SuperNEMO Demonstrator Calorimeter High Voltage System Cabling scheme and cable labels version 0.2

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November 1st, 2018

Abstract

This document presents the cable labelling convention used for the SuperNEMO Demonstrator's Calorimeter High Voltage System (CaloHV). We reuse here some informations available from a couple of documents prepared by Cedric and Mathieu, with some adaptations and addons.

This document and all associated tools are hosted at:

`https://gitlab.in2p3.fr/SuperNEMO-DBD/SNCabling`.

Contents

1 Principle

The SuperNEMO Demonstrator's Calorimeter High Voltage System (CaloHV) uses two CAEN High Voltage crates which host a total of 24 boards to distribute HV to 712 PMTs.

Each HV board manages up to 32 channels and is connected to a specific set of PMTs through a pair of harnesses. A first harness, called *external harness*, links the board to a single connector on the patch panel (external side). From this connector on the patch panel, a new harness, namely the *internal harness*, routes HV channel to the PMTs. The end of the *internal harness* is designed in such a way cables can be routed indivudually to their associated PMTs. Of course, a given harness handles a set of PMTs that are geographically close to each other, in order to optimize the length of the cables.

In the present scheme, it has been decided to identify individual HV distribution cables using the pin identifiers on the connectors they are associated to. Ideally, the pin number on the HV board output connector thus identifies the cable linked to it. This identifier is propagated to the pin number on the patch panel connectors then to the end of the cable linked to the PMT. This enables to build rather simple and comprehensible cabling tables.

Figure 1 shows the basic diagram of the CaloHV system. A dedicated labelling system will be used to ease the cabling operations.

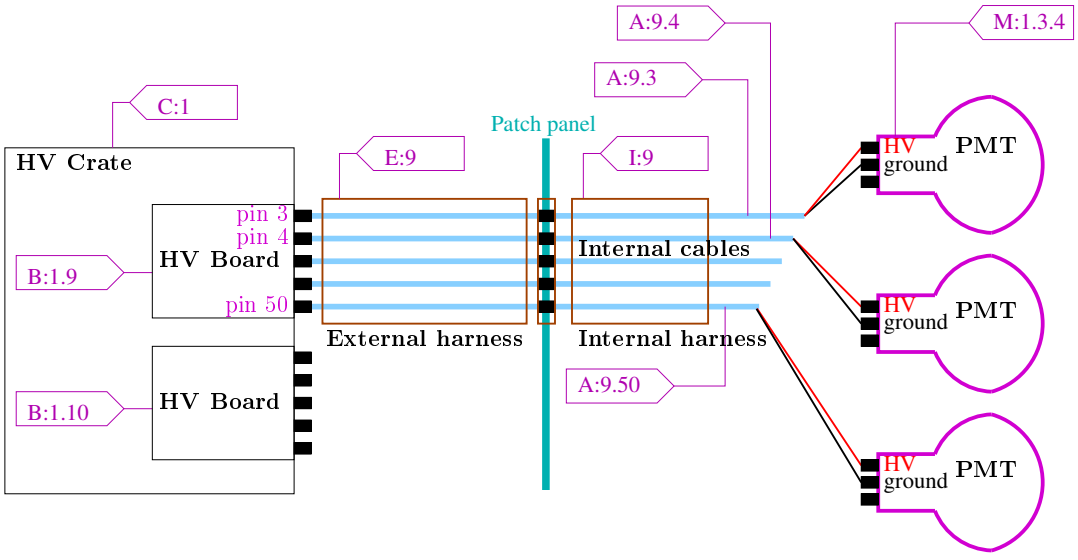

Figure 1: Principle of the HV distribution to the PMTs using the CAEN HV power supplies.

2 Addressing objects

2.1 Format of a CaloHV label

Each label to be used for CaloHV cabling will use the following format:

$$\boxed{\texttt{X:}id_1.id_2\ldots id_n}$$

where `X` is a single letter which describes the category of the labelled object, and the $id_1.id_2\ldots id_n$ sequence is the unique address of the object within its category. The id_x tokens are positive integers (possibly zero). The *colon* character is used to separate the category letter from the address. The sequence of identifiers in the address uses the *dot* character as a separator.

