ATLAS - HEC
Design Review
07-April-2003

Design Review for the Low Voltage Control System of the ATLAS Liquid Argon Hadronic End-Cap Calorimeter

Teresa Barillari

Max-Planck-Institut für Physik
(Werner-Heisenberg-Institut)
Munich, Germany

Contents

1 Introduction **2**

2 ATLAS Detector Control System **2**

3 HEC Low Voltage Control System **2**

3.1 HEC Low Voltage Overview 2

3.2 HEC Control System 3

4 Status of the HEC Control System **4**

5 PVSS II Panels for the HEC **4**

5.1 Liquid Argon Calorimeter and Main Panels for HEC A 4

6 Conclusions **5**

1 Introduction

The experience gained at the LEP experiments at CERN had showed how important is to use a powerful Detector Control System (DCS) [1] and this importance has increased with the size and the complexity of of High Energy Physics detectors. The LHC experiments had become too big and too complex to be controlled manually by an operator. In addition, at the LHC era further requirements are put onto DCS, due to the inaccessibility of the equipment and the hostile environment concerning radiation and magnetic field.

In general, at running time, a few operators supervises a whole experiment. These operators usually have only little knowledge of the hardware of the detector at all. But even a hardware expert will only know in detail the part of the detector, which he is involved in. Therefore the usage of DCS must be based on general common sense and must not presume detailed knowledge. Obviously, the earlier problems get detected by the operators, the lesser the consequences are they have and eventually the easier they can be fixed. For this reason it is essential to have regular checking and good control of the hundred thousand parameters of the detector itself. The level of severity of the problems and the action to be taken has to be defined by the experts and not by the operators.

In the LHC experiments, all the functionalities described above have been implemented as a system, so-called "SCADA" (Survey, Control and Data Acquisition) system [2], that the DCS groups at CERN will use. The software chosen as a tool for SCADA is a product from an Austrian Company (ETM) called PVSS II [4]. A joint controls project (JCOP) [3] between the 4 LHC experiments and the CERN IT/CO group has been organized to develop a common "Framework" and to use as much components as possible in common for the DCS of the 4 experiments. The JCOP team at CERN has already developed a number of sub-projects to look at various control aspects. Various technologies have being employed by JCOP. Some of these technologies have been chosen to be commercial other are custom solutions.

For the Hadronic End-Cap (HEC) [5] of the Liquid Argon Calorimeter in ATLAS the control system for the low voltage supplies is based on the system above described. The 320 preamplifier and summing boards can be operated and controlled individually or in groups by the PVSS II software. The voltages, currents and temperatures can be measured, trended, and archived in a database. Alarms, error messages about over-current or wrong input/output voltages can be set, displayed and controlled.

2 ATLAS Detector Control System

In the ATLAS experiment at LHC, the slow control of detectors, sub-detectors and components of sub-detectors are implemented within the above described DCS and SCADA system, the JCOP Framework, and its software application, PVSSII [1–4].

Hardware links in the detector and connections with its field bus nodes are made with simple cable bus. The ATLAS experiment has chosen to use the commercial CAN as field bus, and its software protocol CANOpen.

3 HEC Low Voltage Control System

3.1 HEC Low Voltage Overview

The supply voltages for the cold front-end electronics of the two Hadronic End-Cap (HEC A and HEC C) wheels for the ATLAS Liquid Argon Calorimeter, are generated in 8 power boxes and distributed to the 320 preamplifier and summing boards (PSB) inside the crayostats. Each of the two HEC wheels consists of 4 quadrants served by a feed-through with a front-end crate on top of it. Each quadrant is equipped with 40 PSBs. A related power box, delivers the low supply voltages. For each wheel 4 power boxes are needed. The JCOP Framework [3] and the PVSSII [4] software allow to design, and create applications on a PC, so that through graphical windows it is possible to control and survey all the HEC supply voltages and channels (PSBs).

The exchange of information between the software part and the low voltage channels takes place via the mentioned field bus nodes, the CAN field bus and its CANOpen protocol. In ATLAS DCS the PC is a bus master, its hardware interface board, the Kvaser card, is controlled by a middleware, chosen to be the driver software OPC.

