

Decoupling of adjacent cryogenic sectors

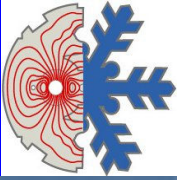
LHC Performance Workshop - Chamonix 2010
Session 3 - Optimise Interventions and Recovery from Collateral
Damages on Cold Sectors

Decoupling of Adjacent Cryogenic Sectors

Gerard FERLIN, TE-CRG-Operation for Accelerators

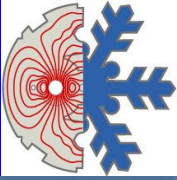
*This presentation and propositions are the result of 3 years of
operation of LHC cryogenic system.*

Decoupling of adjacent cryogenic sectors



Abstract

The LHC sectors are coupled two by two via interconnection boxes allowing cryoplant cooling redundancy and efficient stand-by or low-beam-intensity operation. The present LHC cryogenic sectorization allows to performed mechanical interventions on the magnet cold-mass circuit of a sector, like diode or interconnection splice repairs while the adjacent sector remain in nominal cryogenic operation. However this sectorization does not allow exchanging a magnet or a QRL service module in a sector while keeping the adjacent sector in nominal cryogenic operation and the cooling redundancy ability. This presentation will describe, based on different scenarios, hardware update proposals allowing a complete separation of the two adjacent sectors.



Contents

Actual configuration

Running configuration

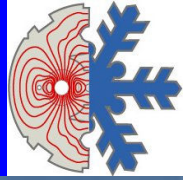
Intervention on sector

Scenarios proposed for intervention

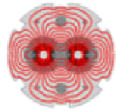
-One sector cooled by "normal" cryopumps, One sector under intervention.

-One sector cooled by "redundant" cryopumps, one sector under intervention.

Summary



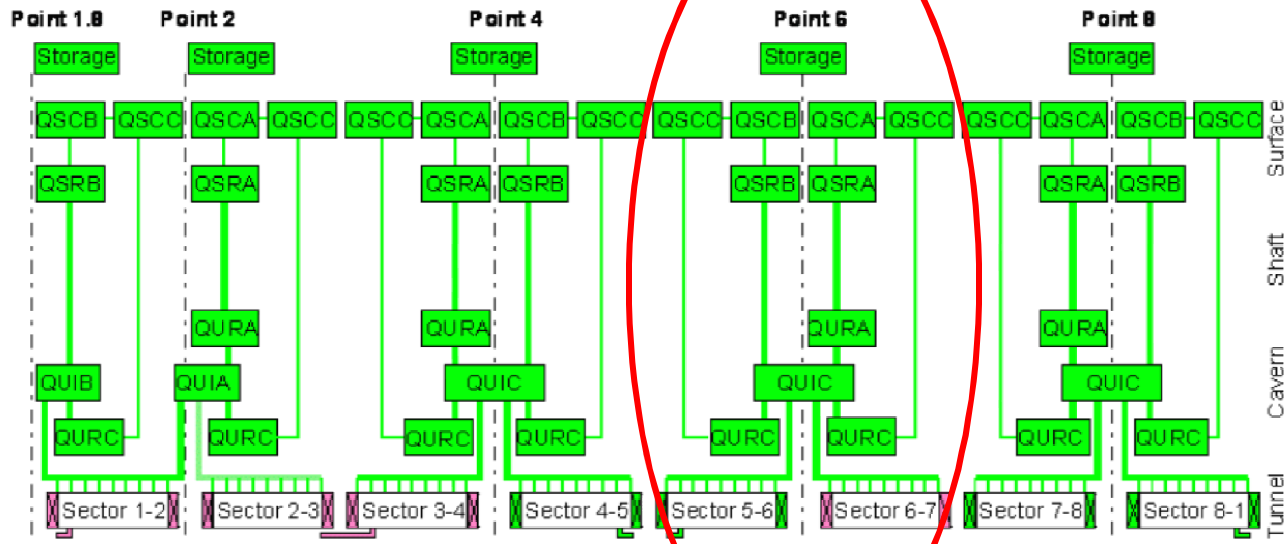
Decoupling of adjacent cryogenic sectors



LHC Progress Dashboard

Accelerator Technology Department

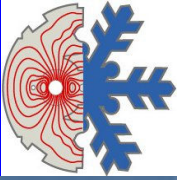
Cryogenics overview



Legend

Cryogenic Distribution Line	QSC_(A,B,C): Warm Compressor Station	Delivered / Under installation
Under commissioning	QSR_(A,B): Surface 4.5 K Refrigerator Cold Box	Under fabrication
Ordered (Contract placed)	QURA: Underground 4.5 K Refrigerator Cold Box	Under definition
Superconducting Link	QURC: 1.8 K Refrigeration Unit Cold Box	
Electrical Feed Box	QUI_(A,B,C): Cryogenic Interconnection Box	

