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Mobile Test Bench for the LHC Cryogenic Instrumentation Crate Commissioning

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The installation of the Large Hadron Collider (LHC) at CERN is completed. The magnets are installed and the emphasis is shifted to the commissioning. This work focuses on the commissioning of the cryogenic instrumentation. The LHC is a two-ring superconducting accelerator and pp collider of 27 km circumference.. The dipoles will operate at 8.3 T, cooled by superfluid helium at 1.9 K. The operation and monitoring of the LHC require a massive amount of cryogenic instrumentation channels with a robust and reliable design. The cryogenic control system has to manage about 33000 input-output signals as well as 4000 control loops.

Summary

The Large Hadron Collider (LHC) is a two-ring superconducting accelerator and proton-proton collider of 27 km circumference. The dipole magnets will operate at 8.3 T, cooled by superfluid helium at 1.9 K. Electrical Distribution Feedboxes (DFB) provide the electrical supply to the superconducting magnets. The LHC ring consists of 8 sectors, each divided in: regular arc (ARC, ˜2.5 km), 2 dispersion suppressors (DS, ˜0.5 km), and 2 long straight sections (LSS, ˜0.5 km). The operation and monitoring of the LHC require a massive amount of cryogenic instrumentation channels - most of them operating in radioactive environment - with a robust and reliable design. The cryogenic control system has to manage about 33000 input-output signals, distributed along 27 km, as well as 4000 control loops.

798 instrumentation crates are installed, connected and tested underground. They house signal conditioning cards for the temperature sensors (TT), pressure sensors (PT) and liquid helium level sensors (LT), power cards to supply electrical power to the LHC cryogenic heaters (EH) and I/O cards to read the digital valve status. These crates communicate through a WorldFipTM field bus.

Information about electronics and instrumentation is stored in Layout Database.

The commissioning of the Cryogenic Instrumentation (electronics, cabling, sensors, actuators), after their installation in the LHC tunnel is done by a Mobile Test Bench (MTB). Four Test Benches have been built at CERN to ensure the correct functionality of all electronics. The MTB is based on a PXI platform, running LabVIEWTM application.

The following tests are performed:

• Consistency test: Verification between actual and Layout database crate configuration.
• Card test: Electronic cards functionality check.
• Instrument test: Instruments presence and their functionality check.
• Pin-to-Pin test: Cable test for undesirable short circuits and continuity.
• FIP test: Full readout chain (sensor+electronics) functionality verification.

The MTB project uses Perforce, a Software Configuration Management (SCM) tool, which provides a centrally managed storage area for all files of a project, keeps detailed track of the history of each managed file and allows collaboration amongst users. More specifically Perforce is used to manage the LabVIEW software distribution from the developer team to the operator team, individual crate configuration files and also the results for all cryogenic instrumentation crates. The results are stored locally in the corresponding folder of the crate and after the completion of tests are submitted to the Perforce server and MTF - a network application that stores the data related to the management of the LHC equipment.

The MTB is a valuable tool for resolving problems related to cables, sensors and connectors (i.e. wrong or not connected cables to the field instrument, wrong grounding/shielding in the cables/connectors, blown fuses, damaged cables or connectors, missing connections and mismatches with Layout DB and even Layout DB self inconsistencies).

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