

CRYOGENIC LINE CIRCUITS, TECHNICAL SERVICE MODULE

Sébastien ROUSSELOT

Patxi DUTHIL

Philippe DAMBRE

Denis REYNET

Gilles MINIER

Sylvain BRAULT

Patricia DUCHESNE

Unité mixte de recherche
CNRS-IN2P3
Université Paris-Sud 11

91406 Orsay cedex
Tél. : +33 1 69 15 73 40
Fax : +33 1 69 15 64 70
<http://ipnweb.in2p3.fr>

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Overview

- Short cryomodule cryogenic scheme

Cryogenic implantation

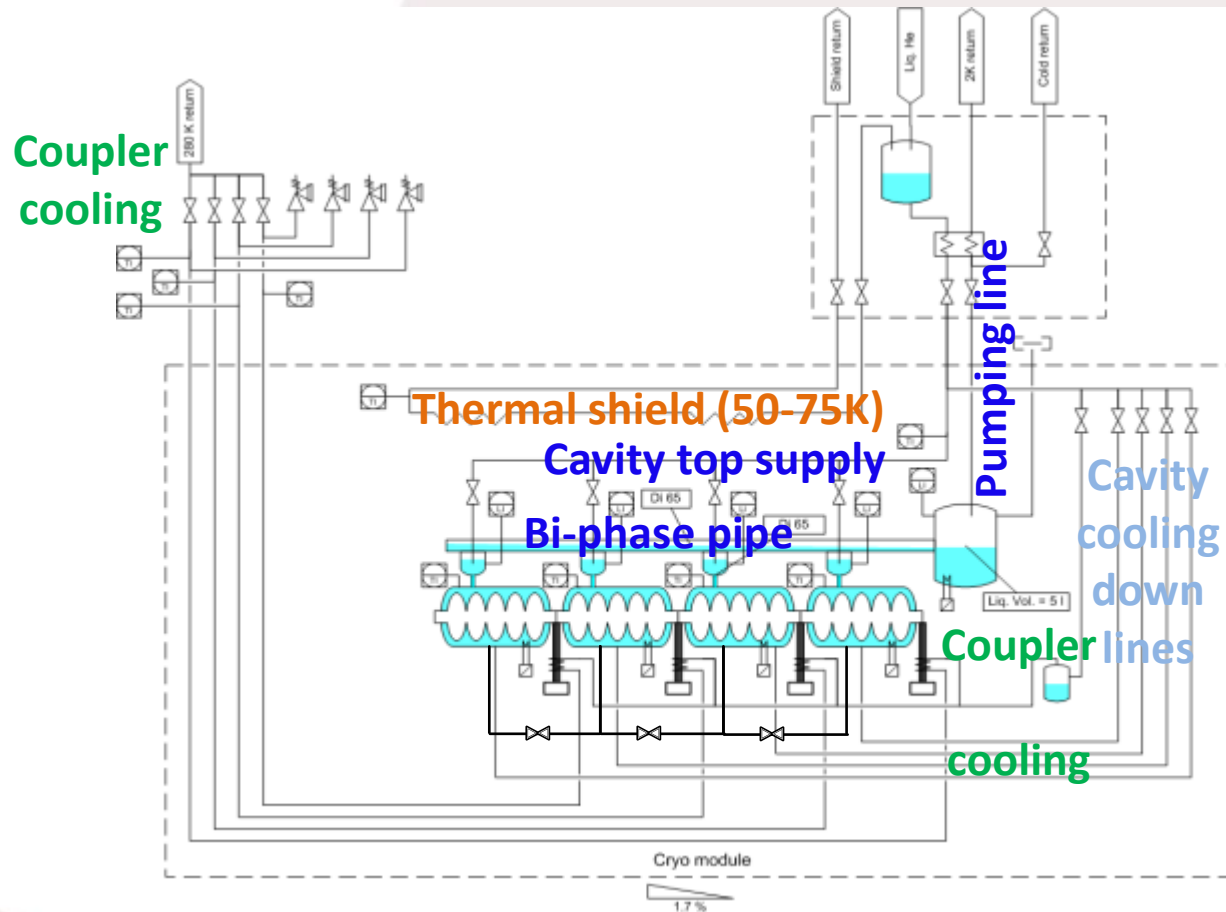
- Interfaces
- Technical principle

Technical aspects

- Interface with the LHe tank of the cavity
- Cooling lines
- Filling lines
- Lines routing
- Coupler cooling line
- Phase separator
- Technical Service Module

Summary

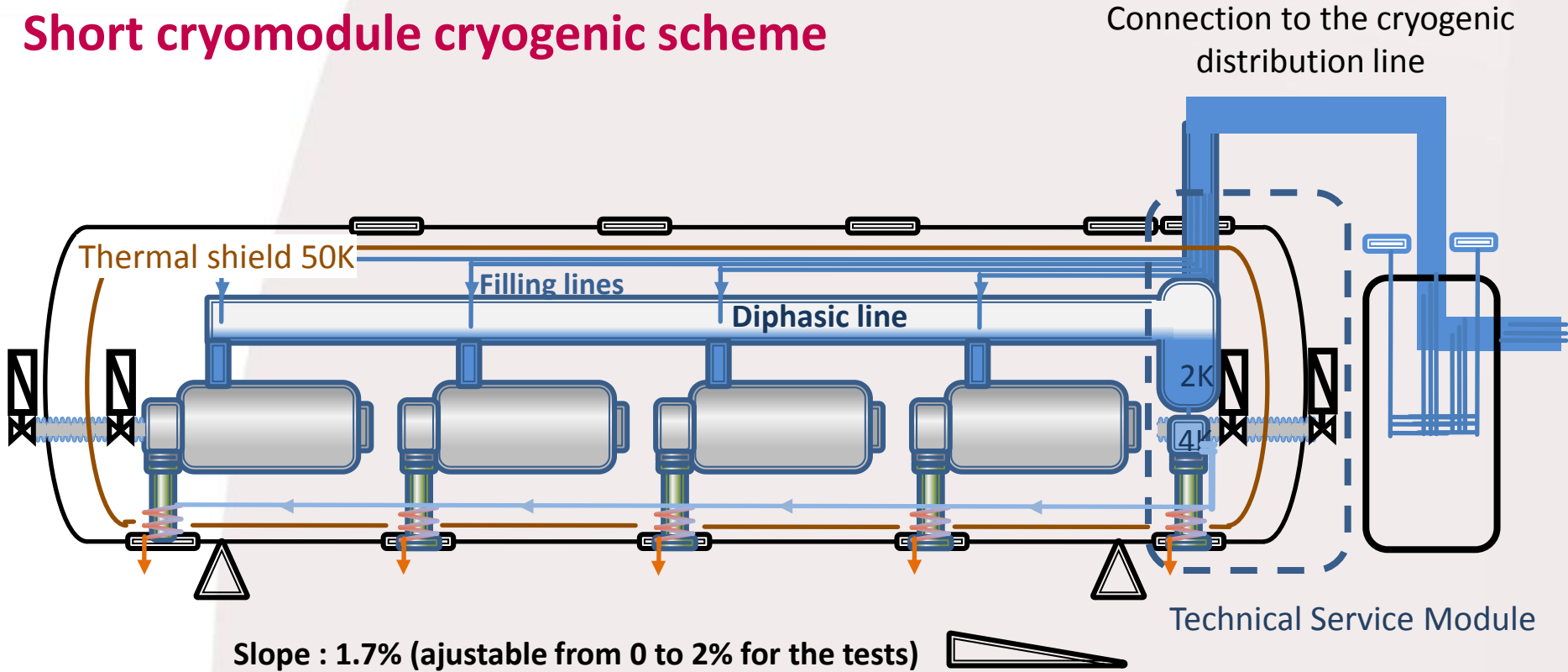
Short cryomodule cryogenic scheme



Different cryogenic procedures to be tested

→ Redundant elements: fill-in lines equipped with JT valves

Short cryomodule cryogenic scheme



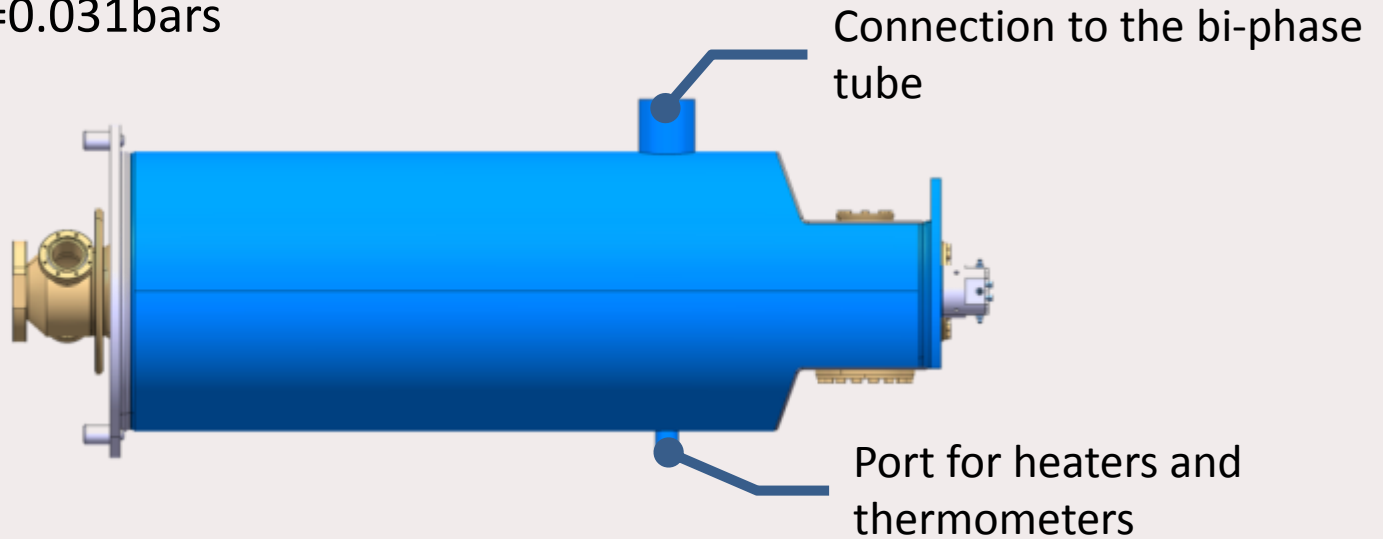
Interfaces

Cavity interfaces

Number of interfaces: as few as possible

→ 1 is ideal: connection to the bi-phase tube (pumping line)

