HL-LHC
Operation scenario/constraints in case new P1/P5 Cryogenic system is down

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P. Fessia for MS optimisation study

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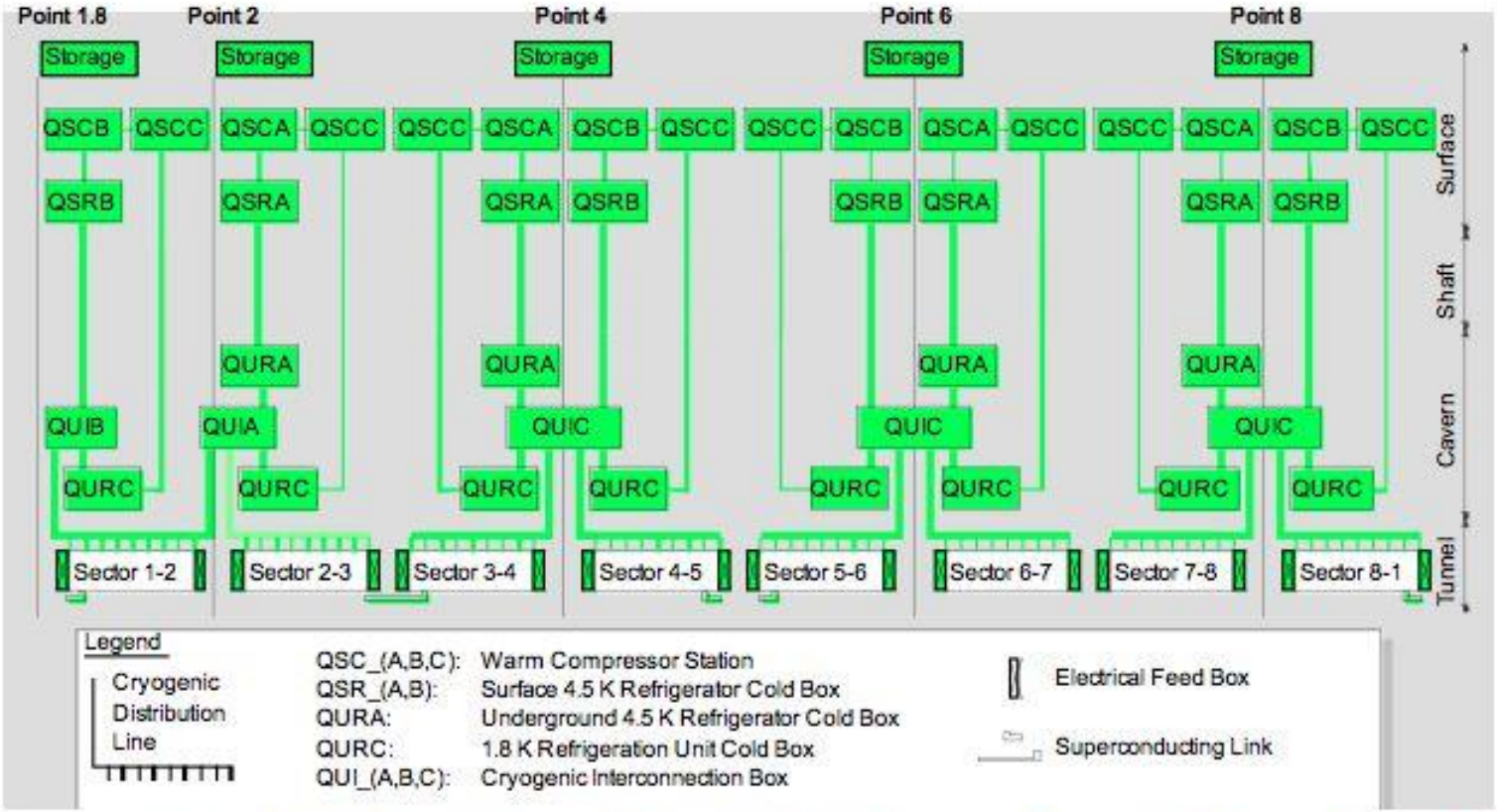
LHC Cryogenics architecture



Large variety of configuration, with provision to use 1 cryoplant on 2 sectors for helium management and up to "low intensity" physics

Identified modes were: Installed – Nominal – Low intensity – Injection stand-by – 75K stand-by

Possible modes identified so far for HiLumi

Decreasing requirements in cooling capacity

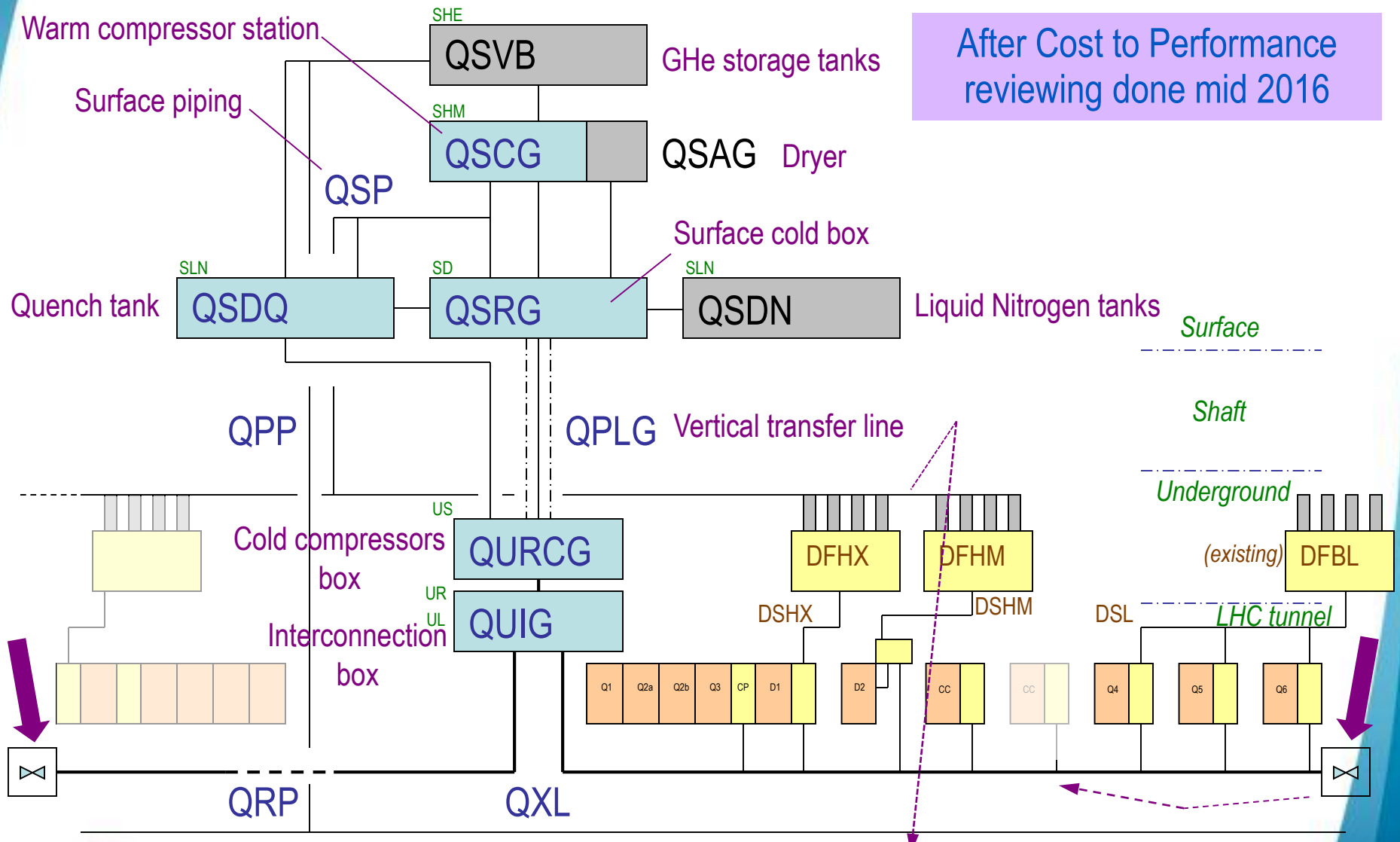
- Ultimate Luminosity (HL)
- Nominal Luminosity (HL)
- Nominal Luminosity (LHC)
- Low Luminosity / Intensity
- Powering conditions to 7TeV, *(maybe pilots or few bunches)*
- Injection stand-by (He preservation in magnets, ELQA) *(maybe pilots or few bunches at injection)*
- Magnets @20K

