

LHCb UT & Velo CO₂ transfer lines sizing – new flow values

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Operational parameters

data from LHCb cooling meeting on October 13th, 2016

<https://indico.cern.ch/event/568964/>

		UT 1/2	Velo 1/2	Main lines
Flow	g/s	28.8	15.6	89
By-pass flow @ detector	g/s	0	0.4	0.8
Flow used * calculations	g/s	28.8	16	89.6
Power	W	2500	1040	7080
Enthalpy heater power	W	100	100	0
Power * calc	W	2860	1254	9051
OD inlet	mm	8	6	10
Thickness	mm	1	1	1
ID inlet	mm	6	4	8
OD return	mm	18	12	26.7
Thickness	mm	1.5	1	2.87
ID return	mm	15	10	20.96
Length	m	11	4.5	55
Volume				
Volume liquid	l	0.3	0.1	2.8
Volume gas	l	1.4	0.2	14.7
Volume total	l	1.7	0.3	17.4
Volume after JB	l	3.1		
Total volume	l	20.5		

Flow always in by-pass at the detector level

Total flow in main lines = sum of both detector max needs (including local by-pass)

includes 10% margin on each detector + 10% on total power

For each detector max flow & max power are considered
 0.9 g/s for UT staves – 5 kW
 0.6 g/s for each Velo module – 2 kW

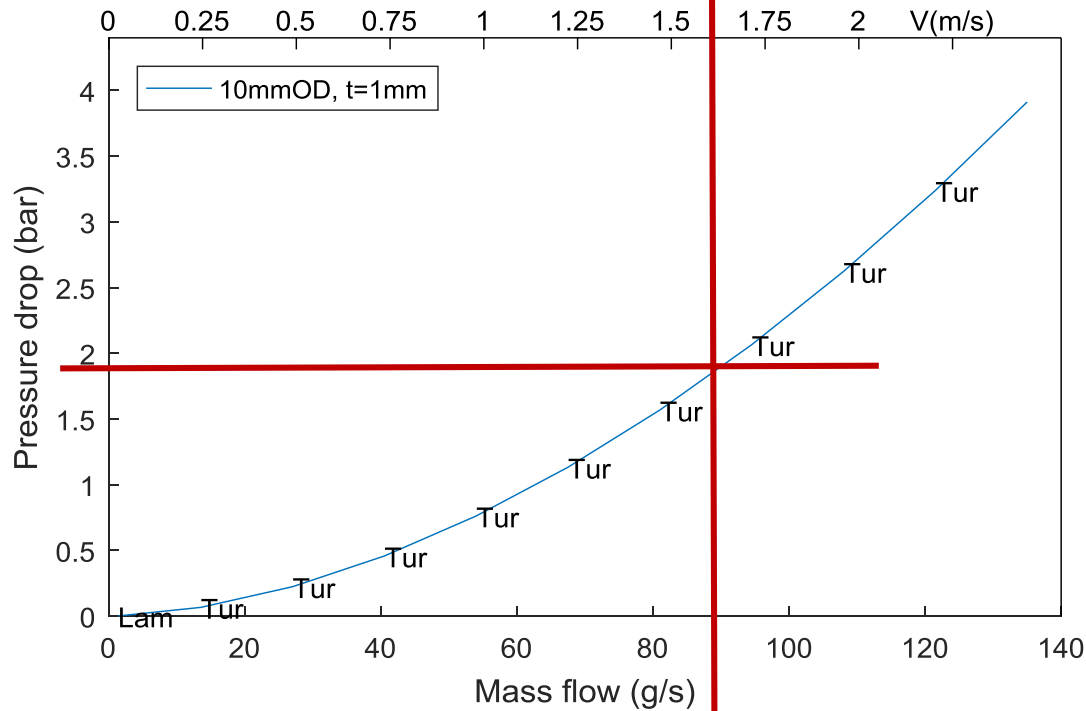
2* Velo transfer lines volume + 1.5* UT transfer line volume
 (one branch is 2 times the length of the other)

