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

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November 3rd, 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 (Radial connector) to a single connector (Redel S Male) on the patch panel (external side). From the internal face of the patch panel (Redel S Female), a new harness, namely the *internal harness*, routes individual HV cables to the PMTs. The end of the *internal harness* is designed in such a way cables can be routed individually to their associated PMTs by splitting in two wires (HV and ground). A given harness aggregates a set of cables for 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 Radial connectors they are associated to on each HV board. 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 principle of the calorimeter HV distribution. A dedicated labelling system is used to ease the cabling operations (see next sections).

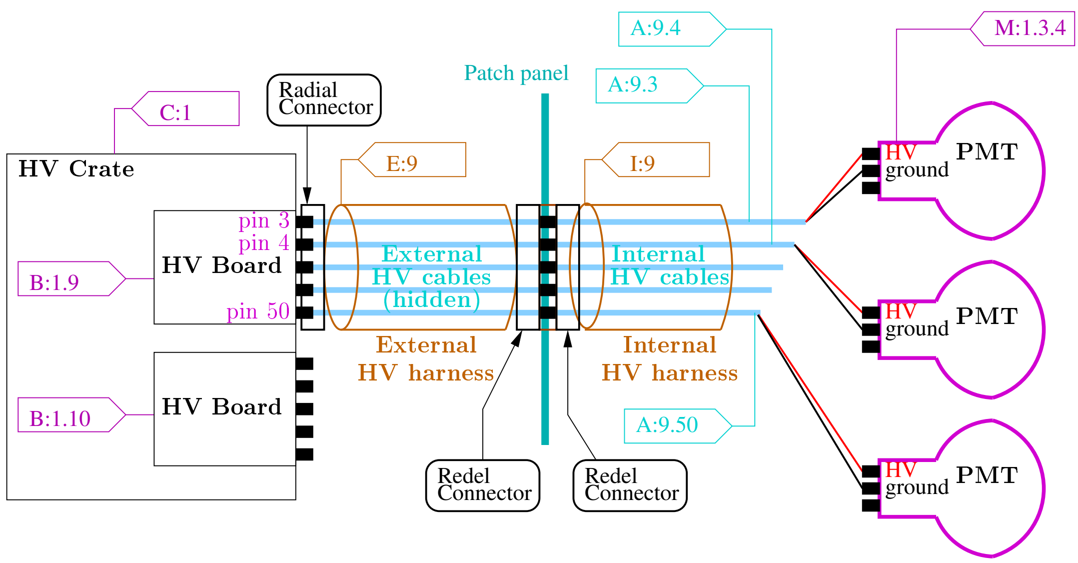

Figure 1: Principle of the HV distribution from the CAEN HV power supplies to the PMTs.

2 Addressing objects

2.1 Format of a CaloHV label

Each label used for CaloHV cabling uses the following format:

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

where `X` is a single letter which indentifies the category of the labelled object, and the $id_1.id_2...id_n$ 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.

Examples: `H:1.3.4`, `A:6.3`.

2.2 HV crates, boards and channels

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`. A given HV crate is labelled with the following scheme:

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

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

Examples: $\boxed{\texttt{C:0}}$, $\boxed{\texttt{C:1}}$.

Conventionally, crate `0` manages HV for PMTs on the *Italy* side and crate `1` manages HV for PMTs on the *France* side (including main wall, X-wall and gamma veto optical modules).

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

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

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

Examples: $\boxed{\texttt{B:0.0}}$, ... $\boxed{\texttt{B:1.11}}$.

Up to 32 HV channels are addressed within a HV board. A given HV channel is identified by a label with the following scheme:

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

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. Table 1 shows the associative map between the CAEN HV board channel numbers and Radial connector pins.

2.3 Harnesses and cables

An 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`. An external HV harness is identified by a label with the following scheme:

`E:`*harness*

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

An internal HV harness connecting a given external harness on the patch panel (Redel connectors) to a PMT uses an unique ID ranging from `0` to `23`. An internal HV harness is identified by a label with the following scheme:

`I:`*harness*

where *harness* is the number of the internal harness.
Examples: `I:0`, ... `I:23`

Compared with the labelling scheme proposed by Mathieu in preliminary 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 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 CAEN 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 external HV cables because they are confined within their harness and thus never addressed individually during cabling operations. Due to the layout of the CAEN HV board connectors, the pin number takes its value in the list shown in table 1.

