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The ALICE trigger system performance for p-p and Pb-Pb collisions

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The ALICE trigger system in the experimental cavern processes information from triggering detectors at 3 hardware levels in p-p and Pb-Pb collisions. The performance of the system exceeds the specification and many automatic functions have been developed to facilitate work in the control room. The hardware is permanently monitored, and around 1200 counters, with considerable built-in redundancy, are read at regular intervals (once per minute). This provides relevant physics information and also verifies the consistency of the hardware operation. In order to compensate for seasonal drift, the CORDE module has been installed, which allows the LHC clock to be delayed in steps of 10 ps. This paper describes the current status of ALICE trigger system after experience with p-p and Pb-Pb runs, the new firmware developments and the appropriate software for this electronics.

Summary 500 words

The ALICE trigger system operates with interaction rates for nucleus-nucleus, proton-nucleus and proton-proton runs at rates between about 8 kHz and 300 kHz. The main block of the ALICE trigger electronics is the Central Trigger Processor (CTP). This block will receive and align up to 60 trigger inputs in parallel from the trigger detectors; it then processes trigger information for each active cluster and generates the result of this processing. There are three different hardware trigger levels (L0, L1 and L2) with latencies from 1.2 microseconds to 100 microseconds. The system allows dynamic partitioning in order to make optimum use of detector readout. The system provides a flexible past-future protection. Outputs from the CTP go to the LTUs of each sub-detector. The LTU serves as an interface between the CTP and the sub-detector readout electronics. The LTU is also able to run in a stand-alone mode of operation where the LTU fully emulates the CTP protocol. The timing of emulated trigger sequences is identical to the timing during the global run.
The trigger electronics is based on ALTERA Cyclone FPGAs (Field Programmable Logic Arrays), which provide flexibility to change the functionality of the trigger system through reprogramming of the FPGA. After experience gained in the Pb-Pb run in November 2010 some of the FPGAs in the trigger system have been upgraded with extended functionality, to provide for example, more complex look-up tables, more bunch crossing masks, and the possibility of negating a class.
The CORDE module has been tested, qualified and installed in the LHC interface VME crate. This module is able to delay the LHC clock in steps of 10 ps and thus compensate for the seasonal drift of the LHC clock. The compensation of the LHC clock is done for each LHC fill, in the LHC mode FLAT-TOP.
An optical scope facility has been completed and tested in the experimental area. It uses six optical fibres running from the experimental cavern to the ALICE control room in order to see signals from the hardware of the trigger system. A conversion from TTL signal to optical signal and optical signal to TTL signal is done by DC-coupled optical transmitters.
The main functions of ALICE CTP software are configuration, control and monitoring of the CTP and LTUs. The CTP software also provides interfaces to other systems like the ALICE DAQ and ECS. Communication with the LHC utilizes the DIP exchange. The distributive nature of the ALICE trigger software is based on the DIM client server architecture. The C, C++ and python languages and ROOT framework are used in different parts. A special program, SMAQ, has been developed to test the alignment of trigger inputs. In addition further monitoring has been implemented using the general ALICE monitoring and data quality package called AMORE.

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