New data acqusition system for the COMPASS experiment

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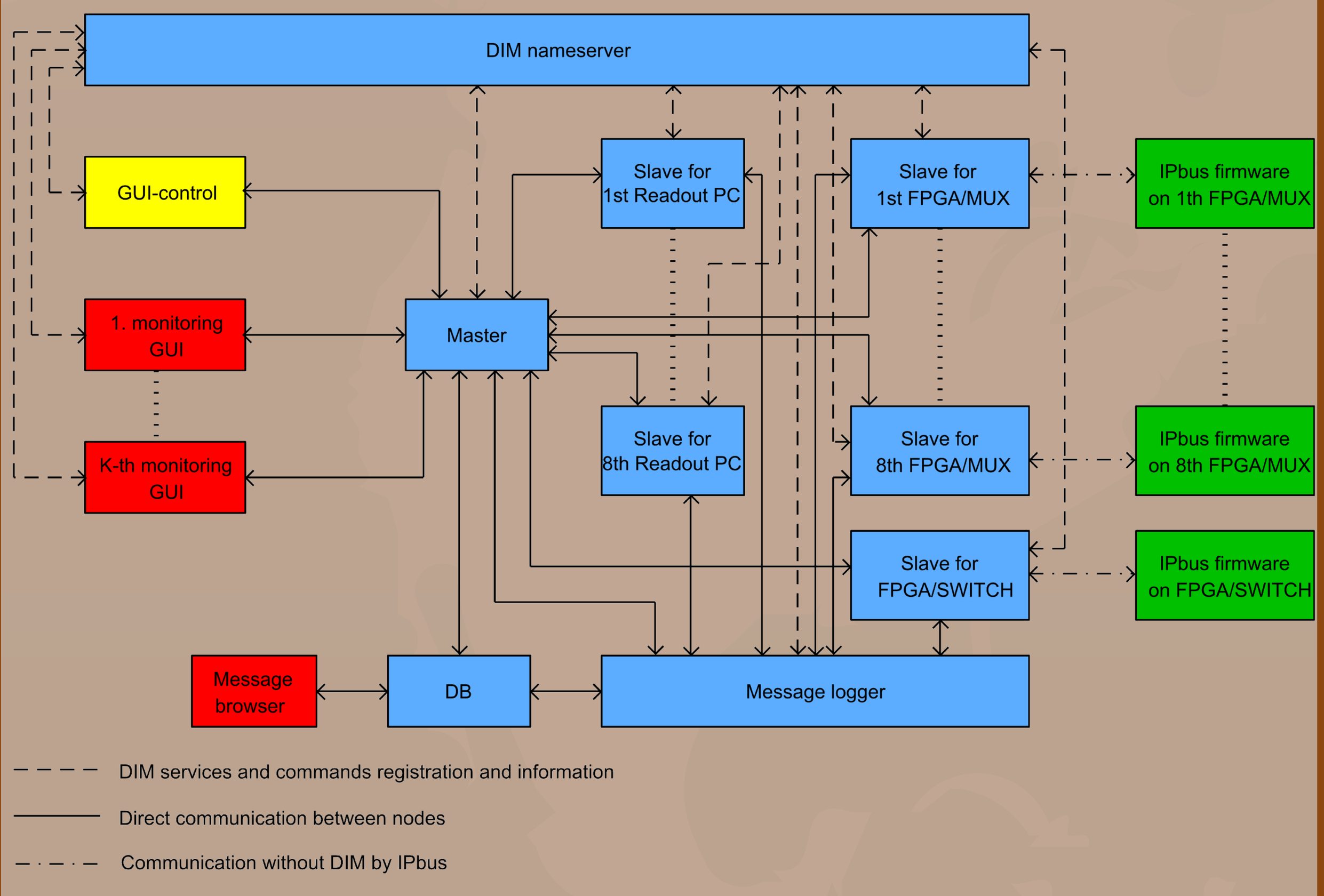
Software architecture

The new data acquisition system is a multilayer system centered around the Master process. The mutli-platform DIM library, that was originally developed for a transportation of messages in a DAQ of the DELPHI experiment at CERN, is used for the communication between the Master process and other processes.

