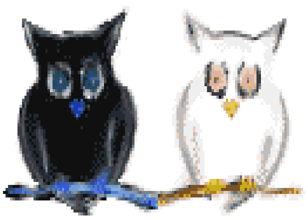
Detector Control System of the COMPASS experiment

User Requirement Document

Document Version: 0
Document Issue: 0
Document Status: DRAFT
Document ID: IT-CO / 1999-COMPASS / 1999
Document Date: 4-November-1999



European Laboratory for Particle Physics
Laboratoire Européen pour la Physique des Particules
CH-1211 Genève 23 - Suisse

Abstract

The purpose of this document is to provide the user requirements for the Detector Control System (DCS) of the COMPASS experiment following the ESA standard PSS-05. As such it will cover all the functionalities required by the whole experiment as well as each sub-detector and sub-system

Document Control Sheet

Table 1 Document Control Sheet

Document	**Title:**	COMPASS DCS User Requirement Document		
	Version:	0		
	Issue:	0		
	Edition:	[Document Edition]		
	ID:	IT-CO / 1999-COMPASS / 1999		
	Status:	DRAFT		
	Created:	[Document Creation Date]		
	Date:	4-November-1999		
	Access: :	D:\pcitco05\COMPASS\URD\book\frontmatter.fm		
	Keywords:	template, framemaker, software documentation, document preperation, sample material		
Tools	**DTP System:**	Adobe FrameMaker	**Version:**	5.5
	Layout Template:	Software Documentation Layout Templates	**Version:**	V2.0 - 5 July 1999
	Content Template:	Control URD	**Version:**	V1.0
Authorship	**Coordinator:**			
	Written by:	Valeri Falaleev, Herve Milcent, Valentine Sougoniaev		
	Reviewed by:			
	Approved by:			

Document Status Sheet

Table 2 Document Status Sheet

Title:	COMPASS DCS User Requirement Document		
ID:	IT-CO / 1999-COMPASS / 1999		
Version	**Issue**	**Date**	**Reason for change**
1	0		

Document Change Record

Table 3 Document Change Record (of changes made since version ...)

Title:	COMPASS DCS User Requirement Document	
ID:	IT-CO / 1999-COMPASS / 1999	
Version: **Date:**		**Originator:** **Approved By:**
Page	**Paragraph**	**Reason for Change**

Document Distribution List

Table 4 Document distribution list

Title:	COMPASS DCS User Requirement Document		
ID:	IT-CO / 1999-COMPASS / 1999		
Version	**Num. copies**	**Name**	**Div. / Org.**

Table of Contents

Abstract . . . iii

Document Control Sheet . . . iii

Document Status Sheet . . . iv

Document Change Record . . . iv

Document Distribution List . . . iv

Table of Contents . . . v

List of Figures . . . ix

List of Tables . . . x

List of Listings . . . xii

Chapter 1
Introduction . . . 1
1.1 Purpose of the document . . . 1
1.2 Scope . . . 1
1.3 Definitions, acronyms and abbreviations . . . 2
1.3.1 [Definitions] . . . 2
1.3.2 [Acronyms] . . . 5
1.3.3 [Abbreviations] . . . 5
1.4 References . . . 6
1.5 Overview of the document . . . 6

Chapter 2
General Description . . . 9
2.1 Product perspective . . . 9
2.2 General capabilities . . . 9
2.2.1 Monitoring and control . . . 10

2.2.2 Supervision 10
2.2.3 Connection to external system 10
2.3 General constraints 11
2.4 User characteristics 12
2.4.1 Operator on shift 12
2.4.2 Shift leader 12
2.4.3 Expert of a detector 12
2.4.4 Maintenance operator 13
2.4.5 System developer 13
2.5 Operational environment 13
2.5.1 High Voltage power supplies 13
2.5.2 Low Voltage Power supplies 14
2.5.3 Crate control 14
2.5.4 Analog monitoring 14
2.5.5 Bit monitoring 15
2.5.6 Start-up 15
2.5.7 External interfaces 15
2.6 Assumptions and dependencies 16

Chapter 3
Specific Requirements 17
3.1 Capability Requirements 17
3.1.1 General System Features 17
3.1.1.1 Access Control 17
3.1.1.2 Types of Access 18
3.1.1.3 Users 19
3.1.1.4 Definition / modification 20
3.1.1.5 Configuration setup 21
3.1.1.6 Hardcopy and report 22
3.1.1.7 Acquisition of parameter 22
3.1.1.8 Alarm Handling 25
3.1.1.8.1 Alarm Definition and Generation 25
3.1.1.8.2 Alarm Management 26
3.1.1.8.3 Alarm Display 28
3.1.1.9 Archiving and Data retrieval 28
3.1.1.10 Logging 30
3.1.1.11 Trending 30
3.1.1.12 Operational mode 30
3.1.1.13 Commanding 33
3.1.1.14 Operator assistance 35
3.1.1.15 Operator Display 35
3.1.2 Operation on HV 35
3.1.3 Operation on LV 37
3.1.3.1 LV with a fieldbus interface 38

3.1.3.2 LV with analogue or digital interface 39
3.1.4 Operation on analog value 40
3.1.5 Operation on digital value 40
3.1.6 Operation on crate control 41
3.1.7 DCS startup 42
3.1.8 External interfaces 42
3.1.9 Detectors. 43
3.1.9.1 RICH 43
3.1.9.2 STRAW 44
3.1.9.3 MWPC 45
3.1.9.4 GEM 46
3.1.9.5 Silicon 47
3.1.9.6 BMS 48
3.1.9.7 Sci-Fi 48
3.1.9.8 Sci-Fi Beam Hodoscope 48
3.1.9.9 ECAL1 / ECAL2 / HCAL2 49
3.1.9.10 HCAL1 49
3.1.9.11 Trigger-Hodoscope 50
3.1.9.12 Muon Wall I 51
3.1.9.13 Muon Wall II 51
3.1.9.14 TOF 52
3.1.9.15 TCS 52
3.1.9.16 Laser Monitoring 52
3.1.9.17 SM1-SM2 52
3.2 Constraint requirements 53
3.2.1 Detector DCS constraint 53
3.2.2 Communication interface 54
3.2.3 External Interfaces 54
3.2.4 User Interfaces 55
3.2.5 Hardware 56
3.2.6 Performances 56
3.2.7 Quality Assurance 57
3.2.7.1 Adaptability 57
3.2.7.2 Maintainability 57
3.2.7.3 Availability 57
3.2.8 Resources 57
3.2.8.1 Systems Resources 57
3.2.8.2 Manpower Resources 57
3.2.8.3 Financial Resources 57
3.2.9 Standards 57
3.2.10 Schedule 57

Chapter 4
List of Items 59

Appendix A **List of the detectors equipment.** 67
A.1 RICH 67
A.2 STRAW 68
A.3 MWPC 68
A.4 GEM 69
A.5 Silicon 70
A.6 BMS 70
A.7 Sci-Fi 70
A.8 Sci-Fi Beam Hodoscope 71
A.9 ECAL1 / ECAL2 / HCAL2 72
A.10 HCAL1 72
A.11 Trigger-Hodoscope 73
A.12 Muon Wall 1 73
A.13 Muon Wall II 74
A.14 TOF 74
A.15 TCS 75
A.16 Laser Monitoring 75
A.17 SM1-SM2 75

Index. 77

List of Figures

Figure 1	p. 4	Detector’s Hierarchy.
Figure 2	p. 13	COMPASS detector.
Figure 3	p. 32	Operational mode transition.

List of Tables

Table 1	p. iii	Document Control Sheet
Table 2	p. iv	Document Status Sheet
Table 3	p. iv	Document Change Record (of changes made since version ...)
Table 4	p. iv	Document distribution list
Table A.1	p. 67	RICH crate equipment.
Table A.2	p. 67	RICH HV-LV equipment.
Table A.3	p. 68	STRAW crate equipment.
Table A.4	p. 68	STRAW HV-LV equipment.
Table A.5	p. 68	STRAW Analogue
Table A.6	p. 69	MWPC crate equipment.
Table A.7	p. 69	MWPC HV-LV equipment.
Table A.8	p. 69	MWPC Analogue
Table A.9	p. 69	GEM crate equipment.
Table A.10	p. 69	GEM HV-LV equipment.
Table A.11	p. 70	GEM Analogue
Table A.12	p. 70	Silicon HV-LV equipment.
Table A.13	p. 71	Sci-Fi crate equipment.
Table A.14	p. 71	Sci-Fi HV-LV equipment.
Table A.15	p. 71	Sci-Fi Beam Hodoscope crate equipment.
Table A.16	p. 71	Sci-Fi Beam Hodoscope HV-LV equipment.
Table A.17	p. 72	Sci-Fi Beam Hodoscope Analogue
Table A.18	p. 72	ECAL1/ECAL2/HCAL2 crate equipment.
Table A.19	p. 72	HCAL1 crate equipment.
Table A.20	p. 73	HCAL1 Analogue
Table A.21	p. 73	Trigger Hodoscope crate equipment.

Table A.22 p. 73 Trigger Hodoscope HV-LV equipment.

Table A.23 p. 73 Trigger Hodoscope Analogue

Table A.24 p. 74 Muon Wall II crate equipment.

Table A.25 p. 74 Muon Wall II HV-LV equipment.

Table A.26 p. 74 Muon Wall II Analogue

Table A.27 p. 75 TOF crate equipment.

List of Listings

Chapter 1
Introduction

1.1 Purpose of the document

This document describes the user requirements for the COMPASS[1] (COmmon Muon Proton Apparatus for Structure and Spectroscopy) DCS (Detector Control System). It is based on the ESA PSS-05 standards[2]. The content of this document is the result of discussions with experts who will build, use or maintain the detectors or sub-systems. The document covers the need for the control of COMPASS as a whole, as well as for the detectors and the sub-systems. It defines the basis for the DCS software development and at the end of the development process will be used for the acceptance test.

The intended readers of the document are the developers of the DCS and the physicists who will eventually use it.

1.2 Scope

The aim of the project is to build the DCS of the COMPASS experiment. The DCS will be used for the operation and supervision of all detector components and infrastructure of the experiment.

COMPASS is a multi purpose experiment and have a few physics programmes. Equipments will be added or removed during the experiment life cycle and the DCS should be flexible enough to follow these hardware modifications.

1.3 Definitions, acronyms and abbreviations

1.3.1 [Definitions]

Acknowledging an alarm

This is an action issued from the user indicating to the DCS software that the user took in account the alarm, this does not always mean that he fix the problem related to the alarm.

Action

An action can be initiated by the user or the DCS itself and can modify the behaviour of the DCS, the experiment's equipment or cause an interaction with an external sub-system. It can be initiated either by the user at any time, within the normal rules of DCS operation, or by the DCS itself on the occurrence of an alarm / event.

Alarm

An alarm is a message which is generated by DCS when a piece of equipment deviates from the desired operation. Several levels or categories of alarm are possible.

Alarm Condition

An alarm condition is an expression which is evaluated by the DCS and if it is found to be met it causes an alarm to be generated. This is an abnormal state of a piece of data.

Archiving

Archiving means writing data to a storage area. This data can be used at a later time for off-line analysis.

~~**Channel**~~

~~A channel is a simplest piece of experiment equipment controlled by the DCS. A channel has a set of measured parameters and may have a set of configuration parameters. Channel can have a number of defined state, e.g. on / off, normal / off-normal.~~

Collection

A collection is a group of logically joined elements for which there is a list of commands applied for all elements of the group at a time. An example of command for all HV channels command may be “set ramp-up voltage to”. A collection is a node in the detector's hierarchy tree shown in Figure 1: the COMPASS element is a collection of detectors and devices. In the next page a collection will stand for COMPASS, detector, device or sub-system except if it is explicitly stated.

Command

A command is defined to be an action which can change the state or the operation of ~~experiment~~ equipment, e.g., switch on / off a HV channel, change from one mode of operation to another, change a set-point, etc. A command can be issued by the user or by the DCS itself.

Command Procedure

A command procedure is a combination of commands that a user can initiate through a single action. It allows the users to perform complex actions in an easy and efficient manner.

Configuration

Configuration is a change of setting of DCS parameters, e.g. changing of alarms condition definition or operating parameters, masking or disabling of equipment, re-mapping of channels, etc. This do not normally require a physical connection / disconnection to the equipment.

Configuration setup

A set of DCS parameters, with their configuration parameter, an example of a configuration setup is a file.

Configuration Parameter

A configuration parameter is a parameter which defines a configurable value for any device, e.g., alarm limit, set-point, scan frequency, etc.

~~**DCS**~~

~~**DCS stands for Detector Control System. In the next sections of the document, the name DCS will stand for detector/sub-system DCS or global COMPASS DCS except if it is explicitly stated**~~.

DCS toolkit

A set of tools to build the supervision process of the DCS.

Derived Parameter

A derived parameter is a parameter which is calculated by the DCS from a combination of measured or other derived parameters.

Detector

The name 'detector' is used for any COMPASS detector or sub-system, except if it is explicitly stated (e.g. Silicon detector).

Detector Hierarchy

The detector's hierarchy is shown in Figure 1. COMPASS is divided into detectors. Each detector branch has a set of devices to control. Usually (but not mandatory) a detector contains a set of channels. A few parameters can be configured for a channel and measured by a channel. This hierarchy is not absolute. It is possible that some devices are attributed directly to COMPASS (for example atmospheric pressure measurement in the hall) or to a detector (for example set of sub-detector temperatures). A device may have a set of parameters (a crate has a set of parameters and no channels), a sub-system may have a set of other sub-systems (HV sub-system can be composed of the Jura and Mont-Blanc HV systems). This hierarchy is not related to the hierarchy of the graphical views. The hierarchy of the graphical views could be similar to the detector's hierarchy but could also be different.

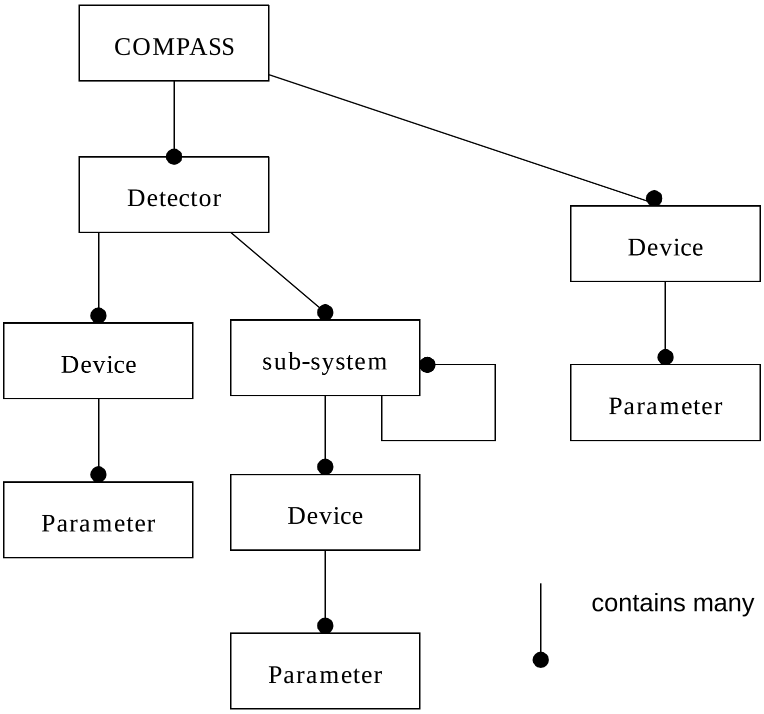


Figure 1 Detector's Hierarchy.

Device

A device is a piece of experiment equipment which is monitored and controlled by the DCS. A device may contain a set of channels and / or other devices. A device can have a number of defined states, e.g., on / off, and one or more parameters associated with it. A device may be able to communicate with the DCS (through CAENET, CAN bus, GPIB, RS232, etc.). A typical example of device is a HV power supply, or a HV channel.

