Contribution ID: **39** Type: **Poster**

# New Quench Detection System to Enhance Protection of the Individually Powered Magnets in the Large Hadron Collider

*Tuesday, 3 September 2019 17:20 (20 minutes)*

To further improve the existing Quench Detection System (QDS) of individually powered magnets installed in the Large Hadron Collider (LHC), a new radiation tolerant electronic board was developed. The board provides three signal acquisition channels able to acquire with different and configurable signal resolution and acquisition rate the analog signals of different properties.
These enhancements enable the application of different quench detection algorithms depending on the protected magnet. Additionally, the board can be used with newly developed current derivative sensors for reliable detection of symmetric quenches. The board flexibility allows as well using both open and closed loop current sensors.

## Summary

The Large Hadron Collider (LHC) consists of a large number of magnets to steer and focus the beam of particles.
The used magnets are made out of superconducting materials. During their operations with currents, it might happen that one part of the magnet changes its state from the superconducting to the resistive one.
This transition phenomenon is known as a quench.
Due to the often large amounts of stored energy in the magnets, a quench has to be detected by highly reliable Quench Detection Systems (QDS) to trigger appropriate protection actions for the magnet circuits and the removal of the particle beams.
To improve the existing quench detection systems of Individually Powered Quadrupoles (IPQ), Individually Powered Dipoles (IPD), Inner Triplets (IT) and 600 A corrector magnets towards higher availability and reliable detection of aperture symmetric quenches, a new, more generic detection board was designed and built.
To protect the magnets of the LHC, different quench detection algorithms are in use today, depending on the available magnet signals. The classical approach for protection is the measurement of the voltages across the two magnet coils and applying a pre-defined threshold and discrimination time to detect a resistive voltage component. This approach is currently used for quench detection of IPQ, IPD and IT magnets.
To detect quenches of the 600 A corrector magnets only one global voltage and one circuit current measurement is available. For quench detection, the current derivative is therefore calculated numerically to allow for the compensation of the inductive component in the measured voltage signal. To measure the current, an open loop sensor has been used to date. As this sensor type exhibits high noise values, new sensor candidates were selected and evaluated. Out of the evaluated types, a closed loop sensor was identified as the most promising candidate.
Therefore, the new board was designed to allow the use of both sensor types depending on the requirements of the protected magnet and circuit.
To allow for a reliable and fast detection of symmetric quenches in individually powered magnets, a new detection method based on a current derivative sensor was recently developed. This sensor is based on a current transformer approach and is faster than detection methods based on numerically calculated derivatives. The output voltage can be directly read with one of the channels of the new detection board.

To allow for the combination of all the mentioned detection mechanisms and new sensors, the new developed electronic board has three fully independent acquisition channels to acquire three different voltages with different signal levels, bandwidth, resolution and readout speed. Because of the flexibility of the system, a wide range of magnets can be protected.
As the board will be exposed to elevated doses of ionizing radiation of up to 10 Gy/y, all used components were qualified in radiation and can withstand the radiation environment of the LHC over their entire lifetime.

**Primary author:** HAAS, Severin (CERN)

**Co-authors:** SIEMKO, Andrzej (CERN); SPASIC, Jelena (CERN); STECKERT, Jens (CERN); DENZ, Reiner (CERN)

**Presenter:** HAAS, Severin (CERN)

**Session Classification:** Posters

**Track Classification:** Systems, Planning, Installation, Commissioning and Running Experience