Physics insight from plasma shaping experiments in the TCV tokamak

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The characterization of the effects of shaping on tokamak plasmas is crucial for the design of future devices, as it influences both transport and MHD stability properties. This is studied in TCV over a broad range of elongations $\kappa \leq 2.8$, positive and negative triangularities δ, limited/diverted configurations, with 4.5MW localized EC heating.

We discovered a strong dependence of electron energy diffusivity on triangularity. The confinement time doubles as δ goes from +0.4 to -0.4 in L-mode. Further, these studies allowed the separation of the effects of shape and collisionality on transport. Trapped Electron Modes turbulence (TEM) is expected to dominate in these conditions and gyrokinetic simulations confirm the strong dependence of anomalous diffusivity on δ. The change of turbulence nature (TEM/ITG) in density ramps may play a role in the abrupt intrinsic toroidal rotation inversion found in TCV as the density is ramped in high current discharges with $\delta > 0$.

Shape also modifies MHD and disruptions. High κ is destabilizing (frequent sawteeth), high $\pm\delta$ is stabilizing, in agreement with MHD stability predictions. Plasma shaping is also found effective in stabilizing modes and preventing disruptions, e.g. in the current ramp-up, of key importance for the ITER high-current scenario.