TECHNICAL NOTE

Gas Pipes Specifications for nBLM System

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CONTENTS

CARTOUCHE D'EVOLUTION - *DOCUMENT REVISION HISTORY*			
Éditions ***Editions***	**Dates** ***Dates***	**§ modifiés** ***Modified part(s)***	**Commentaires –** ***Observations***
A	2017	Tous	Création
V1	2017	All	Created
V2	2018		Final number of lines and final decision on installation point All info exchanged by emails in same document

1. Introduction

The nBLM system is a system of gaseous detectors. They will work in recirculation mode. Therefore, we will need gas pipes to be installed in the accelerator building.

The specifications of the gas type and flow are:

Gas type	He + 10% CO_2	Used of premixed bottles
Total flow	8 - 16 l/h (feeding/exhaust lines)	Limitation of maximum flow immediately after gas bottle at ~20-30 l/h with a rotameter (0-50 l/h)
Flow per line	1-2 l/h[1] (distribution/return lines)	Detectors in series
Pressure after bottle	2 bar total	
Pressure for distribution	1atm + 200 mbar (tbc)	Depends on final pipe cable length
Pressure at exhaust	1atm + 50 mbar	Pressure and flow will be controlled by PLC.

There are more information about the gas system in the ESS link:

https://indico.esss.lu.se/event/835/

In the presentation called: nBLM Gas system characteristics and first design

In this document we specify the characteristics of the gas pipes needed for installation from the gas bottles to the gallery and from the gallery to the accelerator tunnel.

2. System architecture

The gas system consists in 3 parts (*Figure 1*):

1. The bottle storage area outside the building
2. The gas distribution rack
    - Where we have the control system
    - Where we have the distribution and return lines from (to) the rack to (from) the accelerator tunnel
3. The gas detectors line group. Each line feed a group of detectors installed around the accelerator.

The gas lines will go from outside the building, where we expect to store the gas bottles (see section 5) to the gas rack and controller and from there to a patch(s) panel(s) and to the accelerator tunnel.

The final option to drive the pipes from the gallery to the accelerator tunnel is through the FEB-090lvl shielding wall. See *Figure 2* and *Figure 3*.

[1] At the very beginning, or after an intervention that implies the entrance of gas to the system the flow will be higher to have the system ready in a shorter time.

From the FEB-090 they will go to the accelerator tunnel. All the distribution lines can be passed through a cylinder going through the shielding wall like for example the ones in *Figure 4*.

Once in the accelerator tunnel, a pair of distribution-return line should arrive close to each DTL or to other point of distribution and be secured there (fixed in the wall for example as in *Figure 5*). We need to seal both ends with an end cap like in *Figure 9*. Once in the accelerator they will be later routed to each nBLM.

