Blob size and velocity distributions in the ASDEX Upgrade scrape-off layer and their role in determing the density profile using gas puff imaging

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As the density of tokamak plasmas increases towards the density limit, a broadening of the density profile in the scrape-off layer (SOL) is seen, known as shoulder formation [1]. Rather than the expected exponential decay of the density profile, a double-exponential profile is seen with a short decay length close to the separatrix, and a longer decay length further away. The formation of the shoulder has been assumed to be due to a change in filament properties caused by changes in the divertor [2] that alter the conductive closure properties of the filaments. There is evidence to show changes to filament characteristics during the shoulder formation [3] which leads to increased amounts of particle and heat transport. Recent theoretical work has shown how time-averaging over the filaments that traverse the SOL can gives rise to the exponential nature of the profile [4].

A set of discharges was performed in ASDEX Upgrade to investigate the shoulder formation mechanism's dependence on auxiliary heating power in L-mode and H-mode discharges. Using the gas puff imaging diagnostic, blobs were tracked through the SOL, allowing measurements of not only the filament size and velocity distributions (in both the radial and poloidal directions) multiple positions in the SOL, but also direct measurements of the change in size and velocity as the filament traverses the SOL. 2D modelling, using the measured distributions as inputs to the theoretical framework, was performed and the time average of the results compared with the density profiles of the discharges, allowing information about the timescales that govern the parallel drainage of the filaments to be obtained. The modelling work also recovers the experimentally-measured relative increase of fluctation amplitude, and increase of skewness of the single-point probability distribution functions (which follow gamma distributions), with distance into the SOL, further increasing confidence in the validity of the modelling results.

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