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Primary quench detection analysis for DTT Central soledoid (CS) and polidal field coils (PF)

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The CS and PF coils of the DTT tokamak are operated in dynamic mode and, even in normal operation, the induced and self voltages across each coil are of the order of several 100 V. In DTT (Divertor Tokamak Test facility currently being built in the site of ENEA C.R.E. Frascati –Italy), these coils will be realized with superconducting materials and, as a consequence, a reliable and fast quench detection system is required in order to protect the magnets. Being the quench signals 4 orders of magnitude smaller than the operating voltages, the cowound (CW) technology must be adopted for the quench sensors, the only degree of freedom being among a wirnig configuration merely aligned with the coil winding (CWA) or aligned and twisted to the winding (CWA&TW). In this study, a model of the DTT poloidal magnetic system has been developed, up to the details of the single windings of the various coils for each magnet, together with the corresponding model for a CWA sensor. The signals coming from the magnetic system during the various plasma events (Single Null, breakdown, major disruption,
⋯) have been simulated and compared to the analogous signals coming from the CWA. Of course, the analysis has been developed up the level of the elementary structures of each coil of the system (single pancake in double pancakes magnet configurations; Low, Medium and High field portion of a layered magnet configuration). Finally, a simple theory has been developed aimed at the estimations of the improvements coming from the CWA&TW architecture. The outcome of the study will be used for the detailed design of the superconducting cable to be adopted in each portion of each magnet of the DTT magnetic system.

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