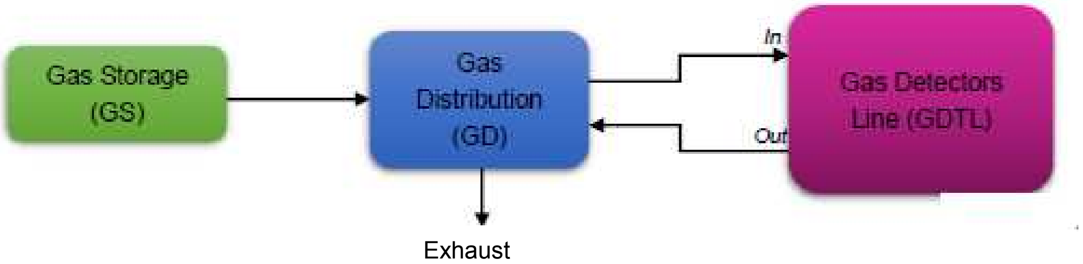


Figure 1: *Gas system architecture*

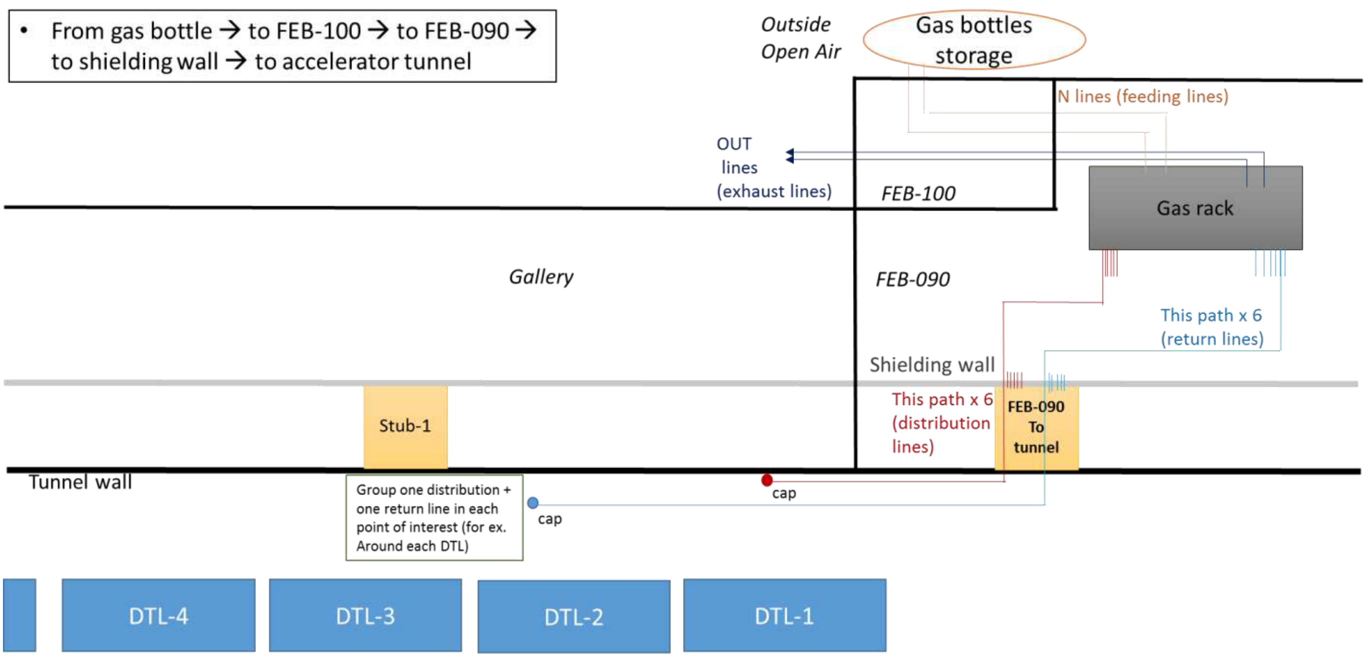


Figure 2: *Sketch of the gas lines from gas bottles (outside building) into tunnel through room FEB090. Until the gas rack is installed each end of the pipes will need to be close. Only one distribution line + one return line path has been drawing through the FEB-090 shielding wall but we need to pass 12 lines (6 distribution + 6 exhaust) from the gallery to the accelerator. The lines will end in each point of interest (for example close to each DTL) as listed in section 3.2. Some lines will need to be driven another 500 m later to reach the MB and HB region. The IN/OUT points are indicative.*

