Asymmetric scrape-off layer currents during MHD and disruptions*

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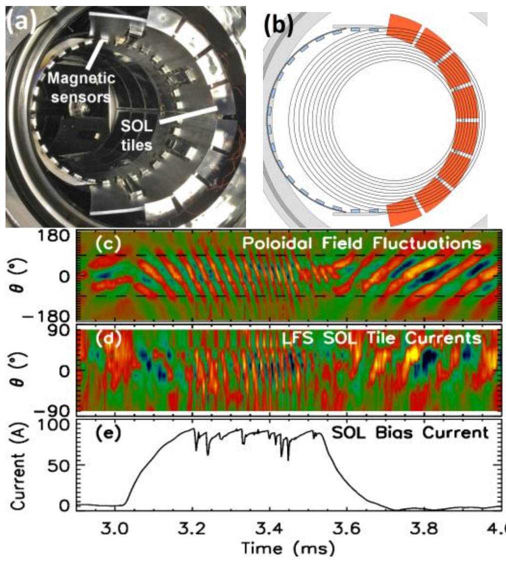
During disruptions, large asymmetric currents arise in the first wall and vacuum vessel that have the potential to damage tokamaks, and understanding this behaviour is important for mitigating disruption loads. In this presentation, we report asymmetric scrape-off-layer (SOL) and vessel currents measured during MHD activity and disruptions in the HBT-EP tokamak. Low-field-side diagnostic tiles measure currents to the vessel with poloidal resolution in three toroidal locations. Tiles and the associated wall segments can be moved radially between shots to investigate radial SOL current structure and dependence on wall geometry. Additionally, a biased electrode in the SOL influences MHD dynamics measured by magnetic sensors and the SOL tiles (see Figure). Measurements reveal poloidal and toroidal structure of currents to the wall that correlate with rotating MHD activity during the main discharge and disruption. Tile currents exceed the ion saturation current during transient events. Electrically-isolated regions of the vacuum vessel detect toroidal vessel currents oscillating between co- and counter-I_p directions when the sections are connected via diagnosed jumpers. Asymmetric vessel currents correlate with rotating kink modes, and reach ~5% of the pre-disruption plasma current during the current quench [1]. Relative increases in local plasma current measured by segmented I_p Rogowski coils coincide with nearby counter-I_p vessel currents. Measurements are interpreted in the context of Wall Touching Kink Mode (WTKM) [2] and Asymmetric Toroidal Eddy Current (ATEC) [3] models, which give contrary predictions for the sign of asymmetric toroidal vessel current during disruptions. Both models are needed to explain HBT-EP disruption data.



Magnetic sensors and SOL current tiles pictured in (a) measure MHD activity with poloidal and toroidal resolution. Sensor layout and SOL flux surfaces for a discharge with SOL biasing are shown in (b). Tile current (c) and magnetic (d) fluctuations versus poloidal angle show rotating MHD responding to applied SOL current (e).

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[2] L.E. Zakharov *et al.*, Phys. Plasmas **19** 055703 (2012)

[3] R. Roccella *et al.*, Nucl. Fusion **56** 106010 (2016)