=> What could be achieved under which conditions if P1/P5 cryogenics would be down (Cryo cause or other origin)

=> Fall back solution considered so far: connection to existing Cryoplant/QRL of adjacent sector

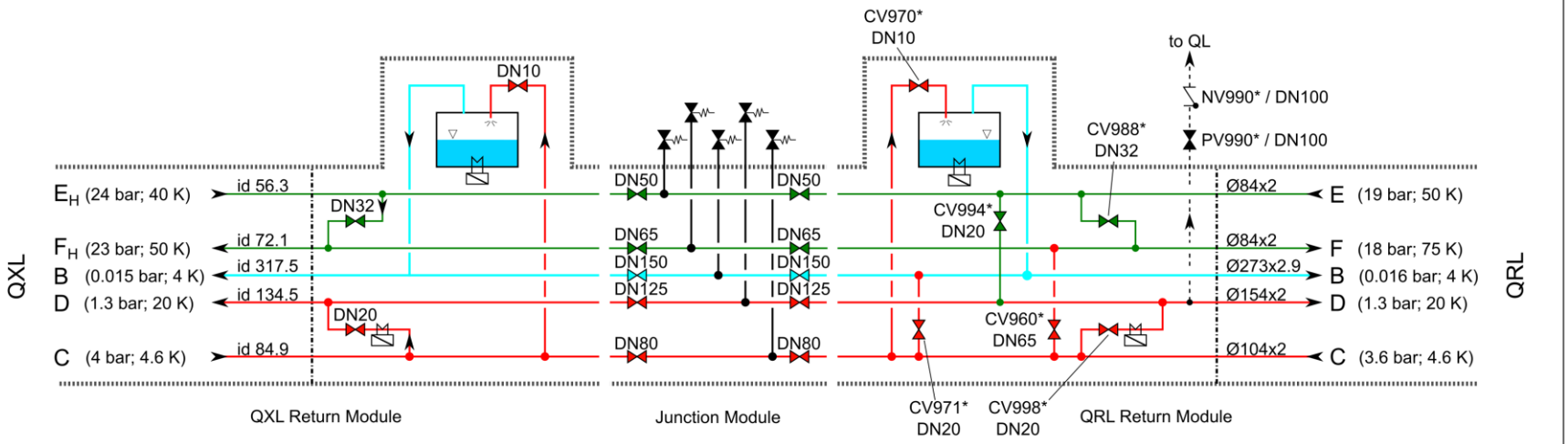
P1/P5 Cryogenic architecture

18 kW equivalent at 4.5 K, including 3 kW at 1.8 K



After Cost to Performance reviewing done mid 2016

Junction module QRL-QXL



LSS R5

slope

* valve naming according to P&ID of MS3 left (LHCLSQR_0039) and Air Liquide return module QRLIC dwg (c1105h001)

