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Advances in negative-triangularity tokamak physics in TCV

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The TCV tokamak has pioneered negative triangularity since the mid-1990's, reporting enhanced confinement in both Ohmic and ECRH L-mode scenarios. Local gyrokinetic simulations reproduced the effect near the plasma edge but not in the core where triangularity vanishes, motivating more recent global simulations.

Experiment also shows a dominant role of the outermost 20% of the minor radius in determining the overall confinement with stiff core profiles. H-mode scenarios have also been developed, with more frequent and less virulent ELMs, explained by the closure of the ballooning second-stability region and a diminished pedestal stability threshold.

Negative triangularity however also shrinks the heat-flux profile in the scrape-off layer.

More recently, the ITER baseline β_N level (1.7) has been reached in limited L-mode plasmas with NBI, a record for TCV L-mode.

Single-null-diverted shapes were also developed for the first time, and the confinement improvement was confirmed, with an H-factor doubling from 0.5 to 1 in Ohmic plasmas (Fig. 1).

Turbulence has now been systematically compared at positive and negative triangularity using correlation ECE and phase-contrast imaging diagnostics, reaching inside mid-radius. Both report a significant reduction of turbulence everywhere when the last-closed flux surface goes from positive to negative triangularity, in both TEM- and ITG-dominated regimes.

Work is currently underway to expand the parameter space, in particular to heat diverted negative-triangularity plasmas with NBI and ECRH, and to find a path to optimum L-mode performance while retaining large-scale MHD stability.

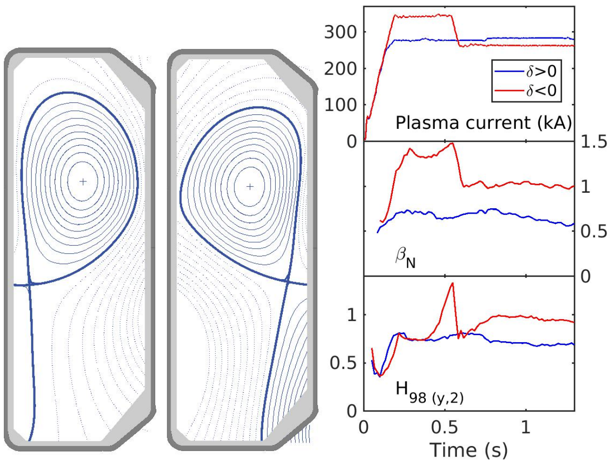

Fig. 1. Performance comparison of positive- and negative-triangularity diverted plasmas.

References

[1] J.-M. Moret et al, Phys. Rev. Lett. **79**, 2057 (1997)

[2] Y. Camenen et al, Nucl. Fusion **47**, 510 (2007)

[3] M. Fontana et al, Nucl. Fusion **58**, 024002 (2018)

[4] Z. Huang et al, Plasma Phys. Control. Fusion **61**, 014021 (2019)

[5] G. Merlo et al, Phys. Plasmas **26**, 102302 (2019)

[7] M. Fontana et al, Nucl. Fusion **60**, 016006 (2020)