## Density control with the water-cooled divertor in Wendelstein 7-X stellarator

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The installation of a water-cooled divertor in the optimized modular stellarator Wendelstein 7-X (W7X) marks a milestone for the project, as it allows the further exploitation of the inherent steady-state properties of the stellarator also with respect to plasma-wall-interaction.

Among other effects, the full PFC cooling leads to equilibration of the internal divertor temperature profiles which has a profound effect on the divertor outgassing and the gas balance. During operation with the inertially cooled divertor [0], long pulses could only be achieved with a step-wise approach, conditioning the divertor for longer pulses [1]. With the new water-cooled divertor this conditioning is not required anymore, and thermal equilibrium of the divertor plates establishes within the plasma pulse. Contrary to the observation of fading gas fueling and final loss of density control as observed with an inertially cooled divertor, stable fueling and exhaust and full density control is observed in attached plasmas with the water-cooled divertor target plates.

We present a comparison of the discussed scenarios and provide an explanation for the differences. An illustration of the scenarios is shown in figure 1 below.



**Figure 1**: (left) 100s plasma (XP\_20181017.19) with the previous, inertially cooled divertor plates. A density increase starting at 80s can be observed. (right) 500s plasma (XP\_20230215.32) with water-cooled divertor. The density is perfectly controlled and follows the setpoint by non-diminishing gas puffs. Images courtesy of A. v. Stechow.

## References

[0] T. Klinger et al, NF2019 (DOI 10.1088/1741-4326/ab03a7)

[1] G. Schlisio et al, NF2021 (DOI 10.1088/1741-4326/abd63f)