THE DETECTOR SAFETY SYSTEM OF NA62 EXPERIMENT

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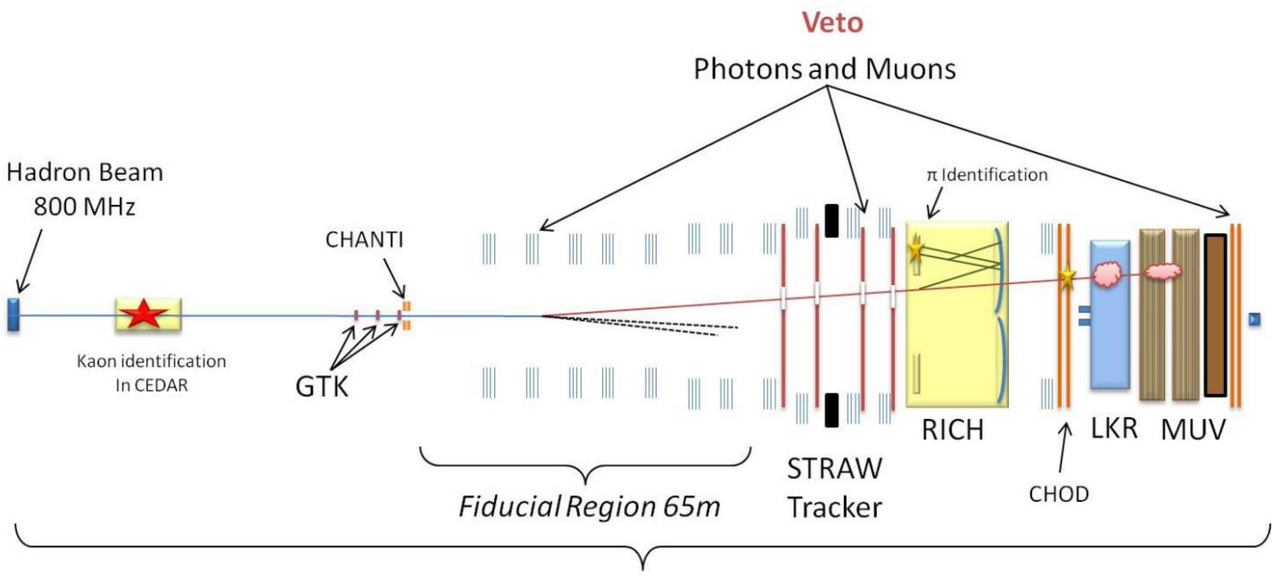
PH-DT Detector Technologies

NA62 EXPERIMENT

The aim of the NA62 experiment is the study of the very rare $K^+ \rightarrow \pi^+ \nu \bar{\nu}$ decay at the CERN SPS.



The NA62 experiment is composed of several sub-detectors installed in underground of the CERN SPS north area. 40 racks, with crucial and expensive equipment (HV and LV chassis) are installed along the experiment setup. This equipment is protected by the Detector Safety System (DSS) in case of abnormal and dangerous conditions.

DETECTOR SAFETY SYSTEM

A novel Detector Safety System has been designed to detect possible operational problems, take preventive actions, and to sense potentially dangerous situations at an early stage to bring the concerned systems into a safe state.

The DSS system should be:

