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The NA62 GigaTracker Detector

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The GigaTracker (GTK) system is a magnetic spectrometer made of 3 detector stations and 4 achromat magnets for the NA62 experiment. NA62 aims to measure the branching ratio of the ultra-rare $K^{\pm} \rightarrow \pi^{+}\nu\bar{\nu}$ at the CERN SPS. The detector measures the momentum, direction and crossing time of all the secondary beam charged particles. The detector has to cope with a non-uniform beam rate as high as 750 MHz, with a an expected peak rate of 1.3 MHz/mm^2 around the centre and provide a time resolution better than 200 ps.

Each detector station is built using hybrid silicon pixel detectors (60.8mm x 27mm active area each) installed in vacuum and it is cooled through an innovative micro-channels system, etched inside a few hundred of microns thick silicon plate. Each station is made of a 200 μm thick silicon sensor read out by 2x5 custom 100 μm thick ASIC (TDCPix), for a total thickness of less than 0.5% of X/X$_0$ and 18000 channels. The TDCPix was specifically developed using a 130 nm CMOS process and incorporates all the electronics needed to perform hit arrival time measurements. Each TDCPix chip contains 40 x 45 asychronous pixels, each one 300 μm x 300 μm, and has 100 ps bin TDC converters.

To cope with the high rate each TDCPix is readout via four 3.2 Gb/s serialisers sending continously data to custom FPGA made off-detector read-out boards (GTK-RO) placed outside of the experimental area. Each boards receives the data of one chip and buffers them while waiting L0 trigger decision which arrives with a maximum latency of 1 ms. Upon reception of a trigger decision, the boards select the data that fall in a 75 ns time window around the selected timestamp. Then they send the data to sub-detector PCs: each board uses UDP packets over two 1 Gb links. The maximum trigger frequency that the GTK-RO board must sustain is 1 MHz. The boards also distribute timing and control signals to the TDCPix.

The purpose of the sub-detector PCs is to merge the data fragments coming from the 10 GTK-RO boards serving one GTK station and send complete events to the online farm. Since the foreseen rate for each GTK-RO is of the order of 1 Gbps, we use an ethernet switch with 24 gigabit ports and 2 10Gb ports as a multiplexer: each PC uses one 10Gb link to receive the data coming from 10 GTK-RO boards, and a second 10Gb link to send the data to the online farm. Each PC runs Linux, and to achieve the full 10Gbps throughput we use the "zero copy" module of the PF_RING libraries to avoid unnecessary memory-to-memory copy.

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