Impurity density and momentum transport during the sawtooth cycle

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Previous works [1, 2] showed that the core intrinsic rotation profiles on TCV are flat, or slightly bulged in the co-current direction, while the gradients outside the q=1 surface are relatively constant for a widespread range of currents. This led to the reported scaling of the maximum toroidal rotation and strongly suggests that the profiles flattening is an effect due to the sawtooth activity, but the limited diagnostic temporal resolution prevented a detailed analysis. This work is devoted to the experimental determination of Carbon impurity density and toroidal angular momentum evolution across the sawteeth events where the time resolution of the Charge Exchange Recombination Spectroscopy (CXRS) diagnostic in TCV reached $1.8 \div 2$ ms, preserving a high spatial resolution of $\approx 1$ cm, corresponding to $\Delta \rho = 0.03 \div 0.05$. To overcome the low photon statistics, caused by the short integration time, conditionally resampling measurements were employed, either utilizing a Real Time (RT) triggering activated by the sawtooth crash or a sawteeth locking/pacing technique, and led to the determination of the properties of an averaged (canonical) sawtooth. ECRH near the q=1 flux surface was used to lengthen the sawtooth period to $\geq 20$ ms, so that every phase in the sawtooth cycle evolution was clearly resolved.

Data show a fast ($\ll 2$ ms) co-current acceleration at the sawtooth crash in the core region, inside the inversion radius $\rho_{inv}$, with a simultaneous counter-current acceleration outside $\rho_{inv}$, as observed in a previous work [2]. Profiles then slowly relax to the pre-crash values, with an evolution of the total angular momentum explainable by a counter-current torque (or outward pinch) in the core region and a co-current momentum diffusion/convection from the $\rho > 0.8$ region. These measurements therefore suggest that the average bulged rotation profiles from the previous observations are indeed due to the sawtooth activity. The Carbon density profiles after the crash are hollowed inside $\rho_{inv}$, a feature that they share with the electron density profiles, and their relaxation times are approximately the same, around 6-7 ms, faster than the rotation relaxation time ($\geq 15$ ms).

REFERENCES


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