Many field bus nodes are offered by industry for different purposes. The field bus nodes used for the ATLAS HEC are the customized ELMB128 [6], offered by the CERN ATLAS DCS[7] group.

3.2 HEC Control System

In the Hadronic End-Cap Calorimeters (HEC A and HEC C) the following systems are controlled and monitored by the SCADA-PVSS II software, see also Fig. 1:

- Power boxes with relative power and monitor boards:
  - The field bus nodes (ELMB) present in each monitor board of the power boxes allow to monitor, control, and make measurements of
    - Temperature inside the power boxes
    - Middle voltages delivered by the power boxes
    - Currents coming out from the power boxes.
- Low voltage distribution boards
  - Each quadrant in a HEC wheel has a total of 4 low voltage distribution boards and one power box. Each distribution board has two ELMBs that allow to survey a total of 10 PSBs per distribution board.
    - Each ELMB can control 5 PSBs, so that for each PSB it is possible to:
      - Set voltage values. Each channel has e.g. the following default voltage values: $+7.2\,V$, $+3.3\,V$, and $-1.6\,V$.
      - Switch on and off the PSB itself
      - Calibrate voltages and currents
      - Monitor, display, and plot voltages and currents
      - Detect problems
      - Gain information to fix the observed problems
      - Archive the collected data and information
      - etc. etc.
- Interlocks between the low and the high voltage systems
  - To protect HEC cold electronic, it is mandatory to first switch on the low voltage system and later on the high voltage channels. If part of the low voltage system has to be switched off also the correspondent high voltage channels need to be witched off. For this reason it is foreseen to have an interlocks system between the high and the low voltage systems, so that in case of need one of the two systems can switch on/off single or groups of voltage channels
- $270\,V$ DC control system

- A "control" box with one or two ELMBs is expected to be placed in the ATALS USA15. This box can operate, monitor and control the system that convert the $380\,V/3$ to $270\,V$ DC.

- Any warning, error, and fault of the whole HEC system is supposed to be monitored, controlled and archived.

4 Status of the HEC Control System

The work to create graphical windows, and panels with PVSS II to operate, control, and monitor the HEC low voltage system has started and is progressing. The links between PVSS II and the ELMBs (via OPC and CAN bus) are operational. At the moment we are using the older versions of ELMBs, and instead of the Kvaser (recent and new CERN choice) we are using the NICANII card.

The PVSS II [4] is a sort of ANSI C - language software with several graphics tools that help the programmer during the design phase. PVSS II has also a "data point" structure and a list a data points has to be established first. This structure is generally created by the people working on the JCOP and ELMB Framework at CERN. The programmer working and designing the control panels for an ATLAS sub-detector should base his work on this Framework. Feedback and collaboration between the programmers and the people working in the JCOP team are essential for the creation of a good and robust Framework.

The mentioned "data points" are like variables in the program, where the hardware information are stored. The PVSS II graphical editor usually helps to design graphical objects and panels that can have various purposes, like display information, operate and take actions, create diagrams, etc. etc. . Behind a graphical objects there are control scripts that define the action and/or the operation to be taken by the object.

For the HEC Low Voltage System we have already developed a set of panels for one quadrant of the HEC A wheel. With these panels we try to fulfill our SCADA needs and at the moment these control panels have been tested at MPI, soon they will be tested at CERN. Our first aim is to be able to build a good SCADA - PVSS II system for just one quadrant of the HEC low voltage system and without the "Control of the $270\,V$ DC box". This SCADA - PVSS II system is expected to be used in the technical run, foreseen at CERN for the end of the year 2003, and in the next combined test beam, foreseen for the summer 2004.

Later on this software will be also used to monitor and control the HEC low voltages during the installation of the ATLAS detector in UX15. In this case the "'Control of the $270\,V$ DC box" will be part of the software. Our final aim is to have a good working SCADA - PVSS II system for the whole HEC.

5 PVSS II Panels for the HEC

In the following some of the control panels already available for the HEC low voltage system are described. These panels at the moment don't comply the new JCOP and ELMB Framework.

