Design and Development of the Software and Computing Framework for the L1/L2 Online PC Farm of the NA62 Experiment at CERN

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Starting in 2013/2014, the NA62 experiment at the CERN SPS will collect about 10^{13} decays of the charged K meson to precisely measure the very rare decay $K^+ \to \pi^+\nu\bar{\nu}$. In total, more than 2 TByte/s of raw data have to be processed with an average rate of 10 MHz. While the first, hardware-based trigger level (L0) reduces the rate by a factor of 10, the remaining data reduction by a factor of more than 100 will be performed on an online PC farm.

For this PC farm, a completely new concept was developped and the corresponding framework was implemented and tested. It physically and logically combines the trigger level 1 (L1, subdetector level) and 2 (L2, event level and event building) into one single, completely homogeneous PC farm. For all sub-components, the digitized raw data of a series of L0-accepted events are sent to one single farm node, which performs all L1 computations simultaneously as well as — in case of a positive L1 trigger decision — the event building and the L2 trigger decision (see Figure).

Compared to the previous and more common scheme of separated L1 and L2 farms, this new layout has significant advantages: All PCs are optimally used and no assumptions on the performance of the L1 algorithms and PCs need to be made. Therefore, the system is easily scalable by simple addition of more computing power. Moreover, the common problem of fixed-target experiments of continuous data collection during burst time alternating with longer out-of-burst periods, which results in waiting times and inefficient data processing, is overcome by all data being present in one single node during the complete processing. Hence the data flow is greatly optimized and allows significant savings in hardware or, on the other hand, free resources for triggering on other rare kaon decay signatures in addition to the main channel $K^+ \to \pi^+\nu\bar{\nu}$.

We present the concept, design, and the specific implementation of the NA62 online PC farm, as well as the results of the performance from both a test system and a preliminary run with the already existing NA62 detector components.