MIRKO POJER

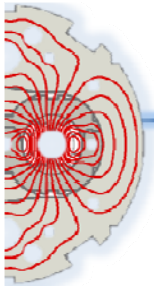
How to deal with non-conformities

HARDWARE COMMISSIONING DAY

Acknowledgements: A. Ballarino, K.-H. Meβ, Y. Thurel, W. Venturini

I'M NOT GOING TO SPEAK ABOUT…

- September 19 related NCs (relief valves, anchored/bypassed splices,…)
- I will only (or mainly) speak about electrical NCs
- Sector 3-4: I don't speak about it, since it will be completely re-qualified (better checked than the others…); but the impact on powering tests will be strong:
  - Short-circuit tests with 24h heat run
  - Full commissioning campaign
  - Cables integrity still to be verified…..
- Cryogenics NC's:
  - SAM, IT copper strips, thermometers, valves/clapets, Y-lines (not in 7-8 and 8-1), …
- AUG discoveries and requested modifications
- Change of cables (pt.4 and 6) and additional cables in pt.3
- SEU being followed by the R2E working group (inspections/iterations on the different points ongoing)



CONTENTS

- Where to find non-conformities
- Already requested changes
- List of non-conformities
- One question…
- Who opens NCs and who solves them
- 2 more NCs

WHERE TO FIND NCS

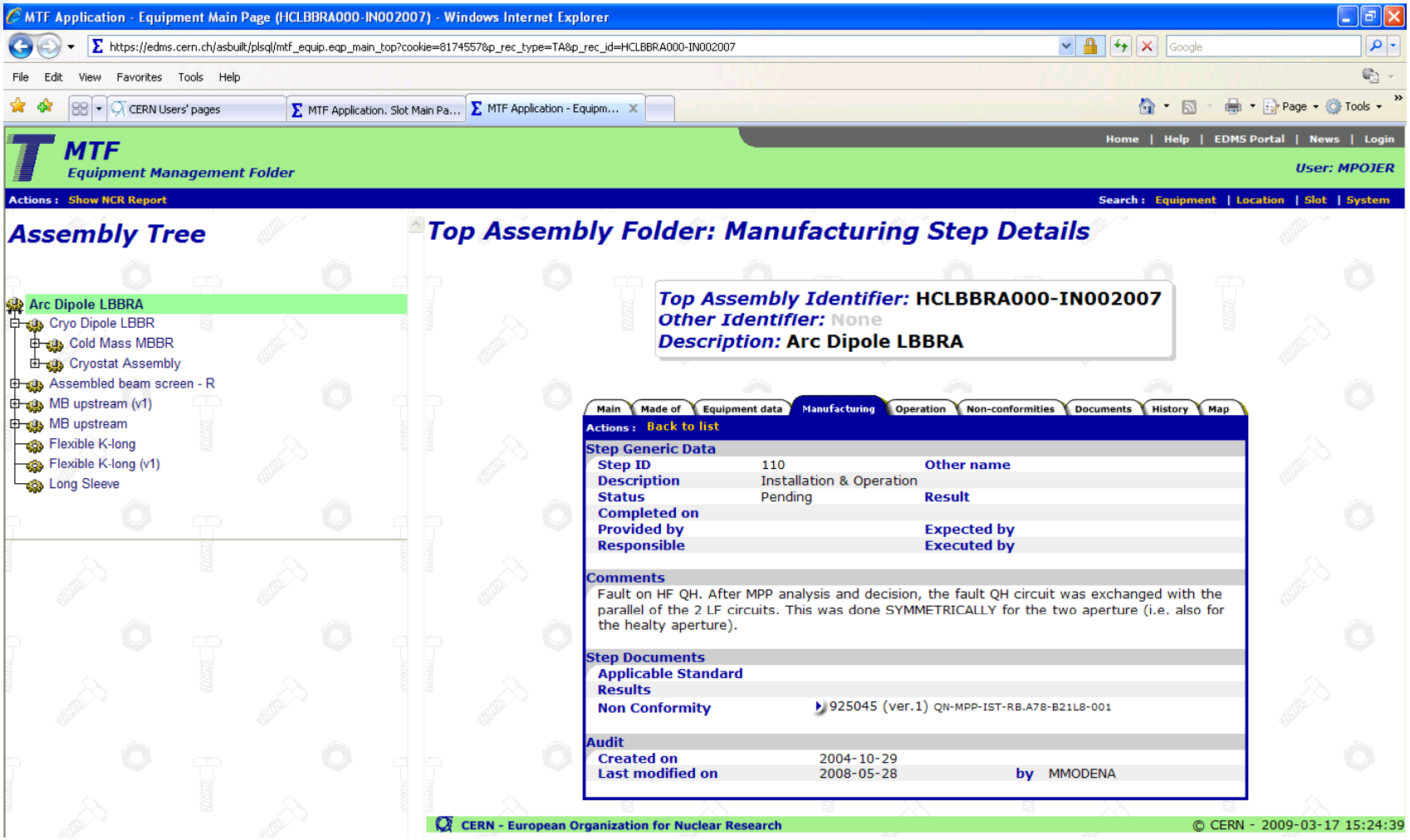
EDMS NCs IN ALL SECTORS

Non Conformity	MTF Entry	Type	Importance	Disposition	"Real" status
Sector 1-2					
QN-ELQA-PAQ-34L2-001	DE.RCD.A12B1	Electrical / Instrumentation	Critical	Decision Pending	Closed with warnings
QN-ELQA-PAQ-19R1-001	DE.RCS.A12B2	Electrical / Instrumentation	Critical	Decision Pending	Closed with warnings
QN-ELQA-TP4E-IRC-RD1.L2-001	DE.RD1.L2	Electrical / Instrumentation	Critical	Decision Pending	Closed with warnings
Sector 2-3					
QN-ELQA-PAQ-14R2-001	DE.RCS.A23B1	Electrical / Instrumentation	Critical	Repair	Closed with warnings
NCR IN020 Smoothing of TCSG.4L3.B2	TCSG.4L3.B2	Mechanical / Geometry	Critical	Decision Pending	Initiated
Sector 3-4					
QN-ELQA-AIV-RQTL7.R3.B1-001	DE.RQTL7.R3B1	Electrical / Instrumentation	Critical	Decision Pending	Following 3-4 incident
QN-ELQA-AIV-RQTL7.R3.B2-001	DE.RQTL7.R3B2	Electrical / Instrumentation	Critical	Decision Pending	Following 3-4 incident
Sector 4-5					
QN-ELQA-DOC-C-RCBV30.R4B2-002	DE.RCBV30.R4B2	Electrical / Instrumentation	Critical	Decision Pending	ElQA to be repeated before pow.
Sector 5-6					
QN-ELQA-MPAQ-26L6/12L6-001	DE.RQD.A56	Electrical / Instrumentation	Critical	Use-as-is	Closed with warnings
Sector 6-7					
Sector 7-8					
QN-ELQA-TP4B-HVQ-RCO.A78B2-001	DE.RCO.A78B2	Electrical / Instrumentation	Critical	Decision Pending	Closed with warnings
NC-ELQA-ICC-Q4L8-YT313-001	DE.RQ4.L8	Electrical / Instrumentation	Critical	Decision Pending	Closed with warnings
PROBLEME D'ISOLATION ELECTRIQUE SUR L'UN DES CABLES DC DU CIRCUIT RQ5.L8 AU NIVEAU DE LA DFBMC	DW.RQ5.L8	Electrical / Instrumentation	Critical	Decision Pending	Closed???
QN-ELQA-TP4E-ORC-MCBCHS5.L8B1-001	DE.RCBCHS5.L8B1	Electrical / Instrumentation	Non critical	Use-as-is	Corrector replaced by WM
Sector 8-1					
QN-ELQA-DOC-W-RCBV19.L1B1-001	DE.RCBV19.L1B1	Electrical / Instrumentation	Critical	Decision Pending	Should be closed!!!
QN-ELQA-TP4E-IRC-RCBXH2.L1-001	DE.RCBXH2.L1	Electrical / Instrumentation	Critical	Decision Pending	Closed with warnings
QN-ELQA-TP4E-ICC-RCO.A81B1-001	DE.RCO.A81B1	Electrical / Instrumentation	Critical	Decision Pending	CL resistance too high
QN-ELQA-TP4E-ICC-RCO.A81B2-001	DE.RCO.A81B2	Electrical / Instrumentation	Critical	Decision Pending	CL resistance too high
QN-ELQA-TP4E-ICC-RCOSX3.L1-001	DE.RCOSX3.L1	Electrical / Instrumentation	Critical	Decision Pending	R in circuit: to be followed in pow.
QN-ELQA-TP4E-HVQ-RD1.R8-001	DE.RD1.R8	Electrical / Instrumentation	Critical	Decision Pending	Closed with warnings
QN-ELQA-TP4A-ICC-RQX.L1-001	DE.RQX.L1	Electrical / Instrumentation	Critical	Decision Pending	Closed with warnings
QN-ELQA-TP4A-POL-RQX.L1-001	DE.RQX.L1	Electrical / Instrumentation	Critical	Decision Pending	Should be closed!!!
QN-ELQA-TP4E-IRC-RTQX2.L1-001	DE.RQX.L1	Electrical / Instrumentation	Critical	Decision Pending	Closed with warnings

Faulty QH

The reconfigurations of the main dipoles quench heaters are missing?

