Overview of the Circuit Powering and Protection Evolution

Felix Rodriguez Mateos, Samer Yammine, Markus Zerlauth (CERN)

on behalf of the HL-LHC Magnet Circuit Forum

10th HL-LHC Collaboration Meeting, 2020-10-07

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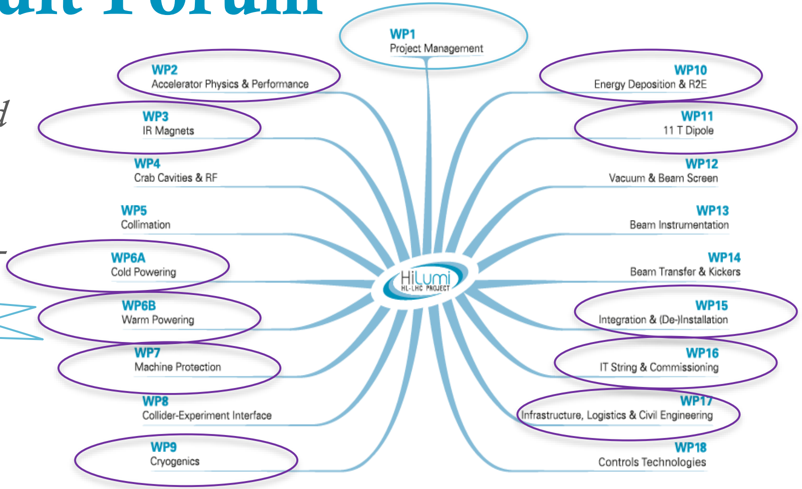
Updates from the HL-LHC Magnet Circuit Forum

Magnet Circuit Forum

Extract from the mandate of the MCF

- *MCF is the meeting where all aspects related to powering and protection of the HL-LHC magnet circuits are discussed.*
- *MCF, also, is mandated to validate the polarities of the HL-LHC circuits.*

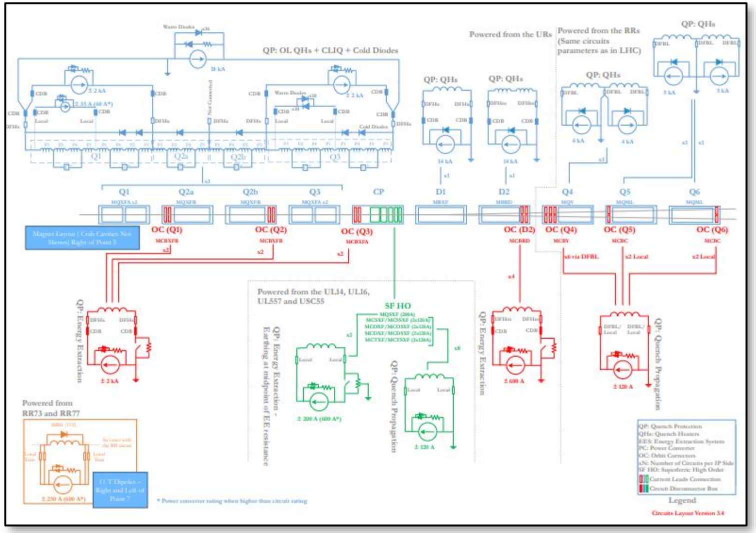
Included in End 2019



M. Zerlauth has been nominated Mr Circuit from April 2020.

- MCF has the responsibility to keep up to date the circuit configurations and parameters
- This is done through updates of the Circuit Table and the Electrical Layout (see MCF Sharepoint)
- So far 71 meetings (17 since last annual meeting), documented with minutes, follow up of actions, etc.
- MCF is also organizing topical meetings with reduced attendance, 31 meetings have taken place so far
- MCF took initiative and responsibilities for the preparation of Engineering Change Requests and other documents related to circuit aspects
- About 50 members are regularly invited

Magnet Circuit Forum



Circuits Layout V3.4

	Circuits for HiLumi	Magnet Type	Number of circuits per IP side	Total number of circuits	$I_{nominal}$ (7 TeV) [kA]	$I_{ultimate}$ [kA]	L per circuit at nominal current [mH]	R per circuit [mΩ]	Collaborations	References
Inner Triplet	Triplet Q1, Q2a, Q2b, Q3	MQXFA / MQFXB	1	4 (IR1/5)	16.47	17.9	255	0.15	US-HiLumi	EDMS no. 2114564
	Trim Q1	-	1	4 (IR1/5)	2	2	69	1.35	-	
	Trim Q1a	-	1	4 (IR1/5)	0.035	0.035	34.5	227.08	-	
	Trim Q3	-	1	4 (IR1/5)	2	2	69	1.2	-	
	Orbit correctors Q1/2 - Horizontal/Inner	MCBXFB	2	8 (IR1/5)	1.625	1.741	58.4	2.38	Ciemat	
	Orbit correctors Q1/2 - Vertical/Outer	MCBXFB	2	8 (IR1/5)	1.474	1.579	124.8	2.42	Ciemat	
	Orbit correctors Q3 - Horizontal/Inner	MCBXFA	1	4 (IR1/5)	1.584	1.702	107.1	1.99	Ciemat	
	Orbit correctors Q3 - Vertical/Outer	MCBXFA	1	4 (IR1/5)	1.402	1.502	232.3	1.98	Ciemat	
	Superferric, order 2	MQSXF	1	4 (IR1/5)	0.174	0.197	1530	18.12	INFN	
	Superferric, order 3, normal and skew	MCSXF / MCSSXF	2	8 (IR1/5)	0.099	0.112	213	54	INFN	
	Superferric, order 4, normal and skew	MCOXF /	2	8 (IR1/5)	0.102	0.115	220	54	INFN	
	Superferric, order 5, normal and skew	MCDXF / MCDSXF	2	8 (IR1/5)	0.092	0.106	120	54	INFN	
	Superferric, order 6	MCTXF	1	4 (IR1/5)	0.085	0.097	805	54	INFN	
	Superferric, order 6, skew	MCTSXF	1	4 (IR1/5)	0.084	0.094	177	54	INFN	
D1	Separation dipole D1	MBXF	1	4 (IR1/5)	12.047	13.18	24.9	0.41	KEK	
D2	Recombination dipole D2	MBRD	1	4 (IR1/5)	12.328	13.357	27.4	0.18	INFN	
	Orbit correctors D2	MCBRD	4	16 (IR1/5)	0.394	0.422	920	1.36	CERN	
Q4	Individually powered quad Q4 (4.5K)	MQY	Same Circuit Paramters for Q4, Q5, Q6 and Correctors in IR1/5 as in the LHC							ECR EDMS no. 2083813
	Orbit correctors Q4 (4.5K)	MCBY								
Q5	Individually powered quad Q5 (4.5K)	MQML								
	Orbit correctors Q5 (4.5K)	MCBC								
Q6	Individually powered quad Q6 (4.5K)	MQML								
	Orbit correctors Q6 (4.5K)	MCBC								
Q10	Individually powered quad Q10 (1.9K)	MQML	2	8 (IR1/5)	5.39	5.83	21	0.4	CERN	
	Orbit correctors Q10 (1.9K)	MCB	2	8 (IR1/5)	0.055	0.06	6020	45.8	CERN	
	Lattice Sextupole (1.9K)	MS	2	8 (IR1/5)	0.55	0.6	432	7.5	CERN	
Q5	Individually powered quad Q5 (4.5K)	MQY	2	4 (IR6)	3.61	3.9	74	0.4	CERN	
	Orbit correctors Q5 (4.5K)	MCBY	2	4 (IR6)	0.088	0.1	5270	34.4	CERN	

Beam Dynamics - WP2 | Magnets - WP3 | Cold Powering - WP6a | Power Converters - WP6b | Protection - ...

Circuits Parameters Table V9.0

Mr Polarity and the Magnet Circuit Forum

- "…define clear conventions (based on LHC experience) and perform the required verifications in order to ascertain the defined circuit polarities to be coherent with the optics layouts and operation with beams…"
- M. Pojer has been nominated Mr Polarity.
- **Mr Circuit and MCF are always acting in close collaboration with Mr Polarity.**

HiLumi HL-LHC PROJECT CERN

EDMS No. 2316942

Mandate for the Verification of Polarities of the HL-LHC Magnet System

(Mr/Ms Polarity)

In the context of the HL-LHC project, a number of magnets and of magnetic circuits will be profoundly modified. The main modifications are:

1. Q1-Q2-Q3 (Inner Triplet) in IR (Interaction Region) 1 and IR5
2. D1 and D2 (Separation/Recombination dipole pair) in IR1 and IR5
3. All corrector magnets of the Inner Triplets in IP1 and IR5
4. The 11 T dipoles in the DS (Dispersion Suppressor) right and left of IP (Interaction Point) 7.
5. Small modifications may involve other magnets in IR6
6. Hollow e-lens in IR4
7. Any new equipment with magnet circuits that may be added to the baseline as, inter alia, LRBB (long-range beam-beam) compensating electrical wires, etc…

The mandated person (Mr/Ms Polarity) will define clear conventions (based on LHC experience) and perform the required verifications in order to ascertain the defined circuit polarities to be coherent with the optics layouts and operation with beams. This will be done in close collaboration with the concerned WP leaders (WP2 - Accelerator Physics and Performance, WP3 - IR Magnets, WP6A-B - Cold-Warm Powering, WP7 - Machine Protection, WP9 - Cryogenics, WP 11 - 11T dipole, WP15 - Integration and Installation, and any other relevant WPs), Operation's representatives and Mr/Ms. Circuit, covering the relevant aspects ranging from the design and manufacturing of circuit components to the assembly of the circuits during construction, tests and hardware commissioning. This applies to both cold powering components and warm parts of electrical circuits.

