# Status and high power performance of the 10-MW 140-GHz ECH system for the stellarator W7-X

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During the last years, electron cyclotron heating (ECH) was proven to be one of the most attractive heating schemes for stellarators because it provides net-current-free plasma start-up and heating. Both the stellarator Wendelstein 7-X (W7-X), which is under construction at the Max-Planck-Institut für Plasmaphysik, Greifswald, Germany, and the ITER tokamak, which will be built in Cadarache, France, will be equipped with strong ECH and current-drive systems. Both systems are comparable in frequency and have continuous-wave (CW) capability (140 GHz, 10 MW for W7-X and 170 GHz, 24 MW for ITER).
The heating- and current drive scenarios, which support W7-X operation at various magnetic fields and in different density regimes are reviewed. The ECH plant consists of ten mm-wave modules with 1 MW power each. The commissioning of the entire ECH-installation is in an advanced state and the status will be presented. All supporting systems like the superconducting-magnets, the water cooling plant, the cryogenic plant, the main power supply and all high-voltage modulators are completed and operating.
The ten gyrotrons at W7-X will be arranged in two subgroups symmetrically to a central beam duct in the ECH hall. The RF beams of each subgroup will be combined and transmitted by a purely optical multi-beam waveguide transmission line from the gyrotrons to the torus. The combination of five 1 MW gyrotron beams to one beam line with a power of 5 MW reduces the complexity of the system considerably. Cold tests of a full-size un-cooled prototype line delivered an efficiency exceeding 90%. The mm-wave power will be launched to the plasma through ten synthetic diamond barrier windows and in-vessel quasi-optical plug-in launchers, allowing each 1-MW mm-wave beam to be steered independently. The polarization, as well as the poloidal and toroidal launch angles, will be adjusted individually to provide optimum conditions for different heating and current-drive scenarios. Integrated high power CW tests of the full transmission system (except the in vessel components) were performed recently and are compared to the low power measurements. The work presently concentrates on the acceptance tests of the gyrotrons, on the front end of the transmission system near the W7-X torus and on the in-vessel components.