5.1 Liquid Argon Calorimeter and Main Panels for HEC A

A graphic view of the all Liquid Argon Calorimeter "Low Voltage System" can be see in Fig. 2 (top). It consists of the two End-Cap wheels and the barrel part of the calorimeter. By mouse clicking on one of the HEC wheels, the operator can open e.g. the main panel for the HEC A Low Voltage control system, see Fig. 2 (bottom). This panel displays the main structure of our HEC A system. By clicking on a graphic object or on an item of this panel the operator can open other windows so to gain and learn more details of the system itself and also have full access to hardware components. To distinguish between different types of daughter panels, a color code is applied in this panel: objects in red and blue are e.g. action panels, items in light yellow, violet and dark gray display hardware details (mechanics, circuit diagram etc.). By clicking on one of the red and blue object, e.g. "CTR Panel Qad. 1", the operator open the daughter panel shown in Fig. 3 (top). This new panel gives an entire overview of one quadrant of HEC A. An operator can use this panel to control and monitor the status of the 40 channels or PSBs related this section of HEC A, see e.g. Fig. 3 (bottom). The operator can switch on and off single or group of channels, can monitor and plot the three voltages and currents measured in each channel. Fault conditions are showed by a blinking red color, the static green color shows that all is fine. In case of faults or problems an expert can click on the "SERVICE NEEDED" button to open a new graphical window, see Fig. 4 (top). This new panel allows to open other windows, see e.g. the graphical window shown in Fig. 4 (bottom), so to be able to learn and gain detailed information on the cause and the severity of the observed problems and eventually fix them. Fig. 4 (bottom) shows an ELMB operational panel. This is the window that will be used to set the voltages (e.g. +7.2, +3.3, and -1.6 Volts), to calibrate the voltages and the current for each of the PSBs present on the ELMB. Only the expert can use this panel.

6 Conclusions

We have developed some "preliminary" work for the software HEC control system at MPI. The link between the SCADA software tool, PVSS II, and the ELMBs (via OPC and CAN bus) is operational. We are using at the moment, the older version of ELMB, and instead of the Kvasar card we are using the NICAN II as hardware interface board on our PC. It is our plan to soon start using the new version of ELMB128 and the Kvasar card, so to also be able to start to work with the new JCOP and ELMB Framework, and let our HEC panels comply this new proposed software. We first foresee to have a good SCADA - PVSS II system for just one quadrant of the HEC low voltage system and without the "Control of the 270 V DC box". This SCADA - PVSS II system is expected to be used in the technical run, foreseen for the end of the year 2003, and in the next combined test beam, foreseen for the summer 2004. This software will be also used to monitor and control the HEC low voltage system during the installation of the ATLAS detector in UX15. The final aim is to have a good working SCADA - PVSS II system for the whole HEC.

