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Application of the ECRH radiation for plasma diagnosis in Wendelstein 7-X

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W7-X is an optimized stellarator with n=5 toroidal symmetry. It is designed to produce high performance steady-state plasmas. The main heating mechanism is ECRH, which is capable of delivering continuously up to 5 MW with six gyrotrons at 140 GHz and in the next campaign the total power of the ECRH set-up will be increased to 9 MW and 10 gyrotrons. Such a powerful source of microwaves can also be used for diagnostic purposes.

Investigation of the ECRH assisted plasma start-up is vital for large fusion devices, such as Wendelstein 7-X, ITER, and possibly DEMO. Here we present a systematic approach to the ECRH start-up studies in W7-X using stray radiation diagnostics.

W7-X is equipped with five absolutely calibrated sniffer probes distributed toroidally. They measure stray radiation which originates from unabsorbed microwaves used for heating. Temporal evolution of the sniffer probe signals is analyzed qualitatively and quantitatively. Quantitative inference of the first-pass plasma absorption is done by means of forward modeling using the multiresonator model applied to the actual W7-X geometry. The inference allows temporally resolved measurements of plasma absorption with good resolution, i.e. plasma startup and shutdown. It also makes possible to distinct between X-mode absorption and O-mode microwave absorption.

Collective Thomson scattering (CTS) is presently being designed for the W7-X stellarator. The goal of the system is to routinely diagnose temporally resolved ion temperature in the next experimental campaign. CTS has already proved to provide accurate Ti measurements in ASEX Upgrade and TEXTOR. The diagnostic is relevant to future machines with high plasma density and, therefore, poor beam penetration which limits the use of charge exchange spectroscopy. The system is intended to use 140 GHz heating gyrotron as a source. The receiver part of the transmission line will share the quasi-optical transmission line with the heating system, which makes the shielding of the receiver from stray radiation challenging. An extra section of the transmission line in combination with a movable shutter mirror will be installed in quasi-optical transmission line in order to facilitate the receiver beam transmission from the additional measurement location.

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