Blob size and velocity distributions in the scrape-off layer during shoulder formation in ASDEX Upgrade 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.

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. The distributions of filament sizes and velocities were measured using gas puff imaging. The filament mean relative amplitudes increase by $\approx \times 3$ from the separatrix to the start of the far SOL ($\rho = 1.04$), correlating with an increase in skewness of the probability distribution functions of the fluctuations, which are shown to follow gamma distributions. The blobs are seen to have elliptical shapes with the means of their heights and widths increasing by $\approx 20\,\%$ over the same distance, with a broadening of the range of heights and widths seen too. Distributions of blob tilt angles with respect to the poloidal flux surfaces are also measured.

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