Momentum transport in TCV across sawteeth events

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Momentum Transport In TCV Across Sawteeth Events

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The scaling of toroidal rotation has been studied over a wide range of in plasma and shape parameters on the TCV tokamak using a diagnostic neutral beam that injects a negligible momentum into the plasma. As on other Tokamaks, the toroidal rotation magnitude on TCV, for a given shape and plasma conditions, is observed to scale inversely with the plasma current. More specifically, this describes the maximum toroidal rotation in plasmas with strong sawteeth activity. The toroidal rotation gradient from the plasma edge was similar over a wide range of plasma currents and only diverged inside the sawtooth inversion radius. By extrapolating the maximum core rotation from the rotation profiles outside the sawtooth inversion radii and adding a correction for the observed ion temperature changes, the scaling of the intrinsic toroidal rotation with plasma current is no longer observed.

The TCV CXRS diagnostic was configured to measure the toroidal rotation profile with a low spatial resolution (4 points across the radial co-ordinate) and a high temporal resolution (2 ms). Using ECH X2 power deposited close to the sawteeth inversion radius, the sawteeth repetition time was extended to over 12 ms. The measurement used a newly available Real-Time node to generate a sequence of trigger pulses from analysis of the soft X-ray such that each spectroscopic frame was taken at 2, 4, 6, 8, ... ms after each sawtooth. The radial toroidal rotation profile evolution over a sawtooth was determined using coherent resampling over many sawtooth events.

Initial results indicate that, at the sawtooth crash, the plasma core accelerates in the co current direction and then the core rotation profile relaxes back to the counter current direction with a time constant $\sim$ 10 ms. This implies that the scaling of intrinsic rotation with plasma current may be better understood as a peaked rotation profile (or an inwards momentum pinch) in the plasma core region that is flattened by sawtooth activity. This change of viewpoint should be integrated into the theory of momentum generation and transport in tokamaks such as ITER in that these mechanisms are not as universally affected by the plasma current as was at first thought.