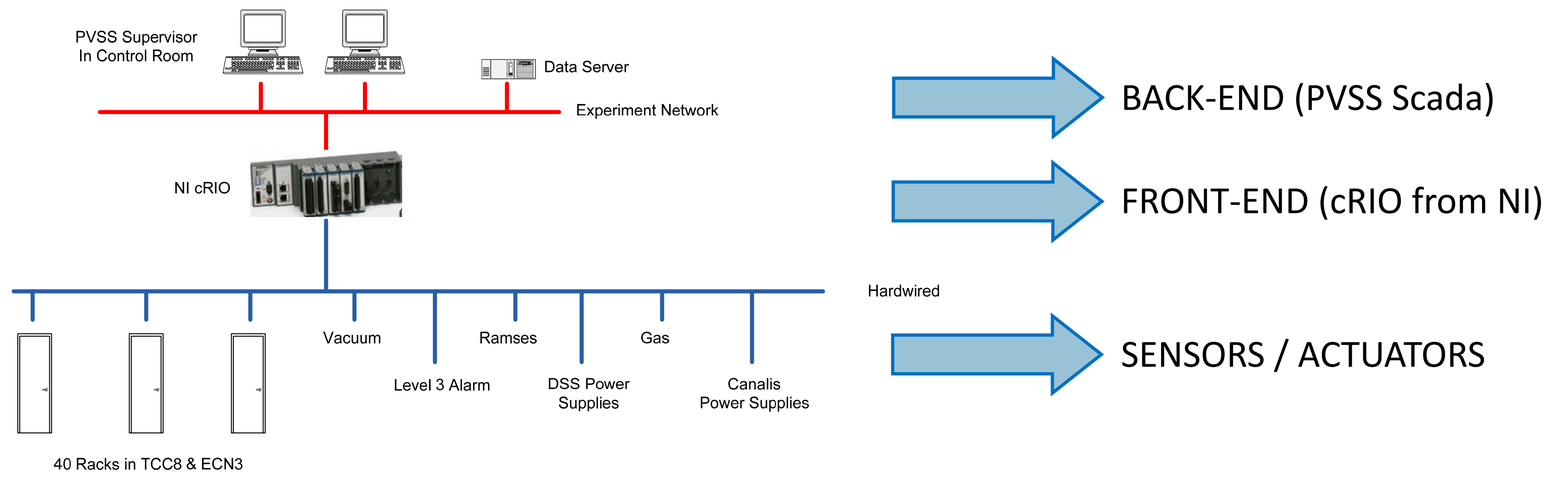
- Reliable, simple, robust and 100% available.
- Able to take immediate action to protect equipment.
- Maintainable over the lifetime of the experiment.
- Flexible and easily configurable.
- Supervised via PVSS.

The NA62 DSS system is required to check:

- The temperatures of 40 electronic racks.
- The vacuum conditions of the NA62 decay volume (≈500 m^3).
- The digital status of three radiation monitors.
- The level 3 alarms in the experimental area (fire, fsat stop emergency, evacuation and oxygen deficiency.
- The status of the gas for the Straw Tracker.
- The redundant power supplies of the DSS front-end.
- The status of the 220V power distribution.

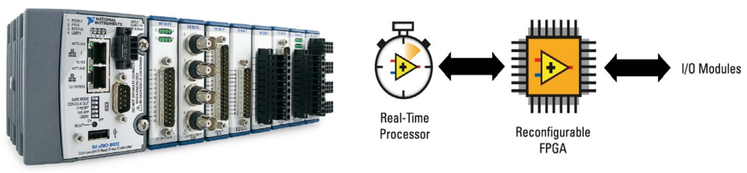
ARCHITECTURE

Due to the safety requirements for the system, the connections between sensors/actuators and the front-end are made hard-wired. The safety matrix in the cRIO controller is programmed in an FPGA and the data exchange with the supervisor is made with a real time processor via a communication bus (Modbus TCPIP). Thus any communication problem between the supervisor and the real time processor of the cRIO does not affect the safety system. The supervisor is a PVSS SCADA application and all data are stored in a data server.

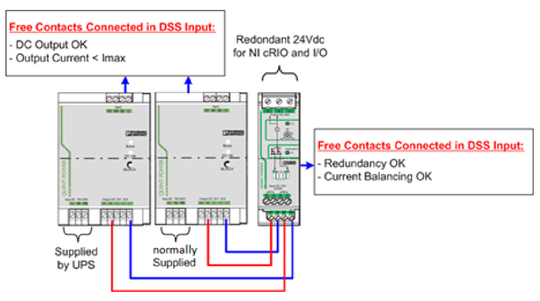


FRONT-END

cRIO is a reconfigurable embedded control and acquisition system developed by National Instruments, integrating a real-time controller, a reconfigurable FPGA and I/O modules. The real-time controller consists of a powerful processor for performing autonomous and deterministic applications. The FPGA is a programmable logic circuit, comparable to the hardwired logic.



The power supply of the acquisition system cRIO and I/O is the most critical part of the DSS system. In order to guarantee uninterrupted operation two redundant 24Vdc power supplies are used and supplied from an UPS. The 24Vdc power supply states are continuously monitored and generate an alarm on the DSS supervisor in case of a problem in one of the power supplies.