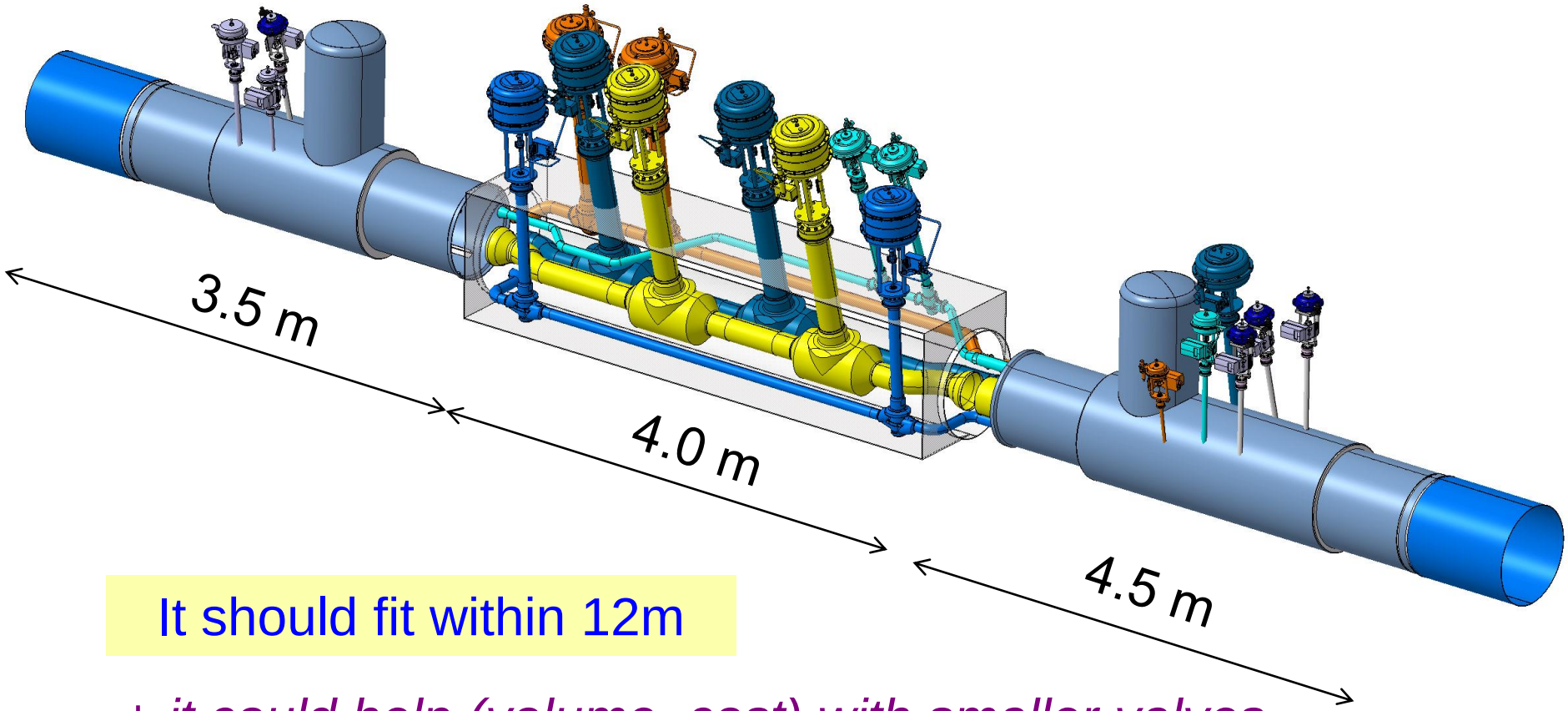
LEGEND

- Electrical Heater
- Non-return valve
- Valve
- LHe 4.5 K
- Vacuum barrier
- Vacuum cryostat

PFD HL-LHC QXL-QRL Junction module @ R5_v.1- EDMS # 1996393 - M.Sisti

Junction module QRL-QXL

Work on-going

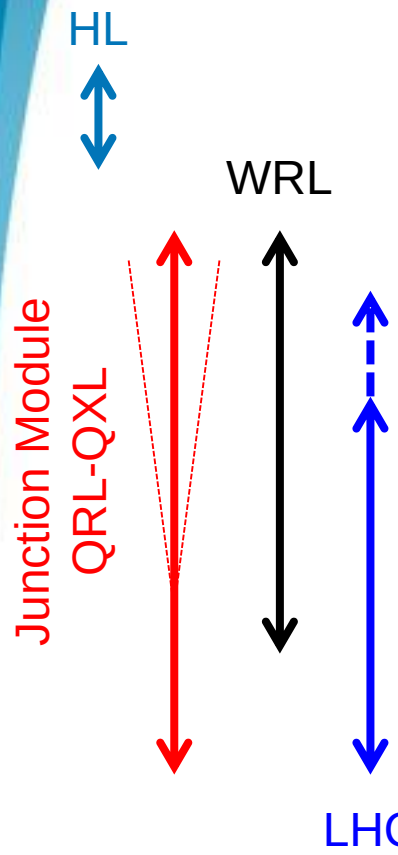


It should fit within 12m

+ it could help (volume, cost) with smaller valves, especially in case this element could be a show stopper !!!

Possible modes and implications, as identified so far for HiLumi

Decreasing requirements in cooling capacity



- Ultimate Luminosity (HL)
- Nominal Luminosity (HL)
- Nominal Luminosity (LHC)
- Low Luminosity / Intensity

. Powering conditions to 7TeV, *(maybe pilots or few bunches)*

- Injection stand-by (He preservation in magnets, ELQA, maybe pilots or few bunches at injection)
- Magnets @20K

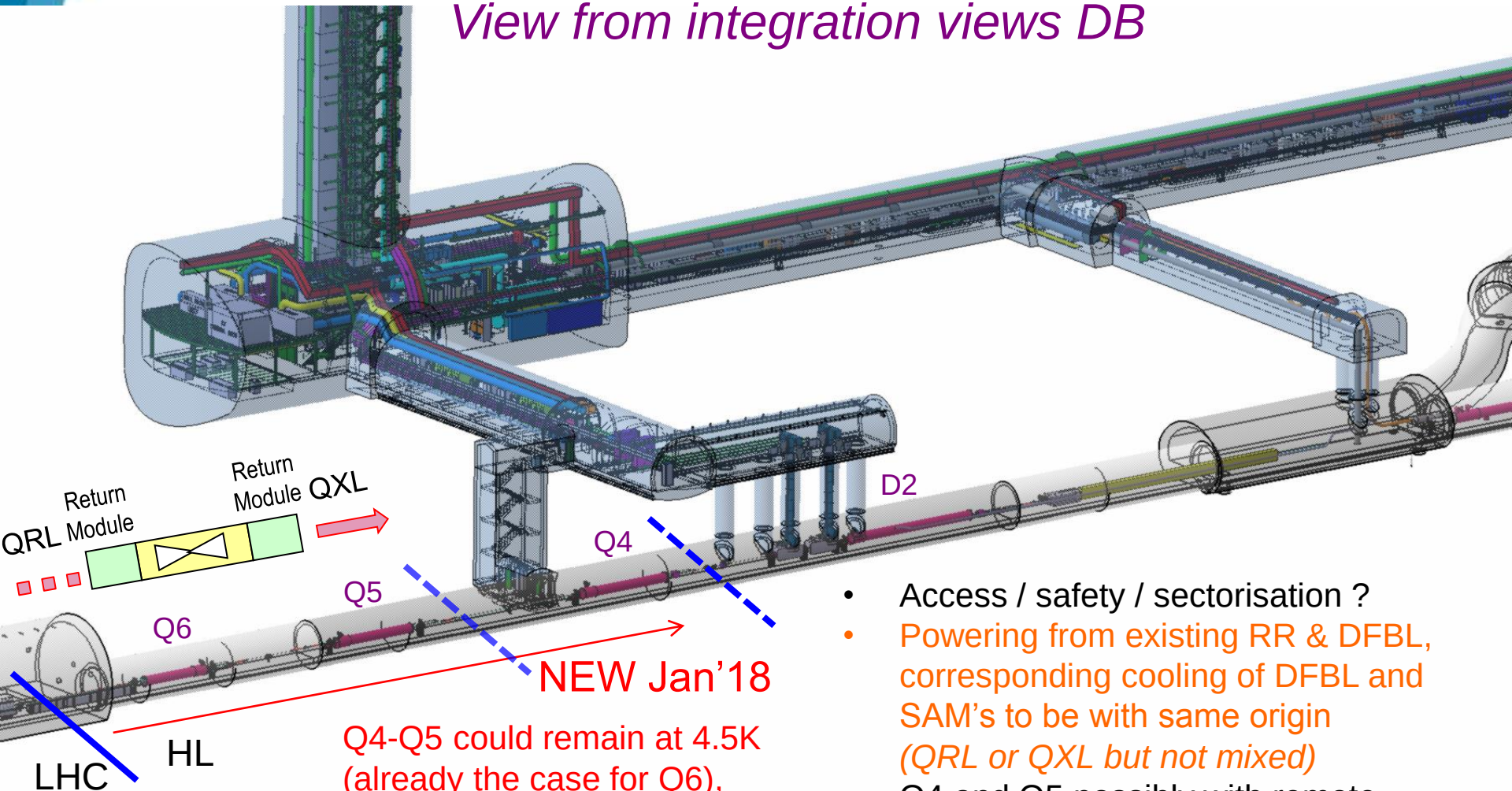
- Any global approach defined so far ?
- Other systems concerned ?