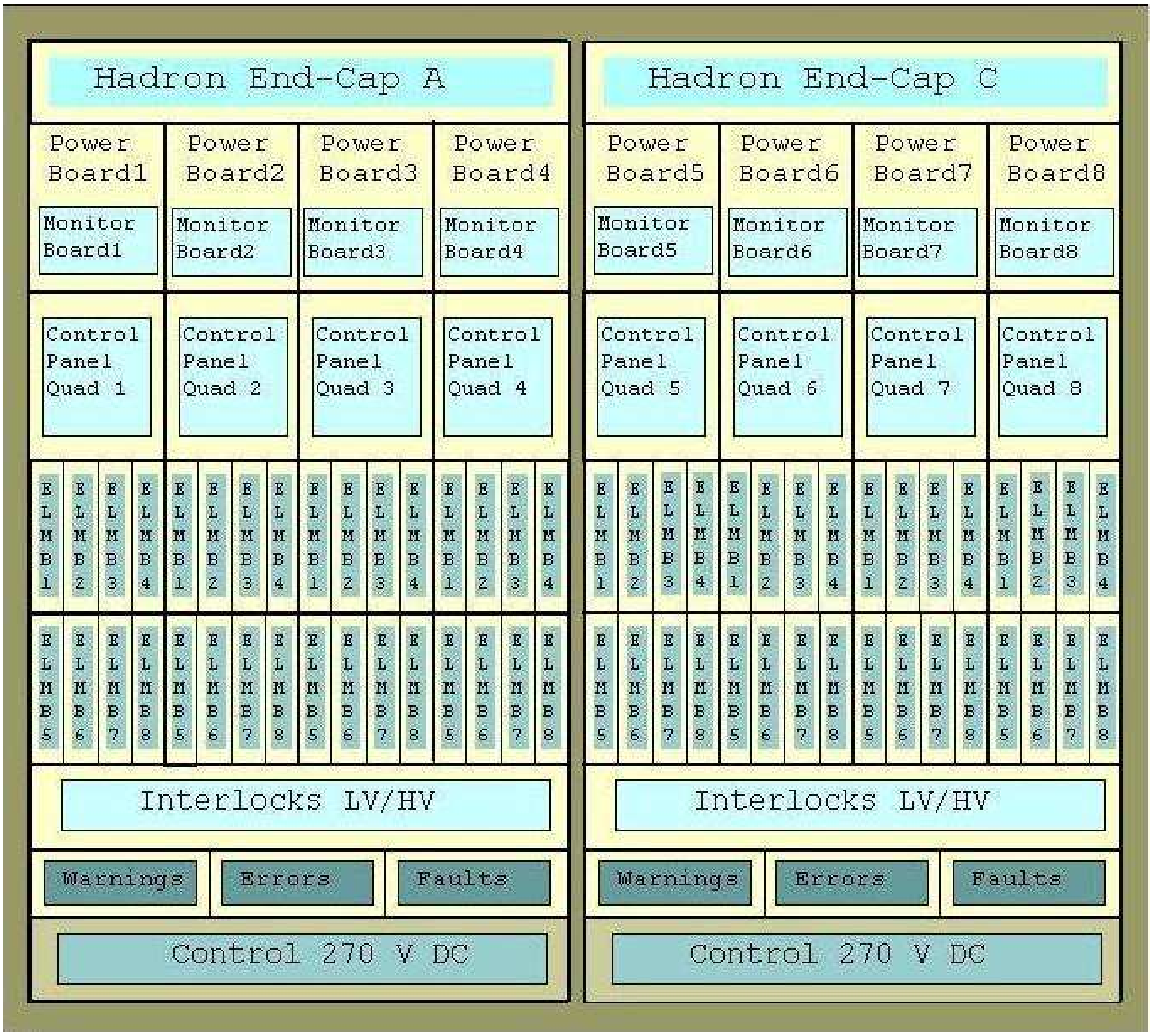


Figure 1: Overview of the control system foreseen for the Low Voltage control of the HEC A and HEC C wheels. By mouse clicking on one of the (light or dark) blue boxes the operator can open an action panel to operate, control, and monitor part of the system.