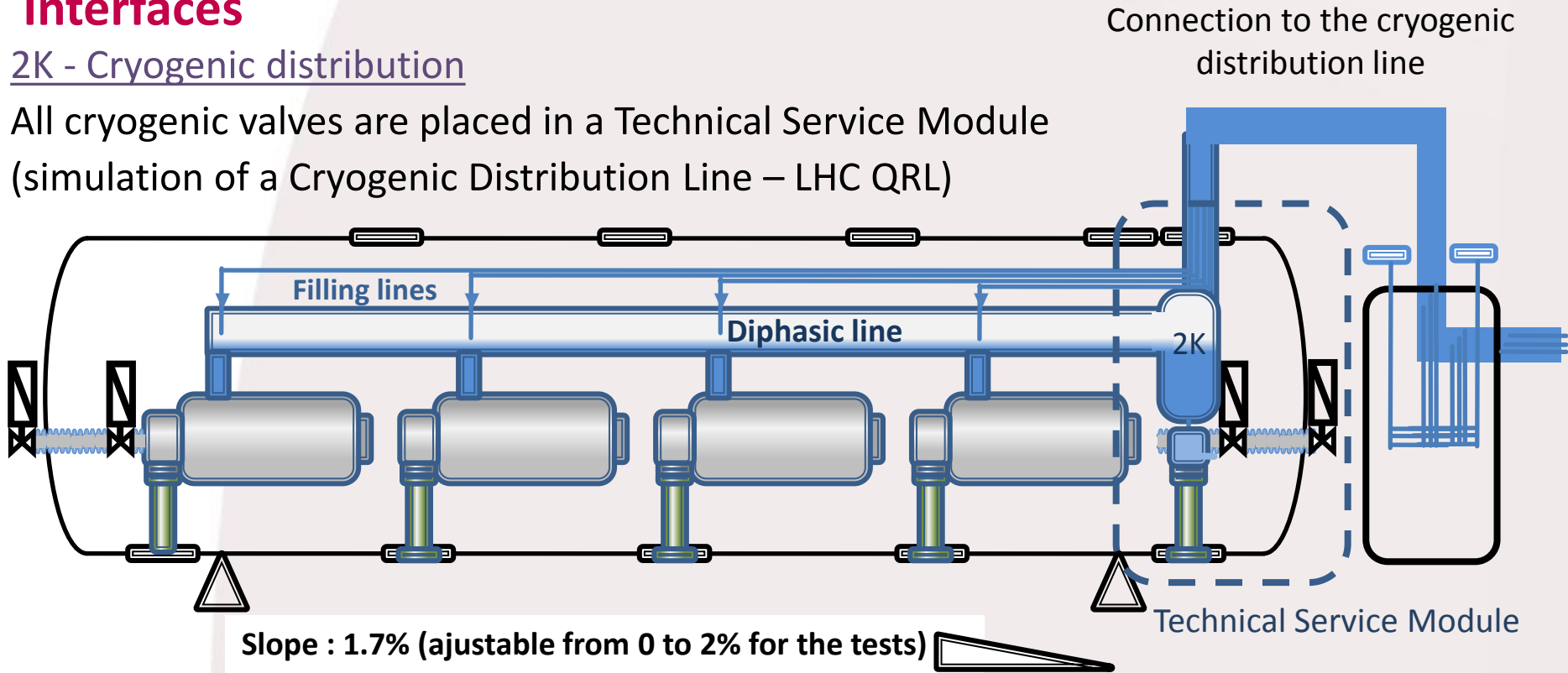
Ø=80mm ; P=0.031bars



Interfaces

2K - Cryogenic distribution

All cryogenic valves are placed in a Technical Service Module (simulation of a Cryogenic Distribution Line – LHC QRL)



Cooling lines: 1 per cavity ; $\varnothing=4\text{mm}$; $P= 1\text{bars}$

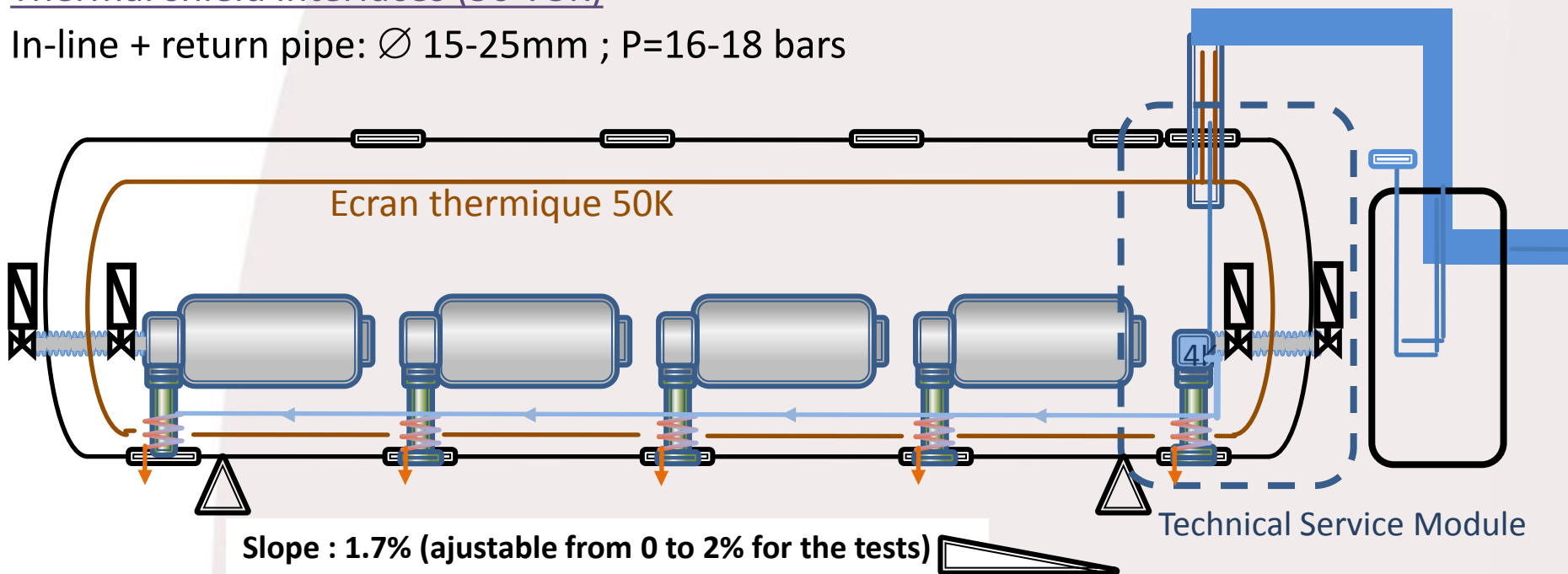
Fill-in lines: 1 per cavity () ; $\varnothing=\text{mm}$; $P=0.031\text{-}1.0\text{bars}$

Bi-phase line (pumping line) ; $\varnothing=100\text{mm}$; $P=0.031\text{bars}$; cryogenic interface with the phase separator

Interfaces

Thermal shield interfaces (50-75K)

In-line + return pipe: \varnothing 15-25mm ; P=16-18 bars



Coupler cooling

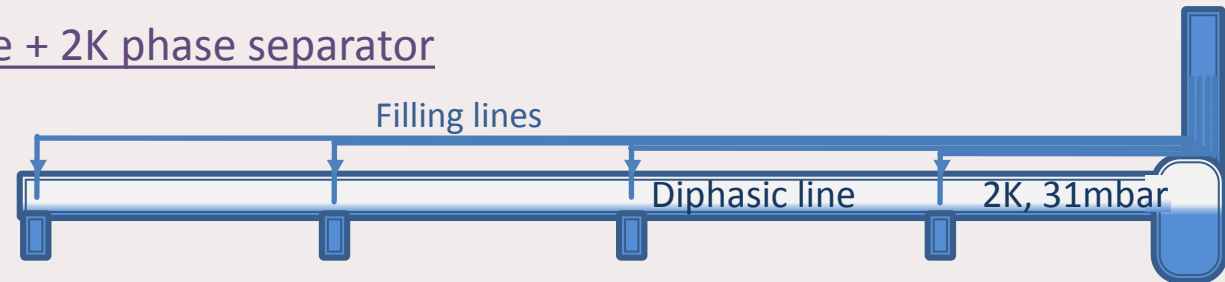
Cooling lines: 1 for the 4 couplers

For the regulation: 4 outlets ; \varnothing 15mm ; P=1.1bars

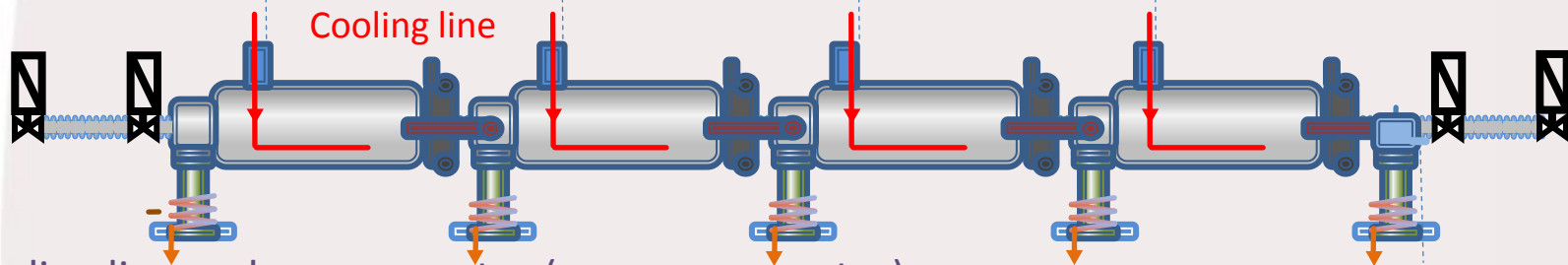
Cryogenic interface with the phase separator

Technical principle proposal

Diphasic line + filling line + 2K phase separator

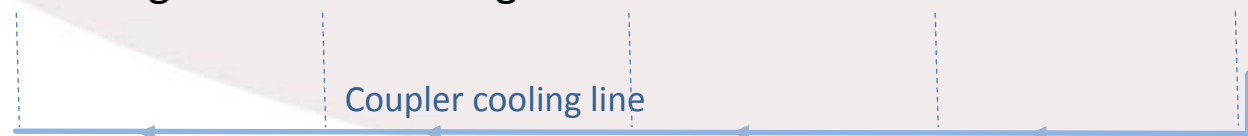


- One ensemble
- Assembled separately **outside** the clean room
- Tightness can be fully tested independently
- Mounted on the string of cavities during the dressing phase

