

The NA62 run control

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Abstract. The NA62 experiment at CERN SPS will soon start taking data to measure the ultra-rare decay $K^+ \rightarrow \pi^+ \nu \bar{\nu}$. The background rejection factor of 10^{12} requires a large number of VETO and particle identification detectors as well as momentum measurement spectrometers. All components are included in the Trigger and/or Data Acquisition system. The RunControl has been designed to centrally link them to achieve their control and monitoring while still allowing non-experts shifters to run the experiment easily.

1. Introduction

The NA62 experiment at the CERN SPS aims to collect about 100 events of the ultra-rare kaon decay $K^+ \rightarrow \pi^+ \nu \bar{\nu}$ with less than 10% background over 2 years of data taking. This process is forbidden at tree level and can occur only through a Flavour Changing Neutral Current loop. It is theoretically very clean, the short distance contribution dominates and the hadronic matrix element can be related to other well measured processes. The prediction of the branching fraction by the Standard Model has been computed to an exceptionally high degree of precision[1]: $BR(K^+ \rightarrow \pi^+ \nu \bar{\nu})_{th} = (7.81 \pm 0.75 \pm 0.29) \times 10^{-11}$.

This channel is therefore an excellent probe of the standard model as any small deviation from this value would indicate new physics. The combined experimental value for this branching ratio is $BR(K^+ \rightarrow \pi^+ \nu \bar{\nu})_{exp} = (1.73_{-1.05}^{+1.15}) \times 10^{-10}$, extracted from the 7 detected events in the E787 and E949 experiments at Brookhaven National Laboratory[2] but its precision is not sufficient to be a significant test of new physics.

To achieve this ambitious goal, NA62 needs to consider at least 10^{13} K^+ decays from the secondary 75 GeV/c unseparated hadron beam with $\sim 6\%$ K^+ . The in-flight decay technique sets the scale of the detector which has a longitudinal extent exceeding 200 m, enclosing the 65 m long fiducial decay region.

2. The NA62 RunControl

The RunControl is a centralised control and monitoring application whose purpose is to allow a non-expert shifter to supervise the data taking easily while still giving specialists the possibility to achieve a high level of control of their own equipment.

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2.1. Technologies and architecture

In order to have a coherent system along with the other central control systems of the experiment (DCS, Gas System, Cryogenics) the industrial software “WinCC Open Architecture” was a natural choice. This software is the central part of two frameworks - JCOP and UNICOS - already widely used at CERN for the LHC experiments. Some of the components provided by these developer toolkits are of special relevance for NA62:

- DIM (Distributed Interface Management) as the communication layer between the RunControl and the equipment spread across the experiment[3].
- The FSM toolkit managing finite state machines with SMI++ processes[4] according to their definition (states, transition rules, actions).
- The configuration database tool to define and apply sets of parameters from database.
- The Farm Monitoring and Control for the management of the PC farm.

The software is implemented as a hierarchical tree of Finite State Machine (FSM) where the state of each node is either defined by a set of rules summarizing the state of the children nodes or by the evaluation of logical expressions involving parameters provided by the devices.

The leaf nodes of the FSM tree model hardware or software devices (boards, computer, crates and control softwares). The internal nodes group their own children nodes into logical subsystems (subdetectors, PC farm). Finally the top node represents the global state of the experiment.

A change of state is always propagated upwards from the device where this change originated to the top node. Conversely, a command can be issued at any node and is always propagated downwards to all the children until it reaches a device node. At this point, the command is formed and transmitted through the network using the DIM protocol. This command is received by the device control software implementing a standardized interface and encapsulating the knowledge of the device, which will then execute the proper sequence of actions on the hardware.

2.2. Infrastructure

The RunControl is a distributed system spread across different machines in the experiment. The core of the system is located on a dedicated WinCC OA data server on the technical network. A machine bridging the networks hosts the DIM managers which are responsible for loosely binding all the devices in the experiment and the RunControl. The DAQ of the experiment will continue to run correctly by itself in case of a connectivity problem or if this node is cut from one or the other network. As soon as communication is re-established, all the clients will reconnect to the DIM servers and the RunControl will resume control over the experiment. The bridge also receives external information such as the start and end of burst signals or information about the current run from the accelerator and beam line. The user interface itself runs on a different computer in the control room and is remotely connected to the main system.

References

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