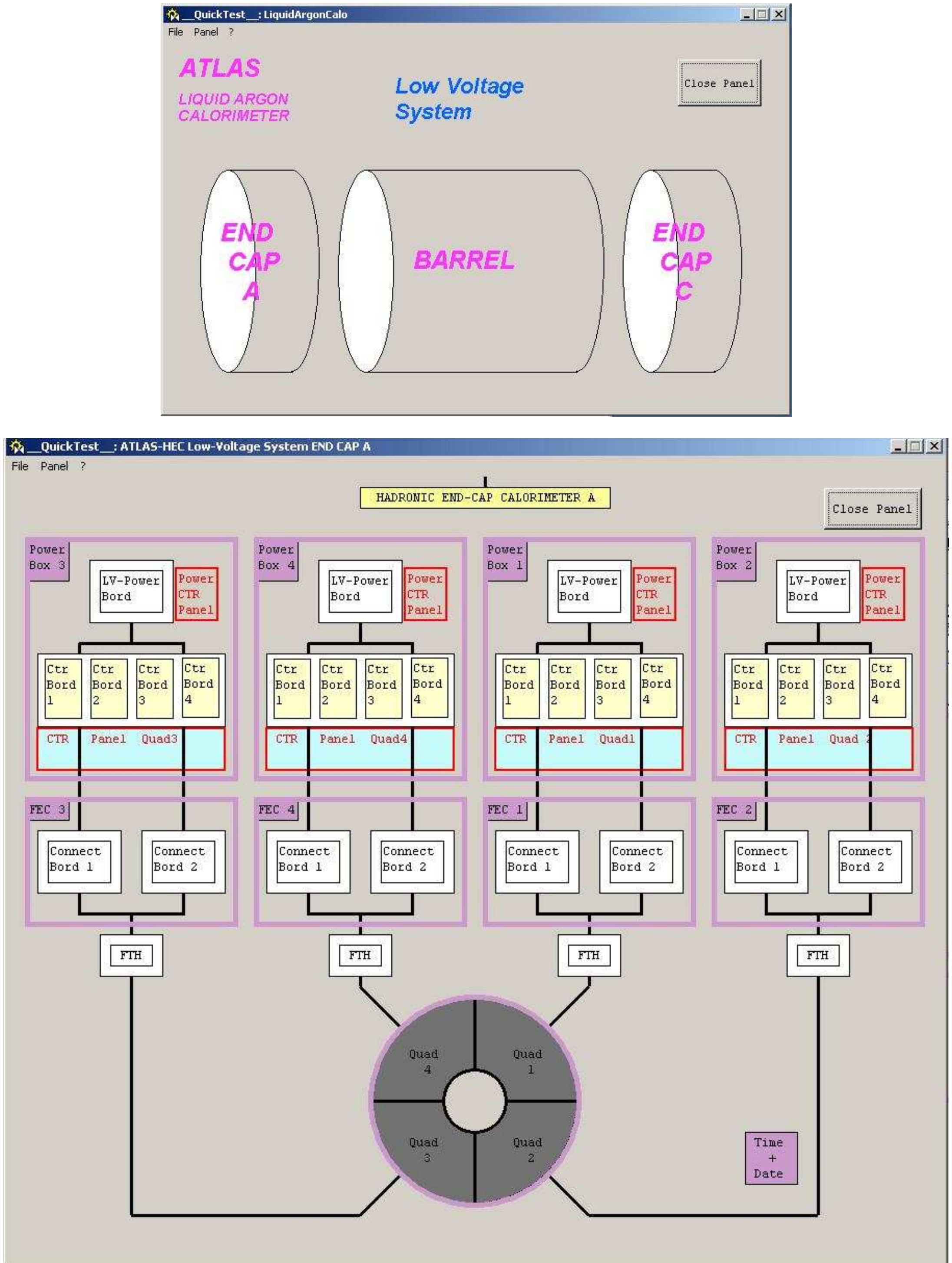


Figure 2: (top) "Start Up" panel, from this graphical window the operator can choose to look at either one of the hadronic End-Cap calorimeters (HEC A or HEC C). (bottom) "Main Access" End-Cap A panel. This panel displays the main structure of our HEC A system. To distinguish between different types of daughter panels, a color code is applied in this panel: objects in red and blue are e.g. action panels, items in light yellow, violet and dark gray display hardware details (mechanics, circuit diagram etc.).

