Contribution ID: **32** Type: **Poster**

Electronic Devices for Controlling the Very High Voltage in the ALICE TPC Detector

Wednesday 27 September 2006 16:20 (25 minutes)

The Time Projection Chamber (TPC) is the core of the ALICE experiment at CERN. The ALICE TPC is an 88m3 cylinder filled with gas and divided in two drift regions by the central electrode located at its axial centre.
The drift field is generated by a 100kV power supply. The TPC Very High Voltage project covers the development of the control system for the power supply.
This paper reports the project progress, introducing the control system architecture from the electronics up to the control level. All the electronic devices will be described, highlighting their communication issues, and the challenges in integrating these devices in a PLC-based control system.

Summary

The TPC is the main tracking detector of the ALICE central barrel and, together with the other central barrel detectors, has to provide charged-particle momentum measurements. Charged particles traversing the TPC volume ionise the gas along their path, liberating electrons that drift towards the end plates of the cylinder. Moving from the anode wire towards the surrounding electrodes, the positive ions created in the avalanche induce a positive current signal on the pad plane. The readout of the signal is done by the 570132 pads that form the cathode plane of the multi-wire proportional chambers located at the TPC end plates.
Under operating conditions the system must safely apply a DC voltage of 100kV to the central electrode placed half way between the two end plates of the detector. Four resistor rods supply the proper potential to the field cage.
The Control System was developed following the TPC subsystems requirements, covering the following features: control and monitoring of the High Voltage power supply, the current in the resistor rods, the cooling, and some additional equipment. Voltage must be smoothly applied by a ramping mechanism.
The Power Supply (PS) is a Heinzinger PNC 150000 neg-2, customized for the experiment needs. It can provide up to 150kV DC. Its main modification is the addition of an electronic controller that limits the slew rate in case of sudden power up or down. It is the first time that such a high voltage power supply integrates this feature. The PS is also controlled by a RS232 interface. A Programmable Logic Controller (PLC) controls the ramping and several safety features. Thanks to its simple architecture and its stand-alone characteristic, the PLC provides more reliability than a common PC. The chosen PLC is a Schneider Electric P575634M. As it directly controls the PS through the RS232, dedicated communication routines were implemented. Currents in the resistor rods of the field cage are monitored as voltage drops over a resistor. Monitoring is performed by two ELMB reading 16 analog inputs. Each ELMB is connected to the PLC through CAN bus. The PLC controls that the voltages remain in range. Status levels of relevant parameters for the operation of the PS are monitored through 13 interlocks (digital inputs) connected to the PLC. They provide status information about cooling water, UPS, gas condition and circulation.
In case of any failure in the monitored elements, the PLC reacts by triggering a ramp down of the PS. Depending on the error level, the ramping down can be slow (PLC driven) or fast (controlled by the electronic slew rate limiter). The PLC itself is monitored by a device designed in order to trigger a hardware ramp down in case of losing the PLC heartbeat.
As the TPC is fundamental for the ALICE experiment to work, the system was chosen

for the PLC reliability. Hence, special effort was put into the development of communication with the electronic devices that, in conventional systems, are usually controlled in transparent way by a common PC.

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Session Classification: Poster sessions