Fast-ion transport in advanced tokamak scenarios with qmin close to two at ASDEX Upgrade

B. Geiger[1], R. Akers[2], A. Bock[1], M. Dunne[1], L. Giannone[1], J. Hobirk[1], A.S. Jacobsen[1], P. Lauber[1], P. Zs. Pölöskei[1], M. Salewski[3], P. A. Schneider[1], A. Snicker[4], A.J. van Vuuren[1], M. Willensdorfer[1] and the ASDEX Upgrade Team

[1] *MPI für Plasmaphysik, D-85748 Garching, Germany*

[2] *CCFE, Culham Science Centre, Abingdon, Oxon, United Kindom*

[3] *PPFE, Department of Physics, DTU, DK-2800 Kgs. Lyngby, Denmark*

[4] *Department of Applied Physics, Aalto University, FI-00076 AALTO, Finland*

Steady state operation of tokamaks is demanding since the toroidal plasma current needs to be sustained by non-inductive means [1]. Although external current drive sources are available, their extensive use would yield an unacceptably high recirculated power fraction in future fusion power plants. Thus, advanced tokamak scenarios are needed that feature high fractions of the intrinsic bootstrap current. The latter can be maximized in discharges with off-axis current distributions (low central poloidal fields) and internal transport barriers (strong gradients). Such discharge conditions are, however, difficult to maintain since they are prone to impurity accumulation [2] and ideal modes [3].

Recently, a stable advanced scenario with a current hole [4] in the plasma center and internal transport barriers in the electron and ion temperature channels was maintained for several confinement times in ASDEX Upgrade. The discharges are almost non-inductive even though counter electron cyclotron current drive (ECCD) was used for current-profile tailoring in the plasma center. However, the high plasma pressure and the exotic safety factor profile (qmin close to two) yield a variety of magneto-hydrodynamic modes that might reduce the confinement of suprathermal particles. The corresponding fast-particle transport will be discussed together with the analysis of the stability and performance of the new discharge scenario. This involves detailed diagnostic measurements and their interpretation, as well as modelling results of the thermal and fast-ion transport.

References

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