Studies of Electron Transport and Current Diffusion in Switched ECCD experiments on TCV

C. Zucca, S. Alberti, R. Behn, S. Cirant [1], E. Fable, F. Gandini [1], T. P. Goodman, O. Sauter

Centre de Recherches en Physique des Plasmas, Association EURATOM – Confédération Suisse, EPFL, Station 13, CH – 1015, Lausanne, Switzerland
[1] *Istituto di Fisica del Plasma, EURATOM – ENEA – CNR Association, Milano, Italy*

The electron temperature behaviour and transport modelling of plasma discharges have been widely investigated in the Tokamak à Configuration Variable (TCV). Recently, steady-state improved electron energy confinement in the core has been related, with clear experimental arguments, to non-monotonic safety factor profiles [1].

The current density profile is generally regarded as a key element which can strongly affect plasma turbulence and it is thus useful to design dedicated experiments, specifically suitable for transport studies, solely based on the current profile modification. L-mode experiments with modulation of Electron Cyclotron Current Drive (ECCD) at constant total input power have been performed at TCV [2], with the purpose to decouple the contributions of specific heating oscillations from those of the current tailoring. Indeed, in these Switched ECCD (SECCD) discharges, co- and counter-ECCD, peaked slightly off-axis, are alternatively injected in the plasma at a constant modulation frequency, maintaining the same absolute value of total driven current and the same power deposition profile. The central electron temperature is clearly seen to be modulated in the experiments, in agreement with the expected modulation of the confinement properties due to the SECCD driven modulation of the magnetic shear.

The ASTRA transport code [3] can be used as a reliable tool for 1-1/2 D transport analysis. The modelling is based on the coupling of the predictive/interpretative ASTRA simulations with the experimental data and the quasi-linear CQL3D Fokker-Planck code for the computation of the ECH and ECCD sources. Radial particle diffusion is taken into account as proportional to the electron heat diffusion and a 2D fixed boundary equilibrium solver is employed. Such theoretical investigations of the SECCD regime are clearly motivated by the need of a detailed reconstruction of the current density profile during the modulation phase, since no direct measurement of the safety factor profile is possible at TCV.

The reconstructed magnetic shear profile increases by at least a factor of 2 around the deposition location, when passing from the experimentally observed higher confinement co-ECCD to the lower confinement counter-ECCD phase. A similar variation of the local parallel electric field is obtained at a location just outside the deposition radius: the main change occurs during the first 20 ms following the imposed flip in ECCD sign.

Comparisons with the experimental measurements as well as discussions of the transport simulations and the current profile evolution will be presented.

This work is supported in part by the Swiss National Science Foundation.

References :

[1] O. Sauter *et al.*, *Phys. Rev. Lett.* **94**, 105002 (2005)
[2] S. Cirant *el al.*, *"Shear modulation experiments with ECCD on TCV"*, *Proc. 20th Int. Conf. on Fusion Energy*, Vilamoura (2004), Vienna, IAEA, CD-ROM file EX/P6-12.
[3] G.V. Pereverzev *et al.*, Max Planck – IPP Report, IPP **5/42** (1991)