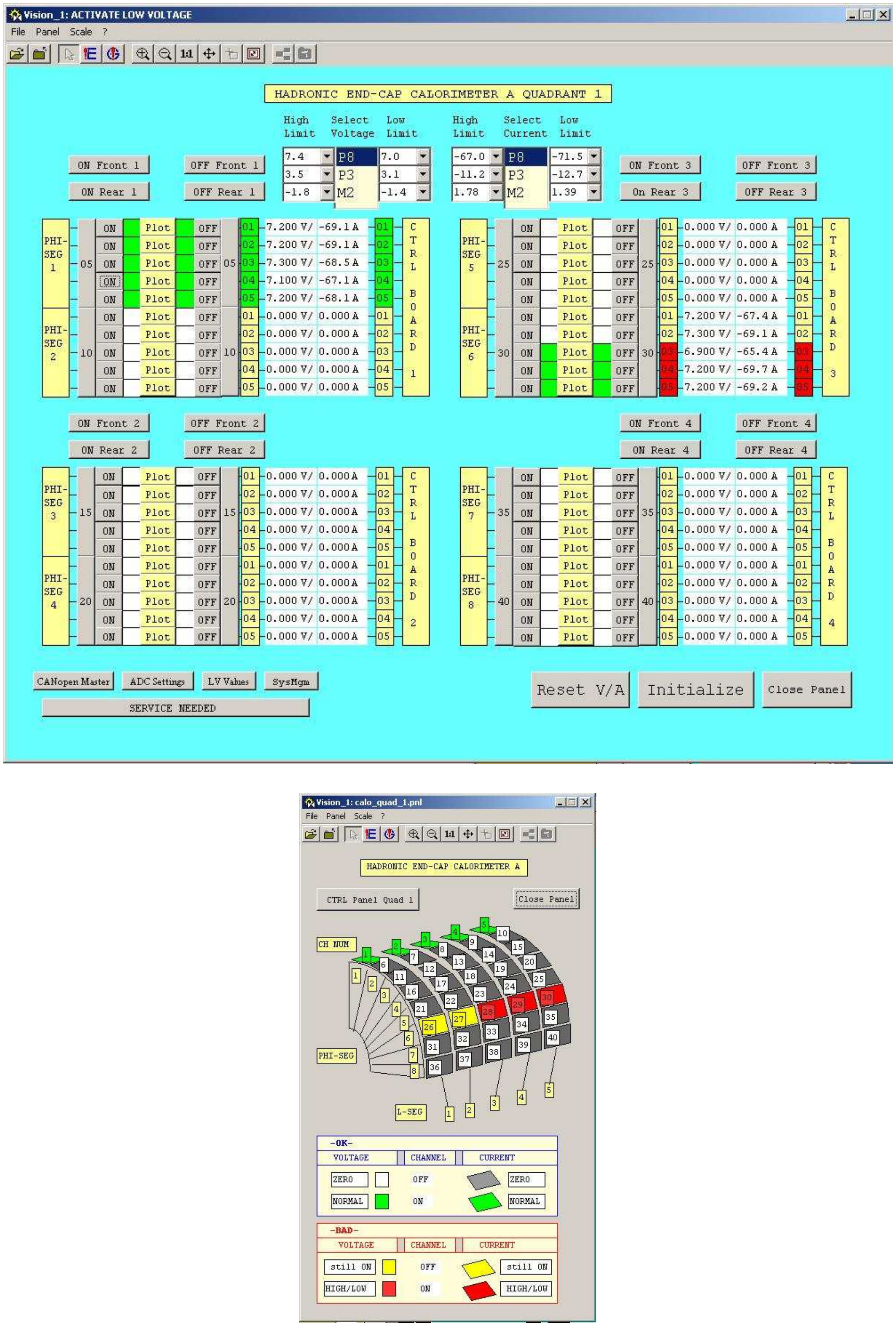
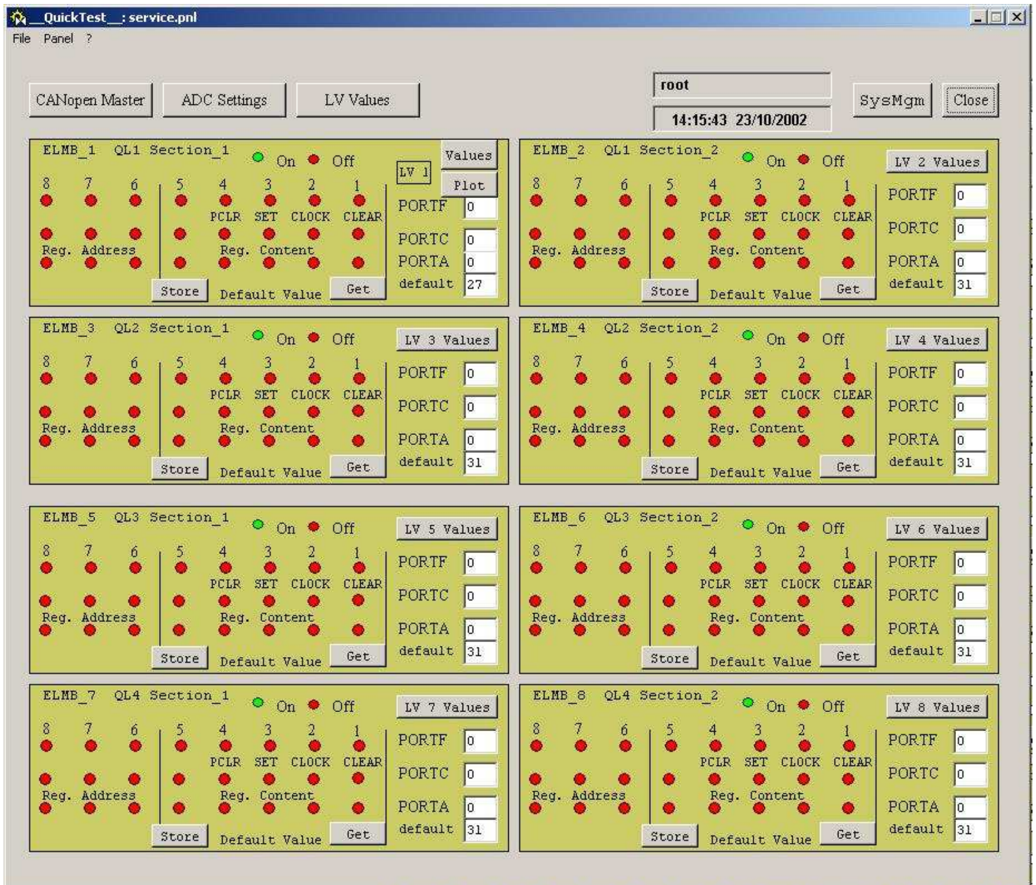