2.2 HV crates, boards, channel, harnesses and cables

Each CAEN HV power supply crate belonging to the CaloHV system is installed in the rack number 2 on the electronics platform. A HV crate is identified with an unique ID, namely a number ranging from `0` to `1`. We propose to label a given HV crate with the following scheme:

$$\boxed{\texttt{C:}\mathit{crate}}$$

where *crate* is the number of the crate (positive integer).

Examples: `C:0`, `C:1`.

Conventionally, crate `0` manages HV for PMTs on the *Italy* side and crate `1` manages HV for PMTs on the *France* side.

A HV crate contains up to 16 HV 32-channel boards but only 12 will be used. A HV board inherits the number of the crate it is plugged into and is addressed through its slot number. We give a given HV board a label with the following scheme:

$$\boxed{\texttt{B:}\mathit{crate}.\mathit{board}}$$

where *crate* is the number of the crate and *board* is the number of the board (slot) ranging from `0` to `15`.

Examples: `B:0.0`, ... `B:1.11`.

Up to 32 HV channels are addressed within a HV board. We propose to label a given HV channel with the following scheme:

$$\boxed{\texttt{H:}\mathit{crate}.\mathit{board}.\mathit{channel}}$$

where *crate* is the number of the crate, *board* is the number of the crate and *channel* is the number of the channel ranging from `0` to `31`.
Examples: `H:0.0.0`, ... `H:1.11.31`

A HV channel is automatically associated to a specific pin number of the output connector of the CAEN HV board.

A external HV harness connecting a given HV board (Radial connector) to the patch panel (Redel Male S connector) uses an unique ID ranging from `0` to `23`. We give to each external HV harness a label with the following scheme:

`E:`*harness*

where *harness* is the number of the external harness.
Examples: `E:0`, ... `E:23`

Compared with the labelling scheme proposed by Mathieu in original documents, it has been decided not to introduce an intermediate cable identifier depending on the location of the PMTs (main walls, top row in main walls, X-walls, gamma veto rows). A unique scheme is used in place, based on an already existing informations, independently of the geometry. Individual cables within an external harness are identified through the pin numbers they are associated to on the HV board output connector. This pin/cable identifier propagates up to the patch panel and beyond to the internal cable terminations. There is no need to label internal cables because they are confined within their harness and thus never addressed individually during cabling operations.

2.3 Optical modules

The identification scheme of the optical modules and their PMTs is based on the addressing scheme defined in the geometry model and implemented in the simulation and data analysis software[1]. There are 4 categories of optical modules and thus of scintillator blocks, depending on their location in the experimental setup:

- Main wall block (Falaise: geometry category `"calorimeter_block"` and type `1302`):

  OMs are addressed through their *side* number from 0 (Italy) to 1 (France), *column* number from 0 (Edelweiss) to 19 (Tunnel) and *row* number from 0 (bottom) to 12 (top).

  We propose to label such a block with the following scheme:

  `M:`*side*`.`*column*`.`*row*

  Examples: `M:0.0.0`, `M:0.19.12`, `M:1.0.0`, `M:1.19.12`.

[1] Falaise: `https://gitub.com/SuperNEMO-DBD/Falaise`

- X-wall block (Falaise: geometry category `"xcalo_block"` and type `1232`):

  OMs are addressed through their *side* number from 0 (Italy) to 1 (France), *wall* number from 0 (Edelweiss) to 1 (tunnel), *column* number from 0 (source) to 1 (calorimeter) and *row* number from 0 (bottom) to 15 (top).

  We propose to label such a block with the following scheme:

  $$\boxed{\texttt{X:}side\texttt{.}wall\texttt{.}column\texttt{.}row}$$

  Examples: `X:0.1.1.15`, `X:1.0.0.8`

- Gamma veto block (Falaise: geometry category `"gveto_block"` and type `1252`):

  OMs are addressed through their *side* number from 0 (Italy) to 1 (France), *wall* number from 0 (bottom) to 1 (top) and *column* number from 0 (Edelweiss) to 15 (tunnel).