An internal HV cable is identified by its label with the following scheme:

`A:`*harness*`.`*pin*

where *harness* is the number of the internal harness the cable belongs to and *pin* is the number of the pin the cable is associated to.
Examples: `A:0.3`, ... `A:0.50`

HV channel	Radial connector pin
0	45
1	46
2	47
3	48
4	49
5	50
6	34
7	35
8	36
9	37
10	38
11	39
12	24
13	25
14	26
15	27
16	28
17	29
18	14
19	15
20	16
21	17
22	18
23	3
24	4
25	5
26	6
27	7
28	8
29	19
30	20
31	30

Table 1: Associative map between HV board channels and Radial connector's pins

2.4 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,

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

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:

  $$\boxed{\texttt{M:}side\texttt{.}column\texttt{.}row}$$

  Examples: $\boxed{\texttt{M:0.0.0}}$, $\boxed{\texttt{M:0.19.12}}$, $\boxed{\texttt{M:1.0.0}}$, $\boxed{\texttt{M:1.19.12}}$.

- 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: $\boxed{\texttt{X:0.1.1.15}}$, $\boxed{\texttt{X:1.0.0.8}}$

- 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: $\boxed{\texttt{G:0.1.0}}$, $\boxed{\texttt{G:1.0.8}}$

- 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 the repartition of HV boards respectively within the CAEN HV power supply crates 0 (Italy) and 1 (France).