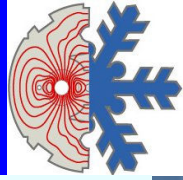
Courtesy L.Tavian



Actual running configuration

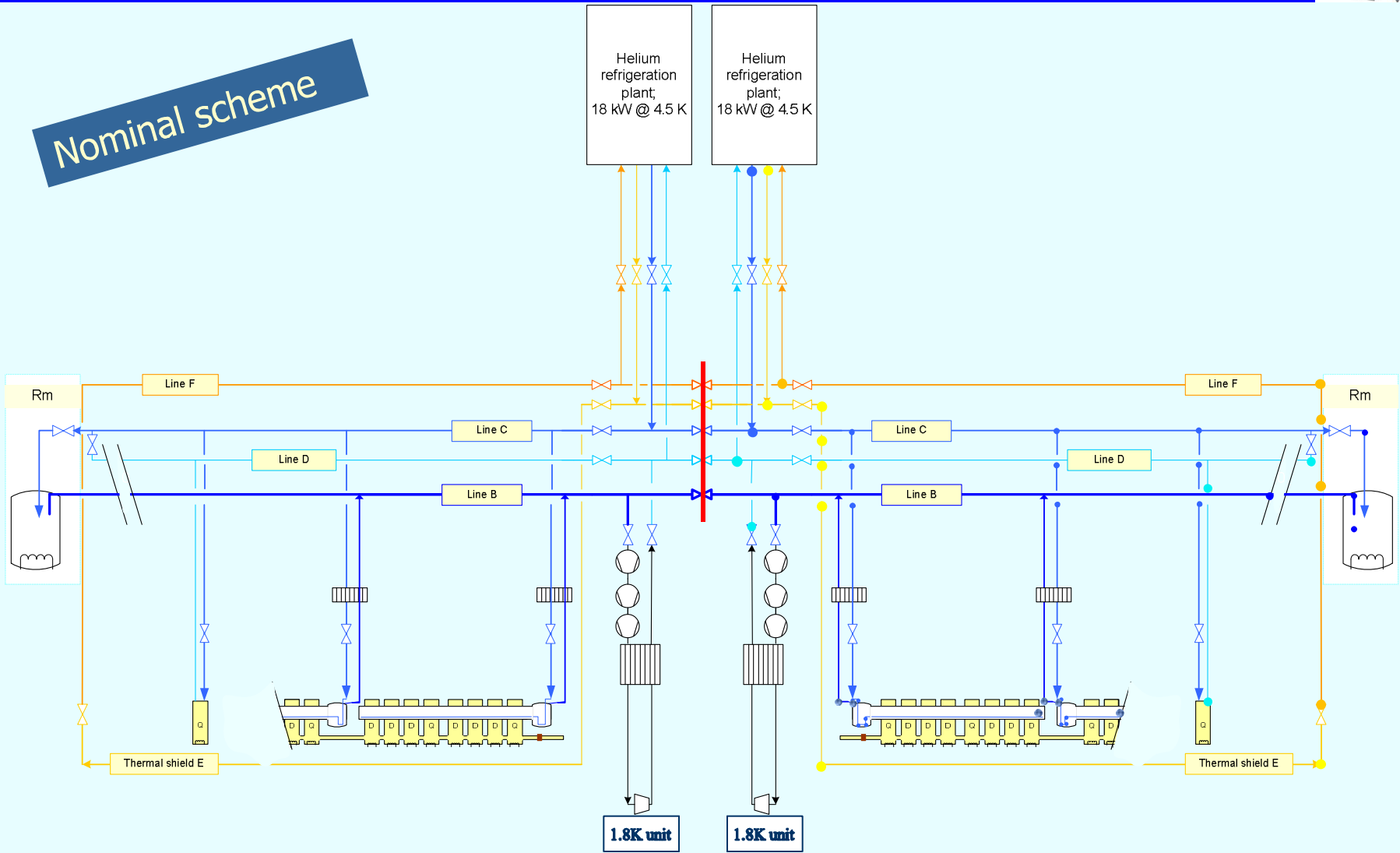
Nominal scheme

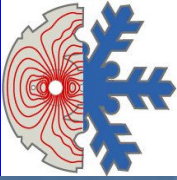
Each sector coupled with corresponding cryoplant.