=> Junction Module AND bridge between WRL's recommended

=> Corresponding cooling capacities and impact on size/cost/volume to be further investigated

Cooling P1/P5 SAM's

View from integration views DB



- Access / safety / sectorisation ?
- Powering from existing RR & DFBL, corresponding cooling of DFBL and SAM's to be with same origin *(QRL or QXL but not mixed)*
- Q4 and Q5 possibly with remote alignment, compatible with QRL ?
- 3D models to be implemented and then integrated (Q2-2018 for CRG)

Summary

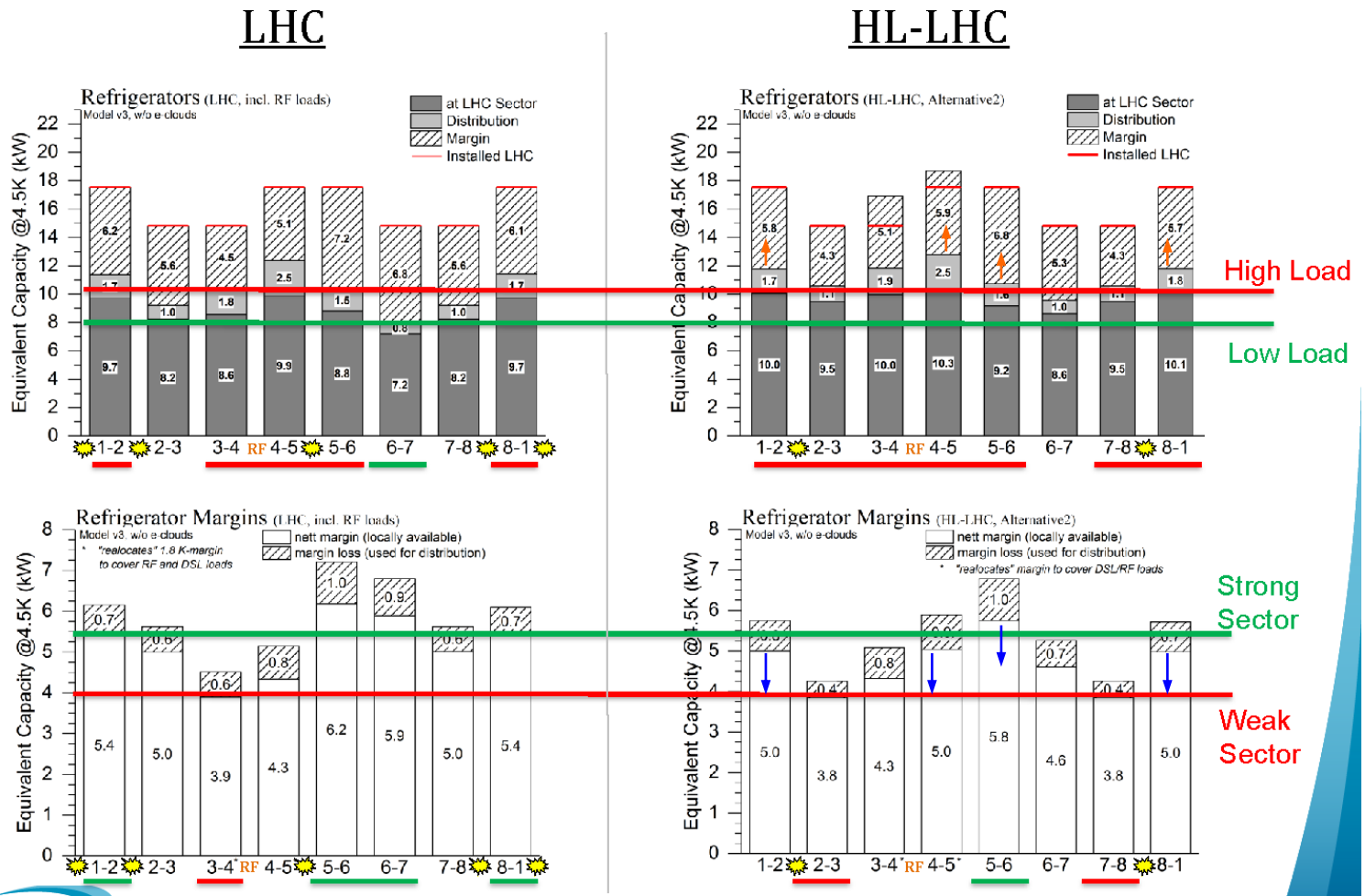
- Cooling capacity of matching section could be taken by main sector cryoplants without creating a weak point
- It should be possible to re-work 70m/side of existing QRL elements, with service modules not changed and pipe elements kept or adapted
- About 12m would be required for the junction module QRL-QXL between Q4 and crab cavities
- The use of remote alignment should be taken without problem by existing QRL elements (provided it remains within existing tolerances)

Cooling capacity

w/o e-clouds!