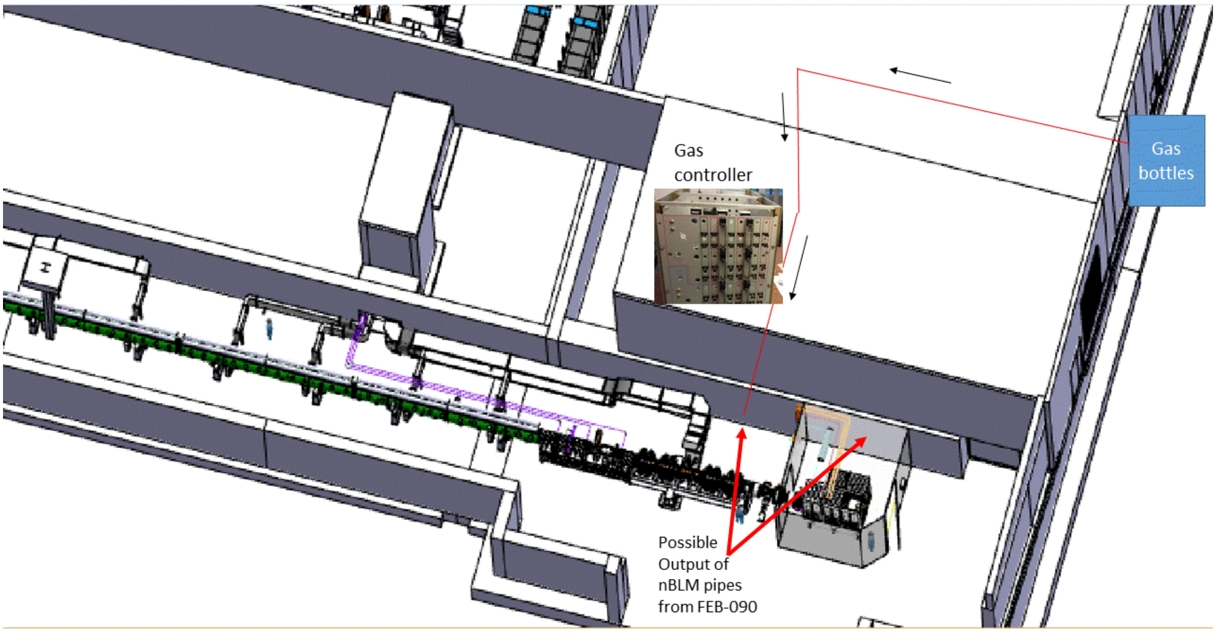


Figure 3: *Another view of the installation.*

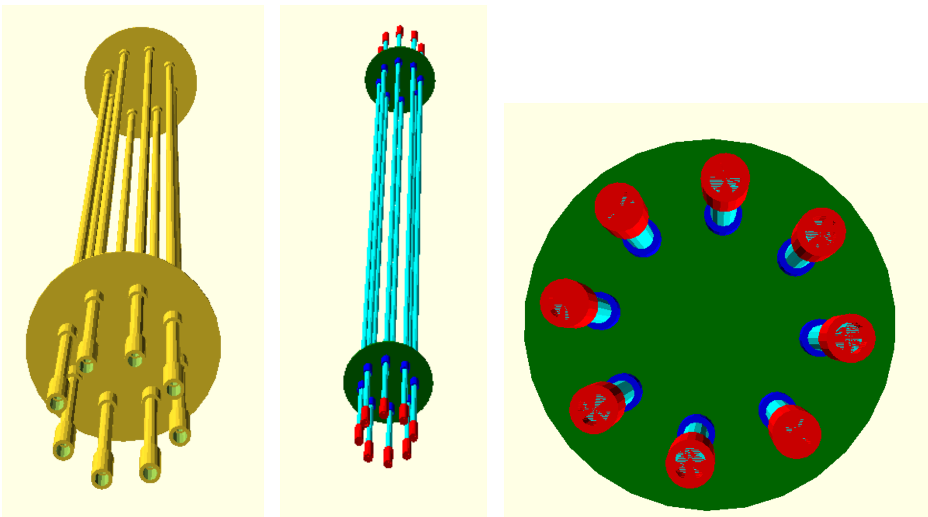


Figure 4: *3D sketch of possible passage through FEB-090 shielding wall. Note that the sketch shows 8 lines, while 6 IN lines + 6 OUT lines were chosen for the final design.*

Figure 5 : Possible attachment of the distribution and return lines inside the accelerator tunnel.

3. Tube Paths and number of tubes

3.1. Lines From bottles storage area to FEB-090 (see P&ID in Figure 6)

- 2 lines (one in use, another spare)
- Dimensions: 6/8 mm (inner/outer)
- All instrumentation will be placed in the gas bottles storage cage
- As for the moment the gas rack will not be populated without the rack crates, each end of the feeding and exhaust lines need to be finished also closed with an end cap to avoid contamination of the pipe (specifications in section 4.4).

