REMOTE CONTROL ROOM FOR COMPASS EXPERIMENT

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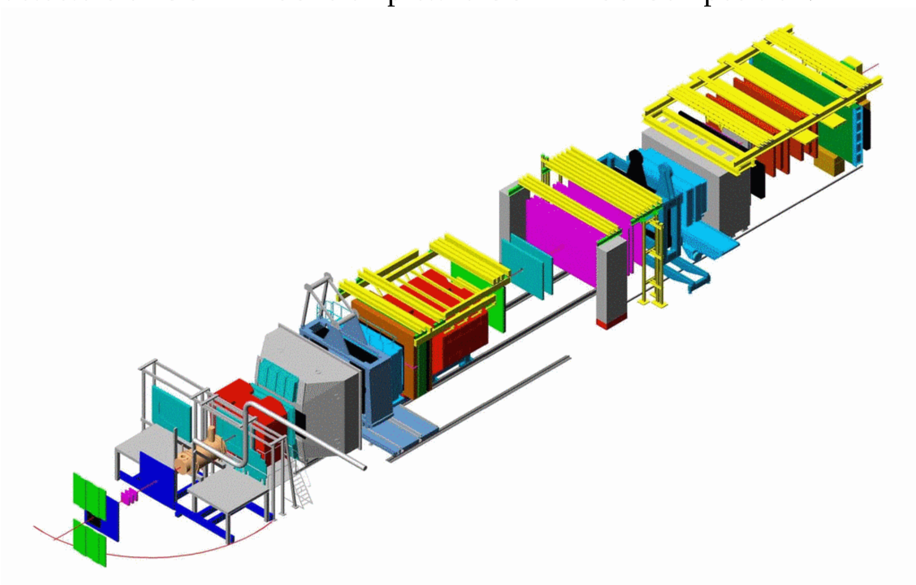
ABSTRACT:
There is a need to create the prototype of the remote control room for the COMPASS experiment. Solution has to be the robust and portable prototype of the whole control room. The implementation uses several PCs with kickstart installation. As a result there is a new control room with the same functionality as the original one. The prototype laid the foundation for spreading control rooms to the institutions involved in the COMPASS experiment.

KEYWORDS:
COMPASS, REMOTE CONTROL ROOM, DAQ, DATA ACQUISITION

COMPASS Experiment[1]

COMPASS is a high-energy physics experiment at the Super Proton Synchrotron (SPS) at CERN in Geneva, Switzerland. The purpose of this experiment is the study of hadron structure and hadron spectroscopy with high intensity muon and hadron beams.
Experiments were running during previous years since 2002. They are going to continue after a short stop on summer 2011.
Nearly 240 physicists from 11 countries and 28 institutions work in COMPASS.
Schema of detectors of COMPASS is on picture COMPASS Composition.



COMPASS Composition

Motivation

The COMPASS experiment is currently being monitored and controlled from the building 888 (experiment hall), where detectors are located, i.e. exactly where the beam of particles goes through. There are many advantages and also many disadvantages of this configuration.

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Advantage is that you can actually see the place you are trying to control. You can go around the place and check whether everything is on its spot and no malfunction occurred. On the other hand main disadvantage is simply, that you have to be in that very building and to perform any task you have to go to the experiment hall and do it there. Also the environment is little uncomfortable because it is actually a detector installation, not monitoring station.

It seems logical to try to make another room, which will also be possible to use for controlling the experiment. It could provide the same functionality in much more comfortable location. One should be able to perform the same task as in the old run control center, because otherwise it will make no use. It could seem to be great idea at all, but there are also disadvantages. Probably the biggest possible problem will be if something goes wrong. For example any of gas tanks starts to leak, some plumbing gets broken or any other malfunction happens. When you are on place you can immediately start to solve the problem issue. When you are not on place, somebody responsible must be contacted to get it done. It can take time and in the worst case it could even be late when the person responsible on place gets there. Because of that reason it is necessary to hold some people in or at least close to the building in the case of emergency.

