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Quantification of Neutral Beam Driven Current and the effect of radial fast ion transport in ASDEX Upgrade

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The neutral beam (NB) driven current, like the other intrinsic and driven current contributions to the total plasma current, is not directly measurable. Therefore, two strategies are used to investigate neutral beam current drive (NBCD). First, for quantitative investigations of the total NB driven current the measured total plasma current is compared with the sum of the calculated contributions. Second, changes in the measured plasma current profile due to changes in the neutral beam injection are examined.

An issue for the quantitative approach is the large uncertainty in the reconstruction of the inductive current. This hampers quantitative conclusions on the current composition. Therefore, quantitative investigations of the non-inductive contributions were done in discharges with maximized neutral beam driven and bootstrap current fraction, leading to an almost vanishing inductive current. A pressure-measurement based correction of the fast ion content, confirmed independently by fast-ion Dα measurements, together with the improved bootstrap current formula of Hager et al. [1] leads to a quantitative decomposition of the plasma current that is consistent with the estimates of the small inductive contribution.

The investigation of the reaction of the total plasma current profile to switching between on- and off-axis neutral beams aimed at revisiting a contradiction that had been found earlier: while the radial profiles of the fast NB ions seemed to behave neoclassically, the current profile appeared to deviate from the neoclassical expectations. In the new discharges the radial fast ion distribution and the radial current profile were measured simultaneously. After improvements to the diagnostics and TRANSP modeling, both diagnostics are now in agreement with each other and the small deviations from the neoclassical theory are of the order of radial transport expected due to microturbulence. Furthermore, reexamination of the old experiments yields results consistent with the new experiments.

[1] R. Hager et al., Physics of Plasmas 23,4, (2016)

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