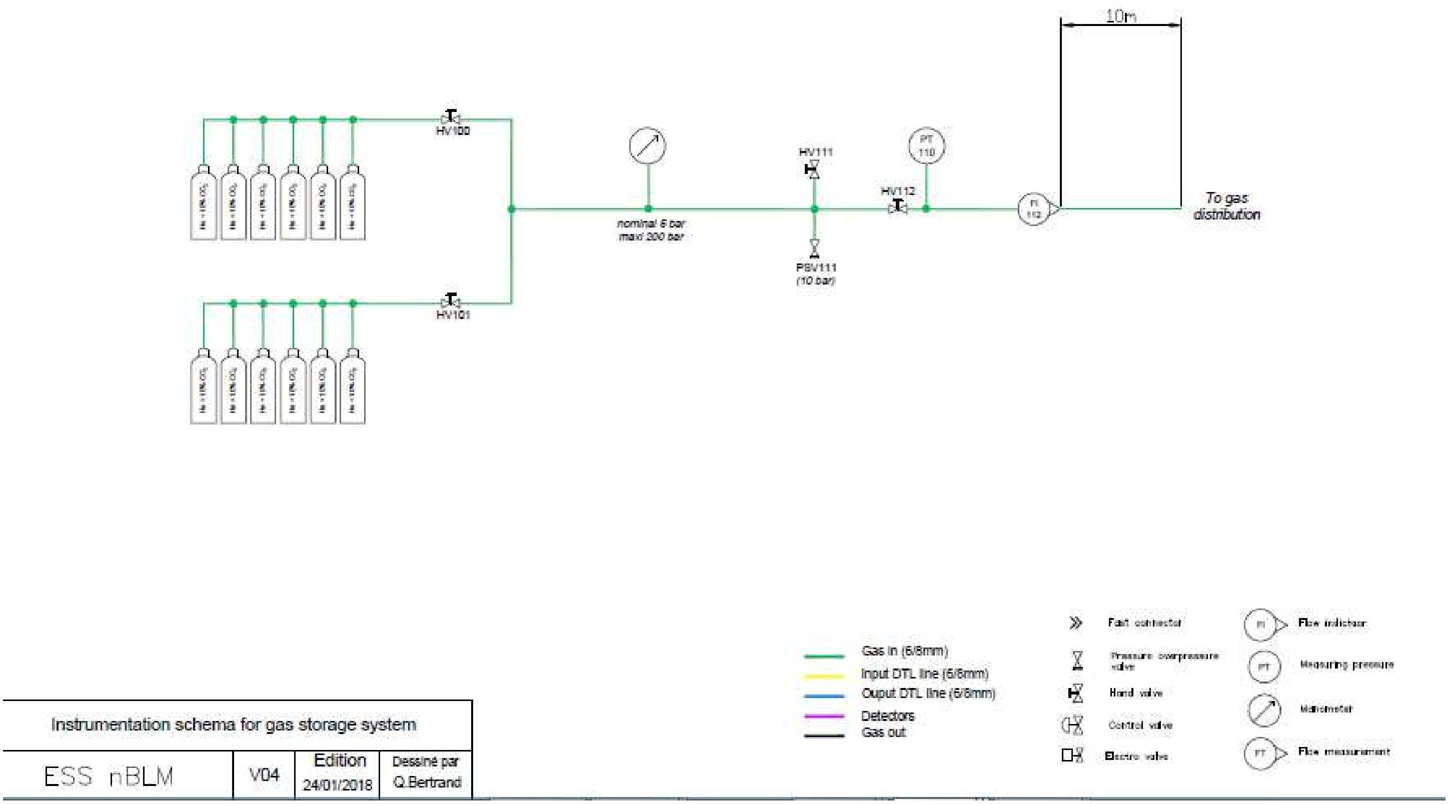


Figure 6: Gas storage system for ESS nBLM (GS) P&ID

3.2. Lines from the gas rack to the accelerator

- 12 tubes (6 IN (distribution lines) + 6 OUT (return lines)) from rack
- Dimensions: 6/8 mm (inner/outer)

Position in tunnel as shown in *Figure 7* and *Figure 8* and summarized in

- Table 1 (position approximately, does not need to be exactly there).
- In line 6 we need to place 2 “T-connections” to connect later to the isolated detectors in the high-energy region of the accelerator. This is also shown in *Figure 7*; basically we need a Swagelok Hand Valve and two Swagelok fitting tubes.

LINE	END POINT
1IN	Beginning MEBT
1OUT	End DTL1
2IN	Beginning DTL2
2OUT	End DTL3
3IN	Beginning DTL4
3OUT	End DTL5
4IN	Beginning Spoke 1
4OUT	End Spoke6
5IN	Beginning Spoke 7
5OUT	End Spoke 13
6IN	Around Bend Magnet
6OUT	Around Raster Magnets

Table 1 : End position of distribution lines in ESS accelerator tunnel. Important: pipe end position not critical, can be moved 1-2m if required by space constraint in the model

