Testing poloidal asymmetry models against impurity density, temperature and toroidal rotation measurements over the entire plasma cross-section

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Poloidal asymmetries are at the core of the neoclassical theory and have a direct impact on neoclassical and turbulent transport. In the last years, original measurements of the carbon impurity density, temperature and toroidal rotation have been developed in TCV to investigate poloidal asymmetries and test the underlying theories. Measurements covering the entire plasma cross-section and an indirect method for measuring poloidal rotation with improved accuracy allowed extensive comparisons between the measured poloidal rotation and the neoclassical theory prediction and the observation of new unexplained poloidal asymmetries of the carbon density.

Local active charge exchange measurements of the carbon impurity sampling the equatorial plane were combined with a shot-by-shot scan of the plasma vertical position for a complete coverage of the cross-section (2D map) totaling 880 measurements points. The carbon temperature is found to be constant on a flux surface within the measurement accuracy whereas the carbon density and toroidal rotation display sizable poloidal asymmetries.

The poloidal variation of the toroidal flow is consistent with the neoclassical theory provided the density asymmetry is taken into account. Beyond a confirmation of the neoclassical theory, this validates *a posteriori* a recently developed indirect poloidal rotation measurement which exploits the toroidal rotation difference between the HFS and LFS of a flux surface to infer the poloidal rotation [1]. This indirect poloidal rotation measurement has been extensively exploited in the last TCV campaign in plasmas covering a large range of plasma parameters. Comparisons with the neoclassical theory (NEOART and NEO codes) will be presented and the improved accuracy of the indirect method, compared to the usual direct poloidal rotation measurement, will be discussed.

While in these TCV Ohmic plasmas, the measured toroidal flow structure agrees with theory predictions, the carbon density does not and the LFS carbon density is almost systematically higher than the HFS density by about 10-40% at mid-radius.
This observation is so far unexplained and represents a serious challenge to the present understanding of poloidal asymmetries. Scalings of the density asymmetry with plasma parameters will be presented and discussed.

[1] A. Bortolon *et al.,* Nucl. Fusion **53** (2013) 023002