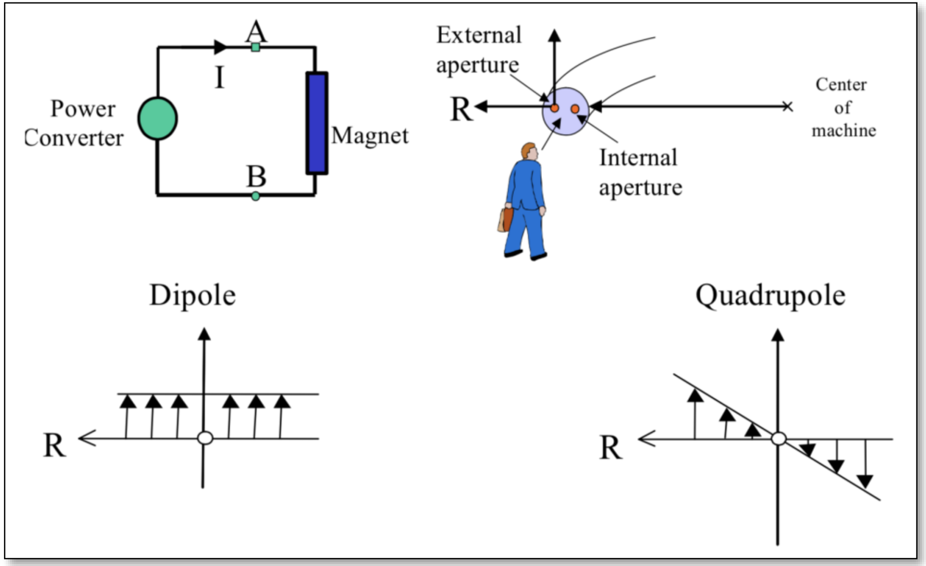
To this end, a revision of the existing reference documentation should be performed, and modifications applied if required. A plan should be prepared in order to have a consistent set of documents (notes, drawings with electrical schemes, etc).

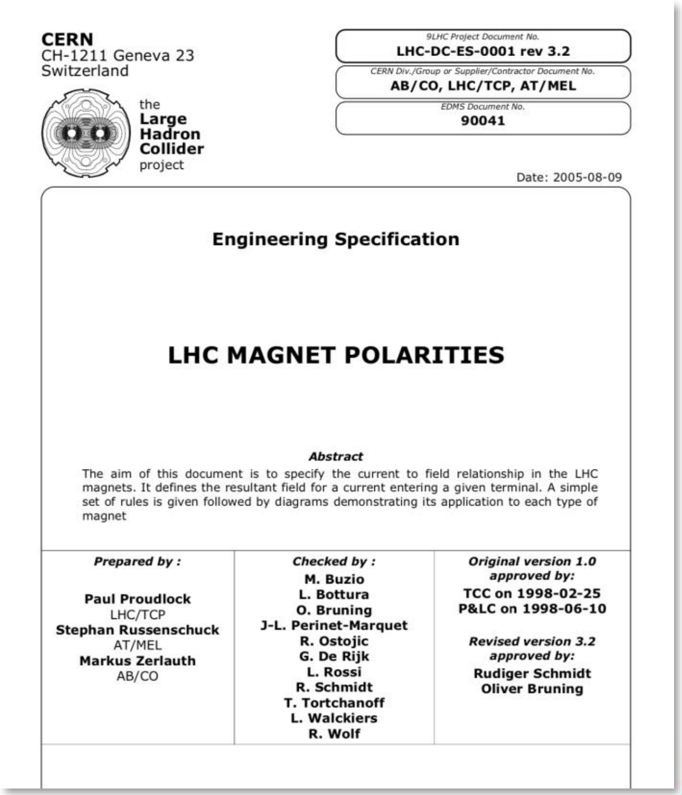
The mandate of Mr/Ms Polarity is established within the framework of the responsibility of Mr/Ms Circuit and includes a regular report to the HL-LHC Magnet Circuit Forum (MCF). When necessary, Mr/Ms Polarity will report to the TCC and to the HL-LHC Project Leader.

Polarities Verification

Circuit Polarities Verification

- The reference document for the polarity of the (HL-)LHC magnets is the **EDMS no. 90041**.





CERN
CH-1211 Geneva 23
Switzerland

the **Large Hadron Collider** project

9LHC Project Document No. **LHC-DC-ES-0001 rev 3.2**
CERN Div./Group or Supplier/Contractor Document No. **AB/CO, LHC/TCP, AT/MEL**
EDMS Document No. **90041**

Date: 2005-08-09

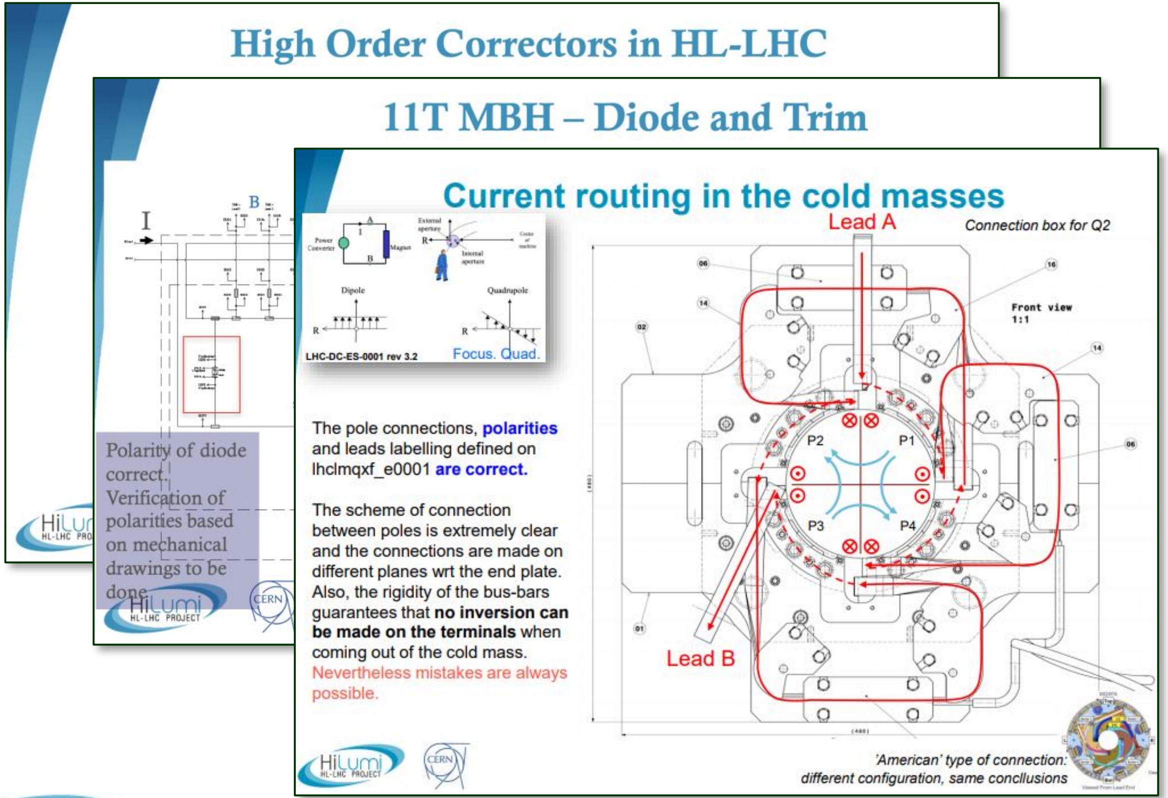
Engineering Specification

LHC MAGNET POLARITIES

Abstract
The aim of this document is to specify the current to field relationship in the LHC magnets. It defines the resultant field for a current entering a given terminal. A simple set of rules is given followed by diagrams demonstrating its application to each type of magnet

Prepared by :	*Checked by :*	*Original version 1.0 approved by:*
Paul Proudlock LHC/TCP **Stephan Russenschuck** AT/MEL **Markus Zerlauth** AB/CO	**M. Buzio** **L. Bottura** **O. Bruning** **J-L. Perinet-Marquet** **R. Ostojic** **G. De Rijk** **L. Rossi** **R. Schmidt** **T. Tortchanoff** **L. Walckiers** **R. Wolf**	**TCC on 1998-02-25** **P&LC on 1998-06-10** *Revised version 3.2 approved by:* **Rudiger Schmidt** **Oliver Bruning**

Circuit Polarities Verification



EDMS NO.	REV.	VALIDITY
2269414	1.1	DRAFT

REFERENCE : LHC-M-ED-0004

HL-LHC: DECISION MANAGEMENT

POLARITY OF HIGH ORDER CORRECTORS IN WP3 HL-LHC MAGNETS

Abstract

This document summarizes the rules for the polarity of the high order corrector magnets i[illegible] magnets. The 3D and 2D cross section views of each corrector magnet (front and rear/conne[illegible]) a[illegible]wn with respect to the LHC magnet polarities rules (LHC MAGNET POLARITIES, EDMS Do[illegible]. 9[illegible]). Th[illegible] and B connections and the magnet polarities for each corrector are highlighted w[illegible]ont and rea[illegible]nnect[illegible] side views.