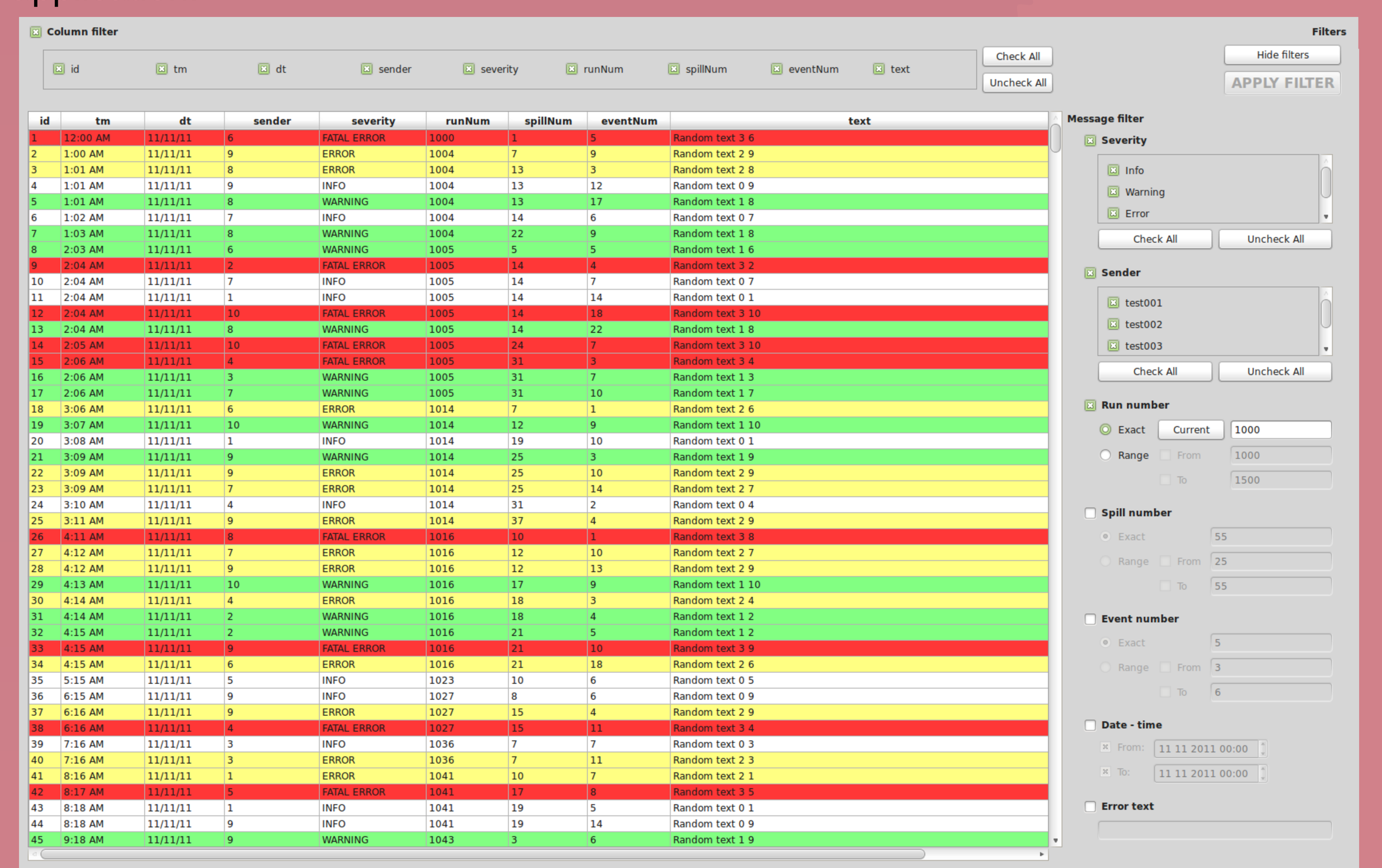
Main DAQ chain process types:

1. FPGA monitoring slave - monitoring and control of FPGA cards through the IPbus[7]
2. Readout slave - the data concentrator monitoring, the readout, and storing of full events from spill-buffer cards
3. Master process - handles all the main communication
4. GUI-control - serves for monitoring and control of the DAQ by a shift crew



Monitoring utilities

Several software nodes are used for the monitoring of the system. The Master process and Slave processes are able to generate informative and error messages that describe their behaviour. These messages are then sent to the Message logger process that evaluates them and eventually stores them into the online database. The Message logger uses the DIM library for communication with the rest of the system. All the stored messages can be then viewed by the Message browser application.