  We propose to label such a block with the following scheme:

  $$\boxed{\texttt{G:}side\texttt{.}wall\texttt{.}column}$$

  Examples: `G:0.1.0`, `G:1.0.8`

- Block for reference optical module:

  OMs are addressed through their *ref* number.

  We propose to label such a block with the following scheme:

  $$\boxed{\texttt{R:}ref}$$

3 The CaloHV crates

Figures 2 and 3 show respectively the repartition of HV boards within the CAEN HV Power Supply crates 0 (Italy) and 1 (France).

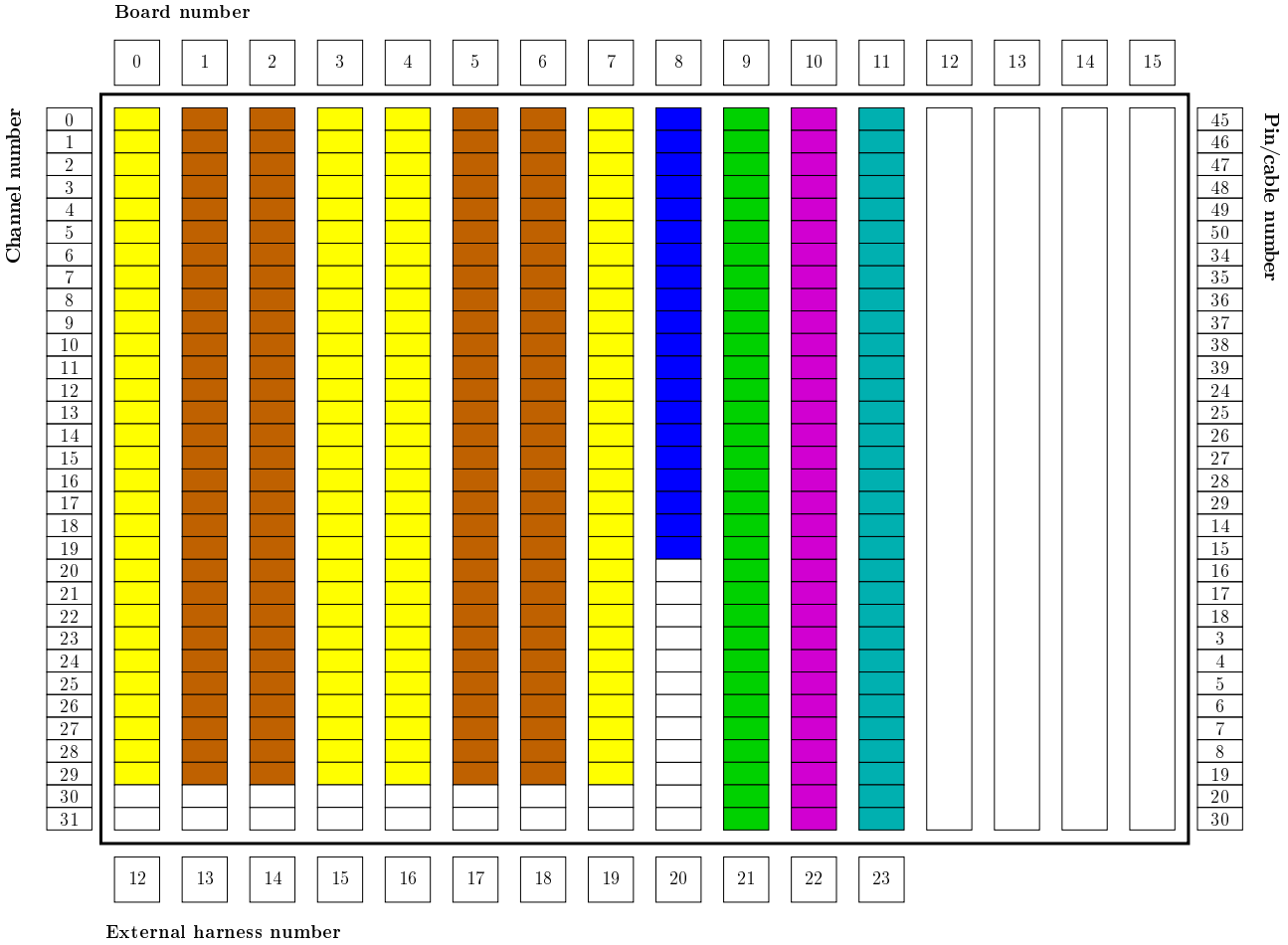

Figure 2: CaloHV crate 0 (Italy).