Disabling

Disabling is an action which stops reading of a parameter, channel, device, or detector and all its child related sub-elements (describes by the detector hierarchy). For disabled elements:

- the associated alarms are not evaluated
- the data are not archived
- the actions are not allowed

Element of detector hierarchy

Detector, device, channel or parameter.

Event

An event is defined to be a situation that arises after whose occurrence an action should be initiated, e.g. a change of temperature above some limit should trigger a change of fan speed.

Masking

Masking of DCS element is an action which stops alarm evaluation for this element and all child related sub-elements. The information is read and achieved. The word “masked” applied for an alarm means the alarm is not evaluated.

Measured Parameter

A measured parameter is an individual piece of information which is read by the DCS. A measured parameter may be boolean or analogue. Each measured parameter will have a unique identification within the DCS.

Modification, DCS modification

Adding or removing of a DCS element, which may require physical connection or disconnection of the equipment.

Monitoring

Monitoring is a process which read and report status of the detector elements.

Operational mode

A mode of detector operation. For the time being three modes are foreseen: Shutdown, Maintenance and Run.

Parameter

A parameter may be measured, derived or configuration.

sub-system

A sub-system is a collection of devices.

User

A user is anyone authorised to use the DCS. There will be different classes of users with different levels of privilege.

1.3.2 [Acronyms]

ESA European Space Agency

CERN European Organization for Nuclear Research

1.3.3 [Abbreviations]

ADC Analog to Digital Converter.

API Application Program Interface.

CAN Fieldbus

CAEN High voltage power supplier

CAENET “Field bus” to control CAEN equipment

COMPASS COmmon Muon Proton Apparatus for Structure and Spectroscopy

DAC	Digital to Analog Converter.
DAQ	Data Acquisition system
ECAL, HCAL	Electromagnetic and Hadron Calorimeters
GUI	Graphical User Interface
HV	High Voltage
LeCROY	High voltage power supplier
LV	Low Voltage
MMI	Man Machine Interface.
MWPC	Multi-Wire Proportional Chambers
RICH	Ring Imaging Cherenkov counter
RS232	Recommend Standard number 232. A serial communication standard
SCADA	Supervisory Control And Data Acquisition.
SD/SS	Sub-detector / Sub-system
SPS	Super Proton Synchrotron
Straw	Honey-Comb Trackers
TBC	To Be Confirmed
TBD	To Be Defined
TDS	Technical Data Server

1.4 References

1 Common Muon and Proton Apparatus for Structure and Spectroscopy, CERN / SPSLC 96-14, SPSC / P 297, March 1, 1996. COMPASS web home page, http://wwwcompass.cern.ch/

2 PSS-05 standard: Software Engineering Standards, C.Mazza, J.Faiclough, B.Melton, D.de Pablo, A.Scheffer, R.Stevens, Prentice Hall, ISBN 0-13-106568-8, 1994

1.5 Overview of the document

The section 2 of this document describes the general aspects of the control of the COMPASS experiment. It also describes the relations to the other systems.

The section 3 goes in detail with the user requirements. The section 3.1 and the section 3.2 state respectively the capability requirements and the constraint requirements. Common operation on alarms, access, operational mode, etc. will be described first, followed by sections (one per detector) where the specific requirements of each detector will be stated.

The hierarchy of the requirements are expressed by shall, should and may. The first one expresses that the requirement is mandatory and must be followed, without exception. Sentences containing the word ‘should’ are strongly recommended practices. Justification is needed if they are not followed. The ‘may requirement is convenient but optional.

Chapter 2

General Description

2.1 Product perspective

The DCS for COMPASS is a new DCS. Nevertheless, it will utilize **use** whenever it is possible existing hardware and software with the aim to use common solutions. Few factors have an influence to the product evolution:

- there is a limited amount of time before the start of the experiment,
- the DCS shall be used since the beginning of the COMPASS experiment,
- few detectors will be installed / modified even after the beginning of data taking,
- the user requirements for many detectors may change during the life cycle of the experiment.

This implies the following:

- the first version of the DCS may not include all the functionalities stated in this document,
- the life cycle of the product shall include a few upgrades reflecting modifications of the hardware and user requirements.

2.2 General capabilities

The DCS shall provide monitoring, control, supervision and external connection facilities needed to operated, supervise and tune the COMPASS experiment as well as all its detectors. It shall offer the links to all the control systems of the detectors which are not included in the COMPASS DCS and to the external services which provide **are** essential for the experiment’s information (beam information, infrastructure, etc.).

The DCS shall be operational during data taking (physics run), shutdown and maintenance phase.

2.2.1 Monitoring and control

The DCS will provide the monitoring and control facilities for:

- crates
- HV and LV power supplies
- slowly varying parameters (e.g. pressure, temperature, gas flow, etc.)
- equipment status.

The DCS should be able to offer:

- closed loop control (adjusting the HV according to the atmospheric pressure, change the speed of the fans in a crate according to the temperature, etc.)
- readings or actions triggered periodically, by an external event or signal (e.g. in-spill / out-off-spill).

2.2.2 Supervision

The DCS should be capable to provide the following supervision facilities

~~The DCS will provide the following supervision facilities~~:

- graphical user interface (GUI, MMI)
- access control for different types of the users and different experiment operational modes
- diagnostic of faults and maintenance of the equipments
- alarm handling, including tools for alarm configuration and statistical treatment
- configuration tools, including possibility of masking and disable the equipments, re-mapping the channels, saving configurations in a file and retrieving them later
- management of different operational modes
- archive and retrieval of collected data, including on-line trending
- logging of actions, alarms and events
- multi user access (up to 20 users simultaneously) from the control room, from the CERN site and from outside CERN
- hardcopy and report generation
- broadcast and inter-user communication tools
- on-line help and system news

2.2.3 Connection to external system

The DCS is not a standalone system, it has to be interfaced to different entities:

- the control systems of some COMPASS detectors, which have been already developed or which will be developed: e.g.: Polarized target, MicroMEGA? ***TBD***

- the DAQ system
- the SPS control system to obtain beam information which is useful to for COMPASS
- the control system of the infrastructure which holds the information such as security in the COMPASS area, etc.
- users program such as monitoring, calibration, pedestals down-loading, thresholds calculation, thresholds down-loading, etc. which are particular to each detector.
- event reconstruction system or central data recording system
- gas control system used for RICH, MWPC, Straw and may be other detectors.

The COMPASS DAQ Control has similar functionalities as the DCS has. The same toolkit could be used which will ease the interface between the two systems. This is also valid for other common detector tasks such as Channels Monitoring, Calibration, Pedestals Downloading, Thresholds Calculation, etc.

2.3 General constraints

The development of the DCS is constraint by list of different factors:

- ~~The equipment that the software is to interface to is decided by the experiment and some of it has already been purchased. Therefore the system will have to interface to existing equipment~~. The system software will have to interface to existing equipment which is decided by the experiment, some of it has already been purchased.
- ~~The experiment will used hadron and muon beams (starting from muon program). A change of the beam (from Hadron to Muon and vice versa) shall not implies a change in the software. It is acceptable that the DCS will be stopped and restarted with new configuration (different setup)~~. The COMPASS experiment is a multi purpose experiment, it has several physics programmes (up to today a Muon and a Hadron programme) using different beams and setups. A change from one programme to another one shall not imply a change in the software. It is acceptable that the DCS will be stopped and restarted with a new configuration (different setup).
- Few detectors shall be installed / modified after the beginning of the first run.
- The user requirements for many detectors may be changed during the experiment life.
- The first stage of the DCS development will be done during the time, when a lot of the experimental equipment will be not yet available. Further development will continue during experiment commissioning and even during its normal operation.
- Some COMPASS detectors have already or will have their own and independent control system. Therefore the DCS will have to interface to them.
- The DCS should have appropriate openness and flexibility to provide a lot of the external connections.
- Common solutions for the control and the supervision of the equipments shall be used as much as possible.
- The DCS shall run 24 hour a day.

- The system shall allow remote access from CERN site as well as from outside.
- There is limited amount of time before the start of the experiment, when the DCS shall be use for the first time.
- The detectors are spread in the experimental area.
- ~~The DCS will be used for the commissioning of COMPASS~~

Even if the DCS is named or seen as a single entity, it is important to note that each detector can be operated / controlled / configured independently. However, in order to reduce the prices, some equipment will be shared between different detectors. Therefore adding or removing hardware equipments may have an influence on other DCS because part of its equipments may be unreachable during a short period of time. e.g. the detectors will certainly shared the same CAENet bus, removing a HV power supply crate from this line will temporarily disturb the HV readout of the other crates, because the CANEet will be disconnected and then re-connected.

2.4 User characteristics

The access the DCS is restricted to its declared users with appropriate password. The users who use the DCS are an operator on shift, a shift leader, an expert of the detector, a maintenance operator and a system developer. They can act on the different equipments with the appropriate user access rights.

2.4.1 Operator on shift

The operator on shift is the normal user of the DCS, he must be able to monitor the operation of the experiment (crate’s temperature, cooling status, etc.) and use this information for analysing the situation.

2.4.2 Shift leader

The Shift Leader is an engineer or a physicist, he is responsible for running the COMPASS experiment on shift. He is only interested in getting general information out of the system, he must be able to make the necessary decisions to run the whole COMPASS experiment, he is not involved in the technical implementation details of the system.

2.4.3 Expert of a detector

The expert of a detector is person responsible for tuning the detector, for the operation and for the maintenance of the detector. He knows in details his equipments and shall be able to operate them in all aspects.

2.4.4 Maintenance operator

The maintenance operator is responsible for the maintenance of the system. He is responsible for the start-up and shutdown of the global system or of a part of it. He is knowledgeable about all the control equipments.

2.4.5 System developer

The system developer is a software engineer who designs and creates the DCS. He is knowledgeable in computer science and in control hardware.

2.5 Operational environment

The COMPASS experiment consist of a number of detectors (Figure 2).

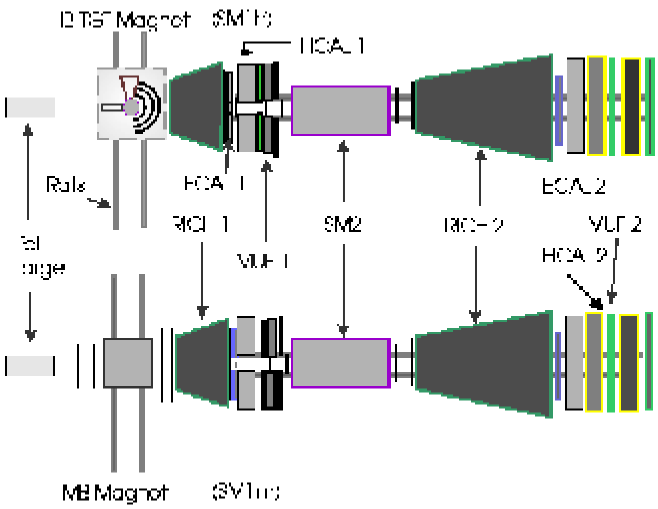


Figure 2 COMPASS detector.

The total length of the experiment is about 50 meters long. The equipment to control is spread all over the COMPASS line.

2.5.1 High Voltage power supplies

COMPASS will use CAEN, LeCROY and home made power supplies. The CAEN and LeCROY power supplies can be controlled remotely by CAENet and Ethernet respectively. In addition both type of power supplies have RS232 serial link. The home made HV system will be used by ECAL and HCAL. In these systems the HV can only be set manually or remotely by a CAMAC interface. The direct reading of HV values for individual channel is not possible.

However the HV level could be calculated from monitoring the value of the PM gain read by the DAQ system.

2.5.2 Low Voltage Power supplies

The LV power supplies provide the power for the front-end electronics. Different kinds of power supplies will be used and have to be monitored and controlled:

- WIENER PL500F series. A remote access via the CAN fieldbus with a proprietary protocol is available
- power suppliers without interface
- home made power supplies

As the power supplies, which belong to two last groups have no standard interface, the following means of control can be considered:

- the power suppliers can be equipped with “On / Off” relays in such a way that it will be possible to switch them On or Off by sending a TTL or NIM signal from the DCS
- it should be possible to read the voltage or current of the power supply by an ADC. Few TTL signals can also be used for the LV state such as “the voltage is in a range”, “the current is in a range”, “the state of the power supply” or “switch off / on the power supply”. ***However whatever solution is selected for the home made LV power supply, a hardware development is needed. TBD.***

2.5.3 Crate control

VME crates will be used in the COMPASS experiment for the front-end electronics readout. These crates are remotely accessible via a CAN fieldbus interface with a WIENER protocol. Crates with no remote access may be used, ***however these crates can be accessed if some hardware development is performed. TBD.***

2.5.4 Analog monitoring

The analog acquisition system provides read-out and monitoring for all the analog sensors which are required for the COMPASS experiment. This consists of variable such as temperature, pressure, humidity, magnetic field. These sensors have traditional hardware interface such as voltage (e.g.: 0-10V) or current (4-20mA) with an accuracy of 10 or 12 bits. The conversion factor from the original measuring unit and the voltage or current must be available to the DCS, the users of the DCS will only see the original measuring unit. All the analog parameters have operational values (expressed in the native unit) which should stay within a pre-defined range. When the value is outside the range, the DCS operator must be notified. ***TBD***.

2.5.5 Bit monitoring

TBD.

2.5.6 Start-up

Different start-up sequences are foreseen with the DCS. They will be applied when the DCS is restarted after a shutdown period, after a power off of the DCS or after a power off of the hardware. Different configuration setup will be applied to the hardware depending on the startup conditions of each COMPASS detector.

2.5.7 External interfaces

The DCS interacts with the detector hardware and its users, but it also has to receive data from and pass data to other systems such as:

- DAQ / Trigger / RUN CONTROL used for the physics data acquisition, the control of this data acquisition and for sending data for off-line analysis. ***TBD.***
- Calibration, pedestal down-loading, threshold calculation, threshold down-loading, etc. systems which are particular to each detector. ***TBD.***
- Monitoring of the Detector channels. ***TBD.***
- PS control system for information on the beam (e.g.: intensity) ***TBD.***
- infrastructure control system which holds security informations such as security in the COMPASS area, etc. ***TBD.***
- the polarized target control system based on LabVIEW, accessible via TCP / IP. ***TBD.***
- MicroMEGA control system based on EPICS. ***TBD.***
- home made hardware access: e.g.: HV access.
- detector control system already existing.
- Event reconstruction system: this system uses a subset of the DCS data, e.g.: state of the detector, state of the HV, etc. The data are saved in the central data recording system.
- GAS system used for RICH, MWPC and Straw detectors. These system are controlled by two PLCs TSX Micro from the Schneider series. The access in read only mode is done via a RS232 serial line. For long distance a RS422 interface can be used. ***TBD***.

The RUN CONTROL task, the read-out configuration task or the detector performance task (e.g.: the “supervision” of the Calibration or pedestal down-loading, etc.) can be done using the same toolkit as the one used for the DCS.

2.6 Assumptions and dependencies

It is assumed that the hardware used for the project will be available for the development of the software. It Is also assumed that the interfaces to the existing software are already defined and available. The system described in this document is for DCS, therefore fast closed-loop control is not required. When automatic adjustment on the HV has to be done for some detectors by getting a feedback from the DAQ, this is considered to be a slow closed-loop control. The DCS will be delivered in few phases. For the commissioning of COMPASS in year 2000 a minimal set of functionalities will be delivered: access to hardware which has a remote access (e.g.: crates via CAN, CAEN HV, LeCROY HV), user access, archiving, alarm, limited MMI. The other functionalities will be added in the future releases. ***TBD***.

Chapter 3
Specific Requirements

This section lists all the requirements of the DCS with its attributes. The URs are composed as shown below:

Explanatory text of the UR when needed to clarify the reason of the UR.

UR Id UR text, the requirement text of the UR.

Each UR has a unique identifier: UR id, and an associated requirement text, it may also be preceded by explanatory text in italics.

3.1 Capability Requirements

This section describes the functions and the operations needed by the DCS, it is divided in two parts. The “General system feature” describes the common features of all the detectors of the COMPASS experiment which are using the same DCS toolkit. It is then followed by the “Detectors” section which describes the specific needs of each detector of the COMPASS experiment.

