Exploring Fusion-Reactor Physics with High-Power Electron-Cyclotron-Resonance Heating (ECRH) on ASDEX Upgrade

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[4] *See: H. Meyer et al., Nuclear Fusion FEC 2016 Special Issue (2017)*

The ECRH system of ASDEX Upgrade has been upgraded over the last 15 years from a 2 MW, 2 s, 140 GHz system to an 8 MW, 10 s, dual frequency system (105/140 GHz). The power exceeds the L/H power threshold at least by a factor of two even for high densities and roughly equals the installed ICRF power. The power of both RF heating systems together (> 10 MW in the plasma) is about half of the available NBI power, allowing significant variations of torque input, shape of the heating profile and Q_e/Q_i even at high heating power. For applications at low magnetic field an X3 heating scheme is routinely in use as it is now foreseen also for ITER to study the first H-modes at one third of the full field.

This versatile system allows addressing important issues fundamental to a fusion reactor: H-mode operation with dominant electron heating, accessing low collisionalities in full metal devices (also related to ELM suppression with resonant magnetic perturbations), influence of T_e/T_i and rotational shear on transport, dependence of impurity accumulation on heating profiles. Experiments on all these subjects have been carried out over the last years and will be presented in this contribution. The adjustable localized current drive capability of ECRH allows dedicated variations of the shape of the q-profile and studying their influence on non-inductive tokamak operation (so far at $q_{95} > 5.3$). The ultimate goal of these experiments is to use the experimental findings to refine theoretical models such that they allow a reliable design of operational schemes for reactor size devices. In this context, recent results comparing a quasi-linear approach (TGLF [1]) with fully non-linear modelling (GENE) of non-inductive high beta plasmas will be presented.

[1] Staebler G.M. et al., 2016 Phys. Plasmas 23 062518