



Insulation fault in sector 67

- ❖ Sequence of events
- ❖ Origin of the short
- ❖ Repair intervention
- ❖ Perspectives for the future

On behalf of many teams:

MSC-LMF, EN-MME, CRG, VSC, ELQA,...



Insulation fault in sector 67

❖ Sequence of events

1. 15/08/09 Start of cool-down of sector
Monitoring system was on
2. 18/08/09 Defect identified on RB circuit
Cool-down was stopped
3. 20/08/09 Defect localised around dipole A12R6
Warm-up launched
4. 24/08/09 Start of the repair intervention
5. 02/09/09 Repair completed; insulation vacuum tested

Documented in NC 1016291

Number:	1016291	ver.1
EDMS Id:	1016291	
Closed		

QN-ELQA-TP4C-HVQ-MB.A67-001

[Giorgio D'ANGELO](#)

Report - Non conformity
2009-08-20

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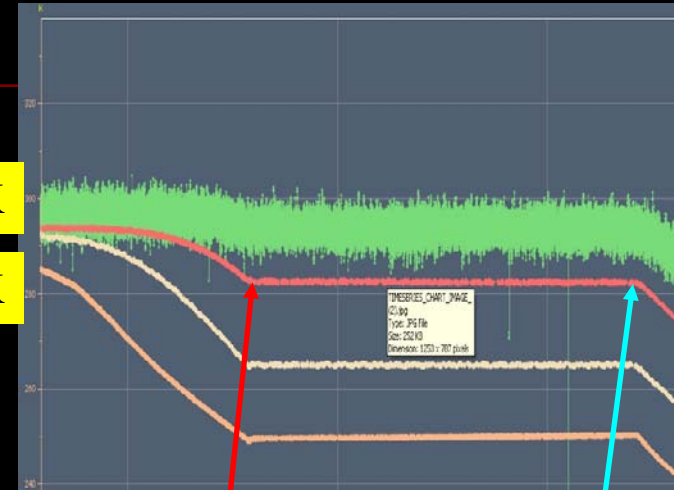


