Experiments with acceleration of neutral beam ions using third harmonic ion cyclotron resonance heating on ASDEX Upgrade

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Among the key plasma physics issues to be studied in ITER is the confinement of 3.5 MeV fusion born alpha particles and the resulting plasma self-heating. Many aspects of alpha particle physics and their diagnosis can already be investigated on present day tokamaks. This is possible thanks to fast ion populations that can be generated and controlled by external means, e.g. via neutral beam injection (NBI) or through resonant interaction with waves in the ion cyclotron range of frequencies (ICRF). In the present work, we report on experiments with controlled simultaneous variations of the confined and the non-confined parts of the ICRF-driven fast deuterium (D) distribution using third harmonic ICRF heating of D NBI ions on ASDEX Upgrade (AUG). The experiments extend our earlier work with this ICRF+NBI scheme on AUG at a magnetic field B_T of ~1.8 T [1] to more robust plasmas with central ECRF heating at $B_T \approx 2.5$ T which has recently become possible given the significantly expanded ICRF frequency range [2]. Controlled variations of the fast D distribution were demonstrated with several physical parameters such as NBI, ICRF power, the background electron temperature, and ICRF resonance location, in line with theoretical predictions. Information on fast deuteron populations was obtained with an array of diagnostics including neutral particle analysers, fast ion loss detectors, neutron diagnostics and ion cyclotron emission (ICE) probe in the energy range of several tens of keVs to MeVs relevant for fusion-born alpha particles. Highlights of the experimental results are presented, and their comparisons with modelling discussed together with plans for future applications.

[1] M.J. Mantsinen et al., 43rd EPS Conference on Plasma Physics, Leuven, Belgium, 2016, P1.035
[2] Vl. Bobkov et al., RFPPC 2019.