Refrigerator Assessment

Results based on *model v.3,* for existing LHC refrigerators only



Cooling capacity for SAM's & DFBL to come from main sector Refrigerators

Cooling capacity margins will be aligned on other sectors *(56 higher as no IT nor RF)*

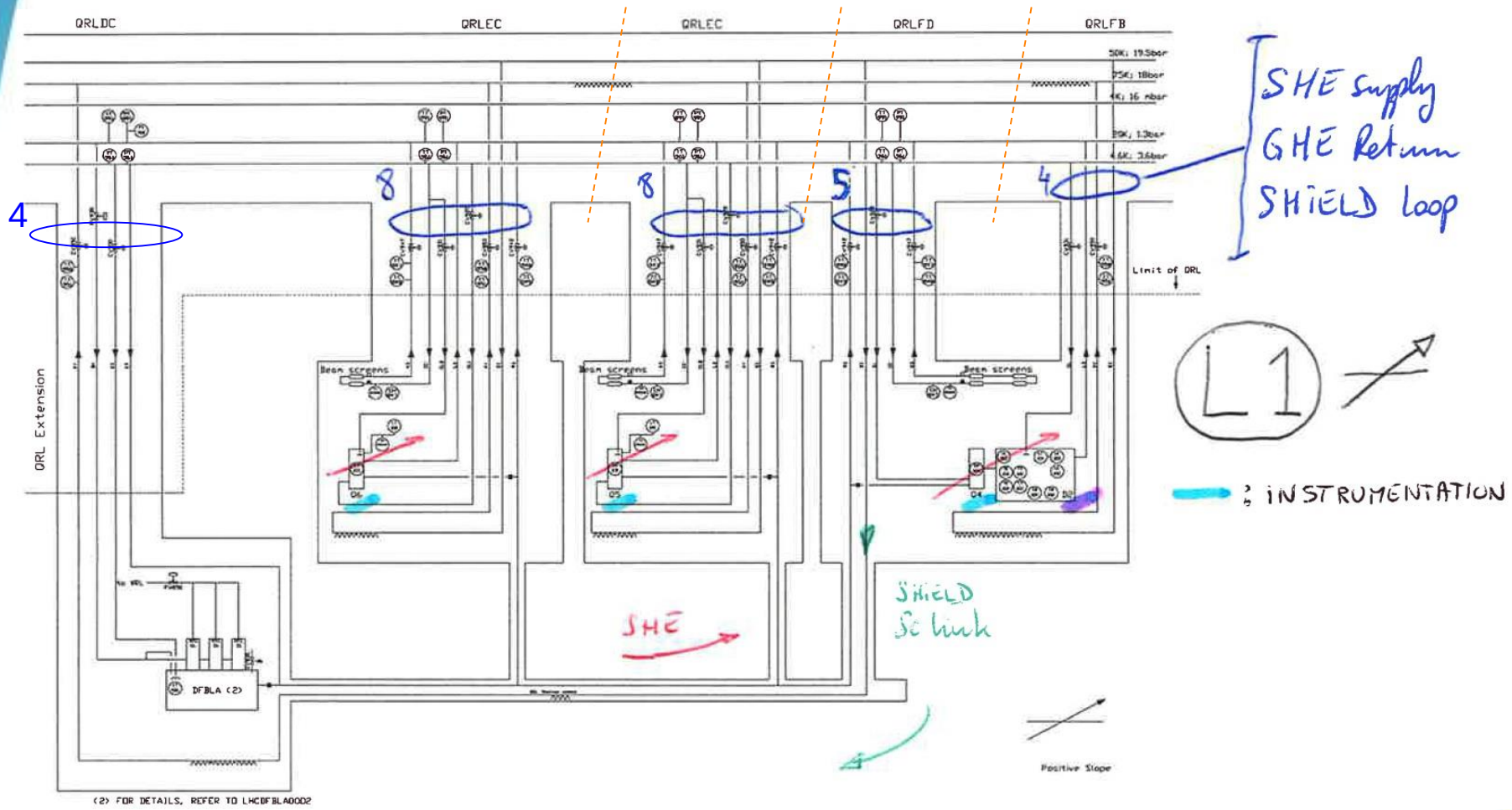
Interfaces QRL-SAM's

Evolution required from present LHC configuration

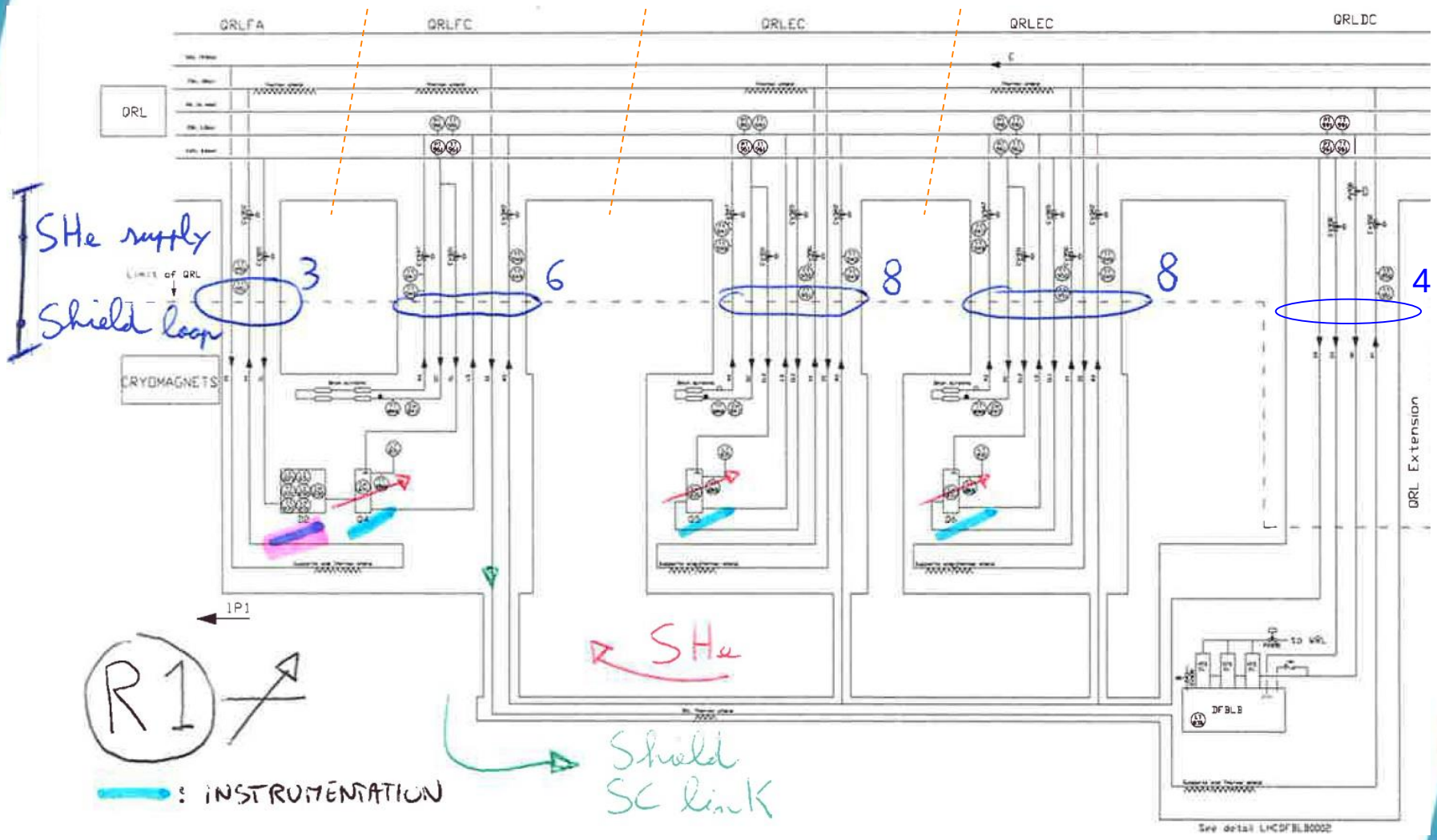
- DFBL & Q6 jumpers would be the same, at the same place
- Q5 jumpers would be the same, translated where needed
- Q4 as real stand-alone (doublet Q4-D2 at present)
  - Re-doing a new single service module + jumper not considered for the moment (would require more effort/cost but more compact)
  - The jumper on Q4 deal as well with the DSL-link cooling
  - The 2nd jumper corresponds to what is presently installed for D2
  - Header configuration for Q4-D2 jumpers depends on the Interaction Point and tunnel slope
  - Q4 instrumentation to be adapted to stand-alone architecture (TT, LT, EH)
- For Q4, proposal to re-use the existing service modules translated where needed, with Q4/D2 jumper translated and to be adapted to required length/position

