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Current flows towards the divertor during VDEs at COMPASS

Direct measurements of current flows during vertical displacement events (VDEs) have been carried out on COMPASS to better understand current pattern distribution within vessel structure and divertor. Especially, asymmetric VDEs resulting in sideways forces on the vacuum vessel, are potentially challenging for ITER. The theoretical understanding of these events is not yet conclusive. The experiments described here aim on testing the model of asymmetric toroidal eddy currents 1 that predicts that toroidal currents between plasma facing components (short-circuited through the plasma) can significantly modify the current flow path between the plasma and the vacuum vessel and thus the resulting forces by VDEs.

Two special divertor tiles were installed in COMPASS to directly measure currents flowing between these tiles and the plasma (Fig.1). The tiles are positioned 135° from each other allowing investigation of toroidally asymmetrical disruptions.The tiles are insulated from the vacuum vessel (VV) inside the chamber and grounded outside of the VV. The low field side (LFS) part of the tile is split in two toroidally separated segments, each measuring current flow during disruptions. The aim of the experiment is to determine whether any short-circuit occurs through the gaps between toroidally neighbouring segments. The two tiles have different gap sizes between the split segments in order to investigate spatial effect on the possible short-circuit.

Experimental setup allows various configurations which includes measurement of the current flowing from the segment to the vessel (grounded mode), between the split segments (floating mode), between the split segments with a capacitor in the circuit (biasing mode).
Experimental campaign consists of intentional downward disruptions (landing on the divertor) with similar plasma parameters (primarily I_p and n_e). Currents up to 1500 A are measured in grounded mode. However, their magnitude varies significantly between the discharges. Four I_p and B_t directions combinations are performed. It is found that currents direction and magnitude exhibit a dependence on B_t and I_p directions. Currents up to 1000 A are observed in floating mode when split segments are connected to each other and there is no contact to the VV. These currents are also dependent on I_p and B_t directions, but the two tiles show different trends. Tile misalignments and eddy currents flowing across the gaps are the two considered hypotheses that could explain the different measured currents in the toroidally separated segments. Although the current path through the plasma is not presently known, these measurements prove that plasma contact can lead to significant currents in the electrically insulated components of the first wall.

In addition to this two arrays of divertor Langmuir probe are used in grounded mode. Parallel Halo current densities up to 2 MA/m^2 are measured at T_e = 10 eV. It is suggested that Halo current is limited by ion saturation current.!

References

1 R. Roccella et al., Nucl. Fusion 56, (2016)

Figure 1: Special divertor tiles in COMPASS. LFS part is split in two toridally separated segments. (a) Tile #1: 2.5 mm gap between the segments; (b) Tile #2: 10 mm gap.

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