Figure 3: (top) "Channels Control" panel. This panel displays voltages, currents, and eventually in case of problems will also show the faulty channels. It allows to switch on and off channels, to display and plot the voltages and the currents measured in each channel. Other daughter panels can be opened from here. (bottom) Quadrant in 3-Dimensional view with blinking yellow and read lights according the fault status of the detector. Green solid lights show that all the PSBs in the quadrant are on, and ok. Dark grey lights indicate that the PSBs are off.



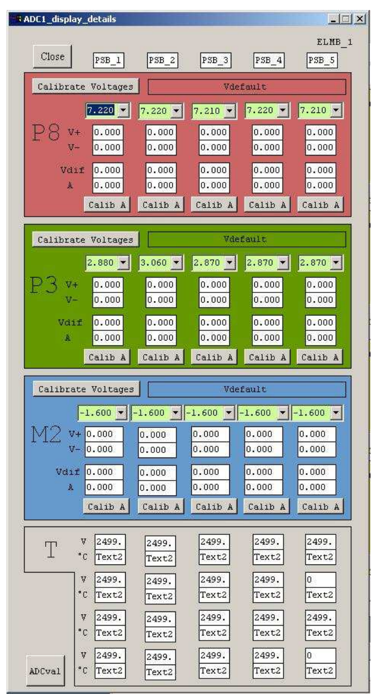


Figure 4: (top) Detailed panel for one quadrant of the HEC A wheel to be used only by the experts. This panel allows a complete control and survey of the 8 ELMBs in the quadrant. (bottom) ELMB panel, the three voltages for each of the 5 PSBs in the ELMB can be set from here. Voltages and currents calibration is also operated from this panel.

References

[1] "The ATLAS DCS User Document", H. J. Burckhart,
http://atlas.web.cern.ch/Atlas/GROUPS/DAQTRIG/DCS/iwn.html (1995)

[2] "What is SCADA?", A. Daneels et W. Salter,
http://ref.cern.ch/CERN/CNL/2000/003/scada/ (2000)

[3] JCOP, IT Divition CERN,
http://itco.web.cern.ch/itco/Projects-Services/JCOP/welcome.html

[4] "PVSS II", Product of ETM,
http://www.pvss.com/english/

[5] "Low Voltage Control for the Liquid Argon Hadronic End-Cap Calorimeter of ATLAS", H. Brettel et al.,
http://atlas.web.cern.ch/Atlas/GROUPS/LIQARGON/Electronics/Monitoring/

[6] ELMB128 Software Resourses, H. Boterenbrood,
http://www.nikhef.nl/pub/departments/ct/po/html/ELMB128/ELMB128resources.html

[7] "Results of radiation tests of the ELMB (ATmega128L) at the CERN TCC2 area", H. Boterenbrood et al.,
http://atlas.web.cern.ch/Atlas/GROUPS/DAQTRIG/DCS/iwn.html (2002)