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Experiments with reduced single pass absorption at ASDEX Upgrade – instrumentation and applications

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The electron cyclotron resonance heating system (ECRH) at ASDEX Upgrade (AUG) has been extended to eight similar Gyrotrons in total. Each Gyrotron operates at 105 and 140 GHz and is designed for up to 1 MW millimetre wave output power. Experimental topics include conditions with high plasma densities [1], potentially above the X-2 cut-off at 140 GHz. New ECRH heating schemes have been proposed [2] which can cope with the demand, at the cost of reduced single pass absorption, however. In order to routinely use the schemes it was necessary to design reflecting gratings, which significantly increase the second-pass absorption, and install them into the heat shield of AUG's inner column [3]. Four of these gratings consist of tungsten coated graphite, which is a composition of materials, established at AUG for a long time. The other four were manufactured out of P92 steel and a thin tungsten coating was applied, which is a newly developed technique. On the grating surface of the P92 steel, the coating reduces the ohmic reflection losses significantly. For beam position control, all gratings are equipped with thermocouple measurements. The fast response of the thermocouples together with the localized measurement opens the possibility to monitor the beam shape after the first pass through the plasma. For a full beam cross section, however, a large number of plasma experiments is necessary, mainly because of the limited capability to sweep the beam across the measurement position in 2D during the flat-top time of the plasma discharge. Thermocouple measurements have also been used in experiments, which try to quantify the X-3 absorption. This technique relies on the thermal response to a millimetre wave beam in the empty vessel, compared to the thermal response to a partly absorbed beam. Possibilities and limitations of the technique are to be discussed.

References:

[1] P. T. LANG, et al., Nucl. Fusion 59, 026003 (2019)
[2] H. HÖHNLE, et al., Nucl. Fusion 51, 083013 (2011)
[3] M. SCHUBERT, et al., EPJ Web Conf 203, 02009 (2019)

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