Portability is also great advantage. Once configured and set up on one place, it is possible to make the exact same installation on basically any other place around the world with internet access (after solution of minor additional problems, which would cause the security of networking), thus it will be possible to make run controls from practically anywhere.

The initialization of the COMPASS Remote Control Room - Kickstart

The data acquisition system of the COMPASS experiment is running on tens of computers mostly with the Scientific Linux CERN operating system. Therefore, it is essential to automate the installation process. The Scientific Linux CERN uses the Anaconda system installation program that supports the unattended installation method based on the kickstart files. The kickstart file is a plain text file that contains instructions and options that are passed to the Anaconda program during the installation process. These parameters include location of the installation tree, disk partitioning scheme, network configuration, package selection, post installation tasks, and other relevant information. The kickstart files are published by the CERN Automated Installations Management Systems (AIMS) infrastructure. During the installation, the computer boots over a network and downloads the kickstart file. The kickstart file is passed to the Anaconda program which parses it, retrieves the installation tree, and attempts to start the unattended installation.

Computers in the COMPASS domain can be divided into several groups according to their purpose (run control, event building, readout, …). Typically, computers in a group share the same configuration which differs only in a network settings (i.e. hostname and IP address), thus the use of templates is supported. A template represents a group of computers; kickstart for individual machines are automatically generated from the templates. This greatly reduces time required to deploy the systems. Additionally, if some machine crashes during the data taking, it is very easy and fast to replace it by a new machine installed according to the same kickstart file. The kickstart file should be updated to hold the most recent configuration of software.

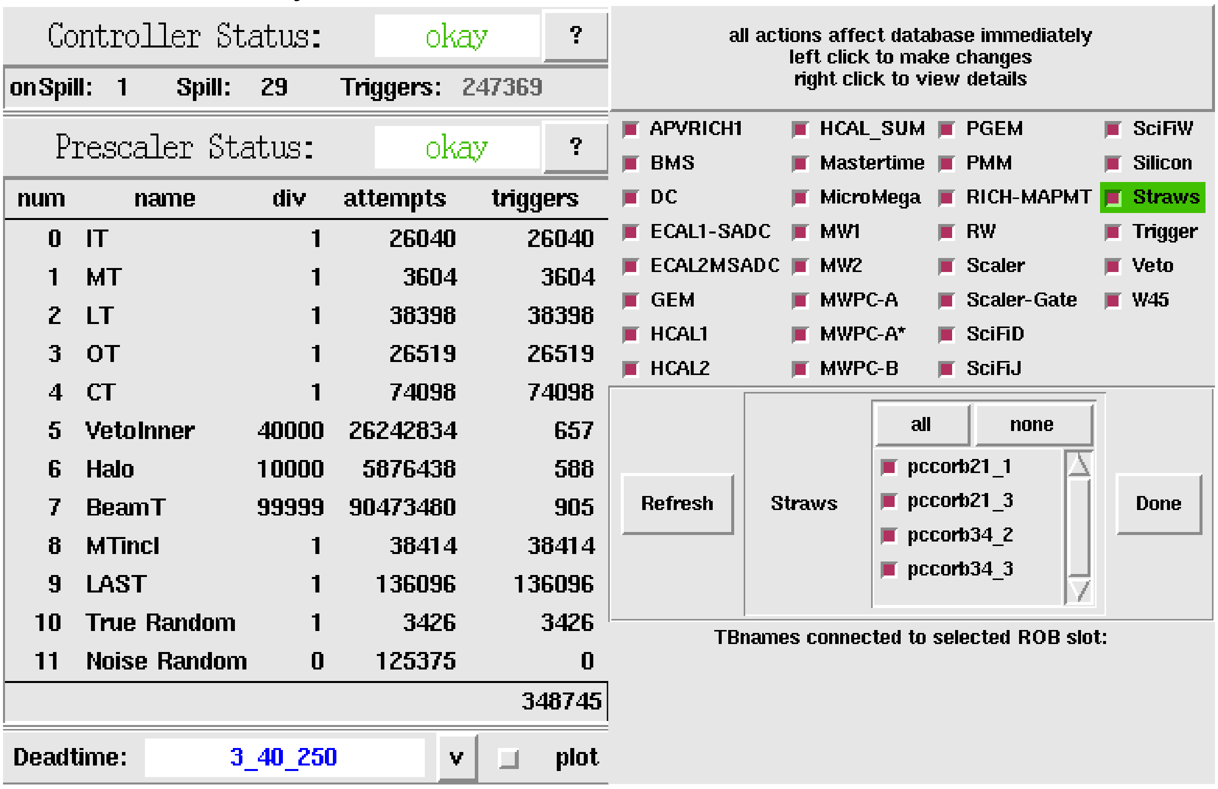
Software of the COMPASS Remote Control Room