Insulation fault in sector 67

❖ Detection of the short

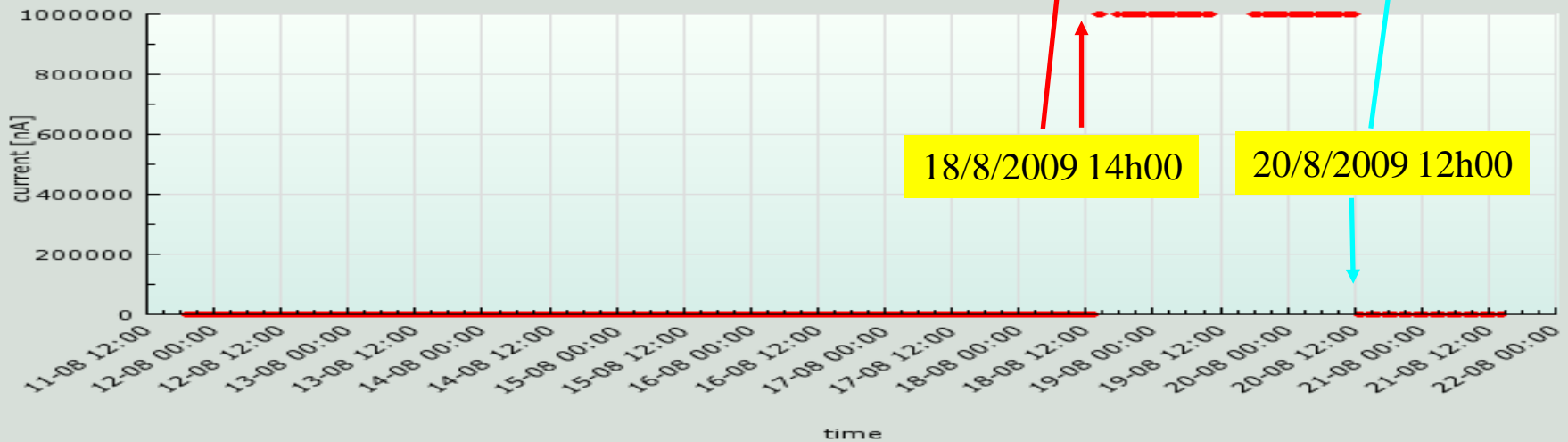
300K

280K



Detailed information for circuit RB.A67_lead_6

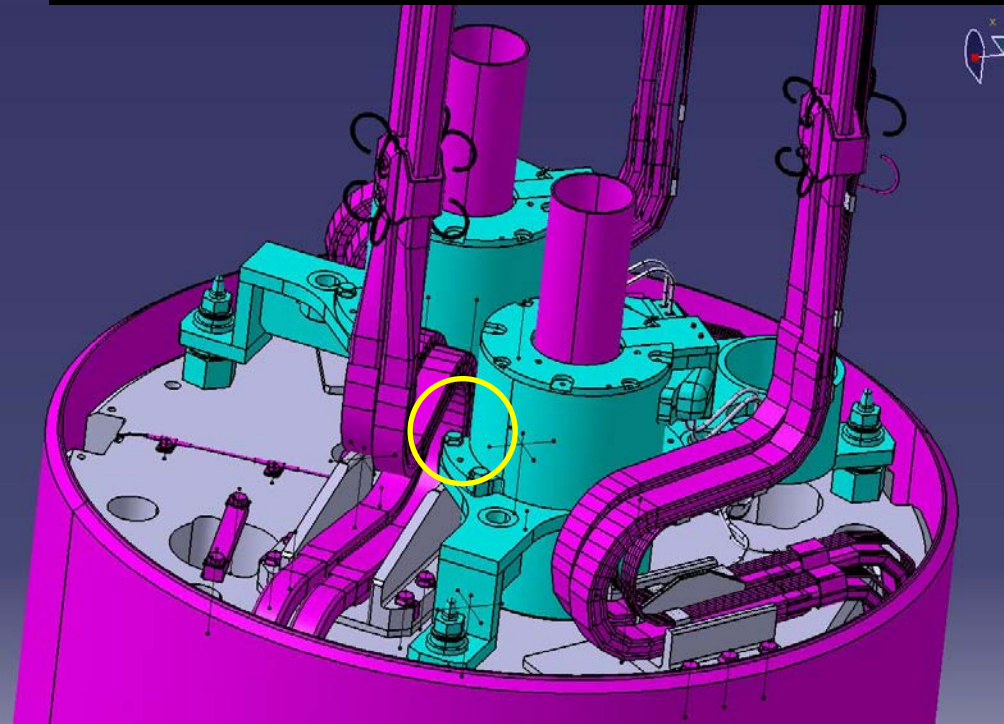
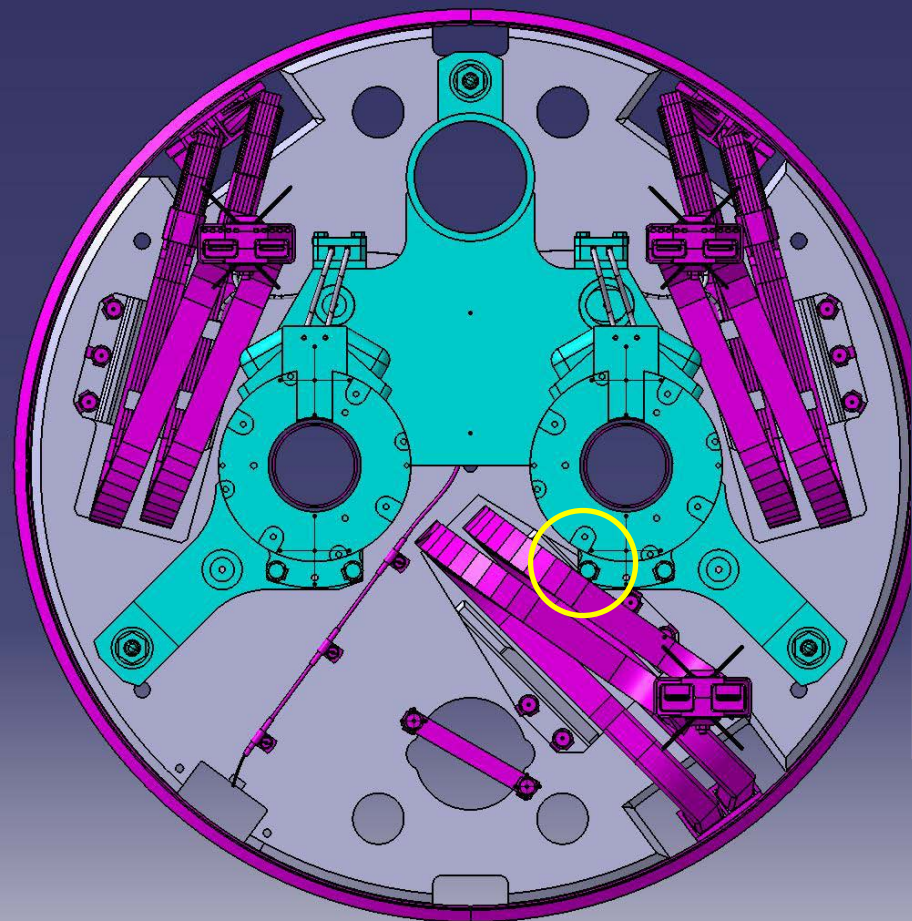
Final leakage current for circuit RB.A67_lead_6