Main transfer lines @ -35 C

max flow and power conditions

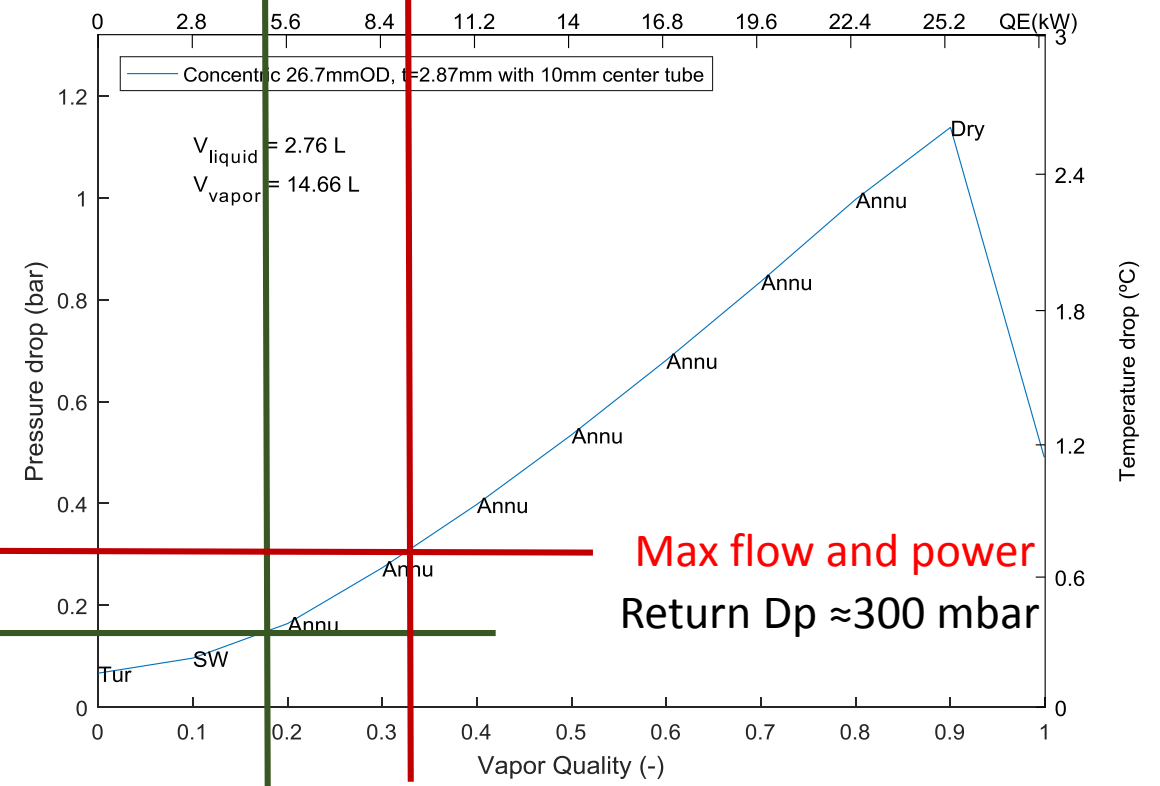
Liquid pressure drop of a LHCb liquid line