QUENCH HEATER NCS

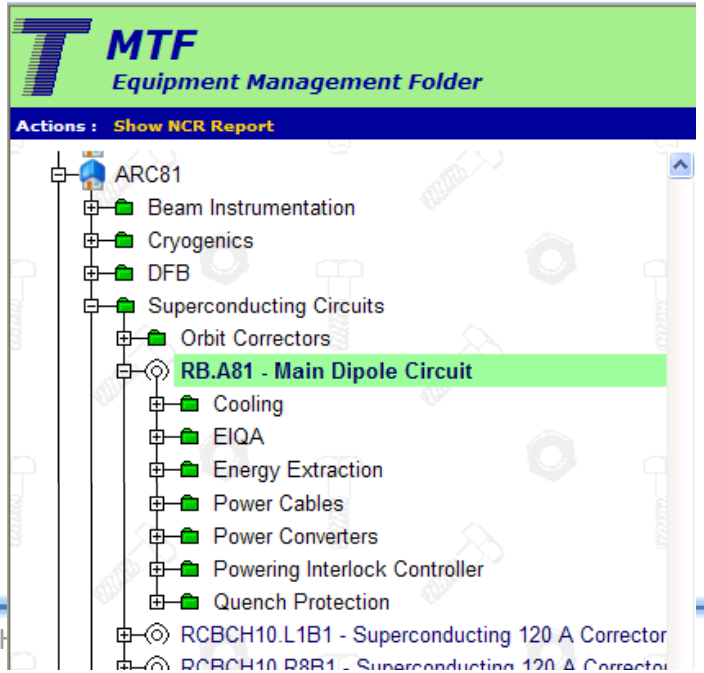


The NC is attached to the magnet but not to the circuit!

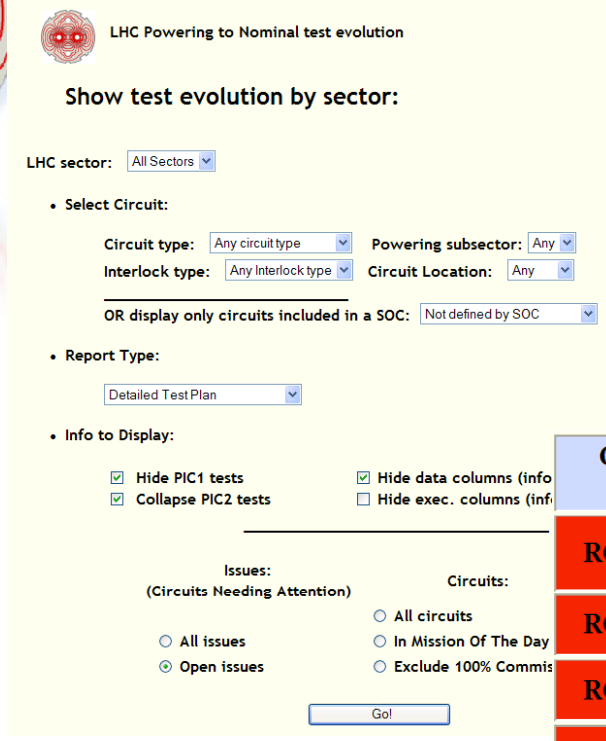
QUENCH HEATER NCs

No	Title	EDMS	HWC phase	Circuit	Application	Date	Current Status	MTF	Status EDMS	Description
1	QN-MPP-IST-RB.A12-C15R1-001	947913	Cold	RB.A12	IST	8-Aug-08	Initiated		Initiated	The IST test performed by the QPS team failed during the discharge of the quench heater YT111 of the magnet 2395 at C.15R1. The QH circuit has been found open below the cover flange, probably at the output of the capillary tube.
2	QN-MPP-IST-RB.A12-C32R1-001	947915	Cold	RB.A12	IST	8-Aug-08	Initiated		Initiated	The IST test performed by the QPS team failed during the discharge of the quench heater YT111 of the magnet 1372 at C.32R1. The QH circuit has been found open below the cover flange, probably at the output of the capillary tube.
3	QN-MPP-IST-RB.A23-A21L3-001	942550	Cold	RB.A67	IST	10-Jul-08	To be opened		Initiated	During IST test, QPS team found abnormal shape during the discharge of quench heaters power supply on magnet A21L3 (MBAL3708). QH YT121 was found broken. Investigations performed by ELQA team confirm that the YT is open and that insulation vs GND and vs coil is fine. On 03/07/08 YT 121 was isolated inside IFS box (wires cut and isolated). On 10/07/08 further investigation (TDR) is done to localise the open circuit. The result of TDR shows that the YT121 is open just below cover flange and might be repaired once the magnet is warmed up. When disconnecting P10 connector on 10/07/08, the capacitor bank where still charged ! This led to a dangerous arc between P10 connector cable and P10 socket. Pins are damaged. Integrity of cable is fine. The connector P10 is changed. Insulation integrity is checked and is fine.
4	QN-MPP-IST-RB.A45 C17R4 001	961338	Cold	RB.A45	IST	29-Aug-08	Initiated		Closed	During IST test, QPS team found abnormal shape during the discharge of quench heaters power supply on magnet C17R4 (MBBL2214). QH YT211 resistance is high (14.5Ohm instead of 11.3) and current decay is fast at the beggining of the discharge. Investigations performed by ELQA team confirm that the YT211 resistance is high and YT211 - is shorted to GND (2.4 Ohm from P10). QH YT211 was isolated inside IFS box and being replaced for protection by two low field quench heaters. Following the standard procedure in case of broken or damaged quench heaters YT211 has been replaced by the two LF heaters YT212 and YT222 wired in parallel. The new configuration has been successfully tested. NC Closed
5	QN-MPP-IST-RB.A67-A32L7-001	938121	Cold	RB.A67	IST	15-Jul-08	Initiated		Initiated	During IST test, QPS team found abnormal shape during the discharge of quench heaters power supply on magnet A32L7 (MBBR1263). QH YT211 was found broken (open circuit). Investigations performed by ELQA team confirm that the YT211 is open and that insulation vs GND and vs coil is fine. TDR diagnostic shows that the YT211 is open just below cover flange and might be repaired once the magnet is warmed up.
6	QN-MPP-IST-RB.A78-B21L8-001	925045	Cold	RB.A78	IST	7-May-08	Can be closed		Initiated	During IST test, QPS team found abnormal shape during the discharge of quench heaters power supply on magnet B21L8 (MBBR2007).

It could be interesting/important to create an arborescence attached to the different circuits for (n)MPP or OP, where to put all NCs related to test or operation of the circuits
("Performance" folder)



"POINT OWNERS' NCs"



CIRCUIT NAME	LAST PASSED TEST	TESTS EXEC	LAST EXEC	SUC	UNDER EXEC	EXECUTION PLAN
RCO.A78B2	PIC2 TEST HW LINKS	9 / 12 (75%)	PCS	N	_	PCL PCC.5 PIC2 PCS PNO.d3 PNO.a3 PIC2 GPM
RCO.A81B1	PCL	1 / 12 (8%)	PCC.5	N	_	PCL PCC.5 PIC2 PCS PNO.d3 PNO.a3 PIC2 GPM
RCO.A81B2	PCL	1 / 12 (8%)	PCC.5	N	_	PCL PCC.5 PIC2 PCS PNO.d3 PNO.a3 PIC2 GPM
RQS.L2B1	PIC2 CRYO-OK	3 / 12 (25%)	PIC2 CRYO-OK	Y	_	PCL PCC.5 PIC2 PCS PNO.d3 PNO.a3 PIC2 GPM
RQS.R2B2	PIC2 GLOBAL PROTEC MECH	12 / 12 (100%)	PIC2 GLOBAL PROTEC. MECH	Y	_	PCL PCC.5 PIC2 PCS PNO.d3 PNO.a3 PIC2 GPM
RCBCHS5.L8B1	24 HOUR HEAT RUN	0 / 9 (0%)	_	_	_	PCL PCC.1 PIC2 PNO.a1 PNO.d1 PNO.e1 PIC2 GPM
RCBYH4.R8B1	PNO.d1	8 / 9 (88%)	PNO.e1	N	_	PCL PCC.1 PIC2 PNO.a1 PNO.d1 PNO.e1 PIC2 GPM
RCBYHS5.R8B1	PNO.d1	8 / 9 (88%)	PNO.e1	N	_	PCL PCC.1 PIC2 PNO.a1 PNO.d1 PNO.e1 PIC2 GPM
RD2.R8	PNO.e2	12 / 12 (100%)	PNO.e2	Y	_	PCL PCC.3 PIC2 PLI1.e2 PLI2.f2 PNO.e2 PIC2 GPM
RQX.L2	PNO.d11	16 / 16	PNO.d11	Y		PCC.T1 PCC.T3 PCC.T5 PIC2 PLI2.e3 PLI3.d8 PLI2.e6 PLI3.d10 PLI3.f6 PNO.d8 PNO.f7 PNO.d11 PIC2