Cesar

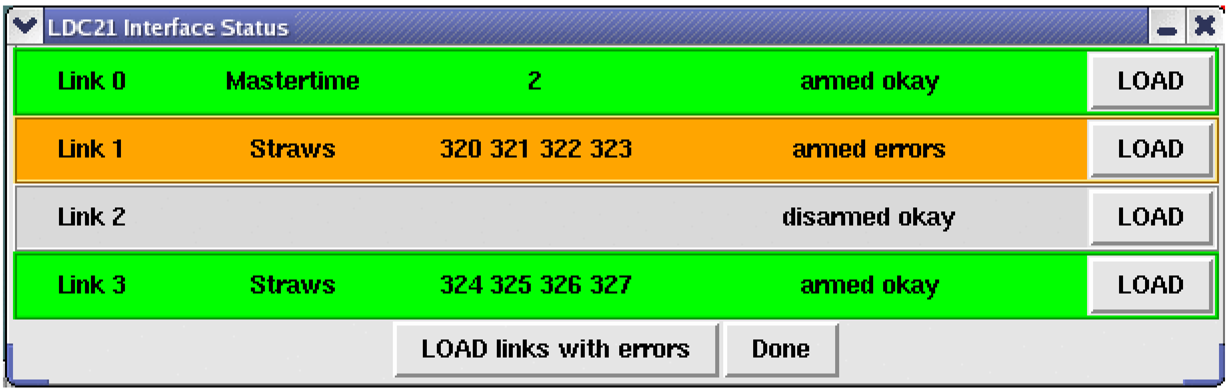
Cesar is the software running on the NetBeans platform. Its main purpose is to provide information about magnetic coils, beamline, shields, targets, and other devices. It can also handle them (for example it is possible to close the beam line with concrete shielding to allow entering the area and do the maintenance).

Date Control

The main purpose of the Data Control rests in data acquisition management. It allows operator to start the data acquisition, set filters and to create or edit triggers. Despite of this functionality the software provides run-time monitoring in the real-time. The Date Control software is intended to be executed on the Run Control machine. Regardless of the Run Control, the Data Control can run on another computer in the very same time. In this case only one instance has permission to manage and the rest of them will only be able to display the data and the status only.



Date Control: Controller Status (left), Detectors Settings (right)

