Contribution ID: **490** Type: **Poster**

EX/P5-22: Reduction of Peak Wall Power Loads in L- and H-mode Tokamak Plasmas in TCV with the Snowflake Divertor

Thursday, October 11, 2012 8:30 AM (4 hours)

This paper presents experimental evidence, obtained on the TCV tokamak, for the feasibility of using the snowflake (SF) divertor for lowering the steady-state and transient heat fluxes to the plasma facing components in both L- and H-mode tokamak plasmas. The SF, characterized by a second-order poloidal field null, features a hexagonal magnetic field structure in the null-region and hence four divertor legs. A systematic study of the physics behind the power redistribution towards the two secondary strike points (SPs) was made by gradually changing the configuration from a standard single null to the SF. The power reaching the strike points was measured with Langmuir probe arrays and fast framing infrared cameras. L-mode experiments were performed with Ohmic heating only, while H-mode experiments had up to 2 MW of ECRH. The parameter sigma, defined as the distance between the two X-points normalized to the plasma minor radius, characterizes the proximity to the ideal SF and was varied between 3 and 0.25, while retaining the main plasma shape. This scan showed that in L-mode most of the exhaust power reaches the primary SPs and that P_SP1 decreases linearly with decreasing sigma (by ~20% at sigma = 0.25). A significant part of the redistributed power reaches the secondary SP at the bottom of TCV (SP3). No significant power reaches SP3 at sigma >= 0.6 in both L- and H-mode. Upon decreasing sigma in H-mode, we observe a sharp drop in peak power to the primary strike point and a strong increase in power to SP3 at sigma <~ 0.6. The power to SP1 during the ELMs keeps dropping as sigma decreases, as in L-mode, while the peak P_SP3 remains approximately constant for the remainder of the scan. This behavior is in qualitative agreement with the model described in [1], which explains strong power redistribution during ELMs by strong convection in the null region, triggered by a high local poloidal beta. The validity of the model and its correspondence with the experimental data is studied. Measurements of the plasma properties at SP4 are in preparation. Further studies include the analysis of filament transport using coherently averaged images from a fast visible camera. Both radial movement of blobs and significant flux-tube squeezing were observed.

References

[1] D.D. Ryutov et al., APS DPP, Salt Lake City, JP9.00104 (2011)

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Session Classification: Poster: P5

Track Classification: EXD - Magnetic Confinement Experiments: Plasma–material interactions; divertors; limiters; scrape-off layer (SOL)