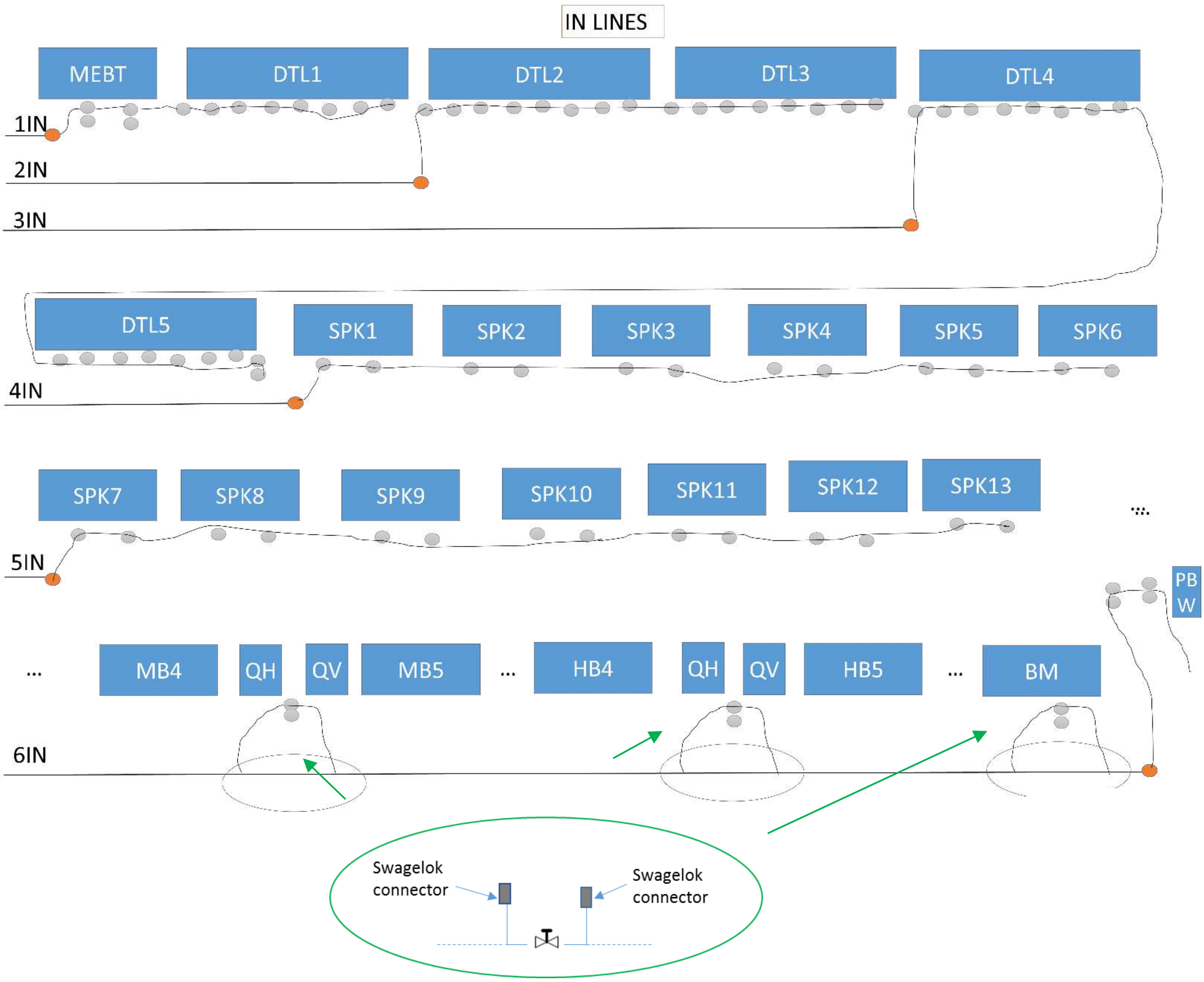


***Figure 7:** Sketch of the end points (marked in orange) of the IN distribution nBLM gas lines in the accelerator tunnel. The lines will later be connected to group of detectors (curve line). Except line 6 that has to have 3 T-connection as marked on the schematic along its way to connect to isolate detectors.*