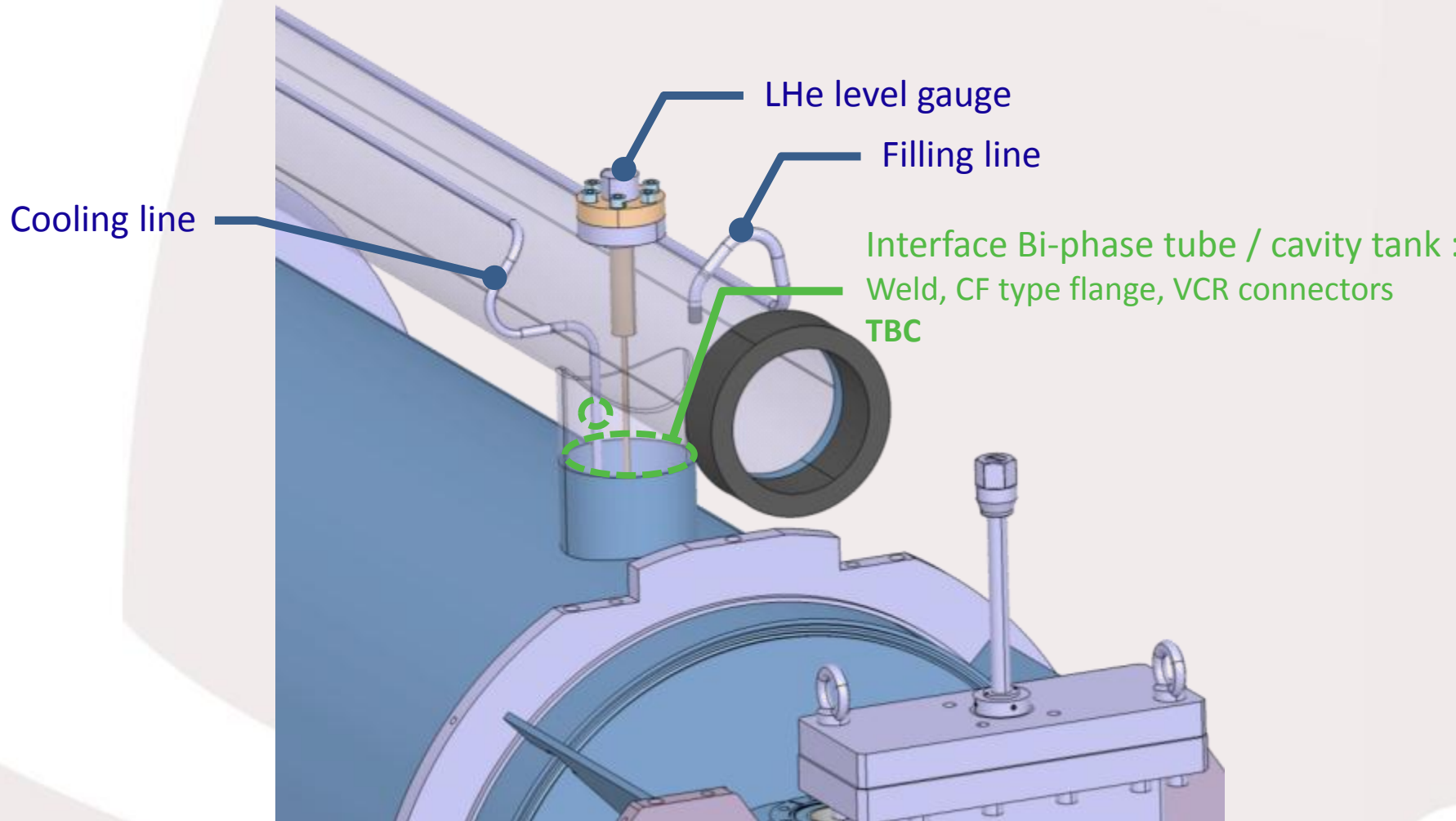


Coupler cooling line + phase separator (vapour generator)

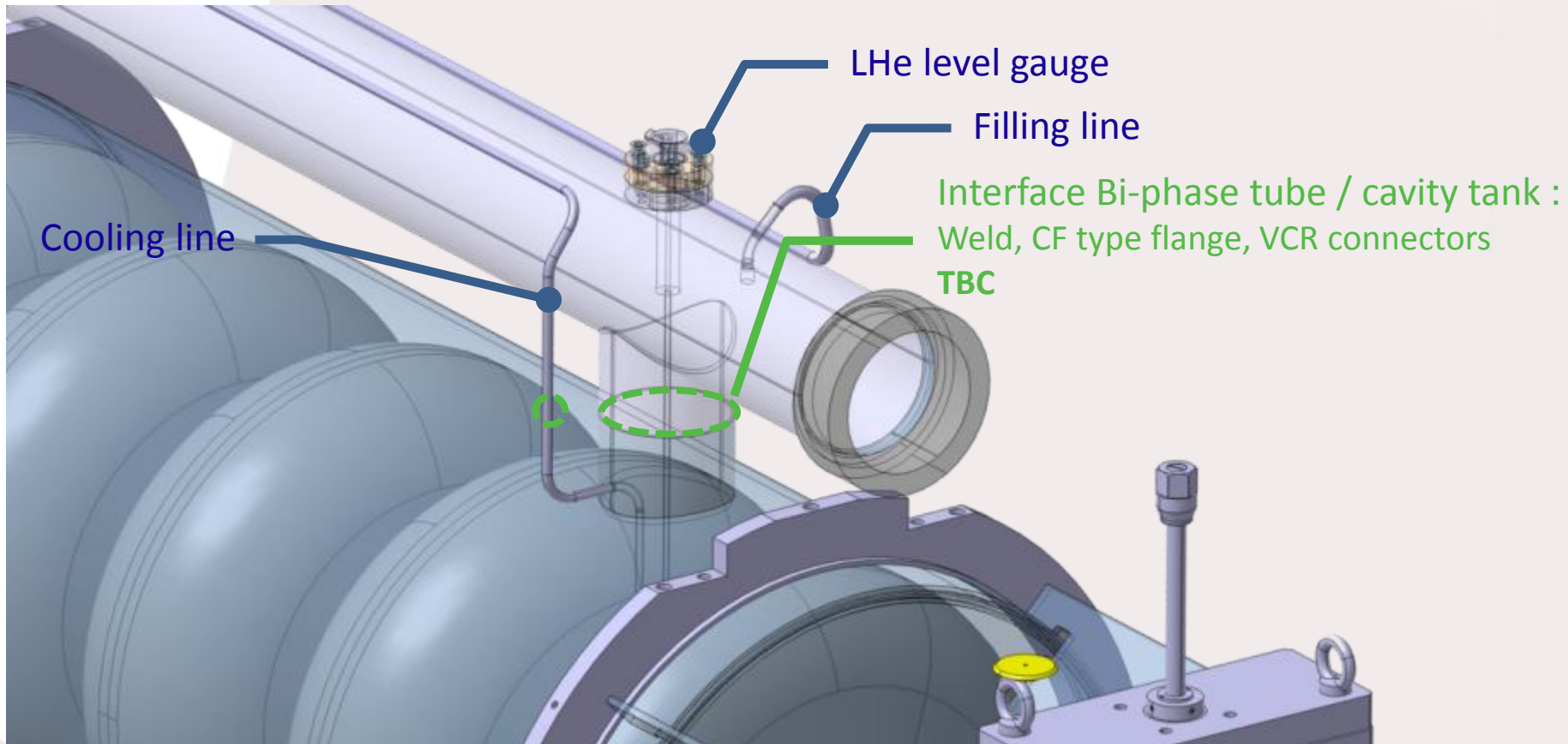
- The line is assembled on the couplers during the dressing phase
- The vapor generator is integrated in the string of cavities



Interface with the LHe tank of the cavity



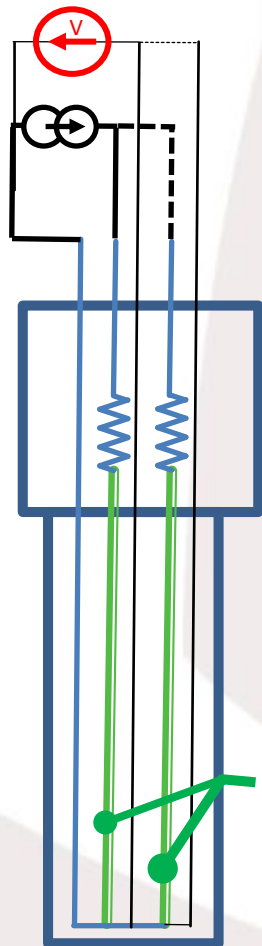
Interface with the LHe tank of the cavity



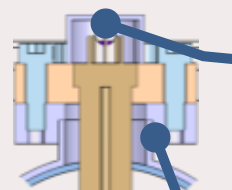
Interface with the LHe tank of the cavity

LHe level measurement

Double superconductive wire probe for redundancy → reliability



Two
superconductive
wires mounted in
a single probe



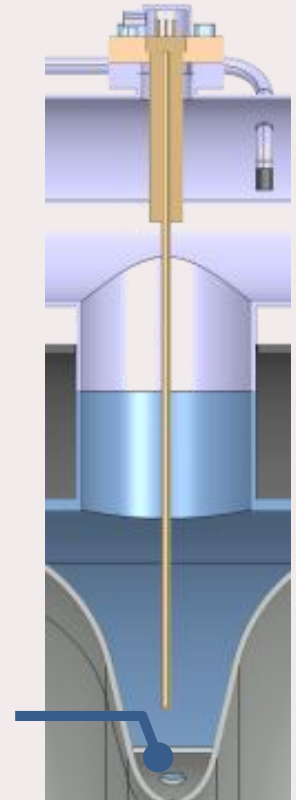
Metal-glass connector
brased on a DN25 CF flange