Decoupling of adjacent cryogenic sectors

Nominal scheme

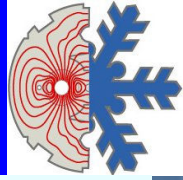




Actual running configuration

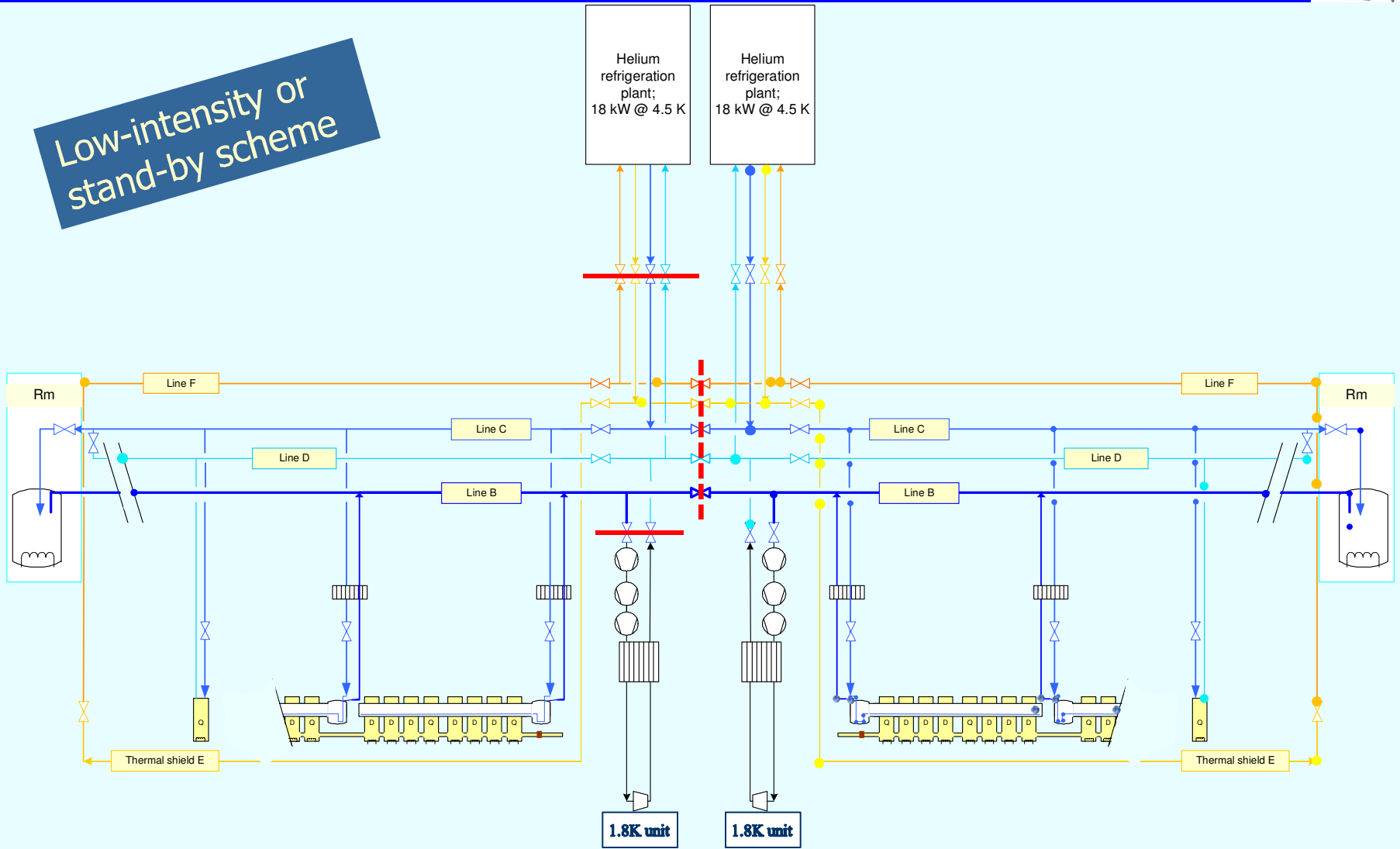
Low-intensity beam or stand-by scheme or
Cryoplant major failure redundancy scheme

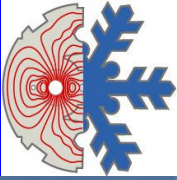
Two sectors coupled with one cryoplant.



Decoupling of adjacent cryogenic sectors

Low-intensity or stand-by scheme





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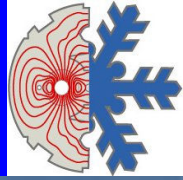
Intervention on sector

Scenarios proposed for intervention

-One sector cooled by "normal" cryopumps, One sector under intervention.

-One sector cooled by "redundant" cryopumps, one sector under intervention.

Summary



Decoupling of adjacent cryogenic sectors

Overall configuration during intervention on one sector

Safety

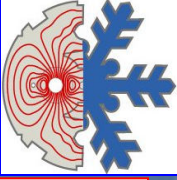
The sector must be “consigned” from pressure and gas flow.

Cryo operation

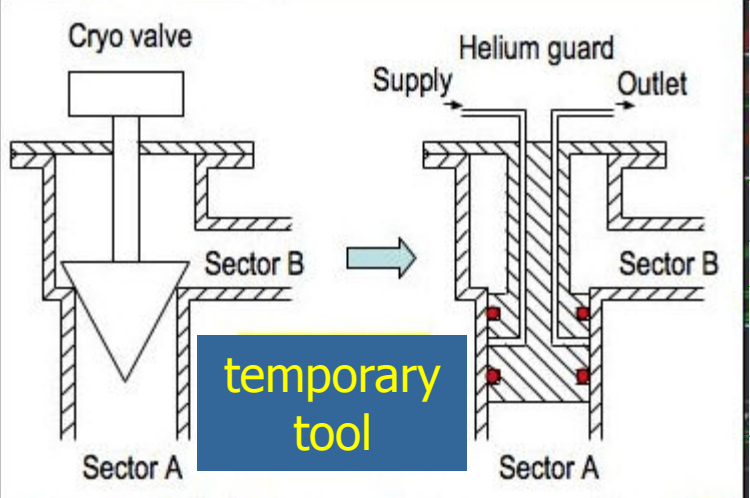
Cold valves must be protected from air and moisture condensation/ice.