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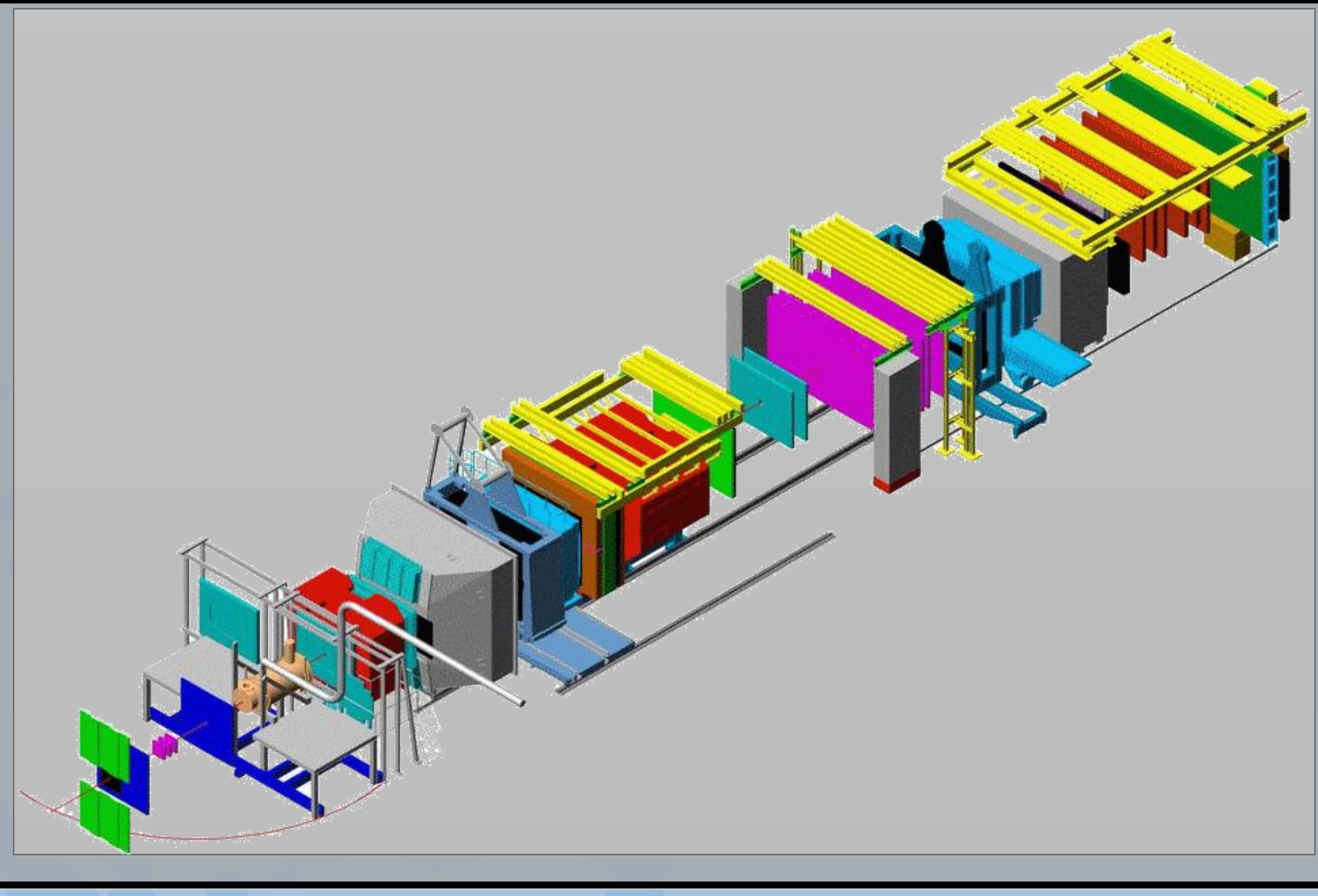
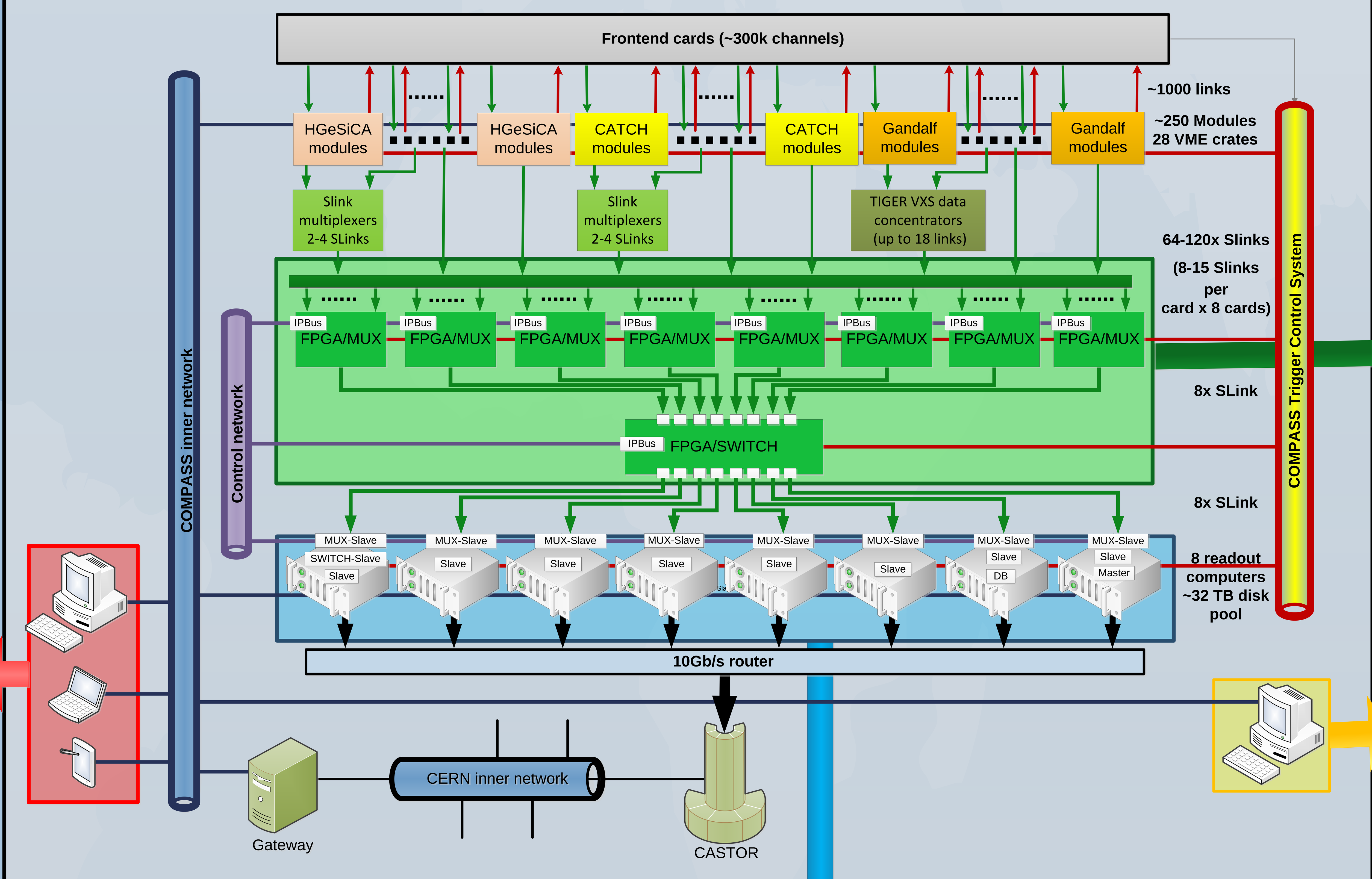
COMPASS experiment

COMPASS is a high energy physics experiment with fixed target situated at the SPS accelerator at laboratory CERN in Geneva, Switzerland. The scientific program covers studies of the gluon and quark structure and the spectroscopy of hadrons using high intensity muon and hadron beams.