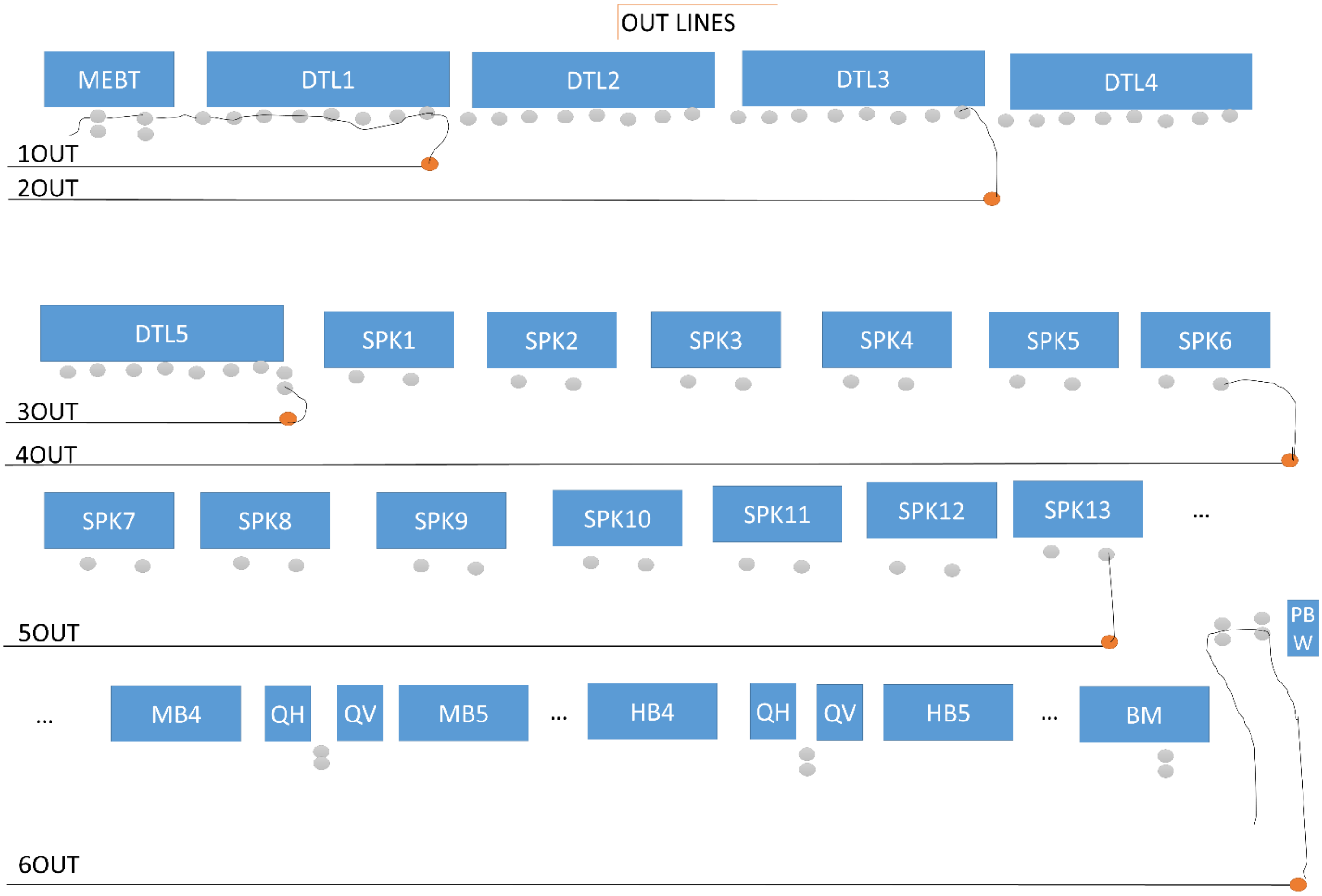


***Figure 8:** Sketch of the end points (marked in orange) of the OUT distribution nBLM gas lines in the accelerator tunnel.*

4. Tubes specifications

4.1. For the long tubes

4.1.1. Metallic

- Preference stainless steel (316L or 304)
- But can be copper

4.1.1. Connection

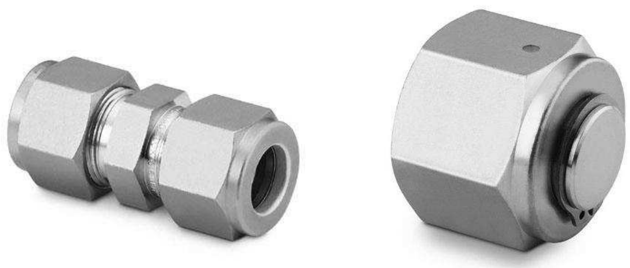
- Connection **on metric system**

4.1.2. Cleaning

- The cleaning specifications are defined here: https://www.swagelok.com/downloads/webcatalogs/EN/MS-06-62-SCS.PDF
    - If the pipes are bought from a gas company (like Air Liquide or Swagelok) they usually follow this procedure and no extra cleaning is required.
    - If the pipes are ordered to a supplier not expert on gas, extra cleaning will usually be needed to remove grease. In that case maybe it is more expensive if we have to subcontract it.

4.1.3. Tube termination

- Tube fitting (*Figure 9*, a) https://www.swagelok.com/en/catalog/Product/Detail?part=SS-8M0-6-6M
- Tube cap (*Figure 9*, b) https://www.swagelok.com/en/catalog/Product/Detail?part=SS-6M0-C



(a) (b)

Figure 9: *(a) Termination of the pipes in order to be able to do the rest of the connections later (i.e from accelerator tunnel distribution point to each detector). They will need to be seal with an end-cap as in (b)*

4.2. For the lines between detectors (to be installed at same time as detectors)

- Polyurethane gas tubes
  - There will be used to bring the gas from the gas pipes in stainless steel arriving to the tunnel to each detector placed close to the accelerator. We have chosen this flexible material instead of stainless steel because we need to be flexible in the positioning of the detectors during commissioning of the system.
- Diameter of the tubes is 4/6 mm (inner/outer)
- Length (approx.):
  - 8 meters close to each DTL (at a distance of ~0.5-1m)
  - 60 meters all along the spokes (at a distance of ~0.5-1m)
  - Few meters between MB4 and MB5
  - Few meters between HB10 and HB115
  - Few meters close to first bend magnet
  - Few meters close to the raster magnets and PBW
- No extra cleaning required
- Here is the link, in French but you can find the documentation in English (doc name: Festo Plastic tubing, standard O.D.)
  https://fr.rs-online.com/web/p/tuyaux-dair/1216292/
  We were considering to use PUN-H that is halogen free and have almost the same characteristics as PUN-VO (flame retardant).
- Connection between detectors not decided yet: either Swagelok hand valves or SERTO fast couplers. It doesn't change anythyn on the design

5. What is needed before going ahead with procurement installation

- Estimation of price from local suppliers for each possible material[2]
- Estimation including also the installation. In case of SS the most expensive part may be the welding of >100m length pipes!
- The cleaning procedure the suppliers will follow. In case this is insufficient, check for price estimation for outscoring the cleaning.

6. What will be needed after installation of pipes

- Standard pipe tight test and vacuum test (~10^{-6} mbar l/h)
- Tags on lines and in gas panels
- Lines ends closed with cap
- Length used for each pair known

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[2] We have found some references from CERN here:
Copper coil: 8.4 CHF/m
https://edh.cern.ch/edhcat/Browser?command=showPage&argument=11835&top=11835&objid=%24%24EDH78j0g58a8&showAdvanced=&scem=&keywords=
SS for vacuum (SS316L): 7.2 CHF/m
https://edh.cern.ch/edhcat/Browser?command=showPage&argument=11645&top=11645&objid=%24%24EDH78j0g58a8&showAdvanced=&scem=&keywords=

7. Bottle Storage area

We suggest to have a bottle storage area with 2 stacks of 6 bottles of premix He + 10% CO_2 outside the accelerator (at open air) protected by a shelter as discussed and shown in *Figure 10*. The 12 B-50 bottles (50 litters) of 200 bar each assure the gas of the system for a 250 days each stack. It is the size for example AirLiquide (https://industry.airliquide.us/high-pressure-cylinders) sell them (in 6 or 16 stacks).