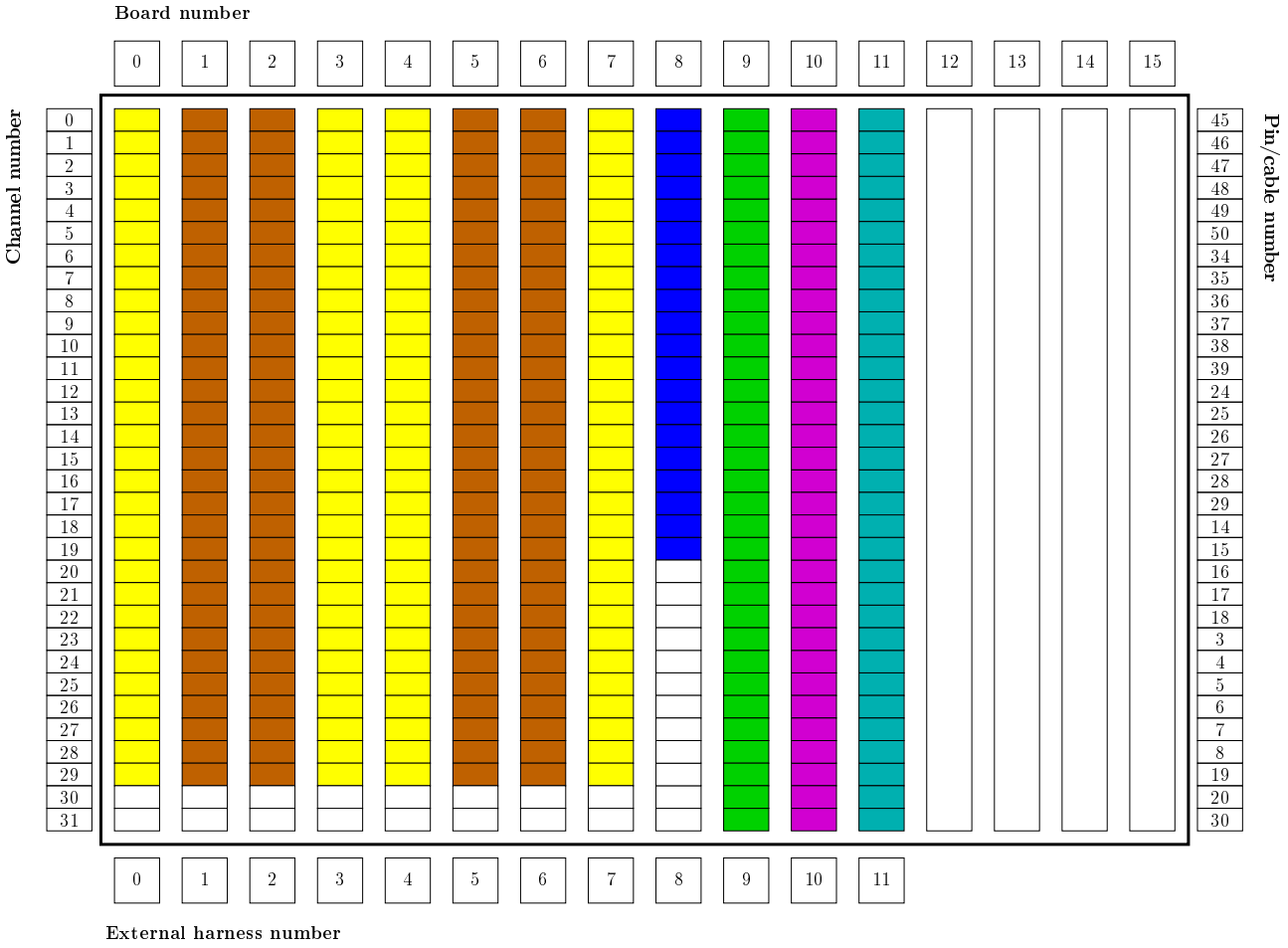

Figure 3: CaloHV crate 1 (France).