Configuration adopted for each affected circuit

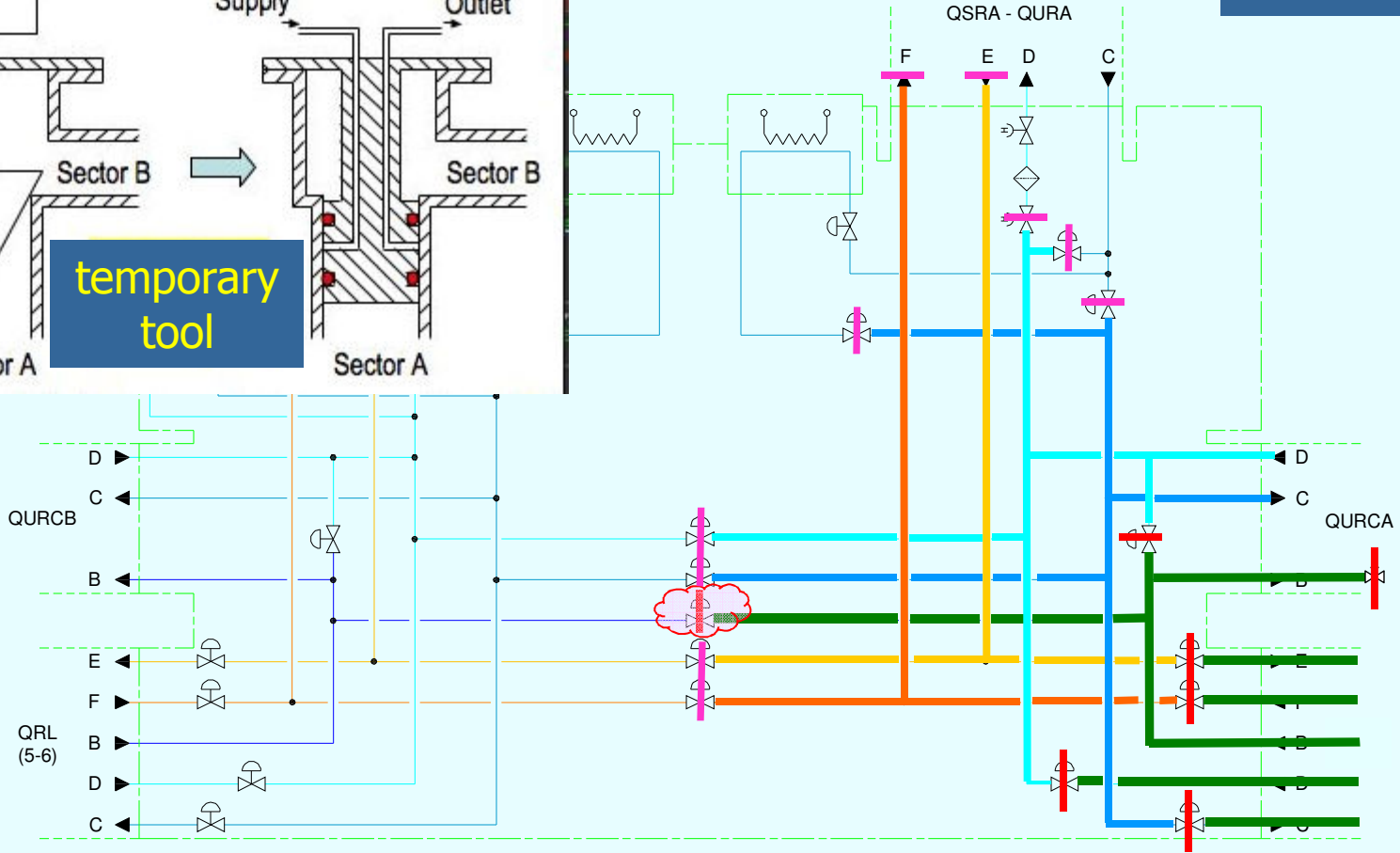
Two valves locally consigned with helium gas buffer in between at room temperature and 1 bar (pressure monitored)

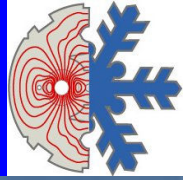


Decoupling of adjacent cryogenic sectors



Present status





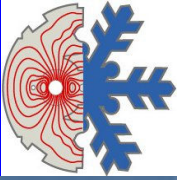
Decoupling of adjacent cryogenic sectors

Present status during magnet exchange.

Circuits C (LHe 4.5K), D (Return GHe 20K), E (Magnet thermal screen 70 K), F (QRL thermal screen 85 K) are protected by GHe buffer, but protection for Header B (GHe pumping line, 15 mbar, 4K) improvable.



Exchanging a magnet or a QRL service module in a sector while keeping the adjacent sector in nominal cryogenic operation is not possible without important risk!