From the bottles we will control the pressure of the stacks (to know when to exchange between them), adjust the pressure to 5 bar, have a purging valve (for when we exchange the stacks), then a rotameter to adjust the maximum flow to ~30 l/h and a release valve at ~7 bar.

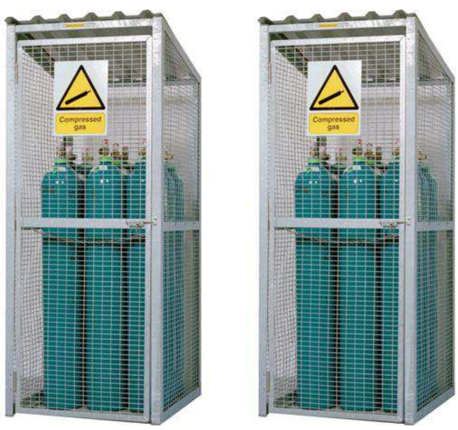


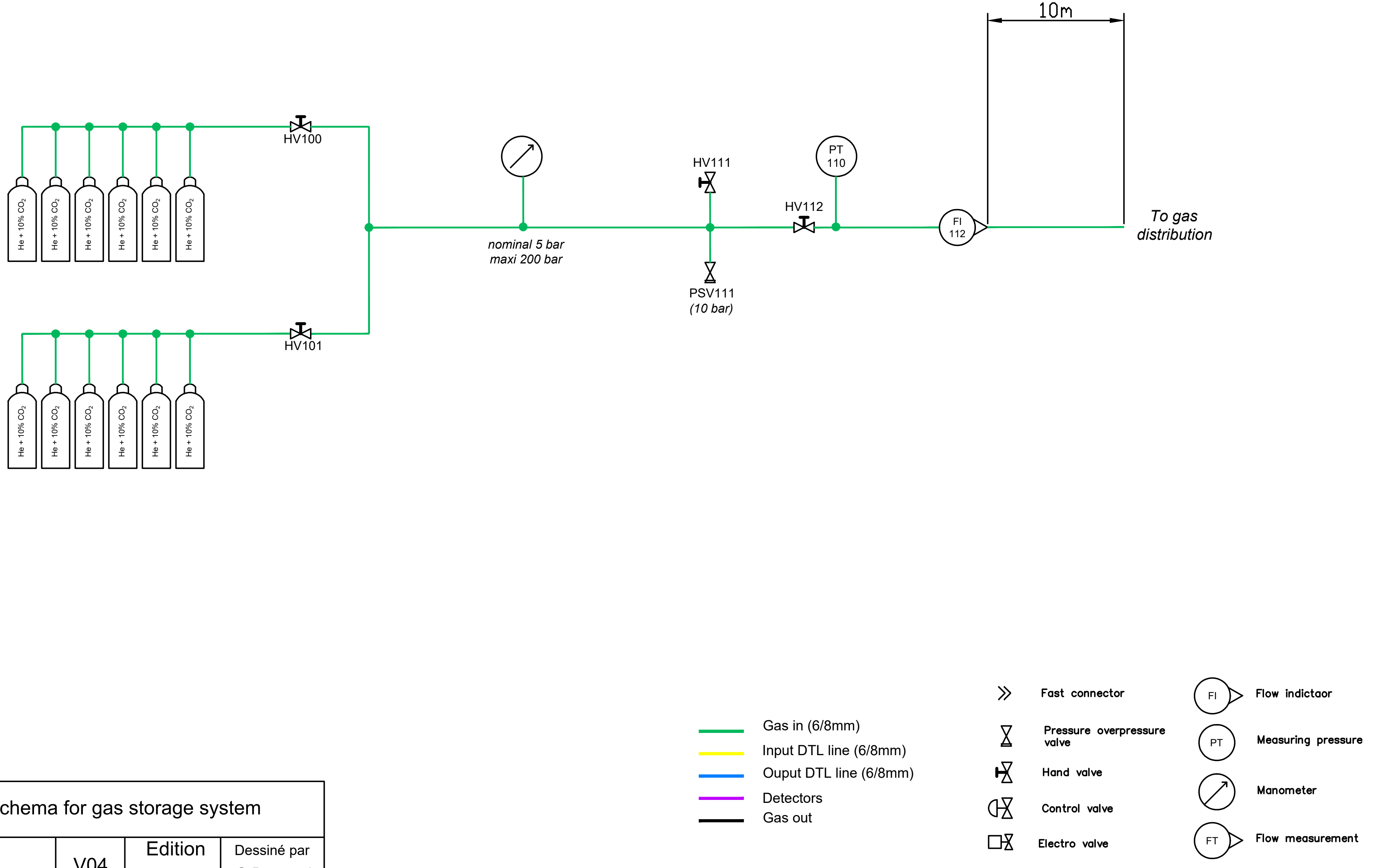
Figure 10 *Possible 2x6 gas storage shelter*