CIRCUIT NAME	Reason	Last Updated	Responsible	Modified by
RCO.A78B2	QPS NEEDS TO DO SOME MORE ANALYSIS - POSSIBLE SPLICE ISSUE	03-SEP-08 09:13:45	QPS	A.VERGARA
RCO.A81B1	RESISTANCE SEEN BY THE PC. POSSIBLY COMING FROM THE CL.	17-JUN-08 11:33:36	MPP	C. FERNANDEZ
RCO.A81B2	RESISTANCE SEEN BY THE PC. POSSIBLY COMING FROM THE CL.	17-JUN-08 11:35:05	MPP	C. FERNANDEZ
RQS.L2B1	IT HAS TO BE DECIDED IF A DC CONTACTOR IS TO BE INSTALLED.	18-JUL-08 10:15:34	PO	M.P.CASAS LINO
RQS.R2B2	IT HAS TO BE DECIDED IF A DC CONTACTOR IS TO BE INSTALLED.	18-JUL-08 10:08:09	PO	M.P.CASAS LINO
RCBCHS5.L8B1	CIRCUIT REPLACED BY THE WARM CORRECTOR MAGNET	08-MAY-08 17:33:20		A.VERGARA
RCBYH4.R8B1	CIRCUIT BLOCKED BY MPP TILL FURTHER INVESTIGATION	09-SEP-08 11:17:08	MPP , PO	A. VERGARA
RCBYHS5.R8B1	CIRCUIT BLOCKED BY MPP	09-SEP-08 11:16:29	MPP, PO	A.VERGARA
RD2.R8	DETRAINING QUENCH AT 5847 A (FIRST ONE AT 5854 A). DECISION OF MPP TO BE TAKEN BEFORE CONTINUING THE POWERING.	28-AUG-08 11:46:36	MPP	C. FERNANDEZ
RQX.L2	LE CABLE 120514 RQX.L2 BFLX 3L2.3 B EST ISOLE' PROVISOIREMENT AVEC DES FEUILLES KAPTON ET DU POLYETHYLENE POUR EVITER UN COURT-CIRCUIT…	11-AUG-08 14:17:34	ALAIN JACOB	M.P.CASAS LINO

ANOTHER CONTAINER FOR NCS

Table 1 Status of commissioning of all circuits in sector 1-2.

Circuit Type	Total number of circuits	Commissioned to 7 TeV	Commissioned only to 5 TeV	To be commissioned
RB, RQ	3	-	3	-
IPQ, IPD	31	31	-	-
Triplet	2	-	1	1
600A	53	36	15	2
80-120A	50	42	8	-
60A	94	94	-	-
TOTAL	**233**	**203**	**27**	**3**

Table 1 Status of commissioning of all circuits in sector 2-3.

Circuit Type	Total number of circuits	Commissioned to 7 TeV	Commissioned only to 5 TeV	To be commissioned
RB, RQ	3	-	3	-
IPQ, IPD	16	16	-	-
Triplet	1	1	-	-
600A	56	32	20+2(<5TeV)	2*
80-120A	37	33	4	-
60A	94	94	-	-
TOTAL	**207**	**176**	**29**	**2**

Table 1 Status of commissioning of all circuits in sector 4-5.

Circuit Type	Total number of circuits	Commissioned to 7 TeV	Commissioned only to 5 TeV	To be commissioned
RB, RQ	3	-	3	-
IPQ, IPD	16	14+2(<7TeV)	-	-
Triplet	1	-	-	1
600A	47	28+1(<7TeV)	4	14
80-120A	35	30+1(<7TeV)	-	4
60A	94	94	-	-
TOTAL	**196**	**170**	**7**	**19**

Table 1 Status of commissioning of all circuits in sector 5-6.

Circuit Type	Total number of circuits	Commissioned to 7 TeV	Commissioned only to 5 TeV	To be commissioned
RB	1	-	1 (6.61 TeV)	-
RQ	2	2 (11280 A)	-	-
IPQ, IPD	12+1	12+1	-	-
Inner Triplet	1	-	1	-
600A	46	17	16 + 13 (<5TeV)	-
80-120A	33	29	3	1
60A	94	94	-	-
TOTAL	**190**	**155**	**34**	**1**

Table 1 Status of commissioning of all circuits in sector 6-7.

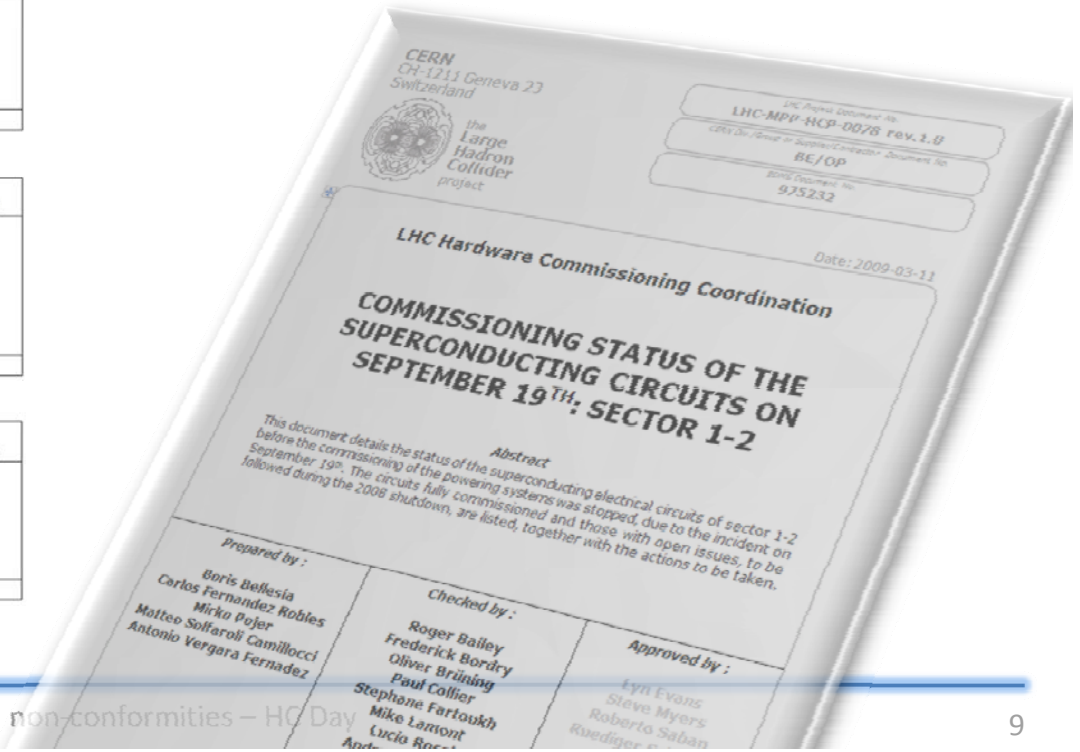
Circuit Type	Total number of circuits	Commissioned to 7 TeV	Commissioned only to 5 TeV	To be commissioned
RB	1	-	1	-
RQ	2	-	2	-
IPQ	5	5	-	-
600A	49	19	28+2 (<5TeV)	-
80-120A	20	20	-	-
60A	94	94	-	-
TOTAL	**171**	**138**	**33**	**-**

Table 1 Status of commissioning of all circuits in sector 7-8.

Circuit Type	Total number of circuits	Commissioned to 7 TeV	Commissioned only to 5 TeV	To be commissioned
RB, RQ	3	-	3	-
IPQ, IPD	9	9	-	-
Triplet	1	1	-	-
600A	56	30	24+1(<5TeV)	1
80-120A	37	32	-	5
60A	94	94	-	-
TOTAL	**200**	**166**	**28**	**6**

Table 1 Status of commissioning of all circuits in sector 8-1.

Circuit Type	Total number of circuits	Commissioned to 7 TeV	Commissioned only to 5 TeV	To be commissioned
RB, RQ	3	-	3	-
IPQ, IPD	17	16+1(<7TeV)	-	-
Triplet	2	-	-	2
600A	53	51	-	2
80-120A	50	38	-	12
60A	94	94	-	-
TOTAL	**219**	**200**	**3**	**16**


CERN
CH-1211 Geneva 23
Switzerland

the Large Hadron Collider project

LHC-MPP-HCP-0078 rev.1.0

BE/OP

975232

Date: 2009-03-11

LHC Hardware Commissioning Coordination

COMMISSIONING STATUS OF THE SUPERCONDUCTING CIRCUITS ON SEPTEMBER 19TH: SECTOR 1-2

Abstract

This document details the status of the superconducting electrical circuits of sector 1-2 before the commissioning of the powering systems was stopped, due to the incident on September 19th. The circuits fully commissioned and those with open issues, to be followed during the 2008 shutdown, are listed, together with the actions to be taken.