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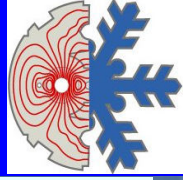
Intervention on sector

Scenarios proposed for intervention

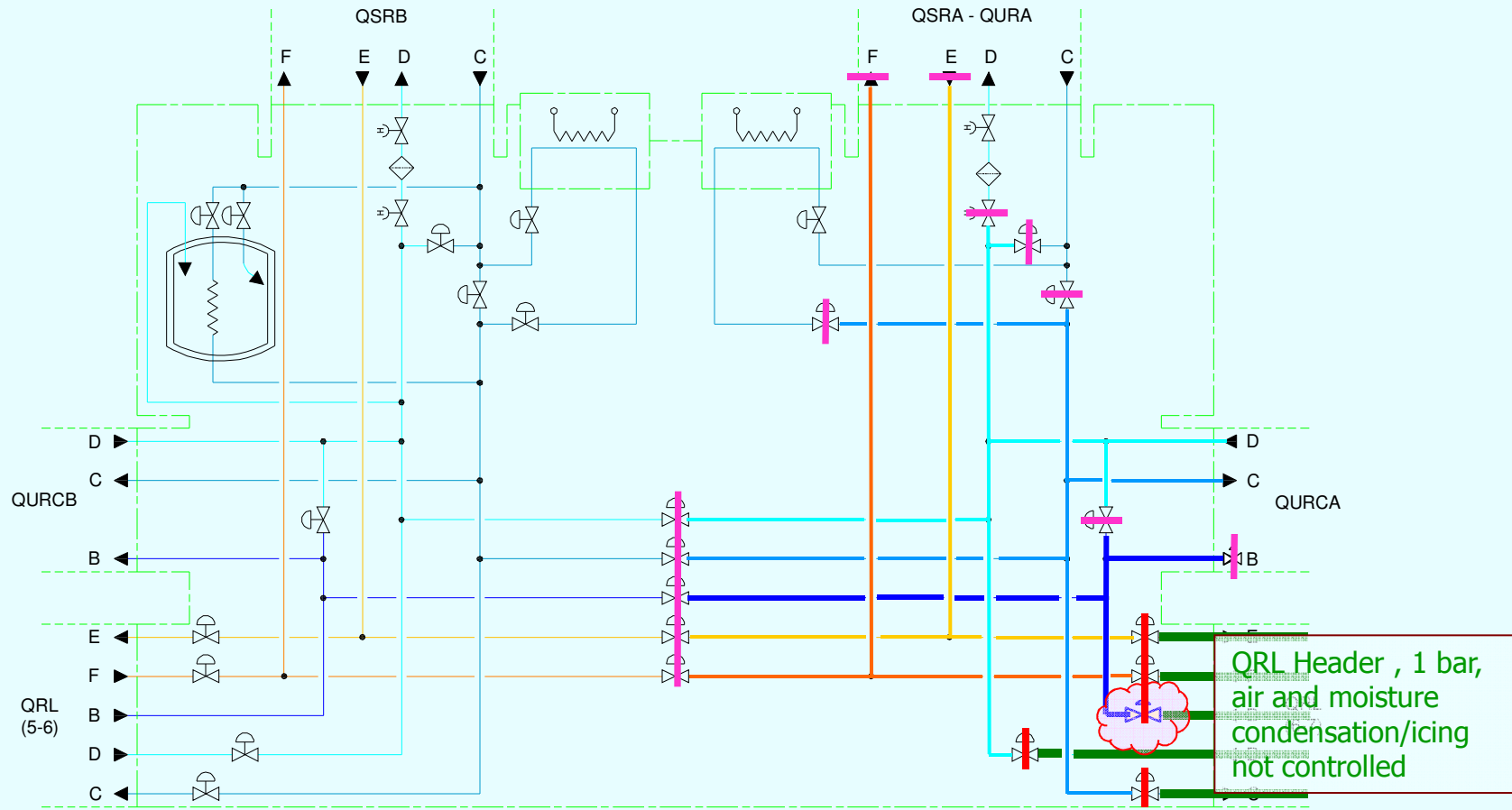
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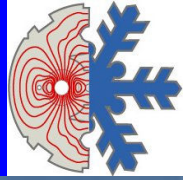
-One sector cooled by “redundant” cryopumps, one sector under intervention.