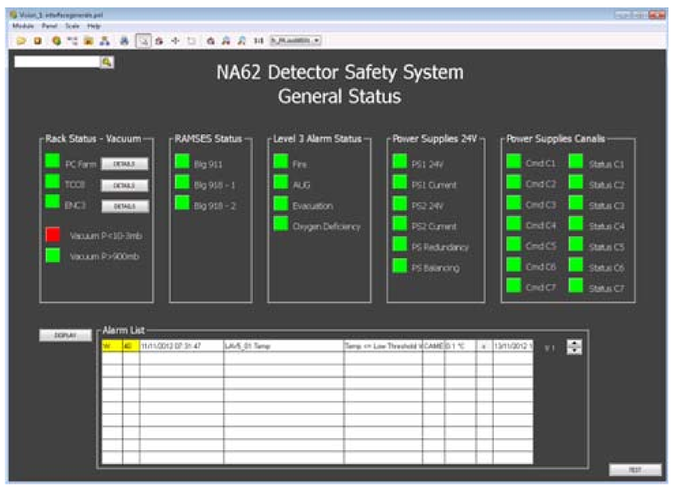
The communication between the back-end and the cRIO material has been realized by a Modbus TCP/IP protocol. it was developed and integrated in the real-time controller of the cRIO. The programming of the safety matrix was done in the Labview environment and implemented in the FPGA.

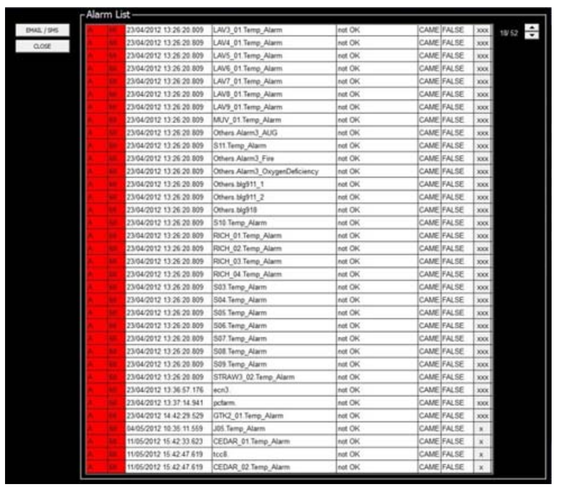
BACK-END

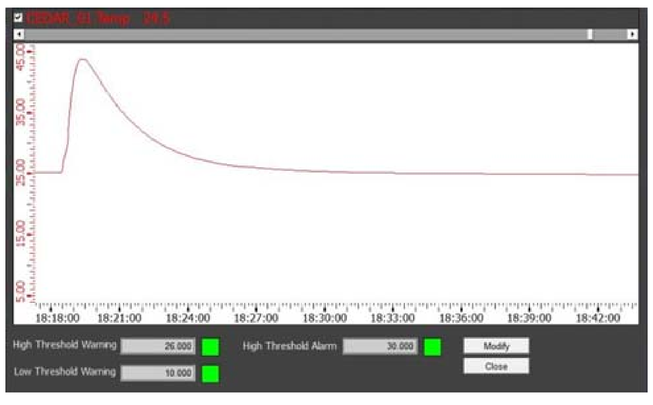
The human interface for the DSS supervisor must be PVSS SCADA which is the standard supervisor at CERN. The communication between the PVSS SCADA and the cRIO materiel has been realized by a Modbus TCP/IP protocol. The advantage of this solution is that an OPC server is not needed, as compared with the DSS systems used in the LHC experiments.

The DSS supervisor must provide the following functionalities:

- Graphical user interface displaying I/O, their status, and graphs of status and values as a function of time.
- Display and acknowledgement of alarms (mode Monitor).
- Administration of settings, e.g. change of alarm thresholds (mode Admin).
- Generation of alarms, send alarms per email or/and SMS.







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SUMMARY

The NA62 DSS system was installed and successfully tested during the Technical Run in autumn 2012. The solution based on cRIO components from National Instruments has proven to be fully satisfactory for the requirements of a Detector Safety System. This is the first time at CERN that the standard PVSS supervisor is used with National Instrument as front-end. The first experience during the Technical Run has shown that this architecture is appropriate and reliable, in particular during the vacuum commissioning where the DSS system has generated a large number of interlocks to the HV LAV. A PVSS warning message has also been reported following a JUMO temperature controller failure requiring the replacement of this element. The full completion of the DSS system, which will include the information from all the sub-detectors of the NA62 spectrometer, will take place during 2014.