3.1.1 General System Features

3.1.1.1 Access Control

Access to the DCS must be restricted to only the users who are authorized to use it. As such the DCS kernel must include features which requires a user to identify himself, e.g. login. The user will then be able to access only the functionality for which he has an appropriate level of privilege.

ACC01 The DCS shall allow any user to identify himself.

ACC02 The user shall only be able to perform actions corresponding to his level of privilege at a time.

In general multiple users of the DCS will have the necessary privilege to access a piece of equipment and modify its behaviour. It is undesirable that two or more users should be able to modify the behaviour of a piece of equipment at the same time. However during maintenance periods, this facility may not be required and it should be possible to disable this feature.

ACC03 The DCS shall provide a facility to prevent users of a same detector from modifying the behaviour of equipment simultaneously. However a read access shall be possible. It shall be possible to disable this feature during maintenance or long shutdown period. The DCS should provide a facility to have only one user of a same detector, with the Local Expert access level (See Section 3.1.1.3, "Users"), logged in the DCS at a time, read access shall be possible. If this feature is implemented, it shall be possible to disable it.

To avoid the situation where a user has the control of an equipment or a DCS resource and cannot be contacted, it must be possible to log him out of the DCS remotely on request from the COMPASS control room.

ACC04 The DCS shall allow for a user to be logged out of the DCS from the control room. A time-out logout may be implemented with the possibility to define the time-out value.

3.1.1.2 Types of Access

During normal operation, start-up phases, etc., most of the experts or users will not be at CERN or in the COMPASS control room. They should have a read access to the COMPASS equipment. A write access to the equipment should also be possible, ***security aspects have to be taken in consideration.***

ACC05 The DCS shall provide the capability for a user to be able to access the DCS from a variety of location in a read mode: the COMPASS control room, the CERN offices, the institute offices which are outside CERN or from home.

ACC06 Any user action which modifies the behaviour of an equipment shall only be accepted from a station located in the COMPASS control room, **from a CERN office or from an office outside CERN**.

Different users will interact with their detector at different levels. An Operator on shift will be interested in the detector as a whole whereas an Expert of a detector could be interested in one particular equipment.

ACC07 The user shall be able to access the DCS at different levels of abstraction, e.g. by browsing a tree of possible views, by entering the view he wants to see.

In general many users will interact with the DCS at any time. They are not aware of the action of the other users except for global action such as acknowledgment of alarm, masking or disabling equipment.

ACC08 The DCS shall provide a facility to establish an individual session with each user, e.g. the result of the commands, the actions, issued by this user shall be transmitted only to him.

3.1.1.3 Users

The access the DCS is restricted to its declared users with appropriate password. Four kinds of access levels can be granted to the user using the DCS (refer to Section 2.4, "User characteristics" for more information on the different kind of users):

- *the Observer: this is the default access level when a new user connects to the DCS. The user with the Observer access level is able to monitor the operation of the DCS, control functions are accepted. The Operator on shift has always the Observer user access level.*
- *the Local Expert: the user with the Local Expert access level has a full access to operate on all aspects of a single detector. Only one Local Expert can have access to one single detector at a time, but each detector may have its own Local Expert. The shift leader and the expert of a detector are typically the users who can have the Local Expert access level rights.*
- *the Global Operator: the user with the Global Operator access level has access to operate all the detectors when they are in the run mode. However, the level of access is restricted to items, which are not a security risk (so, for example, access would not be allowed to voltage trip thresholds). The user with such access level is furthermore at any time responsible for all equipment that is not assigned to a specific detector and for all the detectors for which there is no Local Expert. The Global Operator access level is generally given to a shift leader, a maintenance operator or a system developer.*
- *the Global Expert: the user with the Global Expert access level is equivalent to the Global Operator, but with complete access to all individual detector. The Global Expert access level is generally given to a shift leader, a maintenance operator or a system developer.*

The user who wish to work with a lower privilege to avoid making mistakes has to logout to release its access level and log in again with the appropriate password the get a lower access level.

USE01 Any user using the DCS shall have the Observer access level. The Observer access level shall be given to any user logout from a higher access level privilege. A password shall not be requested for the Observer access level. The user with the Observer access level shall be able to monitor the operation of the DCS, action or command functions shall not be accepted: e.g. **acknowledge of alarm. TBD**.

USE02 The user with the Local Expert access level for a particular detector shall have a full access to operate on all aspects of a single detector. A password shall be requested when the user wants to get the Local Expert access level right. Each detector may have different user with the Local Expert access level. **He shall be able to start/stop the detector DCS.**

USE03 The user with the Global Operator access level shall have access to operate all the detectors when they are in the run mode. A password shall be requested when the user wants to get the Global Operator access level right. The user with the Global Operator access level shall be **able to log out the user having Local expert or Global Expert access level. He shall be able to start/stop the COMPASS DCS and all the detector's DCS. TBD.**

USE04 The user with the The Global Expert access level shall have the same privileges as the user with the Global Operator access level. He shall have access to all the detectors. **He shall be able to change the password of the access level. He shall also be able to grant/remove access level to the users.** A password shall be requested when the user wants to get the Global Expert access level right.

USE05 The Maintenance Operator and System Developer shall have the Global Expert access level.

USE06 The list of users and their access level shall be saved in the configuration setup (see **SET02**) corresponding to the physics programme whenever they are changed. No history shall be kept. See Section 3.1.1.5, "Configuration setup" for more details.

3.1.1.4 Definition/modification

The DCS kernel will use equipment of different types. Part of the process is to define new devices, remove old ones or modify existing ones. The type of equipment is normally defined and not changing every time. Adding a new equipment is normally a simple action and should not required to stop and re-start the DCS if the hardware does not need to be unplugged or plugged in the DCS crates. Furthermore, it should be easy to duplicate equipment of an existing type. Adding/removing/modifying an existing type of equipment is a major change and may require a stop and re-start of the DCS.

DEF01 It shall be possible to add / remove equipment to be monitored and controlled. Consistency checking shall be done to avoid conflicts.

DEF02 It shall be allowed to create new element types. It shall be possible to duplicate elements of an existing types without a deep knowledge of the DCS toolkit.

DEF03 It shall be possible to add / remove / modify element types. The DCS may be stopped and then re-started.

The DCS of the COMPASS experiment will be used since the beginning of the experiment with continuous modifications. Therefore the DCS must allow on-line (dynamic modifications) to avoid to stop a running detector when adding new elements of existing types.

DEF04 The user shall be able to define the detector owner and an identifier of an element~~ / set or marked it as a shared element, it shall be an exclusive choice~~. The user shall be able to modify the owner name and the identifier of an element~~ / set. An element marked as shared shall be an owned by a detector or COMPASS.~~

DEF05 Adding (dynamic or on-line modifications) an element should be allowed by the DCS and this operation should not need a stop and re-start of the DCS~~ in the case of the hardware element is already plugged in a DCS crate~~. If such functionalities is not supported, the state and value of the elements shall be restored as it was before the operation. ~~If a hardware element has to be plugged in the DCS crate, the addition of an element shall be allowed by the DCS and this~~

~~operation shall need a stop and re-start of the DCS.~~ The list of elements shall be saved in the corresponding physics programme (Muon or Hadron) configuration setup (see **SET02**). No history shall be kept. See Section 3.1.1.5, "Configuration setup" for more details.

DEF06 Removing (dynamic or on-line modifications) an element ~~not marked as shared~~ should be allowed by the DCS and this operation should not need a stop and re-start of the DCS ~~in the case of the hardware element is already plugged in the DCS crates~~. If such functionalities is not supported, the state and value of the elements shall be restored as it was before the operation. ~~If a hardware element has to be un-plugged from a DCS crate, the deletion of an element shall be allowed by the DCS and this operation shall need a stop and re-start of the DCS. Removing an element marked as shared shall not be allowed (it shall be first marked as not shared)~~. The list of elements shall be saved in the corresponding physics programme (Muon or Hadron) configuration setup (see **SET02**). No history shall be kept. See Section 3.1.1.5, "Configuration setup" for more details.

The control of COMPASS or detectors will be organized in a hierarchical fashion and the operations will be defined for equipments or for collection of equipments or individual I/O parameters belonging to a detector or shared between few detectors.

DEF07 The user shall be able to define objects representing the behaviour of some part of a detector or equipment. He shall be able to define control action on them. He should also be able to define the sequence of control which results from each control operation action. He shall also be able to group them in a collection. A collection shall be composed of single elements or other collections. It shall be possible to put an element in different collections. It shall be possible to add / remove elements in a collection without stopping the DCS and without a deeper DCS toolkit knowledge. The user shall be able to define the action on the collection~~: mask / un-mask, acknowledge and disable / enable (see **ACQ05**, **ACQ06**, **ACQ07**, **ACQ08**, **ALM05**, **ALM08**, **ALM09** and **ALM16**)~~.

~~**DEF08**~~ ~~The user shall be able to define a hierarchy of control corresponding to the detector / equipment / set hierarchy for such objects.~~ **not necessary: already explained for HV, crate, LV, masking and disable.**

3.1.1.5 Configuration setup

The equipments to be controlled and monitored will be used in different physics programme (Hadron and Muon), during RUN, MAINTENANCE and SHUTDOWN period. Different configuration setup can be loaded to these equipments: at startup, during the run, etc. The DCS should not be stopped when changing this configuration and therefore should not affect the running elements of the DCS.

SET01 It shall be possible to have one or many configuration setups per detector, elements or collection of elements / IO parameters. This configuration setups shall contain the list of devices, elements with their value, disable / enable, the alarm state, masked / un-masked, category and condition (warning, fault, fatal). An error (e.g.: an element was deleted without changing the configuration setup) in the configuration setup shall generate an alarm with the warning category but shall not prevent the DCS to run. He shall be able to add or remove an element in the configuration setup without a deeper DCS knowledge.

SET02 A user with the Local Expert, Global Operator, Global Expert access level shall be able to define a configuration setup per physics programme (Muon and Hadron), containing the list of devices or elements used with their state: the access level for each element, the elements to be archived and their archived conditions, the alarm category and condition (masked, warning, fault, fatal), collection of element, list of users and user access level. The DCS shall be stopped and re-started for loading a configuration setups of another physics programme.

SET03 Except for **SET02**, a user with the Local Expert, Global Operator, Global Expert access level shall be able to change the configuration setup of equipments, collections or I/O parameters without stopping the DCS, he shall be able to select the configuration setup.

SET04 A user with the Local Expert, Global Operator, Global Expert access level shall be able to save the running setup in configuration setup with a given identification. This shall be done on a periodic basis or on a user request. He shall be able to modify this periodic time.

SET05 A user with the Local Expert, Global Operator, Global Expert access level shall be able to view the value of the configuration setup. The configuration setup shall be save in ASCII file format or database format. **TBD.**

3.1.1.6 Hardcopy and report

The user will need to output from the system or copies of screen shots during the course of his work. The output could be to printers and files or screen. This feature could be used for debugging purpose for instance.

REP01 A user with the Local Expert, Global Operator, Global Expert access level shall be able to select data from any data source (elements/collection of elements/IO parameters, etc.) for output to an ASCII file or printer containing the time stamp, the data value and data identifier.

REP02 He shall be able to define when this report is to be generated either on a regular frequency or at a specified time or on an event.

REP03 He shall be able to select data from any data source (elements/collection of elements/IO parameters, etc.) and monitor it on a screen whenever desired.

3.1.1.7 Acquisition of parameter

The acquisition of the parameter will be done by the DCS either at a regular interval or on an external event (e.g. a spill signal). The acquired value will also be sent to the DCS supervisor part either at *regular interval, on event (when the parameter changes by more than a defined limit) or on a combination of the two.*

ACQ01 A user with the Local Expert, Global Operator, Global Expert access level shall be able to define the acquisition's conditions of a parameter either based on a set scan interval or an event driven (in-spill, out-off-spill, etc.) or on a combination of the two. He shall be able to define the scan rate. He shall also be able to define different scan rates for different parameters. The DCS shall be able to acquire the parameters on a set scan interval or on an event (in-spill, out-off-spill, etc.) or on a combination of the two. It shall be possible to acquire parameters during the spill, the number of measurements shall be configurable

The acquired value will also be sent to the DCS supervisor part either at regular intervals, on event (when the parameter changes by more than a defined limit) or on a combination of the two.

ACQ02 A user with the Local Expert, Global Operator, Global Expert access level shall be able to define condition of sending the acquired value of the parameter to the supervisory part of the DCS based on set scan interval or on an event (when the parameter changes by more than a defined limit) or on a combination of the two, he shall be able to define the limits for the event driven mechanism.

ACQ03 He shall be able to obtain and view the current value of the measured parameter. He shall be able to select and force the reading of a parameter or a collection (group of parameters).

ACQ04 The DCS shall read the masked element~~/set~~ in the same manner as if it is not masked.

During the commissioning of COMPASS, the equipment will be added periodically, to avoid to upgrade periodically the running system, they will be prepared in advance, the expert user will connect the new equipment as soon as they will be ready. Also during normal operation, the expert user will temporally remove or switch off equipment because they are faulty for example. These actions should not disturb the running DCS and should not require a stop and a re-start of the DCS. Therefore a disable feature is needed. An equipment disable means that the element is not read, its value is not archived, its alarms are not evaluated and the actions on that element are not allowed. Detectors in COMPASS will share equipments, however there will be only one owner per element. ~~The owner is the only user allowed to disable or enable the element, e.g: disabling a HV crate owned by another DCS will disable only the HV channels.~~

ACQ05 A user with the Local Expert, Global Operator, Global Expert access level shall be able to disable a single equipment or a collection (group of elements)~~ which is not marked as shared,~~ without DCS toolkit knowledge. The disabled elements shall not be read ~~(not read and no alarm evaluation)~~.

ACQ06 Without DCS toolkit knowledge, a user with the Local Expert, Global Operator, Global Expert access level shall be able to enable a single equipment or a collection (group of elements) ~~which was previously disabled and not marked as shared~~. The enabled elements shall be then evaluated by the DCS.

A collection (defined in ***DEF07****) is a node in the detector's hierarchy tree show in Figure 1. The disable/enable feature only apply to the element or the collection, but it is also interesting to be able to* *disable/enable in one command all the elements which are underneath the collection node: that is all the elements of the collections and all the elements of the collection of this particular collection, this is a recursive action on the collection. This action is particularly useful, when a whole part of a detector is switched off for maintenance purpose, to avoid time-out or un-interesting alarms instead of disabling element per element.*

ACQ07 A user with the Local Expert, Global Operator, Global Expert access level shall be able to disable all the element of a collection (group of elements)~~ which is not marked as shared,~~ without DCS toolkit knowledge. The collection shall then disabled and all the elements~~, which are not marked as shared,~~ belonging to this collection shall be then disabled. If the element is another collection, then all the elements of this last collection shall be disabled (this is a recursive action on the collection element).~~Disabling a collection marked as shared shall disable all the elements in the collection but shall not disable the collection.~~

ACQ08 Without DCS toolkit knowledge, a user with the Local Expert, Global Operator, Global Expert access level shall be able to enable all the element of a collection (group of elements)~~ which was not marked as shared. The enabled elements shall be then evaluated by the DCS.~~ The collection shall then be enabled and all the elements~~, which are not marked as shared,~~ belonging to this collection~~ which is enabled~~ shall be then enabled. If the element is another collection, then all the elements of this last collection shall be enabled (this is a recursive action on the collection element). ~~Enabling a collection, which is marked as shared and which is already enable, shall enable all the elements in the collection. It shall not be allowed to enable an element marked as shared and which is disabled, an alarm with the warning category shall be generated.~~

ACQ09 The list of the disabled / enabled elements shall be saved in a configuration setup (see **SET01**) whenever they are changed. See Section 3.1.1.5, "Configuration setup" for more details.

Before adding a new equipment or if during operation an equipment reacts in a strange manner, it is interesting to be able to debug it to test that it reacts correctly.

