SuperNEMO Demonstrator
Light Injection System (LIS)
Cabling scheme and cable labels
version 0.1

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Abstract

This document presents the cable labelling convention used for the SuperNEMO Demonstrator's Light Injection System (LIS).

Contents

1 Principle

The Light Injection System implements 20 LEDs which distribute reference pulses of light to all optical modules (OM) in the demonstrator (main calorimeter walls, X-walls, gamma veto) as well as to a few reference OMs.

Each LED is able to send light through an unique bundle of about 70 optical fibers. The termination of each fiber must be connected to a scintillator block from OM in the main calorimeter walls, the X-walls or the gamma veto setup.

Each scintillator block has two connectors in order to plug the optical fibers which transport light from LEDs to the detector. One of this connector is named the *primary* connector while the other is the *secondary* connector. The *primary* connector is intended to receive light pulse from a LED for routine calibration operations. The *secondary* connector is used as a spare in case of failure of the *primary* line.

Note: We have no information today about the identification of the OM's *primary* and *secondary* connectors with respect to their placement and orientation in the detector.

Figure 1 shows the basic diagram of the LIS system. For practical reason one considers to use a special label stuck on each optical fiber and bundle during cabling operations.

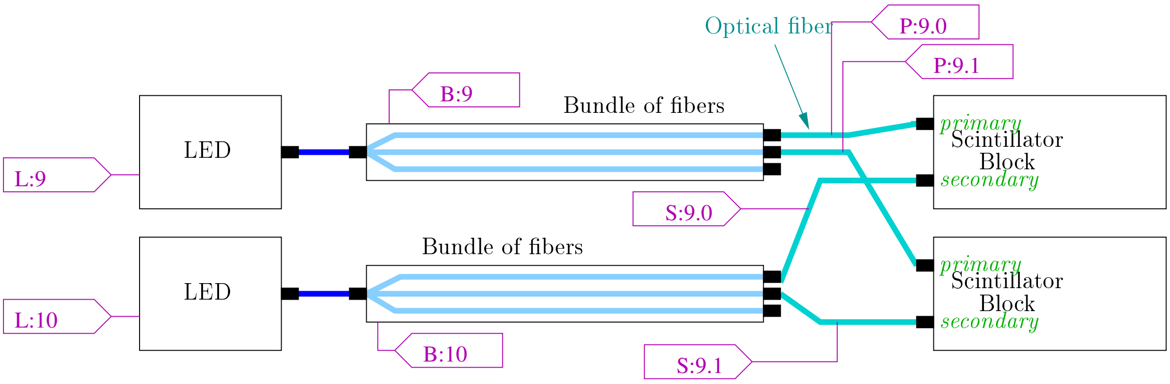

Figure 1: Principle of the light distribution to the OMs using the LIS and labelling.

2 Addressing objects

2.1 Format of a LIS label

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

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

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. The *colon* character is used to separate the category letter from the address. The sequence of identifiers in the address use the *dot* character as a separator.

2.2 LEDs, bundles and fibers

Each LED belonging to the LI system is identified with an unique ID, namely a number ranging from 1 to 20. We propose to label a given LED with the following scheme:

$$\boxed{\mathtt{L:}led}$$

where *led* is the number of the LED (positive integer).

Examples: `L:3`, `L:4`,`L:12`.

Practically, the LED labels should not be necessary unless they can easily be stuck on the LIS crate.

Up to 70 optical fibers are associated to a LED. They all are grouped within a single bundle. A bundle inherits the number of the LED it is connected to. We propose to label a given bundle with the following scheme:

$$\boxed{\mathtt{B:}led}$$

where *led* is the number of the LED associated to the bundle.

Examples: `B:3`, `B:4`...`B:12`.