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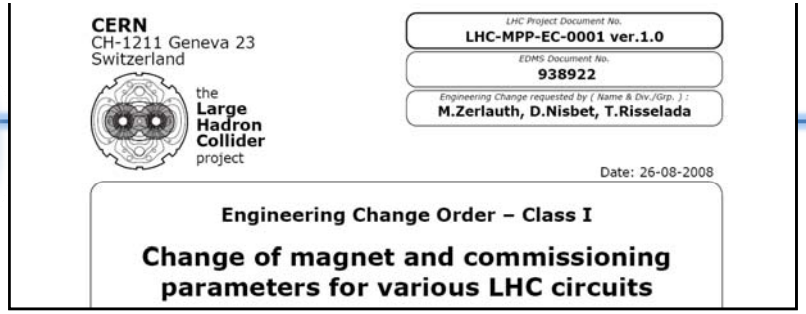
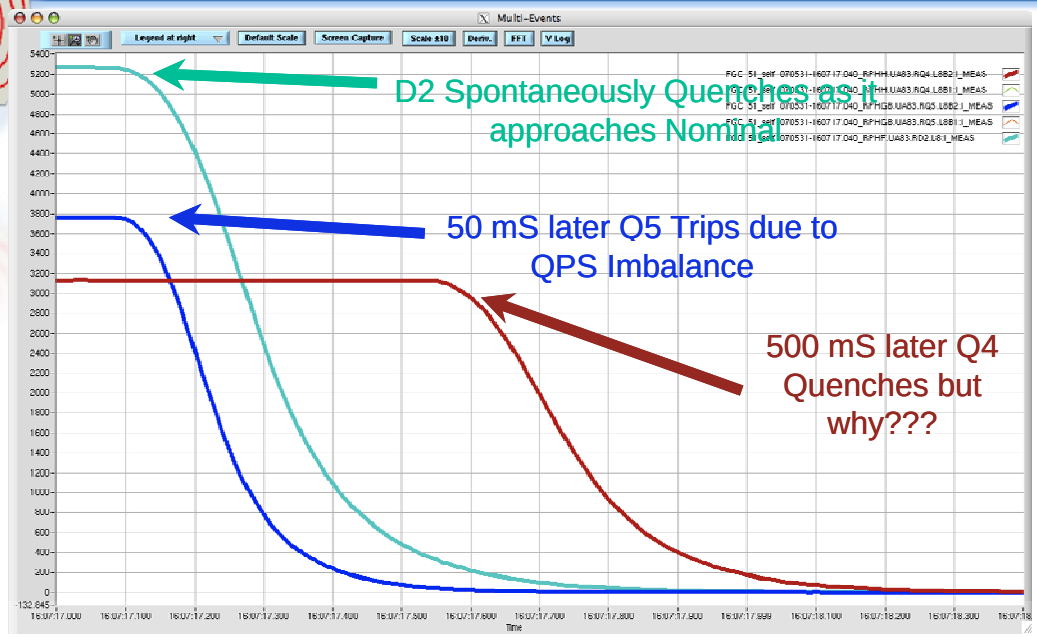

CERN
CH-1211 Geneva 23
Switzerland
the Large Hadron Collider project
LHC Project Document No.
LHC-MPP-EC-0001 ver.1.0
EDMS Document No.
938922
Engineering Change requested by (Name & Div./Grp.) :
M.Zerlauth, D.Nisbet, T.Risselada
Date: 26-08-2008
Engineering Change Order – Class I
Change of magnet and commissioning parameters for various LHC circuits

ALREADY REQUESTED CHANGES

ECR EDMS938922

- RD3 and RD4:
  - Increase of nominal and ultimate current levels and max ramp rate:
    - RD3 →5860 (5520), 6340 (6000)
    - RD4 →6150 (5520), 6650 (6000)
    - Long run to verify cable performance with 20% additional heat load?
- RQX and RTQX2:
  - Problem if the pre-squeeze is done after the ramp
    - RQX in IR2 and IR8 →7180 (6450), 7180 (7000)
    - RQX in IR1 and IR5 →6800 (6450), 7180 (7000)
    - RTQX2 in IR2 and IR8 →4780 (4180), 4780 (4410)
    - RTQX2 in IR1 and IR5 →4600 (4180), 4780 (4410)
- 600 A circuits – change in ramp rate:
  - RCO, from 1 to 3 A/s
  - RQ6.L/R3, RQ6.L/R7, from 1.361 to 3 A/s
  - RCBXH/V1, from 1.667 to 5 A/s
- RCBH/V – change of ramp rate from 0.5 to 1 A/s

D2-Q4-Q5 MIX-UP



The D2 was quenching when the Q4-B1 was at high value

The Quench was likely in the part, where the power busses are in the DFBM "side-by-side"

Once the cable where shaken into place, no quench occurred any more

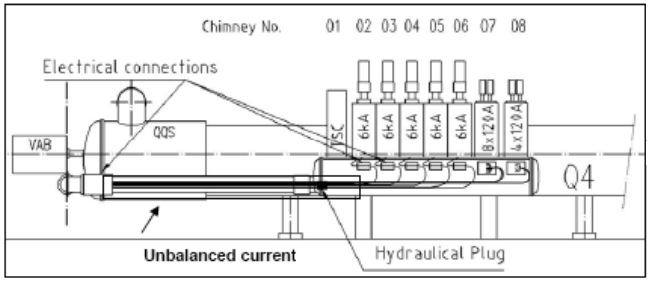


Figure 2. Schematic view of 6kA busbar rou

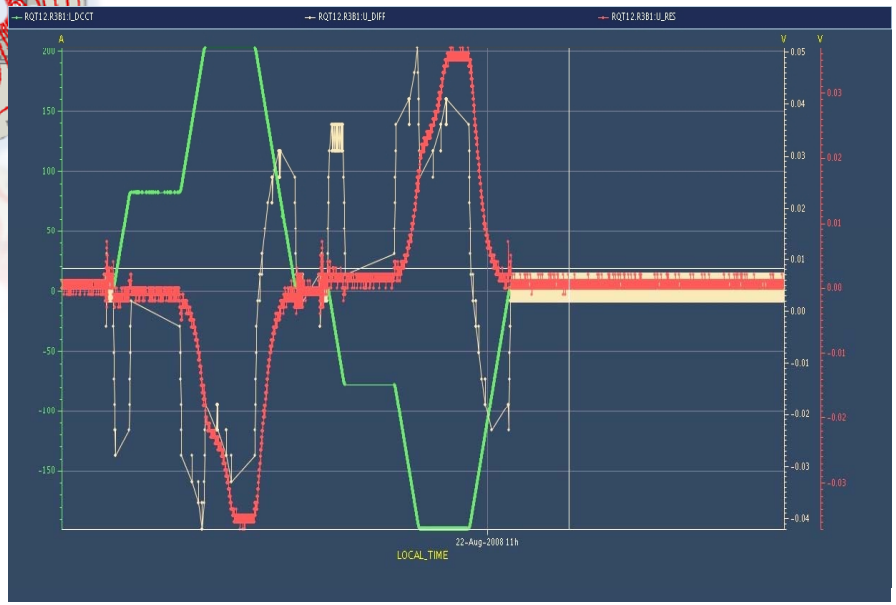
Table 2. Distribution of busbars in DFBMAs with NC

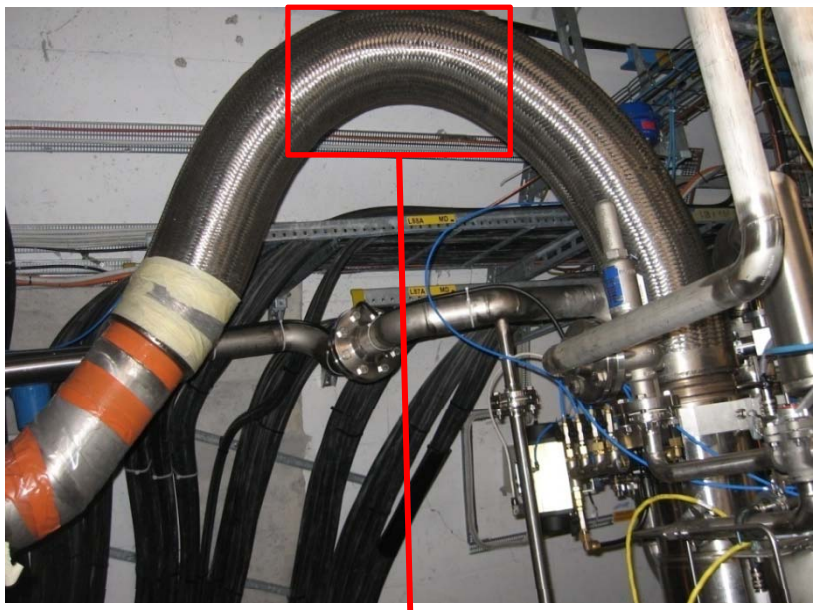
DFB	sector	IR	Cable 1			Cable 2		
DFBMA.4L2	1-2	2L	D2A	D2B	Q4A	Q4B	Q4C	not used
DFBMA.4L8	7-8	8L	D2A	D2B	Q4A	Q4B	Q4C	not used

The fault is still in the LHC and may show up again, here and elsewhere.

