Microwave Diagnostic on W7-X

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At W7-X, the world largest superconducting stellarator with a five-fold symmetry and reduced neoclassical transport, a broad suite of microwave diagnostics is installed and operated. Due to the robustness of in-vessel components and transmission lines against the harsh environment in fusion devices, they are candidates for reactor plasma control.

This presentation will show an overview of microwave diagnostics at W7-X. After introducing the governing equations for the propagation of microwaves in a fusion plasma e.g. the determination of the local positions where the measurements are performed, the different diagnostics are presented. The presentation will encompass the installed diagnostics, but also, the planned upgrades and show important technical details and highlighting results obtained during the last campaigns. It will cover passive microwave diagnostics for the estimation of the electron temperature profile by radiometry from the 2^{nd} harmonic of the electron cyclotron emission (ECE) with a temporal resolution in the MHz-range. Furthermore, the 1^{st} – 3^{rd} ECE radiation is measured with interferometry for both polarization directions. Also fluctuations of the electron temperature are measured by various methods of correlation ECE. Active probing radar applications, so-called reflectometry, are installed to measure density fluctuations and its propagation. They allow to measure the turbulence propagation for a wide wavenumber range. Under certain assumptions the radial electric field, an important quantity for the neoclassical transport is deduced. To measure the electron density profile in the edge a frequency modulated continuous wave reflectometer is installed in the Ion Cyclotron Resonance Heating (ICRH)-antenna, with the aim to improve the coupling of the ICRH-waves into the plasma and which allows, beside the ICRH operation, the measurement of the density profile in the edge with high spatial and temporal resolution. Furthermore, a microwave scattering diagnostic, the collective Thomson Scattering, uses a gyrotron as active probing beam to measure the ion temperature in the plasma center. The measurement yields a direct information of the ion temperature of hydrogen or deuterium species and does not rely on the impurity temperature.