Insulation fault in sector 67

❖ Origin of the short

Beforehand analysis pre-localised the defect

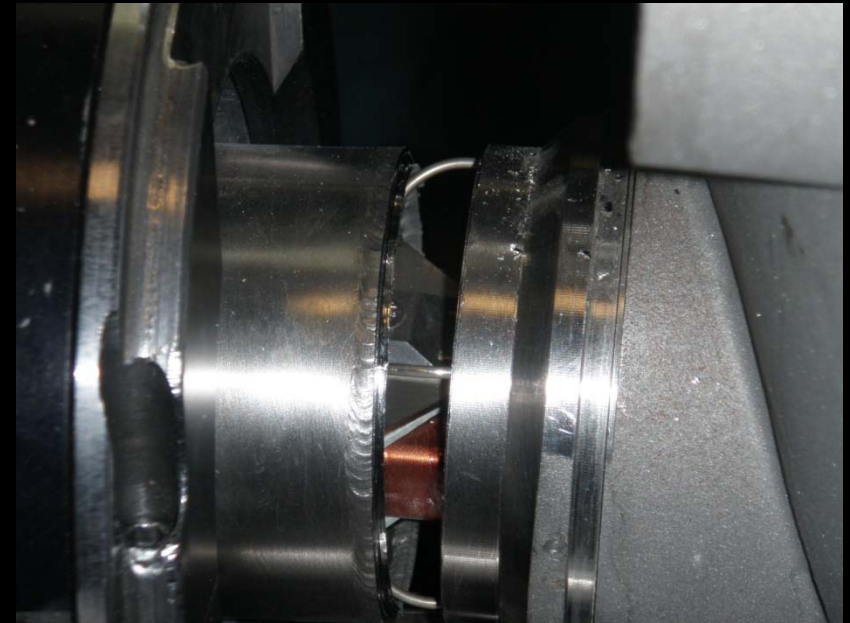
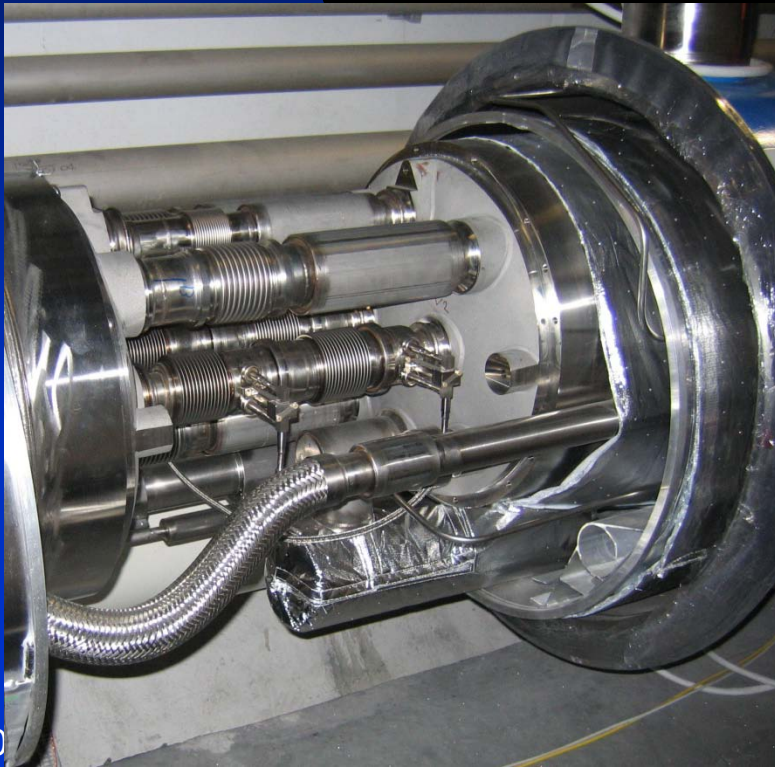




Insulation fault in sector 67

❖ Repair intervention

1. Venting of insulation vacuum
2. Opening of interconnection, removing of thermal shields
3. Cutting of K hose, M3 sleeve and M3 bellows





Insulation fault in sector 67

❖ Repair intervention

4. Endoscope investigation with busbars interconnected

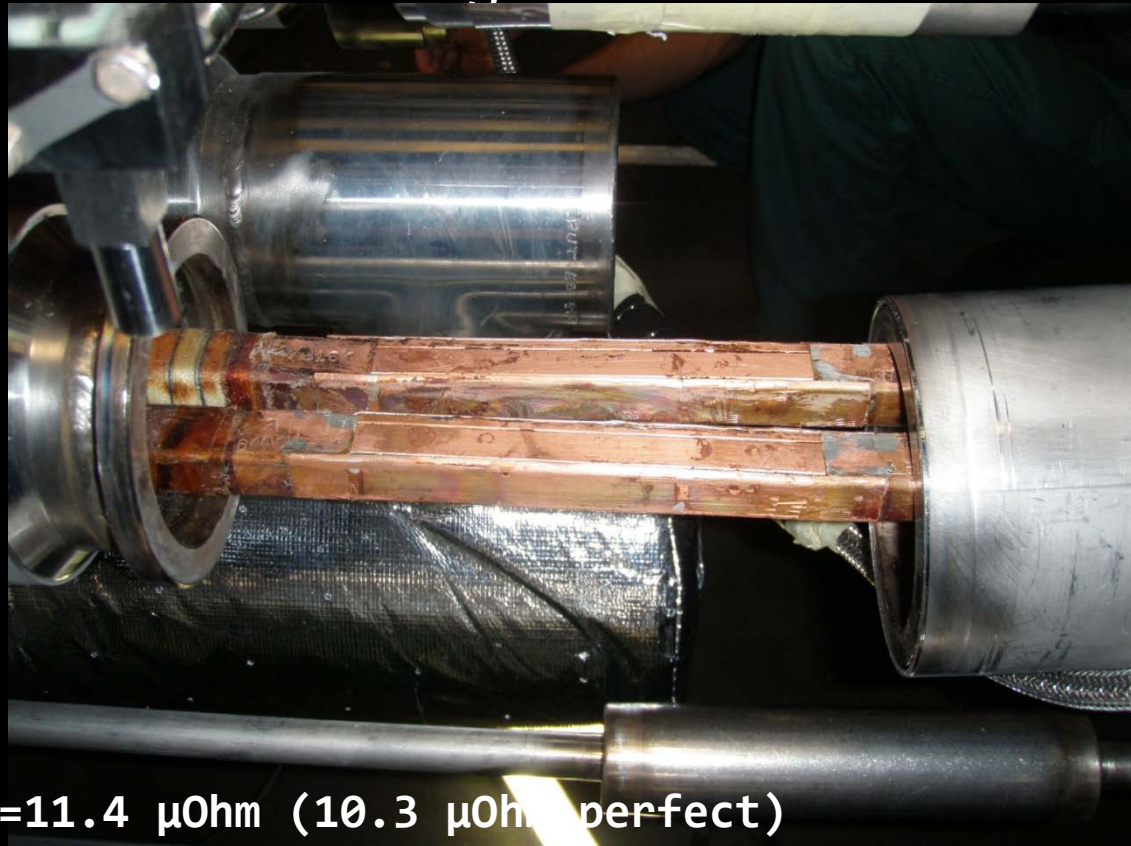




Insulation fault in sector 67

❖ Repair intervention

5. Splice quality control before de-soldering



QC results QBBI.A12R6 M3:

QBBI.A12R6-M3-corridor R-16=11.4 μOhm (10.3 μOhm perfect)

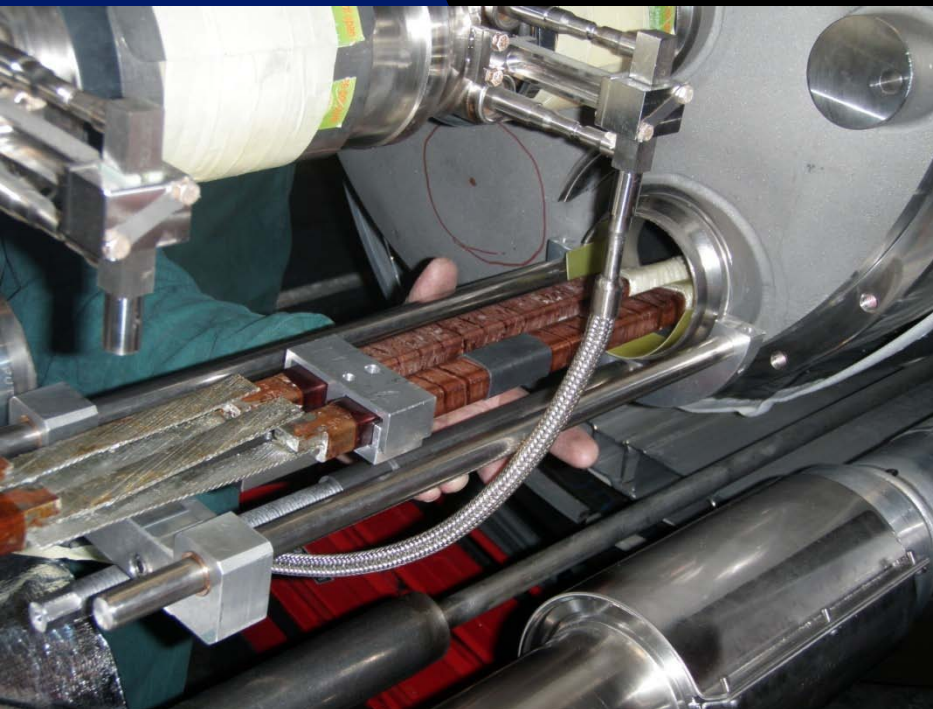
QBBI.A12R6-M3-cryoline R-16=11.2 μOhm (10.3 μOhm perfect)

US test 6 out of 6 above threshold for both splices.

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❖ Repair intervention

6. Splice de-soldering
7. Trials to reproduce the short

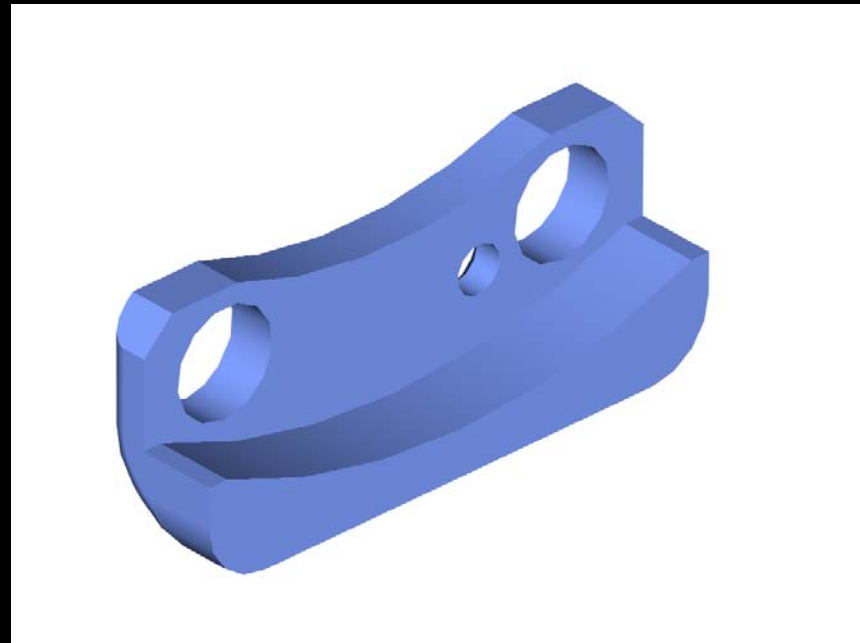
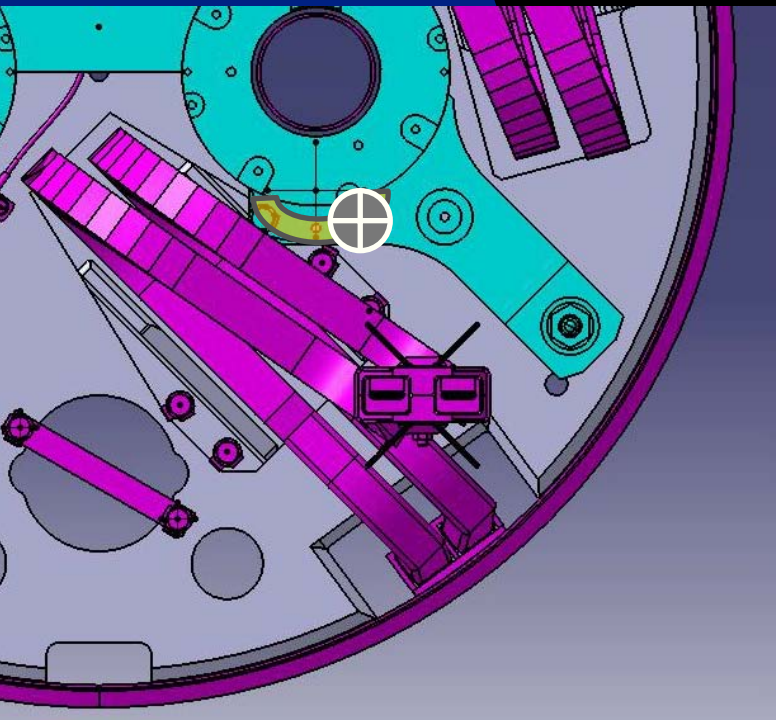