ACQ10 The user with appropriate user access level shall be able to debug its equipment in standalone without interfering with the running version of the DCS. He shall also be able to debug his equipment which is integrated in the running DCS by mean of the value read, the alarm generated.

During the operation of COMPASS, the user will define, remove, switched off, disconnect the equipments, etc. These equipments will be temporally unavailable. The DCS shall generate an alarm when the equipment is not accessible.

ACQ11 The DCS shall generate an alarm if the equipment to be read is not reachable. The alarm category shall be configurable. The DCS shall also generate an alarm if the equipment to be read it is not defined. The alarm category shall also be configurable. This shall not prevent the DCS to run

3.1.1.8 Alarm Handling

This section deals with software alarms, hardware alarms are not listed here.

3.1.1.8.1 Alarm Definition and Generation

Alarms are classified into three categories:

- *Warning: a warning message is generated if a piece of equipment deviates from its normal operating behaviour (e.g. if a temperature is not within its nominal range), but there is no danger for data quality or no need for immediate intervention.*
- *Fault: a fault message is generated when there is a potential risk of data quality damage because of an equipment malfunction (e.g. HV is out of the pre-set limits).*
- *Fatal: a fatal alarm is generated when some important part of the DCS itself has failed or there is a serious equipment failure and an immediate action should be taken (e.g. a HV channel has tripped, a crate is switched off, etc.). In general, a fatal alarm will generated a message to the DAQ system.*

The DCS has to run since the beginning of the COMPASS experiment, and most of the detectors experts do not know exactly to which category the alarm should belong to. Therefore, changing the category of an alarm should be as easy as possible and will be mainly done by detector's expert with no or little knowledge of the DCS toolkit.

Alarms are not evaluated on the disabled or masked elements.

ALM01 A user with the Local Expert, Global Operator, Global Expert access level shall be able to define the alarm conditions and the alarm categories for the elements he is responsible for. He shall be able to change dynamically, without stopping the DCS and without a particular DCS toolkit knowledge, the alarm condition and categories of the elements he is allowed to change.

ALM02 He shall be able to define for each parameter the three alarm categories.

ALM03 An alarm shall be generated whenever an alarm condition is detected and if the element is enabled and not masked.

A piece of equipment may have a different alarm behaviour depending on its operational state, e.g: the alarm on the voltage of a HV channel has to be temporary masked during ramping up state.

ALM04 A user with the Local Expert, Global Operator, Global Expert access level shall be able to define alarm conditions which are state dependent.

The DCS is organized in a hierarchical manner (Figure 1, ***DEF07****): a collection of detectors containing a collection of equipments, etc.: for instance, the RICH detector contains HV system which contains itself HV channels. Two different kind of alarm type are foreseen for collection of equipment: an alarm summary which is the highest level of alarm of the element in the collection, and an alarm associated to the collection. The alarm summary is always calculated by default, the second alarm is user dependant. E.g.: the RICH detector contains HV system which contains itself HV channels, therefore an alarm in* *an HV channel should result in a alarm summary in the HV system and then in the RICH detector. Another alarm could be defined, e.g.: "if more than two HV channels are in fatal alarm, then the HV system is in fatal alarm, otherwise it is not in alarm".*

ALM05 ~~A user with the Local Expert, Global Operator, Global Expert access level shall be able to organize the alarm in a hierarchical manner, by grouping them in a collection. He shall be able to put in that collection whatever element and other collection. As a result,~~ The summary alarm of the collection defined in **DEF07** is the highest level of alarm of all the elements of the collection, this summary alarm is always evaluated. He shall also be able to define other alarm conditions and alarm categories for a collection.

ALM06 He shall be able to save/load the alarm categories and alarm conditions of the parameter in a configuration setup (the summary alarm of the collection is not saved, because it is always evaluated). See Section 3.1.1.5, "Configuration setup" for more details.

3.1.1.8.2 Alarm Management

The users of the DCS require different information. Furthermore, they wish to see alarm information in a manner which allows them to quickly identify the real source of the anomaly.

ALM07 The kernel DCS shall provide the facility to browse, filter or summarize the alarms.

In the case where a piece of equipment is known you be faulty, the user will not want to receive alarms from it. The equipment will be read but its alarm will be masked.

ALM08 A user with the Local Expert, Global Operator, Global Expert access level shall be able to mask the alarms of an element or a collection~~, which are not marked as shared,~~ without having a deeply knowledge of the DCS toolkit. The alarms of a masked element or a masked collection shall not be evaluated. Without DCS toolkit knowledge, a user with the Local Expert, Global Operator, Global Expert access level shall be able to un-masked the alarms of an element or a collection~~, which was previously masked and which are not marked as shared~~. The alarms of the un-masked element or the un-masked collection shall be evaluated.

*A collection (defined in **DEF07**) is a node in the detector's hierarchy tree show in Figure 1. The mask/un-mask feature only apply to the alarms of an element or a collection, but it is also interesting to be able to mask/un-mask in one command all the alarms of all the elements which are underneath the collection node: that is all the alarms of all the elements of the collection and all the alarms of all the elements of the collections of this particular collection, this is a recursive action on the collection. This action is particularly useful to mask or un-mask all the alarms of all the elements of a HV device instead of doing it element per element.*

ALM09 A user with the Local Expert, Global Operator, Global Expert access level shall be able to mask all the alarms of all the elements of a collection~~, which are not marked as shared,~~ without having a deeply knowledge of the DCS toolkit. ~~The alarms of the masked elements shall not be evaluated.~~ All the alarms of all the elements~~, which are not marked as shared,~~ belonging to this collection ~~which is masked~~ shall be then masked. ~~Masking a collection, which is marked~~

~~as shared, shall mask all the elements in the collection but shall not mask the collection.~~ If the element is another collection, then all the alarms of all the elements of this last collection shall be masked (this is a recursive action on the collection element).

ALM10 Without DCS toolkit knowledge, a user with the Local Expert, Global Operator, Global Expert access level shall be able to un-mask all the alarms of all the elements of a collection, ~~which was previously masked and which are not marked as shared~~. All the alarms of all the elements~~, which are not marked as shared,~~ belonging to this collection ~~which is un-masked~~ shall be then un-masked. If the element is another collection, then all the alarms of all the elements of this last collection shall be un-masked (this is a recursive action on the collection element). ~~The alarm of un-masked elements shall be evaluated. Un-masking a collection, which is marked as shared and which is already not masked, shall un-mask all the elements in the collection. Un-masking a collection, which is marked as shared and which is masked, shall not be allowed, an alarm with the warning category shall be generated.~~

ALM11 A user with the Local Expert, Global Operator, Global Expert access level shall be able to save / load the status of the alarm mask of the parameters / collections in a configuration setup. See Section 3.1.1.5, "Configuration setup" for more details.

In some case action can be initiated automatically in an alarm situation, e.g. send a message to the DAQ in the Fatal alarm situation.

ALM12 A user with the Local Expert, Global Operator, Global Expert access level shall be able to define an automatic action to be performed in the case of an alarm condition being detected.

ALM13 All the users of the DCS shall have the same view of the active alarms, masked alarms and acknowledged alarms via a local or remote viewer.

In COMPASS, some external process need to be integrated with the SCADA by mean of alarm: this process can send alarm messages to the DCS alarm management system. These alarm are then shown in the alarm display and handled as alarm coming from the DCS front-end.

ALM14 The alarm management of the DCS shall provide an alarm server mechanism based on string. Whatever external process shall be able to send an alarm string to the DCS alarm management. The behaviour of this alarm and its disable / enable, mask / un-mask and acknowledge features shall be the same as an alarm generated by the DCS.

Before setting an automatic action on an alarm, it could be desirable to be able to test this alarm first.

ALM15 The user with appropriate user access level shall be able to debug the alarm of its equipment in standalone mode without interfering with the running version of the DCS.

3.1.1.8.3 Alarm Display

The main purpose of an alarm is to report an anomaly situation to the users so that he takes actions to fix the problem.

ALM16 The user shall be able to acknowledge the alarm of an element or a collection.

A collection (defined in ***DEF07****) is a node in the detector's hierarchy tree show in Figure 1. The acknowledge feature only apply to the alarms of an element or a collection, but it is also interesting to be able to acknowledge in one command all the alarms of all the elements which are underneath the collection node: that is all the alarms of all the elements of the collection and all the alarms of all the elements of the collections of this particular collection, this is a recursive action on the collection.This action is particularly useful to acknowledge all the alarm of all the elements of a HV device instead of doing it element per element.*

ALM17 The user shall be able to acknowledge all the alarms of all the elements of a collection. If the element is another collection, then all the alarms of all the elements of this last collection shall be acknowledged (this is a recursive action on the collection element).

ALM18 A user with the Local Expert, Global Operator, Global Expert access level shall be able to define which user is allowed to acknowledge or mask an alarm.

ALM19 The user shall be notified of alarms by a bell or which gain his attention. He shall be able to switch off this alarm notification. The alarm notification shall cease as soon as the alarm has disappeared or the user has acknowledged it.

ALM20 From the alarm display, the operator shall be able to open the window where the alarm is present. A help on the alarm or a help on how to fix it shall be available to him.

The users will access the alarm display from different location, they should have a coherent view for the alarm.

ALM21 The alarm visualization shall be the same from the COMPASS control room, from a CERN office, from a institute office and from home. It should also be the same with whatever UNIX or NT computer connected to the DCS.

See Section 3.2.4, "User Interfaces" **UIF07** to **UIF12** for other requirements for alarm display.

3.1.1.9 Archiving and Data retrieval

The DCS will be used for the control of the detectors of COMPASS during RUN period as well as during MAINTENANCE and SHUTDOWN period. Therefore it is very important to be able to *archive the data and to retrieve them for analysis to find what occurred. The elements which are disable shall not be archived.*

ARC01 The user with the Local Expert, Global Operator, Global Expert access level shall be able to select which parameters are to be archived, to define for any parameter the archiving conditions, based on a set scan interval or upon changes or a combination of the two. He shall be able to define the condition for the on change archive. He shall be able to change the archiving conditions without stopping the DCS and with little DCS toolkit knowledge. Value, time stamp and parameter identification shall be included in the archive.

ARC02 The user shall be able to retrieve only the data which are of interest to him.

ARC03 All the data which are read shall be archived if the element is enabled.

A subset of the data read by the DCS are interesting for off-line event reconstruction. These data will be saved in a central data recording area.

ARC04 The user with the Local Expert, Global Operator, Global Expert access level shall be able to define which data from all the archived data is to be sent to the central data recording system and in which conditions, based on a set scan interval or upon changes or a combination of the two. He shall be able to define the condition for the on change sending mechanism. He shall be able to change these conditions without stopping the DCS and with little DCS toolkit knowledge. The DCS shall then be able to send to the central data recording system the selected data (value, time stamp of the last reading and data identification) upon the defined conditions.

ARC05 In the case of the data are sent to the central data recording system on change condition, if the link to the central data recording system was broken, the DCS shall be able to send all the changes, according to the change conditions, since the last time they were sent when the link is re-established.

ARC06 If the subset of data is not sent to the central data recording, the DCS shall provide a set of API or a library to allow the off-line event reconstruction to retrieve the data which are needed without DCS knowledge whenever needed and from a remote computer (NT or UNIX), see Section 3.1.8, "External interfaces" for more details.

ARC07 The list of archived parameters and conditions shall be saved in the corresponding configuration setup, depending on the physics programme, (see **SET02**) whenever they are changed. No history shall be kept. See Section 3.1.1.5, "Configuration setup" for more details.

Some data are read in-spill and out-off-spill. Both of them should be archived.

ARC08 The two values of data which are read in-spill and out-off-spill shall be archived.

3.1.1.10 Logging

To assist in the day to day operation of the detector and to support troubleshooting certain information should be logged and accessible to the users.

LOG01 All user and DCS generated commands, alarms, events and operator actions (masking alarm, setting data, disabling equipment, etc.) influencing the operation of the DCS shall be logged. Each log entry shall be time-stamped and shall include defined supporting information.

LOG02 The user with the Local Expert, Global Operator, Global Expert access level shall be able to define which alarm should be logged or not.

LOG03 All the user generated commands and operator actions shall indicate the user concerned and his access level.

To identify what occurred and why, the user will browse the logged information.

LOG04 The user shall be able to select for viewing only the information that is of interest to him. He shall be able to sort the selected log entry based on defined criteria: between two times, all the equipments of a detector.

LOG05 The user shall be able to select entries from the logs for output to printer or ASCII file.

LOG06 The user with the Global Expert access level shall be able to define the logging duration time. This logging duration shall be the same for all the detectors of the COMPASS experiment.

3.1.1.11 Trending

It is useful for the user to trend the read parameter over the time, during commissioning, RUN, MAINTENANCE or SHUTDOWN period, in order to analyse the behaviour of his equipment, to diagnose problems, etc.

TREND1 From the DCS screen, the user shall be able to select which parameter he wants to trend without any particular DCS toolkit knowledge. He shall be able apply a filter for the selection based on list of equipment of the same type per detector.

TREND2 He shall be able to view on the same trend the historical and real-time data of any element. To be able to view the historical data of an element, this element shall be archived.

3.1.1.12 Operational mode

The DCS will used during the physics operational modes:

- *SHUTDOWN: This the shutdown period of the experiment, most of the hardware is switch off, but some elements are still under control.*

- *MAINTENANCE: part of the experiement is started, the experts are debugging the detectors. This is also the mode before starting a RUN of physic.*
- *RUN: the detectors are taking data.*

The DCS will have also 3 modes:

- *Shutdown: This mode is mainly used at during the SHUTDOWN period of the experiment. The users can disable/enable, masking/un-masking equipment. One configuration set-up is loaded: the shutdown-configuration setup. The user can view, modify and load this configuration setup. The user can also load the run-configuration setup, or whatever maintenance-configuration setups. By loading the run-configuration setup, the DCS mode is set to Run, by loading whatever maintenance-configuration setups, the DCS mode is set to Maintenance.*
- *Maintenance: This mode is used during the MAINTENANCE period of the experiment, or when waiting for the beam, etc.The users can disable/enable, masking/un-masking equipment. The user can view, modify and load this configuration setup. The user can also load the run-configuration setup, whatever other configuration setup, or the shutdown-configuration setup. By loading the run-configuration setup, the DCS mode is set to Run, by loading the shutdown-configuration setup, the DCS mode is set to Shutdown.* ***SIMILAR TO SHUTDOWN TBD WITH VALERI.***
- *Run:This mode is used during the RUN period of the experiment. The run-configuration setup (containing the settings of the elements for the physics run) is loaded. The user is not allowed to disable/enable equipment, masking/un-masking is allowed. Some actions can be not authorised during RUN depending on the detector requirements. The user is not allowed to modify the run-configuration setup and he is not allowed to load other configuration setup. He can end-the-run which will change the DCS mode to Maintenance.*

~~*3 operational modes were identified for the DCS:*~~

- ~~*Shutdown: This mode is mainly used at during the shutdown period of the experiment when most of the hardware is switch off, but some elements are still under control. The users can disable/enable, masking/un-masking equipment and load whatever configuration setup he wants. This is the case when part of the detector is switch off during shutdown but some elements are still under control. Disabling the equipments which are switched off avoid the time-out and alarm readout errors. During this mode, the user can.*~~
- ~~*Maintenance: This mode is used during the maintenance period of the experiment, or when waiting for the beam, etc. The users can also disable/enable equipment in that mode.*~~ ~~***SIMILAR TO SHUTDOWN TBD WITH VALERI.***~~

- *Run: the DCS loaded the settings for the physics run on the elements. The user is not allowed to disable/enable equipment, but masking/un-masking is allowed. Some actions can be not authorised during RUN depending on the detector requirements. The user is not allowed to modify the RUN configuration setup and he is not allowed to load other configuration setup.*

Figure 3 shows the transitions between the different operational modes.