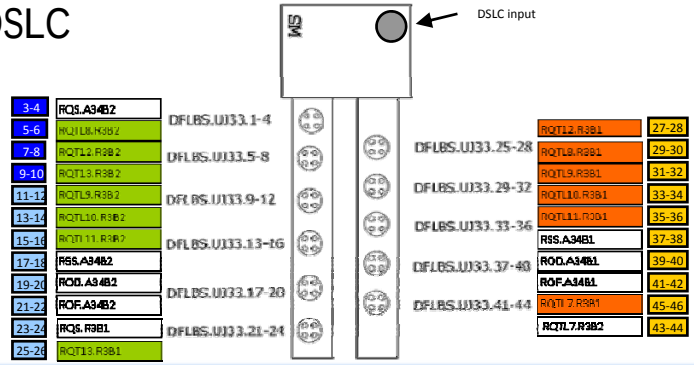
DFB	Cable 1			Cable 2			Cable 3			Cable 4		
DFBAO.L8	?	?	?	?	?	?	?	?	?	?	?	?
DFBAA.L1	Q9C	Q9A	Q7B	Q10A	Q10B	Q10C	Q7A	Q7C	Q8B	Q8A	Q8B	Q9B
DFBAP.R8	Q8A	Q8C	Q10C	Q9C	Q9B	Q8C	Q7A	Q7B	Q9A	Q10A	Q10B	Q7C
DFBAH.R4	Q7C	Q10B	Q9B	Q9A	Q8B	Q9C	Q8A	Q7A	Q8C	Q7B	Q10A	Q10C
DFBAI.L5	Q8A	Q8B	Q10B	Q7A	Q7C	Q8C	Q9B	Q9C	Q7B	Q10A	Q10C	Q9A
DFBMA.4L2	D2A	D2B	Q4A	Q4B	Q4C							
DFBMA.4L8	D2A	D2B	Q4A	Q4B	Q4C							
DFBLA.L1	D2A	D2B	Q6A	Q6B	Q6C		Q4A	Q4B	Q4C	Q5A	Q5B	Q5C
DFBLB.R1	D2A	D2B	Q6A	Q6B	Q6C		Q4A	Q4B	Q4C	Q5A	Q5B	Q5C
DFBLD.R5	D2A	D2B	Q6A	Q6B	Q6C		Q4A	Q4B	Q4C	Q5A	Q5B	Q5C

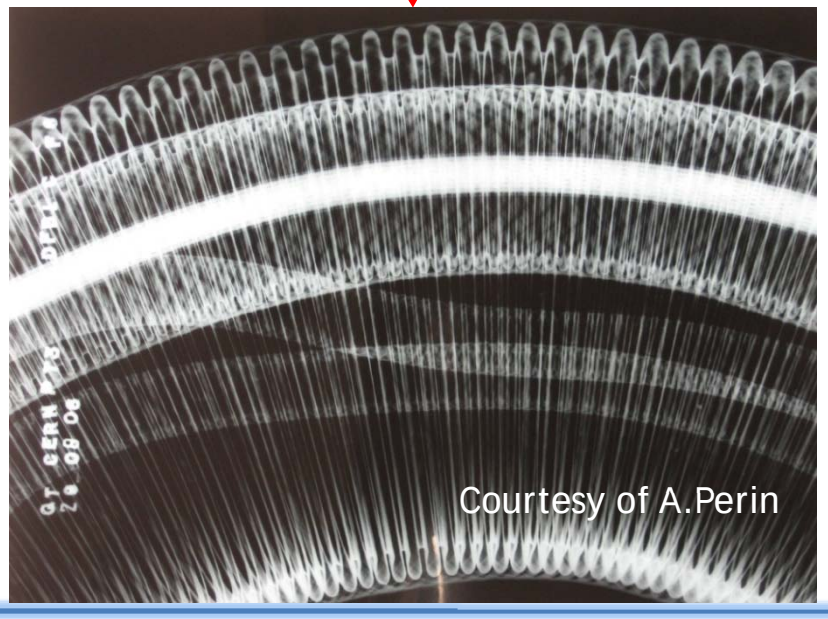
DSLC





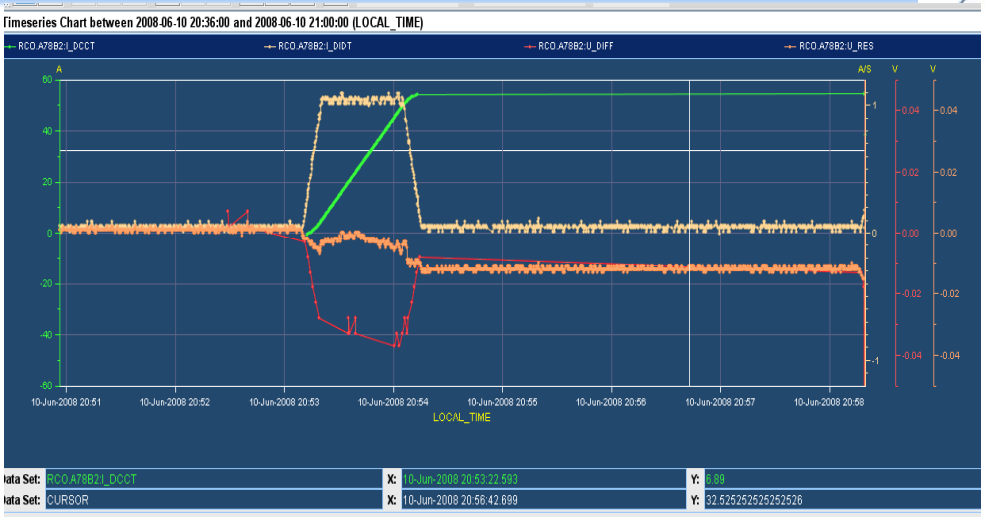
When powering some 600-A correctors of sector 3-4, fed from the DFBMC through the superconducting link, a voltage rise was observed, which is related to a mechanical NC on the DSLC





600-A BAD SPLICES?

- RCO.A78B2:
  - 77 correctors with more than 800 welded splices
- RQT13.L5B1:
  - It was decided to reduce the operating current: dangerous to use it?
- Similar for RQTF.A45B2



Circuit	Current	Delay	Comment
RQT13 L5B1	549.9 A		Quench
	550 A	28 s	Quench
	550 A	90 s	Trip, unknown
RQTF A45B2	525 A		Quench
	362 A		Quench
	454 A		Quench
	550 A	32 s	Quench
	550 A	2 s	Quench
	550 A	24 s	Quench
	550 A	26 s	EE Dump

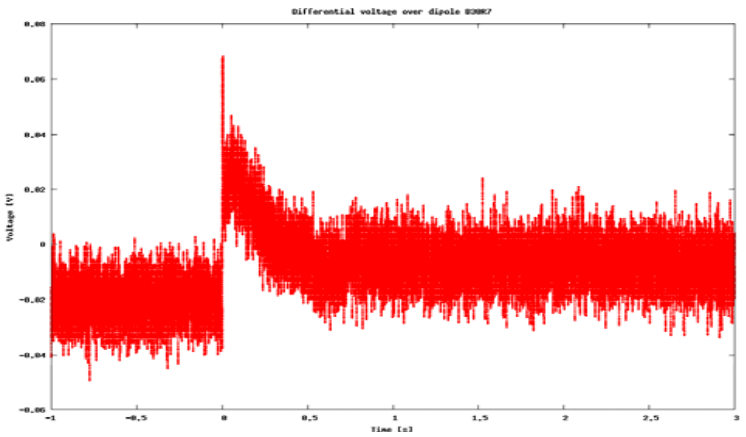
Is there a bad splice hidden somewhere?
Is reducing the nominal current enough?

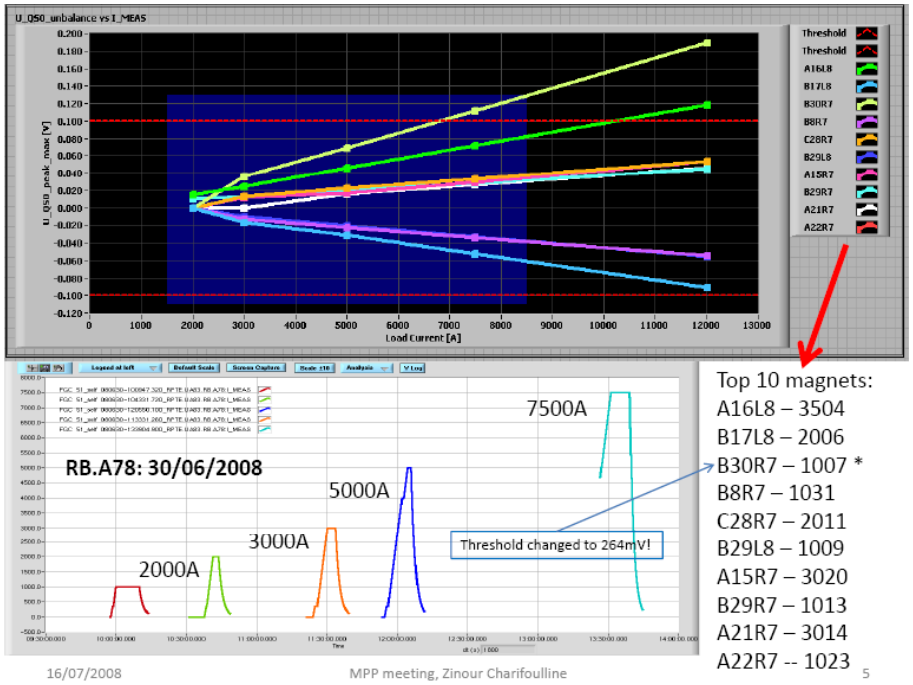
Do non-conformities exist for these circuits?
Are there documented recommendations?
Are we going to follow this up in this SD?

