Power exhaust in high-performance plasmas in Wendelstein 7-X

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In the previous experimental campaign on Wendelstein 7-X (W7-X), a spontaneous but transient increase of global energy confinement time τ_E exceeding the empirical ISS04-scaling after injections of frozen hydrogen pellets was reported [1]. The highest volume averaged plasma β was also reached in such post-pellets phase with measured diamagnetic energy above 1 MJ. Strong density peaking leading to a reduction of the turbulence was considered as the main reason for such transition to high-performance plasmas.

In this study, power exhaust in this high-performance phase will be reported. Preliminary analysis shows a clear correlation between the evolution of the divertor heat distributions and the transition to the high-performance phase. A clear second strike line was found on the horizontal divertor plate at the outboard side connecting to the outer leg of the enlarged magnetic island due to the higher β. A narrower main strike line was also observed in the high-performance phase, which might be attributed to two effects: 1) decreased connection length at the main heat channel with higher β, and 2) similar to tokamaks, a narrower power decay length caused by the higher confinement. A careful comparison with numerical simulations using experimental equilibrium and different perpendicular heat transport coefficients [2] could in principle disentangle the above two effects, and quantify the heat transport during the high-performance phase.

Furthermore, strong transient heat and particle flows at the degradation of the high-performance phase are measured from various edge diagnostics and will be reported in this study. Potential influence of the mitigation of turbulence on the edge transports will also be discussed. This study would be essential not only as a first understanding of the heat transport at the edge during the high-performance plasmas, but also for the preparation for the next W7-X campaign to prolong the high-performance phase with reliable power exhaust solutions.

References

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