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A digital calorimetric trigger for the COMPASS experiment at CERN

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In order to provide a trigger for the Primakoff reaction, in 2009, the trigger system of the COMPASS experiment at CERN will be extend by an electromagnetic calorimeter trigger. Since it was decided to gain from various benefits of digital data processing, a FPGA based implementation of the trigger, running on the front-end electronics, which are used for data acquisition at the same time, is foreseen. This, however, includes further modification of the trigger system to combine the digital calorimeter trigger, with its higher latency, and the analogue trigger signals, which will although make use of digital data processing.

Summary

The COMPASS experiment is a fixed target experiment at CERN, which, since 2002, uses Muon and Hadron beams from the Super Proton Synchrotron to address widely spread tasks of Muon and Hadron spectroscopy. In December 2008, in favor of a possible Primakoff measurement, the decision to include the downstream electromagnetic calorimeter into the trigger system was taken. Investigating all possible option, the implementation of the calorimetric trigger was chosen to be a digital one. Respecting the requirements of the foreseen Primakoff measurement and its expected signature the scheme of the first implementation of the digital electromagnetic calorimeter trigger is a simple summation scheme, which uses the central part of the calorimeter. The design of the trigger system, thereby, make use of the FPGA based readout electronics by adding an additional data processing path into the FPGA. Thus the development and production of new hardware for the electromagnetic calorimeter trigger is limited to a custom VME backplane, which is designed to make the trigger system scalable up to the complete calorimeter. Most efforts are spend in signal detection and noise rejection on channel level. Thus the calorimeter does not need to be divided into relatively small trigger towers containing only a few cells, as it is done for analogue calorimetric triggers, but can use a global sum, to which a energy threshold is applied. Applying energy correlation coefficients on cell level the uncertainty of the energy sum is reduced.
Additional efforts have to be taken to combine the existing analogue trigger signals and the digital one with its by approximately 500 ns higher latency. Thereby the delay of the analogue trigger signals will be applied in a digital way using a FPGA, which also make up the final trigger decision. Thus the whole trigger setup will be an hybrid of analogue and digital electronics.
First simulations of the trigger scheme based on 2008 raw data show promising results regarding temporal and energy resolution. Especially the temporal resolution, which is measured to be 1.1 ns for cells, is of special interest to form a trigger decision using coincidence of measured signals. Due to the good noise suppression of the used algorithm the expected trigger rate at an energy threshold of between 20 and 40 GeV is in the order of 20 to 40 kHz, which is compatible with the limits implied by the data acquisition system of the experiment. Compared with the analogue ECAL trigger, which was used for a first Primakoff measurement in 2004, which had a energy threshold of about 80 GeV using 4x4 trigger towers, this is a major improvement. Thereby the uncertainty of the calculated energy, dominated by rounding errors, which are enrolled by communication limits of the existing front-end electronics, are in the order of only a few GeV.
The trigger concept and implementation as well as monitoring should be present. The performance of the trigger system during the data tacking in 2009 in comparison to the expectations gained from the simulations will although be part of the presentation.

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