On the origin and creation of scrape-off layer filaments

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In magnetic confinement fusion, transport processes in the plasma edge region determine the power load onto first wall components. These power loads have to be controlled and minimized on the way towards a fusion power plant. Steady-state power flux into the scrape-off layer (SOL) determines the power fall-off length in the near SOL. As here plasma profile gradients are steep, turbulence can be driven locally by these gradients. In the far SOL, the gradients are flattened, so that the heat and particle flux to the first wall is carried by convective filaments. In future devices, big filaments might lead to a damage of wall structures by increasing the sputtering rate. Controlled and small filaments, however, might help to widen the wetted area in the divertor, and thus help to minimize the power load. A crucial point here is the filament amplitude, which connects to the region of filament creation. There is no common understanding of the origin of filaments [1], [2], which will help to find the underlying creation mechanism [2], [3]. With this knowledge, the appearance of filaments for future devices can be predicted, which allows to evaluate different plasma scenarios as possible future operational regimes.
To investigate turbulence driven filaments, the thermal helium beam plasma edge diagnostic at ASDEX Upgrade (AUG) is used [4]. It provides unique simultaneous measurements of electron temperature and density over a wide radial range. The diagnostic can resolve filaments in the SOL as well as high frequency modes, which are typical for the confined plasma region. This is demonstrated for the I-phase regime at AUG. We show how regular bursts (1-2 kHz) dominate the behavior around the separatrix. Stochastization in time, however, changes this picture completely from the near to the far SOL, which is dominated by intermittent filaments. These filaments will be characterized by amplitude, size, velocity and occurrence rate. We access the radial position of the origin of filaments, which is the focus of this contribution. Doing so we show how the filaments are related to the burst and how this connects to the conditions in the divertor region. These results for the I-phase will be compared to different plasma scenarios, comprising L- and H-mode, type-I ELMs, small ELMs and inter-ELM filaments.

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[2] B. Nold et al., *PoP* **21**, 102304 (2014)
[3] D. A. D'Ippolito et al., *PoP* **18**, 060501 (2011)
[4] M. Griener et al., *RSI* **89**, 10D102 (2018)

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