



Cryomagnets Interconnections

- ❖ Consolidations of sector 4-5
- ❖ Helium level gauges status
- ❖ Quick interconnection overview



Consolidation of sector 4-5

❖ List of activities

- * Non-recurring / (Potentially) recurring
- * Arc / LSS
- * Risk level
- * Comparison with 7-8

❖ Some figures

❖ Schedule

Warm-up, Overview, Where we are, Critical path

❖ Documents

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Consolidation of sector 4-5

Replacement of failed PIMs (X ICs) [1/2]

Arc / Recurrent – Risk level : Medium

Procedure is known but extent of the work not

Sequence of operations (if reasonable # of collapsed PIMs) :

1. Ball test to localise failed PIMs (2 per beam line) to an accuracy of one half cell [Alternate V1/V2 everyday]
2. Venting of the concerned vacuum sector
3. Opening of the QQBI IC of this sector
4. Cutting of the PIM on the relevant line – Endoscopic inspection (+/- 100m)
5. Installation of a replacement or dummy PIM - In parallel radar type measurement
6. Gamma-ray of the other PIM
7. Loop to clear the whole sector
8. Test of the photometer using cut PIMs if possible
9. In parallel, preparation of replacing PIMs
10. Rewelding of PIMs – Ball test to validate the sector
11. Leak test of beam lines – Displace SSS downwards
12. Reclosure of IC
13. Pumping and leak test of insulation vacuum – RF reference measurements



Consolidation of sector 4-5

Replacement of failed PIMs (X ICs) [2/2]

Arc / Recurrent – Risk level : Medium

Procedure is known but extent of the work not

If most of the PIMs are collapsed :

1. Venting of the insulation vacuum
2. Opening of all the QQBI IC [#55]
3. Radar type measurement or Gamma-rays to identify collapsed ones
4. Cutting of the PIMs - Installation of a replacement or dummy one
5. Test of the photometer using cut PIMs if possible
6. In parallel, preparation of replacing PIMs
7. Rewelding of PIMs - Ball test to validate the sector
8. Leak test of beam lines – Displace SSS downwards
9. Reclosure of IC
10. Pumping and leak test of insulation vacuum – RF reference measurements

Risks / Unknowns :

1. Other type of collapsed PIMs
2. Most of the PIMs to replace (Availability ?)
3. Flanges : material ?
4. Under investigation in QQBI.12L5 and QBBI.12L5 (Gamma-rays)



Consolidation of sector 4-5

Y-Line to repair (#2 or 3)