4 The CaloHV cabling table and its usage

4.1 Source table

Cabling the CaloHV consists in the association of each OM's PMT to one HV cable. An unique cabling table must be provided to give an unambiguous description of the cable paths from the HV boards to the PMTs. The table consists in an associative map like the one shown on table 1. This map contains the minimal informations to ensure the addressing of all HV cables.

HV channel	External harness	Internal cable	Optical Module
H:0.0.23	E:12	A:12.3	M:0.0.0
H:0.0.22	E:12	A:12.18	M:0.0.1
H:0.0.6	E:12	A:12.34	M:0.0.2
H:0.2.23	E:14	A:14.3	M:0.0.3
⋮			⋮

Table 1: Example of CaloHV cabling table

The table is provided in the form of a CSV[2] file. The file must use the following format:

- The file contains only ASCII characters.
- Blank lines are ignored.
- Lines starting with the hashtag character `#` are ignored, enabling to write some comments.
- There is only one HV channel/PMT association per line.
- Each line has four columns separated by the *semi-colon* character `;`.
- The first column contains the label of the HV channel.
- The second column contains the label of the external bundle.
- The third column contains the label of the internal cable.
- The fourth column contains the label of the PMT (optical module).

The CaloHV cabling map file is used as the unique source of information for different purposes:

- generation of labels to be stuck on cables, harnesses, patch panel,

[2]CSV: coma separated value

- generation of printable cabling tables for people in charge of the CaloHV cabling at LSM,
- input for dedicated software modeling tools used by the Control and Monitoring System (CMS), the simulation...

4.2 CaloHV cabling sheets

From the CaloHV cabling table, a Python script is provided to generate a printable PDF document with cabling tables corresponding to each part of the detector.

4.3 Labels

A dedicated script is used to automatically generate labels for all HV harnesses and cables to help the cabling team to identifiy the proper HV board-to-patch panel and internal HV cable-to-PMT connections. The labels must be stuck on the terminations of the harnesses and cables. Figure 4 shows where various kinds of labels are supposed to be stuck on harnesses and cables.

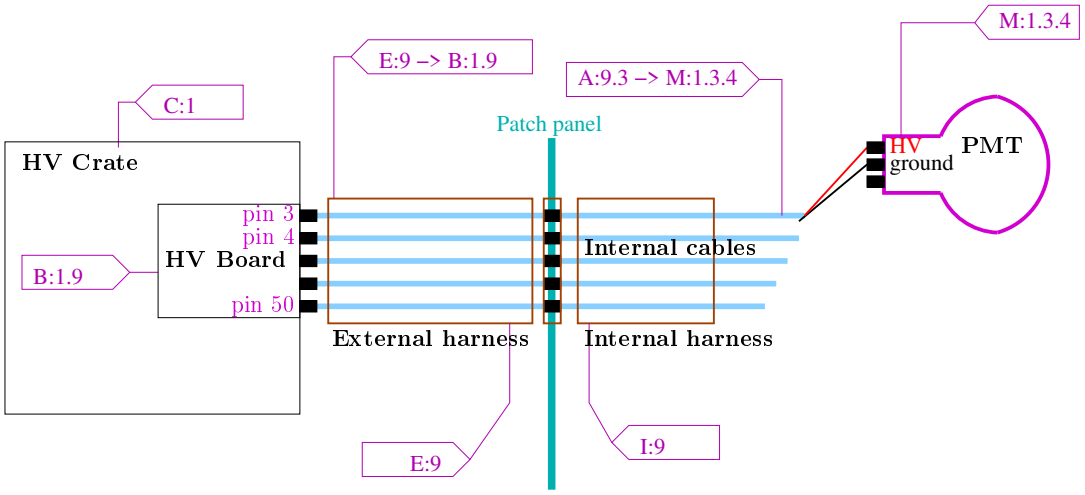

Figure 4: CaloHV labelling