APPROVED

TRACEABILITY

Prepared by: [illegible] Matteis, M. Statera	***Date:*** 2020-04-16
Verified by: A. Musso, H. Prin, M. Pojer	***Date:*** 2020-04-XX
Approved by: F. Rodriguez Mateos, E. Todesco, A. Devred	***Date:*** 2020-04-XX
Distribution: S. Yammine, D. Wollmann,	

Rev. No.	***Date***	***Description of Changes*** *(major changes only, minor changes in EDMS)*
1.0	2019-11-13	First draft
1.1	2020-04-16	Second draft after discussion

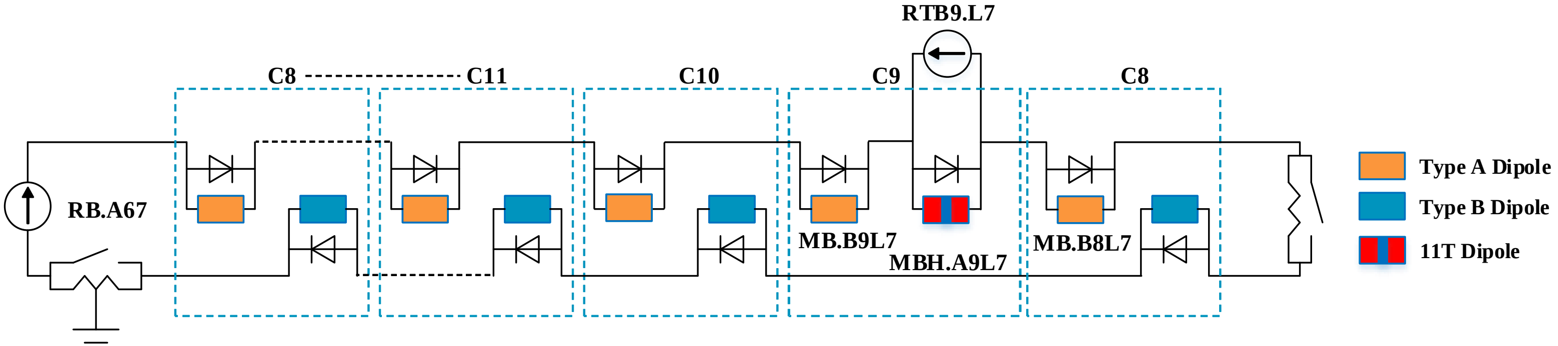
This document is uncontrolled when printed. Check the EDMS to verify that this is the correct version before use

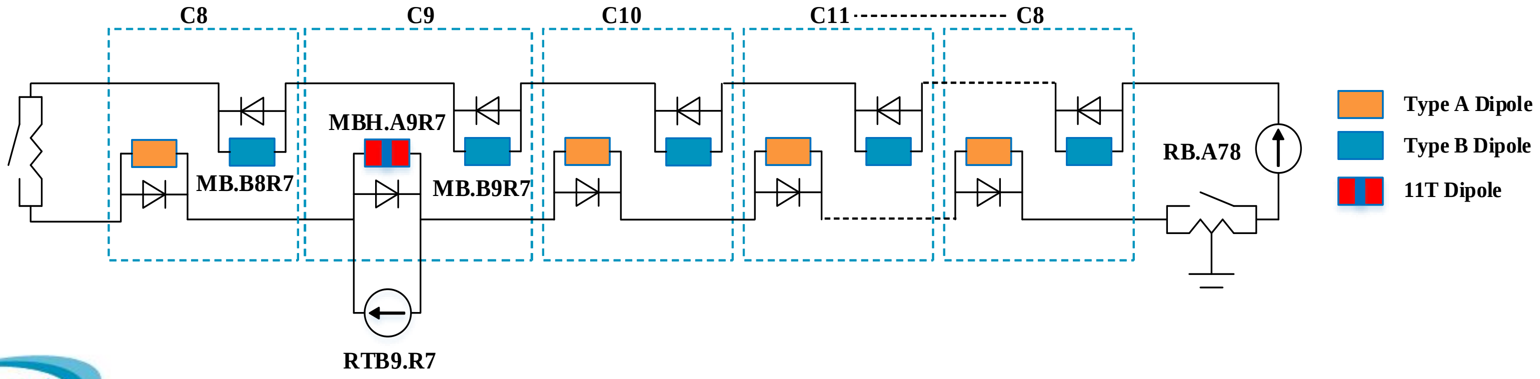
EDMS Doc. Nr. 2269414

Courtesy of M. Pojer

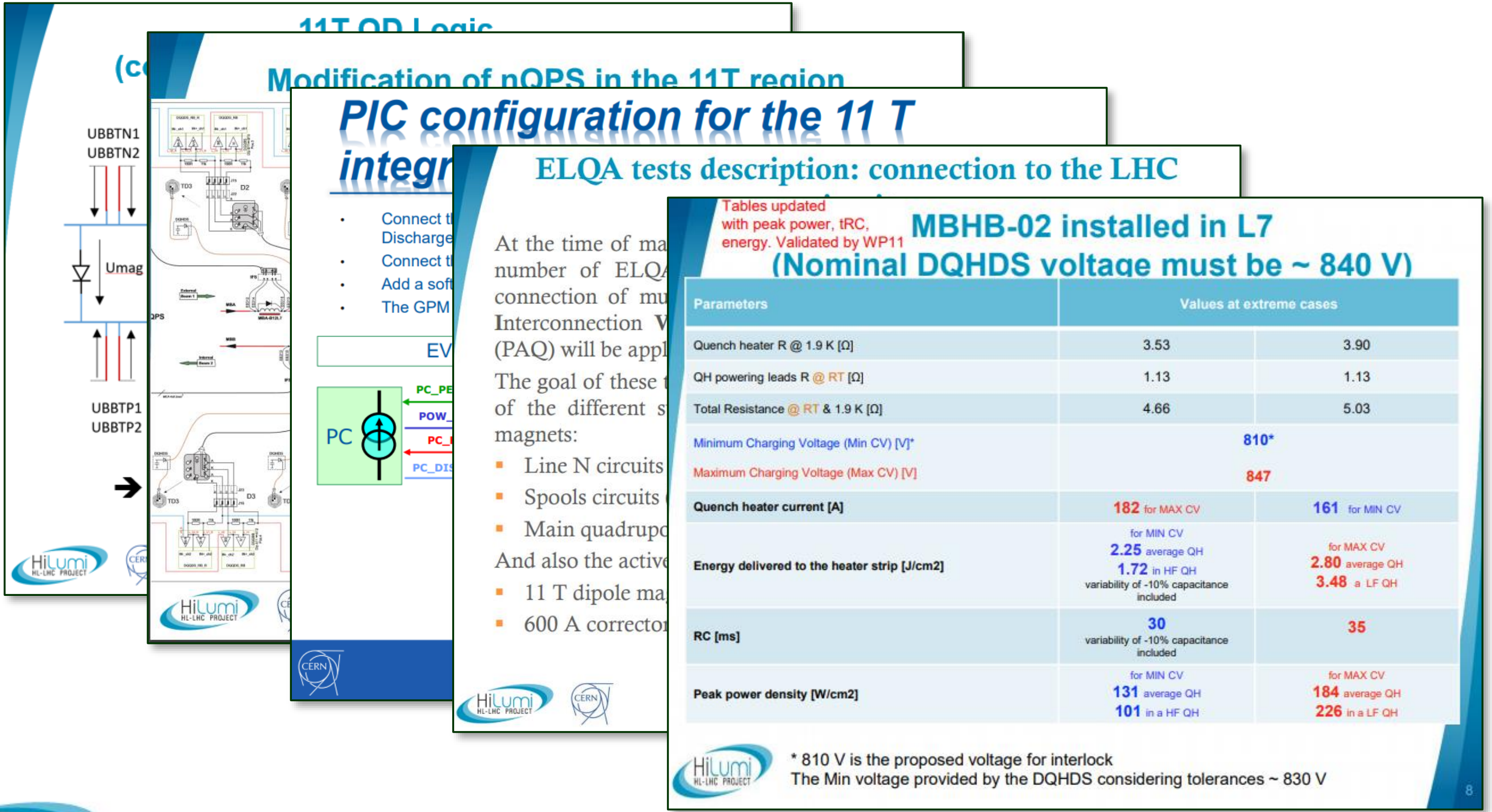
Updates on Circuit Protection

11T Integration and Protection Scheme





11T Integration and Protection Scheme

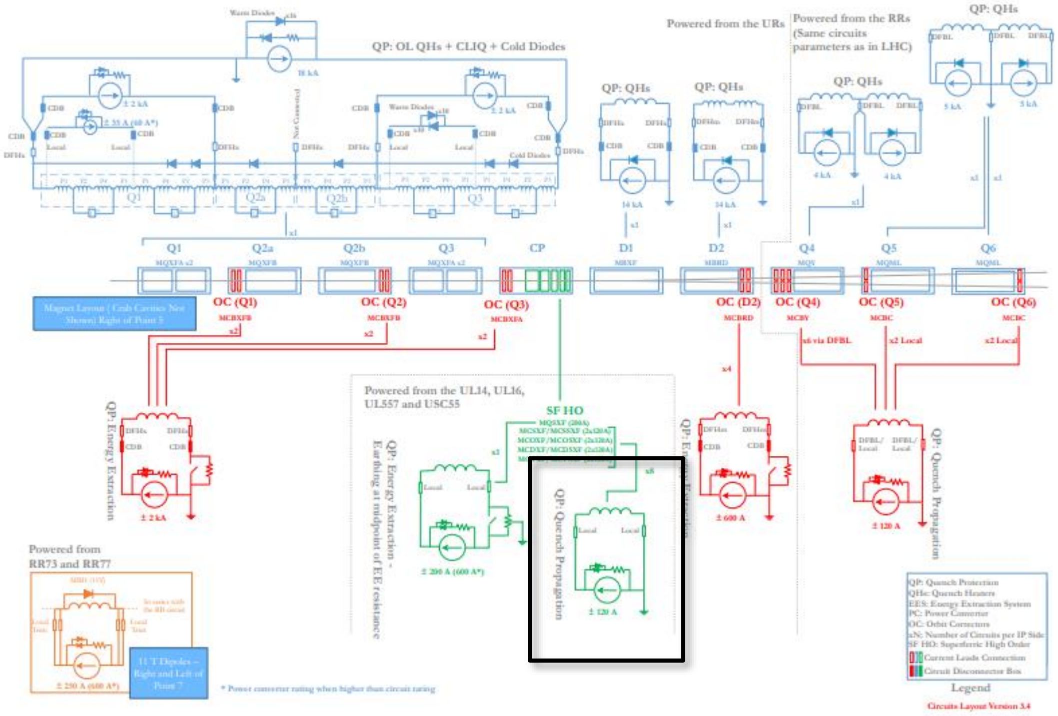


Parameters	Values at extreme cases	
Quench heater R @ 1.9 K [Ω]	3.53	3.90
QH powering leads R @ RT [Ω]	1.13	1.13
Total Resistance @ RT & 1.9 K [Ω]	4.66	5.03
Minimum Charging Voltage (Min CV) [V]*	810*	
Maximum Charging Voltage (Max CV) [V]	847	
Quench heater current [A]	182 for MAX CV	161 for MIN CV
Energy delivered to the heater strip [J/cm2]	for MIN CV 2.25 average QH 1.72 in HF QH variability of -10% capacitance included	for MAX CV 2.80 average QH 3.48 a LF QH
RC [ms]	30 variability of -10% capacitance included	35
Peak power density [W/cm2]	for MIN CV 131 average QH 101 in a HF QH	for MAX CV 184 average QH 226 in a LF QH