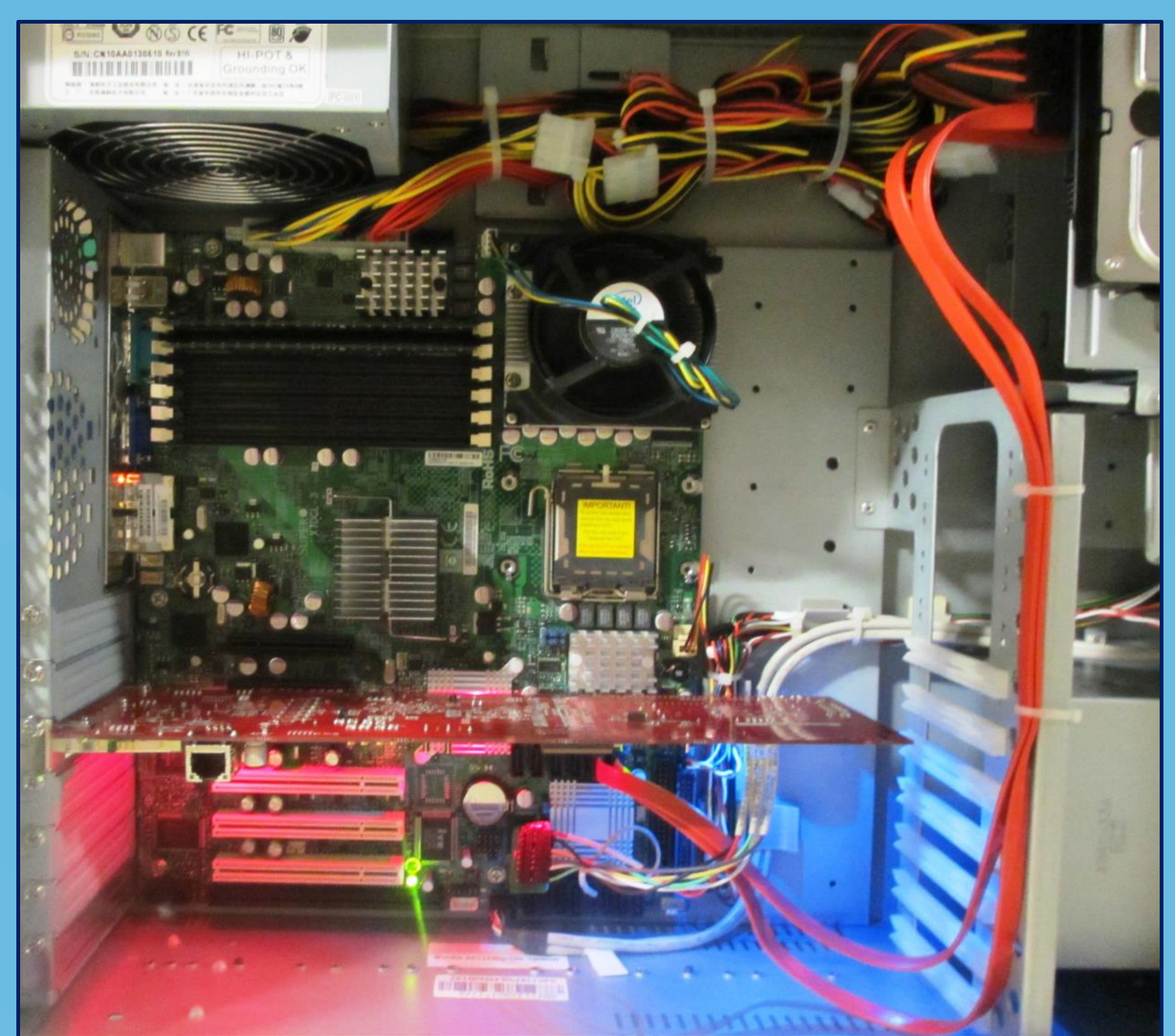
The existing DAQ architecture is more than 10 years old and is based on deprecated technology (PCI cards).

channels	250 000
avg. event size	35 kB
spill length	10 s
beam rate	$2\cdot10^8$
trigger rates	50 kHz
inspill data rate	1.5 GB/s
averege data rate	400 MB/s
data per year recorded	2 PB

