The quasi-continuous exhaust regime on ASDEX Upgrade and JET

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Developing regimes devoid of large ELMs which are compatible with metal walled operation is of paramount importance for the reliable operation of future fusion devices. The quasi-continuous exhaust regime (QCE) has now been established on AUG[1], JET[2] and TCV[3] and is emerging as a promising H-mode operational regime which combines high pedestal top pressure with exhaust-relevant high separatrix density.

This work presents results from the recent experimental campaigns on AUG and JET in the QCE regime. An overview of the pedestal top temperatures and density in the scenario at a range of plasma current and magnetic field will be presented. The normalised pedestal top pressure in QCE is similar to that in Type-I ELMy H-modes in otherwise similar plasmas.

A comparison of QCE plasmas with interpretive peeling-ballooning and predictive pedestal calculations will also be shown. The QCE exists over a wide range of normalised pressure gradient both close to and far away from the global peeling-ballooning boundary, allowing projections of best-case performance to be made for future devices, such as ITER. The pedestal top pressure for JET plasmas is also well-predicted by IPED and Europed, while the pedestal width is underestimated, as often observed in JET.

The understanding of the QCE as being driven by a separatrix localised ballooning mode is further underpinned by high values of the plasma beta at the separatrix in both machines. A model based on linear-MHD calculations of the onset threshold for this edge ballooning mode supports this hypothesis. When combined with an empirical collisional-broadening based scaling for edge gradients a critical separatrix density for QCE access can also be determined, in agreement with experiments on JET and AUG.

Projections of QCE access to ITER, DEMO, and SPARC are shown, indicating favourable access to this regime in each of these devices due to the highly shaped plasmas and high separatrix density required for power exhaust. These projections position the QCE as an excellent option for a reactor scenario, and motivate additional research into the optimisation of the regime for power exhaust and global confinement.

[1] M. Faitsch, et al. *Nuclear Fusion*, 63(7), 2023.

[2] M. Faitsch, et al. *Nuclear Fusion*, submitted.

[3] B Labit, et al. *Nuclear Fusion*, 59(8), 2019.