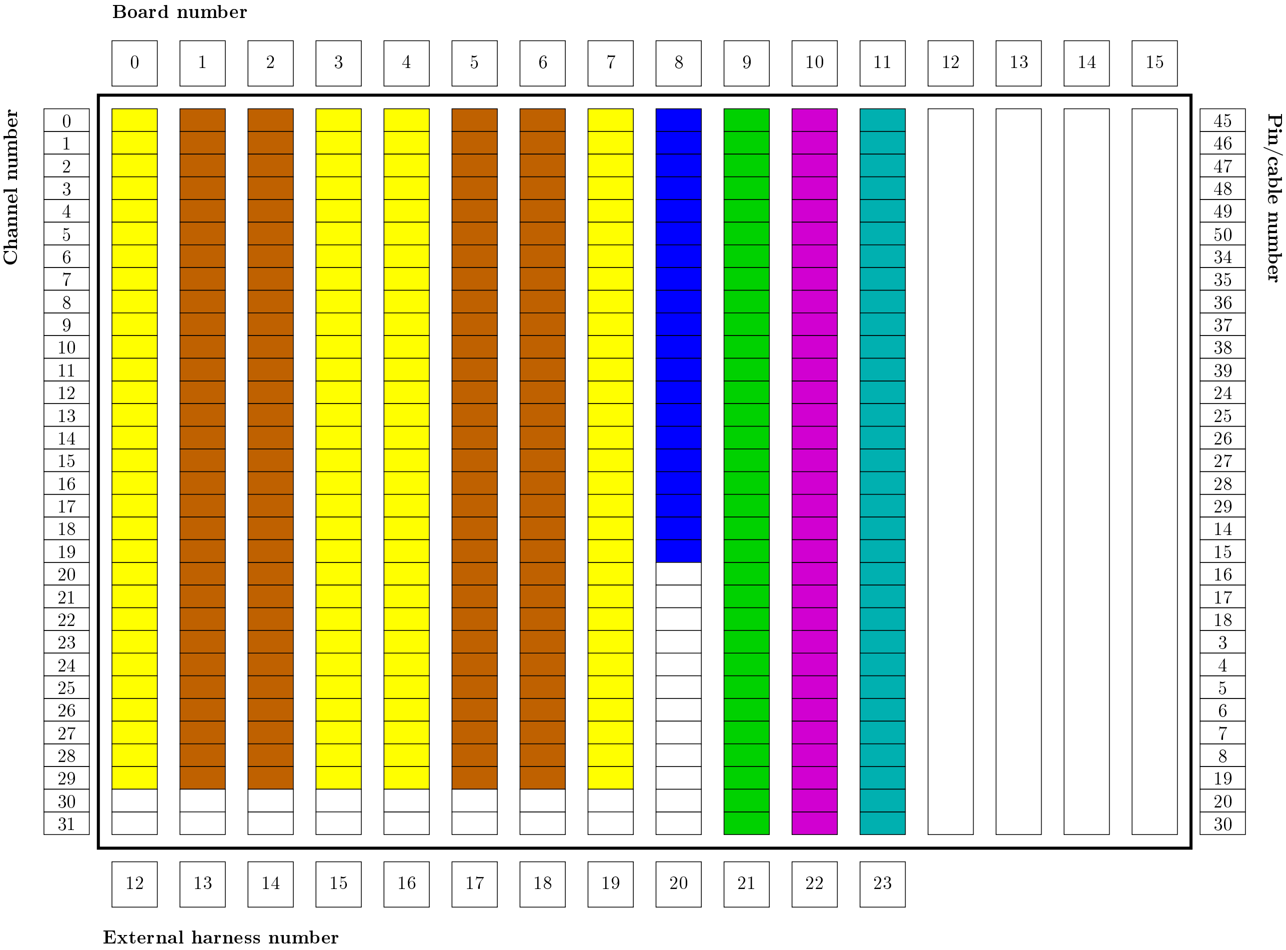

Figure 2: CaloHV crate 0 (Italy).

