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Application of the Universal Quench Detection System to the Protection of the High-Luminosity LHC Magnets at CERN

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The Universal Quench Detection System (UQDS) has been primarily developed to detect quenches in various superconducting magnets of LHC's High Luminosity upgrade (HL-LHC). The functionality of the system, which comprises insulated high-resolution digitizing front-end channels and a central processing element, is mainly defined by the configuration of the central FPGA (Field Programmable Gate Array). Additional elements such as redundant power supplies, configurable interlocking capabilities and a communications controller are completing the functionality of the system. The system's architecture is designed to be flexible enough to detect quenches in all superconducting elements of HL-LHC. The application-specific digital signal processing and quench detection algorithms are implemented in the firmware of the FPGA and thus can be changed according to the required functionalities. To facilitate this process, the firmware has been structured accordingly and automated code generation techniques are used.

The strategy of testing prototypes of the quench detection system with prototypes of the magnets allows an early evaluation of the system, minimizing operational issues in the final installation. This strategy has been already applied at CERN to the 11 T dipole magnets in previous years and extended as well to other magnet families of the HL-LHC Project.

We give a system description and focus on the specific configurations for three different magnet families. Prototypes of these magnets have been recently tested at CERN. For each of these, specific features and detection methods have been developed, implemented and evaluated during the magnet tests.

Primary author: STECKERT, Jens (CERN)

Co-authors: VANCEA, Dragos-Gabriel (CERN); SPASIC, Jelena (CERN); DENZ, Reiner (CERN); Ms MUNDRA, Surbhi (Graduate Fellow); Dr PODZORNY, Tomasz (CERN)

Presenter: STECKERT, Jens (CERN)

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