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First Operation of the Level-0 Trigger of the NA62 Liquid Krypton Electromagnetic Calorimeter

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The setup of the experiment NA62, studying ultra-rare decays of charged kaons at the CERN SPS, is going to be completed for the first physics data taking in the autumn of 2014. We present the final design, implementation and the first on-field performance tests of the Level-0 trigger system of the Liquid Krypton calorimeter, photon veto in the 1-10 mrad region. The system is composed of 36 readout boards (TEL62), 108 mezzanines and 215 FPGAs. It identifies electromagnetic clusters, with an instantaneous hit rate up to 30 MHz, providing information on time, position and energy.

Summary

The goal of the NA62 experiment at CERN SPS is a precision measurement of the branching ratio of the ultra-rare kaon decay $K^+ \to \pi^+ \nu \bar{\nu}$ with 100 expected events and 10% background in two years of data taking. A system of different detectors is needed to achieve an high rejection factor for photons coming from the $K^+ \to \pi^+ \pi^0$ decay, one of the main background sources.
As part of the photon veto, in the 1-10 mrad angular region, the NA48 liquid krypton high-performance electromagnetic calorimeter is reused with an upgrade of both the detector and the trigger electronics.

The object of this contribution is the level-0 trigger for the electromagnetic calorimeter: it identifies electromagnetic clusters in the calorimeter and sends to the Level 0 Trigger Processor a time-ordered list of reconstructed clusters with their arrival time, position, and energy measurements. The trigger is 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.

The trigger design is based on a system of custom readout boards of the experiment (TEL62), 9U size, which can host various mezzanine cards thanks to five 200-pins high-speed connectors. Each TEL62 board is controlled by an on-board PC with fast Ethernet connection. In total, the calorimeter trigger system will be composed of 36 TEL62 boards, 108 mezzanines and 215 high-performance FPGAs. They are combined in a three layers parallel system, divided in front end and concentrator boards.

The readout electronics of the liquid krypton electromagnetic calorimeter reads and sums together the energy deposits in tiles of 16 calorimeter cells. Digitized data are then

transmitted from the readout boards to the Level 0 Trigger over shielded copper twisted pair cables on 864 digital channels. The first (front-end) layer of 28 boards deserializes the incoming data (trough the TELDES mezzanine boards) and performs a parabolic fit to obtain an accurate estimate of the peak amplitude, and then applies a constant-fraction discriminator to measure the cluster arrival time. Since clusters may hit more than one calorimeter tile, the second (concentrator) layer of 7 boards performs cluster reconstruction by merging the information transmitted (trough a custom 4.8 Gbps link) by the first layer and implements additional peak finding algorithms. The final concentrator board is connected to the L0 Trigger Processors and generates and transmits the time-ordered list of the reconstructed clusters.

Since the first data taking is scheduled for October 2014 and the whole trigger system will be commissioned by then, we aim at presenting the whole system and the first performance results obtained at the experimental site.

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