studies in TCV

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This contribution describes the results of recent TCV experiments dedicated to the validation of the projected advantages of the snowflake (SF) divertor configuration. The SF configuration has been proposed as an alternative solution to the conventional single-null (SN) divertor to decrease the power flux to the divertor targets in a fusion reactor. Assuming only parallel transport from the outboard midplane, one can predict the power repartition between the four divertor legs for the three variations (SF+, LFS SF- and HFS SF-) of a SF divertor. However, as seen in L-mode [1] and even more clearly during ELMs in ELMy H-modes [2], the observed power repartition can only be explained with the additional contribution of anomalous cross-field transport in the null region [3]. A mechanism based on the $E \times B$ particle drift is proposed to contribute to this enhanced cross-field transport. This convective transport is predicted to be enhanced at larger values of plasma density and smaller $\sigma$ (normalized X-point separation), which is consistent with the experimental heat flux profiles at the targets. In addition, the statistical properties of the particle flux arriving at the divertor targets for all the variations of snowflake configurations have been analyzed. This particle flux, similarly to the radial SOL flux at the outboard midplane, has clear signatures of intermittency, which is barely affected when the plasma density is increased. Another predicted advantage of the SF configuration is based on its larger divertor volume, which should facilitate the conversion of particle energy into radiation and thereby access to detachment. Experiments were carried out to compare the plasma response to Neon impurity seeding, in Ohmically heated SF and SN configurations. For the same amount of injected Neon, the plasma in the SF configuration radiates approximately 15% more power than in a conventional configuration. With Neon seeding, the radiated power fraction could be increased up to 70%. The power flux due to the plasma at the strike points decreased, accordingly. In both investigated configurations the quantity of injected neon is limited by disruptions but, unlike in the case of the density limit, the disruption is preceded by a radiation instability. However, the Neon dosing was not sufficiently accurate to compare the maximum radiated fraction in the two configurations.

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