The "Performance" repository is the right place…

THE TRANSIENT SPIKE PROBLEM

- "Quench" in MB B30.R7 during fast discharge at 7000A dI/dt =-70A/s
- There is no real quench. There is a voltage difference between the two apertures which grows with dI/dt and exceeds 100mV.





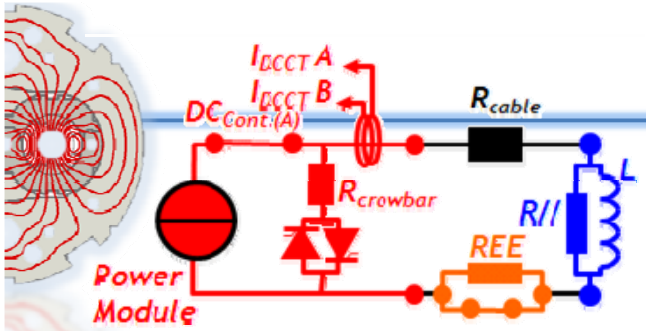
16/07/2008 MPP meeting, Zinour Charifoulline 3

16/07/2008 MPP meeting, Zinour Charifoulline 5

Changing the threshold is potentially dangerous!!!!

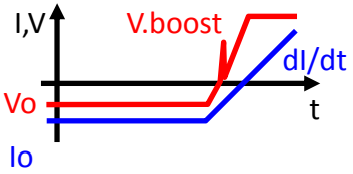
This could become an issue for the n-QPS…

POWER CONVERTERS: LHC 600A-10V



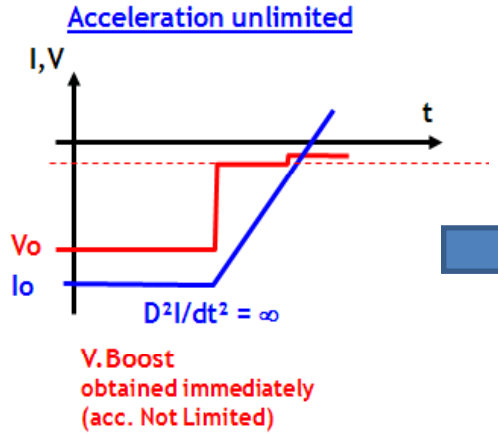
To deduce the resistive component of the magnet load, the di/dt must be calculated by QPS. The use of a derivative in the calculation requires for a long integration time, which is incompatible with reference jumps. Thus the calculation is only accurate for low di/dt and d^2i/dt^2.

The power converters generate some distortion when crossing through zero voltage with current in the load. This is very specific from the 4-quadrant power converter, with the result of a voltage spike, not filterable at the converter level (0V-crossing distortion)

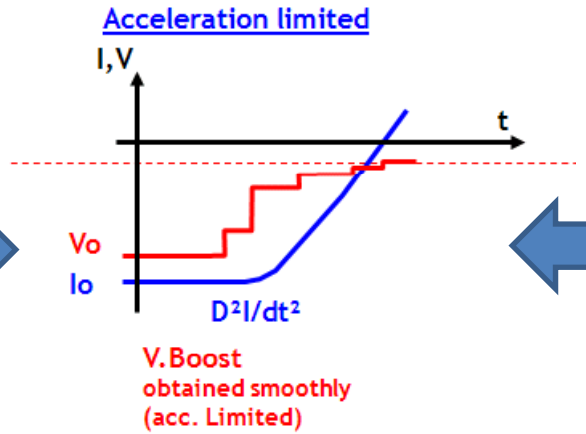


- ✓ PO made several measurements to characterize the zero-voltage-crossing distortion
- ✓ the QPS team has worked with PO to develop a filter to reduce the effect of the distortion on the voltage measurement
  - ➲ the solution also improved QPS robustness to di/dt and d^2i/dt^2 parameters

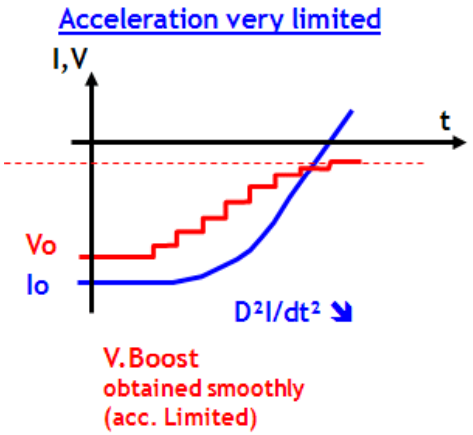
"Physics requirement"



"Compromise"

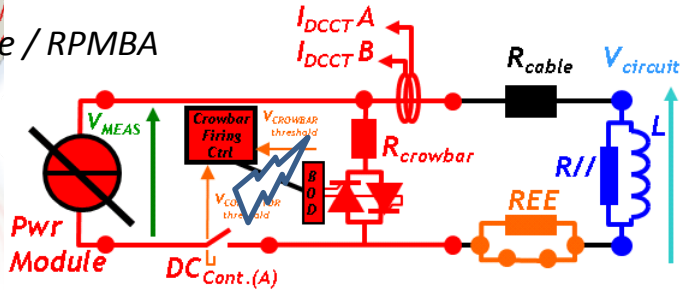


"QPS requirement"



600 A-10 V Crowbar Issue

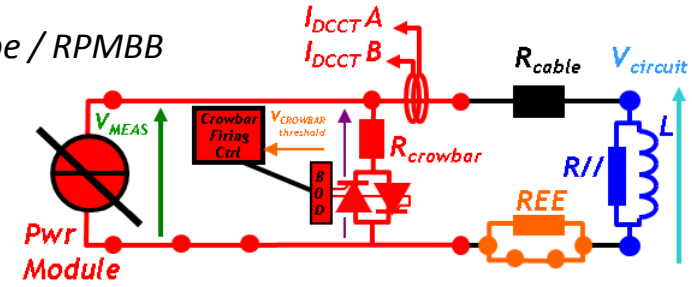
A-Type / RPMBA



A 600 A power module, when off, STILL drives a current in the range [-20A..20A], due to its 4-quadrant stage being STILL operating.

The A-Type rack is not affected by this behavior of the power module, since A-Type means a DC contactor is placed in series between the power module and the circuit.

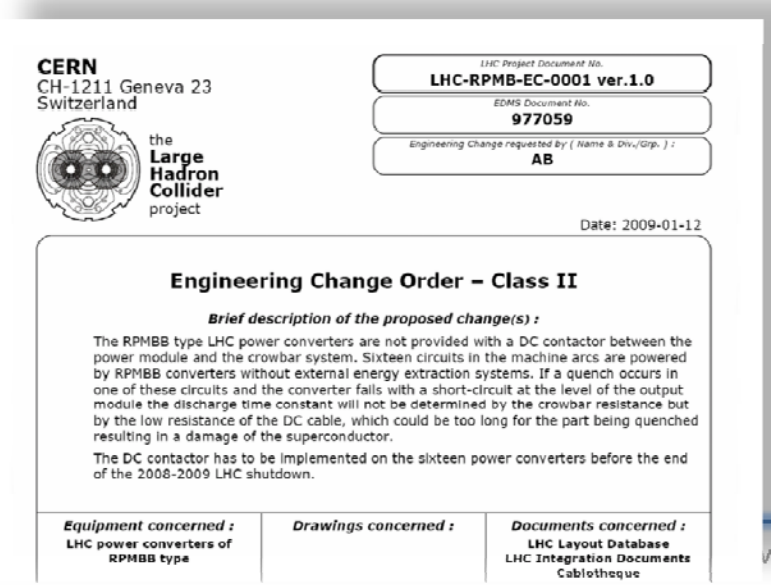
B-Type / RPMBB



For the B-Type, the crowbar activation relies on a 13 V threshold. For a low current (45 A during PCC test), the current generated by the 4-Q stage, when switching off the converter, reduces the voltage developed.

The PCC current was changed to 60 A

- **RPMBB.UJ33.RQTL9.L3B2REE**
- **RPMBB.UJ33.RQTL9.L3B1REE**
- **RPMBB.UJ33.RQTL9.R3B2REE**
- **RPMBB.UJ33.RQTL9.R3B1REE**



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LHC Project Document No.
LHC-RPMB-EC-0001 ver.1.0

EDMS Document No.
977059

Engineering Change requested by (Name & Div./Grp.) :
AB

Date: 2009-01-12

Engineering Change Order – Class II

Brief description of the proposed change(s) :

The RPMBB type LHC power converters are not provided with a DC contactor between the power module and the crowbar system. Sixteen circuits in the machine arcs are powered by RPMBB converters without external energy extraction systems. If a quench occurs in one of these circuits and the converter fails with a short-circuit at the level of the output module the discharge time constant will not be determined by the crowbar resistance but by the low resistance of the DC cable, which could be too long for the part being quenched resulting in a damage of the superconductor.

