Further acceleration of beam ions by 2\textsuperscript{nd} harmonic ion cyclotron heating in ASDEX Upgrade

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The coupling of radio waves to suprathermal ions is an important physics aspect for future fusion devices. In ITER, 2\textsuperscript{nd} harmonic ion cyclotron resonance heating of tritium is one of the foreseen ICRF schemes, along with He-3 minority heating. The 2\textsuperscript{nd} harmonic heating has the benefit, that it can accelerate the main ion species directly, however it is only possible for ions with large Larmor radii (with respect to the RF wave length). The resonant wave absorption results in a non-Maxwellian distribution of fast ions, which heats the bulk plasma by collisions. It is therefore crucial to understand these fast-ion distributions, to know their transport behavior and ensure their confinement.

The tokamak ASDEX Upgrade has a large set of fast ion diagnostics and is therefore very well equipped for fast-ion studies. The 2\textsuperscript{nd} harmonic heating can be studied with 5 MW of ICRF, which is normally used for H minority heating, and hence is resonant with D ions at the 2\textsuperscript{nd} harmonic. The D beam ions (i.e. from 60 keV NBI) have large enough Larmor radii for effective 2\textsuperscript{nd} harmonic absorption.

The fast-ion radial density profile can be measured with the fast-ion D-alpha (FIDA) diagnostic. It has been upgraded recently to five FIDA views, which allows to reconstruct the distribution in 2D velocity space. With neutral particle analyzers, the H and D energy spectra can be measured separately. Neutron measurements are very sensitive to fast D ions because of resulting D-D fusion reactions and hence are a valuable tool for estimating the high energetic D ion distribution.

While the effect of 2\textsuperscript{nd} harmonic heating can be observed directly in each of these diagnostics, we have carried out a quantitative comparison between these diagnostics and towards theoretical predictions by TORIC/SSFPQL and TORIC/TRANSP. The results of these studies will be presented.