2 not touched, 2 translated, 1 translated and adapted

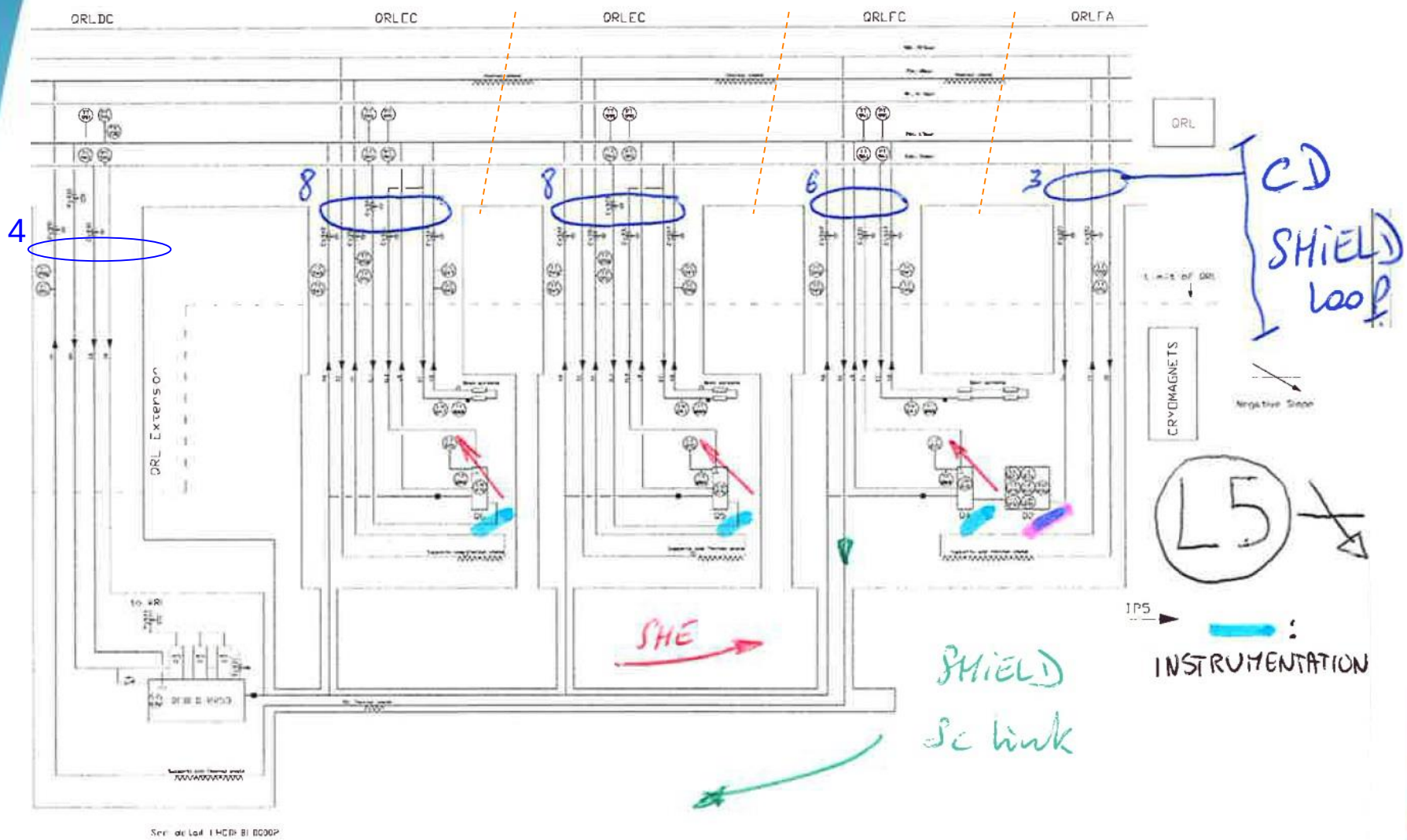
IP1-left (ref. LHCLSQR_0107)



