Modelling of dual-frequency ICRF heating in ASDEX Upgrade discharges relevant to the ITER baseline scenario

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The baseline scenario is one of the basic operational scenarios foreseen for ITER. It is envisaged to deliver fusion power of 500 MW and fusion gain Q~10 using ELMy H-mode discharges at I_p=15 MA, B_T = 5.3 T, normalized plasma pressure β_N = 1.8 and normalized confinement H_{98y2} = 1 with a safety factor q_{95} = 3 [1]. Experiments on present-day devices can provide important insights in preparing ITER operation. In our earlier works [2-3], we explored, both experimentally and with modelling, the viability of pure wave heating to simulate heating by fusion-born alpha particles in ITER baseline relevant plasmas on ASDEX Upgrade (AUG). We concluded that, instead of standard hydrogen (H) minority ICRF heating, central second harmonic ICRF heating of H minority in combination of ECRF heating would lead to improved core electron heating [3].

As a next step, we recently conducted AUG deuterium discharges where central second harmonic H minority heating was applied alone and in combination of off-axis H minority heating and compared with pure off-axis H minority heating. The ICRH was complemented by ECRF heating and in some cases with low-power D NBI. In this paper, we report on the modelling of these discharges using the ICRF code PION [4] which we have upgraded to allow multiple frequencies simultaneously as in [5]. NBI depositions are modelled with the RABBIT code [6], and are taken into account in PION to include NBI+ICRF synergy.

Our modelling shows improved central ICRF power deposition with second harmonic H minority heating and dual-frequency ICRF operation as compared with off-axis H minority heating. As postulated in [3], wWe also observe a moderate increase in total core electron heating in the core region for both heating schemes using second 2nd harmonic H resonance, in line with the theoretical predictions [3]. As a result, these new ICRF schemes position themselves as good candidates for future studies of ITER baseline like scenarios at low collisionality on ASDEX Upgrade.

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