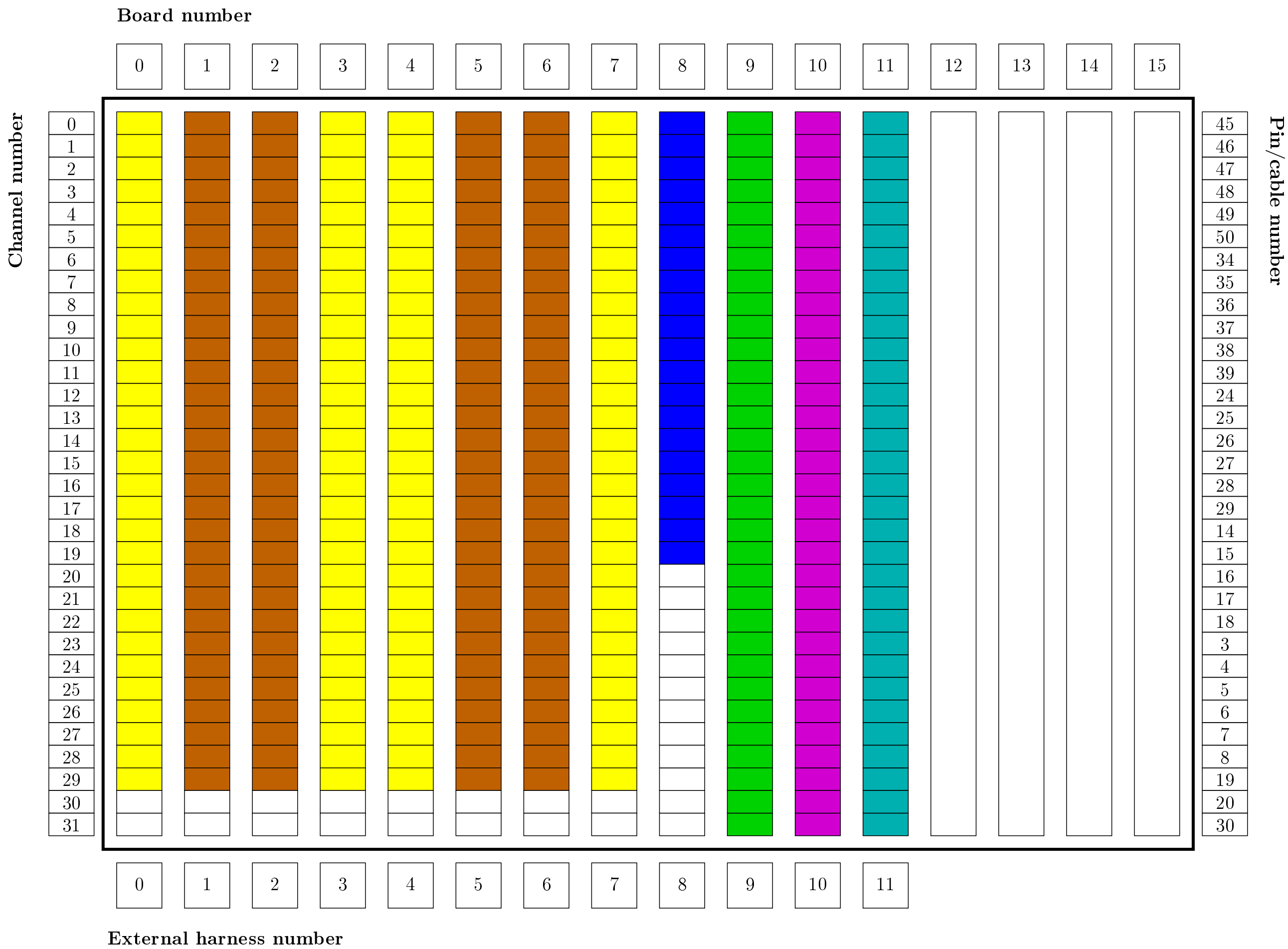

Figure 3: CaloHV crate 1 (France).

4 The CaloHV cabling table and its usage

4.1 Source table

Cabling the CaloHV system consists in the association of each PMT to a CAEN HV board channel. An unique cabling table is 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 2. This map contains the needed informations to ensure the addressing of all HV cables.

HV channel	External HV harness	Internal HV 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 2: 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 CAEN HV board channel.
- The second column contains the label of the external HV harness.
- The third column contains the label of the internal HV cable.
- The fourth column contains the label of the PMT (optical module).

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

[2]CSV: coma separated value

- generation of labels to be stuck on internal HV cables, internal and external HV harnesses,
- generation of printable cabling tables for people in charge of the calorimeter HV cabling at LSM,
- input for dedicated software modeling tools used by the Control and Monitoring System (CMS), the simulation...

4.2 CaloHV cabling sheets

The SNCabling package provides a Python script to automatically generate, from the CaloHV cabling table, a printable PDF document with cabling tables corresponding to each part of the detector. This document can be used during cabling operations.

4.3 Labels

The SNCabling package provides a Python script to automatically generate, from the CaloHV cabling table, the lists of all labels for all HV harnesses and cables. The labels must be stuck on the terminations of all harnesses and cables to help the cabling team to identify the proper connections between CAEN HV boards/external HV harnesses/patch panel/internal HV cables/PMT. Figure 4 shows where various kinds of labels are supposed to be stuck on HV harnesses and cables.

- Each label stuck on the end of an internal HV cable on the PMT side identifies not only the HV cable itself but also the optical module/PMT it is connected to. Example:

```
A:9:3 -> M:1.3.4
```

- Each label stuck on the end of an external HV harness on the HV crate side identifies not only the HV harness itself but also the HV board it is connected to. Example:

```
E:9 -> B:1.9
```

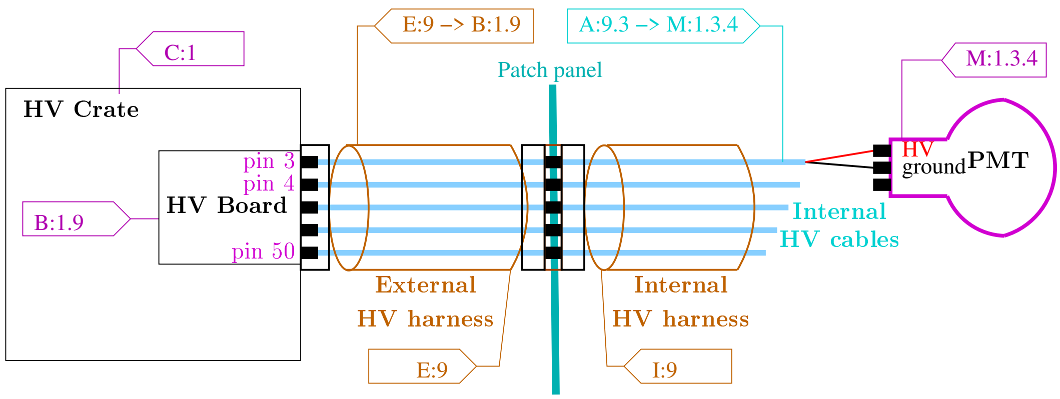

Figure 4: CaloHV labelling of HV harnesses and internal cables