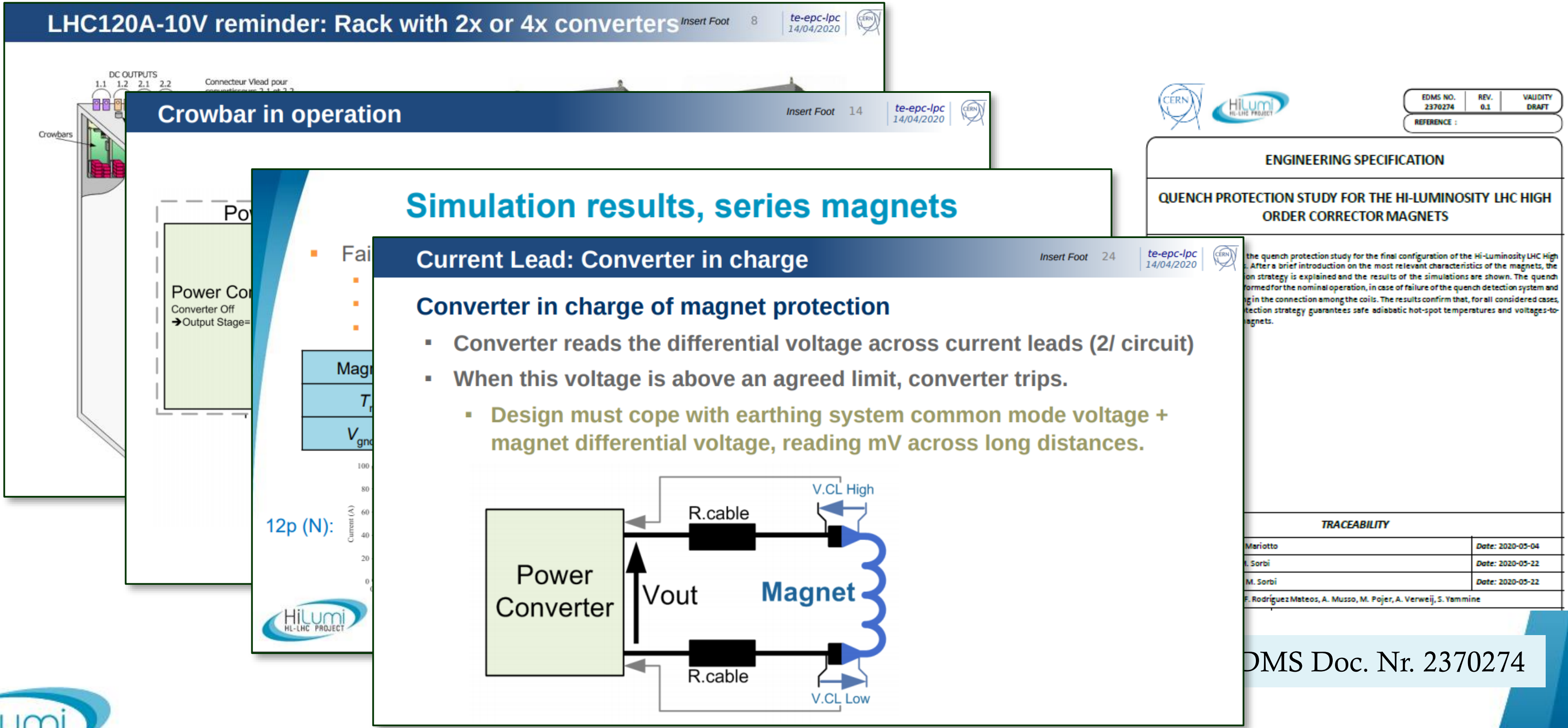
* 810 V is the proposed voltage for interlock
The Min voltage provided by the DQHDS considering tolerances ~ 830 V

Courtesy of J. Steckert, A. Antoine, G. D'Angelo, D. Carrillo, E. Nowak et al.

Confirmation of 120 A Circuit Protection Scheme



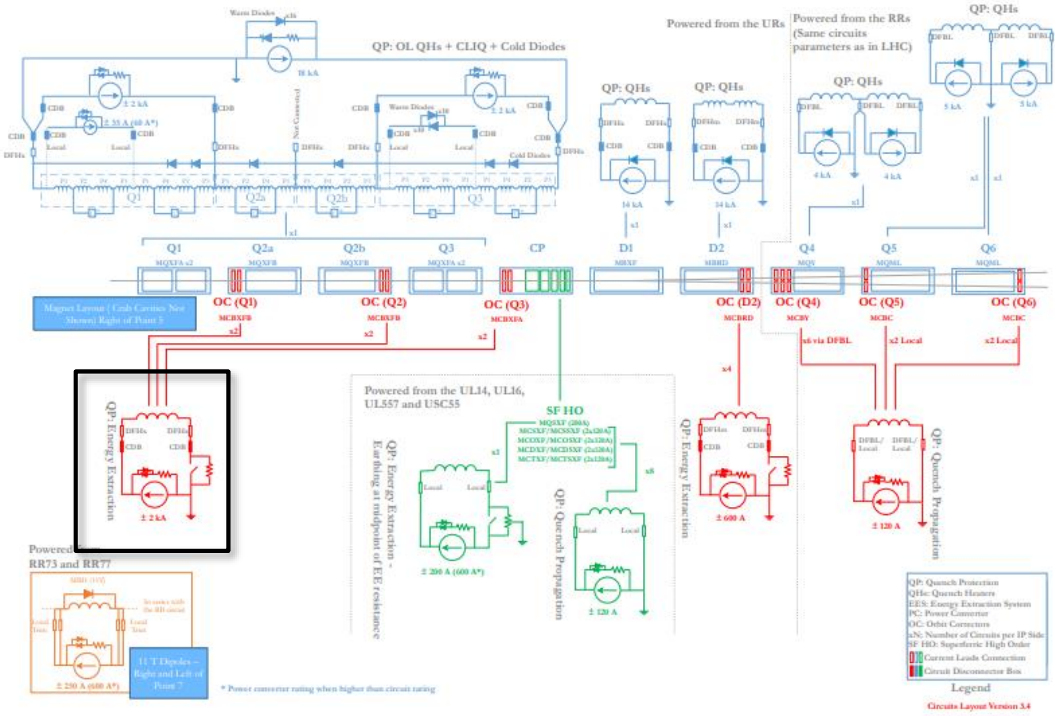
Confirmation of 120 A Circuit Protection Scheme