DN25 CF Flange welded
on the diphasic tube

Active part

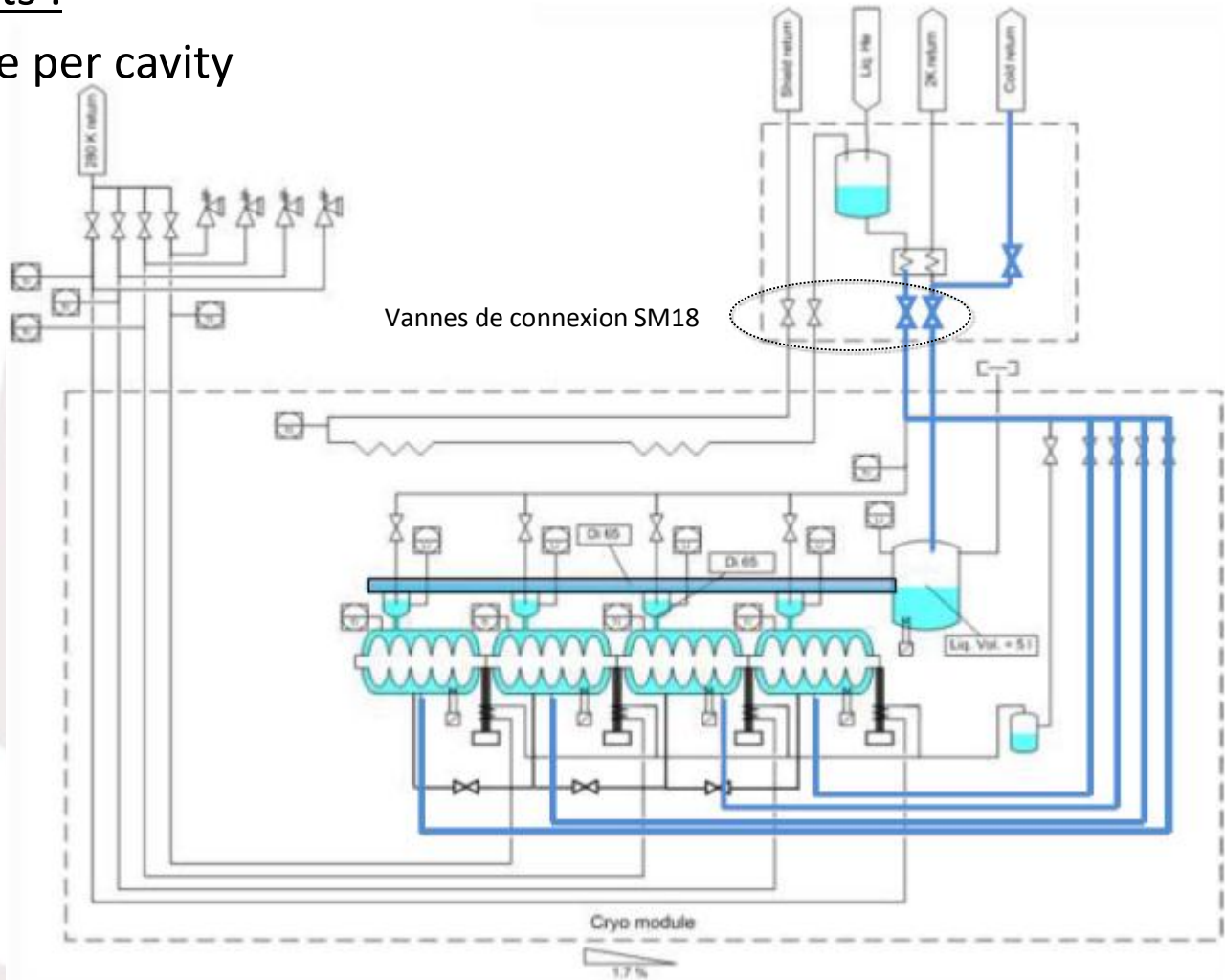
Positionned at the cavity Iris :
→ maximal length of the probe
→ max dynamic range
→ reliability



Cooling lines

Requirements :

1 cooling line per cavity



Cooling lines

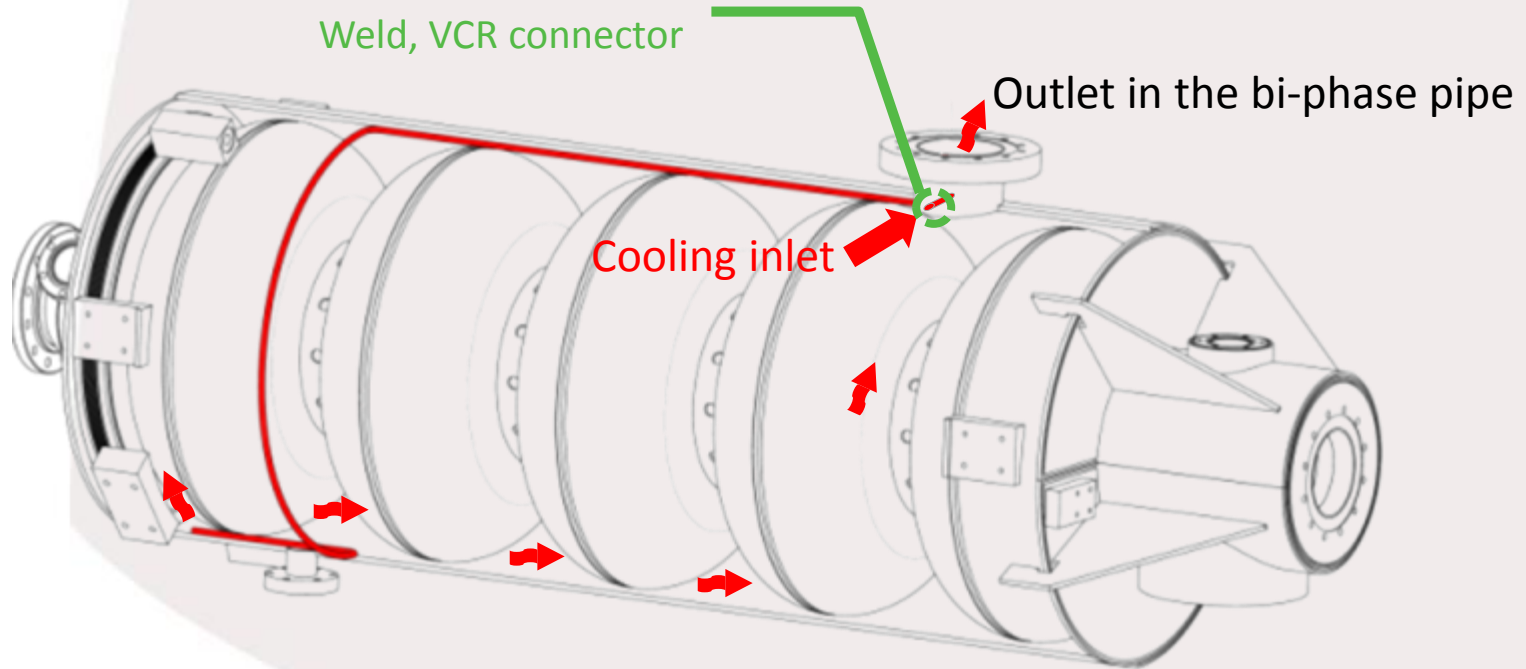
Requirements :

Cooling procedure : cold vapors circulating from the bottom to the top of the cavity

⇒ Use of a $\varnothing 4\text{mm}$ pipe inserted within the LHe tank

Additional interface TBC:

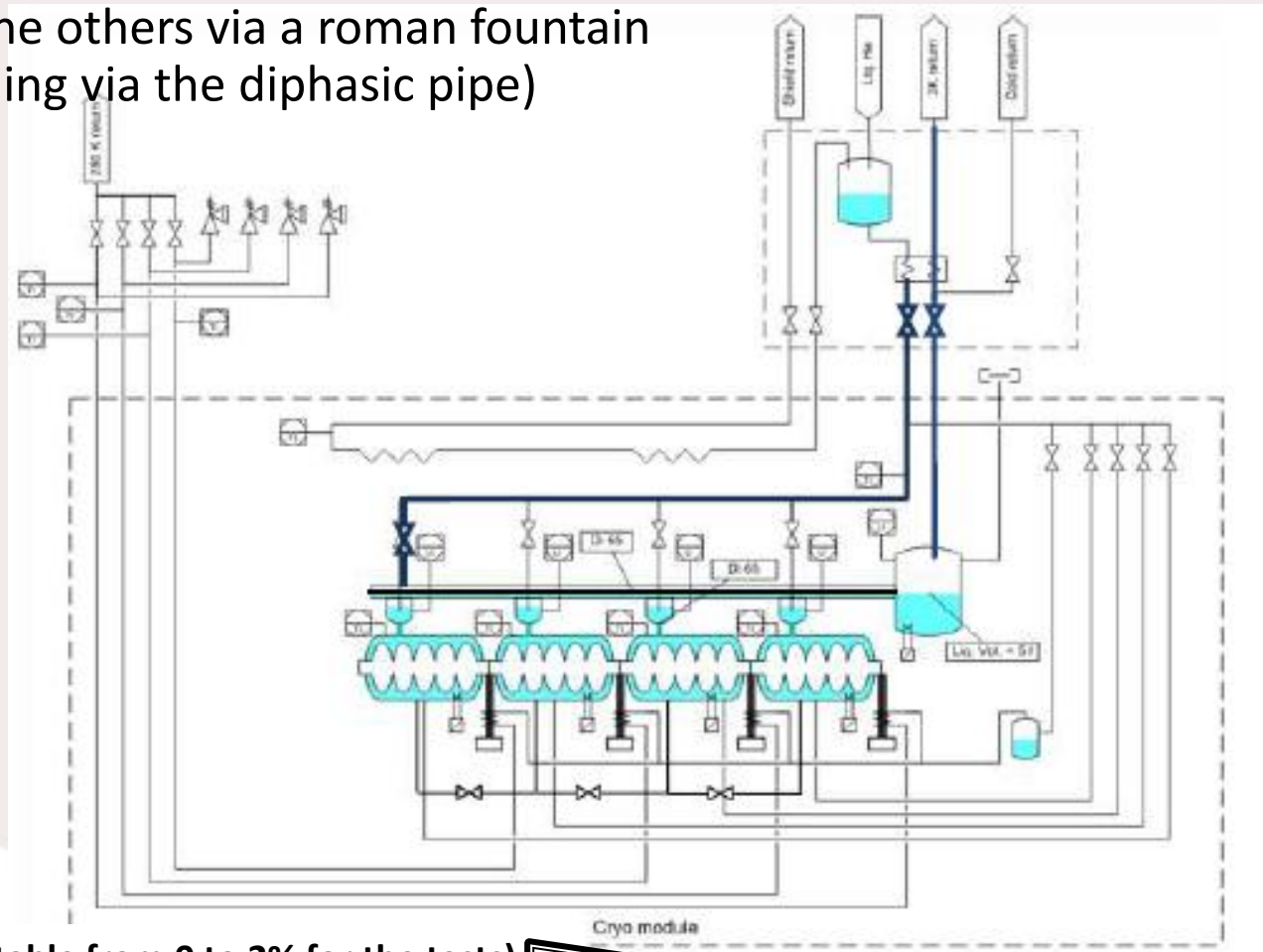
Weld, VCR connector



Filling lines

Requirements :

1 JT valve may allow for the filling of the first cavity
then for the filling of the others via a roman fountain
(successive cascade filling via the diphasic pipe)