Fluid=CO₂, T=-35 °C, Length=55 m, Angle=0°, Roughness=0 mu, Po=10 bar



2-phase pressure drop of a LHCb vapor line

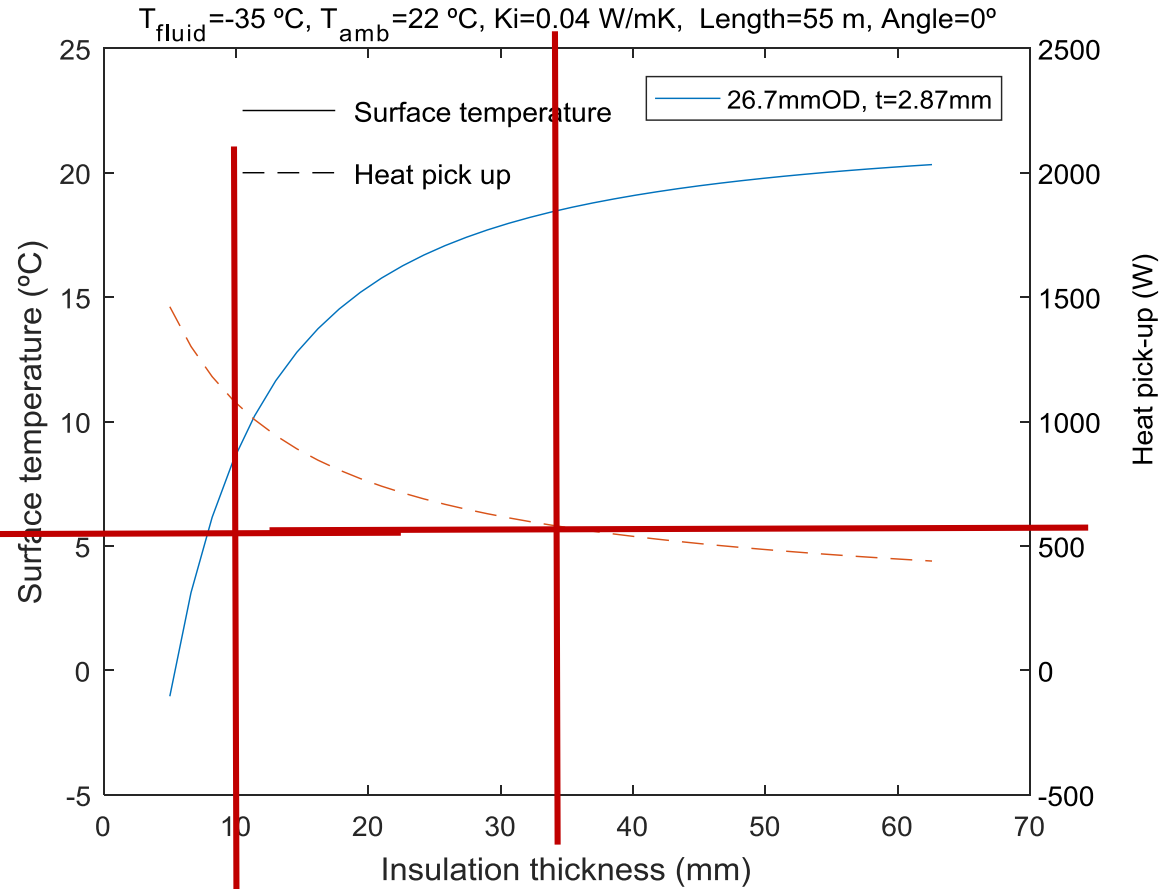
Fluid=CO₂, MF=90 g/s, MFLX=338 kg/m²*s, T=-35 °C, Length=55 m, Angle=0°