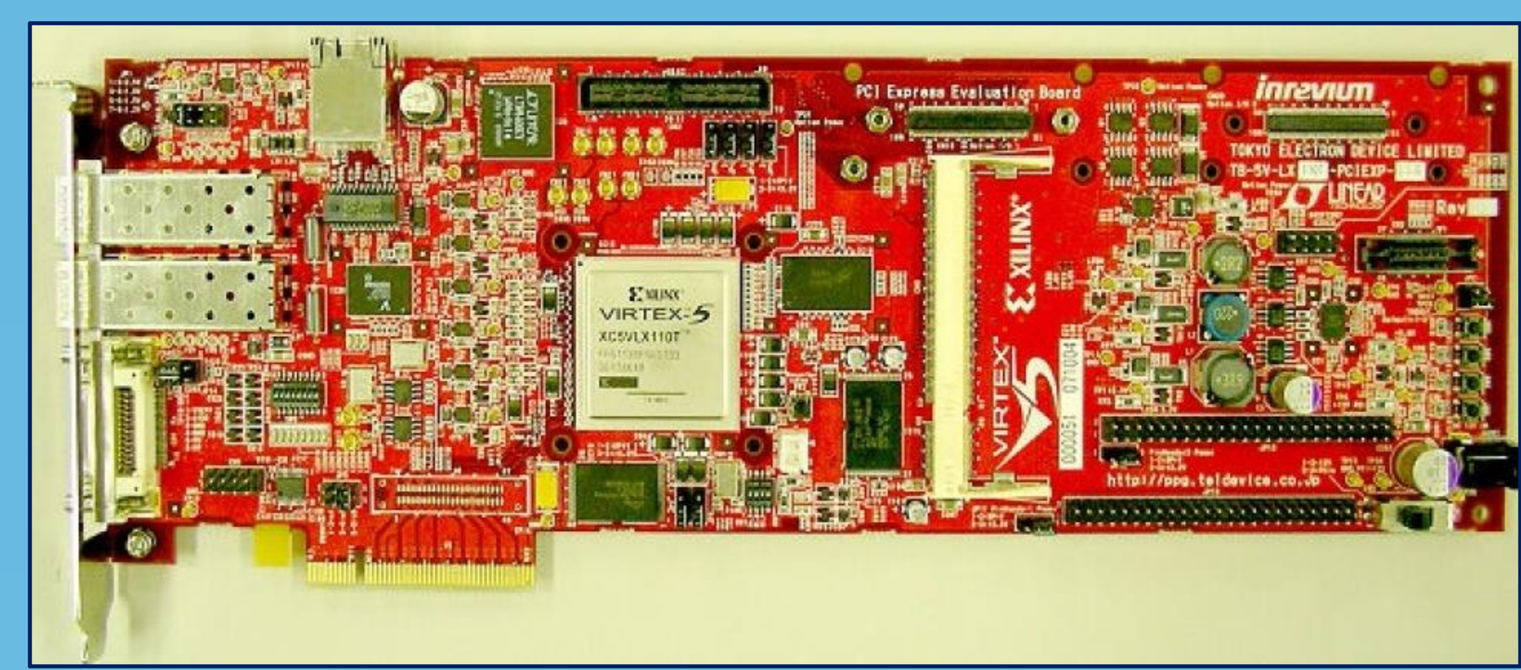




Data concentrators



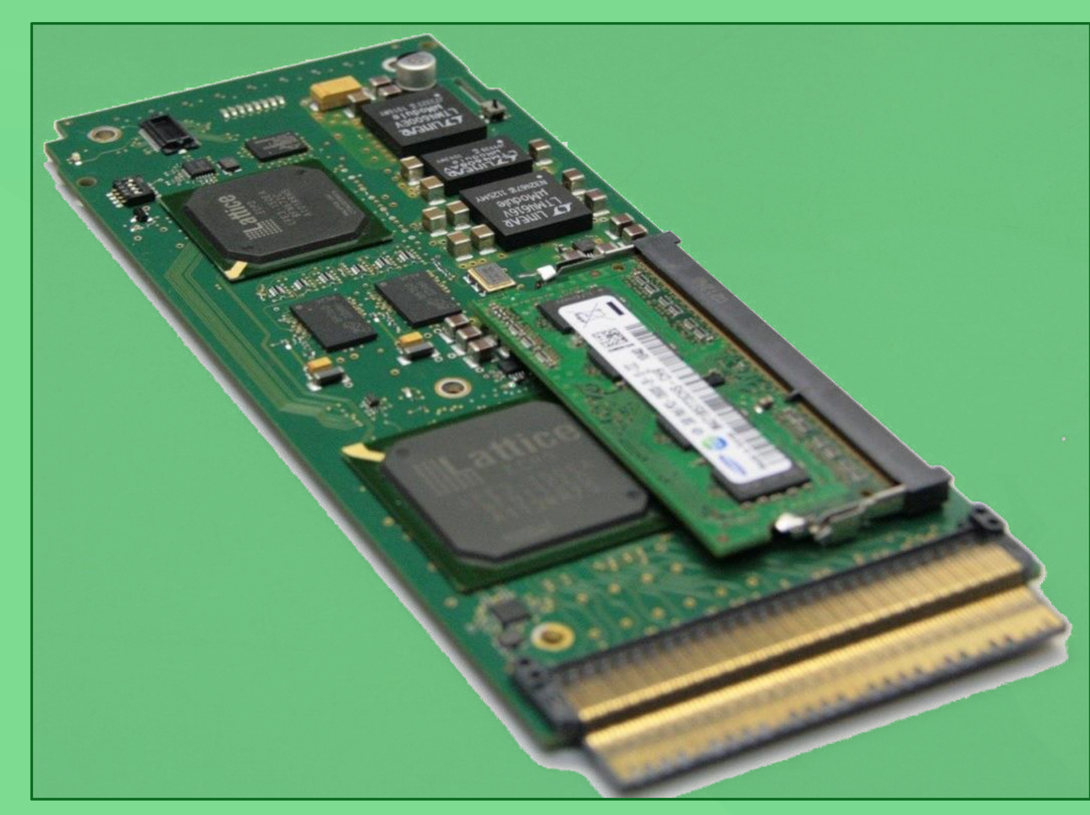
The data concentrator is a computer equipped with a PCIe spill buffer card. The Onboard memory averages in spill data rate of 320 MB/s to 60 MB/s by using off spill time.