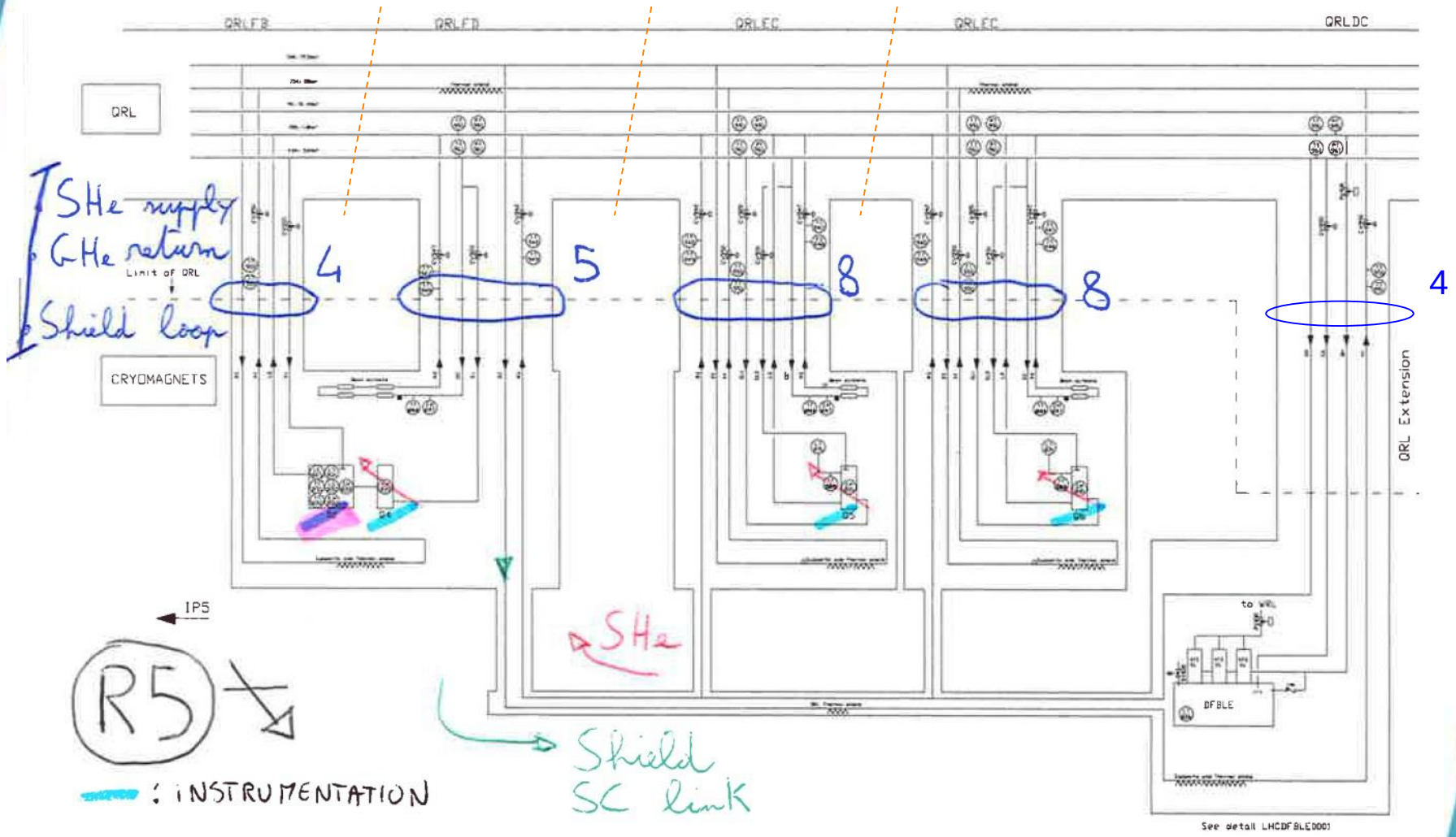
IP1-right (ref. LHCLSQR_0035)



IP5-left (ref. LHCLSQR_0043)



IP5-right (ref. LHCLSQR_0044)