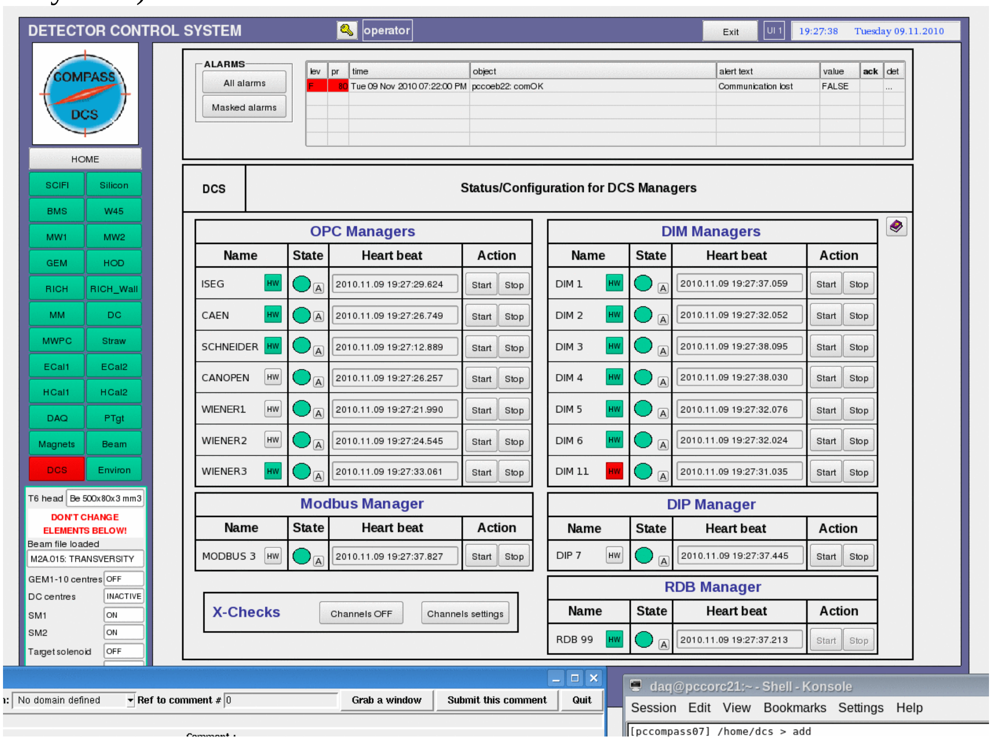


Date Control: Interface Status of Read Out Buffer

DCS

DCS (or the Detector Control System) is a complete user interface for setting and reading all the relevant parameters for the operation of various detectors and data acquisition elements such as gas pressures, voltages, temperatures and magnetic fields. Architecture of DCS allows to check and control a large variety of devices in a coherent and transparent way (such as control of crates and power supplies, monitoring of voltages and currents, monitoring of gas pressure, fluxes and mixtures in gaseous chambers, monitoring of temperature, humidity, pressure and magnetic field in specific places of experiment hall).

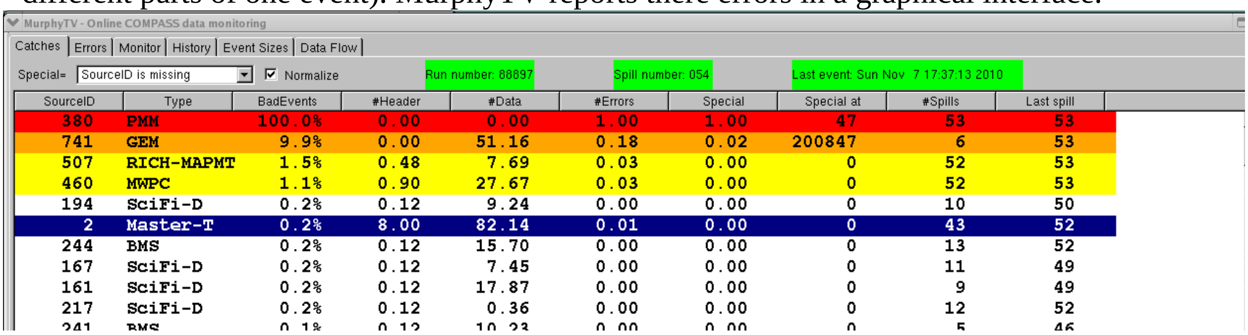
The DCS controls a large number of devices spread over 200 meters along the spectrometer and in the beam tunnel (a total of about 2000 high and low voltage channels are constantly monitored by DCS).[1]



