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Strategy and optimisation of wall conditioning at the Wendelstein 7-X stellarator

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Wall conditioning in fusion devices is prerequisite to provide controlled boundary conditions for operation and to achieve high performance plasmas. Major issues are to achieve low outgassing, low particle recycling and a low impurity level. Implementation and optimisation of a systematic wall conditioning strategy was a major issue during the second operation campaign at the superconducting Wendelstein 7-X stellarator. W7-X was equipped with a graphite divertor and a first wall of stainless steel and graphite surfaces.
Initial conditions for the campaign were provided by baking at 150℃ which removed water and higher hydrocarbons. Intense hydrogen glow discharge cleaning (GDC) reduced residual impurities, such as CO and CH4. Final He-GDC removed hydrogen from the surfaces. Generally, the length of He-GDC was minimised to reduce sputtering at metal surfaces and redistribution of sputtered material.
Since the magnetic field is continuously activated GDC cannot be applied between plasma discharges but only before and after the experiment time of a day when the field is deactivated. Instead, microwave based methods using ECRH are used and continuously optimized for conditioning between plasma discharges. This comprises pulse trains of intermittent short ECRH discharges with pumping intervals as well as single ECRH discharges at low density, both being operated in He. Following this strategy stationary plasma discharges have been achieved lasting for example 25 s at 3 MW heating power and constant density of 3 10^19 m^-3. The pulse length was only limited by the admitted heating energy.
The progress of wall conditioning was monitored throughout the campaign by the normalized outgassing after plasma discharges. It decreased with cumulated discharge time by two orders of magnitude. In the next campaign boronisation will be available which is expected to further reduce the impurity level and particle recycling.

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