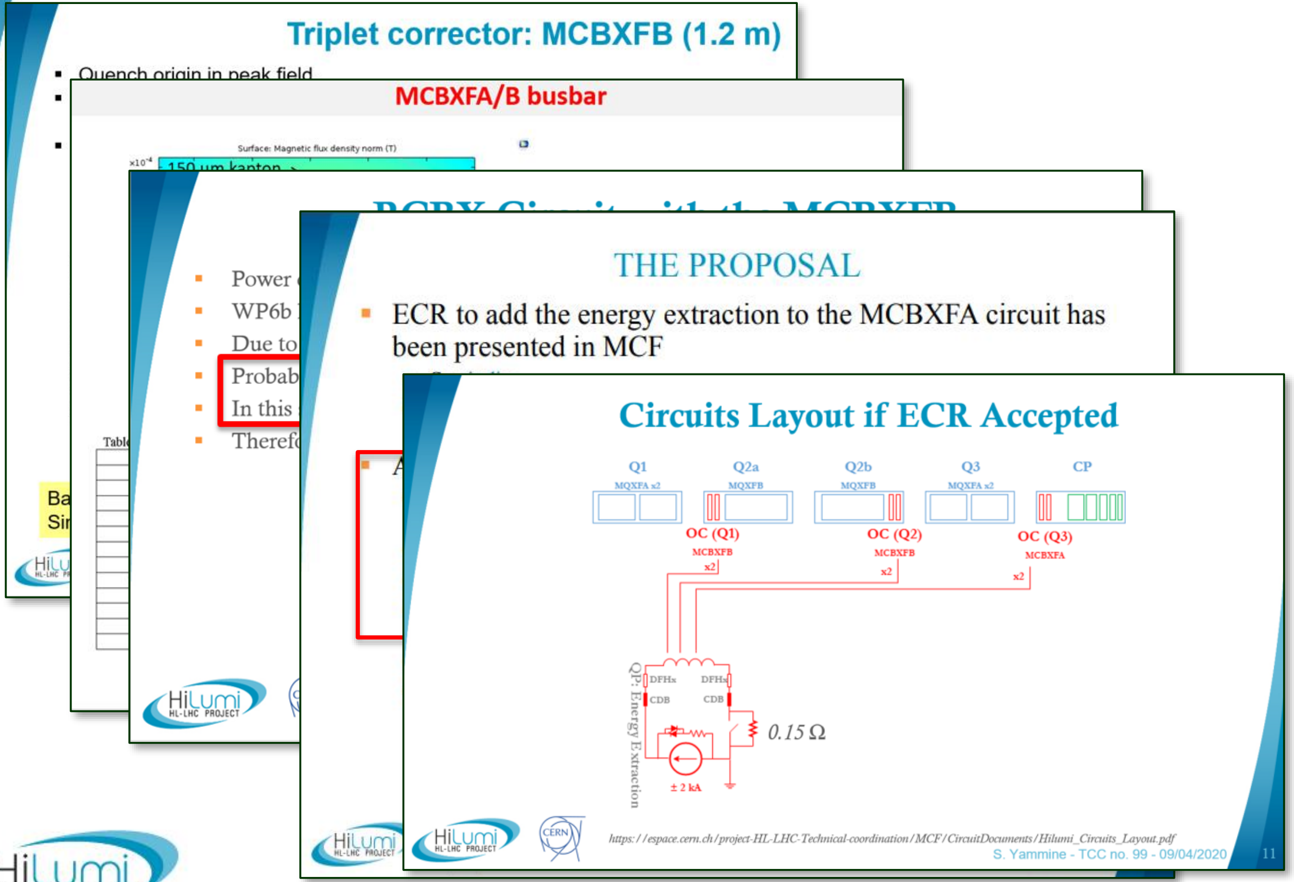
EDMS Doc. Nr. 2370274

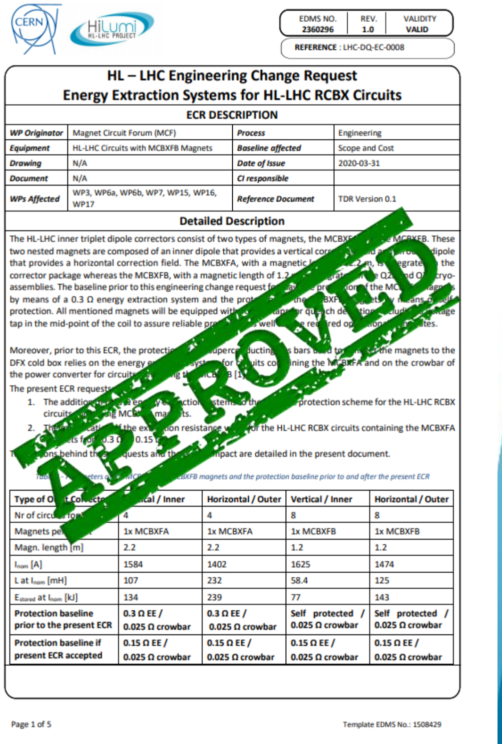
Courtesy of Y. Thurel and M. Prioli

Energy Extraction for MCBXFA/B



Energy Extraction for MCBXFA/B





EDMS NO.	REV.	VALIDITY
2360296	1.0	VALID

REFERENCE : LHC-DQ-EC-0008

HL – LHC Engineering Change Request
Energy Extraction Systems for HL-LHC RCBX Circuits

ECR DESCRIPTION

WP Originator	Magnet Circuit Forum (MCF)	*Process*	Engineering
Equipment	HL-LHC Circuits with MCBXFB Magnets	*Baseline affected*	Scope and Cost
Drawing	N/A	*Date of Issue*	2020-03-31
Document	N/A	*CI responsible*	
WPs Affected	WP3, WP6a, WP6b, WP7, WP15, WP16, WP17	*Reference Document*	TDR Version 0.1

Detailed Description

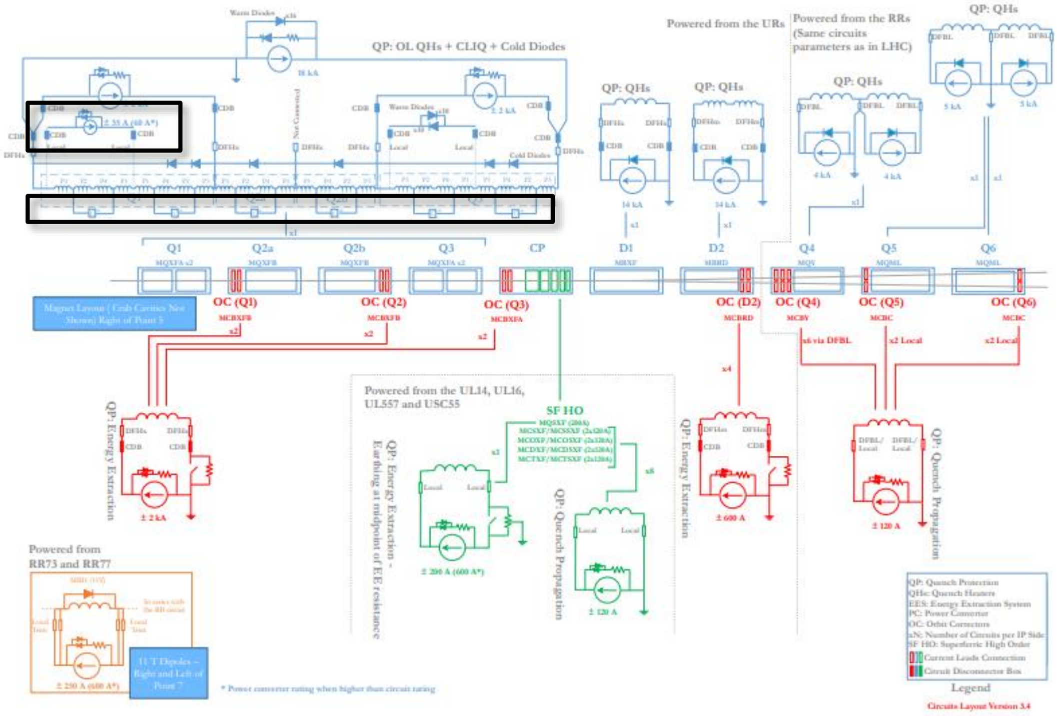
Type of Orbit Corrector	Vertical / Inner	Horizontal / Outer	Vertical / Inner	Horizontal / Outer
Nr of circuits	4	4	8	8
Magnets per circuit	1x MCBXFA	1x MCBXFA	1x MCBXFB	1x MCBXFB
Magn. length [m]	2.2	2.2	1.2	1.2
I_{nom} [A]	1584	1402	1625	1474
L at I_{nom} [mH]	107	232	58.4	125
E_{stored} at I_{nom} [kJ]	134	239	77	143
Protection baseline prior to the present ECR	**0.3 Ω EE / 0.025 Ω crowbar**	**0.3 Ω EE / 0.025 Ω crowbar**	**Self protected / 0.025 Ω crowbar**	**Self protected / 0.025 Ω crowbar**
Protection baseline if present ECR accepted	**0.15 Ω EE / 0.025 Ω crowbar**	**0.15 Ω EE / 0.025 Ω crowbar**	**0.15 Ω EE / 0.025 Ω crowbar**	**0.15 Ω EE / 0.025 Ω crowbar**

Page 1 of 5 Template EDMS No.: 1508429

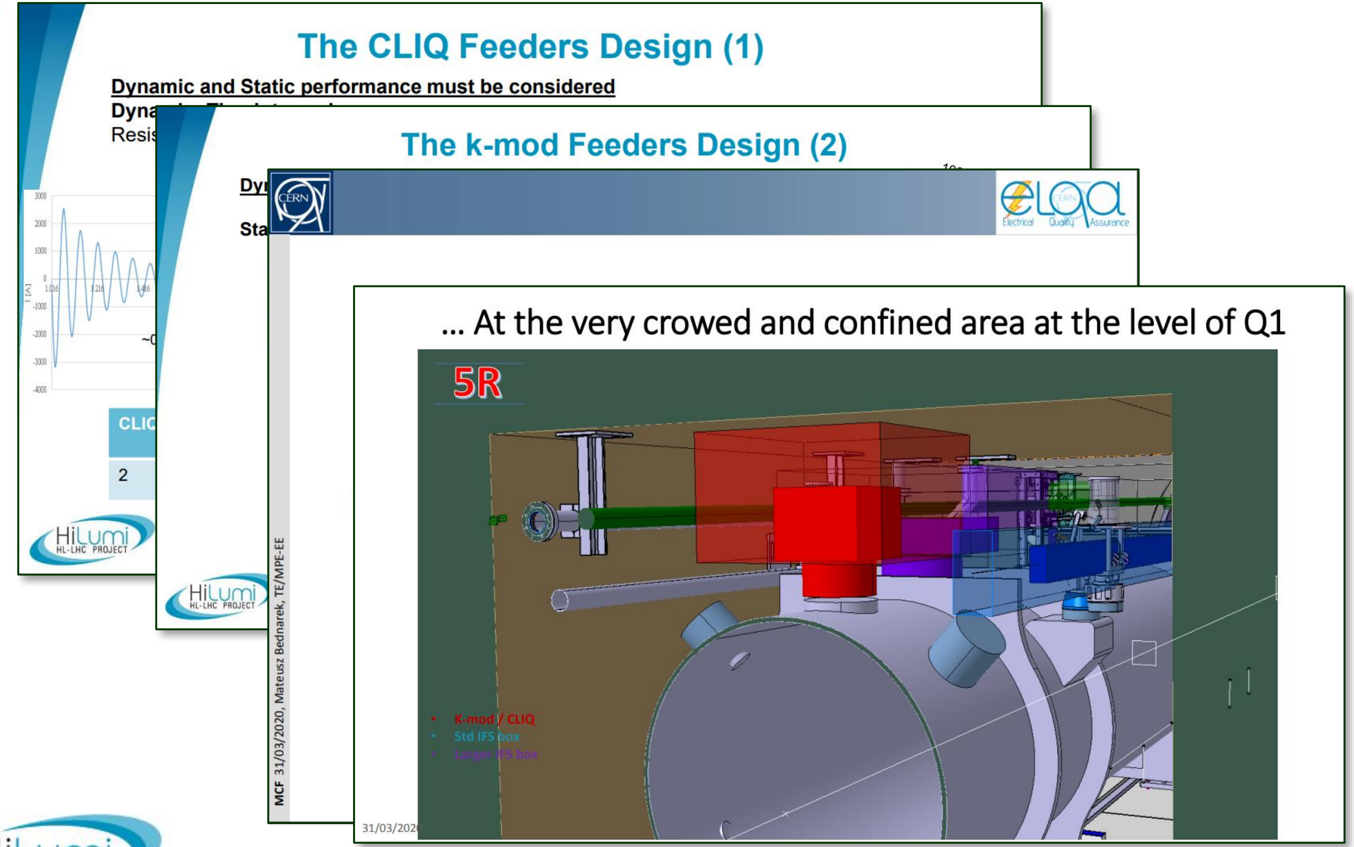
EDMS Doc. Nr. 2360296

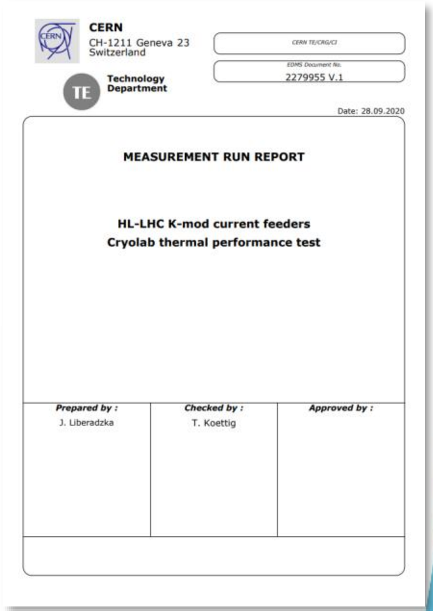
Courtesy of A. Verweij, M. Mentink, V. Herrero, E. Todesco et al.

