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The NA62 spectrometer acquisition system

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The NA62 main spectrometer consists of ~ 7000 straw tubes operating in vacuum. The front-end electronics is directly mounted on the detector. The front-end board provides the amplification, shaping, discrimination and time measurement of the analog signals from 16 channels. After digitization the data is sent to a VME 9U read-out board. The data, once matched with the trigger, is sent to the pc-farm and processed with the trigger level 1 algorithm. The front-end and read-out systems of the detector will be presented along with the first results of the detector performances.

Summary

The NA62 experiment at CERN is a fixed target experiment, it is located in the north area SPS high intensity facility. It aims at a precision measurement of the ultra-rare decay $K^+ \rightarrow \pi^+ \nu \bar{\nu}$. In order to achieve this goal a low mass ($1.8\% X_0$) spectrometer has been built to track charged Kaon decay products. The detector consists of ~ 7000 straw tubes operating in vacuum. The readout system has been designed to sustain an average rate of 60 kHz and a peak rate of 800 kHz per channel. The front-end electronics board processes the analog signals extracted from 16 straws through a flex-rigid PCB (WEB). On the front-end board (COVER) the signal is shaped, amplified and discriminated by an ASIC chip (CARIOCA). The digitized data is sent to the on-board FPGA which contains 32 TDCs with $0.23ns$ ($0.78ns/\sqrt{12}$) resolution. Two TDCs per straw provide the time information for both leading and trailing edges. The clock is external in order to synchronize the readout boards of the whole detector and match them time-of-flight of particles. The COVER should be also able to sustain almost 1 bar of over pressure in case any structural failure will compromise the vacuum tightness of the detector. The data is transferred by custom protocol, RJ45 based serial links to the Straw Readout Board (SRB) that is implemented as a VME 9U board. Time re-ordered data is accumulated in QDR memory based circular buffer that is able to store $1ms$ of data, enough to absorb all latencies required for trigger level 0 processing. Upon arrival of the trigger level 0 decision the time-matched data is selected and packed in IP/UDP Ethernet frames. The maximum data throughput is estimated to be of the order of $1.3Gb/s$ per board, for this reason two gigabit Ethernet ports are installed on each SRB. For on-line monitoring, the data is sampled and stored in DDR3 memory and collected using VME read-out. VME access is also used for SRB configuration, monitoring and control. During the NA62 pilot run (October-December 2014) the detector collected a considerable amount of data, enough to measure the detector performances. Stability of the DAQ system has been successfully tested with a beam intensity up to 20% of the nominal. After channels time alignment the radius-time curve (r-t curve) has been measured using a special "muon data-set". A GARFIELD simulation was also developed and successfully compared with data (leading time distribution and r-t curve).

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