Spill buffer card specifications:
2x Slink 160 MB/s
2 GB DDR2 memory
4 lanes PCIe
Virtex-5 XC5VLX110T

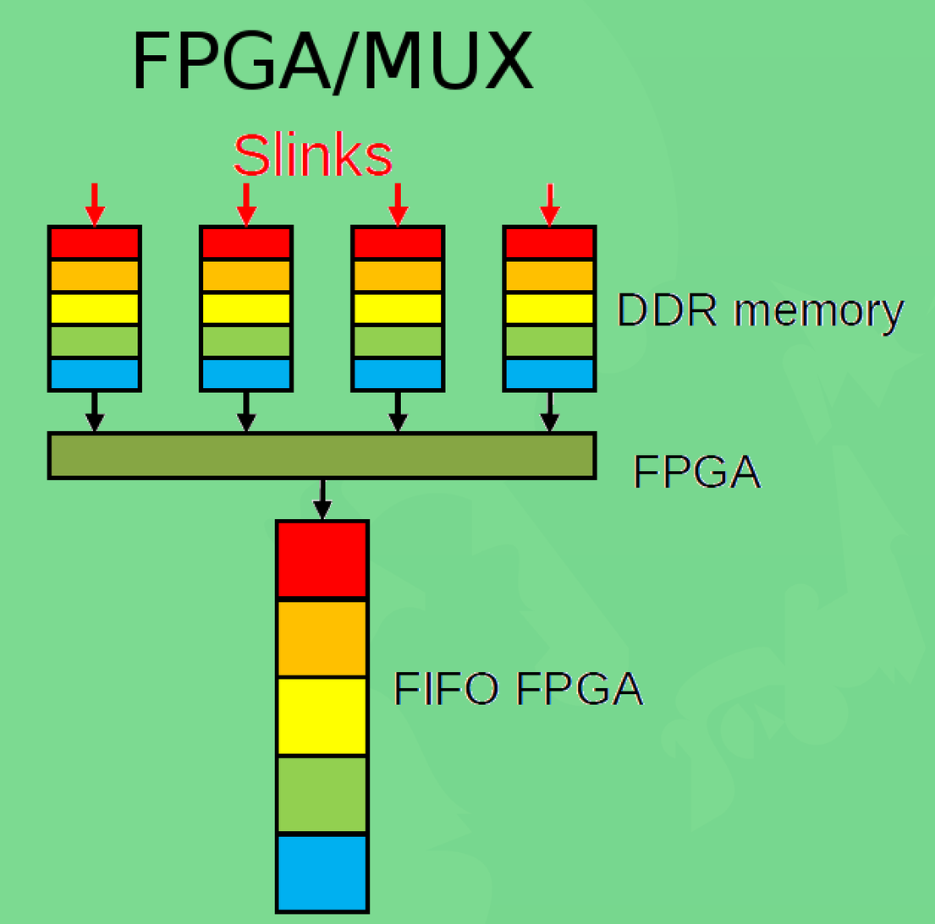
Minimal requirements for DC computers:
x64 processor 2.2 GHz 4 cores
4 GB DDR2 memory
500 GB RAID 5 disk array
PCIe 4x slot