An optical fiber inherits the number of the LED it is associated to. It is distinguished from the other fibers in the same bundle thanks to an additional *fiber number*. We propose to label a given fiber connected to the block's primary connector with the following scheme:

$\boxed{\texttt{P:}\mathit{led}\texttt{.}\mathit{fib}}$ or $\boxed{\texttt{S:}\mathit{num}\texttt{.}\mathit{fib}}$

where *led* is the number of the LED (and bundle) associated to the fiber and fib is the number of the fiber within the bundle (starting at 1). The leading `P` is used for fibers connected to the *primary* connector of a scintillator block; the `S` is used for fibers connected to the *secondary* connector of a scintillator block.

Examples: `P:3.1`, `P:3.34`, `S:12.3`.

2.3 Optical modules

The identification scheme of the optical modules 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:

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

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

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

  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:

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

  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:

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

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

3 The LIS cabling table and its usage

3.1 Source table

Cabling the LIS consists in the association of each OM's scintillator block to one or two optical fibers. An unique cabling table must be provided to give an unambiguous description of the fibers' path from the LIS boards to the detector. The table consists in an associative map like the one shown on table 1.

Fiber label	**Scintillator block label**
Bundle `B:1` (primary)	
`P:1.1`	`M:0.1.0`
`P:1.2`	`M:0.2.0`
`P:1.3`	`M:0.3.0`
⋮	⋮
Bundle `B:2` (primary)	
`P:2.1`	`M:0.6.0`
`P:2.2`	`M:0.7.0`
⋮	⋮
Bundle `B:12` (secondary)	
⋮	⋮
`S:12.5`	`X:1.15.8.2`
⋮	⋮

Table 1: Example of LIS cabling table

The Austin group, in charge of the LI system, has to provide this table 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 fiber/OM association per line.
- Each line has two columns separated by the *semi-colon* character `;`.
- The first column contains the label of an optical fiber (primary or secondary).
- The second column contains the label of an optical module (main wall, x-wall, gamma veto or reference OM).

With this system, a given optical module can be addressed twice because of its connections to both primary and secondary LIS fibers.
The LIS cabling map file will be used as the unique source of information for different purposes:

- generation of labels to be stuck on fibers and bundles,
- generation of printable tables for people in charge of the LIS cabling at LSM,
- input for dedicated software modeling tools used by the Control and Monitoring System (CMS), the simulation...

An extract of the expected LIS cabling map file is shown on table 2.

[2] CSV: coma separated value

$\vdots$

P:led_a.fib_a ; M:1.12.11
S:led_b.fib_b ; M:1.12.11

$\vdots$

Table 2: Extract of the LIS cabling map file. Symbol led_X corresponds to the identifier of a LED. Symbol fib_X corresponds to the identifier of an optical fiber in its bundle. In this example, the scintillator block of the optical module on French side, column 12 and row 11 is connected to two fibers (one primary and one secondary) lit up by two different LEDs.

3.2 LIS cabling sheets

From the LIS cabling table, a Python script will be provided to generate a printable PDF document with cabling tables corresponding to each part of the detector. A typical output is shown on figure 2.

	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	
12	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	12
11	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	11
10	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	10
9	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	9
8	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	8
7	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	7
6	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	6
5	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	5
4	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	4
3	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	3
2	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	2
1	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	1
0	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	P:?.? S:?.?	0
	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	

Figure 2: Expected printable LIS cabling table for a calorimeter main wall. Question marks will be replaced by the real fibers' identifiers when the final table will be available. Similar tables will be provided for X-walls and gamma veto lines.

3.3 LIS labels

Practically, we plan to generate labels for all bundles and optical fibers to help the cabling team to identifiy the proper OM's connection for each fiber. The label will be prepared and stuck near the termination of the fiber. We propose that the label shows both the fiber identifier and the OM's identifier.
Example below displays the full text expected to be printed on a fiber label:

$\boxed{\texttt{P:2.34} \rightarrow \texttt{M:0.2.5}}$

Such informations are of course redundant with respect to the printable plain table shown in the previous section. The fiber labels could possibly be removed before installing the coil.
We consider to write a Python script to automatically generate all labels (up to 1400).