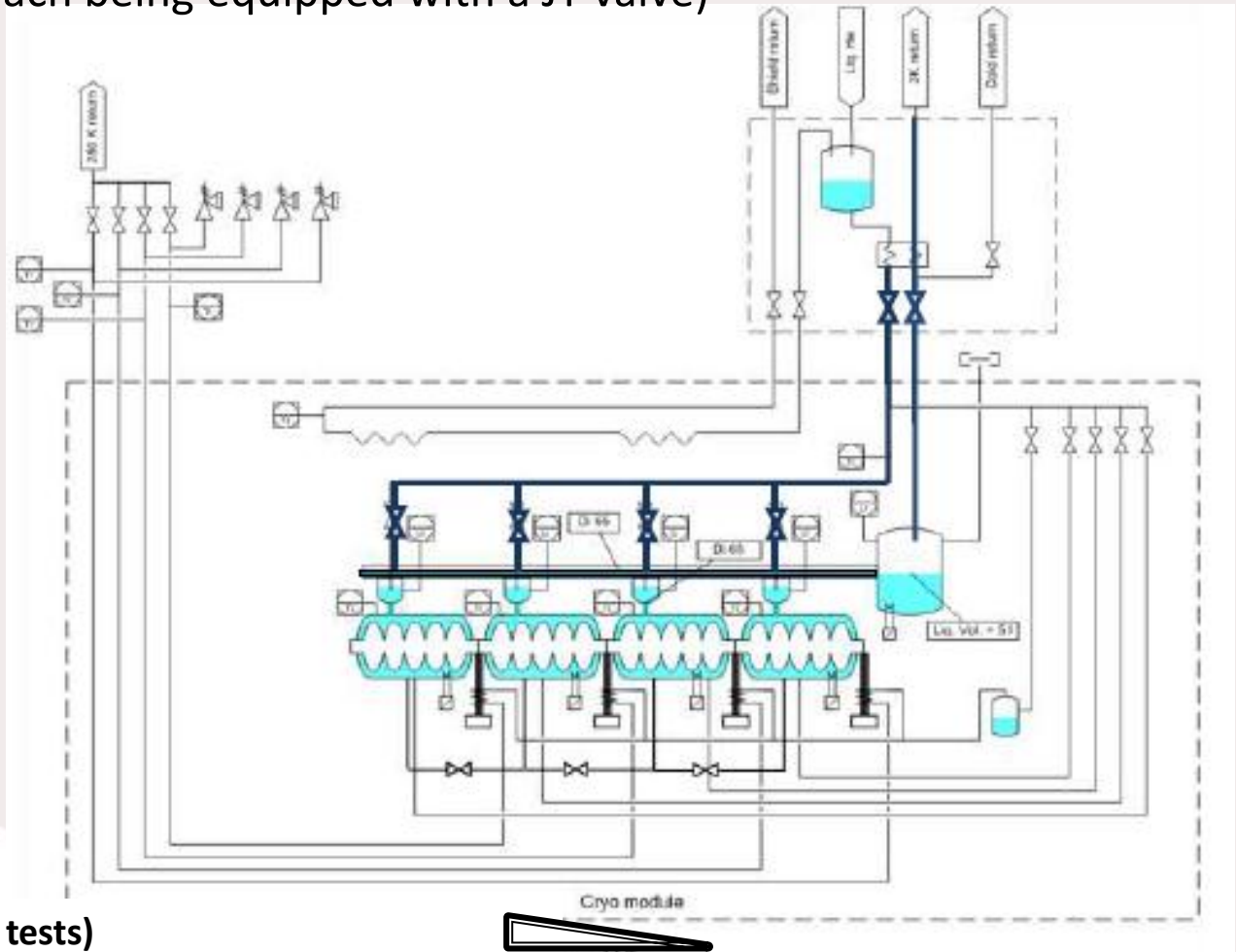


Slope : 1.7% (ajustable from 0 to 2% for the tests) 

Filling line

Requirements :

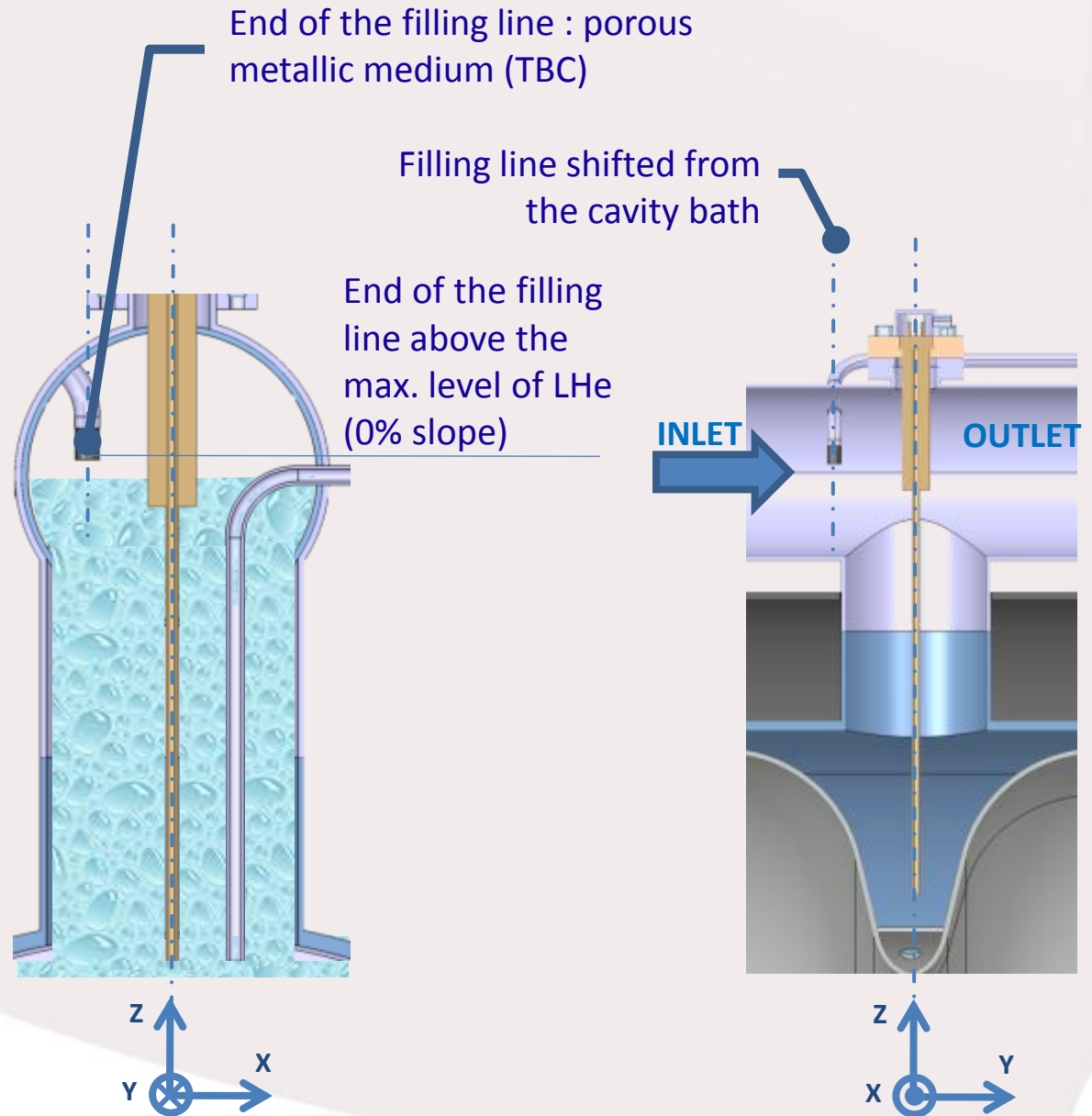
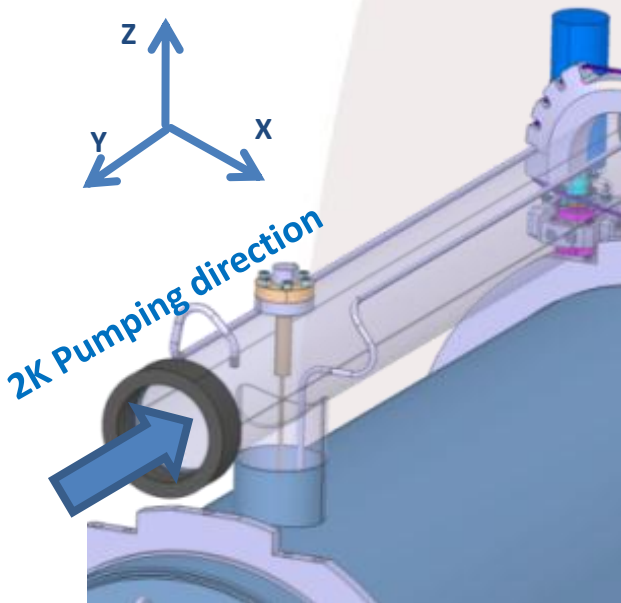
If slope = 0% or in case of a problem with the roman fountain (superfluid)
1 filling line per cavity (each being equipped with a JT valve)



Slope : (0% for the tests)

TECHNICAL ASPECTS

Filling line

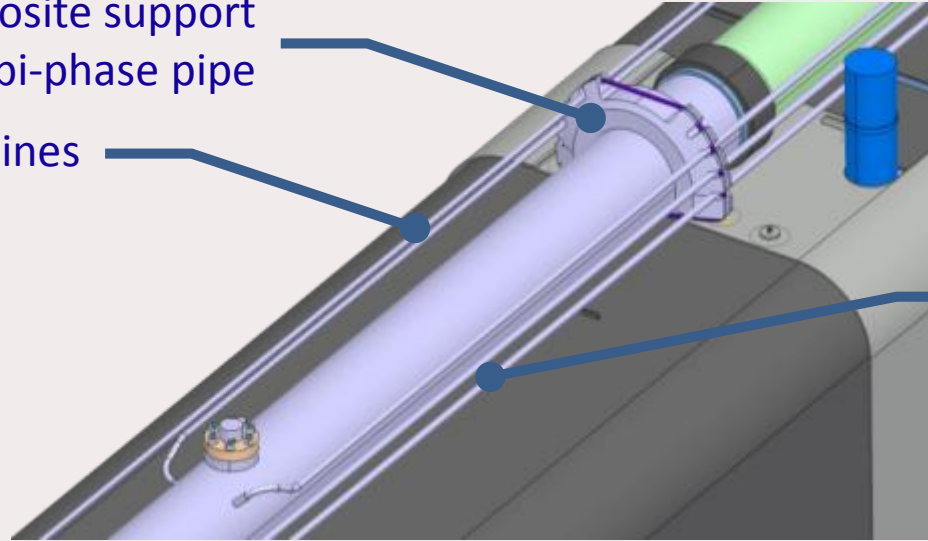


TECHNICAL ASPECTS

Lines routing

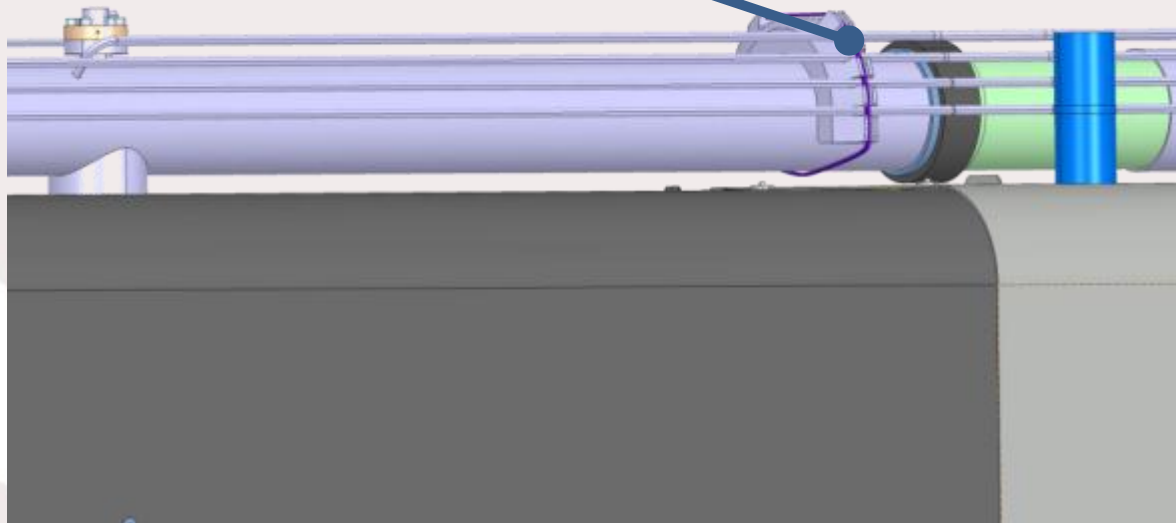
Composite support
on the bi-phase pipe

Cooling lines



Filling lines

Metal collar (LHC)