The DC contactor has to be implemented on the sixteen power converters before the end of the 2008-2009 LHC shutdown.

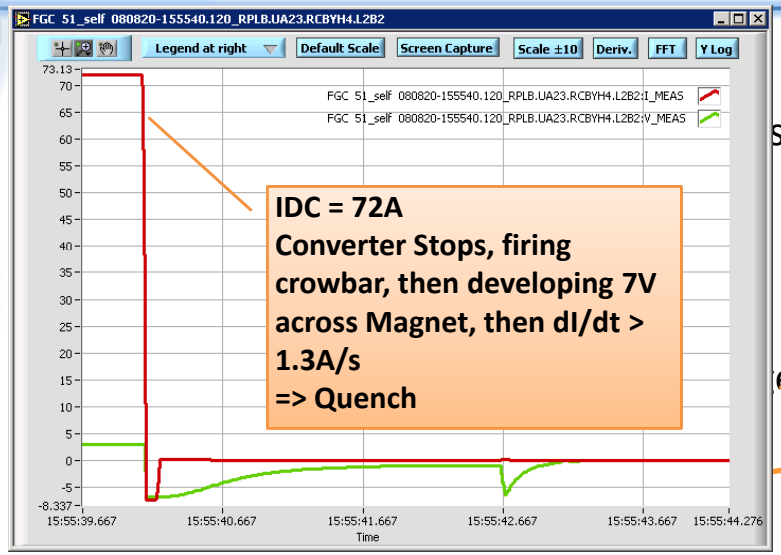
Equipment concerned :	*Drawings concerned :*	*Documents concerned :*
LHC power converters of RPMBB type		LHC Layout Database LHC Integration Documents Cablotheque

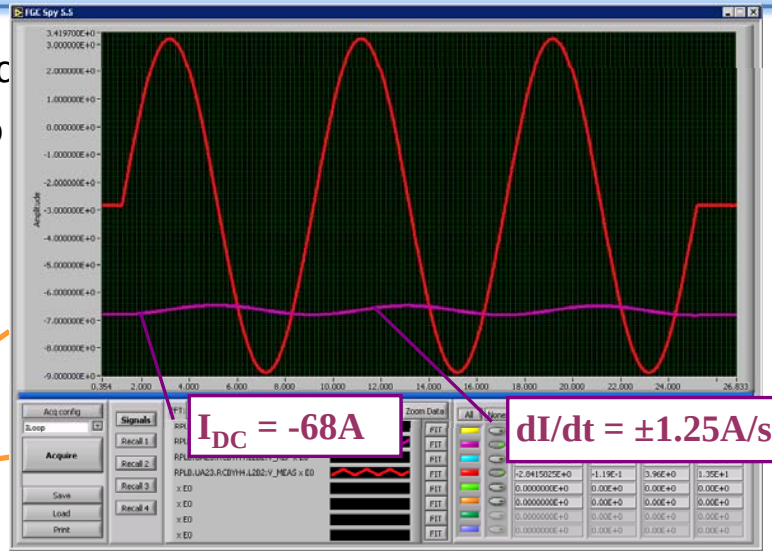
As in the previous case, with the difference that the current decay takes much longer.

The installation of a DC contactor has been requested

- **RPMBB.UA23.RQS.L2B1 No REE**
- **RPMBB.UA27.RQS.R2B2 No REE**
- **RPMBB.UA43.RQS.L4B1 No REE**
- **RPMBB.UA47.RQS.R4B2 No REE**
- **RPMBB.UA63.RQS.L6B1 No REE**
- **RPMBB.UA67.RQS.R6B2 No REE**
- **RPMBB.UA83.RQS.L8B1 No REE**
- **RPMBB.UA87.RQS.R8B2 No REE**
- **RPMBB.UXxx.RxxXx.xxxNo REE**

120 A Weak Magnets





Electrical circuit	Fault	Critical ramp rate
RPLB.RR53.RCBYHS4.L5B1	Cannot handle LHC di/dt	0.6 A/s (LHC: 0.66A/s)
RPLB.UA87.RCBYHS5.R8B1	Cannot handle LHC di/dt	0.46 A/s (LHC: 0.66A/s)
RPLB.UA87.RCBYH4.R8B1	Cannot handle LHC di/dt	0.6 A/s (LHC: 0.66A/s)
RPLB.UJ83.RCBCH7.L8B1	Quench @ discharge	> 2.5 A/s (LHC: 1A/s)
RPLB.UA23.RCBYH4.L2B2	Quench @ discharge	> 1.25 A/s (LHC: 0.66A/s)
RPLB.RR13.RCBCV8.L1B2	Quench @ discharge	1.2 A/s (LHC: 1A/s)
RPLB.UJ23.RCBCV7.L2B2	Quench @ discharge	> 2.5A/s (LHC: 1A/s)
RPLB.UA43.RCBYV5.L4B2	Cannot reach nominal current	

Rated 72 A, it cannot go higher than 65 A

- Quench in a reference magnet
  - "On Jan 30th 2008 it was rediscovered that the LHC contains really superconducting magnets"
- Symmetric quenches
- RCBCV10.L6B1: lost&found voltage tap – Avoid using this circuit!!!
- The undulator in 4L: missing resistor, different transfer functions and slow ramp rate

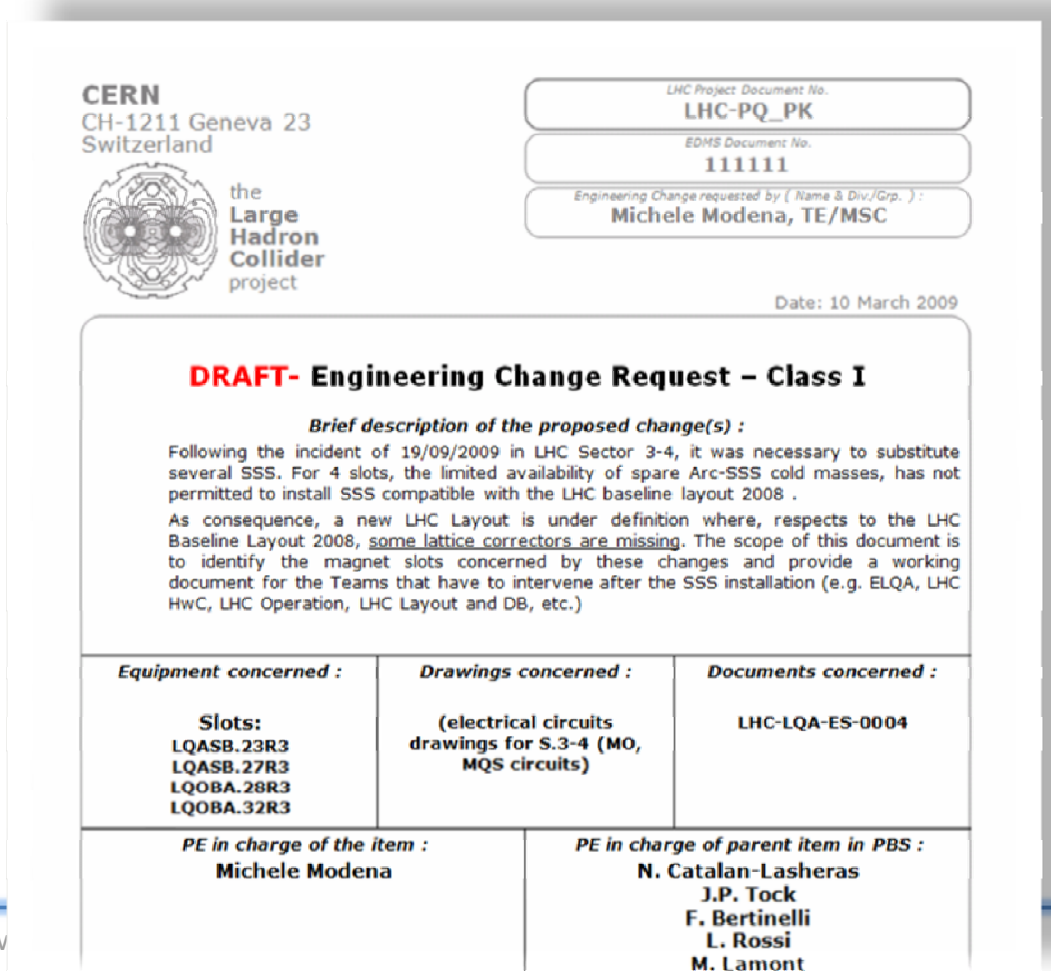
Quench Protection Reference Magnets				
	Dipoles		Quadrupoles	
"1-2"	C21R1	C21L2	A21R1	A20L2
"2-3"	C21R2	C18L3	A21R2	A17L3
"3-4"	C21R3	C18L4	A20R3	A18L4
"4-5"	C21R4	C21L5	A20R4	A20L5
"5-6"	C21R5	C21L6	A20R5	A20L6
"6-7"	C21R6	C21L7	A20R6	A20L7
"7-8"	C21R7	C21L8	A21R7	A20L8
"8-1"	C21R8	C21L1	A20R8	A20L1
"1-2"	C21R1	C21L2	A21R1	A20L2
"2-3"	C21R2	C18L3	A21R2	A17L3