The bottles specifications are:

- Premix He + 10% CO_2
  - We can also add a mixer to the gas system and buy independent bottles but we will prefer to use premix bottles.
- Usually they come in 200 bar bottles → 50 l
  - Operating at 1 bar → 10000 l @ 10l/h → 6000 h the 6 bottles → 250 days
- Purity of 5.0 (99.9990 %)

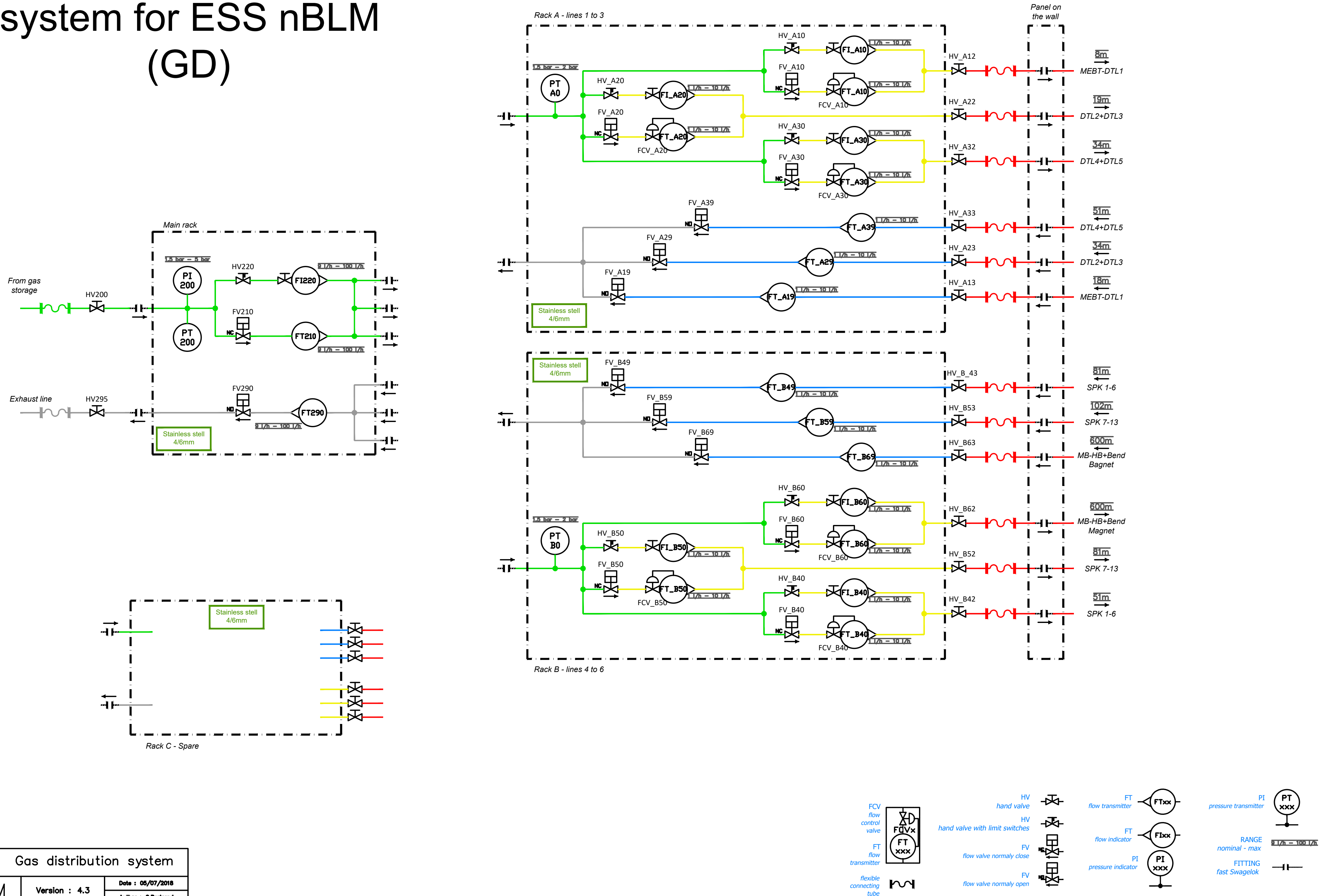
8. P&IDs

Gas storage system for ESS nBLM (GS)



Instrumentation schema for gas storage system			
ESS nBLM	V04	Edition 24/01/2018	Dessiné par Q.Bertrand

Gas distribution system for ESS nBLM (GD)



Irfu - CEA Saclay	Gas distribution system		
ESS–nBLM	Version : 4.3	Date : 05/07/2018	Author : Q.Bertrand