CLIQ and K-mod Feeders



CLIQ and K-mod Feeders



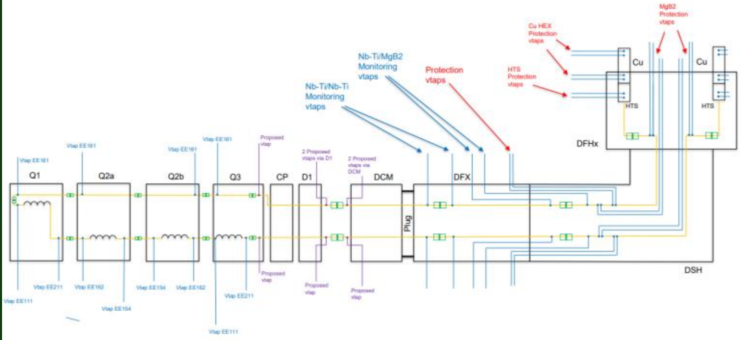


EDMS Doc. Nr. 2279955

Courtesy of J. Liberadzka, L. Williams, J. Ludwin, M. Bednarek and G. D'Angelo

Circuit Instrumentation and Review of Sep-2020

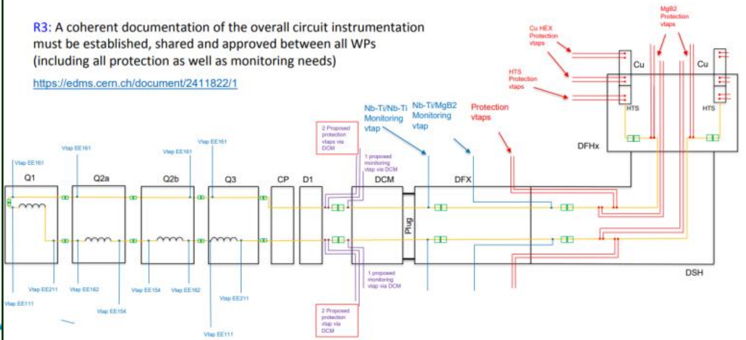
Inner triplet circuit busbar v-taps proposal ver.2 (prior to review)



Inner triplet circuit busbar v-taps proposal ver.7 (incl Review Recommendations)

R3: A coherent documentation of the overall circuit instrumentation must be established, shared and approved between all WPs (including all protection as well as monitoring needs)

https://edms.cern.ch/document/2411822/1



HL-LHC Circuit Instrumentation Review

1 September 2020
Europe/Zurich timezone

Overview
Timetable
Contribution List
Participant List
Videoconference Rooms

Scope

The scope of the review is the instrumentation of the s.c. magnet circuits of the Inner Triplet, D1, D2 as well as all the related correctors. The review includes quench protection and monitoring voltage taps, as well as cryogenic instrumentation.

The review does not include the instrumentation of the 11T MBH magnets.

It is recommended to have a review of the instrumentation from a global viewpoint rather than a review by Work Package. A global, circuit approach is necessary in order to look at the details of quench detection for all the components, from coils to the warm part of the current leads through every single part.

Given this global approach, the Review is organized under the umbrella of the Magnet Circuit Forum. It should be a DDR (Detailed Design Review). Aspects related to the status of procurement are relevant and could also be part of the review.

The results of the Review will be reported to the TE Department Head and the HL-LHC Project Leader, and presented at TCC.

Panel and Sc. Secretary

- Markus Zerlauth - Chair
- Luca Bottura
- Mirko Pojer
- Andrzej Siemko
- Rob Van Weelderen
- Samer Yammine - Scientific Secretary

Charter

The mandate given to the Panel is as fol

- Assess on the soundness of the in requirements given by protection, r commissioning phase;
- Verify the adequacy of the technic aspects of long term reliability;
- Make sure that there is no showst signed in the near future;
- Ascertain that the documentation
- Recommend actions on open poin

Starts 1 Sep 2020, 10:00
Ends 1 Sep 2020, 17:45
Europe/Zurich

Executive Summary

- The panel would like to thank and congratulate the organisers, speakers and participants for their efforts in the preparation and conduction of this important review for the HL-LHC instrumentation
- We have been presented with a comprehensive overview of the current understanding of the instrumentation baseline and associated hardware developments
- The panel considers this a first functional review of the instrumentation, allowing to converge and approve the instrumentation baseline for the machine configuration
- A detailed design review should be conducted in the near future

Indico Event no. 948311

Circuit Instrumentation and Review of Sep-2020

IN PROGRESS

Magnet	IFS Nam[illegible]	Cover F[illegible] [illegible]ype	Raw I[illegible] Bo[illegible] Dimensions (mm)	Vtap (old value)	Feedthrough pins needed – HV Feedthroughs: Comment	QH	EH	Total HV (old value)	LV Feedthroughs: Nb TT sensors	Nb TT wires	Nb TT LV connectors	Spare HV Feedthroughs in present design : 48/18 pins for L/S	Spare HV Feedthroughs in proposed scheme : 48/30 pins for L/S	Spare HV Feedthroughs in proposed scheme : 48/26 pins for L/S	Spare LV Feedthroughs (4pins) in present design
Q1A	Q1A-1	L - Type	402.5 x 310 x 110	21		16	4	**41**	2	8	**2**	**7**	**7**	**7**	**2**
Q1B	Q1B-1	L - Type	402.5 x 310 x 110	20		16	4	**40**	2	8	**2**	**8**	**8**	**8**	**2**
Q2A	Q2A-1	S- Type	280.0 x 230 x 110	12	12 vtaps for MCBXFBs			**12**			**0**	**6**	**18**	**14**	**5**
	Q2A-2	L - Type	402.5 x 310 x 110	22	**23** vtaps based on version AC (in-work) https://edms.cern.ch/document/2002347/AC	16	4	**42**	2	8	**2**	**6**	**6**	**6**	**2**
Q2B	Q2B-2	L - Type	402.5 x 310 x 110	22	**23** vtaps based on version AC (in-work) https://edms.cern.ch/document/2002347/AC	16	4	**42**	2	8	**2**	**6**	**6**	**6**	**2**
	Q2B-1	S- Type	280.0 x 230 x 110	12	12 vtaps for MCBXFBs			**12**			**0**	**6**	**18**	**14**	**5**
Q3A	Q3A-1	L - Type	402.5 x 310 x 110	21		16	4	**41**	2	8	**2**	**7**	**7**	**7**	**2**
Q3B	Q3B-1	L - Type	402.5 x 310 x 110	20		16	4	**40**	2	8	**2**	**8**	**8**	**8**	**2**
CP	CP -1	L - Type	402.5 x 310 x 110	48	**48** vtaps for 120A circuits based on https://edms.cern.ch/document/2058711/0			**48**			**0**	**0**	**0**	**0**	**4**
	CP- 2	S- Type	280.0 x 230 x 110	22	12 Vtaps internal MCBXFA + 6 Vtaps internal MCQSXF + 4 Vtaps 120A C.L. splices		4	**26**	1	4	**1**	**-8**	**4**	**0**	**4**
D1	D1	S - Type	280.0 x 230 x 110	8	8 Vtaps for MB	8	4	**20**	4	16	**4**	**-2**	**10**	**6**	**1**
D2	D2-1	L - Type	402.5 x 310 x 110	10	MBRD dipole Vtaps	16	4	**30**	2	8	**2**	**18**	**18**	**18**	**2**
	D2-2	L - Type	402.5 x 310 x 110	32	MCBRDs 4 corr. x 8 Vtaps			**32**	2	8	**2**	**16**	**16**	**16**	**2**

EDMS Doc. Nr. 2411822

Courtesy of G. D'Angelo

HL-LHC High Voltage Withstand Levels

HL-LHC High Voltage Withstand Levels

EDMS NO. 1963398 | REV. 5.2 | VALIDITY VALID

REFERENCE : LHC-MQXF-ES-0001
US HL-LHC-AUP#: US-HiLumi-doc-879

ENGINEERING SPECIFICATION

ELECTRICAL DESIGN CRITERIA FOR TH[illegible] LHC INNER TRIPLET MAGN[illegible]

Abstract
This document describes the strategy to [illegible] in [illegible] to define t[illegible] withstand levels for the MQXF superconducting magnets manufact[illegible] under [illegible] US [illegible] LHC Acce[illegible] de Project and CERN. The values presented here will be th[illegible] to b[illegible] d du[illegible] tests [illegible] qualifications, installation and commissioning as syst[illegible] nel.

