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The electronics of ALICE Dimuon tracking chambers

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The Alice Muon Spectrometer tracking system is composed of five stations (ST) with two wires chambers each. IPN Orsay is responsible for the electronics design and production for the tracking (1.1M channels), for the readout electronics software and for the ST1 design and building. We will describe the readout architecture based on dedicated Front-End boards, embedded digital crates, and a Trigger crate. We will explain the process to reach the final electronic design. We will describe the electronics production, specially the tests for the 20000 Front-End boards. We will focus on ST1 integration at CERN, EMC issues and commissionning.

Summary

At CERN LHC energies, the formation of a quark-gluon plasma (QGP) is expected. One of the main signature of this formation is the quarkonia suppression. The ALICE muon spectrometer is designed to study this QGP observable. The Muon Spectrometer tracking system is composed of five stations with two wires chambers each. IPN Orsay is responsible for the electronics design and production for the tracking (1.1M channels), for the readout electronics software and for the ST1 design and building.

The chambers pads signals are processed by a MANAS (Multiplexed ANAlog Signal) ASIC embedded on MANU (MAnas NUmérique) boards which insure the digital conversion and the data transmission through a MARC (Muon Arm Readout Chip) ASIC. Sets of MANU boards are connected together on a data Patch Bus (Protocol for Alice Tracking Chamber) line managed with a token. Data go to a digital CROCUS Crate close to the detector and connected to ALICE DAQ via optical links. CROCUS (Concentrator Read-Out Cluster Unit System) crate insures the data tagging and their concentration. It can send calibrating signals to the front-end electronics with a dedicated board. All the Spectrometer CROCUS receive the trigger signals through a dispatcher Trigger Crate.

During the electronics design, we performed electronics radiation hardness tests. The ST1 first tests allowed us to tune the impedance matching of each Patch Bus what is a key point, because most of the MANU boards on the line are not impedance matched. We tuned the current in some Bus patch to be able to read them in a safe way. The detector readout sequence was tested and required many FPGA additional programs. We implemented a Jtag chain on the CROCUS boards so that all the CROCUS FPGA programs can be modified and reloaded from Alice control room.

About 20000 MANU boards were produced, numbered with a barcode and tested in industry. A dedicated test bench was developed and transferred to industry with a go no go function and a diagnostic option for repairing. It produces a test sequence for the power supplies and for the transmission protocols. It also tests the MANAS circuit: pedestals, gains, calibration internal capacitor value. A data file for each MANU board was delivered to the collaboration. We designed, produced and tested 600 link boards, 22 full CROCUS crates (375 boards, 4 types) and 2 TCI crates.

Each MANU board location on the chambers was numbered with a barcode, so we built a full ST1 map. The 9 ST1 chambers were fully tested with a cosmic rays test bench. We had to fulfill CERN safety requirements like using Halogen Free and amagnetic materials. After its building at Orsay, each quadrant was carried to CERN, tested in a surface building before being commissionned in the Alice cavern. We choose to be very careful with EMC questions. We designed special mechanical parts for grounding. We also designed and installed power supplies high frequency filtering boxes. ST1 and ST2 successfully participate to the first Alice Commissioning runs in December 2007.

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