- Implementations to QPS implies new problems:
  - Sensitivity to reference magnet quench in any case
    - "Note that a similar problem will arise with the new bus fault detection system. The new system compares electrically adjacent magnets. The new system will signal a "fault" situation after each quench, because the quenched magnet will always be compared with a "healthy" one. It might be a good idea to enforce a magnetization cycle after each and every quench." *K-H Meß, "Superconducting Electrical Circuits" – Chamonix09*
  - Transient spike problem for adjacent magnets
    - "The effect of the sudden voltage change is not very visible, while looking at the voltage difference over the two coils of one aperture, because the strong coupling between the coils washes out the differences in the response of the single coils. This is different for the difference in voltage between apertures (or, even worse, between magnets; this is probably an issue for the symmetric quench detection)." *K-H Meß, idem*

- **Are there limitations to operate the machine at 5 TeV?**
  - The installation of the symmetric quench detection is a *sine qua non* to go to high current in main circuits
  - 600A ramp rate and acceleration
    - 17 circuits were not fully commissioned
    - 85 circuits were commissioned with provisional acceleration/ramp rate values
    - 18 circuits were commissioned to an energy lower than 5 TeV
  - For the RCBXH/V1 circuits, a request was made to increase their ramp rate to reduce the time to collision; experiments would be needed, but LMC has judged this won't be necessary for the first run.

IMPORTANT REMARK

- The changes in the optics in sector 3-4, due to the lack of spare or time contingencies, will imply a change in the number of corrector magnets per circuit; this means that QPS will have to re-calculate the inductance tables



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LHC Project Document No.
LHC-PQ_PK

EDMS Document No.
111111

Engineering Change requested by (Name & Div./Grp.) :
Michele Modena, TE/MSC

Date: 10 March 2009

DRAFT- Engineering Change Request – Class I

Brief description of the proposed change(s) :

Following the incident of 19/09/2009 in LHC Sector 3-4, it was necessary to substitute several SSS. For 4 slots, the limited availability of spare Arc-SSS cold masses, has not permitted to install SSS compatible with the LHC baseline layout 2008 .

As consequence, a new LHC Layout is under definition where, respects to the LHC Baseline Layout 2008, some lattice correctors are missing. The scope of this document is to identify the magnet slots concerned by these changes and provide a working document for the Teams that have to intervene after the SSS installation (e.g. ELQA, LHC HwC, LHC Operation, LHC Layout and DB, etc.)

Equipment concerned :	*Drawings concerned :*	*Documents concerned :*
Slots: **LQASB.23R3** **LQASB.27R3** **LQOBA.28R3** **LQOBA.32R3**	**(electrical circuits drawings for S.3-4 (MO, MQS circuits)**	**LHC-LQA-ES-0004**

PE in charge of the item :	*PE in charge of parent item in PBS :*
Michele Modena	**N. Catalan-Lasheras** **J.P. Tock** **F. Bertinelli** **L. Rossi** **M. Lamont**

WHO CREATES NC'S AND WHO SOLVES THEM

NC Opening

"PRAYING HANDS"

04-03 2009

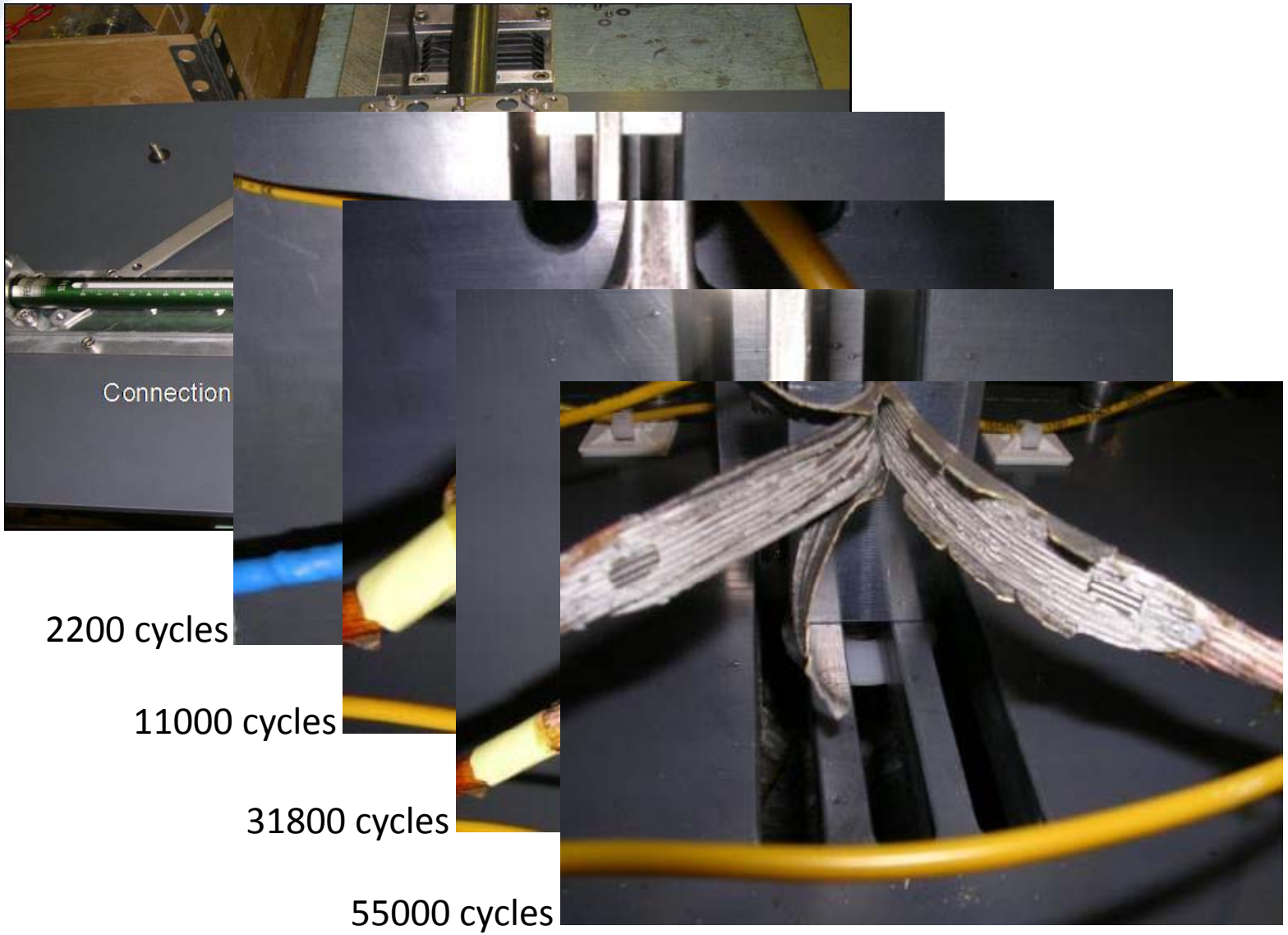
SUMMARY OF THE CYCLING TESTS PERFORMED ON A 6 kA LHC-TYPE ELECTRICAL CONNECTION

A. Ballarino, A. Jacob

At the request of Karl Hubert Meβ, a mechanical cycling test at room temperature was performed on a 6 kA "hand-prayer" type LHC electrical connection. A set-up was assembled to verify the reliability of the joint when subjected to thousands of mechanical cycles (see Fig.1). An electrical connection, supplied by the interconnection team, was tested in the configuration shown in Fig.1. A force of 88 N (as in EDMS procedure N. 533260) was applied at both ends of the connection. In total, 60000 cycles were performed. As visible in the following pictures, the degradation of the joint starts at 2200 cycle. At 11000 cycles the copper crimping box around the connection starts to open. At 30000 cycles the soldered joint is open along a length of about 50 %. At the end of the cycling tests, the joint is completely open.

The test configuration is more severe than the final configuration in the tunnel – the force is applied at a 90° angle. Conclusions should only be taken after comparing the results of these tests with those obtained after electrical cycling at nominal current and cryogenic temperatures.

"PRAYING HANDS"



… but not without problems

- SSS006:
  - missing solder between SC cable and Cu stabiliser in M3 busbars
  - oxidised SC cables
  - CERN fabrication
  - ➢ Cutting M tubes and bellows, try re-soldering

- MB3383: ready for SM18 mid-week
- MB2868: short being repaired, will be retested in SM18
- SSS279 (CM assembled at CERN): rebuilding the diode insulation, will be the last SSS for 3-4 at cold-testing in SM18
- Intensive week for final preparation and installation (e.g. SSS221 finished welding at 13h Thursday 12 March, left for Point 4 at 14h, lowered in the evening, installed with SSS369 during the night): "are we in a crash program or not?"

16 March, 2009 MMM and TEMB - Francesco Bertinelli 3