Lyra moved over working range
(and even more)
Resistance varied from a
minimum of 50 k Ω to G Ω but no
clear short

Insulation fault in sector 67

❖ Repair intervention

6. Manufacture insulating (polyethylene) pieces both to cover screws and U shape to be fixed on the busbar
7. In parallel, test at the surface on another dipole to validate procedure and tooling to carry out the intervention without drilling hole in the cold mass enclosure





Insulation fault in sector 67

❖ Repair intervention

8. Install pieces in-situ (Very delicate operation carried out by MSC-LMF)



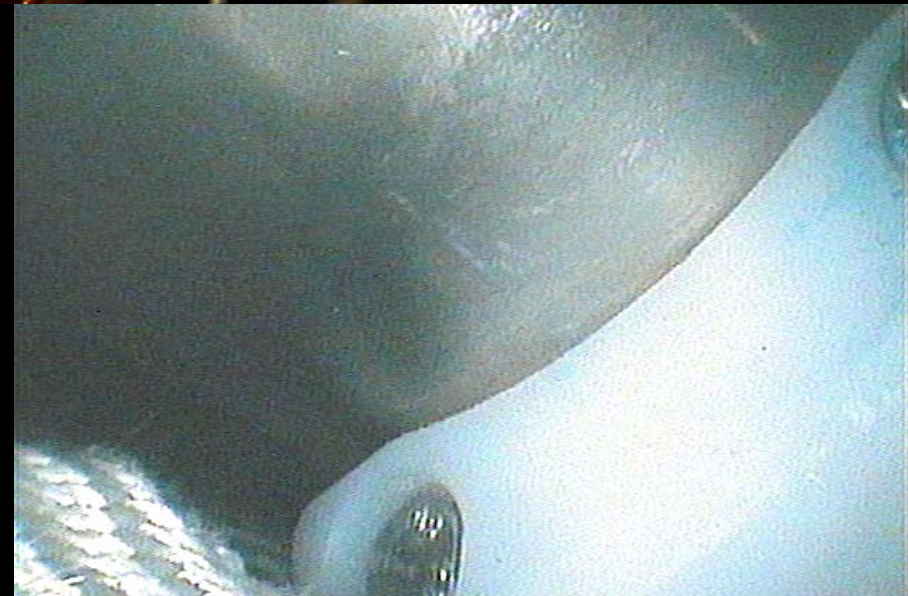
Unscrewing 1 of the fixing screw and removing it



Introducing protecting piece



Bolt it in place blocking the screw with ecobond





Insulation fault in sector 67

❖ Repair intervention

9. Install pieces U shape piece on busbar (Very delicate operation carried out by MSC-LMF)

Piece on the supporting tooling



Glue



Using a fiber glass strip to be knotted
And glued to ensure extra safety



U sleeve in place with Lyra
in maximum compression



Knot fixed by glue





Insulation fault in sector 67

❖ Repair intervention

10. Electrical validation of the insulation after repair

Segment to be tested from DFBA to A12.R6

* 600 V / 60 sec

External line (where the problem was found) 1.9 μ A

Internal line (where the problem was found) 1.5 μ A

Results difficult to interpret surely due to conditions in cold mass (GHe at 1 bar from DFBA to Q11 at about 250K)

Two options :