Summary

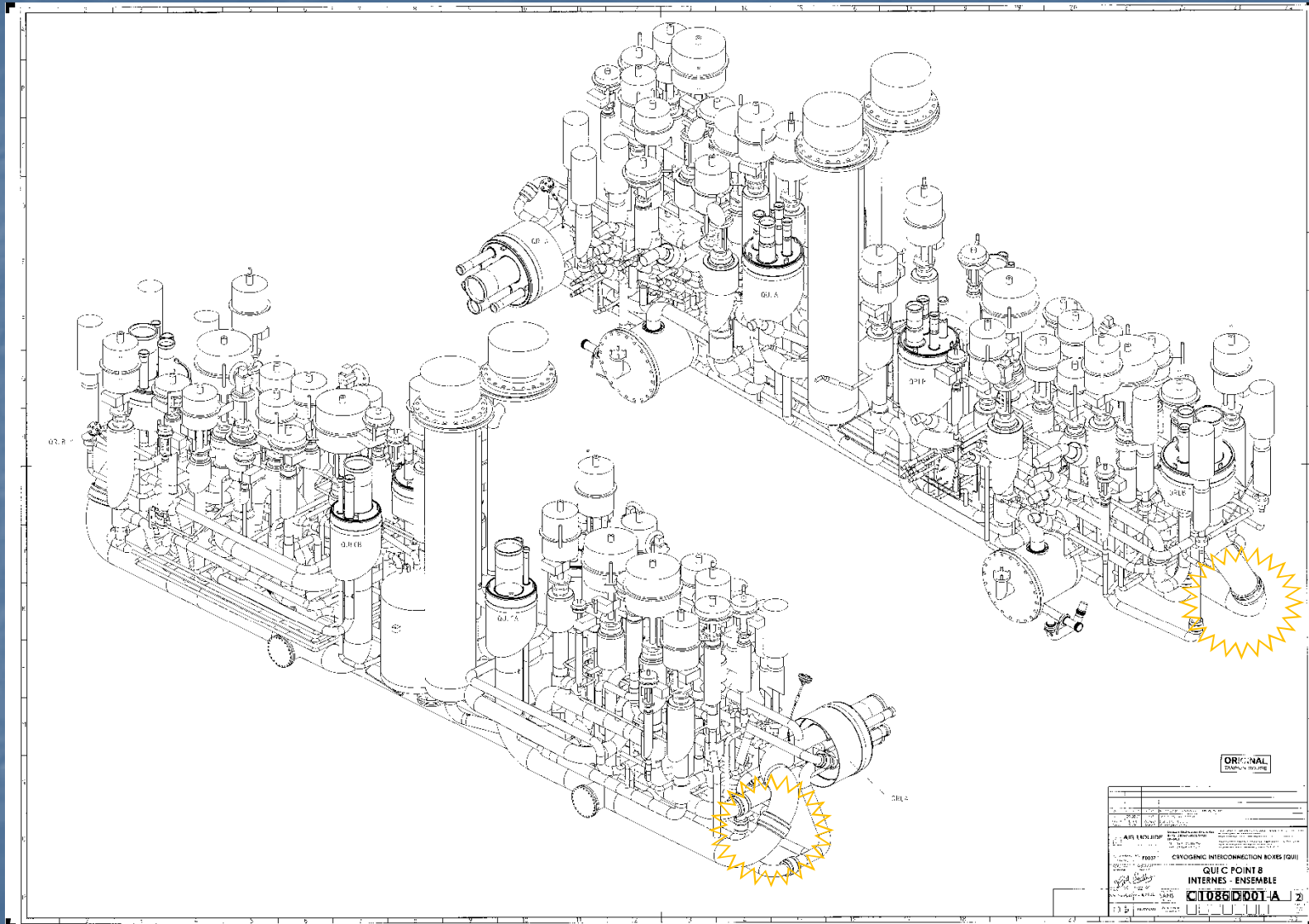


Decoupling of adjacent cryogenic sectors

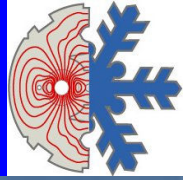




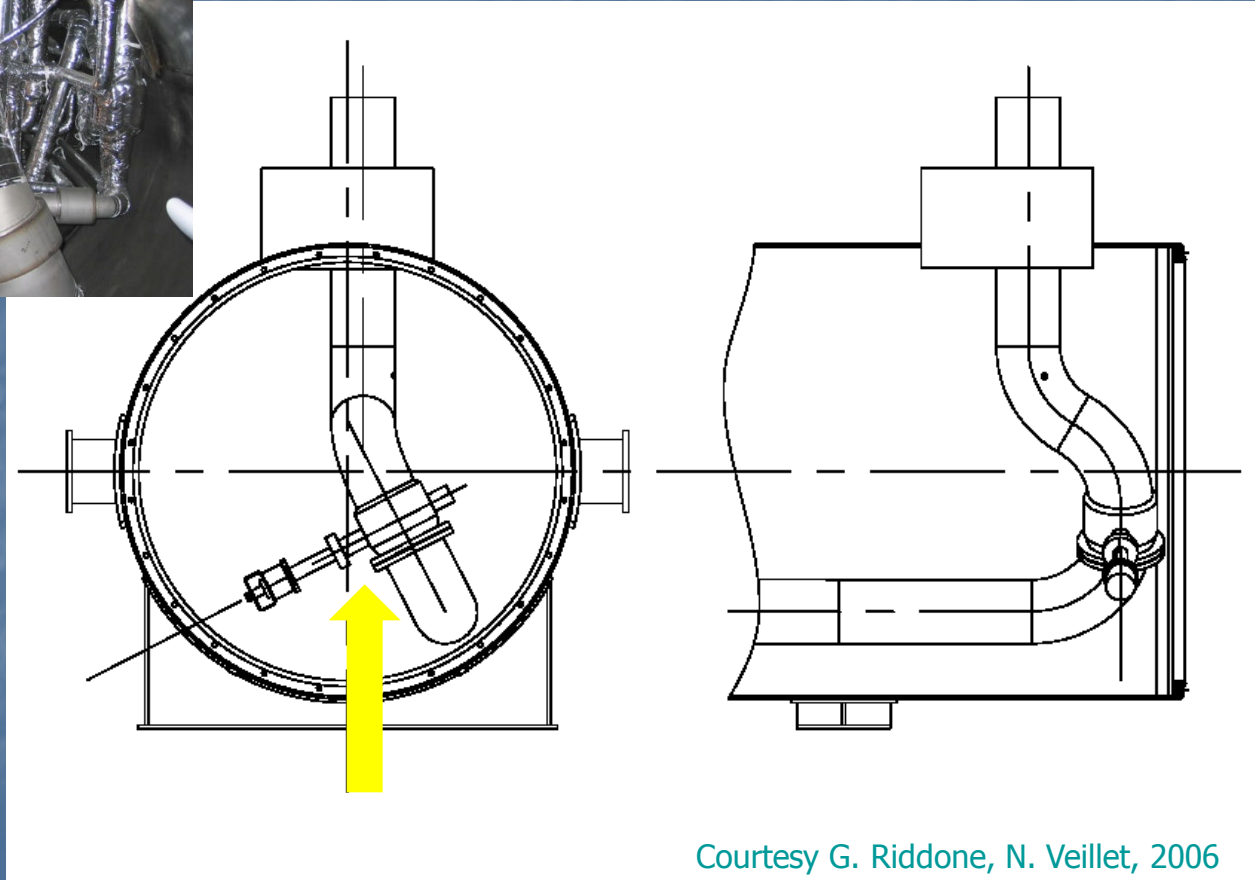
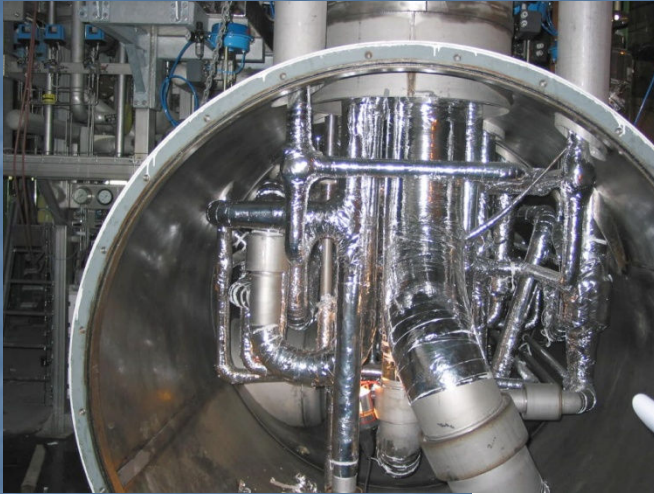
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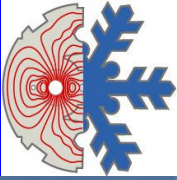
Chamonix 2010, Session 3_06;
TE_CRG_OA_GF



Decoupling of adjacent cryogenic sectors



Courtesy G. Riddone, N. Veillet, 2006



Add DN250 valve on header B

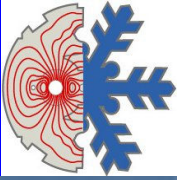
To be done

Validation of design for the 5 valve boxes. In particular free space in QUI, point 18 and point 2 needs to be carefully checked.

Impact on proximity piping & safety valves to be checked.

Cost estimation (design, materiel, installation, pressure and X-ray tests): from 120 to 150 kCHF/sector

Duration: 3 to 4 weeks.



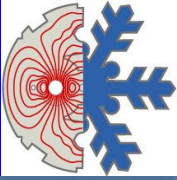
Add DN250 valve on header B

Pros:

- Gas flow safety guaranteed during mechanical intervention.
- Air and moisture condensation/icing prevented.
- Warm up and de-icing of the cold compressor inlet filter much more easier.
- Restore possibility of leak-tight insulation between header B and QURC (repair inlet valve, Cold Compressor exchange...)

Cons:

- Possible only with the two sectors at room temperature.
- Time schedule impact.



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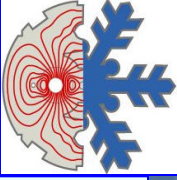
Intervention on sector