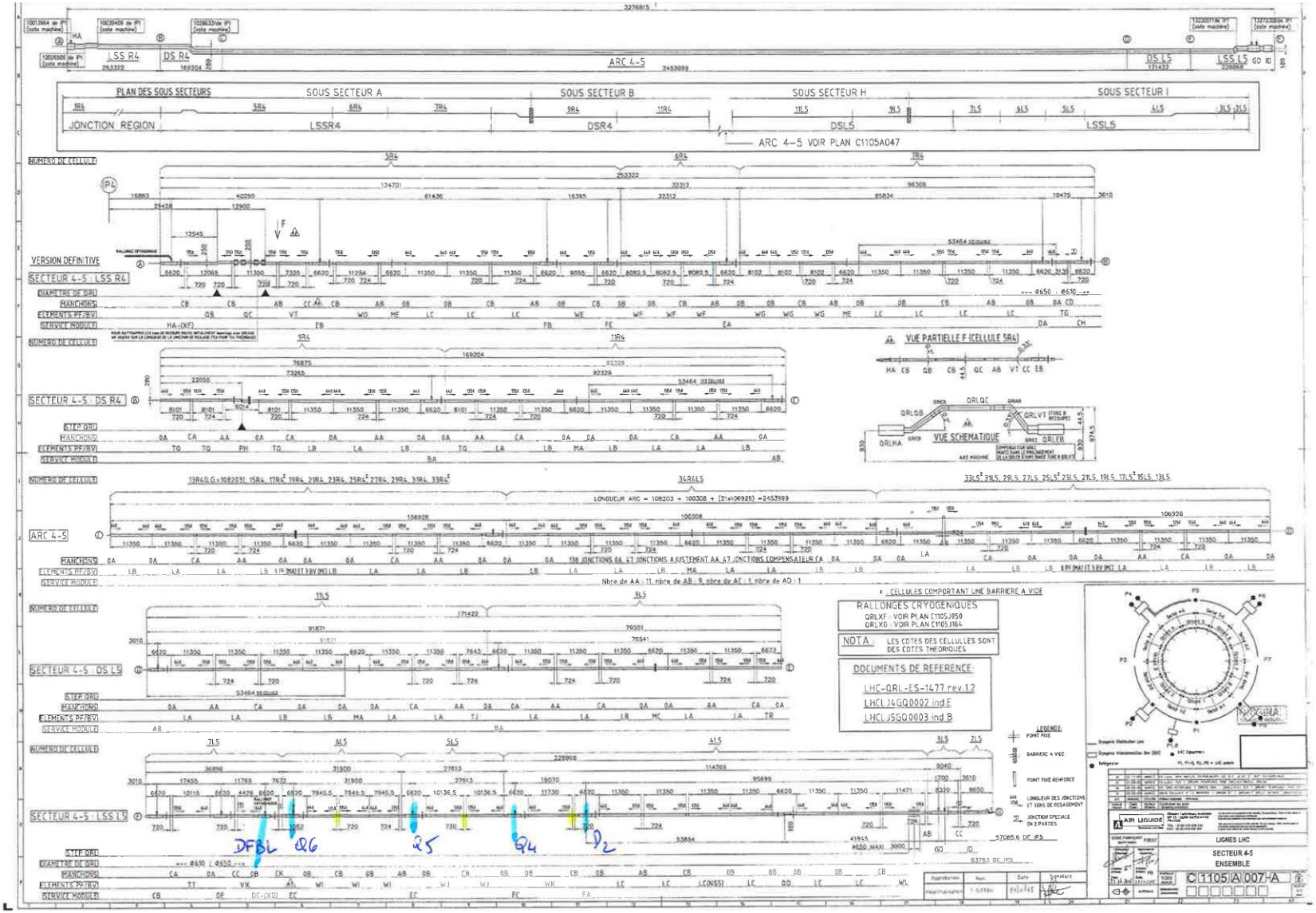
Summary table

IP1-left				*IP1-right*				*IP5-left*				*IP5-right*			
Q4		*Q5*	*Q6*	*Q4*		*Q5*	*Q6*	*Q4*		*Q5*	*Q6*	*Q4*		*Q5*	*Q6*
left	*right**			*left**	*right*			*left*	*right**			*left**	*right*		
RD	CL	KD	KD	EE	KD	KD	KD	RD	CL	RD	RD	EE	KD	RD	RD
EE	LD	CC’	CC’	FF	CC’	CC’	CC’	EE	FF	EE	EE	FF	CC’	EE	EE
CL	FF	CL2	CL2	CL	CL	CL2	CL2	LD	EE	FF	FF	LD	CL	FF	FF
CC’	EE	LD	LD		LD	LD	LD	CL		CL1	CL1	CL	EE	CL1	CL1
KD		CL1	CL1		EE	CL1	CL1	CC’		CL2	CL2		RD	CL2	CL2
		FF	FF		RD	FF	FF	KD		LD	LD			LD	LD
		EE	EE			EE	EE			CC’	CC’			CC’	CC’
		RD	RD			RD	RD			KD	KD			KD	KD
5	4	8	8	3	6	8	8	6	3	8	8	4	5	8	8

Beam screen circuit	**SHe supply**	**SC link thermal shield supply**
Thermal shield circuit	**GHe return**	**GHe from SC link return**

* new Q4 jumper (former D2)

Elementary units of QRL “LEGO-like”



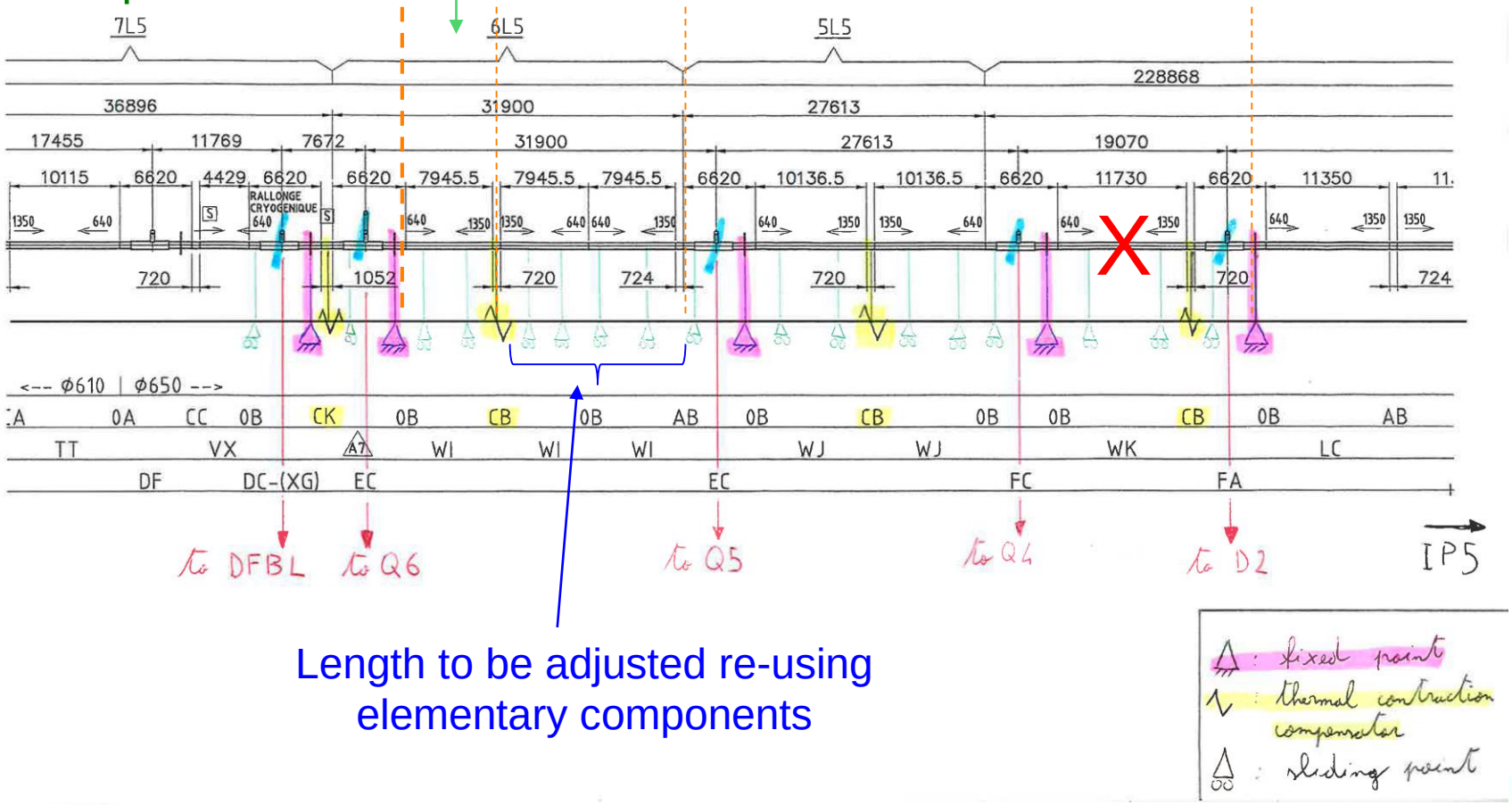
ref. C1105A007 (sector 4-5)

Constraints & Th. contraction compensation layout for the Junction Module QRL - QXL

Kept to avoid removing Q6

Translated, with possible "minor" adjustments of length

QRL kept untouched



Length to be adjusted re-using elementary components