-Put 6 bar GHe : Cancelled for safety reasons / compensatory measures

-Open the interconnect at the other extremity of the dipole and unsolder busbars

Electrical test performed showing a leakage current of 300 nA

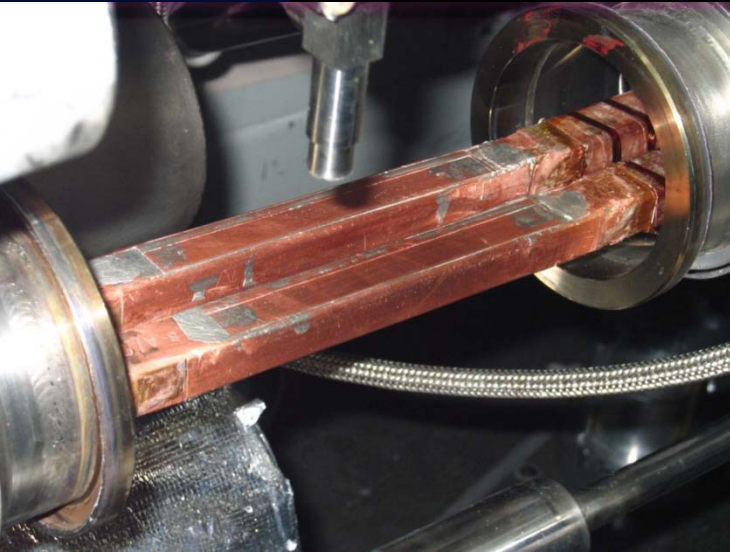
So OK for reclosure



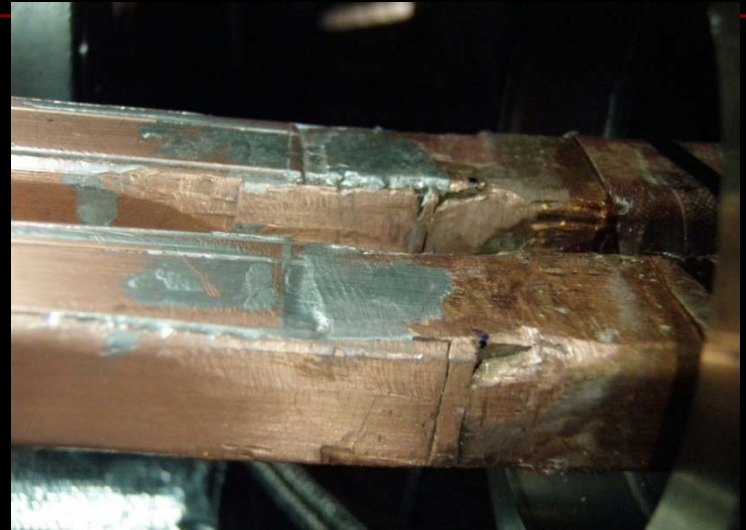
Insulation fault in sector 67

❖ Repair intervention

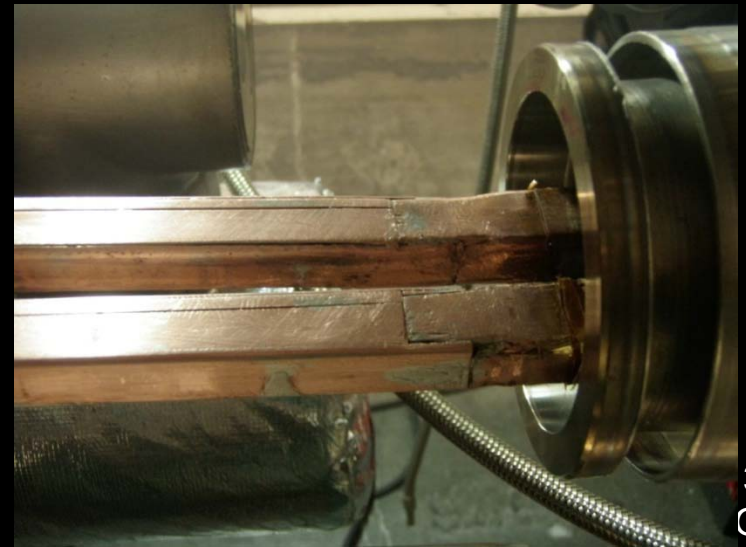
QQBI.11R6 M3 splices (SSS500 series)



old



new





Insulation fault in sector 67

❖ Repair intervention

11. Resoldering of splices
115 mm in QBBI.A12R6 instead of 120 mm to gain margin when lyra fully compressed
12. Quality Assurance of redone splices

		old	new
QBBI.A12R6	QRL	11.2 $\mu\Omega$	10.9 $\mu\Omega$ [5 mm shorter]
	Corridor	11.4 $\mu\Omega$	10.9 $\mu\Omega$ [5 mm shorter]
QQBI.11R6	QRL	10.9 $\mu\Omega$	10.9 $\mu\Omega$
	Corridor	11.9 $\mu\Omega$	-



Insulation fault in sector 67

❖ Repair intervention

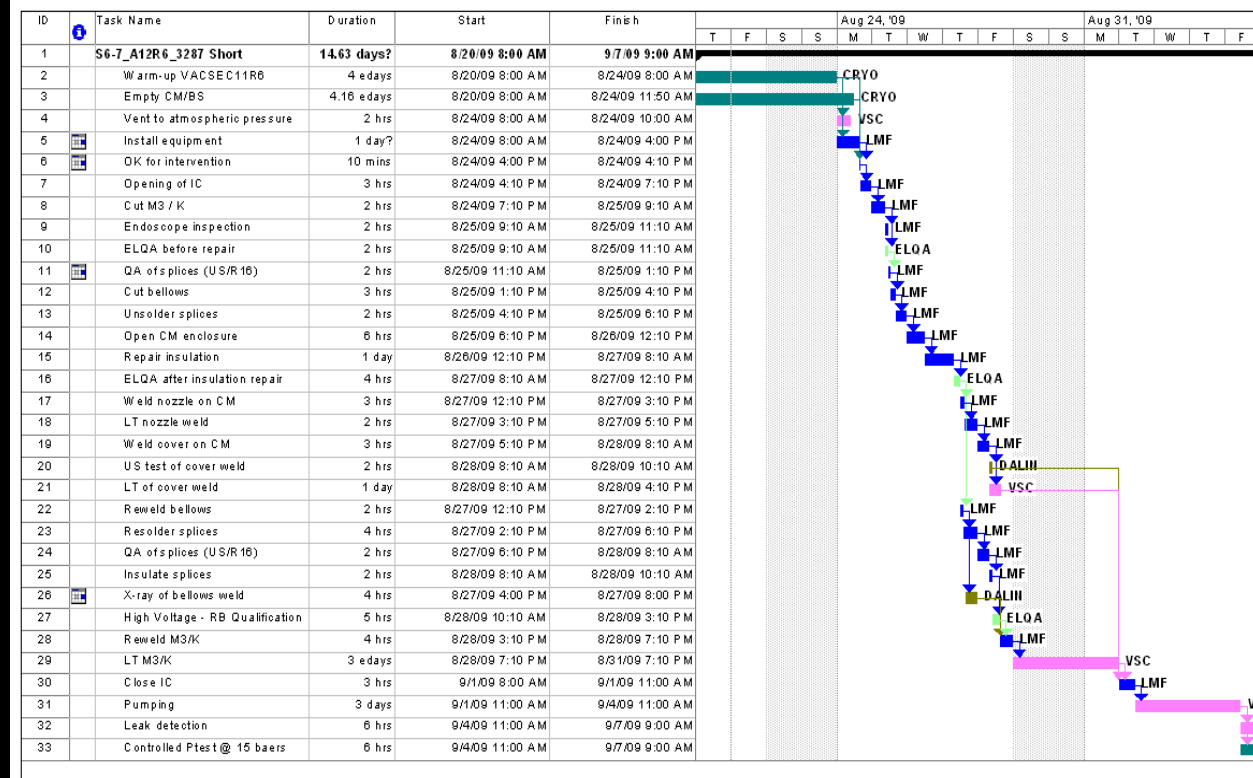
13. Reweld bellows
14. X-ray of bellows (butt weld)
15. Electrical insulation of the electrical connections
16. Reweld M3 sleeves and K hoses
17. Leak test of internal lines
18. Reinstallation of thermal shields (2 ICs)
19. Closure of the 2 ICs (Friday 28/08)
20. Pumping down of insulation vacuum
21. Electrical validation of repair (6 bars in CM / 2 bars in DFBs)
22. Leak tightness validation of insulation vacuum