Arc / Non-recurrent – Risk level : Low

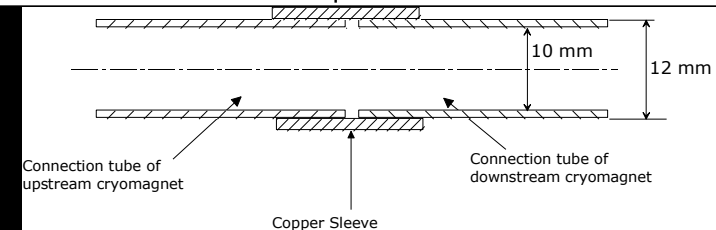
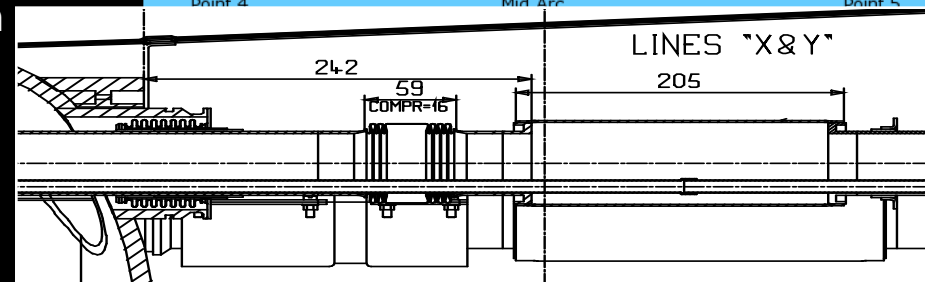
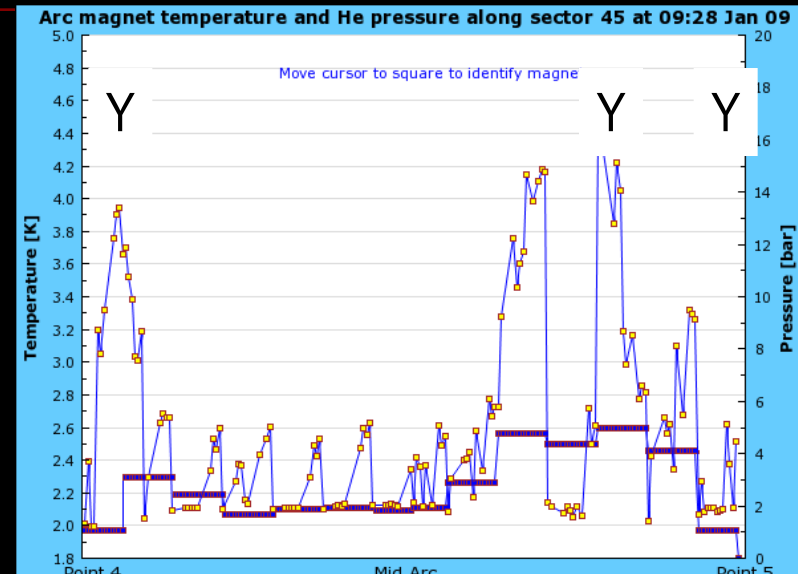
Loss of time for re-cooldown

Interventions :

- 3 locations : Q10-Q11R4 : QBBI.11R4 (TBC)
Q18-Q17L5 : QBBI.B18L5 (TBC)
Q9-Q7L5 : QQBI.8L5 (TBC)
(No line Y in Q7 by design)
- Precise localisation could require a dedicated time for experiment (Warm-up above lambda point then re-cool-down following the lambda front propagation) : 1 day except with acquisition of relevant sensors (reconfiguration necessary) if analysis of data provides sufficient information
- Opening of IC and line X
- Endoscopic inspection
- Repair – Test – Reweld line X – Leak test
- Reclosure of IC

Risks / Unknowns :

- Time to localise the defect
- Procedure for repair (different type of the one in 7-8)





Consolidation of sector 4-5

Helium guards to repair (#8 TBC)

Arc / Non-recurrent – Risk level : Low

Procedure known, improved and validated

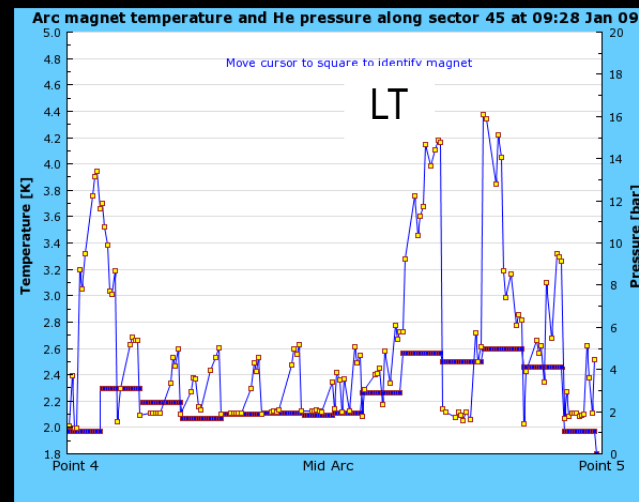
Interventions :

1. Vent line X to atmospheric pressure to allow endoscopic inspection and identification/ confirmation of the units to be repaired
2. Cutting of the damaged piece
3. Rewelding and testing

Also, one Helium level gauge to change (CRG)

Risks / Unknowns :

1. Number of replacement required





Consolidation of sector 4-5

Leaks to repair

Arc / Potentially recurring – Risk level : Low

It was possible to leave with it so ...