DCS

MurphyTV

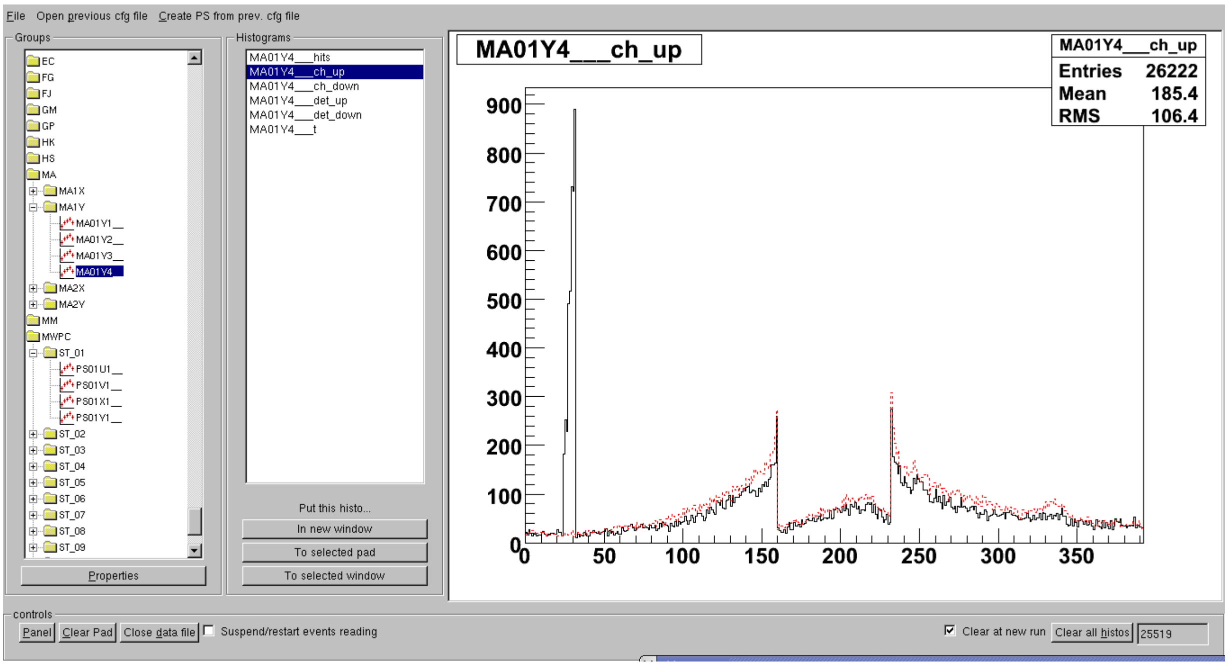
The read-out chain and the front-end electronics of the detectors are monitored by a software tool MurphyTV. Headers of events are read on the fly during the data taking and are monitored to test their quality. Failures are detected by error words generated before monitoring, or by inconsistent data format (missing headers, incoherent event numbers in different parts of one event). MurphyTV reports there errors in a graphical interface.[1]



MurphyTV

COOOL

Regardless of the data acquisition runs a software package named COOOL (**C**OMPASS **O**bject **O**riented **O**n**l**ine). The COOOL package is based on the ROOT[7] library and is designed to either obtain data from CASTOR (CERN's Advanced Storage) or to acquire online data during experiment and its pre-processing. Preprocessed data are then stored back into CASTOR or into COMPASS online databases. COOOL also provides user interface for real-time control of data which can be produced into histograms using ROOT. COMPASS experiment device contains over 200 detectors and COOOL monitors all of them.



COOOL

The most common output stream of COOOL are ROOT histograms (as mentioned above), which are generated during experiments and provide essential information for indicating current status of an experiment in real-time and almost without delay. Histograms typically show currently measured data and normalized values. Differences between those values may indicate nonstandard detector behavior or error.[4]

IP Cameras

An internet protocol (IP) camera can send and receive data via a computer network. The main advantage of the IP cameras is, that live video from selected locations in experiment hall can be broadcasted to control room; especially live stream from key points which can be the cause of malfunctions during the run. Basically, they remove the duty to provide control sentry-go. Additionally, the use of the IP cameras saves up control room staff's time and doesn't distract attention from a run control. For IP Cameras control, there is one stand-alone computer equipped with one standard 21-inch LCD flat screen.

