Plasma turbulence studies in the TORPEX basic plasma physics device: from concentric flux surfaces to single null X-points.

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TORPEX is a basic plasma physics device where a simple magnetized torus (SMT) is produced by adding a small vertical magnetic field to a main toroidal component, generating helical field lines. The SMT configuration features the main ingredients of a tokamak Scrape-Off Layer (SOL), namely density gradients in the presence of magnetic field curvature and gradient.

Recently, a toroidal in-vessel copper conductor has been installed in the TORPEX device. A current up to 1kA can be driven in the toroidal conductor. This produces a poloidal magnetic field, which closes the field lines together with the toroidal field, resulting in a monotonic safety factor profile from 1 to 12 along the radial direction with an almost constant magnetic shear of 2. Several magnetic field geometries are accessible using the vertical field coils, from wall-limited plasmas with a SOL on the high-field side or low-field side, to single or double-null X-points as well as magnetic snowflakes. This way, more fusion relevant configurations of increasing complexity are achieved, while maintaining plasma parameters in ranges that allow a complete spatio-temporal diagnostic coverage across the plasma cross-section.

Magnetic configurations with almost circular and concentric flux surfaces are considered for the analysis of plasma coherent structures. Quasi-coherent modes with a strong poloidal asymmetry are measured. A dominant localization on the bad-curvature region of the plasma volume (low field side) suggests a ballooning nature for these instabilities. A spectral characterization at the position of maximum fluctuation amplitudes is performed, including measurements of the power spectral density, indicating mode frequencies in the range 15-30 kHz. Measurements of vertical and toroidal correlations for several values of the poloidal magnetic field have been performed, allowing us to calculate the poloidal and toroidal mode-numbers. Field aligned modes with a toroidal mode number n=1 are identified. This is being compared with the numerical results obtained with the linear version of the Global Braginskii Solver (GBS) to assess the nature of the observed dominant instabilities. Initial measurements of plasma turbulence in TORPEX plasmas with a single null X-point will also be discussed, including analysis of the blob dynamics in this configuration performed using imaging techniques and conditional average sampling.

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