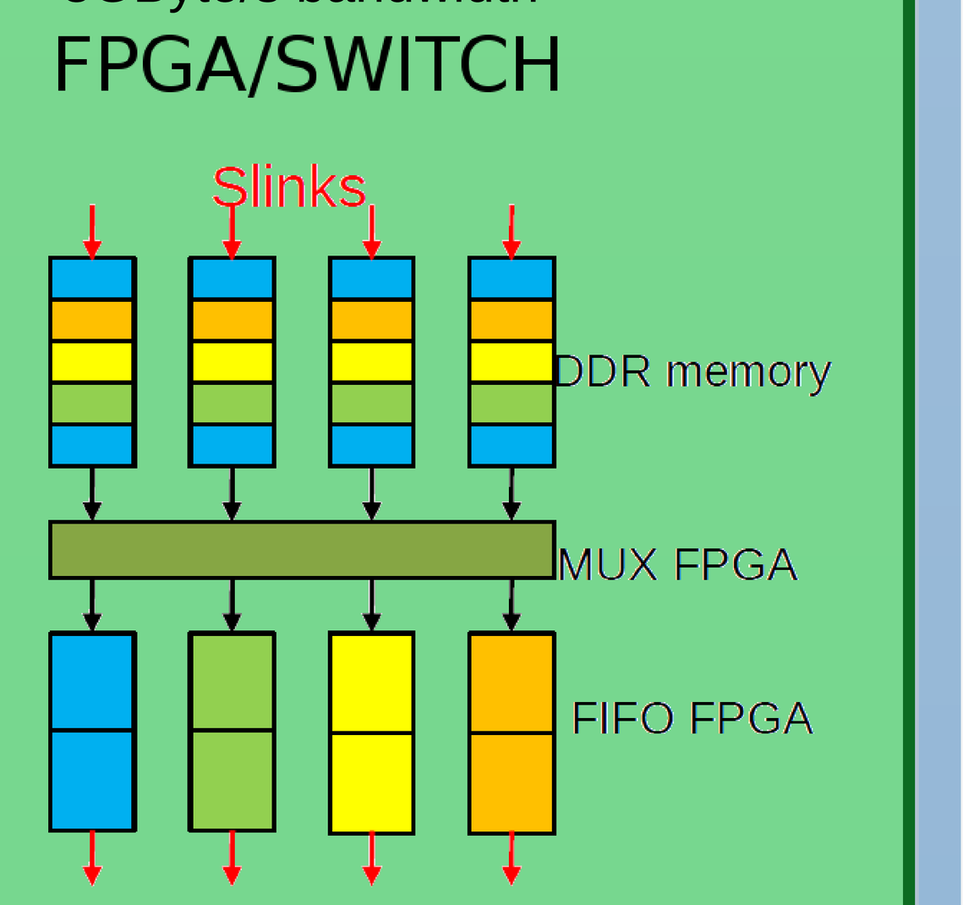
FPGA cards

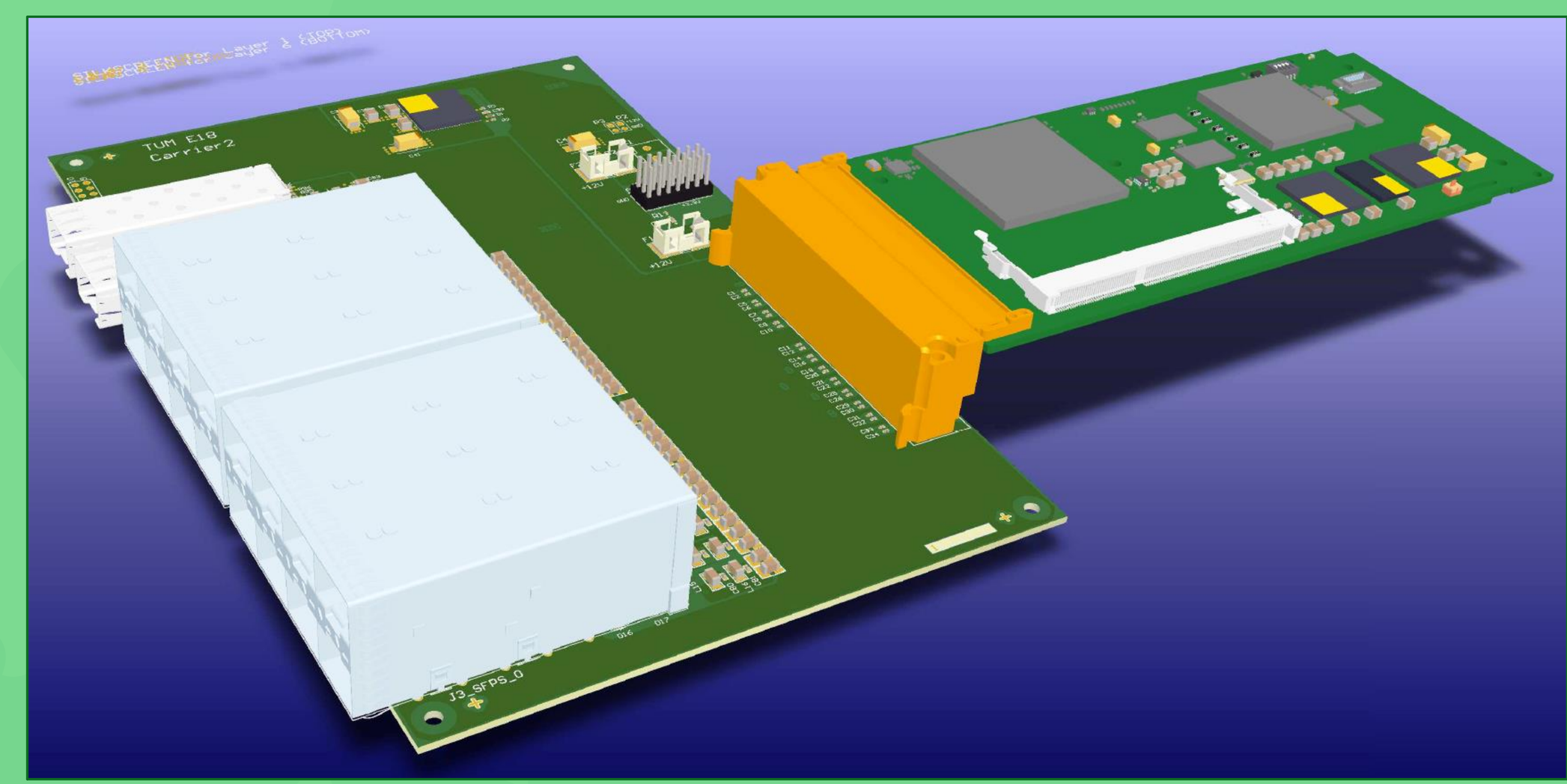


A field-programmable gate array (FPGA) is an integrated circuit designed to be configured by a customer or a designer after manufacturing. In our case the FPGA technology is used as a base for multiplexer and switch(event building) cards.