Max power for UT only
Return Dp ≈180 mbar

Max flow and power
Return Dp ≈300 mbar

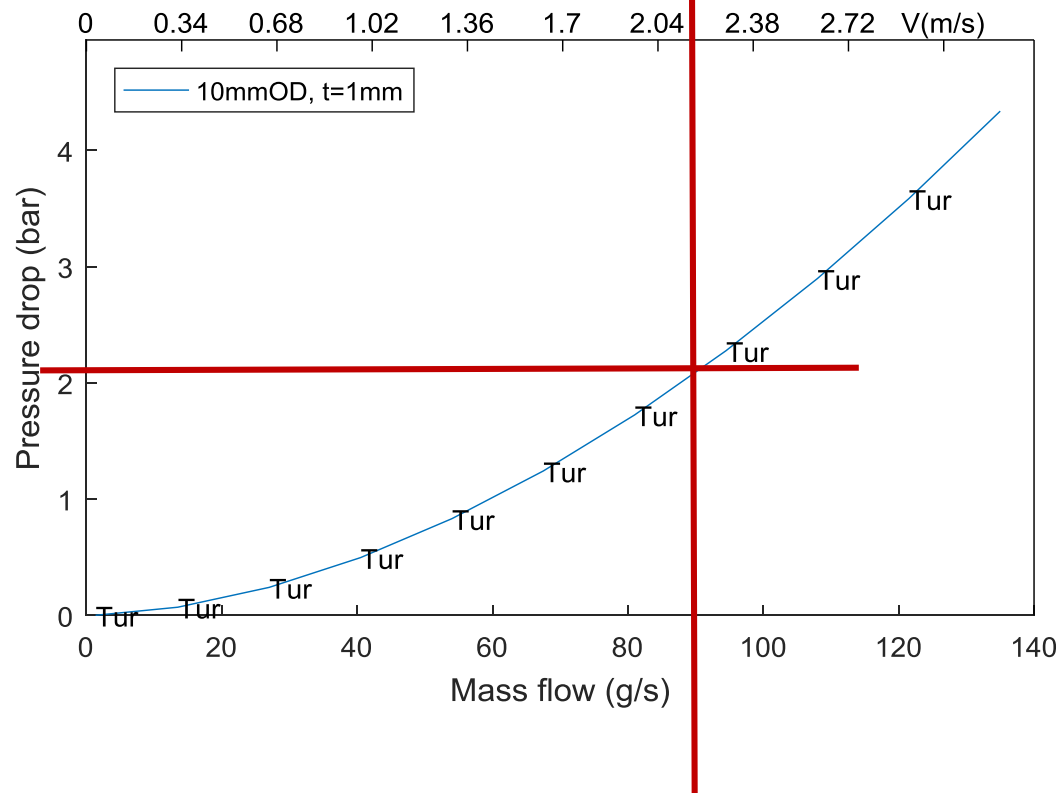
Heat pickup -35 C



Main transfer lines @ +15 C

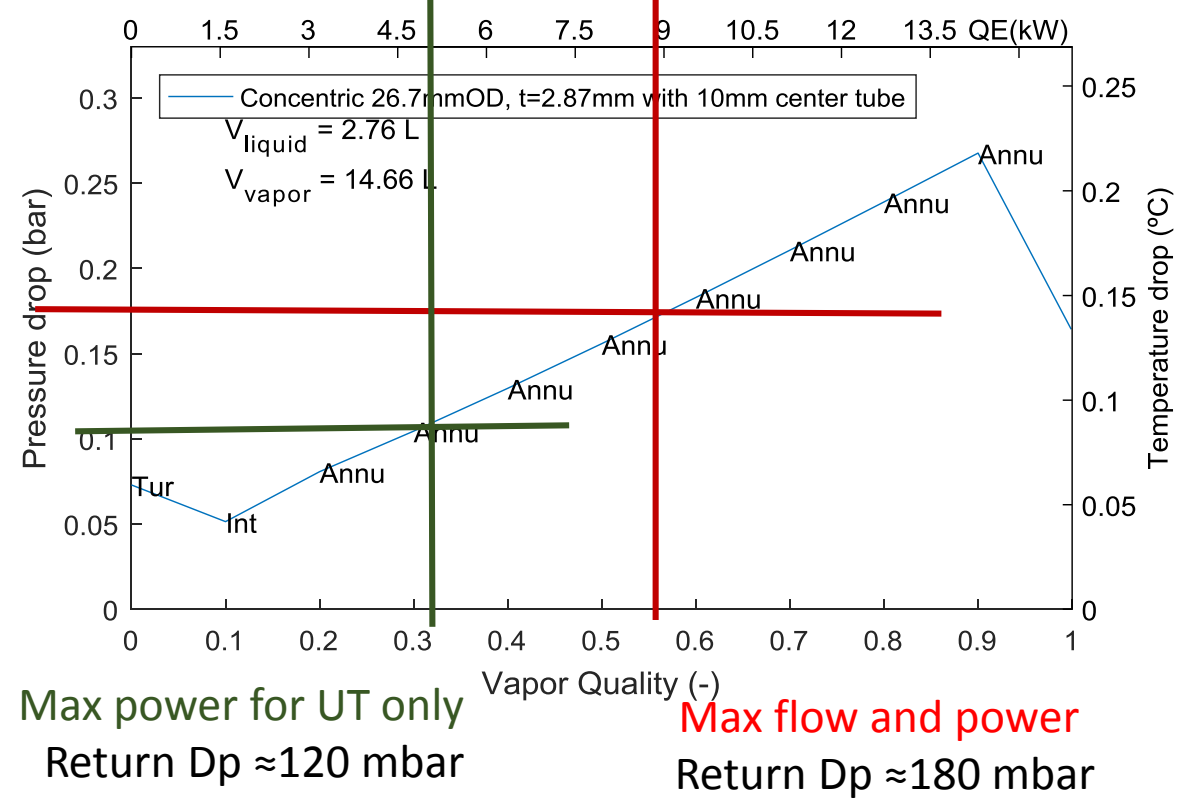
Liquid pressure drop of a LHCb liquid line