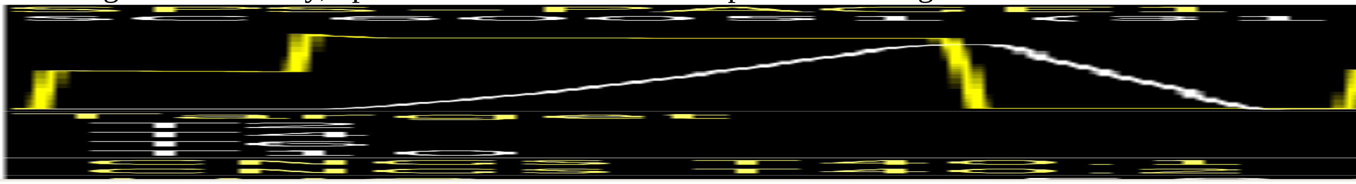
InfoLogger

InfoLogger is a part of the DATE[2] system which by default runs under the GNU/Linux. Basically, infoLogger provides storing of the infomaking output from data acquisition over the experiment to the MySQL database server[3]. There is also **infoBrowser** along with infoLogger to display data. MySQL database, where the data from experiment are stored, is being accessed by the infoBrowser. Plus, infoBrowser provides additional functionality of displaying acquired data.

InfoBrowser

OP Vistars Tool

The display runs on a single-purpose computer. It's determined to provide the information about the status of the particle accelerator. In fact, CERN TV displays information about the beam such as the cycle status and energy. It also provides info about the intensity of the beam on each target. Additionally, operator's announcements are provided through CERN TV.



Cern TV Screen

General Purpose Computer

Within remote control room, there are two computers intended to be used for general purposes. Both workstations are connected to the general purpose network (GPN) and one of them is connected to COMPASS network, too. The connection to the GPN allows browsing the internet. There are two computers with different OS. The first one is powered by the Windows, the second one by the Linux OS.

Logbook

The logbook is a web-based application developed for the COMPASS experiment connected to a MySQL database for the permanent storage and easy search of the comments and annotations. A large variety of information is stored automatically at the beginning of each data run. The list of automatically stored information is following:

- information from the DAQ system
- information provided by the shift crew
- trigger information
- beam line information
- status of the COMPASS target
- currents of spectrometer magnet SM1 and SM2
- COOOL histograms
- text output from the MurphyTV software

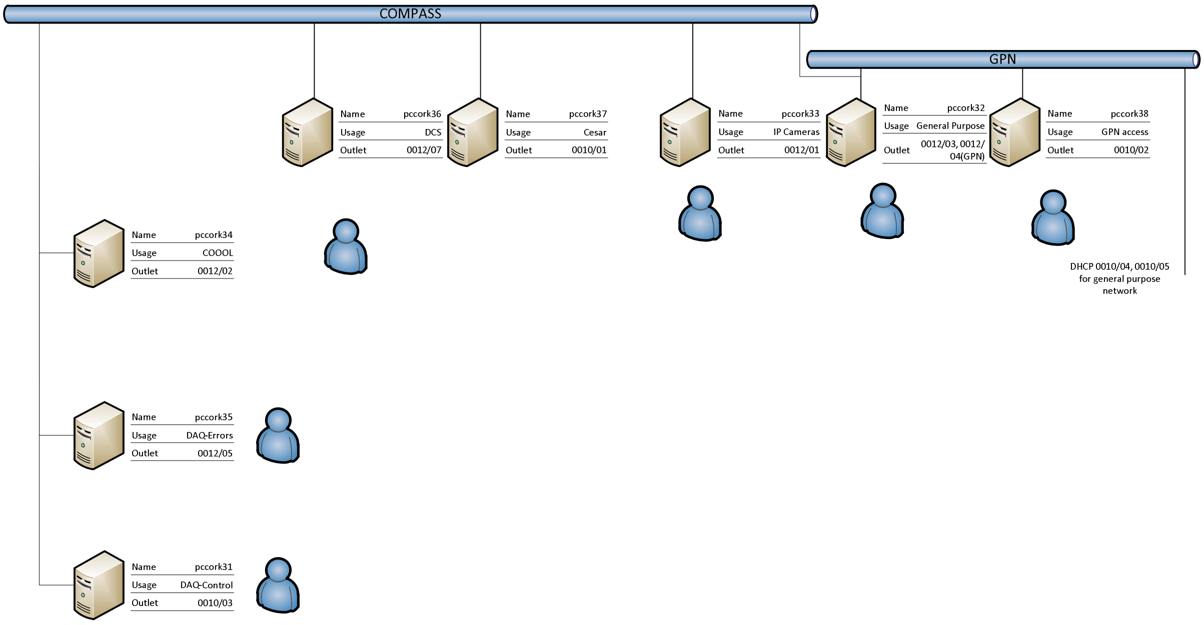
All stored information can be retrieved, searched and displayed through a web client.