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❖ Repair intervention

Planning

Detailed planning done
 2 weeks foreseen
 3 [1] days gained
 Because IC reclosed before WE
 So pumping down time hidden





Insulation fault in sector 67

❖ Perspectives for the future

- ❑ 6 sectors are below 60 K so most of thermal contraction done
- ❑ 3-4: T_{\max} in arc around 90 K / 8-1: T_{\max} around 110 K
No large motion expected any more
- ❑ Risks for this run is very limited

- ❑ Wearing effect + small margin
 - ❑ Similar cases for next thermal cycles can not be excluded

- ❑ Actions:
 - ❑ Prepare sets of insulating pieces
 - ❑ Procure more adequate tooling (surgical)
 - ❑ Integrate disconnection of both sides of the affected magnets from the beginning of the intervention for ELQA

- ❑ Open issues
 - ❑ Preventive actions ? Probably not ...
 - ❑ Reoccurrence of similar problem : possible (wearing)



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❖ Thank you for your attention

Special thanks to P Fessia for all the stolen slides



Sector 67 · RB circuit short to ground

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[Giorgio D'ANGELO](#)

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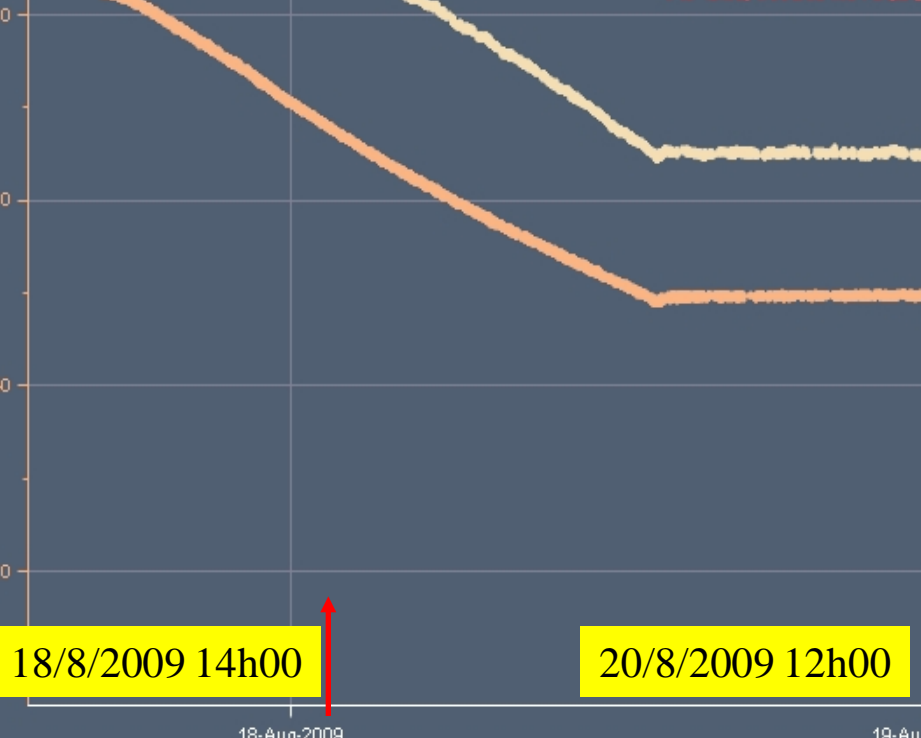
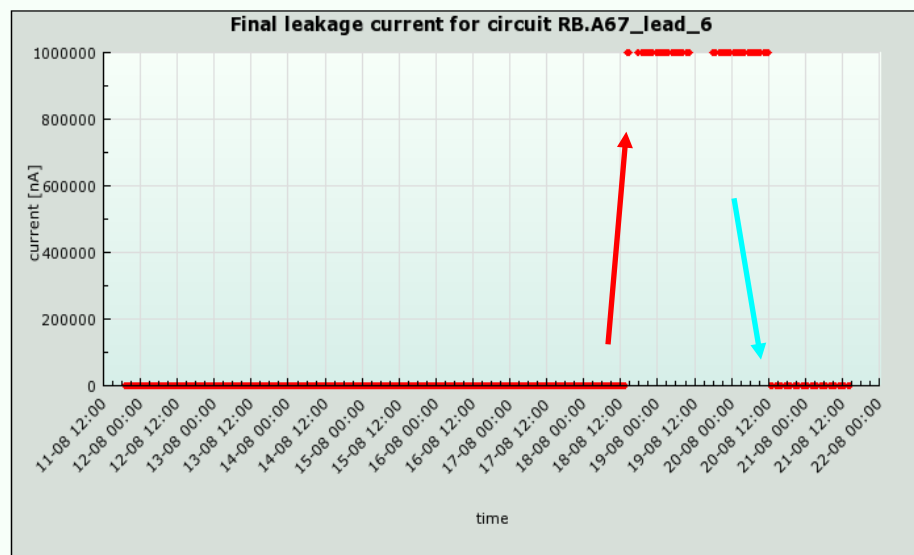
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Reference and Keywords

After 3 day of cool-down, a short circuit to ground was detected on the MBA.A67 line of the main dipole circuit. After diagnostic, the defect is localized at the level of dipole 3287 at the position A12R6. The warm-up is launched for repair.