Fluid=CO₂, T=15 °C, Length=55 m, Angle=0°, Roughness=0 mu, Po=10 bar



2-phase pressure drop of a LHCb vapor line

Fluid=CO₂, MF=90 g/s, MFLX=338 kg/m²*s, T=15 °C, Length=55 m, Angle=0°



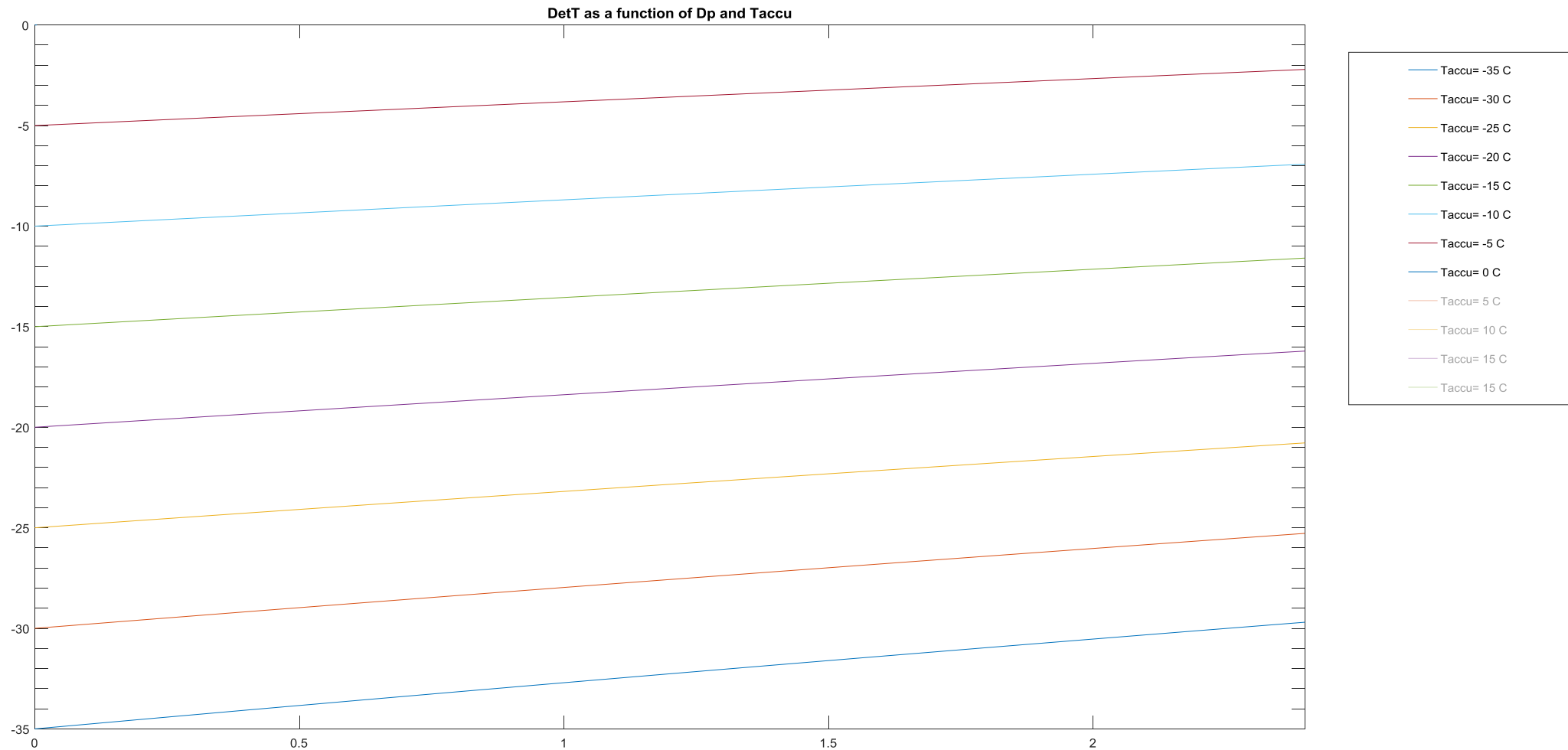
Summary of valves on the two plants & junction box

