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The influence of Filaments in the Private Flux Region on Divertor Power and Particle Deposition

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Recent advances in imaging of the MAST divertor have revealed, for the first time, evidence for filaments in the private flux region (PFR). Detailed analysis of the image data shows 3 distinct types of fluctuations occurring within the divertor volume: highly sheared filaments in the SOL originating from the outer midplane, high frequency (>50kHz) filaments near the separatrix of the outer divertor leg and filaments in the private flux region originating from inner divertor leg. With the need to extrapolate divertor performance from existing machines to future devices, these observations can contribute to our quantitative understanding of transport in the PFR. In particular, they suggest that transport in the PFR is, at least in part, driven by turbulence, which may not be well captured by the Eich/Wagner description of the divertor footprint [1], expressed in terms of exponential decay in space above the X-point and Gaussian spreading below the X-point. The PFR filaments are observed to move largely parallel with the flux surfaces in a way equivalent to a toroidal angular velocity of order $2x10^4$ rad/s in H-mode, and slower by a factor of order 2 in L-mode. During their transit parallel to the flux surfaces across the PFR, the filaments eject plasma in bursts, away from the separatrix, deeper into the private flux region. Correlation analysis suggests that they are generated by processes local to the inner divertor leg, as there is a weak correlation between fluctuations in the SOL and PFR above what is expected from line integration effects. Scaling of filament properties with machine operating parameters, such as plasma current, density and auxiliary heating power will be presented, together with a comparison with data from divertor Langmuir probes and IR thermography to estimate the role PFR filaments play in determining the width of the divertor footprint.

[1] T. Eich et al., Phys. Rev. Lett. 107, 215001.