TIMESERIES_CHART_IMAGE_(2).jpg
Type: JPG File
Size: 252 KB
Dimension: 1253 x 787 pixels

Detailed information for circuit RB.A67_lead_6



18/8/2009 14h00

20/8/2009 12h00

18-Aug-2009

19-Aug-2009



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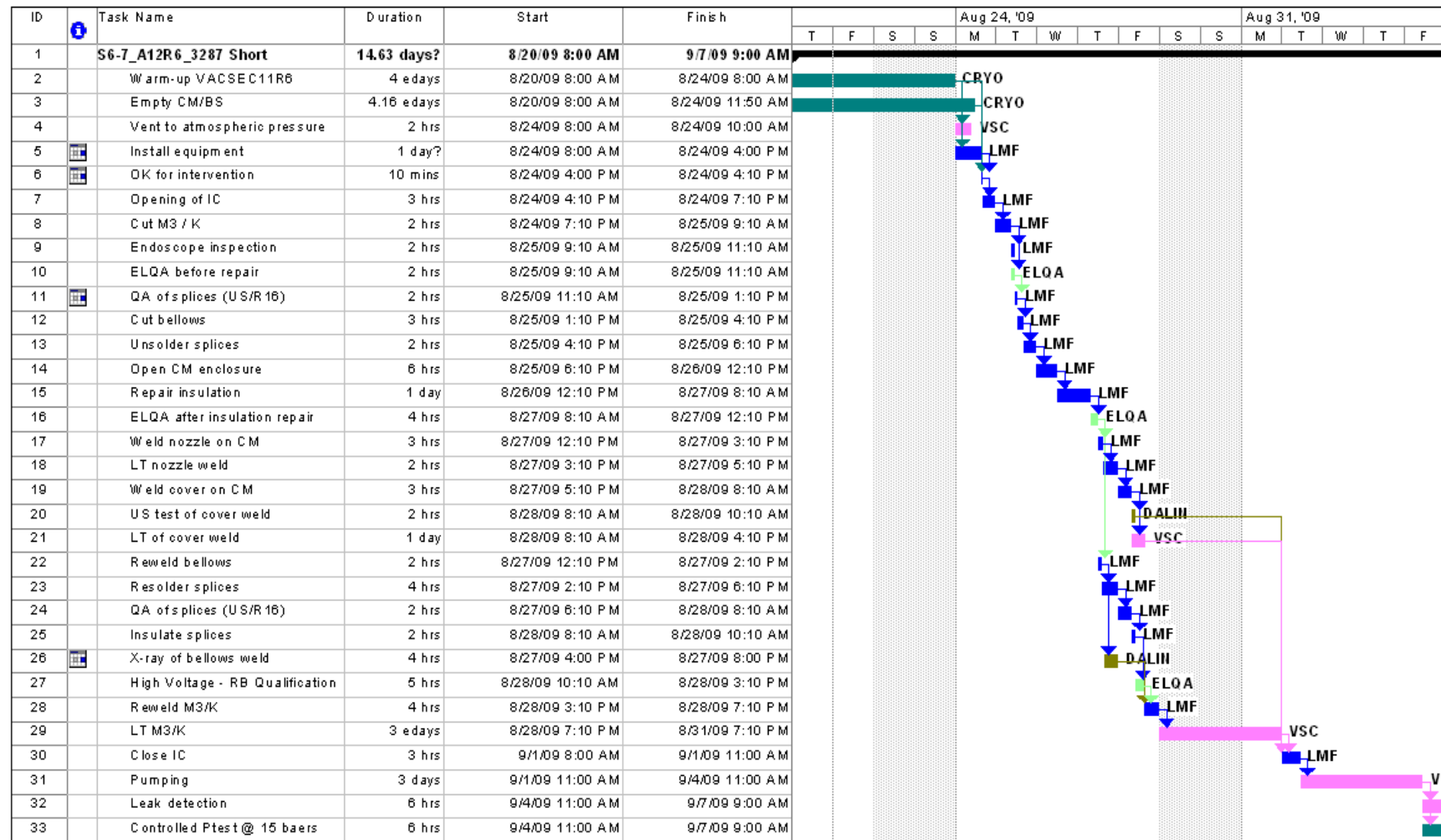
MSC-LMF, Main workshop, CRG, VSC, ELQA,...



Sector 67 : RB circuit short to ground

❖ Intervention : Planning

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Sector 67 : RB circuit short to ground

❖ Intervention : Main Milestones

Will be updated in daily emails

1. 25/8/09PM Localization of defect
2. 27/8/09 Repair of insulation done and tested
3. 28/8/09 Internal lines reconnected
4. 31/8/09 Leak test of internal lines
5. 1/9/09 IC reclosed
6. 4/9/09 Repair completed; insulation vacuum tested.



Sector 67 : RB circuit short to ground

❖ Intervention : Reference documents

NC: 1016291
ADI: 4175765
AOC: 4171998
Fire Permit: 4172321
RadioProteccion: (N Conan) informed.
Elec consignation: EN/MEF/LPC A1825
Cryo work permit: Should be OK at 12:00

No intervention before this