Characterisation of edge filamentary structures  
in the 3D geometry of Wendelstein 7-X limiter plasmas  
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In the first experimental campaign of the Wendelstein 7-X (W7-X) stellarator experiments were done in limiter configuration with Helium and Hydrogen fuelled plasmas with ECRH heating up to 4.3 MW. Five inboard graphite limiters were installed to act as main recycling and impurity sources. Observation with the tangentially viewing video diagnostics showed that the visible radiation of these limiter plasmas is concentrated in a narrow radial range around a magnetic flux surface which, depending on the plasma conditions, can be located either in the SOL or at the edge of the confined plasma. If the plasma light emission was intense enough (e.g. provoked by strong wall recycling or local gas puff), short exposure imaging (<200 µs) could be applied to visualize turbulent filamentary structures both in Helium and Hydrogen plasmas. The filaments follow field lines, have a few cm cross-field dimension, several meter B-parallel length and a few hundred µs lifetime. These structures rotate poloidally with velocities consistent with an E×B advection velocity corresponding to a radial electric field of about 5 kV/m, which is in agreement with neoclassical expectations. The filaments seem to be similar to SOL blobs seen in tokamaks and Wendelstein 7-AS stellarator but they can be observed on the whole poloidal circumference on a closed flux surface, too.

The magnetic field of W7-X stellarator was optimised to minimise the neoclassical loss channels. Due to the 3D geometry of the resulting magnetic field turbulence drive, and thus anomalous transport, might be different from axisymmetric tokamaks. Accordingly gyrokinetic simulations have revealed that turbulence is also expected to display peculiar properties in this device like the poloidal localisation (also susceptible to E×B advection) of fluctuation levels on a flux surface.

The combination of a careful treatment of the 3D viewing geometry of visible cameras and the local measurements from other edge diagnostics provides a unique possibility to characterise these turbulent structures in detail and confront the results with the prediction of simulations. These studies are presented in this contribution.