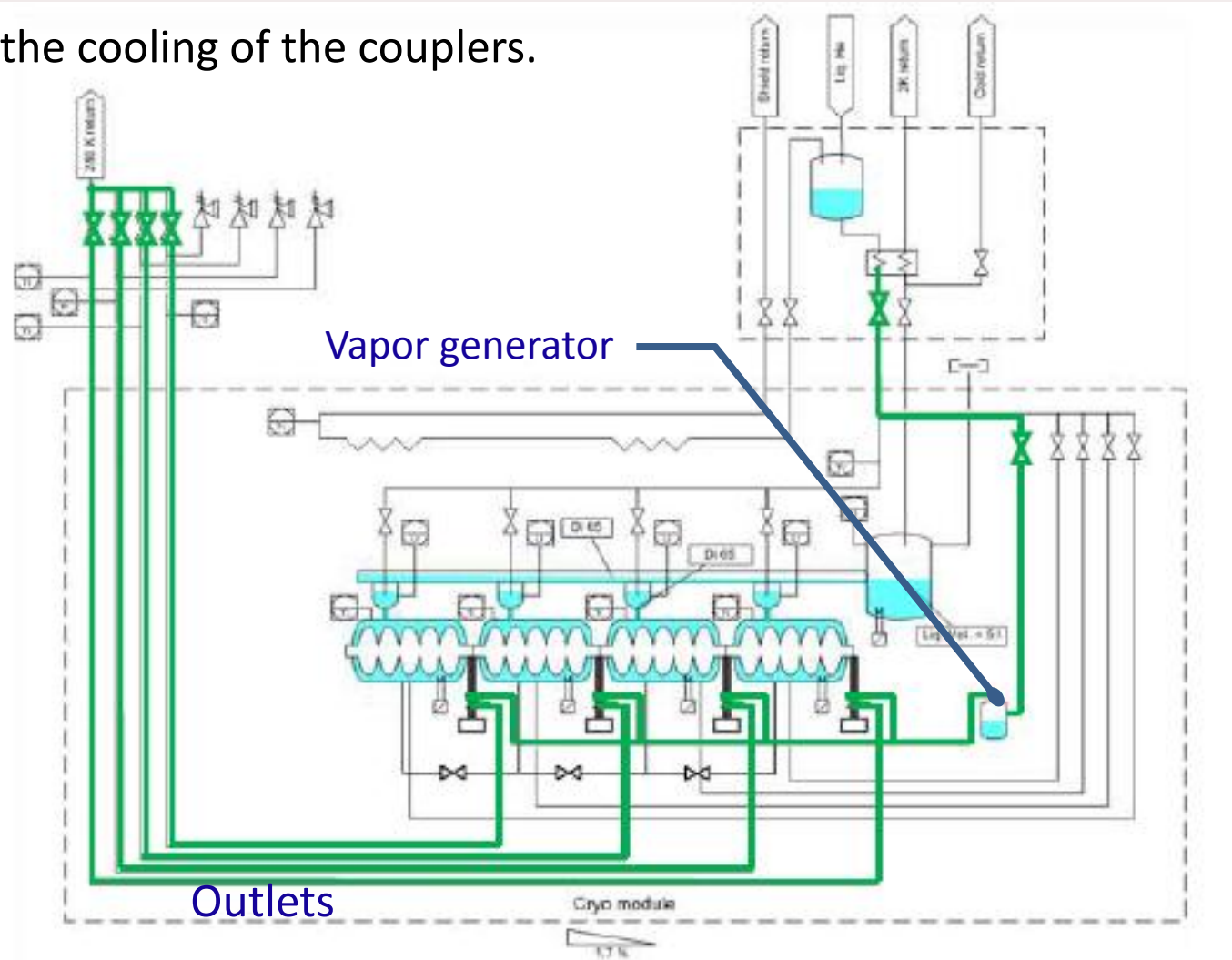
Coupler cooling line

Requirements :

One single line for the cooling of the couplers.

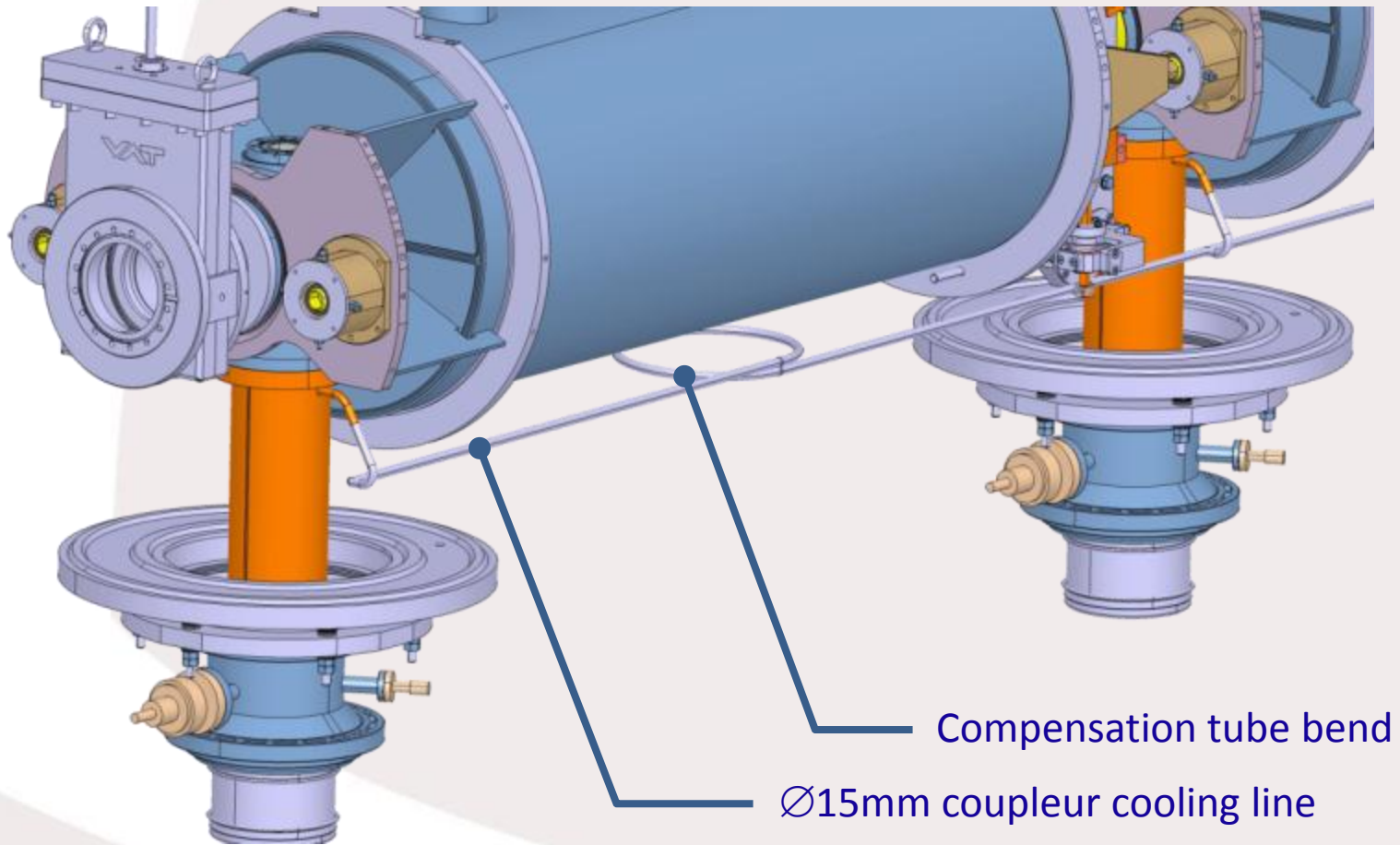
4 outlets @ 293K

1 vapor generator



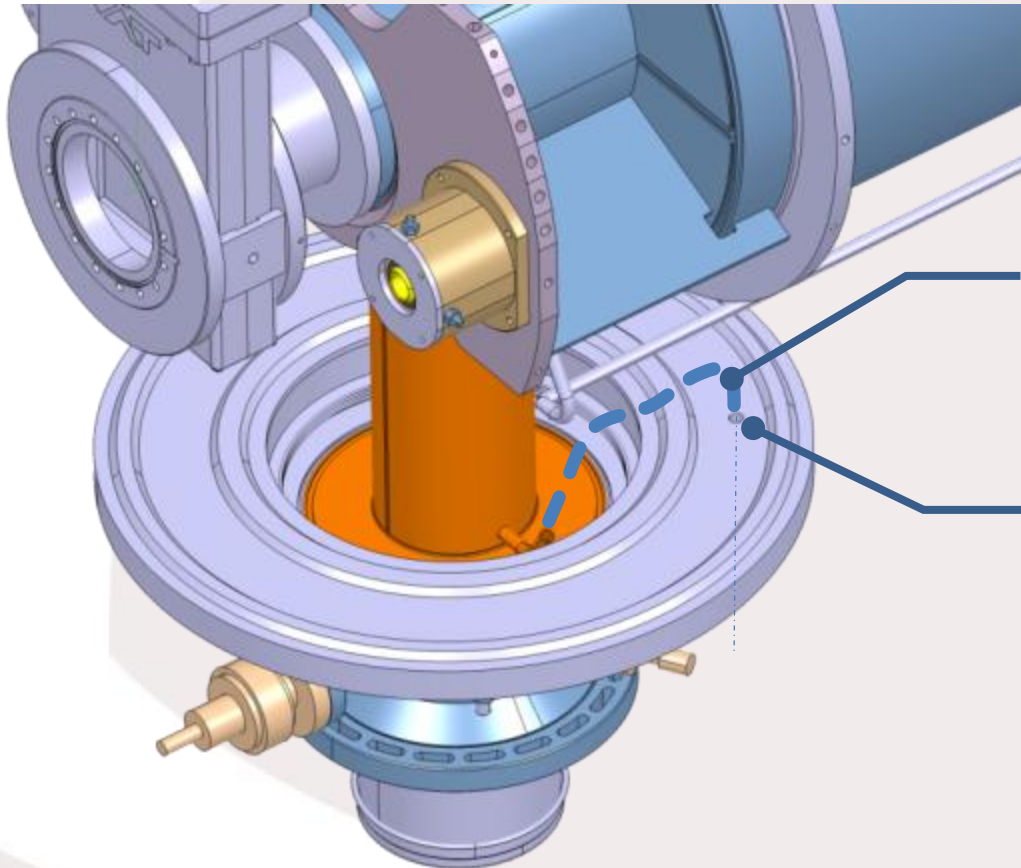
Coupler cooling line

Inlet line



Coupler cooling line

Outlet line



TBD:

Compensation tube bend
or flexible tube (pressure)

Interface with the sealing
flange of the vacuum vessel
bearing is defined (hole)

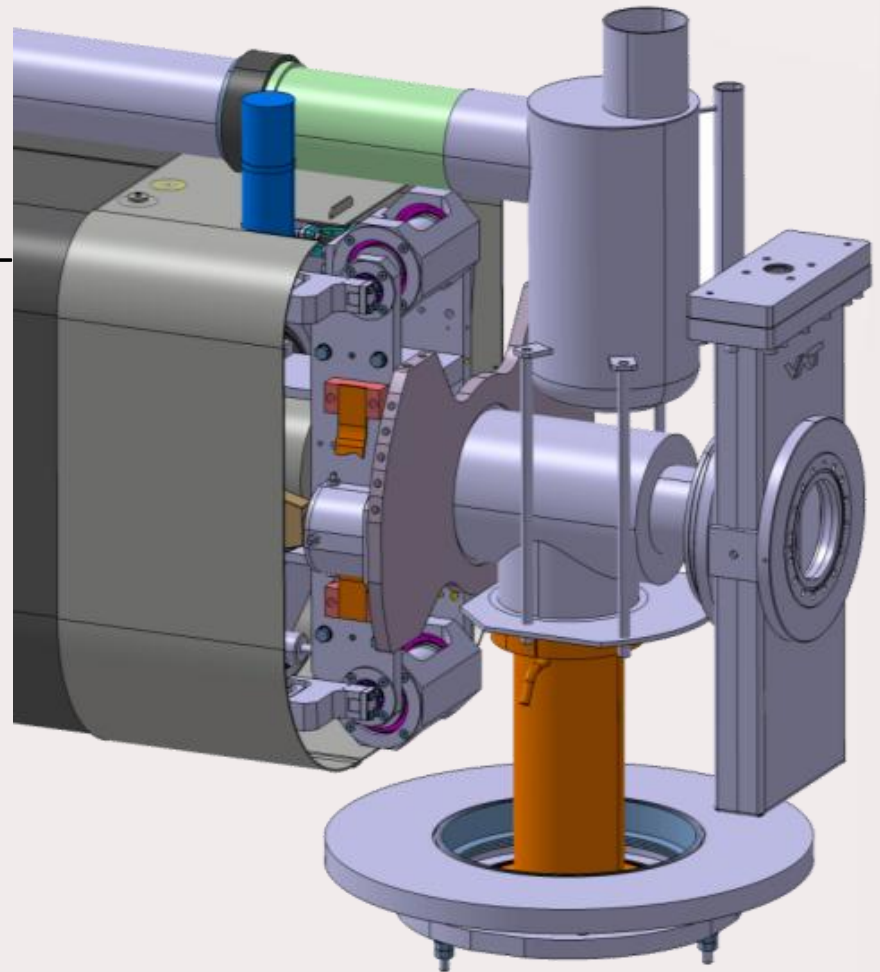
Phase separators

Concepts:

Integrated on the string of cavities during the dressing phase.

Supported on the complementary double-walled tube (last cavity pod)

⇒ Inserted during the cryostating



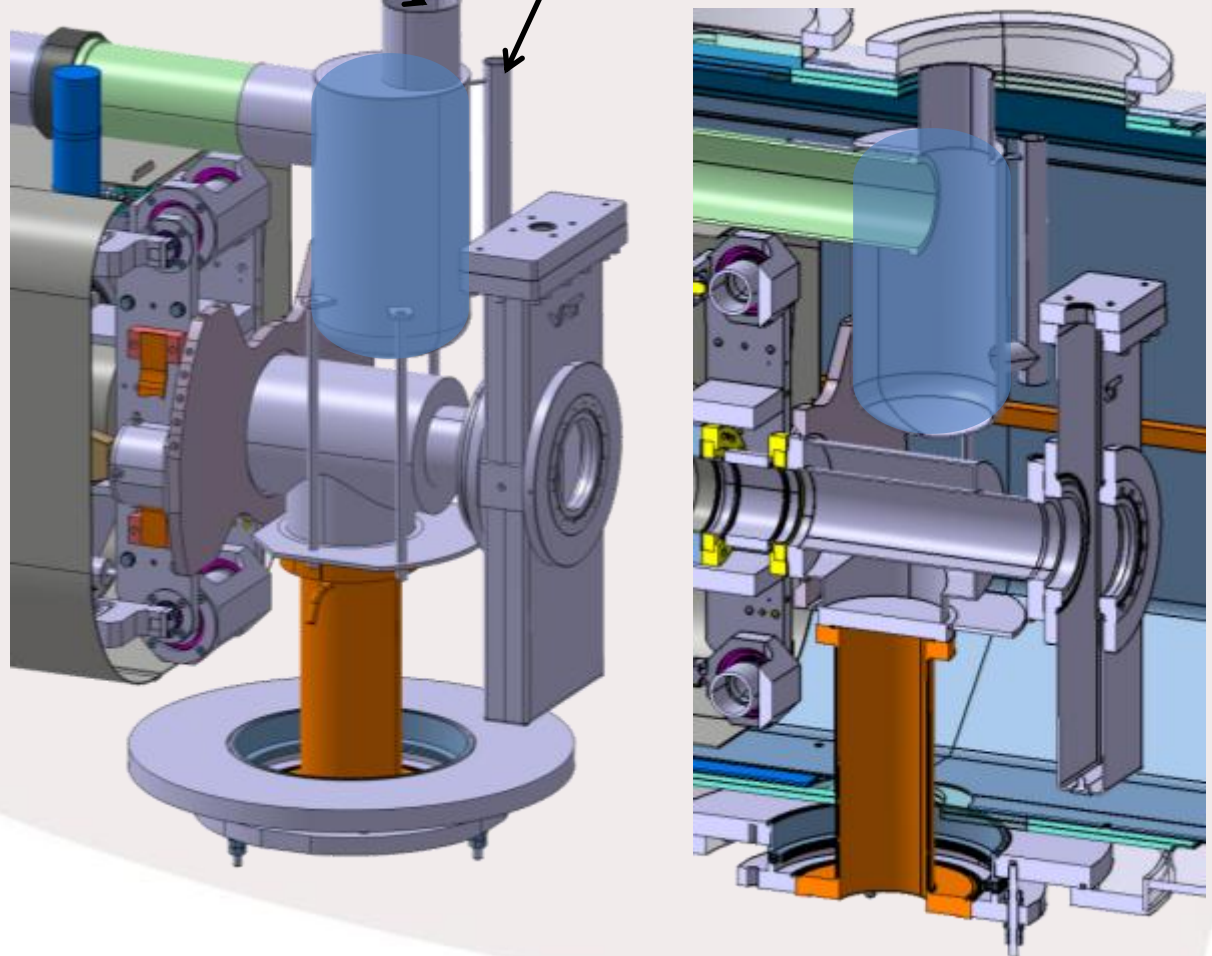
Phase separators

2K Phase separator

Volume: 5L

Pumping line
(2K mode)

Tube of the LHe
level gauge



Phase separators

Coupler Phase separator

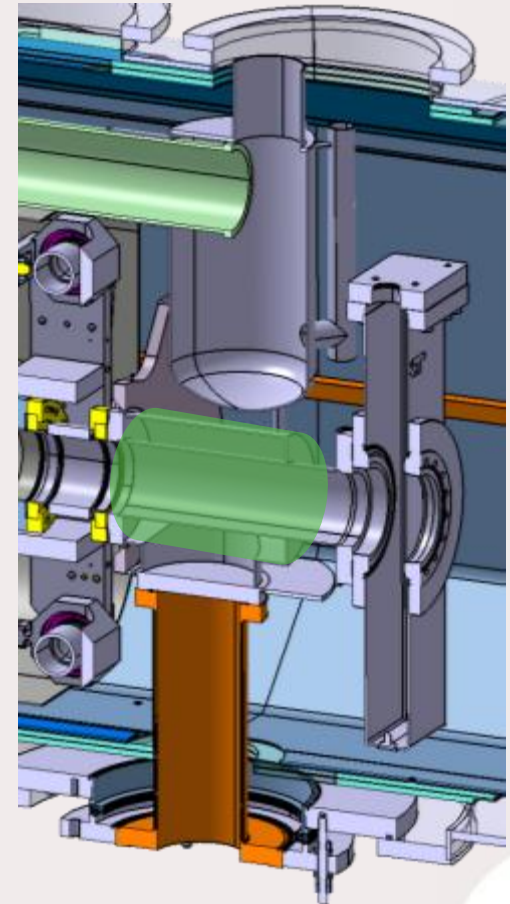
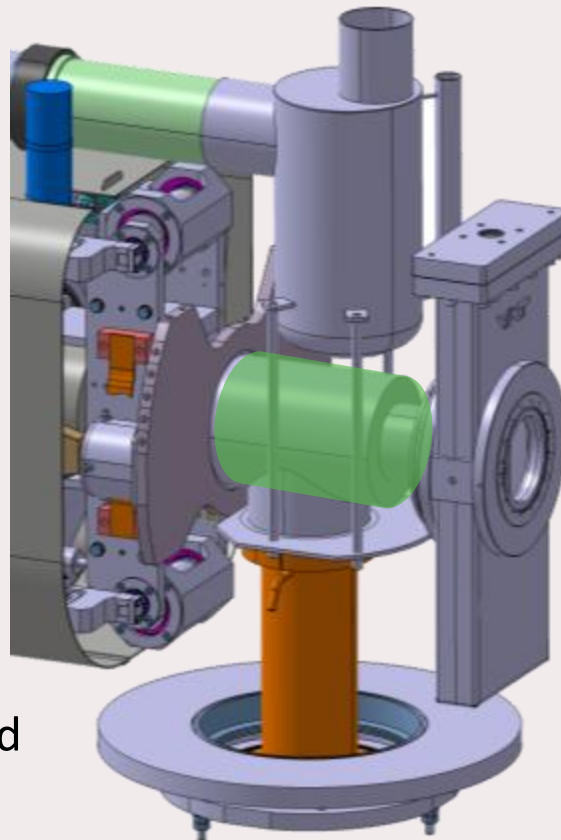
Volume: 1L; $T^\circ=4,5K$.

