Title: Studies of plasma disruptions in the COMPASS tokamak

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Abstract:

Plasma disruption in a tokamak is an important physical phenomenon, when there is a sudden loss of plasma confinement and rapid drop of plasma current. During the disruptions, there is significant mechanical stress on the constructional structures of the tokamak and thermal stress on the first wall. Allowable number of disruptions with the maximum plasma parameters in the ITER tokamak (international thermonuclear experimental reactor under construction) will be very limited. Therefore, investigation of disruptions and their consequences is a key problem for sustainable operation of tokamak devices.

The thesis focuses on studies of current quench phase and related currents flowing in the vacuum vessel at the COMPASS tokamak. An extensive disruption database was collected and critical disruptions' parameters were determined. Plasma current was measured at 5 toroidal position as a consequence of data acquisition system improvement that allowed reliable measurements by magnetic coils without analogue integrators. Special divertor tiles were installed in order to perform dedicated vertical displacement event (VDE) experiments and validate asymmetric toroidal eddy currents model (Roccella et al, Asymmetric toroidal eddy currents (ATEC) to explain sideways forces at JET, 2016). It was shown that the gaps between the plasma facing components (PFCs) can be short-circuited during disruptions creating a parallel vessel current circuit, previously neglected. This brings new perspective on estimation of electromagnetic forces acting on the vacuum vessel and PFCs. A unique set of magnetic diagnostics was used to measure poloidal and toroidal vessel currents including their distribution in poloidal cross-section. New magnetic coils were put into operation allowing measurement of halo current and their poloidal extension. The results contributed to confirmation of a hypothesis that halo current density might be limited by ion saturation current.

Keywords: fusion, tokamak, disruption, magnetic diagnostics, halo currents