Specifications:
uTCA/AMC card
Lattice ECP3 FPGA
2GByte DDR3 memory
16x3.25Gb/s Serial Links
3GByte/s bandwidth



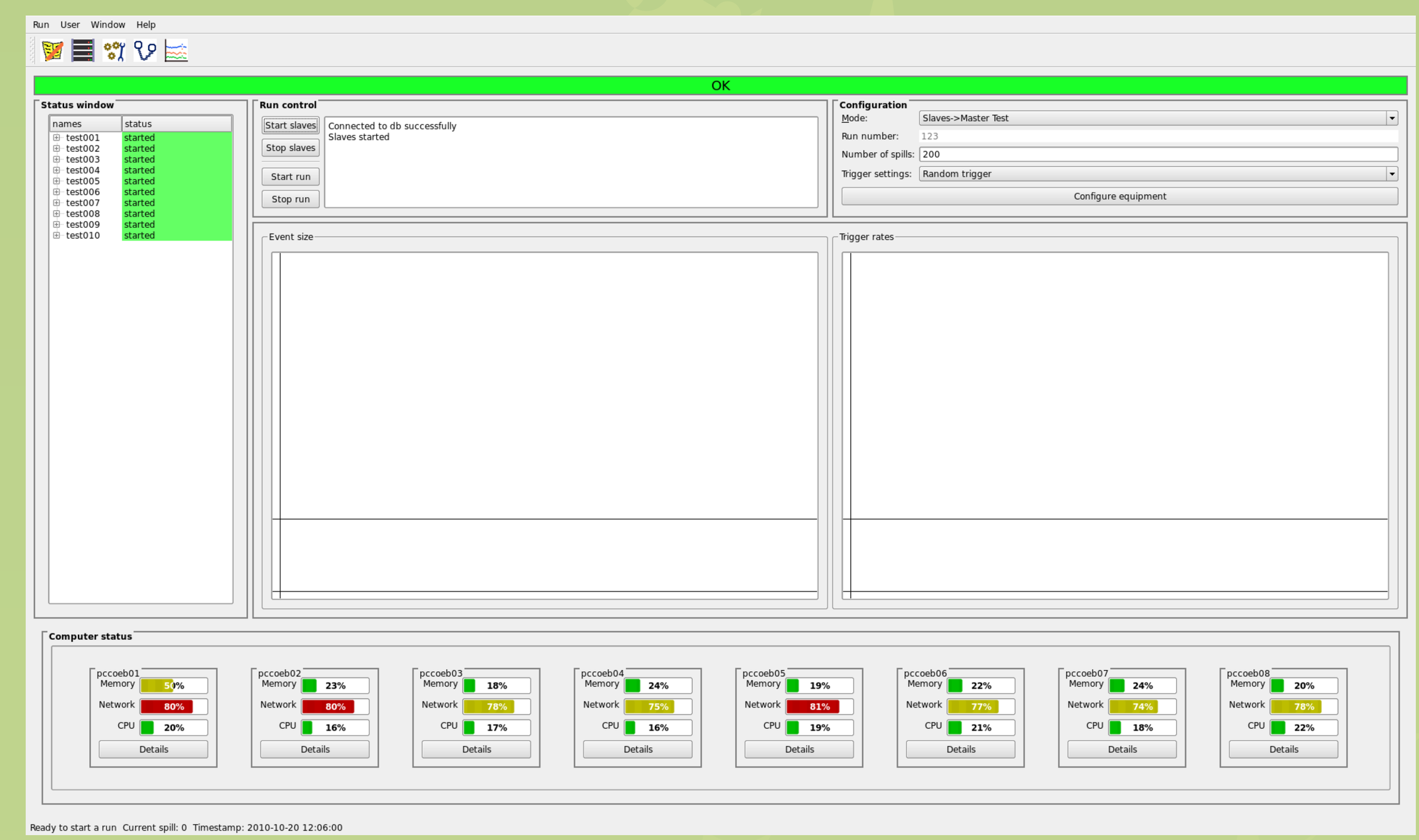




Run Control GUI

The Graphical user interface is being developed in the QT framework. It can run in two different modes. The basic one is a monitoring mode, this is accessible without any login and can run on many PCs simultaneously. The second mode is a control mode, where the operator can change the state of the DAQ system. Only one GUI of this type is allowed.

Modularity of this GUI is a matter of great importance, thus no one should be overwhelmed by the amount of information, but experts should still be able to find details they need for an error identification.



Conclusion and outlook

The existing data acquisition system of the COMPASS experiment based on the ALICE date package has been evaluated and it was decided not to use DATE for the development of the new system for its complexity.

Both the hardware and the software parts of the new system are still being developed. Some parts of the system have already been successfully tested - e.g. the communication between the Master process and Slave processes using the DIM library and basic tests of the software side of the IPbus with a dummy hardware.

The new system is to be extensively tested during the shutdown of CERN's accelerators in 2013 and if these tests prove successful, the new system should take part in COMPASS data taking since 2014.