Positioned around the beam pipe

On the complementary support bi-tube.

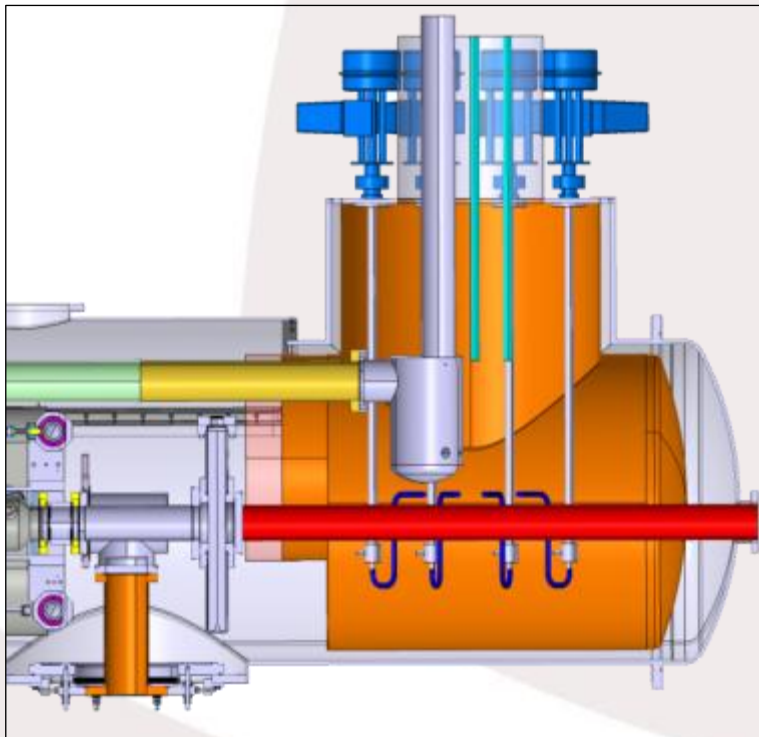
$T^\circ=4,5K > 2K$ will not affect the alignment ($\Delta L/L \ll 1$ for the double-walled tube)

NB: The double-walled tube will partially provide heat loss to generate helium vapor for the couplers cooling (0.1W).
(10W are required; heaters would be required for regulation - TBC)



Technical Service Module

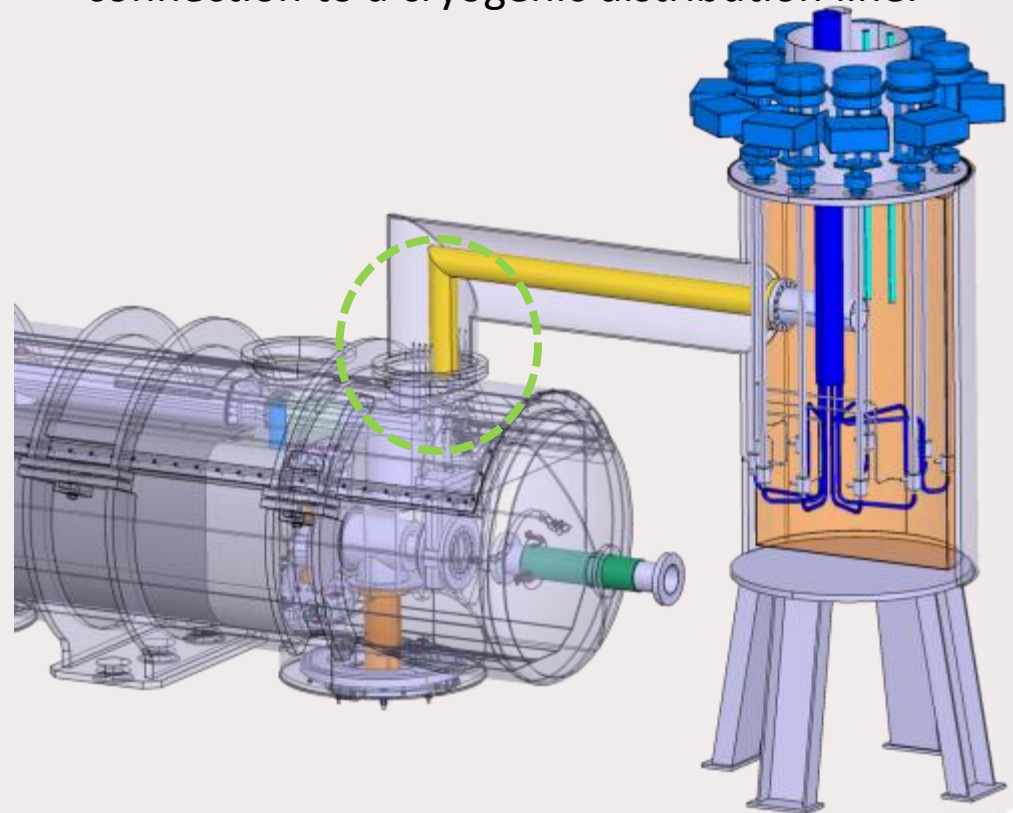
Technical Service Module
Including the cryogenic valves



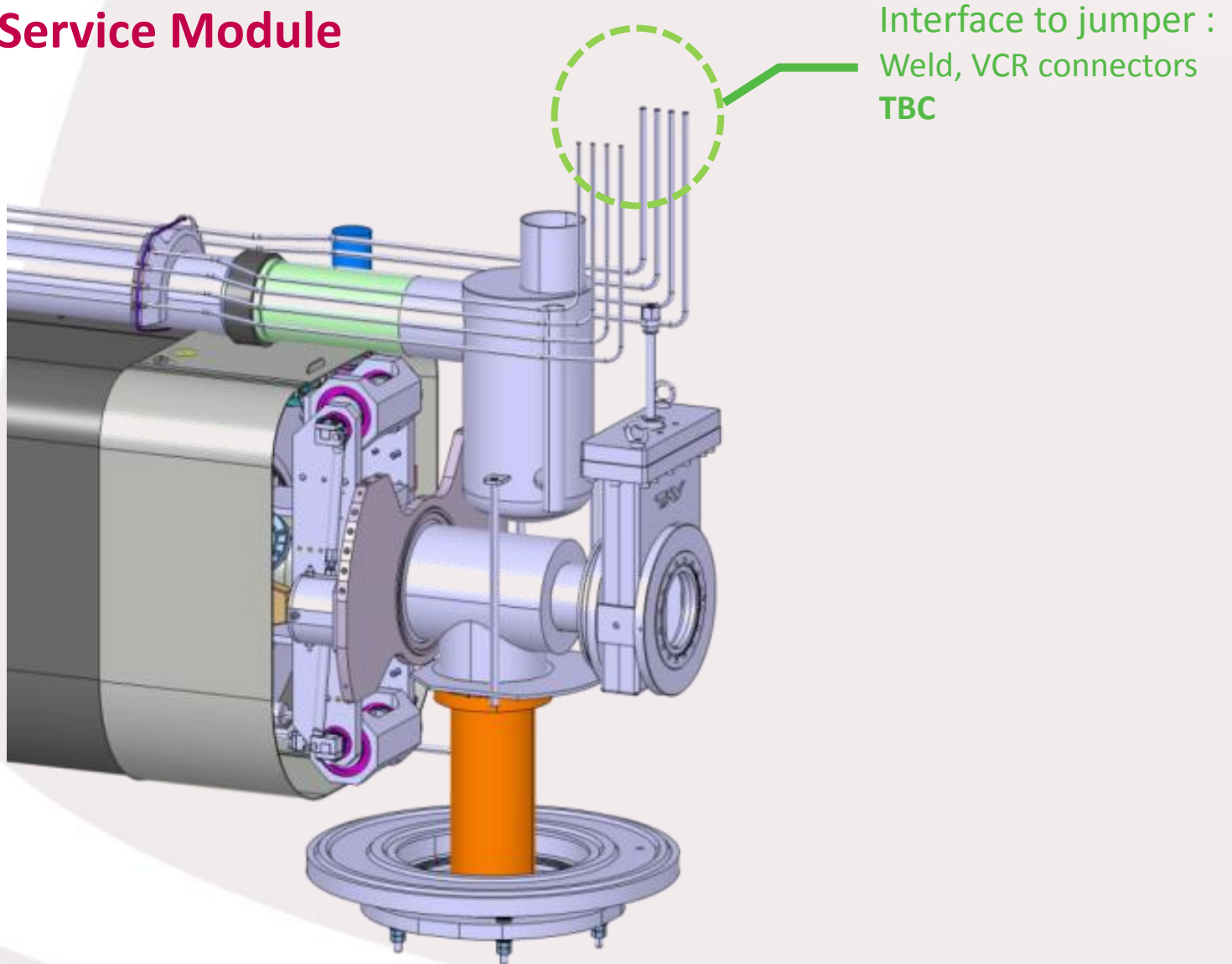
Proposed solution:

cryogenic valves are placed in a separated cold box

Connection via a jumper to simulate the connection to a cryogenic distribution line.



Technical Service Module



2K circuit

- One multi-interface port is proposed between the diphasic tube and the LHe tank of the cavity.
- It includes : one double LHe level gauge, one filling line, one cooling line.
- It allows the independent assembly and the tightness testing of the cryogenic distribution for 2K operations outside the clean room.
- The phase separator is part of this distribution and will be assembled on the string of cavities during the dressing phase and before cryostating.

Coupler cooling

- One single line is proposed for the cooling of all the couplers.
- The phase separator (vapor generator) would be integrated around the beam pipe.
- The interface between the outlets of this cooling with the coupler flange has to be defined.

Technical Service Module

- The Technical Service Module containing the two phase separators would included on the string of cavities and supported by the last double walled tube (complementary support pod).
- All the cryogenic valves may be placed in a cold box separated from the cromodule with a dedicated connection, simulating a cryogenic distribution line interface.

THANK YOU FOR YOUR ATTENTION

Unité mixte de
recherche
CNRS-IN2P3
Université Paris-Sud 11

91406 Orsay cedex
Tél. : +33 1 69 15 73 40
Fax : +33 1 69 15 64 70
<http://ipnweb.in2p3.fr>