Plasma rotation and low-Z impurity transport across sawteeth in TCV

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The local particle and heat transport increase across sawteeth (ST) crashes in a tokamak plasma is well documented. Although plasma momentum transport, often estimated from radially resolved plasma rotation, is often modelled as a continuous process that depends on the plasma parameters and their gradients, MHD has long been shown to strongly affect TCV's experimental profile, and that in many other machines. For similar conditions (plasma shape density and temperature) the rotation profile gradient outside the ST-mixing radius was seen to be reasonably constant whereas the average profile is flattened inside, with what appeared to be a co-plasma current core-weighted additional component, and this for a wide range of plasma currents. In the experiments reported in this paper, the natural ST period (~2ms) was lengthened by precision X2 ECCD deposition close to the q=1 surface stabilising the ST to obtain regular ST periods in the range of 8-40ms. A diagnostic neutral beam system based CXRS system measured the Carbon intrinsic impurity rotation profiles, in the absence of a perturbing external torque, with a 2ms temporal resolution. Acquisition was synchronised to the ST crashes where conditional resampling was then particularly appropriate to decrease the measured rotation profile uncertainties. The ST event was found to reset the rotation profile to similar values independently of the ST period with the whole rotation profile then increasing at similar rates after each crash so that the pre-ST profile peaks with increasing ST period. The behaviour of the ion temperature and Carbon impurity density measured during the ST crash is also presented showing that this low-Z impurity is preferentially evacuated from the plasma core, compared to the Deuterium working gas. Together, these measurements underline how a description and prediction of plasma rotation and impurity transport must include the effect of ST and, most probably, all other strong MHD activity.

a See the author list of S. Coda et al, 2017 Nucl. Fusion 57 102011