APPROVED

TRACEABILITY

Prepared by: T. D. [illegible] da R[illegible] riguez Mateos	***Date:*** 2019-12-17
Verified by: P. Ferr[illegible] ierdo Bermudez, E. Ravaioli, S. Yammine	***Date:*** 2019-11-12
Approved by: [illegible] osio, S. Feher, E. Todesco, D. Wollmann	***Date:*** 2019-11-25
Dist[illegible] [illegible]. Baldini, R. Denz, V. Marinozzi	

Rev. No.	***Date***	***Description of Changes***
0.1	2018-02-09	First draft version
0.2	2018-02-22	Second draft version including corrections and changes to text by M Mentink
0.3	2018-03-28	Third draft version including corrections and changes to text by G Ambrosio
0.4	2018-03-28	Fourth draft version after meeting on prototype tests in BNL
0.5	2018-04-10	Fifth draft after proposal of changes by G Ambrosio
1.0	2018-04-20	Version for approval
2.0	2018-05-17	Modification of the minimum design withstand coil to heater voltage at warm
3.0	2019-10-09	Addition of test in gaseous helium at intermediate temperature and general review of the document
4.0	2019-11-01	Small changes following email exchanges
5.0	2019-11-05	New version for approval
5.1	2019-12-17	Modification on test level in gaseous helium for MQXFA and MQXFB
5.2	2020-04-09	Update abstract to clarify that the document is applicable for MQXFA and B

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EDMS Doc. Nr. 1963398, 2187266, 2363905, 1995595, 2060633, 2363906, 2363904 and 1821907

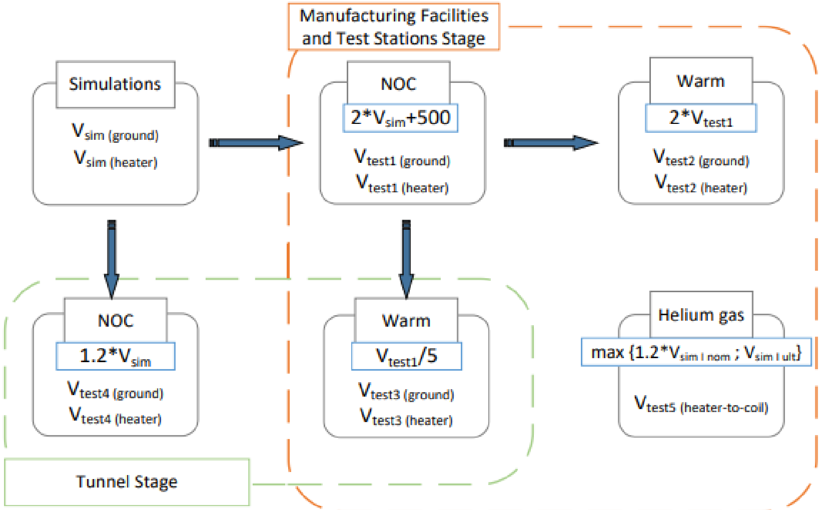


Table 7. Intermediate temperature test in gaseous helium at 1.2±0.2 bar.

MQXF

Test	Temperature [K]	Voltage [V]
Coil-to-ground Coil-to-quench heater	100 ± 20	425 (MQXFA) 850 (MQXFB)

Table 6. Intermediate temperature test in gaseous helium at 3.0±0.2 bar.

11T

Test	Temperature [K]	Voltage [V]
Coil-to-ground Coil-to-quench heater	200 ± 20	800

Courtesy of T. Da Rosa, M. Bednarek and F. Rodriguez Mateos

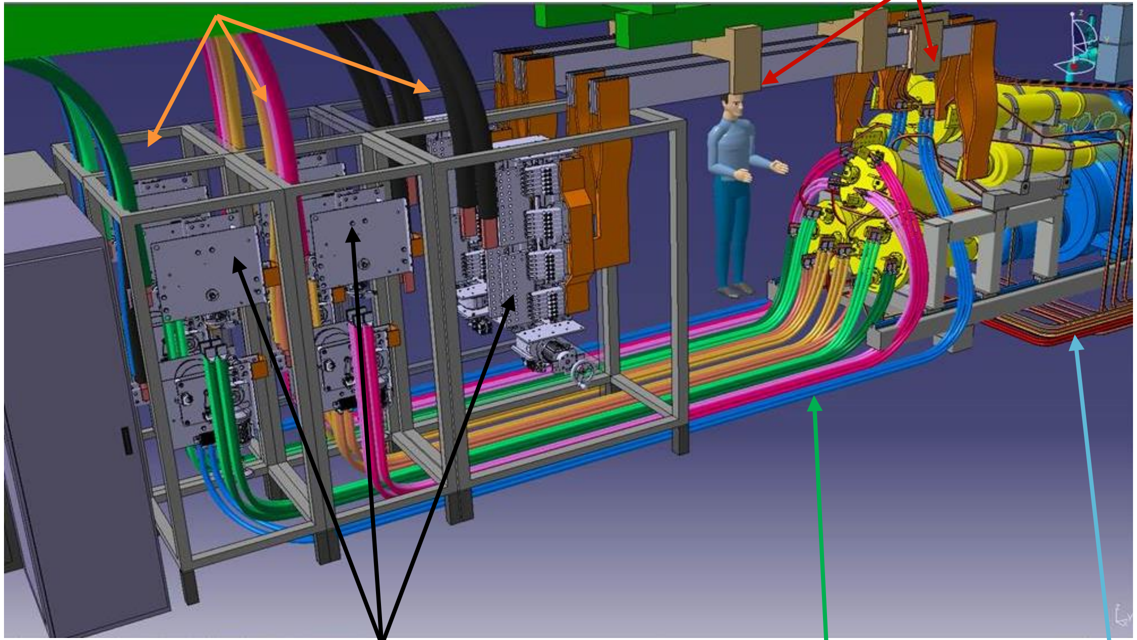
Circuit Disconnector Boxes

Circuit Disconnector Boxes

to Power Converters

Water Cooled Cables

High Current Bus Bars and Insulated Heat Sinks



CDBs

Air Cooled Cables

DFHX

ECR for Bus Bars is in preparation

EDMS NO.	REV.	VALIDITY
2317207	1.0	VALID

REFERENCE : LHC-RP-EC-0005

HL – LHC Engineering Change Request
Circuit Disconnector Boxes

ECR DESCRIPTION

WP Originator	WP6b	*Process*	Technical
Equipment	HL-LHC Superconducting Magnet Circuits	*Baseline affected*	Scope, Cost
Drawing	None – New element	*Date of Issue*	2019-12-17
Document		*CI responsible*	S. Yammine
WPs Affected	WP1, WP6a, WP6b, WP7, WP15, WP17, Project Safety Office	*Reference Document*	TDR Version [illegible]

Detailed Description

This ECR concerns the addition of the Circuit Disconnector Boxes (CDBs) to the HL-LHC [illegible] located in the new UR15 and UR55 technical galleries. These circuits are listed in [illegible]

Table 1 – List of Circuits with CDBs in [illegible]

Circuit Name	Rated Current [illegible]	[illegible]
RQX		1
RTQX		2
RTQXA	[illegible]	
RD1		1
RD2		
RCBX		4

[illegible] predominantly [1].

For the magnet circuits [illegible] regions, CDBs are proposed in between the warm and cold powering systems in order to comply with the [illegible] standards. In addition, this system is proposed in order to eliminate the need for disconnection and reconn[illegible] of cables (except for maintenance and/or repairing of current leads).

The CDBs are composed of the following sub-systems:

- Electrical racks that ensure compliance with the electrical protection index required for the powering systems in the UR (IP2X).
- Motorized disconnecting devices that provide two positions (converter connected to current leads OR connection in short circuit and disconnected from current leads) as shown in Figure 1;
- Isolated heat exchangers connected to the bus bar systems (18 kA and 14 kA) in order to limit the heat dissipation into the current leads.
- Earthing and short circuit devices (MALT-CC) in order to be compliant with the norm NF-C18-510.
- Padlocked command module that permits the change of the position only when correct conditions are met.
- PLC system to ensure the correct manipulation of the system and to provide all relevant diagnostic data.

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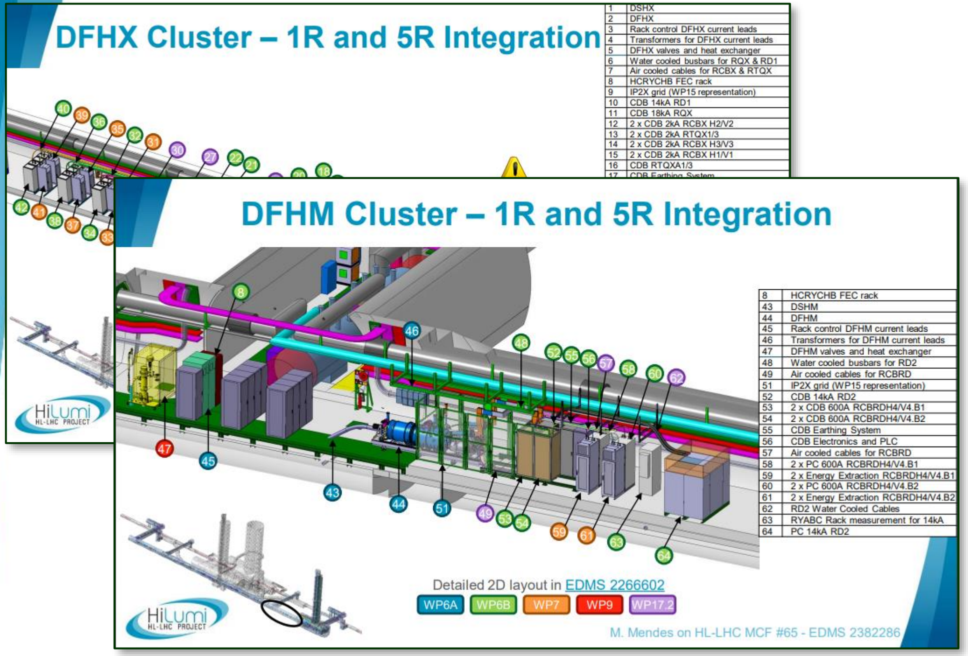
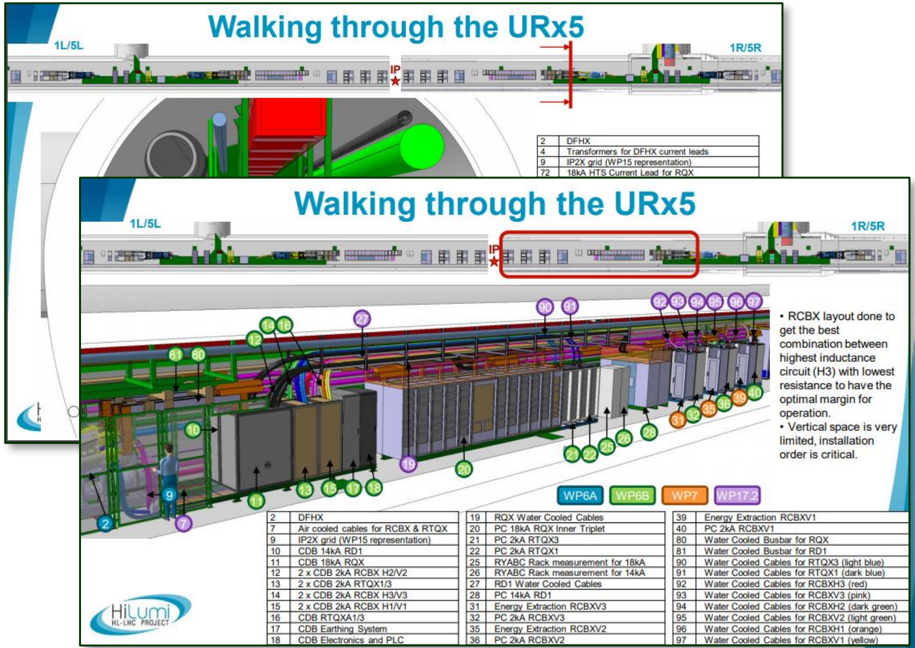
APPROVED

EDMS Doc. Nr. 2317207

Update of Integration of Warm Powering in URs

Update of Integration of Warm Powering in URs





Courtesy of M. Mendes, M. Modena and P. Fessia

Concluding Remarks

Concluding Remarks and Outlook

- In a very collaborative atmosphere under the umbrella of the MCF, the protection studies of HL-LHC magnet circuits are completed and main parameters are defined.

