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The ALICE Transition Radiation Detector Control System

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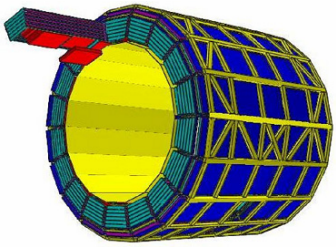
1 Introduction

The ALICE (A Large Ion Collider Experiment) detector at the Large Hadron Collider (LHC) at CERN incorporates a transition radiation detector (TRD) which has the primary function to identify high transverse momentum electrons (p_T > 1 GeV) and to deliver fast trigger information within a few micro-seconds after the interaction. The number of analog channels to be processed is enormous — over 1.2 million, spatially distributed over a barrel with a mean diameter of 6.6 m, length of 7 m and a total active area of all layers of 736 m².



Schematic view of the 18 TRD super-modules showing some of the 540 drift chambers and its relative size.

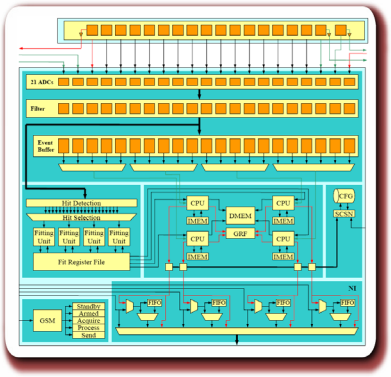
2 The ALICE TRD

The ALICE TRD will cover the kinematic region of $|\eta| \leq 0.9$ in pseudo-rapidity with a total of 540 individual chambers arranged in 6 radial layers which are subdivided into 18 azimuthal and 5 longitudinal sections. Each detector consists of a sandwich radiator of 48 mm thickness; it is followed by a drift chamber with a 30 mm drift gap and a 7 mm amplification gap read out via a segmented cathode pad plane glued to a multi-layer carbon fiber honeycomb backing.

3 The ALICE TRD readout electronics

The tracks of the charged particles are reconstructed using the current induced on the detector cathode pads which feed a charge-sensitive preamplifier (PASA) which also implements first-level shaping. The differential PASA outputs are digitised with a custom 10-bit ADC at 10 MHz.

The remainder of the TRD electronics chain implements a short 64-word single event buffer plus a tracklet processor (TRAP) which identifies potential high-p_T track candidates for further processing.



Both chips, PASA and TRAP, are assembled in Multi-Chip Modules (MCM) which are hosted by Readout Boards (ROB) that integrate voltage regulators, DCS interface boards and optical data links.

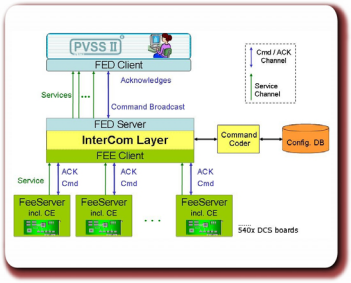
The read-out is performed in two stages: first, during the trigger processing, where all tracklet candidates are shipped within 600 ns from the 65664 MCMs to the global tracking unit (GTU) using 1080 2.5 GBit optical links for merging of the six detector layers; second, the event buffer is read out in case the event is accepted.

4 The ALICE TRD control system

4a TRD Detector Control System

The primary task of the DCS is to ensure correct and safe operation of the TRD detector. It provides configuration, remote control and monitoring of all the sub-systems' equipment from a single workplace in an efficient way.

The entire detector has been modelled as objects behaving as Finite State Machines (FSM) using the framework State Management Interface, SMI++. For device access and description, the commercial SCADA system PVSS is used.



4c TRD FEE slow control

A 3-layer software architecture has been adopted for the FEE communication chain. In the lowest level, the DCS interface boards run a Control Engine (CE) and a dedicated FEE server (FeeServer). The CE contacts the underlying hardware, provides values to the FeeServer and processes the received commands, while the FeeServer itself takes care of the communication path and updates the published values.

4b TRD low and high voltage systems

Low voltage system

In normal running conditions, the TRD would amount an electrical power of more than 65 kW. For this to be accomplished, 89 water-cooled Wiener PL512/M low voltage power supplies provide 224 individual channels. These power supplies use OPC (OLE for Process Control) via Ethernet as communication protocol with the supervisory layer. Each single LV channel implements more than 30 OPC items among settings, read-back values, limits and status.

High voltage system

The TRD readout chambers (ROC) require a potential of −2.1 kV to generate the necessary drift field and about +1.7 kV in order to reach sufficient gas gain. This leads to a total of 1080 HV channels needed to operate the entire detector. The relative stability per channel is required better than 0.1% over 24 hours while the ripple is required to be smaller than 50 mV peak-to-peak. Currently, the TRD HV system is foreseen to be operated with 32-channel Iseg EDS series modules.

4d Summary and present status

A TRD control system based on FSM is being developed. The main FSM nodes are nearly finalised. All device units are ready as well as the main FSM hierarchy. The system is being commissioned with one fully equipped TRD supermodule.

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