	Valve P&I reference	Qty x1 system	Qty for 2 systems	Liquid or gas	Flow rate	Valve proposed	Cv	Dp @-40	Dp @ 10	
Transfer lines	PV1008, PV3010		2	4L		1008UW		1.2	109	141
Junction box	PV3814		1	2L		1008UW		1.2	109	141
Junction box	By pass PV3010		1	1L		808UW		1.2	69	90
Junction box	PV3A14, PV3C14		2	4L		508UW		1.2	27	35
Transfer lines	PV1008, PV3010		2	4L		100 HP9008		1.02	150	195
Junction box	PV3814		1	2L		100 HP9008		1.02	150	195
Junction box	By pass PV3010		1	1L		80 HP9008		1.02	96	125
Junction box	PV3A14, PV3C14		2	4L		50 HP9008		1.02	38	49
Plant	PV1H56, PV1G56, PV1052		3	6L		150 HP9012		1.9	97	126
Transfer lines	PV1040, PV3036		2	4G		80 HP9012		1.9	600	300
Junction box	By pass PV3036		1	1G		80 HP9012		1.9	600	300

baseline	8UW	11
backup	HP9008	11
decided	HP9012	11 (tested @ -25 and +15 with 80 g/s and 7 kW load)

P&ID reference [link](#)

Effects of D_p on return line on the detector evaporation T



Summary of limits

- The pressure drops on the return line are driving the minimum evaporating T that can be reached at the exit of the detector
- The pressure drop on the return line from the detector to the accumulator are due to the transfer lines and to the valves along this path
- Transfer line contribution is about (by calculation) 0.3 bar when in backup mode (full flow and full power – 90 g/s & 7 kW). When operating one detector only on that flow we reduce Dp to about 120 mbar
- Valve contribution may go up 600 mbar in worst case, lowers to 300 mbar in single detector operation (*2 for two valves in series)
- The total of 1.5 bar Dp on the return lines translates into 3 C delta T at low T. – Effect can be further mitigated by a choice of a bigger valve and maintained down to about 2 C.

References

Transfer lines lengths by O. Jamet – 25 May 2016

53060 mm from the alcove to the box
52800 mm from the alcove to the box

4180 mm from the box to the velo
4050 mm from the box to the velo

10800 mm from the box to UT
5000 mm from the box to UT