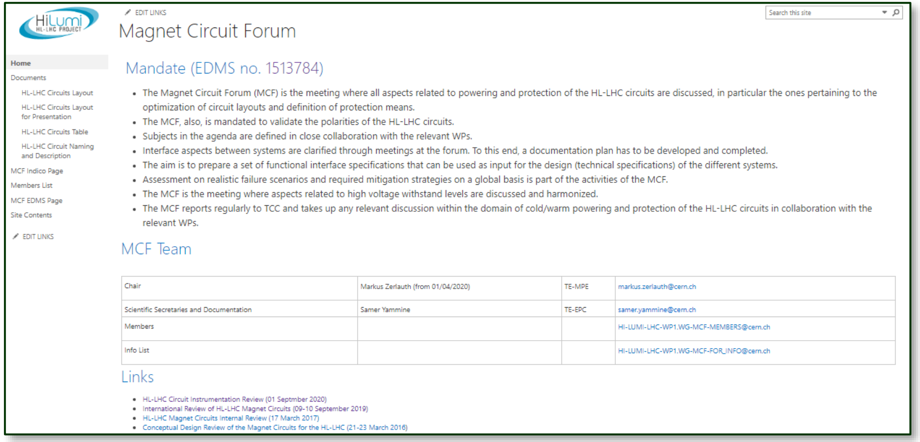
- Up to the Circuit Review of September 2019 and the 9th Collaboration Meeting, the focus was on the finalization of the conceptual design of the circuits.

- During the past year, the MCF concentrated increasingly on the detailed design and implementation of magnet circuits powering and protection in line with the preparation of the HL-LHC string and the pre-series and series components manufacturing.

- This detailed approach and studies will continue for the next years, in view of the important validation of the circuit and component design in the HL-LHC IT string.

References

- MCF meetings no. 55-71 (indico page link)
- MCF Sharepoint (link)
- TCC meetings no. 93, 99, 108, 115 and 116



EDIT LINKS

Magnet Circuit Forum

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Documents
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HL-LHC Circuits Layout for Presentation
HL-LHC Circuits Table
HL-LHC Circuit Naming and Description
MCF Indico Page
Members List
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Mandate (EDMS no. 1513784)

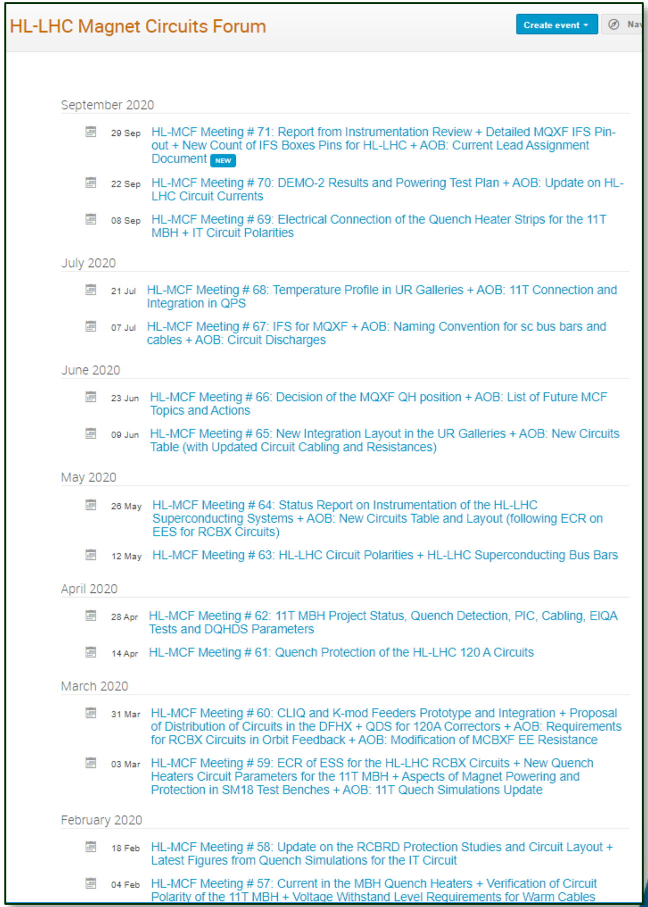
- The Magnet Circuit Forum (MCF) is the meeting where all aspects related to powering and protection of the HL-LHC circuits are discussed, in particular the ones pertaining to the optimization of circuit layouts and definition of protection means.
- The MCF, also, is mandated to validate the polarities of the HL-LHC circuits.
- Subjects in the agenda are defined in close collaboration with the relevant WPs.
- Interface aspects between systems are clarified through meetings at the forum. To this end, a documentation plan has to be developed and completed.
- The aim is to prepare a set of functional interface specifications that can be used as input for the design (technical specifications) of the different systems.
- Assessment on realistic failure scenarios and required mitigation strategies on a global basis is part of the activities of the MCF.
- The MCF is the meeting where aspects related to high voltage withstand levels are discussed and harmonized.
- The MCF reports regularly to TCC and takes up any relevant discussion within the domain of cold/warm powering and protection of the HL-LHC circuits in collaboration with the relevant WPs.

MCF Team

Chair	Markus Zerlauth (from 01/04/2020)	TE-MPE	markus.zerlauth@cern.ch
Scientific Secretaries and Documentation	Samer Yammine	TE-EPC	samer.yammine@cern.ch
Members			HI-LUMI-LHC-WP1.WG-MCF-MEMBERS@cern.ch
Info List			HI-LUMI-LHC-WP1.WG-MCF-FOR_INFO@cern.ch

Links

- HL-LHC Circuit Instrumentation Review (01 Septmber 2020)
- International Review of HL-LHC Magnet Circuits (09-10 September 2019)
- HL-LHC Magnet Circuits Internal Review (17 March 2017)
- Conceptual Design Review of the Magnet Circuits for the HL-LHC (21-23 March 2016)



HL-LHC Magnet Circuits Forum

Create event

September 2020

- 29 Sep HL-MCF Meeting # 71: Report from Instrumentation Review + Detailed MQXF IFS Pin-out + New Count of IFS Boxes Pins for HL-LHC + AOB: Current Lead Assignment Document NEW
- 22 Sep HL-MCF Meeting # 70: DEMO-2 Results and Powering Test Plan + AOB: Update on HL-LHC Circuit Currents
- 08 Sep HL-MCF Meeting # 69: Electrical Connection of the Quench Heater Strips for the 11T MBH + IT Circuit Polarities

July 2020

- 21 Jul HL-MCF Meeting # 68: Temperature Profile in UR Galleries + AOB: 11T Connection and Integration in QPS
- 07 Jul HL-MCF Meeting # 67: IFS for MQXF + AOB: Naming Convention for sc bus bars and cables + AOB: Circuit Discharges

June 2020

- 23 Jun HL-MCF Meeting # 66: Decision of the MQXF QH position + AOB: List of Future MCF Topics and Actions
- 09 Jun HL-MCF Meeting # 65: New Integration Layout in the UR Galleries + AOB: New Circuits Table (with Updated Circuit Cabling and Resistances)

May 2020

- 26 May HL-MCF Meeting # 64: Status Report on Instrumentation of the HL-LHC Superconducting Systems + AOB: New Circuits Table and Layout (following ECR on EES for RCBX Circuits)
- 12 May HL-MCF Meeting # 63: HL-LHC Circuit Polarities + HL-LHC Superconducting Bus Bars

April 2020

- 28 Apr HL-MCF Meeting # 62: 11T MBH Project Status, Quench Detection, PIC, Cabling, EIQA Tests and DQHDS Parameters
- 14 Apr HL-MCF Meeting # 61: Quench Protection of the HL-LHC 120 A Circuits

March 2020

- 31 Mar HL-MCF Meeting # 60: CLIQ and K-mod Feeders Prototype and Integration + Proposal of Distribution of Circuits in the DFHX + QDS for 120A Correctors + AOB: Requirements for RCBX Circuits in Orbit Feedback + AOB: Modification of MCBXF EE Resistance
- 03 Mar HL-MCF Meeting # 59: ECR of ESS for the HL-LHC RCBX Circuits + New Quench Heaters Circuit Parameters for the 11T MBH + Aspects of Magnet Powering and Protection in SM18 Test Benches + AOB: 11T Quech Simulations Update

February 2020

- 18 Feb HL-MCF Meeting # 58: Update on the RCBRD Protection Studies and Circuit Layout + Latest Figures from Quench Simulations for the IT Circuit
- 04 Feb HL-MCF Meeting # 57: Current in the MBH Quench Heaters + Verification of Circuit Polarity of the 11T MBH + Voltage Withstand Level Requirements for Warm Cables

Thank you to the participants and collaborators of the MCF for all their efforts

Thank you for your attention