Interventions :

1. VACSEC 7R4 (NC847504) – CM leak to insulation vacuum of $1 \cdot 10^{-5}$ mbar l /sec
In DS zone, additional mobile turbo pumps are used
2. VACSEC 15R4 – C' K leak to insulation vacuum of $6 \cdot 10^{-6}$ mbar l /sec
Disappeared during localisation ; leak tightness to be verified
3. Check of beam lines leak tightness
4. Q17L5 and Q29R4 (NC 826696 and 820313) – leak air to insulation vacuum – temporary solution now but to be consolidated by AT-VQC

Risks / Unknowns :

1. Time for localisation – Extra openings to support leak localisation work
2. New leaks created by warm-up



Consolidation of sector 4-5

Intervention on Q5R4

LSS / Non-recurrent – Risk level : High

Still under discussion

Short circuit on a corrector circuit ; suspected between corrector and D4 busbars

Interventions :

1. Open the D4/Q5 IC
2. Open the busbar line
3. Endoscopic inspection
4. Repair

Risks / Unknowns :

1. Location of the defect
2. Possibility to repair
3. The DFBML link could be required to be opened
4. What if it is not accessible from the IC ?



Consolidation of sector 4-5

Planned interventions : Arc / Non-recurrent

- * Improve splices of CC instrumentation (same as 7-8)

1 day work / Risk level : very low

Planned interventions : Arc / Non-recurrent

- * Intervention on JT valves of the triplets and possibly DFBs (CRG)
In the shadow / Risk level : low
- * If QBQI ICs are opened, verification of the instrumentation (CRG)

Preparation activity :

- * Removal of BLM (No survey instrumentation in this sector)

Potential critical issues :

- * Electrical issues discovered during commissioning :

Nothing up to now but ...

- * Leaks during the closure phase (impact on schedule)

- * Sector 4-5 shutdown is on the critical path for the LHC
general schedule



Consolidation of sector 4-5

Some figures

- ❖ About 45 (24 for PIMs) ICs to open [220 in 7-8]
- ❖ 35 persons involved (not full time)
- ❖ Several teams :

MCS, MEI, CRG, VAC, IEG, FSU, TS-SU, AB-BI, TS-IC, ICIT

From MCS: 18 persons (various proportion)

A Bastard, F Bertinelli , N Bourcey, O Denis, H Dupont, M Duret, D Etiembre, M Felip, JM Hubert, A Jacquemod, A Musso, M Pozzobon, F Savary, I Slits, P Thonet, J Ph Tock, S Triquet, L Williams

Duration : 8 weeks [6+2] ;

Starting date to be defined to allocate resources



Helium guards status

<u>Sector</u>	<u>To be replaced</u>	<u>Done</u>	<u>Remark</u>
1-2	24	12	Planned W 6-7-8
2-3	9	8	End for W4
3-4	3	3	Completed
4-5	8 ?	0	During shutdown of 4-5
5-6	13 ?	0	After warm-up
6-7	18 ?	0	Endoscopy W 5 ; planned W6-7
7-8	7	7	Completed
8-1	1	1	Completed

- * Components available for 2-3
- * Next batch delivery on W5 so critical for 1-2 and 6-7
- * Endoscopic inspections will confirm quantity
- * Improved procedure, not requiring the opening of the IC is validated in 2-3 (N Bourcey)
- * 1-2 and 6-7 partially in parallel (Priority ?)
- * If impact on schedule, necessity to replace has to be assessed (No failure in 7-8, 4-5, 5-6)