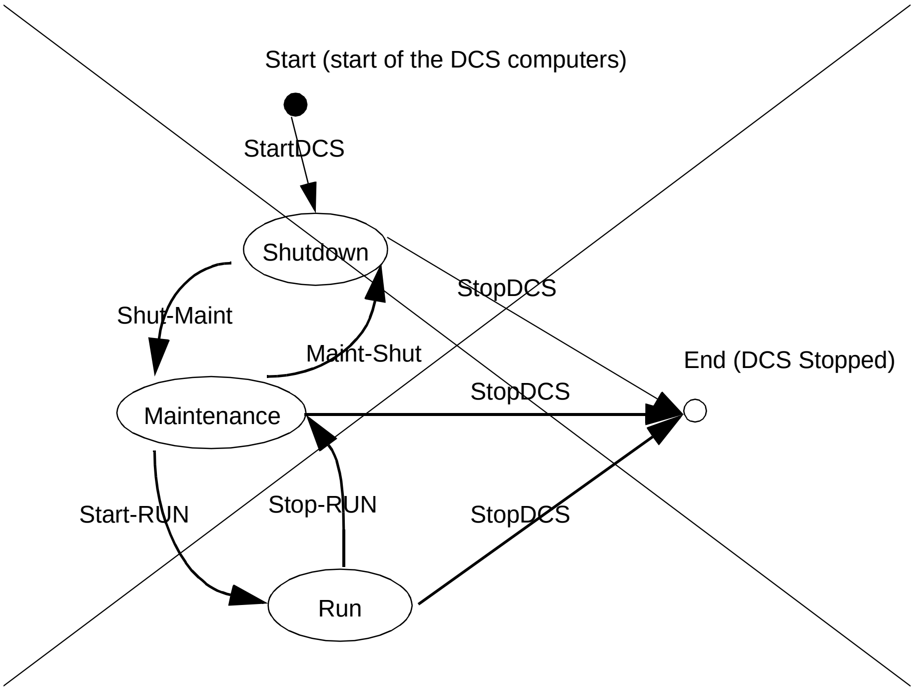


Figure 3 Operational mode transition.

The transitions between the different modes are:

- *StartDCS: starting the DCS application or the DCS computer. This action is done automatically and a Shutdown configuration setup is loaded (see* ***SET01****), this is to avoid fake alarms due to equipment which are off.*
- *StopDCS: stopping the DCS application or the DCS computer.*
- *Shut-Maint: going from Shutdown to Maintenance mode. This action is be done automatically after a crash or on user request, with the appropriate configuration setup.*
- *Maint-Shut: going from the Maintenance mode to Shutdown. This action is be done on user request, with the appropriate configuration setup.*
- *Start-RUN: the run is starting for the DCS, this action is triggered on user request or by an internal event: e.g. when the COMPASS DCS goes to the RUN mode, all the detectors goes to RUN mode automatically. The RUN configuration setup is loaded.*
- *Stop-RUN: the run is ending, this action is triggered on user request or by an internal event: e.g. when the COMPASS DCS goes to Maintenance mode, all the detectors goes to Maintenance mode automatically. The appropriate configuration setup is loaded.*

~~**OM01**~~ ~~If the COMPASS DCS is not in RUN mode, the user shall be able to choose independently the detector DCS mode: Shutdown, Maintenance, RUN. If the COMPASS DCS is in RUN mode, it shall not be allowed to change the mode of the detector DCS. If the COMPASS DCS goes in RUN mode, all the detectors DCS shall go in RUN mode.~~

~~**OM02**~~ ~~The user shall be able to select all the transitions. On the StartDCS transition, Muon or Hadron configuration setup and then the shutdown configuration setup shall be loaded. On the Start-RUN transition, the RUN configuration shall be loaded. On the Stop-RUN transition, the DCS shall be able to load the configuration setup selected by the user. See Section 3.1.1.5, "Configuration setup" for more details. The user with appropriate access rights shall be able to configure the Shut-Maint transition: automatic with condition or on user request.~~

~~**OM03**~~ ~~It shall only be possible to add/remove modify new elements, to modify/save/load configuration setup in the Shutdown and Maintenance mode. Viewing configuration setup is allowed in all modes.~~

~~**OM04**~~ ~~In the RUN, the user shall not be able to test his equipment (see **ACQ09**, **ALM13** and **COM06**).~~

~~**OM05**~~ ~~The operational mode, state transition value and state transition configuration setup name shall be logged.~~

OM01 The operational mode, mode transition, shall be configured.

The DCS is organized in

3.1.1.13 Commanding

The commanding section is about changing a value on the hardware, changing a value on a memory element or sending a signal to a user process. Changing the alarm catgories and conditions of an element, the archived conditions of an element, modifying configuration setup, or the user access level on that element are described in the previous sections. During operation, the user will use his hardware and sends commands to it such as set the voltage on the HV channel, etc. He needs to know if this action was successful or not. The list of action may be complex, e.g.: starting a detector results in a lot of action. The actions are sometimes asynchronous, e.g.: writing on a CAEN HV power supply need few ms or synchronous, e.g: sending a message to a user program. Setting a digital output bit is considered as an asynchronous action because from the point of view of the user a command is sent to the hardware, and the result of this command is calculated by reading back the value of the digital output. A synchronous command has generally a short duration.

The actions on the disabled elements shall not be allowed.

COM00 The actions or commands on disabled elements shall not be allowed.

COM01 The user shall be able to execute a command and have a feedback on the result of his command. The feedback on a synchronous action shall have one of the following value:

- OK: the command was performed by the DCS on the equipment
- inconsistency error: the DCS detected inconsistency in the command
- not existing: the DCS tried to send a command to act on a hardware which is not existing
- communication failure: the DCS failed communicated with the hardware
- failed: the DCS did not performed the command.

The feedback on an asynchronous action shall have one of the following value:

- OK: the command was taken by the DCS and in progress
- insconsistency error: the DCS detected inconsistency in the command
- not existing: the DCS tried to send a command to act on a hardware which is not existing
- failed: the DCS did not accept the command.

COM02 The user with the Local Expert, Global Operator, Global Expert access level shall be able to define complex action or sequence. This may require DCS toolkit knowledge. If the complex action is split in many other action, the feedback is the 'logical and' of all the feedback, e.g: if one feedback of one command of this complex command failed, the feedback of that command is failed.

It is interesting to know the result of an asynchronous action, e.g.: the user set a new value for the voltage of a HV channel, this command was accepted by the DCS, but for some reason it was not set on the hardware. An alarm should then be generated.

COM03 He shall be able to define a duration on the asynchronous action. An asynchronous action which is not done after the defined time (a timed out action) shall generate an alarm. The alarm is generated comparing the requested value to an attribute of an equipment and the read value of the same attribute of that equipment or the result on the real action on that equipment. The DCS shall not be blocked during a synchronous actions. It shall be possible to cancel a synchronous action.

COM04 The user shall be able to do action already done or timed out whenever he wants. The DCS shall not accept a command on a parameter which is disable.

COM05 He may be able to see the progress of the action he initiated.

Before adding a new equipment or if during operation an equipment reacts in a strange manner, it is interesting to be able to debug it to test that it reacts correctly.

COM06 The user with the Local Expert, Global Operator, Global Expert access level shall be able to test the correct operation of a command or a command procedure. he shall also be able to test that the command is correctly sent to the equipment.

3.1.1.14 Operator assistance

During operation, fixing problems require some help, specially for non expert.

ASS01 The user shall be able to access an on-line help facility. It shall contain the information required by the user to operate the DCS.

ASS02 A help facility for the alarm: description, action to take, etc., shall be accessible to the user.

3.1.1.15 Operator Display

The operation on the DCS will be done via displays.

DIS01 The user shall be able to navigate between different displays via a mouse click. It shall be possible to create displays off-line and then incorporate them in the running DCS without disturbing it.

DIS02 The DCS shall provide a template display for CAEN and LeCROY HV power supply, crate control, DCS operational mode, analog and digital operations.

DIS03 The user shall be able to have multiple windows simultaneously.

Some data are read in-spill and out-off-spill. Both of them should be presented on the displays.

DIS04 Data which are read in-spill and out-off-spill should be presented on the screen in two different location.

3.1.2 Operation on HV

A high voltage power supply is a box composed of HV channels. This section describes the requirements for the CAEN and LeCROY HV boxes except if it is stated explicitly. All the requirement on alarm, archive, configuration setup should be applied. A HV channel is composed of writeable attributes and readable attributes.

HV01 The DCS shall be able to set asynchronously all the writeable attributes and to read all the readable attributes of a HV channel, see Section 3.1.1.13, "Commanding" (there are no synchronous commands). The DCS shall be able to read periodically, in-spill and out-off-spill and few times during the spill. The choice shall be configurable.

HV02 During voltage RampUp or voltage RampDown no alarm shall be set for the read voltage and read current. The user with the Local Expert, Global Operator, Global Expert access level shall be able to set a duration during which the alarm on the read voltage and read current shall not be evaluated.

The alarm on the read voltage is evaluated by: Vread within Vset +- range.

HV03 The user with the Local Expert, Global Operator, Global Expert access level shall be able to set a range for the alarm category on the read voltage, current, status (warning, fatal, fault). He shall be able to set an alarm category (warning, fatal, fault) on a trip.

HV04 The user shall be able to reset the trip.

HV05 It shall be possible to save / restore / load configuration setup for HV (the values of the HV attributes, alarm conditions, enable / disable, masked / unmasked, etc.) depending on the operational mode. This configuration setup shall be selectable. See the requirements of the Section 3.1.1.5, "Configuration setup" and the Section 3.1.1.12, "Operational mode".

Most of the time the attributes value of the HV channel are similar, and to simplify the interface to the user, it is interesting to group these HV channels in a set and send one command to the set, even if this is internally split in as many commands on the hardware as there is element in the set. This list of equipment is the set shall be saved in a configuration setup. An example of a configuration setup could be a list of HV channels in a set. Adding a new HV channel or removing a channel from the set is a configuration setup operation.

HV06 It shall be possible to group the HV channel in a set and send commands to that set. The commands shall be on the attributes of the HV channels. The attribute shall be defined later. **TBD**.

Some channels are not used, they are kept as spare channels in case of those which are used are broken. The user will then change the channel without stopping the HV power supply.

HV07 The user with the Local Expert, Global Operator, Global Expert access level shall be able to add / remove a HV channel in set without DCS toolkit knowledge and without stopping the DCS ~~if the HV power supply is not switched off. If the HV power supply shall be switched off to replace an element, the user with the Local Expert, Global Operator, Global Expert access~~

~~level shall be able to disable / enable the power supply equipment. If the power supply is used by other DCS detector, it shall also be disabled / enabled~~. The list of HV channel in a set shall be saved in the configuration file of the physics programme (see **SET02**).

A HV channel has different states: RampUP, RampDown, OFF, ON, TRIP, OVC, OVV, UNV and Stable. This state is read from the HV channel equipment or calculated by the DCS.

HV08 A HV channel shall have the following state: RampUP, RampDown, OFF, ON, TRIP, OVC, OVV and UNV read from the HV hardware, the state stable shall be calculated by the DCS based on Vread = Vset +- range. These state shall be presented on the graphical interface if needed.

*The CAEN power supply has a **NIM** or **TTL** signal named ‘status’, this signal is set when a HV channel trips. If there is no special requirements for reading the HV, the DCS can read the HV channel only when one of them has tripped.*

HV09 It shall be possible to connect the **NIM** or **TTL** ‘status’ signal from the CAEN HV power supply to the DCS, and trigger the readout of all the HV channel of that power supply.

There is different start-up cases for the HV: after a long shutdown, a short power off or a hardware off. Switching on/off automatically the HV will depends on the users choice.

HV10 The user with the Local Expert, Global Operator, Global Expert access level shall be able to select an automatic switch on / off of the HV for a startup after a long shutdown, a short DCS interruption and a short power off of the HV. The exclusive choice shall be a configuration setup (see Section 3.1.1.5, "Configuration setup"), switch on or switch off for all the HV channels he is responsible for.

3.1.3 Operation on LV

LV power supplies are used in the COMPASS experiment in application such as powering preamplifiers, transceivers, etc. Many possibilities exist on how to access the LV parameters:

- using a fieldbus interface: WIENER PL500F with a CAN interface is an example
- with custom development to read / set analogue value for the voltage or current
- with custom development to get / set boolean value which represent status of the voltage, current, etc.

3.1.3.1 LV with a fieldbus interface

In this section it is assumed that the connection to the LV power supply is via a fieldbus (e.g.: CAN) and all the attributes of the power supply are accessible via the fieldbus interface. A LV channel is composed of writeable attributes and readable attributes.

LV01 The DCS shall be able to set asynchronously all the writeable attributes and to read all the readable attributes of a LV channel, see Section 3.1.1.13, "Commanding" (there are no synchronous commands). The DCS shall be able to read periodically, in-spill and out-off-spill and few times during the spill. The choice shall be configurable.

LV02 The user with the Local Expert, Global Operator, Global Expert access level shall be able to set range for the alarm categories (warning, fatal, fault) on the read voltage, current, status.

LV03 It shall be possible to save / restore / load configuration setup for LV (the values of the LV attributes, alarm conditions, enable / disable, masked / unmasked, etc.) depending on the operational mode. This configuration setup shall be selectable. See the requirements of the Section 3.1.1.5, "Configuration setup" and the Section 3.1.1.12, "Operational mode".

Most of the time the attributes value of the LV channel are similar, and to simplify the interface to the user, it is interesting to group these LV channels in a set and send one command to the set, even if this is internally split in as many commands on the hardware as there is element in the set. This list of equipment is the set shall be saved in a configuration setup. An example of a configuration setup could be a list of HV channels in a set, adding a new HV channel or removing a channel from the set is a configuration setup operation.

LV04 It shall be possible to group the LV channel in a set and send commands to that set. The commands shall be on the attributes of the LV channels. The attribute shall be defined later. **TBD**.

Some channels are not used, they are kept as spare channels in case of those which are used are broken. The user will then change the channel without stopping the LV power supply.

LV05 The user with the Local Expert, Global Operator, Global Expert access level shall be able to add / remove a LV channel in set without DCS toolkit knowledge and without stopping the DCS ~~if the HV power supply is not switched off. If the LV power supply shall be switched off to replace an element, the user with the Local Expert, Global Operator, Global Expert access~~

~~level shall be able to disable / enable the power supply equipment. If the power supply is used by other DCS detector, it shall also be disabled / enabled~~. The list of LV channel in a set shall be saved in the configuration file of the physics programme (see **SET02**).

There is different start-up cases for the LV: after a long shutdown, a short power off or a hardware off. Switching on/off automatically the LV will depends on the users choice.

LV06 The user with the Local Expert, Global Operator, Global Expert access level shall be able to select an automatic switch on / off of the LV for a startup after a long shutdown, a short DCS interruption and a short power off of the LV, via a configuration setup (see Section 3.1.1.5, "Configuration setup") or by choosing this feature for all LV channels he is responsible for. This shall be an exclusive choice.

3.1.3.2 LV with analogue or digital interface

In this section it is assumed that the attribute of the LV channel are read by analog to digital conversion and some setting are via digital interface. A LV channel is composed of writeable attributes and readable attributes.

LV07 The DCS shall be able to set asynchronously all the writeable attributes and to read all the readable attributes of a LV channel, see Section 3.1.1.13, "Commanding" (there are no synchronous commands). The DCS shall be able to read periodically, in-spill and out-off-spill and few times during the spill. The choice shall be configurable.

LV08 The user with the Local Expert, Global Operator, Global Expert access level shall be able to set range for the alarm categories (warning, fatal, fault) on the read voltage, current, status.

LV09 It shall be possible to save / restore / load configuration setup for LV (the values of the LV attributes, alarm conditions, enable / disable, masked / unmasked, etc.) depending on the operational mode. This configuration setup shall be selectable. See the requirements of the Section 3.1.1.5, "Configuration setup" and the Section 3.1.1.12, "Operational mode".

Most of the time the attributes value of the LV channel are similar, and to simplify the interface to the user, it is interesting to group these LV channels in a set and send one command to the set, even if this is internally split in as many commands on the hardware as there is element in the set. This list of equipment is the set shall be saved in a configuration setup. An example of a configuration setup could *be a list of HV channels in a set, adding a new HV channel or removing a channel from the set is a configuration setup operation.*

LV10 It shall be possible to group the LV channel in a set and send commands to that set. The commands shall be on the attributes of the LV channels. The attribute shall be defined later. **TBD**.