Scenarios proposed for intervention

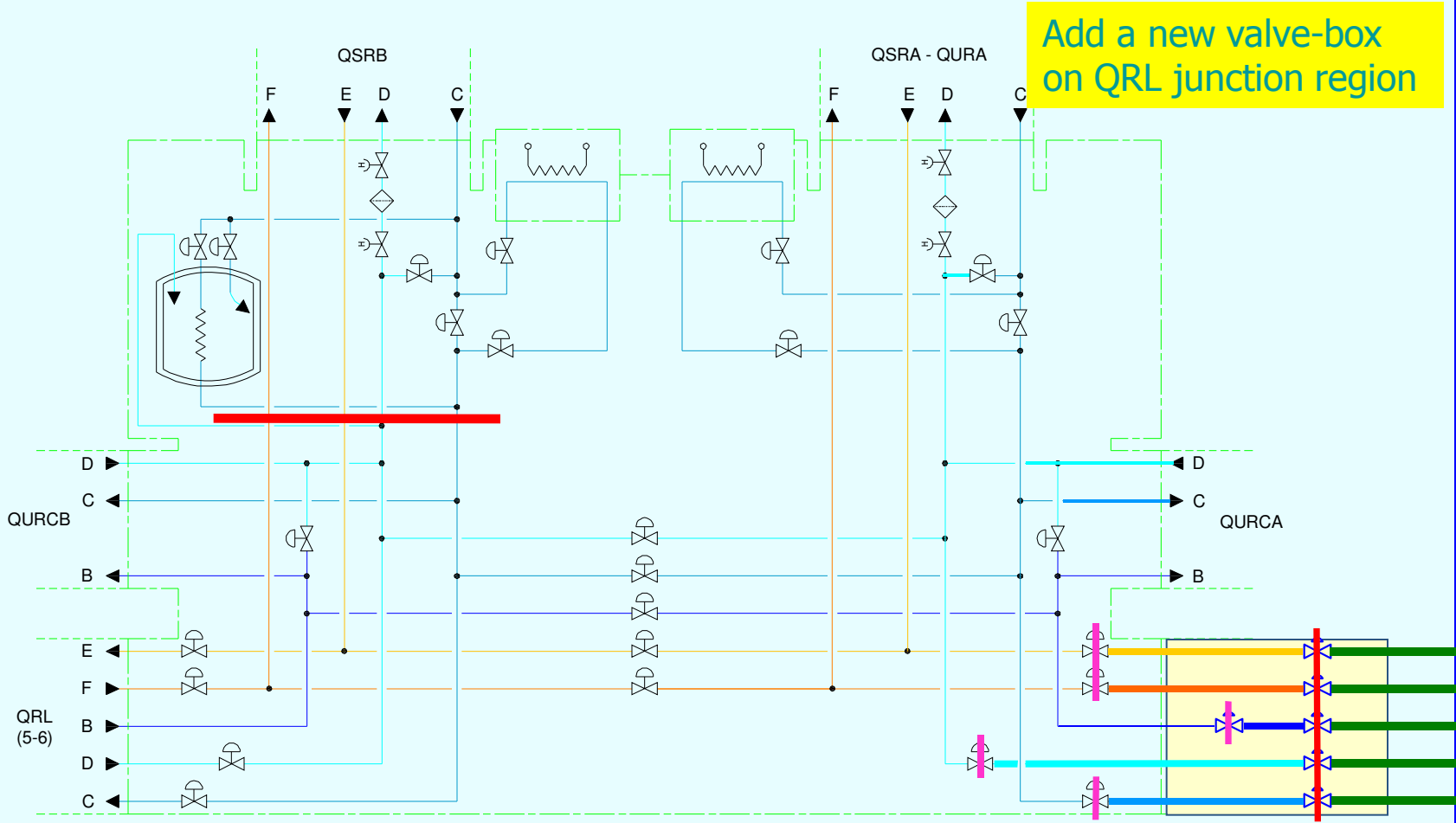
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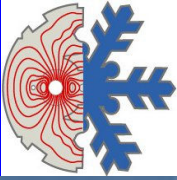
-One sector cooled by "redundant" cryopumps, one sector under intervention.

Summary



Decoupling of adjacent cryogenic sectors





Add new valve box on junction region with 6 cryo-valves

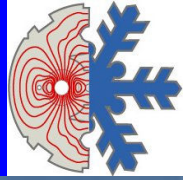
To be done

Validation of design for the 8 junction region.

Impact on proximity piping & safety valves to be checked.

Cost estimation (design, materiel, installation, pressure and X-ray tests): from 300 to 350 kCHF/sector

Impact on LHC time schedule: 4 to 6 weeks.



Decoupling of adjacent cryogenic sectors

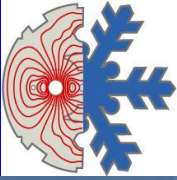
Add new valve box on junction region with 6 cryo-valves

Pros:

- Same than previous solution **plus**
- Redundancy of cryoplant guaranteed

Cons:

- Integration design to be checked and validated.
- Possible only with the two sectors at room temperature.
- Cost (time schedule and money)



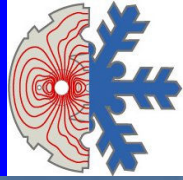
Other points not detailed

HRL valves to be remotely driven

WRL by pass in QUI area

QUI purge panel to be separate in two half parts (one part/sector).

...



Decoupling of adjacent cryogenic sectors

Summary

Heavy intervention (exchanging a magnet or a QRL service module) while keeping the adjacent sector in nominal cryogenic operation will be possible only by upgrading the gas buffer system on header B. To restore possibility of leak-tight insulation between header B and Cold Compressor unit, a new valve is needed.

If the cryoplant redundancy is mandatory during the magnet exchange, a valve box must be added on the junction region.

Thank you