Logbook

Control room

The solution of installation of the control room has been projected and then carried out regarding to the integrity of individual workspaces and their relationships. The robust and portable prototype of the remote control room has been implemented. For the implementation has been used eight PCs which were ergonomically deployed according user requirements. Due to the fact that some workspaces are intended to run multiple programs simultaneously additional graphic cards have been installed and screens connected. For these workspaces additional graphic cards have been installed. On all workspaces have been installed operation systems and required software using kickstart files from network. The connection to the

COMPASS project has been established and workstations have been tested.



Final workspace set up

Ganglia

Ganglia is a scalable distributed system monitor tool for high-performance computing systems such as clusters and grids. It allows the user to remotely view live or historical statistics (such as CPU load averages or network utilization) for all machines that are being monitored.[6]

Problems

The nonstandard configuration of multiple monitors on two specific computers was the biggest problem in the instalation of control room. The first problematic computer was the one with DAQ intended to be split on 24-inch monitor and 22-inch monitor. There was the problem with resolution, which is not same on both, the bigger monitor has ratio 16:10 and the smaller has 16:9. This has been solved by changes in configuration file and newer drivers for dedicated grafic card has been installed.

Configuration of the computer with three 22-inch monitors (with the request of option of extension to four monitors, which will be made as soon as monitors are mounted on the wall) was the second problem. This has been solved by adding two dedicated graphic cards Radeon 5450 to the computer and by re-writing the default configuration file xorg.conf. At first it was necessary to write two sections for each combination of graphic card and monitor, where GPUs are identified by the BusID and monitor by screen number.

```
Section "Device"
        Identifier   "Device0"
        Driver       "fglrx"
        BusID        "PCI:32:0:0"
        Screen           0
EndSection

Section "Device"
        Identifier   "Device1"
        Driver       "fglrx"
        BusID        "PCI:32:0:0"
        Screen           1
EndSection

Section "Device"
        Identifier   "Device2"
        Driver       "fglrx"
        BusID        "PCI:1:0:0"
EndSection
```

//continue in the second column

Acquirement of unique desktop for each monitor instead of cloning was a second thing to do.

```
Section "ServerLayout"
        Identifier     "Multihead layout"
        Screen      0  "Screen0" 0 0
        Screen         "Screen1" LeftOf "Screen0"
        Screen         "Screen2" LeftOf "Screen1"
        InputDevice    "Keyboard0" "CoreKeyboard"
EndSection
```

Finally was written default resolution section.

```
Section "Screen"
        Identifier "Screen0"
        Device     "Device0"
        Monitor    "Monitor0"
        DefaultDepth     24
        SubSection "Display"
                Viewport   0 0
                Depth     24
                Modes     "1920x1200"
        EndSubSection
EndSection
```

Acknowledgement

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