Some channels are not used, they are kept as spare channels in case of those which are used are broken. The user will then change the channel without stopping the LV power supply.

LV11 The user with the Local Expert, Global Operator, Global Expert access level shall be able to add / remove a LV channel in set without DCS toolkit knowledge and without stopping the DCS ~~if the HV power supply is not switched off. If the LV power supply shall be switched off to replace an element, the user with the Local Expert, Global Operator, Global Expert access level shall be able to disable / enable the power supply equipment. If the power supply is used by other DCS detector, it shall also be disabled / enabled~~. The list of LV channel in a set shall be saved in the configuration file of the physics programme (see **SET02**).

There is different start-up cases for the LV: after a long shutdown, a short power off or a hardware off. Switching on/off automatically the LV will depends on the users choice.

LV12 The user with the Local Expert, Global Operator, Global Expert access level shall be able to select an automatic switch on / off of the LV for a startup after a long shutdown, a short DCS interruption and a short power off of the LV, via a configuration setup (see Section 3.1.1.5, "Configuration setup") or by choosing this feature for all LV channels he is responsible for. This shall be an exclusive choice.

3.1.4 Operation on analog value

ANA01 It shall be possible to set alarm limits on analogue value and load / restore / save this configuration setup, see the Section 3.1.1.13, "Commanding", the Section 3.1.1.5, "Configuration setup" and the Section 3.1.1.12, "Operational mode".

ANA02 The DCS shall also be able to set asynchronously an analogue output, see Section 3.1.1.13, "Commanding" (there are no synchronous commands). The DCS shall be able to issue a read periodically or in-spill and out-off-spill. It shall also be able to read few times during the spill.

3.1.5 Operation on digital value

DIG01 It shall be possible to set alarm limits on analogue value and load / restore / save this configuration setup, see the Section 3.1.1.13, "Commanding", the Section 3.1.1.5, "Configuration setup" and the Section 3.1.1.12, "Operational mode".

DIG02 The DCS shall also be able to set asynchronously an digital output, see Section 3.1.1.13, "Commanding" (there are no synchronous commands). The DCS shall be able to issue a read periodically or in-spill and out-off-spill. It shall also be able to read few times during the spill

3.1.6 Operation on crate control

In COMPASS, crates such as 9U VME are used, they are in barracks or in area where there is no access. In the later case, a remote access is mandatory for monitoring or acting on it: e.g.: switching off, switching on. This section assumes that the crates are remotely accessible via a fieldbus, e.g.: WIENER fantray via CAN interface, or via a custom development. A crate is composed of writeable attributes and readable attributes.

CRATE1 The DCS shall be able to set asynchronously all the writeable attributes and to read all the readable attributes of a crate, see Section 3.1.1.13, "Commanding" (there are no synchronous commands). The DCS shall be able to read periodically, in-spill and out-off-spill and few times during the spill. The choice shall be configurable.

The alarm on the read voltage is evaluated by: Vread within Vset +- range.

CRATE2 The user with the Local Expert, Global Operator, Global Expert access level shall be able to set range for the alarm categories (warning, fatal, fault) on the read voltage, current.

CRATE3 It shall be possible to save / restore / load configuration setup for a crate (the values of the crate attributes, alarm conditions, enable / disable, masked / unmasked, etc.) depending on the operational mode. This configuration setup shall be selectable. See the requirements of the Section 3.1.1.5, "Configuration setup" and the Section 3.1.1.12, "Operational mode".

Most of the time the attributes value of the crate are similar, e.g.: current limits, etc., and to simplify the interface to the user, it is interesting to group these crates in a set and send one command to the set, even if this is internally split in as many commands on the hardware as there is element in the set. This list of equipment is the set shall be saved in a configuration setup.

CRATE4 It shall be possible to group the crates in a set and send commands to that set. The commands shall be on the attributes of the crates. The attribute shall be defined later. **TBD**.

Some crates may be used within a set. Sometimes it can be required to remove a crate from this set.

CRATE5 The user with the Local Expert, Global Operator, Global Expert access level shall be able to add / remove a crate in set without DCS toolkit knowledge and without stopping the DCS~~ if the HV power supply is not switched off. If the LV power supply shall be switched off to replace an element, the user with the Local Expert, Global Operator, Global Expert access level shall be able to disable / enable the power supply equipment. If the power supply is used by other DCS detector, it shall also be disabled / enabled~~. The list of crate in a set shall be saved in the configuration file of the physics programme (see **SET02**).

3.1.7 DCS startup

Different startup sequences can be foreseen with the DCS: after a shutdown period, after a power off, after a failure in the hardware, changing from Hadron to Muon programme.

START01 The DCS shall load the Muon or Hadron configuration setup when starting.

START02 The DCS shall be in the Shutdown operation mode after a start. The DCS shall be able stop only when it is the Shutdown operational mode except if there is a reset, shutdown or power off of the DCS computers. See Section 3.1.1.12, "Operational mode".

START03 The DCS shall know if the re-start is after a long shutdown period or after a global power off. See Section 3.1.1.12, "Operational mode" and Section 3.1.1.5, "Configuration setup".

START04 The user shall able to define the startup condition after a long period, after a short stop / start of the DCS or after a re-start of the hardware. **TBD If this is a short stop/re-start of the DCS computer, the DCS shall go to maintenance mode and reload the latest running values and configuration setup. TBD startup condition, case crash, hwd off/on etc.**

3.1.8 External interfaces

The DCS interacts with the detector hardware and its users, but it also has to receive data from and pass data to other systems, see Section 2.5.7, "External interfaces".

EXT01 The DCS shall allow for data exchange with the following external system or detectors:

- DAQ / Trigger / RUN CONTROL.
- Calibration, pedestal down-loading, threshold calculation and down-loading, etc. systems.
- Monitoring of the COMPASS channels.
- PS control system for information on the beam (e.g.: intensity).
- infrastructure control system which holds the information such as security in the COMPASS area, etc.
- the polarized target control system based on LabVIEW accessible via TCP / IP.
- MicroMEGA control system based on EPICS.
- home made hardware access: e.g.: HV access.
- detector control system already existing.
- Event reconstruction system: this system uses a subset of the DCS data, e.g.: state of the detector, state of the HV, etc. The data are saved in the central data recording system.
- GAS system used for RICH, MWPC and Straw detectors. These system are controlled by two PLCs TSX Micro from the Schneider series. The access in read only mode is done via a RS232 serial line. For long distance a RS422 interface can be used.

EXT02 The DCS shall provide an API.

EXT03 Real-time and historical data in the DCS shall be accessible from external applications.

3.1.9 Detectors.

This section describes the specific requirements of the COMPASS detectors. It gives also the list of hardware elements and the operation on them. The common requirements: Section 3.1.1, "General System Features", Section 3.1.2, "Operation on HV", Section 3.1.3, "Operation on LV", Section 3.1.4, "Operation on analog value", Section 3.1.5, "Operation on digital value", Section 3.1.6, "Operation on crate control", Section 3.1.7, "DCS startup" and Section 3.1.8, "External interfaces" are valid. The polarized target, the MicroMEGA detectors and DAQ system are not in these section, refer to Section 3.1.8, "External interfaces" for more details on the interface to them.

3.1.9.1 RICH

Brief description of the RICH detector **TBD**.

The RICH is connected to a Schneider PLC TSX Micro with a RS232 serial interface or OFS. See Appendix A.1, "RICH" for the list of equipment to be integrated in the DCS. HV, LV and readout BORA shall be ready by April 2000, the GAS shall be ready by February 2000.

RICH1 HV requirement

The DCS shall be able to set a same value (one different per attribute) for all the HV channels for the following attributes: Vmax, Imax, Ramp-up, Ramp-down, Trip time.

RICH2 Analogue monitoring

The DCS shall be connected to the Schneider PLC.

RICH3 Startup

TBD.

RICH4 Special procedure

A reference on the BORA read-out pedestal level shall be kept in the DCS. **TBD**.

Calibration, monitoring: **TBD**.

RICH5 Trending-Archiving

All the data read by the DCS shall be archived. A sub-set shall be sent to the central data recording via the DAQ. **list TBD**.

RICH6 Constraint

The DCS shall allow a remote access on read and write from CERN and outside CERN. It shall be allowed to stop / re-start the DCS when adding / removing elements: **TBD**.

3.1.9.2 STRAW

Brief description of the STRAW detector **TBD**. See Appendix A.2, "STRAW" for the list of equipment to be integrated in the DCS.

STRAW1 Crate

The DCS shall be able switch off the crates in case of overheating: **TBD overheating condition**.

STRAW2 HV requirement

The DCS shall be able to set a same value (one different per attribute) for all the HV channels for the following attributes: Ramp-up, Ramp-down, Trip time. The DCS shall be able to automatically adjust the HV according to the atmospheric temperature out-off-spill. The DCS shall reset automatically the trip. A parametrisable statistic measurement on the automatic reset with alarm shall be provided.

STRAW3 LV requirement

The DCS shall switch off the LV power supply when the read voltage or current is respectively out its uper / lower voltage or current limits.

STRAW4 Analogue Monitoring

The DCS shall provide to the STRAW the value of the magnetic field every spill. The DCS shall be connected to the Schneider PLC.

STRAW5 Alarm

A Warning alarm shall be issued if a channel trips. A Fault alarm shall be issued if an automatic trip recovery failed. A Fault alarm shall be generated when a LV is switched off due to voltage or current limits

STRAW6 Startup

After a long shutdown, the DCS shall load pre-defined values except for HV voltage. The HV voltage shall always be set on user request. The latest running values shall be restored after a crash or a short power off of the DCS. If the hardware is off and comes on again, the DCS shall reload the latest configuration values.

STRAW7 Special procedure

Monitoring of the STRAW channel (13000 bit value: first phase, 20000: final) shall be integrated in DCS. **TBD**.

Calibration procedure: threshold calculation.

TDC and CATCH configuration file shall be stored in the DCS. The DCS shall be able to trigger the down-load of the CATCH configuration file.

STRAW8 Trend-archive

All the data shall be archived forever. A sub-set shall be sent to the central data recording via the DAQ. **TBD**.

STRAW9 constraint

The DCS shall be interfaced to the VME running Linux. It shall be allowed to stop / re-start the DCS when adding / removing elements.

3.1.9.3 MWPC

Brief description of the MWPC detector **TBD**. See Appendix A.3, "MWPC" for the list of equipment to be integrated in the DCS.

MWPC1 Crate

The DCS shall be able switch off the crate in case of overheating: **TBD overheating condition**.

MWPC2 Analogue Monitoring

The DCS shall provide to the MWPC the value of gas flow, temperature and pressure from a GAS system. **TBD: DUBNA**.

MWPC3 Startup

After a long shutdown, the DCS shall load pre-defined values. The on / off command shall be issue on user request. After a crash or a short power off of the DCS, the value read from the HV crates shall be restored. If the hardware is off and comes on again, the DCS shall reload the latest configuration values on user request.

MWPC4 Trend-archive

The current, status and the voltage of the gas flow, temperature and pressure shall be archived forever. A sub-set shall be sent to the central data recording via the DAQ. **TBD**.

MWPC5 constraint

The DCS shall be interfaced to the DAQ and shall send few MWPC status. **TBD**. The DCS shall allow a remote access on read and write from CERN and outside CERN. It shall be allowed to stop / re-start the DCS when adding / removing elements.

3.1.9.4 GEM

Brief description of the GEM detector **TBD**. See Appendix A.4, "GEM" for the list of equipment to be integrated in the DCS. The GEM detector provides its own gas system.

GEM1 Crate

The DCS shall be able switch off the crate in case of overheating, over-current, power supply failure, fan failure: **TBD overheating condition**. The DCS shall be able to increase / decrease the fan speed according depending on the temperature in the crate.

GEM2 HV requirement

The DCS shall be able to set a same value (one different per attribute) for all the HV channels for the following attributes: Ramp-up, Ramp-down, Trip condition (time, current limit). The ramping up of the HV shall be divided in a number of equal step, the trip time and current limit shall be changed during ramping up: e.g: for one step phase: change trip time and overcurrent, set V0, wait stability, go to the next step. The user shall be able to set the number of step, current condition and trip time for all the channel. If a channel trips, the operation on that channel shall be re-started by the user.

GEM3 Analogue Monitoring

The DCS shall stop the HV if the gas flow is out of its limits. **TBD**.

GEM4 Startup

After a long shutdown, the DCS shall load pre-defined values except for switch on. The latest running values shall be restored after a crash or a short power off of the DCS. If the hardware is off, the DCS shall reload the latest configuration values when it comes on again.

GEM5 Special procedure

Pedestal calculation and down-load process shall be triggered by the DCS. The reference of the pedestal configuration shall be archived in the DCS. **TBD**.

GEM6 Trend-archive

All the data shall be archived forever. All the data shall be sent to the central data recording via the DAQ. **TBD**.

GEM7 constraint

The DCS may run on the VME-VMIC CPU under Linux (CPU used for the CATCH). The cryostat control system shall not be stop when changing the configuration of the DCS (in the case the DCS is stopped and then started which is allowed). The user shall not be allowed to change certain parameters when the GEM is in Run operating mode. **TBD**. The DCS shall allow a remote access on read and write from CERN and outside CERN.

3.1.9.5 Silicon

Brief description of the Silicon detector **TBD**. See Appendix A.5, "Silicon" for the list of equipment to be integrated in the DCS. The Silicon detector uses a Cryostat. The Silicon detector shares equipment such HV-LV, with the GEM detector.

SILIC1 Crate

Same requirement as GEM: **GEM1**.

SILIC2 HV requirement

Same requirement as GEM: **GEM2**.

SILIC3 Analogue Monitoring

Same requirement as GEM: **GEM3**. The DCS shall be connected to a cryostat control system. **TBD**.

SILIC4 Startup

Same requirement as GEM: **GEM4**.

SILIC5 Special procedure

Same requirement as GEM: **GEM5**.

SILIC6 Trend-archive

Same requirement as GEM: **GEM6**.

SILIC7 constraint

The DCS may run on the VME-VMIC CPU under Linux (CPU used for the CATCH). The cryostat control system shall not be stop when changing the configuration of the DCS (in the case the DCS is stopped and then started). The user shall not be allowed to change certain parameters when the Silicon is in Run operating mode. **TBD**.

3.1.9.6 BMS

Nothing for the time being.

3.1.9.7 Sci-Fi

Brief description of the Sci-Fi detector **TBD**. See Appendix A.7, "Sci-Fi" for the list of equipment to be integrated in the DCS. **According to the questionnaire, but different from the URD from Bruce Barnett. TBD**

SCIFI1 HV requirement

The DCS shall do an automatic HV setting. **TBD**.

SCIFI2 Startup

After a long shutdown, the DCS shall load the last setting used for HV except for switch on. **TBD**. The latest running values shall be restored after a crash or a short power off of the DCS. If the hardware is off, the DCS shall reload the latest configuration on user request when it comes on again.

SCIFI3 Special procedure

setting of 2560 discriminator levels. **TBD**.

SCIFI4 Trend-archive

All the HV current and voltage shall be archived. All the HV current and voltage shall be trend for 72 hours (no selectable trend). **TBD**.

SCIFI5 constraint

All data shall be saved every hour in ASCII format, and shall be sent to the DAQ every 6 hours in ASCII. The DCS shall allow a remote access on read and write from CERN and outside CERN. The Linux PC used for DAQ shall be allowed to access to DCS. It shall be allowed to stop / re-start the DCS when adding / removing elements as long as the HV setting and the discriminator levels are not changed.

3.1.9.8 Sci-Fi Beam Hodoscope

Brief description of the Sci-Fi Beam Hodoscope detector **TBD**. See Appendix A.8, "Sci-Fi Beam Hodoscope" for the list of equipment to be integrated in the DCS.

