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Performance and Operation of the Calorimetric Trigger Processor of the NA62 Experiment at CERN SPS

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The NA62 experiment aims to measure the branching ratio of the rare kaon decay K+->pi+nu nubar at the CERN SPS. The calorimeter L0 trigger is the part of the TDAQ used to select events with a pi+ in the final state hadronic and to veto one of the most dominate background from events K+ -> pi+pi0. It has been developed and installed (it has taken first physics data in autumn 2014). We present the design, performance and operation during the last two years (2015 and part of 2016) high intensity data taking of the calorimeter Level 0 trigger.

Summary

The goal of the NA62 experiment is a precision measurement of the branching ratio of the ultra-rare kaon decay K+ -> pi+ nu nubar with 100 expected events and 10% background. Since a high-intensity kaon beam is required to collect enough statistics, the L0 trigger plays a fundamental role in both the background rejection and in the particle identification. For this reason, a complex Trigger and Data Acquisition (TDAQ) system has been designed. This is divided in three different main levels: a hardware trigger (Level 0) and two software levels (Level 1 and Level 2). In particular, the Level 0 Calorimeter (Cal-L0) Trigger is a parallel system based on TEL62 cards able to identify clusters from different calorimeters: electromagnetic (LKR, IRC and SAC) and hadronic (MUV1 and MUV2). The Cal-L0 trigger receives digitized data from all detectors readout through the Calorimeter REAdout Modules (CREAM) and it performs trigger algorithms, sends trigger primitives to the L0 Trigger Processor, and sends filtered calorimeter raw data to the DAQ system. The Cal-L0 trigger outputs consist of a time-ordered lists of the reconstructed clusters together with the arrival times, positions, and energy measurements. The system has been designed to sustain the instantaneous hit rate of 30 MHz, to process data with a maximum latency of 100 us, and to achieve a time resolution of 1.5 ns on the single cluster. These boards are arranged in three different layers of boards: Front-End, Merger (only for LKR calorimeter) and Concentrator. The Front End boards receive trigger sums from the CREAM, perform peak searches in space and compute time, position and energy for each detected peak. The Merger boards (only used for the LKR) receive trigger data from the Front-End boards and merge peaks from different Front-End boards into single clusters. Finally, the Concentrator boards receive reconstructed clusters from the five NA62 calorimeters, perform cluster counting, calculate sums for electromagnetic and hadronic energy and generates trigger primitives for the L0 Trigger Processor. The whole Calorimeter trigger system is composed of 37 TEL62 boards, 185 mezzanine cards and 221 high-performance FPGAs. These boards are arranged in three different layers of boards: Front-End, Merger (only for LKR calorimeter) and Concentrator and each of them is controlled by an on-board PC with fast Ethernet connection.

The system was installed and has started to take the first physics data in autumn 2014. In this contribution we present the architecture of the Cal-L0 trigger processor with particular emphasis on the performances and the operation during the 2015-16 high intensity data taking for the photon veto in the 1-8.5 mrad decay region.

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