Quick IC overview

	1.2	2.3	3.4	4.5	5.6	6.7	7.8	8.1				1.2	2.3	3.4	4.5	5.6	6.7	7.8	8.1
QBOL7 R												QBOL34 L							
QBOL7 R												QBBLB34 L							
QBBLA8 R												QBBLA34 L							
QBBL8 R												QBOL34 L							
QBOL8 R												QBBL33 L							
QBBL8 R												QBBLB33 L							
QBOL9 R												QBBLA33 L							
QBOL9 R												QBOL33 L							
QBBL9 R												QBBL32 L							
QBBL10 R												QBBLB32 L							
QBOL10 R												QBBLA32 L							
QBOL10 R												QBOL32 L							
QBBL11 R												QBBL31 L							
QBEL11 R												QBBLB31 L							

Sector	On-going	Planned
1-2	Closure of last Ics	Leak test, closure of ICs and Helium LT replacement
2-3	Replacement of He level gauge	Purge and flushing
3-4	NA	ELQA - Purge and flushing
4-5	Q1/Q2/Q3 IC	Consolidation from W10?
5-6	Cold	Cool-down
6-7	5 openings to check BPMs	Helium LT replacement
7-8	NA	Cool-down
8-1	Leak Test	One IC to close W4 or 5

QBBL19 R												QBOL23 L							
QBBLA20 R	VAC											QBOL22 L							
QBBLB20 R	VAC											QBBLB22 L							
QBOL20 R	VAC											QBBLA22 L							
QBBL20 R	VAC											QBOL22 L							
QBBLA21 R	VAC											QBOL21 L							
QBBLB21 R	VAC											QBBLB21 L							
QBOL21 R	VAC											QBBLA21 L							
QBOL21 R												QBOL21 L							
QBBLA22 R												QBOL20 L							
QBBLB22 R												QBBLB20 L							
QBOL22 R												QBBLA20 L							
QBBL22 R												QBOL20 L							
QBBLA23 R												QBOL19 L	VAC						
QBBLB23 R												QBBLB19 L	VAC						
QBOL23 R												QBBLA19 L							
QBOL23 R												QBOL19 L							
QBBLA24 R												QBOL18 L							
QBBLB24 R												QBBLB18 L							
QBOL24 R												QBBLA18 L							
QBOL24 R												QBOL18 L							
QBBLA25 R												QBOL17 L							
QBBLB25 R												QBBLB17 L							
QBOL25 R												QBBLA17 L							
QBOL25 R												QBOL17 L							
QBBLA26 R												QBOL16 L							
QBBLB26 R												QBBLB16 L							
QBOL26 R												QBBLA16 L							
QBOL26 R												QBOL16 L							
QBBLA27 R												QBOL15 L							
QBBLB27 R												QBBLB15 L							
QBOL27 R												QBBLA15 L							
QBOL27 R												QBOL15 L							
QBBLA28 R												QBOL14 L							
QBBLB28 R												QBBLB14 L							
QBOL28 R												QBBLA14 L							
QBOL28 R												QBOL14 L							
QBBLA29 R												QBOL13 L							
QBBLB29 R												QBBLB13 L							
QBOL29 R												QBBLA13 L							
QBOL29 R												QBOL13 L							
QBBLA30 R												QBOL12 L							
QBBLB30 R												QBBLB12 L							
QBOL30 R												QBBLA12 L							
QBOL30 R												QBOL12 L							
QBBLA31 R												QBOL11 L							
QBBLB31 R												QBBLB11 L							
QBOL31 R												QBBLA11 L							
QBOL31 R												QBOL11 L							
QBBLA32 R												QBOL10 L							
QBBLB32 R												QBOL10 L							
QBOL32 R												QBOL10 L							
QBOL32 R												QBOL10 L							
QBBLA33 R												QBOL9 L							
QBBLB33 R												QBOL9 L							
QBOL33 R												QBOL9 L							
QBOL33 R												QBOL8 L							
QBBLA34 R												QBOL8 L							
QBBLB34 R												QBOL8 L							
QBOL34 R												QBOL8 L							
QBOL34 R												QBOL7 L							

20 ICs to close:
15 in the arc
5 in L5 triplet