SIFIB1 HV requirement

The DCS shall be able to set a same value (one different per attribute) for all the HV channels for the following attributes of a HV channel: Ramp-up, Ramp-down, Trip condition (time, current limit) V0, V1, Vmax, Imax, ON / OFF.

SIFIB2 Startup

The DCS shall allow to set on the system in the following order: LV, HV and Booster, it shall allow to set if off in the following order: Booster, HV, LV. Theses action shall be done automatically or on user requests. **TBD if LV, HV and Booster started, then HV is off.** After a long shutdown, the DCS shall load pre-defined values except for switch on. After a crash or a short power off of the DCS or if the hardware is off, the user shall be able to select the configuration parameters he wants to load when it comes on again.

SIFIB3 Special procedure

The DCS shall be able to interface to the threshold down-loading system (using RS485) serial interface (800 channels).

SIFIB4 Trend-archive

The thresholds and the HV history shall be sent to DAQ (central data recording system)

SIFIB5 constraint

It shall be possible to switch each station individually. The intensity of the beam shall be given to the Sci-Fi Beam Hodoscope detector. It shall be allowed to stop / re-start the DCS when adding / removing elements.

3.1.9.9 ECAL1/ECAL2/HCAL2

Brief description of the ECAL1 / ECAL2 / HCAL2 detector **TBD**. See Appendix A.9, "ECAL1 / ECAL2 / HCAL2" for the list of equipment to be integrated in the DCS. The ECAL1 / ECAL2 / HCAL2 detector provides its control system.

CALO1 constraint

The DCS shall be interfaced to the local DCS of ECAL1 / ECAL2 / HCAL2 in term of alarm server. It shall be allowed to stop / re-start the DCS when adding / removing elements.

3.1.9.10 HCAL1

Brief description of the HCAL1 detector **TBD**. See Appendix A.10, "HCAL1" for the list of equipment to be integrated in the DCS. The HCAL1 HV system is composed of two CAMAC crates with home made card. A program already exist to set the HV. A feedback is read from the DAQ system to know if the HV is on or off.

HCA1 HV requirement

The DCS shall be able to interface to the HCAL1 HV program to send command for the HV system. The DCS shall act also as an alarm server.

HCA2 constraint

pedestal, gain monitoring shall be interfaced to the DCS. It shall be allowed to stop / re-start the DCS when adding / removing elements.

3.1.9.11 Trigger-Hodoscope

Brief description of the Trigger-Hodoscope detector **TBD**. See Appendix A.11, "Trigger-Hodoscope" for the list of equipment to be integrated in the DCS.

TRHOD1 Crate

The DCS shall be able switch off the crate in case of condensation within the crates: **TBD sensors**. The switch on shall be on user request.

TRHOD2 HV requirement

The DCS shall be able to set a same value (one different per attribute) for all the HV channels for the following attributes: Vmax, Imax, Ramp-up, Ramp-down, Trip condition (time, current limit) for the group of channel which are specially mapped to the hardware. **TBD**. The voltage shall always be set indiviually. A config file shall be used for basic operation. a Special RS232 module shall be used (it allows to read up to 32 serial lines).

TRHOD3 Startup

After a long shutdown, the DCS shall load for the HV the last values saved by the operator except for switch on, the DCS shall load the latest running values of the thresholds. The latest running values shall be restored after a crash or a short power off of the DCS. If the hardware is off, the HV value shall be set by operator action and the previous threshold shall be down-loaded automatically when it comes on again.

TRHOD4 Special procedure

Threshold download process shall be triggered by the DCS. The reference of the threshold configuration shall be archived in the DCS. **TBD**. An alarm shall be generated if the Linux CPU to load the threshold is not running.

TRHOD5 Trend-archive

All the data shall be archived forever on a periodic basis. All the read data shall be sent to the central data recording via the DAQ. **TBD**. Some TDC value shall be sent to the DAQ. **TBD which data and how they are read**.

TRHOD6 constraint

The DCS may run on the VME-VMIC CPU or PC under Linux or shall be connected to Linux computer. The monitoring of the DAQ channel shall be done by the DCS: **TBD quantity of channels**. Remote access shall be provided. An access to the DCS archiving area shall be provided. All the information from the beam line shall be given to Trigger-Hodoscope. It shall be allowed to stop / re-start the DCS when adding / removing elements.

3.1.9.12 Muon Wall I

Nothing was defined for the Muon Wall I detector.

3.1.9.13 Muon Wall II

Brief description of the Muon Wall II detector **TBD**. See Appendix A.13, "Muon Wall II" for the list of equipment to be integrated in the DCS.

MWII1 Crate

The Muon Wall II shall share the same hardware as the MWPC detector (see Section 3.1.9.3, "MWPC"). The Muon Wall II has a gas system under design.

MWII2 HV requirement

The Muon Wall II shall share the CAEN HV power supply with the MWPC detector. The DCS shall be able to set a same value (one different per attribute) for all the HV channels for the following attributes: Vmax, Imax, Ramp-up, Ramp-down, Trip condition (time, current limit). The ovc, ovv, unv status of the HV channel shall be used to calculate statistic and generate alarm of the warning category. It shall be possible to adjust the HV in function of the atmospheric pressure with a user acknowledge. It shall be possible to switch off automatically the HV in case of gas alarm detected by a flammable gas detection system of the infrastructure control system.

MWII3 Analogue-Bit Monitoring

The DCS shall be connected to the Muon gas system, and shall be able to set / read flow meters, pressure transmitter, temperature transmitter. The position of the chamber (by 2 / 4 micro switches) shall be read by the DCS at the beginning and end of each run. Sliding the detector off / inside the beam for reparation shall be followed by the DCS providing some switches exist.

MWII4 Startup

After a long shutdown, the DCS shall load for pre-defined values, It shall be possible to modify them. The switch on action the LV and HV shall always be on user request. The latest running values shall be restored after a crash or a short power off of the DCS. If the hardware is off, the configuration shall downloaded by the operator when it comes on again.

MWII5 Special procedure

Threshold download process shall be triggered by the DCS. The reference of the threshold configuration shall be archived in the DCS. **TBD**. An alarm shall be generated if the Linux CPU to load the threshold is not running.

MWII6 Trend-archive

T, P and gas flow shall be archived and kept for 30 days, the trends for P, T and gas flow shall be for 3 days. For HV, I, V shall be archived and kept for 5 days, the trends for V and I shall be for 1 days with. All the read attributes of the HV and LV channels, gas flows, gas mixture shall be saved in the central data recording system each 10th measurement and in ASCII format for at least 3 days. **TBD**. 1 global flag for LV, gas system off, no gas, detector not in operation shall be sent the central data recording. The micro-switch value shall be sent to the DAQ every start of run. **TBD**.

MWII7 constraint

Some equipment shall be share with the MWPC detector, therefore some action on Muon Wall II: disabling equipment should have influence on the MWPC and vice versa. The DCS shall be able to get the gas alarm status from the flammable gas detection system of the infrastructure control system. The DAQ shall send the start of run and end of run signal to the DCS. It shall be allowed to stop / re-start the DCS when adding / removing elements.

3.1.9.14 TOF

Brief description of the TOF detector **TBD**. See Appendix A.14, "TOF" for the list of equipment to be integrated in the DCS. **Nothing from the TOF**.

3.1.9.15 TCS

Nothing was defined for the TCS detector.

3.1.9.16 Laser Monitoring

Nothing was defined for the Laser Monitoring detector.

3.1.9.17 SM1-SM2

The SM1-SM2 are the magnets used in COMPASS in two different locations.

SM01 Analogue requirement

The DCS shall be able to read the magnetic field measured in different location: inside the magnets but also around the magnets close to some detectors.

3.2 Constraint requirements

This section places restrictions on how the software can be build and operated.

3.2.1 Detector DCS constraint

The DCS of the COMPASS experiment will be used since the beginning of the experiment, first for commissioning of the detectors and later for the normal operation. Some hardware interface is not yet defined and will be defined during the year 2000-2001, this impose a high flexibility on the DCS toolkit. Even if the DCS is named or seen as a single entity, it is important to note that each detector can be operated/controlled/configured independently. However, in order to reduce the prices, some equipments will be shared between different detectors. Therefore adding or removing equipment may have an influence on other DCS because part of its equipment may be unreachable during a short period of time.

DCSC01 The DCS shall be composed of independent entities: one per detector.

During normal operation, and also during commissioning, different configuration setup can be down-loaded for a particular detector such as startup configuration.

DCSC02 Each detector shall be operable, maintainable, configurable independently. Starting / stopping, re-configuring a detector shall not have any influence on the operation of the other detectors.

DCSC03 The kernel of the DCS shall be easily re-configurable, it shall be possible to easily add or delete new items with all their functionalities: hardware access, alarm, archive, user access without having a deeper knowledge of the DCS toolkit except if there is some automatic feedback or closed-loop control which require DCS toolkit knowledge (e.g. script or program using the API).

DCSC04 Adding or deleting new element / detector shall not have any influence on the operation of the other detectors if the hardware or CAN, CAENet or PROFIBUS line is not shared between these detectors. In the other case, the access to the equipment may be temporary un-accessible.

DCSC05 Disabling / enabling an equipment, acknowledging alarms, masking / un-masking alarms of a detector shall not have any influence on the operation of the other detectors, if the hardware is not shared between these detectors.

DCSC06 Changing physics programme (Muon to Hadron or Hadron to Muon) shall not implies a change in the DCS software. However this may require to stop and start again the DCS.

The DCS toolkit could also be used by other system like RUN CONTROL, "Calibration" supervision, pedestal supervision, threshold supervision or Monitoring of the channels for the graphical interface, alarm handling, archiving and user access.

DCSC07 The DCS toolkit shall be open by means of a rich API to allow an easy integration of external users program.

The DCS will be connected to external systems which most of the time run in UNIX computer such as Linux PC or HP.

DCSC08 The DCS shall be able to run on computer with the NT or Linux kernel. If the Linux kernel is not supported an API or framework shall be provided to interface or integrate the systems running on UNIX computers. Even if the Linux kernel is supported this API shall be provided for HP workstations.

3.2.2 Communication interface

COMIT01 The DCS shall be able to run in the CERN network.

COMIT02 The DCS shall be able to use OPC when running on a NT computer.

COMIT03 The DCS shall support the PROFIBUS-DP protocol and WIENER CAN protocol.

COMIT04 CAENet or RS232 protocol shall be used to control remote equipment.

3.2.3 External Interfaces

The DCS interacts with the detector hardware and its users, but it also has to receive data from and pass data to other systems such as DAQ, Polarized target, MicroMEGA, beam control system, etc. A DCS library or API may be written if needed to ease the connection to the external systems. A change in the protocol may require a compilation of the DCS interface of this external system.

EXINT1 A TCP / IP connection to external interfaces shall be supported by the DCS.

EXINT2 A connection to a Schneider TSX Micro PLC shall be done via a RS232 line. ***TBD***. or OFS Server.

EXINT3 The API or DCS library shall not have to be changed as a result of changes in the DCS configuration or DCS modification (adding / removing elements).

3.2.4 User Interfaces

The DCS will be used by many user at the same time specially during start-up phases.

UIF01 The DCS shall support multiple simultaneous users. ***maximum number TBD***.

UIF02 The DCS shall have multiple control consoles.

During normal operation, most of the experts or users will not be at CERN or in the COMPASS control room.

UIF03 The remote access to the DCS from a station outside CERN shall not required a specialized software.

UIF04 ~~The remote access shall only be done to monitor the parameters~~. A remote access to monitor the parameter shall be provided. A remote access to send command on parameters shall be provided with a password protection. ***TBD***.

The MMI will be used to operate the DCS detectors. This will be the only interface for finding and browsing the problems. It will be used also for maintenance of the equipment.

UIF05 The graphical interface shall be divided in two main parts:

- the upper part of the window to show an overview of the COMPASS experiment. Any detector having alarm elements shall be identified in this window. The alarm state shall follow the alarm colour rules (see **UIF09**). The state of each detector shall also be presented.
- the bottom part of the window to show the detailed information on selected element from the top window or bottom window. Any detector having alarm elements shall be identified in the this window. The alarm state shall follow the alarm colour rules (see **UIF09**).

UIF06 The user shall be able to change from whatever view by clicking on a single button.

UIF07 The MMI shall be organized as a hierarchical tree, composed at the top level of the detectors. Each intermediate node shall be composed of a set of sub-node or equipment. The alarm state of each node shall follow the alarm colour rules (see **UIF09**) and shall represent the sum of the alarm state of its sub-node or equipment.

The MMI will be used also to browse the alarm, the default equipment, the list of masked or disabled equipment, list of operation actions.

UIF08 A view per different alarm level shall be available (masked, warning, fault, fatal). A filter per detector or equipment type may be used to display in these view the elements in alarm of the same detector or same type. A view containing all the elements in alarm shall be available. A view of the disabled equipment shall be available. A view of all the operator logged actions shall be available.

UIF09 The following colour rules shall be used to display the alarm state of the elements: data, equipment, display node, set or detector:

- grey: masked state and enable
- green: no error and not masked and enable
- orange: warning state and not masked and enable
- red: fault state and not masked and enable
- purple: fatal state and not masked and enable
- white: disable equipment.

~~**UIF10**~~ ~~Whenever change there is in an alarm state of an element, the operator shall be notified on the alarm window. He shall be notified by a beep. The operator shall be able to enable or disable the beep option.~~ already defined ALM16

UIF11 The operator with appropriate user access level shall be able to acknowledge or mask / un-mask the alarm, disable / enable the equipment from the alarm views.

UIF12 The operator with appropriate user access level shall be able to mask / un-mask or disable / enable a node of the hierarchical tree. Therefore, all the sub-nodes or elements belonging to this node shall be masked / un-masked or disabled / enabled.

3.2.5 Hardware

The DCS will be built using a toolkit and can be connected to commercial hardware whenever it will be possible.

HWD01 The DCS shall support the PROFIBUS, CAN fieldbus, CAENet bus or RS232.

HWD02 The DCS shall be able use any off the shelf card: PCI, ISA, VME with any traditional hardware interface such as 0-10V, 4-20mA, TTL, etc. The DCS shall be able to read CAMAC modules. The DCS shall be able to read NIM signals.

~~**HWS03**~~ ~~CAENet bus or RS232 serial line shall be used to control remote equipment.~~

3.2.6 Performances

*Most of the elements will be read in-spill and out-off-spill. Some will be read faster. A spill is 2.5 seconds, **TBD**.*

PERF01 The DCS shall be able to read all the necessary element in-spill and out-off-spill. ***The approximated quantity is TBD for CAEN, LeCROY, crate, etc***.

PERF02 The DCS shall be able to read few times during the spill. In the case of the CAENet bus this may need to have view crates per CAENet line to speed up the communication.

3.2.7 Quality Assurance

3.2.7.1 Adaptability

3.2.7.2 Maintainability

3.2.7.3 Availability

3.2.8 Resources

3.2.8.1 Systems Resources

3.2.8.2 Manpower Resources

3.2.8.3 Financial Resources

3.2.9 Standards

3.2.10 Schedule

Chapter 4

List of Items

1.1 Purpose of the document

1.2 Scope

1.3 Definitions, acronyms and abbreviations

1.3.1 [Definitions]

1.3.2 [Acronyms]

1.3.3 [Abbreviations]

1.4 References

1.5 Overview of the document

2.1 Product perspective

2.2 General capabilities

2.2.1 Monitoring and control

2.2.2 Supervision

2.2.3 Connection to external system

2.3 General constraints

2.4 User characteristics

2.4.1 Operator on shift

2.4.2 Shift leader

2.4.3 Expert of a detector

2.4.4 Maintenance operator

2.4.5 System developer

2.5 Operational environment

2.5.1 High Voltage power supplies

2.5.2 Low Voltage Power supplies

2.5.3 Crate control

2.5.4 Analog monitoring

2.5.5 Bit monitoring

2.5.6 Start-up

2.5.7 External interfaces

2.6 Assumptions and dependencies

UR Id **3.1 Capability Requirements**

3.1.1 General System Features

3.1.1.1 Access Control

ACC01 ACC02 ACC03 ACC04 **3.1.1.2 Types of Access**

ACC05 ACC06 ACC07 ACC08 **3.1.1.3 Users**

USE01 USE02 USE03 USE04 USE05 USE06 **3.1.1.4 Definition/modification**

DEF01 DEF02 DEF03 DEF04 DEF05 DEF06 DEF07 DEF08 **3.1.1.5 Configuration setup**

SET01 SET02 SET03 SET04 SET05 **3.1.1.6 Hardcopy and report**

REP01 REP02 REP03 **3.1.1.7 Acquisition of parameter**

ACQ01 ACQ02 ACQ03 ACQ04 ACQ05 ACQ06 ACQ07 ACQ08 ACQ09 ACQ10 ACQ11 **3.1.1.8 Alarm Handling**

3.1.1.8.1 Alarm Definition and Generation

ALM01 ALM02 ALM03 ALM04 ALM05 ALM06 3.1.1.8.2 Alarm Management

ALM07 ALM08 ALM09 ALM10 ALM11 ALM12 ALM13 ALM14 ALM15 3.1.1.8.3 Alarm Display

ALM16 ALM17 ALM18 ALM19 ALM20 ALM21 **3.1.1.9 Archiving and Data retrieval**

ARC01 ARC02 ARC03 ARC04 ARC05 ARC06 ARC07 ARC08 **3.1.1.10 Logging**

LOG01 LOG02 LOG03 LOG04 LOG05 LOG06 **3.1.1.11 Trending**

TREND1 TREND2 **3.1.1.12 Operational mode**

OM01 OM02 OM03 OM04 OM05 OM01 **3.1.1.13 Commanding**

COM00 COM01 COM02 COM03 COM04 COM05 COM06 **3.1.1.14 Operator assistance**

ASS01 ASS02 **3.1.1.15 Operator Display**

DIS01 DIS02 DIS03 DIS04 **3.1.2 Operation on HV**

HV01 HV02 HV03 HV04 HV05 HV06 HV07 HV08 HV09 HV10 **3.1.3 Operation on LV**

3.1.3.1 LV with a fieldbus interface

LV01 LV02 LV03 LV04 LV05 LV06 **3.1.3.2 LV with analogue or digital interface**

LV07 LV08 LV09 LV10 LV11 LV12 **3.1.4 Operation on analog value**

ANA01 ANA02 **3.1.5 Operation on digital value**

DIG01 DIG02 **3.1.6 Operation on crate control**

CRATE1 CRATE2 CRATE3 CRATE4 CRATE5 **3.1.7 DCS startup**

START01 START02 START03 START04 **3.1.8 External interfaces**

EXT01 EXT02 EXT03 **3.1.9 Detectors.**

3.1.9.1 RICH

RICH1 HV requirement 43

RICH2 Analogue monitoring 43

RICH3 Startup 43

RICH4 Special procedure 43
RICH5 Trending-Archiving 43
RICH6 Constraint 44

3.1.9.2 STRAW

STRAW1 Crate 44
STRAW2 HV requirement 44
STRAW3 LV requirement 44
STRAW4 Analogue Monitoring 44
STRAW5 Alarm 44
STRAW6 Startup 44
STRAW7 Special procedure 45
STRAW8 Trend-archive 45
STRAW9 constraint 45

3.1.9.3 MWPC

MWPC1 Crate 45
MWPC2 Analogue Monitoring 45
MWPC3 Startup 45
MWPC4 Trend-archive 45
MWPC5 constraint 46

3.1.9.4 GEM

GEM1 Crate 46
GEM2 HV requirement 46
GEM3 Analogue Monitoring 46
GEM4 Startup 46
GEM5 Special procedure 46
GEM6 Trend-archive 46
GEM7 constraint 47

3.1.9.5 Silicon

SILIC1 Crate . . . 47
SILIC2 HV requirement . . . 47
SILIC3 Analogue Monitoring . . . 47
SILIC4 Startup . . . 47
SILIC5 Special procedure . . . 47
SILIC6 Trend-archive . . . 47
SILIC7 constraint . . . 47

3.1.9.6 BMS

3.1.9.7 Sci-Fi

SCIFI1 HV requirement . . . 48
SCIFI2 Startup . . . 48
SCIFI3 Special procedure . . . 48
SCIFI4 Trend-archive . . . 48
SCIFI5 constraint . . . 48

3.1.9.8 Sci-Fi Beam Hodoscope

SIFIB1 HV requirement . . . 48
SIFIB2 Startup . . . 49
SIFIB3 Special procedure . . . 49
SIFIB4 Trend-archive . . . 49
SIFIB5 constraint . . . 49

3.1.9.9 ECAL1/ECAL2/HCAL2

CALO1 constraint . . . 49

3.1.9.10 HCAL1

HCA1 HV requirement . . . 49
HCA2 constraint . . . 50

3.1.9.11 Trigger-Hodoscope

TRHOD1 Crate . . . 50
TRHOD2 HV requirement . . . 50
TRHOD3 Startup . . . 50
TRHOD4 Special procedure . . . 50
TRHOD5 Trend-archive . . . 50
TRHOD6 constraint . . . 51

3.1.9.12 Muon Wall I

3.1.9.13 Muon Wall II

MWII1 Crate . . . 51
MWII2 HV requirement . . . 51
MWII3 Analogue-Bit Monitoring . . . 51
MWII4 Startup . . . 51
MWII5 Special procedure . . . 52
MWII6 Trend-archive . . . 52
MWII7 constraint . . . 52

3.1.9.14 TOF

3.1.9.15 TCS

3.1.9.16 Laser Monitoring

3.1.9.17 SM1-SM2

SM01 Analogue requirement . . . 52

3.2 Constraint requirements

3.2.1 Detector DCS constraint

DCSC01 DCSC02 DCSC03 DCSC04 DCSC05 DCSC06 DCSC07 DCSC08 **3.2.2 Communication interface**

COMIT01 COMIT02 COMIT03 COMIT04 **3.2.3 External Interfaces**

EXINT1 EXINT2 EXINT3 **3.2.4 User Interfaces**

UIF01 UIF02 UIF03 UIF04 UIF05 UIF06 UIF07 UIF08 UIF09 UIF10 UIF11 UIF12 **3.2.5 Hardware**

HWD01 HWD02 HWS03 **3.2.6 Performances**

PERF01 PERF02 **3.2.7 Quality Assurance**

3.2.7.1 Adaptability

3.2.7.2 Maintainability

3.2.7.3 Availability

3.2.8 Resources

3.2.8.1 Systems Resources

3.2.8.2 Manpower Resources

3.2.8.3 Financial Resources

3.2.9 Standards

3.2.10 Schedule

Appendix A List of the detectors equipment.

The appendix lists all the equipment used per detector or sub-system.

A.1 RICH

TBD

- crates:

Table A.1 RICH crate equipment.

hardware	interface	zone	quantity	read	set
NIM	none	no	?	5min, 10%: V	
VME	WIENER CAN	no	?	5min, 10%: V, I, T, on/off	rst communication

- HV-LV equipment:

Table A.2 RICH HV-LV equipment.

equipment	interface	nb channel	read	set
HV	CAEN SY527+A821 board; H.S. CAENnet VME: V288	16+12	in spill/out spill: V, I periodically: status	on/off, V, I
LV	WIENER PL500F, CAN	32+24	in spill/out spill: V, I periodically: status	on/off, V, I
FE board, BORA	PC-NT interface		V, I, T	on/off

- GAS system: 150-200 parameters.
- environmental: pressure atmospheric.
- boolean: 10 (which one).

A.2 STRAW

TBD

- crates:

Table A.3 STRAW crate equipment.

hardware	interface	zone	quantity	read	set
VME	WIENER CAN	yes	1	1min, 1%: V, I, T, on / off	on / off rst communication

- HV-LV equipment:

Table A.4 STRAW HV-LV equipment.

equipment	interface	nb channel	read	set
HV	LeCROY 1458, Ethernet	50 to 200	in spill / out spill: V, I, status during spill: V, I, status	out spill: on / off, V, I
LV: +6V, -6V, 8-12V	?	?	twice in / out spill, 1%: V, I, status, T	on / off, V, I

- analogue monitoring.

Table A.5 STRAW Analogue

kind	quantity	from	read/precision
Temperature inside a tent around the STRAW detector	10	?	min / 0.1K
Atmospherice pressure	1	?	min / 0.5mB
gas flow meter	18	?	min
humidity	2: inside / out side tent	?	min
smoke detection	1: inside tent	?	min

A.3 MWPC

TBD

- crates:

Table A.6 MWPC crate equipment.

hardware	interface	zone	quantity	read	set
VME	WIENER CAN	yes no	2 1	1min, 1%: V, I, T, on / off	on / off rst crate

- HV-LV equipment:

Table A.7 MWPC HV-LV equipment.

equipment	interface	nb channel	read	set
HV	CAEN SY527, CAENet	30-35	in spill / out spill: V, I, status	out spill: on / off, V, I
LV: +8V-10A	?	?	in spill / out spill, 1%: V, I, status, T	on / off, V, I

- analogue monitoring.: from a GAS system: See DUBNA

Table A.8 MWPC Analogue

kind	quantity	from	read/precision
Temperature	15	DUBNA	
pressure	15	DUBNA	
gas flow meter	15	DUBNA	

A.4 GEM

TBD

- crates:

Table A.9 GEM crate equipment.

hardware	interface	zone	quantity	read	set
VME	WIENER CAN	yes	5	every spill, 1%: V, I, T, fan speed, fanfailure, on / off	on / off fan speed

- HV-LV equipment:

Table A.10 GEM HV-LV equipment.

equipment	interface	nb channel	read	set
HV	CAEN SY527, CAENet LeCROY, Ehternet: **optional**	60	few times during in spill / out spill: V, I, status	out spill: on / off, V, I
LV: + / -5V	?	20	periodically	?

- analogue monitoring.: from a home made GAS system:

Table A.11 GEM Analogue

kind	quantity	from	read/precision
atmospheric pressure	1	?	
Temperature	30	?	1min, 100K +/-1K
Pressure	15	?	1min, 1-10mB
flow	20	?	1min, 0.1cm2/min
humidity	?	?	?

A.5 Silicon

TBD

- crates shared with GEM see **Table A.9 GEM crate equipment.**:
- HV-LV equipment:

Table A.12 Silicon HV-LV equipment.

equipment	interface	nb channel	read	set
HV	CAEN SY527, CAENet LeCROY, Ehternet: **optional**	15-30	few times during in spill/out spill: V, I, status	out spill: on/off, V, I
LV: +/-5V	?	20	periodically	?

- analogue monitoring.: from a cryostat system, **TBD**.

A.6 BMS

Nothing, TBD.

A.7 Sci-Fi

According to the questionnaire, but different from the URD from Bruce Barnett. TBD.

- crates:

Table A.13 Sci-Fi crate equipment.

hardware	interface	zone	quantity	read	set
VME	WIENER CAN	yes no	4 1	5min, 3%: V, I, T, fan speed, fanfailure, as fast as possible: on / off	reset communication reset crate
NIM	?	yes no	4 1	?	?
CAMAC	?	yes	1	?	?

- HV-LV equipment:

Table A.14 Sci-Fi HV-LV equipment.

equipment	interface	nb channel	read	set
HV	CAEN SY4037+A503, CAENet	256	all attribute, 1 over 256 every 5 sec.	all attribute
LV: + / -6V	?	18 (8 stations, 3 LV)	periodically every 5min	?

A.8 Sci-Fi Beam Hodoscope

TBD

- crates:

Table A.15 Sci-Fi Beam Hodoscope crate equipment.

hardware	interface	zone	quantity	read	set
?	Home made	yes	4	?	?

- HV-LV equipment:

Table A.16 Sci-Fi Beam Hodoscope HV-LV equipment.

equipment	interface	nb channel	read	set
HV	CAEN SY527-A734N, CAENet, CAMAC interface	50	periodically 1 min: V, I, status	on / off, V, I
LV: + / -5V	?	8	periodically 1min: V, I	no

- analogue monitoring.

Table A.17 Sci-Fi Beam Hodoscope Analogue

kind	quantity	from	read/precision
Temperature	8: LV PS	?	1min, 1%
magnetic field	8	?	1min, 1%

A.9 ECAL1/ECAL2/HCAL2

TBD, ECAL1/ECAL2/HCAL2 has a local DCS already running.

- crates:

Table A.18 ECAL1/ECAL2/HCAL2 crate equipment.

hardware	interface	zone	quantity	read	set
VME	CAN	?	ECAL1: 4 ECAL2: 4-5 HCAL2: ?	V, I, T, status	on / off
CAMAC	?	?	ECAL1: 1 ECAL2: 1 HCAL2: ?	?	?
NIM	?	?	ECAL1: 1-2 ECAL2: 1-2 HCAL2: ?	?	?

A.10 HCAL1

TBD

- rates:

Table A.19 HCAL1 crate equipment.

hardware	interface	zone	quantity	read	set
VME	CAN	no	1	V, I, T, status	on / off
CAMAC CAMAC	? home made	no yes	1 1	?	?
NIM	?	?		?	?

- HV-LV equipment: HCAL1 has its own HV system based on CAMAC crates.

- analogue monitoring.

Table A.20 HCAL1 Analogue

kind	quantity	from	read/precision
Temperature of home made crate	1	?	?
position of platform	4	?	?

A.11 Trigger-Hodoscope

TBD

- crates:

Table A.21 Trigger Hodoscope crate equipment.

hardware	interface	zone	quantity	read	set
VME	CAN	no	3/5	30sec: V, T, I, on/off	no (ON/OFF)
NIM	?	no	1/2	?	?
?	Home made	no	2	?	?

- HV-LV equipment:

Table A.22 Trigger Hodoscope HV-LV equipment.

equipment	interface	nb channel	read	set
HV	LeCROY 4032-RS232: **decision in january 2000** (30 boxes*32 channels)	500 (2000) 1000 (final)	periodically 30sec: V, I, status	all
LV: +/-5V	?	10-20	periodically 30sec/60sec: status	no

- analogue monitoring.

Table A.23 Trigger Hodoscope Analogue

kind	quantity	from	read/precision
Temperature: atmospheric in the hall	10-20	?	1min
magnetic field	1	?	need to know
position of the detector: CCD or microswitch	?	?	?

A.12 Muon Wall 1

Nothing, TBD.

A.13 Muon Wall II

TBD

- crates:

Table A.24 Muon Wall II crate equipment.

hardware	interface	zone	quantity	read	set
VME	CAN	yes	1	3min: V, T, I, on / off, OVC, fan failure, over heating. on event or 30s: status	ON / OFF, reset communication, reset crate
NIM / CAMAC	?	no	1	?	?

- HV-LV equipment:

Table A.25 Muon Wall II HV-LV equipment.

equipment	interface	nb channel	read	set
HV	CAEN SY527 / CAENnet (power supply box shared with MWPC)	6 (6 spares)	in / out spill: V, I, status between spill: V, I, status	all
LV: +6V -6V +6 / 12V	?	6 6 6	periodically every 10 spill / during spill / in between: V, I, status	no

- analogue monitoring.

Table A.26 Muon Wall II Analogue

kind	quantity	from	read/precision
Temperature: atmospheric in the hall	1	?	10min / on request
pressure	1	?	10min / on request
gas flow	2 12 (1 per line) total flow input	?	10min / on request 10min 10min
micro switch (position of the chambers)	4 (vertical / horizontal) or 2 (position in the beam)	?	10min / on request

A.14 TOF

TBD

- rates:

Table A.27 TOF crate equipment.

hardware	interface	zone	quantity	read	set
VME	CAN	no	1	V, I, T, status	on / off
CAMAC	?	yes	1	?	?

- HV-LV equipment: TOF has not decided on its HV system (60 channels, 2000V).

A.15 TCS

Nothing, TBD.

A.16 Laser Monitoring

Nothing, TBD.

A.17 SM1-SM2

Nothing, TBD. But magnetic field measurements are needed.

Index